Diabetes knowledge levels and the learning journeys of health volunteers in Thailand: An explanatory sequential mixed methods study

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Abstract

Diabetes is a non-communicable disease that requires continuous care and a knowledgeable healthcare workforce. The prevalence of diabetes has increased and is known to affect both the quality of life and finances of patients in countries without universal healthcare provision. Thailand is a developing country and has experienced the health care shortage for many years. In contrast, the number of people who need the health service is increasing day by day. It is challenging for the country to manage their population health within the limited budget and availability of the healthcare staff. For many decades, the HVs have been recognised and involved in several community health projects in Thailand. Employing HVs to work in the community is seen as a means of increasing service provision without increasing expenditure. Currently it is approximately one million HVs are active in Thailand. A HV is a lay person who is recruited by the community. The HV received the trainings from the healthcare staff, then delivered multiple health services for the community. They were also assigned to take care of 10-15 households in their community. As the HV is a voluntary job the HV is not required to work full time. The HV works only once a week or four times a month. Initially the HV was not given the monetary incentive; however, currently the HV earned monthly compensation from the government for doing service every month. In Thailand, the Health Volunteer (HV) plays an important role in providing care for diabetic patients in the community. However, the knowledge levels and learning experience of this workforce are key to the provision of high-quality patient care. Yet little is known about these phenomena. This study employed an explanatory sequential mixed methods design to explore the HVs' knowledge of diabetes and their learning experiences. The study was undertaken in two phases. The first phase included amending, cross culturally adapting and translating, testing and administrating a diabetes knowledge questionnaire. This modified questionnaire was found to be valid (CVI=0.875-1) and reliable (KR= 0.830) and

was therefore administered to 390 HVs in Thailand. The results of the study enabled the researcher to identify those with differing knowledge levels, a factor that was included in the purposive sampling framework for the second phase of the study where 15 HVs participated in a semi-structured interview. The findings of the first phase highlighted that 73.3% of the HVs lacked knowledge of diabetes with greater knowledge being noted in the management of diabetes and lower knowledge recorded in areas focussed on the prevention of the disease. HVs who possessed high knowledge levels were likely to be motivated to learn whereas the converse was true in those with lower knowledge levels, underlining the importance of motivation to learning. Classroom training was the main learning resource available for the HVs. HVs who attended the training were likely to have higher knowledge levels compared to those who did not attend class; however, findings from the second phase of the study found that the training was not prioritised due to financial pressures and family commitments. Although the classroom lecture-based training was deemed to be beneficial for the HVs, the high number of classroom attendees and the didactic teaching methods presented a number of barriers to learning including, noise, peer pressure and unfavourable teaching methods. In addition, poor memory, limited prior knowledge and a perception of a theory-practice gap inhibited the HVs' effective learning. Although there were several online diabetes learning resources available, these were rarely accessed, the reason for which was unclear but may have been related to internet access.

Conclusion: The study findings indicate that the current diabetes knowledge of the HVs may not be enough to provide holistic care for the population they serve, as the HVs possess knowledge gaps in several areas. The study findings also highlight that the large class teaching, inadequate relevance to practice, competing priorities and limited focus on the prevention of the complications of diabetes, contributed to a lack of knowledge among the HVs. It is necessary to eliminate many of the barriers to learning that have been identified

in this thesis and reshape the educational provision to enable the HVs to play a more productive role in the management of people with diabetes in the local community.

Conference Presentations/Posters

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Abbreviations

AACE	The American Association of Clinical Endocrinologists
AC	Abstract conceptualization
ADA	American Diabetes Association
AE	Active experimentation
AGEs	Advanced glycation end products
ASCVD	Atherosclerotic cardiovascular disease
A1C or HbA1c	Glycated haemoglobin
A 7-dFR	A 7-day food record
BKQ	The Body Knowledge Questionnaire
BMI	Body Mass Index
CDA	Canadian Diabetes Association
CE	Concrete experience
CHD	Coronary Heart Disease
CHW	Community Health Workers
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CKD	Chronic Kidney Disease
CLT	Constructivism learning theory
CVD	Cardiovascular disease

CVI	Content validity index
DBKT	Diabetes Basic Knowledge Test
DBP	Diastolic blood pressure
DD	Double Diabetes
DKA	Diabetic Ketoacidosis
DKN	The Diabetes Knowledge Assessment
DKQ	Diabetes Knowledge Questionnaire
DKT	The Diabetes Knowledge Test
DNT	The Diabetes Numeracy Test
DPN	Diabetic Polyneuropathy
DR	Diabetic Retinopathy
DSMQ	Diabetes Self-Management Questionnaire
eGFR	Estimated glomerular filtration rate
ELT	Experiential learning theory
EM	Extrinsic motivation
FBS	Fasting blood sugar
FFQ	A food frequency questionnaire
FPG	Fasting plasma glucose
GBP	Great British Pound
GDM	Gestational Diabetes Mellitus

GDP	Gross Domestic Product
GFR	Glomerular filtration rate
GPs	General Practitioners
g/day	Grams per day
HA	A severe hypoglycaemic event requiring any assistance
HDFQ	The Heart Disease Fact Questionnaire
HDL	High density lipoprotein
HHS	Hyperosmolar hyperglycaemic state
HMA	A severe hypoglycaemia requiring medical assistance
HRQoL	Health-related quality of life
HVs	Health Volunteers
Hz	Hertz
I-CVI	Item -Level Content Validity Index
IDF	International Diabetes Federation
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
IM	Intrinsic motivation
Kcal	Kilocalories
kg/m^2	Kilogram-Meter Squared
KR	Kuder–Richardson Formula

LBP	Low back pain
LCD	Low carbohydrate diet
LDL	Low density lipoprotein
MDBKT	The Modified Diabetes Basic Knowledge Test
MDRC	The Michigan Diabetes Research Training Center
MEDLINE	Medical Literature Analysis and Retrieval System Online
MfM	Mobile for Mother
mg/dL	Milligrams per decilitre
mHealth	Mobile Health
MI	Myocardial infarction
mmHg	Millimetres of mercury
mmol/L	Millimoles per litre
NICE	National Institute for Health and Care Excellence
NPDR	Non-proliferative diabetic retinopathy
OGTT	The oral glucose tolerance test
PA	Physical Activity
PAD	Peripheral arterial disease
PDR	Proliferative diabetic retinopathy
PIS	Participant information sheet
PNs	Practice nurses

RCT	Randomised control trials
RO	Reflective observation
RPG	Random Plasma Glucose
SBP	Systolic blood pressure
SCT	Social cognitive learning theory
S-CVI	Scale – Level Content Validity Index
S-CVI/Ave	Scale Level Content Validity Index/average
S-CVI/UA	Scale Level Content Validity Index/Universal Agreement
SGLT-2 Inhibitors	Sodium-Glucose Co- Transporter 2 Inhibitor
SKILLD	The Spoken Knowledge in Low Literacy patients with Diabetes
SMBG	Self-monitoring of blood glucose
TA	Thematic analysis
TC	Total cholesterol
TDQ	The Diabetes Questionnaire
TL	Transformative learning theory
TNRR	Thai National Research Repository
T1D	Type 1 Diabetes
T2D	Type 2 Diabetes
UAE	United Arab Emirates
UHC	Universal Health Coverage

UK	United Kingdom
U/mL	Units per millilitre
USA	United States of America
vWF	von Willebrand factor
WHO	World Health Organization

Chapter 1 Background to Thailand

1.1 Thailand profile

Thailand is a developing country, located in the centre of Southeast Asia (Ministry of Public Health, 2011; National Statistical Office, 2019). The country is approximately 513,120 square kilometres (National Statistical Office, 2019) and has a population of nearly 70 million people (The World Bank, 2019), making it the third biggest country in Southeast Asia (Minister of Public Health, 2011).

Thailand is surrounded by four countries; Burma (Myanmar) and Laos to the North, Laos and Cambodia, to the East and Malaysia to the South (Minister of Public Health, 2011; National Statistical Office, 2019). The country is divided into six regions and 77 provinces. The regions are—the north, the northeast (also known as Isan), the centre, the south (southern peninsula), the east region and the west region. Thailand's climate is tropical (Minister of Public Health, 2011; National Statistical Office, 2019), comprising of three main seasons, summer, rainy and winter (National Statistical Office, 2019).

Ninety three percent of the Thai population are Buddhist (National Statistical Office, 2019) with almost every settlement possessing at least one temple-monastery (wat), for religious activities. However, other religions are also practised, as Thais are able to worship with religious freedom. Around five percent of Thais identify as Muslim (The National Statistical Office, 2019) with the remaining two percent of the population practising Christianity or other religions (National Statistical Office, 2019).

Education

Thailand has both a formal and informal education system (Ministry of Education Thailand, 2016; National Statistical Office, 2019). Currently, Thai children are provided with access to 12-years of free education, nine years of which is compulsory. This includes kindergarten, primary school, and lower secondary school (National Statistical Office, 2019). After lower secondary school, children can decide whether to attend upper secondary school, college or military police institutes (Ministry of Education Thailand, 2016; National Statistical Office, 2019).

Language

The official language of Thailand is Standard Thai (Minister of Public Health, 2011; National Statistical Office, 2019). However, outside the central parts of Thailand local languages are spoken which, are often sharply different from Standard Thai. Nevertheless, as Standard Thai is taught in schools and is used in most of the country's print media, nearly all Thais are able to communicate using Standard Thai.

Political

Thailand was established around the 14th century and was known as Siam until 1939. Thailand is the only country in Southeast Asia never to have been colonised by Western Imperial powers (Library of Congress, 2007). Independent Siam was ruled by an absolute monarchy until a revolution in 1932. Currently, Thailand has a constitutional monarchy and a Prime Minister who is the leader of the government (National Statistical Office, 2019).

Population

The number of people in Thailand aged over 60 years has increased by six percent within only two decades. A combination of the labour control policy (Minister of Public Health, 2011) and increased life expectancy have contributed to Thailand's increased prevalence of older people (Hsu et al., 2015). Whilst increased life expectancy is welcomed, it does present a number of new challenges. The increased need for long-term care for people with often complex chronic long-term disease and associated disability, frailty, and dependency (Minister of Public Health, 2011; Sasiwongsaroj and Burasit, 2019) is costly and logistically difficult to manage. In addition, these additional needs pose a challenge for the country's capacity to provide healthcare professionals that are adequately prepared to care for these populations (Harper, 2014).

Economy

To meet the financial costs associated with an ageing population it is imperative that a country's economy is robust. Until the early 1990s Thailand was one of the largest growing economies in the world (Sachayansrisakul, 2012). However, in 1997 an Asian financial crisis often called the 'Tom Yum Kung financial crisis' (Wonglimpiyarat and Tripipatkul, 2017) spread throughout the world. The effect on Thailand was profound. The Thai Baht lost half its value and the government were forced to adopt a floating exchange rate system causing further unrest and limiting the funds available to support healthcare.

Currently, Thailand is a mixed type economy based on agriculture, industry, tourism, natural resources and the service sector (National Statistical Office, 2019). Rubber is the country's primary export; however, Thailand also exports other crops such as rice and vegetables (National Statistical Office, 2019). In addition, Thailand generates substantial wealth from tourism due to the many tourist attractions and excellent hospitality (National Statistical

Office, 2019). The tourism economic review in 2019, estimated that tourism contributed 23 million pounds to the Thai economy in the first six months of the year. The Gross Domestic Product (GDP) of the country in 2018 was estimated as 504.99 billion US Dollars, equal to 0.81 percent of the world economy (Trading economic, 2019).

Nearly half of employees in Thailand are employed within in the service sector, approximately 33 percent in the agricultural sector and 22.56 percent in industry (Statista, 2019). However, with an increasing ageing population this is expected to reduce over the coming years (Otsu and Shibayama, 2016)

Figure 1 Thailand map

Source: Wikipedia

1.2 Thailand's Healthcare system

As discussed previously, Thailand is becoming an ageing society (Pagaiya and Noree, 2009; Haque et al., 2016), which is likely to increase the need for healthcare provision and reduce the labour market. It is therefore necessary to describe the makeup of the current healthcare system in Thailand and explore how the government has responded to this demographic shift.

The Thai health system is financed form a combination of sources; including general taxes, social insurance contributions, private insurance premiums and direct out of pocket payments (World Health Organization (WHO), 2017). The government provides the main source of public expenditure on health (Wibulpolprasert et al., 2011). Hence, like many state-funded health systems its budget is reliant on the country's economy. This became a stark reality following the 1997 financial crisis when health spending was reduced significantly (WHO, 2017). Consequently, new models of care that were less costly were sought.

The Health Service in Thailand can be divided across 5 levels: self-care, primary health care, primary care, secondary care and tertiary care (Keiwkarnka, 2014).

Self-care is focused on enhancing people's capacity to look after themselves and make informed decisions regarding their health, including health promotion, self-management and rehabilitation (Keiwkarnka, 2014). The second level of care, Primary health care encompasses the provision of services which are delivered by the village health volunteer and other private volunteers working alongside professional health workers (Keiwkarnka, 2014). They include health promotion, disease prevention, health care and rehabilitation. Primary care, the third level of care is a more medicalised level of care normally delivered by qualified health care professionals within a health centre (Keiwkarnka, 2014). The fourth level of care is termed secondary care and tends to encompass all hospital level care,

regardless of whether this care is delivered in a community hospital, regional hospital or private hospital. Lastly, tertiary care describes any specialist type of care that is delivered in a general hospital, regional hospital, university hospital or large private hospital (Keiwkarnka, 2014).

Thailand's health service is managed primarily by the Ministry of Public Health (MOPH) with some authority for delivery devolved to other administrations (Woratanarat et al., 2017). Around two-thirds of hospitals are managed by the MOPH, while other public hospitals such as medical school hospitals are under the Ministry of University and the rest are under the Ministry of Interior and the Ministry of Defence (International Labour Organization, 2015).

The public sector healthcare structure is classified from provincial to village and family level as outlined in table 1 below.

Table 1 The public sector healthcare structure

Provincial	Regional and specialist hospitals providing health service to 300,000-1,000,000. (International Labour Organization, 2015).
District level	Community hospital covering a population of around 20,000-100,000. The main health providers are general practitioners
Primary Care	Health Centres including health workers and technical nurses +/- Physicians
Primary Health Care	Health Volunteers
Village and family	Focusses on self-care

The Public Health insurance system in Thailand consists of the Civil Servants Medical Benefits Scheme, Social Health Insurance Scheme and Universal Health Coverage Scheme (UHC) (Woratanarat et al., 2017; Sumriddetchkajorn et al., 2019). UHC is the largest scheme covering around 49 million people (Woratanarat et al., 2017). The Social Health Insurance Scheme covers around 14 million people (Woratanarat et al., 2017). Finally, around 5 million people, government employees and their dependents, are included in the Civil Servants Medical Benefits Scheme (Tangcharoensathien et al., 2010; Woratanarat et al., 2017).

As mentioned previously, the largest portion of the health protection scheme is provided by UHC. The Thai Government introduced the UHC in 2002 in a desire to increase access to health for people from all areas of Thailand and reduce unaffordable health costs (World Health Organization, 2017). In line with the other countries who have adopted such a scheme, there was a vision to extend healthcare access for everyone, based on health needs rather than the ability to pay for the service (Agustina et al., 2019; Aregbeshola, 2018). Patients in this scheme can obtain health services from registered health facilities classified as primary, secondary and tertiary medical care units. However, the primary medical care unit is the first contact point for all beneficiaries. The three medical care unit levels are connected through a referral system, the patients are referred for specialist care based on their conditions and hospital capacity (Department of medical service, 2014). Except in emergency cases, patients are not allowed to progress to secondary or tertiary medical care units without referral from the primary medical care unit. Although there are several public hospitals in Thailand, people have limited access to the service due to the high volume of customers in public hospitals (Thungthong et al., 2017).

However, some have raised concerns that the wholesale introduction of UHC has seen a rapid increase in the scale of care, which may have negatively affected the quality of care

(Bloom et al, 2018). Examples provided include medical error, infection control and mistreatment (Bloom et al, 2018). In addition, some have questioned the sustainability of such a scheme in low and middle-income countries. Whilst the introduction of the UHC provides health insurance for over 75% of the population (WHO, 2017) managing the long-term costs that are met through general taxation is challenging (Wibulpolprasert et al., 2011; Tangcharoensathien et al., 2018; Agustina et al., 2019; Sumriddetchkajorn et al., 2019,). This challenge is only likely to become more difficult as the population ages and the income from taxation decreases (Wibulpolprasert et al., 2011; Tangcharoensathien et al., 2018). The resource requirement is increasing and is expected to increase year on year (International Labour Office, 2016). In contrast, the healthcare expenditure per capita rate as approved by the government tends to be lower than the amount requested by the healthcare facility (International Labour Office, 2016; Reutrakul and Deerochanawong, 2016). Although the health budget per capita has increased over the last decade increasing from 1,202 to 2,693 Baht (32 to 72 GBP) (International Labour Office, 2016) increased labour and material costs has resulted in much of this additional income being lost (International Labour Office, 2016). Consequently, each hospital must tightly manage their budgets (Sumriddetchkajorn et al., 2019) exploring cost reduction and income generation. Indeed, several hospitals in Thailand currently rely on donations from the private sector and charities to maintain their infrastructure (Sumriddetchkajorn et al., 2019). In 2017, medical equipment for 11 hospitals was funded by a fundraising campaign involving running 55 days cross country (Sumriddetchkajorn et al., 2019).

The private sector provides the final means in which the people of Thailand can access healthcare. During the economic expansion from 1992-1997, the government launched a policy to promote private hospitals by allowing tax incentives to invest in such facilities. The number of private hospitals increased exponentially with 491 private hospitals being

available by 1997. However, most of these hospitals are located in central Thailand (National Statistical Office of Thailand, 2018), including Bangkok and more urban areas (International Labour Organization, 2015). Unfortunately, the economic crisis that beset Thailand led to financial issues in all private sectors. The change in foreign loans and interest rates caused an increase in the cost of medical supplies and a reduction in customers, hence in 2004, only 60% of these hospitals remained (International Labour Organization, 2015) so the Thai government launched a project to become the centre of the medical hub of the region. This project was driven mostly by private hospitals. (Nooseisai et al, 2016).

This medical hub led to an increase in medical tourism with around 4 million international tourists visiting Thailand for medical services in 2017 and earning the country nearly 3 trillion Baht (65 billion pounds), which equals 38% of the market share of the Asian medical service hub (Pattharapinyophong, 2019). However, the consequence of this project led to an increase in the internal brain drain from public to private hospitals and an increase in healthcare inequality (Nooseisai et al., 2016). The healthcare workforce shortage has been reported in Thailand for many years, however, the rise in the number of private hospitals in Thailand to serve medical tourism caused a high demand for healthcare staff and many healthcare staff left the rural public hospitals to work in the urban private hospitals where salaries and benefits were greater. Consequently, the public sector was placed under increased pressure.

The second issue was the increase in the cost of private healthcare. As many private hospitals were built to serve medical tourists, they provided a service similar to a hotel with high quality meals, furniture, decoration, tools, technology and personal care for the customers. This resulted in the cost of care increasing substantially with many from the local market unable to afford this expensive service. The increase in the cost of the private hospital care in Thailand widened the access gap, especially for those with low income. The majority of

Thais who live with a chronic disease and receive a low-income, were likely to use the basic health service (Namjaidee, 2014). Only those with a high income can afford to use the services of private hospitals (Namjaidee, 2014). Finally, there is an infrastructure gap between private and public hospitals. The private sector provides an alternative to public hospitals for Thais, as it is convenient and saves time. However, the people benefiting from this sector are limited to those with a high income who can afford the price, those who do not require complicated or continuous care and those living in urban areas. Therefore, public hospitals are still needed and play a key role in providing a health service, especially for those living with chronic disease, low income and living in the countryside. However, it is challenging for the public hospitals to provide health service for the patients with the limited resources.

In summary, Thailand is a progressive country that recognises the health needs of its population and whilst the introduction of the UHC has provided increased access to healthcare, it is not without its challenges. The Thai economy is fundamental to the continued availability of care that is free at the point of delivery. However, with an ageing population that is likely to generate increased health demand and yet lower income from taxation, alternative models of healthcare are needed.

This thesis aimed to assess the HVs' knowledge of diabetes and their learning experiences. The thesis involves two phases; a quantitative phase followed by a qualitative phase. The aim of phase 1 of the study was to assess the HVs' knowledge of diabetes, using the HVs diabetic-knowledge questionnaire. While the aim of phase two of the study was to explore the HVs' experience of learning regarding diabetes. The thesis was presented in ten chapters which were shown as follows: 1) background to Thailand 2) the healthcare workforce 3) diabetes 4) learning theory 5) research paradigms and methodology 6) identification and critical appraisal of existing diabetic knowledge questionnaires 7) quantitative study 8)

qualitative study 9) integrated findings and discussion and 10) recommendation and conclusion.

In this first section of the thesis, I have provided an overview of Thailand, the country in which the study was undertaken. This has included an exploration of its history, economy, demography, geography and its health infrastructure. By doing so, I have highlighted the challenge that many countries face when delivering universal healthcare; that is, attempting to provide high quality care for an ageing society with limited financial resources. However, Thailand's topography increases these challenges with large numbers of the population living in rural areas with limited access to formal healthcare. Consequently, alternative models of care are needed. The Health Volunteer is one such model that promotes the importance of locally delivered lay care, the merits of which are reduced healthcare costs and access to a form of health care in local communities. However, despite these perceived merits little is known about the preparation of such volunteers working within these communities. Later in the thesis, I will explore the knowledge base and educational preparation of these personnel within a finite patient group, namely diabetes. In the next section I will provide an overview of diabetes and the risks that it poses. I will then discuss how the health volunteer role has developed to support people with diabetes and subsequently I will explore the knowledge base of the volunteers.

Chapter 2 The Healthcare Workforce

2.1 Health care in Thailand

This section of the thesis will describe the nature of the healthcare workforce in Thailand, exploring how this affects the way that care is delivered and the role that Health Volunteers (HVs) play in diabetes care. Whilst Thailand is a progressive country, the number of qualified healthcare professionals per capita is well below the global average. However, this problem is not new (Pagaiya and Noree, 2009) and is believed to have been caused by a combination of an outward migration of healthcare professionals to America and England (Woratanarat et al., 2017), known as the external brain drain and an efflux of staff from state to private hospitals, known as the internal brain drain (Pagaiya and Noree, 2009).

According to Khunthar (2014), the number of nurses in Thailand is insufficient to support the needs of the population. The ratio of nurse per population in Thailand between 2010-2020 was noted to be just 1: 400. However, in addition, only 130,388 of the total number of nurses in Thailand were under 60 years of age despite a projection of 165,300 nurses needed to care for the 65.4 million Thais. These findings are supported by a wider health workforce review (nurse, dentists, and physicians) by Jithitikulchai (2020). Jithitikulchai reported that in September 2019, around four fifths of hospitals were functioning with fewer recommended numbers of nurses' dentists and physicians. These shortages related to 16,000 nurses, 3,400 doctors, and 1,000 dentists. It was also noted that shortages were especially prevalent in sub-district hospitals. When comparing figures to other healthcare systems, it is clear that the ratio of nurses and physicians per 1000 people in Thailand is substantially lower than the world average. According to the world bank (2021), Thailand had only 0.8 medical doctors per 1000 people, while the UK had approximately 2.8 medical doctors per 1000 people and the world average was 1.6 per 1000. Similarly, the ratio of nurses in

Thailand was reported as only 2.8 nurses per 1000 people compared to the UK who reported 8.2 per 1000 people and the world average of 3.8 per 1000.

In addition, Government policies, such as the promotion of Universal Health Coverage (UHC) and the Medical Hub of Asia whilst likely to increase healthcare access for millions of people has resulted in the need for a larger nursing workforce at a time where the emigration of nurses is high. Moreover, the introduction of the Medical Hub of Asia resulted in an increase in the number of private hospitals in Thailand with many nurses choosing to move from the public to the private sector. Furthermore, Jaikong et al (2020) noted that an increased number of nurses in Thailand are retiring from their roles early and the numbers of nurses entering the profession is diminishing because of the Government's decision to cancel nursing scholarships.

These numerous factors have resulted in a dramatic shortage of qualified nurses and medical Doctors in Thailand at a time when the expectation of access to universal healthcare is increasing.

Accordingly, the Thai government, introduced a number of initiatives in an attempt to ameliorate the effects of the shortage of healthcare workers. Medical School scholarships were introduced to attract medical students from rural areas who, it was hoped would then return to work in their hometown (Woratanarat et al., 2017). The initiatives were a short-term success reducing the migration rates of physicians (Woratanarat et al., 2017). Nevertheless, in the long term, only half of the physicians remained working in rural areas (Pagaiya et al., 2015) leaving rural residents with limited access to professional healthcare. The government launched a similar campaign for nurses studying in their local nursing institute with a goal of retaining nurses in their local communities. However, support for this

project was short-lived and was cancelled due to the national financial problems (Srisuphan and Sawaengdee, 2012).

In an attempt to ameliorate these gaps in healthcare provision, the Fourth National Economic and Social Development Plan (1977-1981) recommended the introduction of a Health Volunteer or Health Advocator in each village (Office of the National Economic and Social Development Board, 1977). This approach was seen as a means of increasing service provision without increasing expenditure (Reutrakul and Deerochanawong, 2016). In 2017, over one million HVs were providing care in Thailand (Primary Health Care Division, 2017) at a ratio of approximately 1 Health Volunteer per 10-15 households (Department of Health Service Support, 2011).

The solutions for the global and Thailand healthcare workers shortage

Task shifting has been promoted as a means of addressing the healthcare workforce shortage (Aithal and Jha, 2017). The concept of task shifting involves shifting a task that was previously performed by one group of healthcare professionals to a less experienced group of staff (Deller et al., 2015). Task shifting has been reported in several countries, as tasks were moved from higher to lower cadre of health staff, and even to lay people (Deller et al., 2015; Aithal and Jha, 2017). For example, in Thailand and Ghana, the cervical cancer screening programme was shifted from physician to nurses. While in Zambia and Mozambique, HIV counselling was shifted from the nurses and midwives to the community health workers (Deller et al., 2015). Some positive outcomes associated with task shifting task include oral cancer (India and Sri Lanka), cervical cancer (India), Epilepsy (Kenya, Ethiopia, Cameroon), mental health (Tanzania, Pakistan, Zimbabwe, India and China), hypertension and diabetes (Cameroon) (Joshi et al 2014). Furthermore, the positive outcome of task shifting on health system were shown in a study by Zachariah and colleagues (2009),

they reported that task shifting increased access to treatment, geographical coverage and improved survival. In addition, they highlighted that task shifting optimised workforce skill and engaged the community. However, task shifting also posed some limitations such as institutional resistance, sustainability of motivation and continuation of quality (Zachariah et al., 2009). Role redundancy and patient safety concerns underpin many of these concerns (Joshi et al, 2014). For example, Mullan and Frehywot (2007) found that the scaling up of non-physician clinicians (NPC) increased concern of redundancy of care and resulted in competition between the physicians and the nurses. However, NPC included in Mullan and Frehywot's study were different compared to the community health worker in other studies. Although many of NPC were recruited from the countryside and poor areas, they had a different scope of practice such as undertaking caesarean section and anaesthesia, and their clinical skills were more advanced when compared to nurses but fewer than physicians. Most Thai HVs have lower educational levels than nurses and they are not trained to perform any kind of surgery including minor surgery or caesarean section.

Although the evidence showed that employing task shifting is cost effective, its obstacles such as the staff retention and equipment insufficiency have also been reported (Joshi et al, 2014).

Prior to the last decade many community-based tasks such as malaria management, malnutrition, diarrhea, pneumonia as well as maternal and child health were all carried out by nurses but more recently these tasks have been shifted to CHW (Bennett et al., 2014; Chilundo et al., 2015). The benefits of this shift were highlighted in paediatric HIV care by Naburi and colleagues (2017) who found reductions in nursing workload and cost reduction. Conversely, some limitations were reported by Sevene et al (2021) Although Sevene and colleague (2021) found that it was possible to share tasks associated with initial screening and pre referring management of pre-eclampsia to the CHW, barriers were also highlighted

including lack of tool (equipment), human resources (supervisor), and transportation. Therefore, it is essential to remove these barriers and minimize the stakeholder's perceptions of the CHW's inability to undertake complicated tasks.

Task shifting from qualified health professionals to the CHW has been proven to be effective in hypertension management in several studies in low- and middle-income countries (Kar et al., 2008; Joshi et al., 2012; Gaziano et al., 2015; Mendoza Montano et al., 2015). The CHW took responsibility for monitoring the patient's blood pressure (He et al., 2017; Neupane et al., 2018), assist the nurse to organize care, such as booking appointments for the patient (Goudge et al., 2018), and following up the patient's blood pressure (Kar et al., 2008; Mendoza Montano et al., 2015; He et al., 2017; Neupane et al., 2018). They also referred the patient to a health care facility for anti-hypertensive drugs (Tian et al., 2015; Neupane et al., 2018). The success is not only limited to hypertension, but also diabetes (Joshi et al., 2014). A systematic review by Joshi and colleagues (2014) reported that training non physician healthcare workers (NPHW) in hypertension and diabetes management resulted in patients with hypertension and diabetes recording improved blood pressure and blood sugar levels. Furthermore, a study in India by Deo and Singh (2021) investigated the possibility of using lay people (CHW) with minimal training to screen and manage NCDs in locations where nurses or others health workers were in short supply. The authors reported improvements in the patients' blood sugar and blood pressure control. However, comparisons with Thailand are difficult to make. Deo and colleague's (2021) study was conducted with CHW who work in the private sectors in urban areas and all respondents were female with high school educational levels. In addition, they worked 4-5 hours a day and obtained fixed salary. While the HVs in Thailand are by definition volunteers, working at a primary care level in the public sector, consisting of mixed gender with a variety of educational backgrounds and are only required to work one day a week, or four times a month.

The HVs have worked as a key part of Thailand's primary health care for several years. This was never more evidenced than during covid 19 outbreak. The HVs provided advice for community residents about the covid 19 prevention, symptom and self-observation. They also distributed health flyers, face masks and alcohol gel to those people in their locality (WHO, 2020). In addition, the HVs worked closely with the healthcare personal undertaking surveillance and monitoring the close contact of those with covid 19.

2.2 The Health Volunteer

A Health Volunteer is the name given to a community health worker in Thailand. Globally, these roles attract different titles, which include community health agents, community health promoters, community health representatives or community health volunteers (Gilroy and Winch, 2006). The WHO Study Group (WHO, 1989) stated, "community health workers should be members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should be supported by the health system but not necessarily a part of its organisation, and have shorter training than professional workers". The benefit of locally based staff has been highlighted in two studies. In the first, Castillo et al. (2010) indicated that local people are more motivated to become involved in local community projects than in regional or national ones. A second study by Daivadanam et al. (2013) found that success rates in healthcare projects are higher if local people are actively involved in them.

The Thai HVs context

Thailand has around one million HVs (Primary Health Care Division, 2019). These volunteers tend to be female (75%) and mature in age with 90% being over 40 years of age (Primary Health Care division, 2019). The workforce is not highly educated with almost two thirds (59%) of HVs possessing only primary school level education, while less than 3%

possess a bachelor's degree or higher. Due to the voluntary nature of the role many HVs are employed in paid positions elsewhere. Approximately 63% of the HVs work in the agricultural sector, 20% are freelance, 8% are unemployed, 7% have their own business and fewer than 1 percent are pensioners (Primary Health Care division, 2019). With 90% of HVs in employment it is likely that the HV role which is described below is not prioritized and undertaken when their other commitments allow.

HVs provide health screening and monitoring, basic health care, promote healthy lifestyles, distribute prescribed drugs and coordinate the activity of health professionals (Woratanarat et al., 2017). They are responsible for a common set of community health issues such as dengue fever, maternal and child health, depression and non-communicable diseases such as diabetes, hypertension and cancer (Department of Health Service Support, 2011; Kowitt et al., 2015). They are also responsible for improving the area context-specific concern (Kowitt et al., 2015; Boonpleng et al., 2020) such as tobacco cessation.

HVs work within a multidisciplinary team including doctors, nurses and public health staff (Ontha et al., 2016; Jukchai et al., 2017; Chavitranurak, and Jewjinda, 2020). They prepare information about patients and coordinate, and support community health care staff (Department of Health Service Support, 2011; Kasemsuk and Koshakri, 2015; Jukchai et al., 2017) to undertake home visits, to monitor care, prepare reports, and refer high-risk patients to the healthcare centre (Primary Health Care Division, Ministry of Public Health, 2011; Jukchai et al., 2017).

The Health Volunteer role has been evaluated in different populations across a number of low and middle-income countries and whilst the findings should be considered cautiously due to the differing models of care studied, they are mainly positive. Mock and colleagues (2007) reported that Health Volunteers are able to support women to acquire cervical

screening. Similarly, Linn et al (2018) found that Health Volunteers in Myanmar provided effective malaria care. While in high-income countries, such as Australia (Javanparast et al, 2018) and UK (Malby et al., 2017), the health volunteers are able to effectively provide a range of care services. These services include the provision of chronic care, improving access to healthcare for people from disadvantaged groups (Malby et al., 2017; Javanparast et al, 2018), reducing malnutrition rates, improving maternal and child health and the prevention and management of HIV and AIDS (Perry et al., 2014). Moreover, employment of Health Volunteers has been found to increase the time for qualified staff to concentrate on higher order clinical tasks (Malby et al., 2017). However, in America the role has not been fully accepted by qualified health professionals, possibly due to lack of role clarity (Payne et al., 2017). Javanparast and colleague (2018) review literature on CHW programme in Australia and conduct telephone interviews with 11 stakeholders to examine the value of the CHWs in Australia and the challenge of involving the CHW into the health system, reported that the CHWs in Australia were valuable as they bridged trust between service and community, and they enhanced equality of access to the health service especially the disadvantage group. For example, the evidences showed that the Aboriginal health worker (AHW) in Australia overcomes the language and culture barriers to contribute the access to health service. However, there were no national or standardized for the CHW training course in Australia. The CHWs were not required to register and attended the formal training, but in some cases, the CHWs were required at least post-secondary educational levels based on their employer (Javanparast et al, 2018). The lack of qualification and unclear scope of the role of the CHW caused the issue between the health providers, as the CHW were perceived as the role competitor by other health providers (Javanparast et al, 2018). In addition, the funding constraints which affect the staff sustainability and the lack of trust in the health system due to the short-term project were also found in the CHW of Javanparast's study.

However, the limitation should be highlighted as the scope of Javanparast (2018)'s study limited only the literature published after 2005 and stakeholder's perception on the CHW, it did not include the community or client's perspective on the CHWs. In the UK, Malby and colleague (2017), reviewed the evidences on the effectiveness and impact of volunteers in the NHS and reported that volunteering can mainly be classified into formal and informal. In 2014/15, over 14 million people formally volunteering at least one time per month (Malby et al., 2017). While the type of volunteering was varying, some people contribute skill and labour to earn time credit and some group share information and support to people who have similar health issues in different settings including community base, hospitals, home care and schools (Malby et al., 2017). Although, as above, the health volunteer in the UK were benefits and seem to engage numerous of health and care arena, Malby and colleague (2017) did not detail about the supervision and trainings of the volunteer regarding health and care. Therefore, it cannot compare the effectiveness of these volunteers with other health volunteer scheme in others studies in the low- and middle-income countries.

There was no consensus definition of volunteering, however, a study by Australia (2005) and a study of Angermann and Sittermann (2010) define volunteering as the type of activities performed in the non-profit sector and voluntary civic engagement without concern for financial gain. Similarly, the National Council for Voluntary Organisations (n,d) defines volunteering as "any activity that involves spending time, unpaid, doing something that aims to benefit the environment or someone (individuals or groups) other than, or in addition to, close relatives" so volunteers are likely to be unpaid. However, CHW is some countries such as Bangladesh (Schneider et al., 2008; Shankar et al., 2009; Mpembeni et al., 2015), receive payment as this is seen as key to the retention of the workforce (Owek et al., 2013). However, the HVs in Thailand do not receive a salary, they receive compensation paid by the government and healthcare welfare instead. Although, originally, the HVs did not receive

any financial incentive. Prior to 2021 when the data was collected, the HV received a monthly compensation payment (money paid by the government to support the HVs working in Thailand) of around 600 Baht, this amounts to circa £13 Great British Pound (GBP). This payment has recently increased to 1000 Baht approximately £22 GBP (Government Gazette 2021). However, Nurses in Thailand earn between 16,000 and 40,000 Baht per month dependent on their age and working experiences (Ruangrattanatrai and awaengdee 2019) and therefore employing HVs to work in the community is seen as a means of increasing service provision without increasing expenditure. Nevertheless, little is known about the knowledge levels of these HVs and the services that they provide or how this compares to qualified nurses.

To receive this compensation payment, the HVs must work at least one day a week, or four days per month undertaking the assigned activities. The HVs' leader and local health workers have a responsibility to check and confirm that the HVs remain active and work their allocated hours each month. In addition, the HVs must attend a monthly meeting and attend training sessions related to community problems. The compensation is either a direct transfer to the HV's personal bank account or paid in cash by the Ministry of Finance. If the HV has died during the process of paying compensation, the money will be transferred to the HVs' descendants.

Additional benefits for HV and family members include access to a private room and free food if admitted to hospital for those that hold over ten years' service. Those with fewer years of service receive a 50% discount on costs when admitted to public hospitals

In Bangladesh, 95% of the community health workers stated that receiving a financial incentive was a vital factor when considering their role (Rahman et al., 2010). However, job satisfaction, adequate supervision (Rahman et al., 2010; Greenspan et al., 2013),

a motivation to help people (Greenspan et al., 2013) and making new friends (Low et al., 2007) have also been found to be important.

Although the HV role has been adopted in several countries, differences in culture, social context, policy and is likely to results in a range of diverse roles, hence the researcher would like to provide the reader with information about the Thai HV role.

People can enrol to work as a health volunteer if they:

1. Are 18 years of age or older
2. Are the community resident or have lived at the current address for at least six months.
3. Are able to read and write
4. Voluntarily sacrifice their time to support public health operations
5. Committed to joining public health activities and want to develop their own community
6. Behave within the framework of good morals, gaining trust and praise from the community.
7. Have good health both physically and mentally, and have exemplary health behaviours
8. Have time to work in the role of the health volunteer

Registration as a HV.

The status of the HV is awarded when the person has been selected, passed the basic training and has been assessed on their knowledge and abilities in both basic and specific knowledge related to the needs of the community. Their own province will issue a certificate and identity card to be used as evidence of their role. The validity of the card and the rights granted are as prescribed by the Ministry of Public Health.

The training

Newly recruited health volunteers receive training to inform their attitudes and provide them with the knowledge needed to perform duties in accordance with established standards

1. Training methods

Health professionals can plan HV training according to the needs of the local population. The training is delivered at the health centre or community hospital and should include theoretical knowledge and practical training.

2. Course content: The content of the training is divided into two groups:

2.1 Fundamental knowledge (compulsory) consists of subjects that form the basis for working as a health volunteer. It is a course that deals with the main public health problems of the country and covers ways of prevention and management of common public health problems in the community, including:

1) Roles and duties of HVs.

2) Rights of HVs.

3) Knowledge transfer and dissemination of news at the village level

4) Finding, analysing and solving local public health problems

5) Personal hygiene

6) Health promotion, surveillance and prevention of public health problems

7) Diagnosis of symptoms and First Aid

8) Restoration

9) Referral of patients to public health facilities

10) Activities and use of tools in the Community primary health centre

11) Working with community leaders to improve local public health

2.2 Specific knowledge groups

Knowledge of public health problems that are highly prevalent in the local area. The province can update the course content as new health threats emerge. The content may vary depending on the health problem or condition and their related factors.

The HVs are taught about diabetes prevention, management and complications in their initial training (Primary Health Care Division, 2007; The Health Department, 2008).

The refresher courses

The purpose of the course was to refresh HV's essential knowledge and reduce the national health problems (Ministry of Health, 2010). The HV is refreshed on several topics, consisting of a one-hour training session about diabetes. The objective of the training about diabetes is to enhance the HV's capacity in diabetes care (screening, managing risk factors, giving advice and caring for the diabetic patient, and being led in the diabetic prevention campaign). The HVs learn about the definition of diabetes, risk factors, symptoms, and diabetic prevention (Ministry of Health, 2012). They also learn how to use the diabetic screening form, interpret the screening results and then refer the patients for further examination if detected any conditions (Ministry of Health, 2012). Furthermore, information about diabetic care such as dietary advice, exercise and foot care were included in this training (Ministry of Health, 2012). The content consists of general knowledge about diabetes (definition, cause, risk factors, diabetic sign and symptom, complications), screening technique, blood sugar test, screening interpretation and referring patients for advance examination. Taking care of the diabetic patients and giving advice about exercise, foot care and diet (e.g. avoid fat, salt, sweet food and alcohol), the patient should consume more fibre and low fat. In addition, the HVs advise and recall the patient to continue diabetic drugs and meet the doctor regularly. They were also educated on how to build community networks to monitor and prevent diabetes in the community. Although the knowledge

assessment was done before and after the session, the test items are not specific about diabetes, it includes other topics and the score criteria to pass the training has not been reported.

Blood Glucose Training course

The training course was established in collaboration with three main healthcare, organisations including the Ministry of Public Health, the Medical Council and the Medical Technology Council (Ministry of Health, 2013). The training aims to prevent and control diabetes in the community. The HVs training includes administration of blood sugar testing, interpretation and reporting of blood results (Ministry of Health, 2013). In addition, the HVs also learn how to screen for risk factors such as age, BMI, BP, family history of diabetes and symptoms of diabetes by using the approved screening tools (Ministry of Health, 2013).

Term and termination of the HV.

HV serve for a period of 4 years. At the end of the term, the HV's performance is reviewed. The Public Health official is part of the review process but cannot terminate the HV without input from other professionals. If necessary, meetings and consultations are conducted in a friendly manner with the existing HVs, including village Director to prevent potential conflicts.

2. Dissolution

1) death

2) resignation

3) being considered as an incompetent person or a quasi-incompetent person

4) The termination process is commenced if two/thirds of the households that are served by the HV requests dissolution. For example, if the HV was assigned to take care of 15 households and at least ten households requested dissolution, a report will be forwarded and

reviewed by the provincial health office committee and an investigation undertaken. The HV could then be discontinued if there is evidence of:

1. Has never participated in a health activity organized by the Ministry of Public Health or a government agency without reason or necessity.

2. Has detrimental behaviour that may lead to causing disgrace to the dignity of the organization

HV standard

The Ministry of Public Health has set standards for the competence of health volunteers in 2007 and is as follows:

1. Able to put policies into practice to develop and solve problems that are consistent with the area.

2. Be a leader in health promotion and disease prevention, primary medical care as well as health surveillance and screening

3. Able to build and manage a network in partnership to build health.

4. Able to campaign to drive the community to be alert and responsible for themselves, the community and the environment.

5. Be able to prepare and initiate new social measures that will have an effect on eliminating and reducing health problems

6. Able to build people's consciousness of health surveillance

7. Able to create opportunities for children and young people to participate in health and community development

According to the policy of the Ministry of Public Health (Proactive)

1. Proactive health care among mothers and children, the elderly, the disabled and the chronically ill in the community

2. Strengthening health and solving community health problems with the sub-district health plan together with various network partners in the community to reduce diabetes, high blood pressure, cancer, cardiovascular disease (CVD), paralysis and support the health promotion operation.

3. Check for iodine level in salt, fish sauce, seasoning sauces, and advise pregnant women to consume iodized salt.

2.3 Roles and duties of the HV.

The HV has a role to play in leading the health development programme and the quality of life of the people in the village/community acting as a change agent, and have a duty to combat bad news, spread the good news, point out services and coordinate public health activity. Act as a good role model with the following responsibilities:

1. Being a public health conduit between the health professionals and people in the village. Meet with members of the community who receive public health services. Provide public health information, such as the outbreak of a major communicable disease or local epidemic, as well as news and community activities. Make a note and record in the form of the HV's performance.

2. To provide advice and transfer knowledge into the community on various matters, such as the use of health services and drug use, immunisation, environmental sanitation and the provision of clean water, nutrition and food sanitation, prevention and control of communicable diseases, maternal and child health and family planning, care. Maintain oral health, mental health care and prevention and control of AIDS, prevention and control of

accidents. Providing essential medicines for use in the community and promoting the use of herbs and traditional Thai medicine.

3. To be a public health service provider, including patient referral and follow-up care for patients who have been referred from hospitals. Dissemination of condoms and contraceptive pills in cases that have been approved by the health professionals. Perform first aid based on conditions such as, wound dressing and basic immobilization.

4. Working in rotation at the health centre, with activities as follows:

- Establish a village information centre

-Transfer knowledge and organise activities according to community problems

- Provide essential services in 14 primary health care activities

5. Surveillance and prevent public health problems in villages such as monitoring nutrition problems by weighing children and co-solving problems. Surveillance and prevention of malnutrition and iodine deficiency in children. Surveillance of maternal and child health by following up with pregnant women. Monitoring vaccination uptake and watch out for communicable diseases endemic by eliminating mosquito breeding sites.

6. Be a leader in management, planning, problem solving and community development.

7. Be a leader in persuading neighbours to participate in community health development activities.

8. In collaboration with community leaders and sub-district levels, encourage planning and implementation of village health activity.

Primary health care work consists of a combination of services in four areas: disease prevention; health promotion, medical treatment and rehabilitation, which can be divided into tasks that people can do by themselves, which are known as the 14 elements. These are 14 elements.

1. Nutrition: The HV has a duty to encourage people to be aware of nutritional problems that arise, such as malnutrition in children 0-5 years old or low-weight new-borns by collaborating with village committees, leaders of housewives' groups in searching and surveying child health conditions. They are required to weigh every 0–5-year-old baby regularly and intervene if malnourishment is found. They are expected to educate mothers on how to feed their babies.

2. Health education work: The HV should provide health education in various matters such as local public health problems. Work with local people to solve these problems, disseminate knowledge about disease prevention and health promotion to people in villages or communities.

3. Provide basic medical care to villagers, inform the public about the ability of the HV to provide medical treatment as well as referring patients if they exceed the ability of the HV.

4. Providing medicines and medical supplies or procure necessary medicines for services in the Community Primary Health Centres.

5. The HV explains to the villager and community leader the importance of providing clean drinking water, building toilets, and disposing of solid waste, and keeping house clean.

6. HVs explain and motivate people to be aware of the importance of family planning. The need for prenatal care (antenatal care) and postnatal care. Make appointments for mothers to receive services and knowledge on how to behave, food, weight and blood pressure measurement. Make an appointment for children to get vaccinated against communicable diseases.

7. In the context of communicable disease control work, the HV informs people about the local health issues such as diarrheal diseases, parasitic diseases, dengue fever, which need to be prevented and treated in the control and prevention of epidemics.

8. The HV informs the public about the importance of vaccination against communicable diseases, and make an appointment for health professionals to provide services to people at various meeting points.

9. The HV clarifies and educates people on dental care. maintaining oral and dental health. They will make an appointment for villagers to receive services in a service facility.

10. The HV explains provides information about mental health promotion and support those who require mental health care

11.The HV shares knowledge about the importance environmental health. All people are vigilant to prevent any action that causes pollution. The HV works with community organisations with a plan to solve the community's environmental toxicity problems as well as promote and educate about the risks of chemicals in agriculture.

12. The HV educates neighbours in purchasing products such as food, seasonings, snacks, and cosmetics that meet FDA standards for use.

13. The HV has a role in supporting the prevention and control of accidents, and non-communicable diseases. HV are responsible for identifying people with diabetes, high blood pressure, cancer, as well as prepare a list of patients for treatment or referral.

14. The HV educates the public on the importance of, and the need to control and prevent the transmission of HIV and AIDS. They organize activities or campaigns to promote AIDS prevention and control, as well as the ability to care for people with AIDS to live in the

community through acceptation, and reducing the transmission of AIDS to others in the community.

The factors that influence the Thai HVs' activities were described in a study by Kowitt et al (2015), using interviews, focus groups and observation to collect data from HVs, community leaders, community residents and public health officials. The findings showed that HVs provide support for the community and deal with a range of public health issues as described previously. However, the HVs perceived that 1) an increase in tasks and training decreased flexibility 2) Incentives have both a positive and negative effect on the HVs role 3) community residents were not confident about the HVs' competency, so, stay connected with the healthcare personal to maintain community trust 4) The HVs were unique, and they provided a flexible approach. The HVs in Kowitt's study explained that their jobs role had increased compared to previous times, and the increase in training, job tasks, quality control and data reporting, which requires computer skills caused contention as these things were identified as decreasing flexibility. Secondly, incentives were viewed with mixed feelings. Some HVs support monetary incentives explaining that it helped them to pay their bills. On the other hand, some HVs felt that money changed the spirit of the HVs role which should be as a natural helper without pay. There was concern that people may apply for the role for financial reasons and not have the service in mind. Some HVs stated that service is more important for the HVs than skill because skill can increase via training. Therefore, the community should be clear about the purpose of financial incentives to prevent misunderstanding. Thirdly, the study also reported that, the community did not have confidence in the HVs' competency, especially using needles during diabetes screening, however, having a strong connection and being supervised by the healthcare staff, allows the HVs to gain the community's trust regarding their competency. Finally, the HVs expressed

that being a peer of the patients makes them unique and the HVs can approach the community in a different way (more flexible) that is not open to other healthcare workers.

2.4 Health volunteers' role in diabetes care

Diabetes is a chronic illness and people require continuous care following diagnosis (Ontha, 2016). Several diabetic guidelines recommend diabetic patients regulate their blood sugar to delay/avoid its complications, reduce medical costs and improve the patient's quality of life (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019). However, studies suggest that diabetic patients are unable to adequately control their blood sugar independently (Ovatakanont, 2011; Ngwogu et al., 2012; Viana et al., 2013; Ashur et al., 2016; Mahmood et al., 2016; Mauricio et al., 2017; Noor et al., 2017; Li et al., 2018; Afroz et al., 2019; Biesman-Simons et al., 2019; Chetoui et al., 2020; Viengthong and Arkhom Bunloet, 2020; Cedrick et al., 2021; Oluma et al., 2021). The prevalence of poor glycaemic control is common internationally, ranging from 50-85%. In Thailand, between 73.7% and 76.4% of diabetics could not maintain their blood sugar within the optimal range and are at risk of increasing further complications, this means only around a quarter of patients are achieving the optimal blood glucose level (Ovatakanont, 2011; Suwattanakul, 2018; Viengthong and Arkhom Bunloet, 2020). This statistic is similar to other countries in China (50%) (Li et al., 2018), Malaysia (68%) (Mahmood et al., 2016), Bangladesh (82%) (Afroz et al., 2019, Nigeria (62%) (Ngwogu et al., 2012), Morocco (66.3%) (Chetoui et al., 2020), South Africa (75%) (Biesman-Simons, et al., 2019), Congo (78%) (Cedrick et al., 2021), Libya (78.2%) (Ashur et al., 2016), and Sudan (85%) (Noor et al., 2017) and Brazil (74%) (Viana et al., 2013).

However, poor glycaemic control blood sugar was not limited to developing countries (Mauricio et al., 2017). Indeed, a retrospective longitudinal analysis of medical records in European countries and the USA by Mauricio and colleagues (2017) reported that less than one-third of 40,627 patients who were treated with basal insulin achieved target blood glucose levels (HbA1C=<7%).

In Thailand, diabetics are often unable to access healthcare services, even in the areas which are located near a city (Nopphonkrang et al., 2015) and a lack of public or affordable transportation is common (Varela et al., 2019). Older diabetics experience even fewer opportunities for health check-ups after retirement (Wirojratana et al., 2014). Moreover, appointments to monitor diabetes may not be valued by some as they witness other diabetics living to old age (Chaichanan, 2009).

Yet, healthcare accessibility is key to the prevention and management of disease, none more so than diabetes. Alarmingly, many elderly diabetics engage with health services only once a serious complication of the disease has arisen (Syed et al., 2013; Doetsch et al., 2017). Factors contributing to this disengagement include; the patient's financial situation, low socio-economic status, lack of family support, distance and transport to attending hospital, a lack of hospital equipment and the number of health care specialists (Syed et al., 2013; Mirattanaphrai et al., 2014; Reutrakul and Deerochanawong, 2016; Doetsch et al., 2017). Furthermore, overcrowding and long waiting times in hospitals may also compound these difficulties (Nam et al., 2011; Kamlungdee et al., 2017).

To overcome these issues, some have suggested that a home visit is needed to provide the patient with education and support (Kanyakan et al., 2019). The benefits of a home visit for diabetic patients in controlling blood sugar have been shown previously (Depinta, 2010; Sirithanawutichai et al., 2010). The home visit is viewed as an effective method for keeping

blood sugar under control, it is also shown to improve the diabetic patient's quality of life and lowers the risk of heart disease (Han et al., 2017). It allows two-way communication between patients and healthcare providers (Depinta, 2010) allowing the healthcare professional to assess the patient's knowledge and remedy any deficit (Depinta, 2010).

The nurse plays a key role in providing a home visit to diabetic patients (Dechakul, 2021). However, a shortage of nurses and healthcare staff in Thailand has been highlighted in several studies (Pagaiya and Noree, 2009; Khunthar, 2014; Jithitikulchai, 2020). According to Koshakri et al (2009), who studied the quality of diabetes care provided by 300 health care providers working in Primary Care Units (PCU) in central Thailand, only 19% of PCUs have sufficient healthcare staff. Less than 3% met the standard staffing numbers recommended by the Ministry of Public Health. Less than 10% of PCUs had full-time doctors, and around 81% of PCUs had full-time nurses. Many PCUs could not provide standard continuity of care, around 63.7% of PCUs could not perform standard home visits. The health care providers indicated that they could not provide essential procedures such as home visits and health education to the patients. Reduced staffing levels has been shown to contribute to sub-optimal levels of care (Kanhachin and Limtragool, 2020). Kanhachin and Limtragool (2020) conducted a study to assess the care of diabetic patients in one sub-district health centre in Thailand and found several issues due to staff shortages: In addition, Koshakri et al (2009), reported that only one third of diabetic patients receive home visits from a nurse.

Recognising the public health emergency that diabetes poses and the inaccessibility of diabetes care for many, the Ministry of Public Health in Thailand included diabetes management within the health volunteer's role (The Policy and Strategy Section, Bureau of Non-Communicable Disease, Ministry of Public Health, 2017).

The Health Volunteer's role in diabetes care includes educator, supporter, advocator, and coordinator (Egbujie et al., 2018). According to Nakrukamphonphatn et al (2019), the HV has three main roles in diabetes management across primary, secondary and tertiary levels. Primary prevention level; HVs offer health promotion advice to those at high-risk of developing diabetes. They also act to communicate news of diabetes innovations to the community. Secondary level; the HVs provide basic screening such as weight measurement, blood pressure assessment, finger-prick blood test for diabetes and people without diabetes. The HV also inspects the patient's feet, educating the patient about chronic illness. Tertiary level; the HV advises the patient to avoid the complications of diabetes. For instance, blood sugar monitoring, educating the patient to take care of their feet and delivering diabetes drugs from the health centre to the patients when they are unable to go to the hospital. Chatchaiphan et al (2016) also studied the HV role with 60 participants in one district in Thailand. Chatchaiphan and colleagues divided the essential role of the HV in caring for diabetic patients into 9 sections including 1. Basic health assessment, 2. BP assessment and interpretation, 3. perform finger prick blood sugar test and interpret blood sugar results, 4. monitor and screen for diabetic complications such as retinopathy, nephropathy and neuropathy 5. refer the patients with serious conditions or diabetic complications for ongoing care 6. to be a leader of health promotion campaigns in communities, 8. to be the leader for healthy diets in communities and 9. give diabetic medical advice to the patients. Within the study time frame (1 month), the results showed that the mean score of the participants in caring behaviour (n=60 HVs) was fair and needed to improve. The suboptimal performance of those HVs might be caused by multiple agendas (9 sections) and a lack of experience in performing some procedures (Chatchaiphan et al., 2016).

Most of these activities are undertaken within the community with many taking place in the patient's own home. Kasemsuk and colleagues (2015), reported that the HVs perform a home

visit every week, approximately 4 times a month. The primary aim of a diabetic home visit is to assess the patient's health and to ensure that they are managing their condition effectively, including their diet, exercise, medication use (Nakrukamphonphatn et al., 2019), and their blood sugar levels. These recordings are subsequently reported to the health professionals (Nakrukamphonphatn et al., 2019). Where patients are either newly diagnosed or unable to monitor their blood sugars, the Thai HVs are able to measure capillary blood glucose performed via a finger prick allowing the patient to be screened for prediabetes and diabetes (Kowitt et al., 2015).

The success of Thai HVs in supporting diabetics to regulate blood sugar levels has been reported previously (Sanguanprasit et al 2016) and is commensurate with the roles in other countries (Gyawali et al., 2018). The patients in the Sanguanprasit study improved knowledge, self-care management behaviour, and reduced blood sugar levels and BMI once they gained support from the HVs. Sanguanprasit also recommended that the HVs should be trained to increase their competency in providing both direct and indirect support to build the patient's confidence and self-efficacy. In addition, it should highlight and remind diabetic patients on the topic of the adverse effect of diabetic drugs and self-care management (Healthy diet, adequate exercise, stress management and foot care). The study by Sanguanprasit was conducted to assess the effect of peer support of 20 HVs (specially trained for the purpose of study) on the patients' glycaemic control, which it was found to improve.

A quasi-experimental study by Kum-oo et al (2014), conducted with 32 HVs working in one community health centre in Thailand found that the HVs had higher knowledge about finger prick glucose procedures after receiving a training programme. In addition, the diabetic patients were satisfied with the health service provided by the HVs as the home-based service saved the patient the cost of transportation and waiting for a service at the community health

centre. The findings indicated the effectiveness of employing the participatory learning method, demonstration technique, and using video in teaching enhanced the capacity of the HVs in diabetes care. However, the findings could not be generalised to other areas due to the small sample size (pre and post-test in one group) and the study is limited to one community health centre.

The previous paragraph highlights the important role that HVs play in diabetes care. They are viewed as vital in supporting continuous care in the community and reducing the gap between healthcare staff and patients. Their knowledge of diabetes is provided via an initial course and specialist training courses. Topics learned include definition, cause, risk factors, complications, screening technique, blood sugar testing, screening interpretation and referring patients for advanced examination. The contents also include giving advice about exercise, monitoring foot complications and medications. The potential HVs must attend every activity of the initial training course before starting their role (Ministry of Health, 2007). Subsequently, they are examined and if they pass, they are allowed to work as a HV (Ministry of Health, 2007). However, the pass requirement is unclear as this has not been reported.

A refresher course to refresh HV's essential knowledge is also available (Ministry of Health, 2010). The HV is refreshed on several topics (screening, managing risk factors, giving advice and caring for the diabetic patient, and the diabetic prevention campaign) within a one-hour training session. They also learn how to use the diabetic screening form, interpret the screening results and then refer the patients for further examination if any problems are detected (Ministry of Health, 2012). They are also educated on how to build community networks to monitor and prevent diabetes in the community. Although the knowledge assessment was completed before and after the session, the test items are not specifically

related to diabetes, it includes other topics and the score criteria to pass the training has not been reported.

The HVs blood sugar testing training course was established through a collaboration between three main organisations including the Ministry of Public Health, the Medical Council and the Medical Technology Council (Ministry of Health, 2013). The training aims to control and prevent diabetes in the community. The HVs are expected to attend the training which consists of several topics including blood sugar testing, blood results interpretation and results reporting (Ministry of Health, 2013). In addition, the HVs also learn how to screen for risk factors in all people by using established screening forms (Ministry of Health, 2013). As above, whilst all HVs complete the training course their post course knowledge levels are unclear.

It is evident that Health Volunteers play a key role in supporting patients with diabetes. However, to be able to carry out this role effectively it is essential that HVs possess a sound understanding of the biopsychosocial aspects of diabetes care.

2.5 Health volunteers' knowledge regarding diabetes

Diabetes management is multifactorial and includes patient education to reduce the risk of diabetes, minimising complications and delaying progression of existing complications and referring to specialist treatment providers (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; ADA, 2019).

Early detection is a significant factor for the prevention of the complications of diabetes (Herman et al., 2015; ADA, 2019) and can lead to a decline in mortality rates, reduce health costs and improve the patients' quality of life (Herman et al., 2015). Diabetics, particularly those newly diagnosed, require education about the possible complications and the methods

for preventing them (Gautam et al., 2015). It is therefore reasonable to expect that the Health Volunteers, who are often the first point of contact for patients, are knowledgeable and well informed. However, a number of studies have shown that healthcare providers have insufficient knowledge of diabetes care (Stallwood, 2006; Sranacharoenpong and Hanning, 2012; Ogbera et al., 2013; Smide and Nygren, 2013). In Nepal, Gyawali and colleagues (2018) reported that whilst community health volunteers' knowledge of diabetes improved after a five-day workshop, they were still uncertain about the causes of diabetes.

Nakrukamphonphatn who interviewed 22 HVs who were caring for patients in the community, reported that the HVs role was multidimensional. Their role can be separated into primary, secondary and tertiary prevention which included performing education for the patients about diet, and exercise. In addition, they performed diabetes screening by doing weight measurement, blood pressure check, waist measurement, finger prick, foot care and diabetic drug delivery for the patients. The study highlights the need for enhancing the capacity of the HVs in terms of knowledge and practice.

A cross-sectional study to assess the association between knowledge, attitude and practice regarding capillary blood checking amongst 151 HVs in Thailand reported that two thirds of the HVs had high knowledge about blood sugar testing (67.5%) (Srijompon and Muktabhant, 2018). Srijompon and colleagues also found that the HV's knowledge regarding blood sugar testing was gained through their practice experience. Practice requires knowledge and knowledge consolidates practice. The study highlighted the need for providing regular training for the HVs, as it increased their knowledge and confidence. However, this study solely assesses the knowledge of capillary blood sugar testing, it did not cover other diabetic topics.

Again, a quasi-experimental study by Prombutr et al. (2015), reported that around 70% of the HVs living in northeast Thailand, had high knowledge of diabetes and hypertension. The

Sirithanawutichai et al (2010), reported that although the HVs received formal training, they had inadequate knowledge. Hence, additional training should be provided. The HVs reported that they were proud to participate in the study as they felt they could improve the patient's quality of life, but they felt that they should be paid an incentive for taking part in this project. Sirithanawutichai's study showed improvements in the diabetic patient's knowledge and blood sugar management following exposure to the HVs. However, some barriers were also reported. The diabetic patient's relatives were not confidence about the advice provided by the HVs. These findings are in line with a study by Anunta and Tonganake (2012), which was conducted in one province in Thailand, to evaluate the effectiveness of home visits and training programs for health volunteers. Anunta and colleagues found that some HVs were not confident in performing home visits to patients (e.g. chronic disease, older age, disability and post-op patients who recover at home) in the community as they were unsure about their performance. In addition, during home visits, some patients and their relatives did not cooperate with the HVs as they were not confident in the HVs' performance. In addition, the authors recommended the HVs attain training to increase their knowledge and home visit skills, before doing the home visit in the community. Although the HVs increased their knowledge and practice once they attended the training, the assessment was not specific to diabetes, it included several knowledge areas regarding the home visit, and the author did not document the item details.

The HVs' training manual provides the only evidence that HVs possess adequate knowledge of diabetes. However, the test results have not been officially published or reported. Unlike the blood sugar test training course (Ministry of Health, 2013) where participants are

expected to score 80%, or they must undertake retraining it is unclear what level of knowledge the HVs possess.

In Bangkok, Health Volunteers are mandated by the Health Department, Bangkok Metropolitan Administration (The Health Department, Bangkok Metropolitan Administration, 2008) to undertake training courses on a regular basis. However, despite their critical role in diabetes care, their knowledge of diabetes has never formally been assessed, indeed, whilst they play a key role in educating the public, most HVs possess only an elementary education level (Primary Heath Care Division, 2017) and little is known about the origin of their perceived knowledge or their ability to discriminate between sources and quality of this knowledge.

2.6 Conclusion

HVs in Thailand play a key role in supporting diabetic patients in the community. With a limited healthcare workforce, several tasks have been shifted from the nurse to the HVs including diabetes care. To ensure that these HVs can fulfil the task, they were required to attend generic training sessions. Nevertheless, the literature indicates that although HVs receive formal training about diabetes, they may have insufficient knowledge to optimise care and should be subject to additional training. However, the extent of this knowledge and the areas of deficit are unknown. Moreover, while several studies report that HVs increase their knowledge levels following attendance at a training programme, the lack of holistic assessment has resulted in limited understanding of the merit of such training. Consequently, the levels of knowledge, the knowledge gap, the HVs experience of training and the barriers and facilitators to learning are not understood. Indeed, most published research in Thailand that has explored the merit of diabetes training for HVs has focused solely on the knowledge of the patient's blood sugar control. However, as a consequence of task shifting, the HVs are

expected to perform home visits providing holistic education for patients when qualified health staff are not available. Accordingly, it is essential that HVs possess the knowledge base in order to provide this information.

Thus, before designing future training programmes it is essential to identify the areas of education that require specific attention and to understand the learning experiences of current HVs. Gaining such information will ensure a targeted approach to learning which takes place so infrequently whilst ensuring the methods used are meaningful and manageable.

Chapter 3 Diabetes

3.1 Introduction

As has been stated in the previous chapter, the HVs have been the cornerstone of the primary health care in Thailand for many decades (Jopang et al., 2015), and are key to the expansion of health services in Thailand. They are engaged in several health schemes, including diabetes care. The previous chapter highlighted that diabetes is a chronic disease that not only affects worldwide health but also the global economy. Therefore, this chapter will discuss the literature in relation to diabetes, including the definition, prevalence, diagnosis, classification, risk factors, complications, treatment and the HVs' role.

3.2 Diabetes definition

As mentioned in the previous chapter, HVs learned about the definition of diabetes from their training, therefore it may be useful to provide an overview of this topic for the reader.

Diabetes is defined as "a group of metabolic disorders characterised and identified by the presence of hyperglycaemia in the absence of treatment" (WHO, 2019). This chronic disease causes the death of around 1 in 20 of all diabetic patients (International Diabetes Federation (IDF), 2015) and places a physical and emotional burden on those living with the condition (Mustapha et al., 2014). Consequently, the disease is recognised as a major health problem among the populations of both developing and developed countries (IDF, 2015).

3.3 The prevalence of diabetes

Diabetes effects over 400 million people globally (WHO, 2021); 150 million of these people live within the Western Pacific region (IDF, 2015; Reutrakul and Deerochanawong, 2016). In 2020, the prevalence of diabetes in Thailand was estimated to account for in excess of 8%

of the adult population, equating to approximately four million Thai citizens (IDF, 2021). However, the prevalence of diabetes increases significantly in people over the age of 60 years (Kirkman et at., 2012), accounting for 15% of this subgroup in Thailand (Novo Nordisk, 2013; WHO, 2016).

Complications are common, often leading to sensory and organ impairment, with particular emphasis on the skin, eyes, nerves, feet, and kidneys (Kulshrestha et al., 2015; American Diabetes Association (ADA), 2019). These complications may lead to renal disease, visual problems, amputations (Novo Nordisk, 2013) and in 13.40 per 100,000 of Bangkok diabetics, death (Division of Non-Communicable Diseases, 2019).

The impact of diabetes was reported in a study by Khunkaew et al (2018). Thai people living with diabetes experienced several physical, emotional, and socioeconomic issues. The patients expressed feelings of stress, anxiety and even depression which we related to managing physical complications such a leg ulcer and a fear of limb amputation once their prognosis became worse. Limited mobility of the patients was also not uncommon with patients reporting that daily activities, as they could not walk properly and they felt exhausted when doing activities even small activities which also affected their work. Post-amputation stated that they could no longer work, so they had no income. Although they received around 800 Baht per month disability funding from the Government, it was not enough for their living expenses. In addition, being diabetic caused social withdrawal; the diabetic patients suffered with low self-esteem and were excluded from society, as they were embarrassed about their image.

In addition to the physical and emotional impact of the disease, diabetes can also cause financial hardship (Chatterjee et al., 2011). People with diabetes are required to pay both direct and indirect costs. Direct costs include medical costs consisting of medical visits,

medications, treatment and laboratory costs. While indirect costs include transportation cost for each hospital or clinic visit (Paek et al., 2016; WHO, 2016). In addition, there are several hidden costs. Relatives who give up their time freely (Chatterjee et al., 2011) often provide informal care. The annual care cost per one Thai diabetic patient is estimated to be circa $115 (£93) but this can rise dramatically to $479 (£389) if the person suffers complications (Riewpaiboon et al., 2011). It is therefore clear that diabetes is a life changing disease that is common in Thailand.

Although Thailand introduced the UHC which reduced the financial burden on patients and increased access to a healthcare facility, the gaps in disease detection have remained. A study by Yan et al (2020), conducted amongst 15,663 adult diabetic patients across all regions of Thailand, reported that 67% of diabetic patients had not been screened for diabetes, and 34% of those diabetic patients were previously diagnosed. However, the use of the single-time fasting blood sugar level > 126 mg/dL to define diabetes in this study may overestimate the prevalence of diabetes, if the people did not truly fast. One possible explanation for this poor uptake is that long waiting times and low service quality may discourage patients from screening and diagnosis.

3.4 Diagnosis

As mentioned previously, the HVs perform screening for prediabetes and diabetes, and screen for risk factors amongst the people within community. Therefore, HVs must be familiar with the criteria and interpretation of the results of the screening. In this section the researcher will explain the conventional criteria for diabetes testing and result interpretation.

Many people with diabetes are asymptomatic and therefore unaware of the harmful effects of the disease. Consequently, there are numerous global diabetes guidelines including ADA

(2019) which Thailand have adopted which suggest that individuals who are at greatest risk should be screened to provide early identification of disease thus allowing greater plasma glucose control (Table 2).

Table 2 2019 ADA Criteria for testing for diabetes or prediabetes in asymptomatic adults

1. Testing should be considered in overweight or obese (BMI ≥25 Kilogram-Metre Squared (kg/m^2) or ≥ 23 kg/m^2 in Asian Americans) adults who have one or more of the following risk factors: • First degree relative with diabetes • High risk race /ethnicity (e.g., African American, Latino, Native American, Asian American Pacific Islander) • History of CVD • Hypertension (≥ 140/90 Millimetres of mercury (mmHg) or therapy for hypertension) • High density lipoprotein (HDL) cholesterol level <35 milligrams per decilitre (mg/dL) (0.9 mmol/L) and/ or a triglyceride level > 250 mg/dL (2.82 mmol/L) • Women with polycystic ovary syndrome • Physical inactivity • Other clinical conditions associated with insulin resistance (e.g., severe obesity, acanthosis nigricans)
2. Patients with prediabetes (Glycated haemoglobin (A1C) ≥ 5.7% [39 mmol/mol], IGT, or IFG) should be tested yearly.
3. Women who were diagnosed with Gestational Diabetes Mellitus (GDM) should have lifelong testing at least every 3 years.
4. For all other patients, testing should begin at age 45 years.
5. If results are normal, testing should be repeated at a munimum of 3 year- intervals, with consideration of more frequent testing depending on initial results and risk status.
*IFG= impaired fasting glucose; IGT= impaired glucose tolerance

There are some different testing criteria between Thailand and the ADA guidelines, although the ADA recommends performing diabetes tests amongst people aged 45 and older, in Thailand, diabetes screening should be conducted in people aged≥35 years. In Thailand, obesity is not only defined by a BMI ≥25 Kilogram-Metre squared (kg/m2), it also includes

waist circumference with females with a waist circumference >80 centimetres and males with waist circumference >90 centimetre classified as obese.

The diagnostic criteria outlined in table 3 are consistent across a number of national guidelines (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019; WHO, 2019) including the Thailand guideline (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017). All guidelines recommend a diagnosis of diabetes be considered where the patient's fasting plasma glucose≥ 7.0 mmol /L or a 2-hour post-load plasma glucose ≥200 mg/dL (≥11.1 mmol/L) or HbA1c≥6.5% (48 mmol/L). Where diabetes is suspected during pregnancy a diagnosis is only confirmed when fasting plasma glucose 5.1-6.9 Millimoles per litre (mmol/L) or 1-hour post load plasma glucose≥ 10.0mmol/L or 2-hour post-load plasma glucose 8.5-11.0 mmol/L. However, it is worth noting that a diagnosis of diabetes should not be made based on the results of a single test result.

Table 3 Criteria for the screening and diagnosis of diabetes

	Prediabetes	Diabetes
A1C	5.7-6.4%	≥6.5% (48 mmol/mol)
FPG	100-125 mg/dL(5.6-6.9 mmol/L)	≥126mg/dL (7 mmol/L)
OGTT	140-199 mg/dL(7.8-11 mmol/L)	≥200 mg/dL (11.1 mmol/L)
RPG	-	≥200mg/dL (11.1 mmol/L)

A1C =Glycated haemoglobin, FPG =Fasting plasma glucose, OGTT =The oral glucose tolerance test,

RPG =Random Plasma Glucose

3.5 Diabetes classification

The American (ADA, 2019), Canadian (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018), Australian (The Royal Australian College of General Practitioners, 2016), Singaporean (Ministry of Health, Singapore, 2014) and Thai (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017) Diabetes Associations classify diabetes into 4 groups: Type 1 Diabetes (T1D), Type 2 Diabetes (T2D), GDM and other specific types caused by a wide variety of relatively uncommon conditions (Punthakee et al., 2018). Whilst the World Health Organization acknowledge these four forms of diabetes, they also advocate the inclusion of an additional form of the disease, namely Double Diabetes (DD) or Hybrid Diabetes.

Type 1 Diabetes (T1D) is caused by ß -cell destruction and absolute insulin deficiency (WHO, 2019) while T2D is caused by either insulin resistance or the reduction of insulin secretion from pancreatic beta cells (Solis-Herrera et al., 2018). GDM, whilst ranging in prevalence between ethnic groups, has been found to be as high as 22% in some populations (Wu et al., 2018) and is therefore not uncommon. Other less prevalent forms of diabetes are caused by infections, drugs, endocrinopathies, pancreatic destruction, and genetic defects such as monogenic diabetes, diseases of the exocrine pancreas, endocrine disorders, drug-or chemically-induced, infection-related diabetes and less common specific forms of immune-mediated diabetes (Petersmann et al., 2018; Solis-Herrera et al., 2018).

DD or Hybrid Diabetes is characterised by the presence of both T1D and T2D (Mottalib et al., 2017; Mishra et al., 2018). This form of diabetes often develops subsequent to the existence of the alternative form of the disease i.e., type 1 or type 2 diabetes (Pozzilli et al., 2011). The prevalence of DD is unclear. Three studies have reported data related to the condition. In a European study, Merger and colleagues (2016) noted the prevalence of DD to be 25.5% (7,926) amongst 31,119 adults aged ≥18 in Germany and Austria. Mishra et al

(2018) noted that double diabetes was prevalent in 7% of Indian teenagers whereas Braham et al (2016) reported that 31% of young people in Saudi Arabia met the criteria for DD. Unfortunately, due to the heterogeneity of the samples in these studies it is difficult to calculate accurately an overall prevalence. Mishra and colleagues (2018) noted in their study that 21 % of those diagnosed with DD had been previously diagnosed with T2D. While the remaining 79% of the sample were characterized as suffering T1D, highlighting the weaknesses of diagnostic classifications as a means of collecting prevalence data.

3.6 Risk factors

HVs are educated about risk factors via their training and are responsible for screening community residents. Therefore, the HVs are expected to have knowledge on these topics. The previous studies and recent guidelines indicate numerous risk factors for the development of diabetes; thus, the researcher will discuss the risk factors of diabetes including modifiable and non-modifiable factors.

Several risk factors for diabetes have been reported in previous studies, which can be separated into modifiable factors such as being overweight, physical inactivity, hypertension, increased lipid levels and smoking, and non-modifiable factors such as older age and family history of diabetes (Wang et al., 2015). This section describes the association between these risk factors and diabetes.

3.6.1 Modifiable factors

Weight

A number of studies, in different populations, have reported a link between body weight and increased risk of diabetes including studies in developing countries (Ahasan et al., 2011; Hadaegh et al., 2011; Li et al., 2015; Wang et al., 2015; Hu et al., 2017; Mohamed et al.,

2018; Aravinda, 2019) and developed countries (Ärnlöv et al., 2011; Wing et al., 2011). A number of prospective cohort studies have reported that overweight or obese people increase their chances of developing diabetes when compared with people of normal weight (Ärnlöv et al., 2011; Hadaegh et al., 2011; Wang et al., 2015). A study in Thailand also found that obesity (BMI≥30 km/m^2) increased the risk for type 2 diabetes among male and females (OR=23.1, (95% CI 16.1, 33) and (OR=28.5, 95% CI 18.7, 43.4), respectively (Papier et al., 2016).

However, whilst being overweight or obese is associated with increased risk of diabetes, weight loss has been found to improve plasma blood glucose levels (Wing et al., 2011) and positively impact secondary risk factors such as hypertension, triglycerides and HDL cholesterol levels (Wing et al., 2011). Consequently, weight management is included in numerous international guidelines (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019; ADA, 2019, (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017). These guidelines recommend that overweight diabetic patients reduce their initial body weight by 5% to 10% through diet, physical activity (PA), and behaviour counselling. However, weight loss drugs and bariatric surgery are considered in patients who fail to lose weight by these non-medication treatments. The Korean guidelines suggest that type 2 diabetics with BMI>25 kg/m^2 who fail to lose weight with diet, exercise and lifestyle modification, should be considered for weight loss medication (Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019). In addition, bariatric surgery should be considered as the treatment for diabetics with BMI ≥ 30 kg/m^2 who are unable to maintain their blood sugar within target. The number of Thai people who are overweight and

obese is increasing. Sakboonyarat et al (2020), conducted a study amongst adults in rural areas of Thailand and found that the prevalence of obesity (BMI≥25 kg/m2) has increased from 33.7 % in 2012 to 44.8% in 2018. The statistic is consistent with a report by Peltzer et al (2015), reporting that around one-third of Thai males (38%) aged, 18-60 years were identified as obese (BMI≥25 kg/m2). However, Peltzer 's study was conducted solely on males living in one province, it may not be representative of the Thai population. A previous study by Hatthachote et al (2019), indicated that the main risk factor for obesity amongst Thais was a lack of exercise. While Jitnarin et al (2011), stated that consuming high carbohydrates and protein is associated with overweight and obesity in Thais. Therefore, the HVs should consider the link between diet, obesity and exercise to provide proper advice for diabetic patients.

Diet

The consumption of an unhealthy diet (unhealthy food is defined by the WHO as food that is high in saturated fats, high in sugars, high in salt > 5 grams per day and low in fruit and vegetables) is associated with an increased risk of diabetes (Hu et al., 2017). The dietary importance of fruit and vegetables is supported by Li et al's (2014) systematic review and meta-analysis. Li and colleagues (2014) reported that adding a 0.2 serving per day (approximately 21.2 grams) of green leafy vegetables was associated with a 13% lower risk of type 2 diabetes, in addition increasing 1 serving (approximately 106 grams) of fruit per day was associated with a 6% reduced risk of type 2 diabetes. Carter et al (2010) highlighted the benefits of consuming green leafy vegetables in preventing diabetes in a meta-analysis where they claim that such benefits are related to the reduction of systemic oxidative stress, increased antioxidants, and α linoleic acid, which is related to insulin sensitivity within skeletal muscle. In addition, unhealthy foods such as sugar-sweetened beverages

(≥1 serving/ day) have been found to increase the risk of diabetes in several prospective cohort studies (Bhupathiraju et al., 2013; Sakura et al., 2014; Papier et al., 2017).

In a European study, Burger et al (2012) showed that consuming dietary fibre reduces mortality among diabetic patients. In addition, eating high wheat fibre such as whole wheat, breads and brown rice (16.6 g per 1000 Kilocalories (kcal)) and low glycaemic index food such as cooked beans, chickpeas (190 g per day) can reduce HbA1c value, fasting blood sugar, body weight, triglyceride level and the risk of Coronary Heart Disease (CHD) risk in type 2 diabetic patients (Jenkins et al., 2012).

Low carbohydrate diets and low-fat diets are beneficial for the management of diabetes (Cao et al., 2011; Yamada et al., 2014; Wang et al., 2018). Wang et al (2018), in a Chinese study found that a low carbohydrate diet (the meal was replaced by consuming 60 grams per day (g/day) of nuts for men and 50 g/day for women had benefits for T2DM patients improving blood sugar, reducing lipid levels and BMI. Cao et al (2011) also found that the consumption of a low carbohydrate diet (LCD) can decrease body weight and HbA1c in type 2 diabetic patients. Similarly, in Japan, type 2 diabetic patients who received a low carbohydrate diet for 6 months (total carbohydrate 70-130 g/day) reduced their HbA1c and triglyceride levels (Yamada et al., 2014).

A low-fat diet has been found to improve blood glucose levels in Chinese diabetic patients (Cao et al., 2011). The finding is consistent with a study by Wang et al (2018) who found that a low-fat diet decreased patients' glycated haemoglobin (HbA1c) levels. In an attempt to compare the two diets, Tay et al (2018) conducted a-2-year randomised controlled trial with type 2 diabetic patients in Australia. The study found that those on low-carbohydrate and high fat diet (14% carbohydrate (< 50 g/day), 28% protein and 58% total fat), and high carbohydrate and low-fat diet (53% carbohydrate, 17% protein and < 30% total fat), reduced

their body weight and HbA1C. However, the low carbohydrate group required less diabetic medication.

However, it is not definite that eating fatty meat is a risk factor for diabetes (Aynalem and Zeleke, 2018; Kindarara and Silva, 2019). A cross-sectional study by Aynalem and Zeleke (2018) conducted in Ethiopians of age ≥ 15 years found that the frequency of eating fatty meat was not associated with diabetes in an Ethiopian population. However, Aynalem and Zeleke did not provide details about the questionnaire and the definition of fatty meat. The participants were simply asked about the frequency of consuming fatty meat which was categorised as not eating, every day, every three days, once a week and once a month. In line with the findings of Kindarara and Silva (2019), who carried out a cross sectional study in African immigrants age 21 and over, living in California, found that unhealthy eating habits (Slightly careful/not at all careful selecting healthier diet) were not associated with diabetes. However, the author did not define healthier diet, the participants were only asked how careful they were when selecting a healthier diet with four options including very careful, somewhat careful, slightly careful and not at all careful. In addition, it should be noted that the different assessment tools (self-report), daily intakes measured and their populations may explain the difference in the findings of these two cross-sectional studies when compared to studies undertaken in Europe and North America. According to a Thai cohort study by Papier et al (2017), women who drank sweetened fizzy drinks once or more per day were at increased risk of type 2 diabetes at 8 years of follow-up (odds ratio =2.4, 95% CI 1.5–3.9).

Physical inactivity

Physical activity is ‘any bodily movement produced by skeletal muscles that results in energy expenditure’ (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; WHO, 2020). Duration and frequency of physical activity is vital, a number of

national and international guidelines recommend 150 min/week of moderate intensity physical activity, such as brisk walking, to delay or prevent type 2 diabetes (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019). There were several studies have reported an association between a lack of physical activity and the risk of diabetes (Fretts et al., 2009; Engberg et al., 2010; Sieverdes et al., 2010; Lee et al., 2012; Shi et al., 2013; Grøntved et al., 2014; Kindarara and Silva, 2019) in western countries (Fretts et al., 2009; Engberg et al., 2010; Sieverdes et al., 2010; Grøntved et al., 2014), Asia (Lee et al., 2012; Shi et al., 2013) and Africa (Kindarara and Silva, 2019). Kindarara and Silva (2019), recruited African immigrants living in America who were over the age of 21 years. They found that moderate physical activity, on less than 2 days per week was associated with diabetes, the author defines a moderated physical activity as 'activity that may make a person breathe slightly harder than when he or she is sitting, like fast walking, gardening, or mowing with a push mower'. In addition, Fretts et al (2009) found that physical activity reduced the risk of developing diabetes in Native Americans. Fretts and colleagues used a self-report physical activity questionnaire designed specifically for Native Americans. The participants were required to document the frequency and duration of 24 structured leisure-time activities during the last 12 months. Similarly, regular exercise and highly active physical work were shown as protective factors against type 2 diabetes amongst hill tribes living in northern Thailand (Apidechkul, 2018).

As above, several pieces of evidence including guidelines and studies supports the link between a lack of exercise and the risk of diabetes, but some studies conducted in Kenya and

Australia found no association between workout and diabetes (Burke et al., 2007; Mohamed et al., 2018). However, it should be noted that target physical activity levels and measurement tools varied between studies. Mohamed et al (2018) incorporated data from the 2015 Kenya STEPs survey. This survey was the first national household survey on Non-Communicable Disease in adults aged 18–69 years in Kenya. The authors reported that insufficient physical activity (moderate intensive activity <150 minutes or vigorous intensive physical activity <75 minutes per week) was not a risk factor for diabetes in Kenyan adults. Burke et al (2007) reported that regular exercise was not a predictor of type 2 diabetes in Australian Aborigines aged 15-88 years (mean for follow-up was 12.9 years). Physical activity was measured using a self-complete questionnaire including three questions about the frequency of exercise.

Although, most studies were prospective cohort studies (Burke et al., 2007; Fretts et al., 2009; Engberg et al., 2010; Sieverdes et al., 2010; Lee et al., 2012; Shi et al., 2013; Grøntved et al., 2014) and one cross-sectional study, the accuracy of these results may be limited as a consequence of the self-reporting methods of data collection. In addition, the respondents were required to retrospectively complete the questionnaires, relying on memory. Ayhan and Işiksal (2005) conducted a Turkish study over a 12-month period comparing self-reporting of activity. They found that memory recall error was considered to be an important issue in the use of the retrospective surveys, as memory recall error happened in both the short term (within 3 months) and the long term (12 months). It is clear from international evidence that a lack of exercise is a risk factor for diabetes. Thailand's population have a reduced level of exercise (Ethisan et al., 2017; Piboon et al., 2020), Indeed, Ethisan et al (2017), showed that many older Thais (41%) did not perform any physical activity, whereas Piboon et al (2020) reported that 62% of university students aged 18 years and above indicated that they did not do any exercise or exercised only once a month in the past six months. Moreover,

Katewongsa et al (2021) reported that only 26% of Thai children aged between 6-17 years reached the recommended level of physical activity. Therefore, physical inactivity amongst Thais is common placing them at risk for diabetes.

Smoking

The association between smoking and diabetes has been reported in a number of previous studies (Jee et al., 2010; Clair et al., 2011; Saeed, 2012; Shi et al., 2013; Luo et al., 2013; Li et al., 2015; Papier et al., 2016; Bucheli et al., 2017; Aynalem and Zeleke, 2018). The studies have been undertaken across a number of countries including the US (Clair et al., 2011; Luo et al., 2013), Mexico (Bucheli et al., 2017), Ethiopia (Aynalem and Zeleke, 2018) and Asian countries such as Korea (Jee et al., 2010), Saudi Arabia (Saeed, 2012), China (Shi et al., 2013; Li et al., 2015), and Thailand (Papier et al., 2016). Shi et al (2013) reported in a Chinese population that men who smoked more than 20 cigarettes per day were at 1.25 (95% CI: 1.00, 1.56) increased risk of type 2 diabetes and men with a history of smoking ≥ 40 pack-year had a risk of 1.28 (95% CI: 1.04, 1.57). Additional studies comparing current versus non-smokers also found that current smoking increased the risk of type 2 diabetes. These findings were supported in a Thai cohort study by Papier et al (2016) conducted between 2005 and 2013. The study commenced in 2005 with people without diabetes and then followed them up by a questionnaire in 2013. Of the 39,507 participants, there were 698 developed types 2 diabetes. The findings showed that being a current smoker increased the risk of diabetes (OR=1.7, (95% CI 1.3, 2.2). Conversely, three studies showed that the use of tobacco was not associated with diabetes (Arugu and Maduka, 2017; Mohamed et al., 2018; Kindarara and Silva, 2019). The difference in study design, population and study settings may have contributed to the difference in findings. However, as the vast majority of these studies point towards greater risk, several diabetes guidelines (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015) recommend that diabetic patients cease smoking.

Although we found that being a smoker was one risk factor for diabetes, the evidence showed that many Thais smoke especially the young (Waehayi et al., 2020). A study by Waehayi et al (2020), reported that around 67% of males aged between 19 and 24 years were smokers, and approximately 58% smoked 1-9 cigarettes/day. In addition, Pronvarin et al (2012) found that around 38% of Thais workers aged 19-60 years were cigarette smokers. The results from the National Thai Food Consumption Survey amongst Thai adults also reported that around 22% of people aged 18 years and older were smokers (Jitnarin et al., 2011). Smoking is a worrisome problem amongst Thais, as it is linked to diabetes. Therefore, to manage and reduce the risk of diabetes in the community, the HVs should have sufficient knowledge regarding this risk factor for diabetes.

Hypertension

Hypertension, defined as a resting blood pressure >140/90 mmHg contributes to the development of diabetes (Movahed et al., 2010; Arugu and Maduka, 2017; Hu et al., 2017; Aynalem and Zeleke, 2018; Mohamed et al., 2018; Kindarara and Silva, 2019). Four cross-sectional studies including two studies in China (Li et al., 2015; Hu et al., 2017), one in Ethiopia (Aynalem and Zeleke, 2018) and one in Kenya (Mohamed et al., 2018) reported that the presence of hypertension (BP≥140/90 mmHg) increased an individual's risk of diabetes reporting odds ratios of 1.62, 1.55, 4.7 and 2.8 respectively. In a UK meta-analysis that included the outcomes of 4.1 million patients without vascular disease and diabetes, Emdin et al (2015) reported that the diabetes risk increased alongside blood pressure elevation. The authors stated that a 20 mmHg increase in Systolic blood pressure (SBP) resulted in a 58% higher risk of new-onset diabetes, while a 10 mmHg increase in Diastolic blood pressure (DBP) was associated with 52% increased risk of developing diabetes.

Consequently, achieving target blood pressure is a mainstay of diabetes care. However, the level of this target varies internationally. Whilst Thailand (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017) and Singapore (Ministry of Health, Singapore, 2014) have adopted a target of <140/90 mmHg, in America (ADA, 2019), Australia (The Royal Australian College of General Practitioners, 2016) and Korea (Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019) target blood pressure is set at a slightly lower level of < 130/80 mmHg (Whelton et al., 2018).

3.6.2 Non-Modifiable factors

As mentioned in chapter 2, the HVs are responsible for screening for diabetes amongst the community residents, family history of diabetes and age were included in the screening form. Therefore, the HVs should have an adequate knowledge of these topics.

Family History

Having a first-degree relative with type 2 diabetes has been shown to increase the risk of developing diabetes (Ahasan et al., 2011; Arugu and Maduka, 2017; Aravinda, 2019) and is noted as a risk factor for diabetes in several diabetes guidelines including the American (ADA, 2019), Canadian (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018), Singaporean (Ministry of Health, Singapore, 2014), and Thai (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017). In addition, we also found that a family history of diabetes was a risk factor for developing diabetes in a Thai population (Muktabhant et al., 2015; Apidechkul, 2018). Evidence emerged from a study of a hill tribe in Thailand by Apidechkul (2018), which showed that having a parental history of type 2 diabetes is associated with diabetes. The finding supports a recent study by Muktabhant et al (2015) who found that having a father

or mother (first-degree relative) with diabetes was a risk factor for type 2 diabetes. The findings highlight the importance of asking for a family history of diabetes in the screening process to enhance the validity of the screening process (Muktabhant et al., 2015). Based on international and national evidence, the HVs who work closely with community should take a family history of diabetes into their screening process.

Age

A series of cross-sectional studies (Li et al., 2015; Adhikary et al., 2017; Hu et al., 2017; Kindarara and Silva, 2019) undertaken within different populations including China (Li et al., 2015; Hu et al., 2017), America (Kindarara and Silva, 2019) and Bangladesh (Adhikaey et al., 2017) have demonstrated that age is a risk factor for the development of diabetes. The findings of these studies have been adopted into a plethora of national risk factor guidelines. Several guidelines including the US (ADA, 2019), Australia (The Royal Australian College of General Practitioners, 2016), Canada (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018), UK (NICE, 2015), and Singaporean (Ministry of Health, Singapore, 2014) state that people aged ≥40 should be screened for diabetes risk. A previous study in Thailand conducted amongst 39,507 Thais aged between 15-88s also found an association between age and type 2 diabetes in people age 50 and older (Papier et al., 2016). However, in Thailand screening commences at ≥35 years (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017), which is unremarkable given some guidelines (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018), suggest that being of South Asian heritage is a risk factor for diabetes. A recent study in Thailand by Kittithaworn et al (2019), also found that old age, especially age over 50 years increases the risk of developing type 2 diabetes which was similar to Papier et al's study in 2015.

When scrutinising the evidence from international studies and some studies in Thailand, most studies found that being aged over 40 is a risk for diabetes. However, diabetes screening in Thailand starts earlier at 35 years despite reports of the Thailand national health examination survey 2004-2014 showing that diabetes was more prevalent in people aged over 50, and only a small number of younger people lived with diabetes (Aekplakorn et al., 2018) providing screening at an earlier age provides an opportunity to intervene to address the additional risks outlined previously. As mentioned in the previous chapter, prevention is cost-effective and benefits diabetes management, therefore, it is reasonable to perform early screening for diabetes in Thailand.

3.7 Complications

In chapter 2, I explain that HVs are responsible for managing the complications of diabetes in addition to screening for risks. HVs are taught about the complications of diabetes and assisted with a referral when diabetic complications are suspected. In order to identify patients with the associated complications, the HVs need to possess adequate knowledge about diabetes and its complications. In this segment, the researcher will review and discuss the current diabetic complications, namely acute and chronic complications.

Left untreated, diabetes can cause health issues that can affect the patient's quality of life such as skin complications, CVD, nephropathy, neuropathy, retinopathy and foot complications (Nickerson and Dutta, 2012). Diabetic complications can be separated into two types: acute complications, which occur immediately when the blood sugar level increases or reduces significantly, for instance, hypoglycaemia, ketoacidosis and hyperosmolar hyperglycaemic state (HHS) (Nickerson and Dutta, 2012), and chronic complications resulting from long term uncontrolled blood sugar levels (Nickerson and Dutta, 2012). Chronic complications include microvascular and macrovascular disease.

Microvascular complications include retinopathy, nephropathy, and neuropathy caused by capillary damage (Zimmerman, 2016), while macrovascular disease is associated with atherosclerotic plaque development in the vasculature of the heart, brain, limbs, and other organs, obstructing the proximal vessels leading to myocardial infarction (MI), stroke, claudication, or tissue necrosis (Zimmerman, 2016).

3.7.1 Acute complication

Hypoglycaemia

Hypoglycaemia is defined by the ADA, (2019) as a blood sugar level, which is lower than the standard range. However, the terminology is not consistently defined. The ADA (2019) states that hypoglycaemia is comprised of 3 levels. Level 1 is defined as a blood glucose <70 mg/dL (3.9 mmol/L). Level 2 is defined as a blood glucose <54 mg/dL (3.0 mmol/L) and finally, level 3 is a low blood glucose level where the patient shows signs of mental change and/ or alter physical function that needs another person for recovery (ADA, 2019). The Canadian Diabetes Association (CDA) in their Clinical Practice Guidelines (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018) also define hypoglycaemia across three levels but their criteria differ. The CDA define level 1 as the development of autonomic or neuroglycopenic symptoms, level 2 as a plasma glucose level lower than 4.0 mmol/L in a patient who is treated with insulin or an insulin secretagogue and level 3 as symptoms responding to the administration of a carbohydrate (Clayton et al., 2013). Bonds et al (2010) also separate hypoglycaemia into three groups. Level 1 is defined as severe hypoglycaemia requiring medical assistance (HMA) with a blood glucose concentration <2.8 mmol/l (50 mg/dl) or symptoms that are promptly resolved with either oral carbohydrate, intravenous glucose, or subcutaneous or intramuscular glucagon. Level 2 is defined as a severe hypoglycaemic event requiring any assistance (HA) with a blood glucose

concentration equal to the HMA group. Finally, level 3 is defined as hypoglycaemia based on a finger stick blood glucose measurement of less than 3.9 mmol/l.

Farrokhi et al (2012) states that impaired kidney function, daily insulin dose, and increasing age leads to hypoglycaemia in the non-clinically ill patient with type 2 diabetes (hypoglycaemia was defined as a blood sugar less than 70 mg/dl, while blood sugar less than 40 mg/dl was defined as severe hypoglycaemia). Some patients also experience recurrent hypoglycaemia caused by poor kidney function, infection, loss of current meal and having coronary artery disease (Lin et al., 2010). In addition, hypoglycaemia was associated with the risk of CVD in a UK based retrospective cohort study (Khunti et al., 2015).

Hypoglycaemia level 1 and 2 can be monitored and recovery can take place at home (ADA, 2019). Although any form of carbohydrate which contains glucose can be used as a treatment of level 1 hypoglycaemia, glucose 15-20 gram is preferred (ADA, 2019). Once the patient receives glucose for 15 minutes, a blood glucose test is required. If the blood sugar remains low the treatment should be repeated and a second blood glucose test should be undertaken (ADA, 2019). Once the plasma blood glucose returns to normal, the patient should be encouraged to consume food to prevent the recurrent hypoglycaemia (ADA, 2019). In contrast, glucagon is the treatment choice for patients' suffering hypoglycaemia-level 2. The patient and caregiver should learn how and when to use Glucagon in the event of an emergency (ADA, 2019).

To prevent hypoglycaemia-level 3, those patients who experience hypoglycaemia level 2 and patients who require insulin should be advised to relax their glycaemic target (ADA, 2019). In addition, the family member should learn how to assess the patient's cognitive function as this might decline in the presence of severe hypoglycaemia (ADA, 2019).

Diabetic Ketoacidosis (DKA) and Hyperglycaemic Hyperosmolar State (HHS)

International diabetes guidelines including those of Canada and Australia state that DKA and HHS are acute metabolic complications of diabetes that can cause, and should therefore be considered as, a diabetic emergency (Gosmanov et al., 2018). DKA is characterised by a triad of hyperglycaemia, ketonaemia and metabolic acidosis (Dhatariya et al., 2013). Diagnostic criteria for DKA in the USA include a glucose concentration > 250 mg/dL (13.9 mmol/L), combined with the presence of urine or serum ketones with an anion gap and arterial pH <7.3 (Umpierrez and Korytkowski, 2016; Dhatariya and Vellanki, 2017; ADA, 2019). While in the UK, diagnosis of DKA is made when the patient has a combination of three criteria: 1) glucose concentration >200 mg/dL (>11 mmol/L) or known diabetes, 2) the presence of ketones ≥ 3.0 mmol/L or significant ketone urea (greater than 2+ on standard urine ketone sticks), 3) venous pH <7.3 and or bicarbonate < 15 mmol/ L (Dhatariya et al., 2013). The difference in diagnostic criteria between the US and UK may be the result of a lack of high-quality research to guide effective diagnosis and treatment. In addition, serum chloride is not universally available, making it impossible to calculate the anion gap and therefore grade the severity of DKA. Some countries have subsequently chosen to base the diagnosis on glucose concentration and the presence of ketones and confirmation of an acidosis without anion gap (Dhatariya et al., 2013).

HHS is characterised by severe hyperglycaemia, high serum osmolality and dehydration (French et al., 2019). Umpierrez and Korytkowski, (2016) and Dhatariya and Vellanki, (2017) suggest that HHS is diagnosed when blood sugar levels >600 mg/dL (>33.33 mmol/L), pH >7.3, and Bicarbonate level > 20 mmol/L. Frank and Solomon (2016) and Scott et al (2015) differ slightly defining HHS as the presence of high osmolality (>320

mosmol/kg), high blood glucose levels (>30 mmol/L), hypovolaemia and mild metabolic acidosis (pH greater than 7.3, bicarbonate over than 15 mmol/L).

The patient with HHS may develop a change in mental state such as confusion, seizure and even coma. In some cases, the patient may show signs of hypovolaemic shock (Frank and Solomon, 2016). Patients with HHS need close monitoring and require hospital admission (Frank and Solomon, 2016; French et al., 2019). Treatment for both DKA and HHS includes fluid replacement, reducing the glucose level and preventing further complications (Dhatariya and Vellanki, 2017).

3.7.2 Chronic complication

Macrovascular complications

Around 32% of people with type 2 diabetes worldwide suffer from Atherosclerotic cardiovascular disease (ASCVD) (Einarson et al., 2018), defined as, a history of myocardial infarction, stable or unstable angina, coronary or other arterial revascularization, stroke, transient ischaemic attack, or peripheral arterial disease (PAD) (Chamberlain et al., 2016). ASCVD is a leading cause of morbidity and mortality of diabetic patients (Chamberlain et al., 2016).

Whilst ASCVD macrovascular complications occur in patients with and without diabetes (Leon and Maddox, 2015), the risk of atherosclerosis is greater when diabetes is present. Leon and Maddox (2015) stated that the pathophysiology of cardiovascular disease progression in the diabetic patient is currently unclear. However, diabetes may promote atherosclerosis through increased coagulability (Leon and Maddox, 2015) and dyslipidaemia (Dokken, 2008; Koba, and Hirano, 2011). It is suggested that the presence of diabetes increases the binding of glycoprotein IIB/IIIA receptors and increases the release of von Willebrand factor (vWF), two features that promote platelet aggregation (Leon and Maddox,

2015). Asymptomatic hyperglycaemia is one risk factor for cardiovascular disease (DiNicolantonio and OKeefe, 2017).

Microvascular complication

Diabetic retinopathy

Diabetic retinopathy (DR), defined as the presence of lesions within the retina causing death of retinal cells and retinal dysfunction (Forbes and Cooper, 2013) leads to blurred vision, cataracts, glaucoma and blindness (Solomon et al., 2017). DR can be separated into four stages namely mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR and proliferative diabetic retinopathy (PDR) (Corcóstegui et al., 2017; Wang and Lo, 2018). To provide early identification of DR it is important that the diabetic patient is assessed by a qualified ophthalmologist or optometrist as outlined below.

Several studies in both type 1 and 2 diabetes that have been undertaken in Spain (Pedro et al., 2010), China (Zhang et al., 2017), US (Wang et al., 2017), Brazil (Lima et al., 2016) and an international cohort (Yau et al., 2012) have all reported that diabetic retinopathy is related to the presence of increased blood glucose. Pedro et al (2010), Yau et al (2012), Lima et al (2016) and Wang et al (2017) identified that patients with an A1C > 7 are at greater risk of DR. Moreover, diabetes duration also appears to increase DR risk in both Western (Pedro et al., 2010; Thomas et al., 2015; Lima et al, 2016) and Eastern (Zhang et al., 2017) populations. However, the duration of diabetes was inconsistently classified throughout these studies

Having longer duration of both diabetes and hypertension also increases the risk of diabetic retinopathy. Yau et al (2012) undertook a systematic review to assess the prevalence of risk factors of diabetic retinopathy. The review included 35 studies with a total sample of 22,896 diabetic patients. The studies were published between 1980-2008 and concluded that the prevalence of diabetic retinopathy increases when people have longer duration of diabetes

(comparing <10 years with ≥20 years), blood pressure greater than 140/90 mmHg compared with ≤140/ 90 mmHg and have high HbA1C levels comparing levels ≤7.0 with >9.0%. Whilst the review included a large sample size, an appraisal of study methodology and heterogeneity limited the findings somewhat.

Diabetic neuropathy

Diabetic neuropathy is defined as nerve damage due to high blood glucose levels in diabetic patients (Inzucchi et al., 2016). A number of risk factors including older age (Al-Rubeaan et al., 2015) and high blood glucose (Nisar et al., 2015; Yang et al., 2017) cause the condition. However, one African study (Amour et al., 2019) reported no relationship between HbA1C levels and diabetic neuropathy. The difference in findings between Nisar et al (2015) and Yang et al (2017) and those of Amour and colleague (2019) may be the result of the varying samples and type of research. Both Nisar et al (2015) and Yang et al (2017) recruited patients with type 2 diabetes whereas Amour et al (2019) recruited type 1 and type 2 diabetes. In addition, Yang et al (2017) conducted a cohort study with a long follow up period (average 7.23 years) using data from a large national database of type 2 diabetics (n = 36,152) who were aged ≥30 years without diabetic polyneuropathy (DPN). Nisar et al (2015) undertook a case-control study recruiting 152 type 2 diabetics and Amour et al (2019) undertook a cross-sectional study of 327 types 1 and 2 diabetes. The latter study lacked appropriate retrospective scrutiny of long-term blood values limiting the validity of the findings.

There are two types of diabetic neuropathy, namely distal polyneuropathy and autonomic neuropathy (Inzucchi et al., 2016). Patients with distal polyneuropathy may experience pain, tingling, burning, and numbness or muscle weakness in the limbs as it affects the sensitivity of the legs, feet, arms, and hands (Inzucchi et al., 2016). Autonomic neuropathy affects several bodily systems including digestive, urinary tract, reproductive organs, sweat glands,

eyes, and cardiovascular system. Consequently, some patients are unable to control their bladder and others may experience digestion issues such as nausea, vomiting or constipation. In addition, some men experience erectile dysfunction (Inzucchi et al., 2016). The lack of sensitivity can also cause ischaemic necrosis in people wearing tight shoes. Repetitive moderate pressure leads to tissue inflammation and ulceration (Volmer-Thole and Lobmann, 2016), leading to possible amputation. An outcome that is supported by Mantovani et al (2017) who found that ulceration increased the risk of amputation among Brazilians with diabetes. Maintaining, blood sugar levels within a target range can help the patient to slow the progress of this complication (ADA, 2019).

Al-Rubeaan et al (2015) found that the prevalence of diabetic foot complications increases with age (age≥45 years) and diabetic duration (≥ 10 years). This finding is supported by the findings of Andersen et al (2018) and Amour et al (2019). The latter study noted that age > 40 years (OR=4.3) was associated with increased risk of diabetic neuropathy, however this risk was further increased (OR= 6.4) for those over 60 years of age. Two studies (Andersen et al., 2018; Amour et al., 2019) identified an increased risk of diabetic neuropathy in patients who were overweight. While Amour et al (2019) found that hypertension was a risk factor for diabetic neuropathy.

Diabetic nephropathy

Diabetic nephropathy is defined as the presence of microalbuminuria in a person with diabetes (Eboh and Chowdhury, 2015) which can lead to worsening albuminuria, hypertension and declining renal function (Rask-Madsen and King, 2013).

In the early stages of diabetic nephropathy renal hyper-function and hypertrophy are present (El Din et al., 2017) resulting in increased albuminuria. This is followed by a thickening of the basement membrane and mesangial proliferation with normalization of Glomerular

filtration rate (GFR) but there are often no signs of clinical disease at this point (Gheith et al., 2016). The first clinically detectable sign of glomerular damage and microalbuminuria (albumin 30-300 mg/day) follow, usually occurring within 5 to 10 years after the onset of the disease with or without hypertension (Gheith et al., 2016). Chronic kidney disease (overt diabetic nephropathy) with irreversible proteinuria (>300 mg/day), decreased GFR below 60 mL/min/1.73 m^2, and sustained hypertension ensue. Finally, end-stage renal failure arises, the patient becomes Uraemic with (estimated glomerular filtration rate) eGFR $\leq$ 15 mL/min/1.73 m^2 (El Din et al., 2017). Nearly 50% of patients will need renal replacement therapy in the form of peritoneal dialysis, haemodialysis or kidney transplantation (Gheith et al., 2016). Controlling both blood pressure and blood glucose can reduce the risk and progression, of kidney disease (ADA, 2019).

In a Zimbabwean study of adult diabetic patients, Machingura et al (2017) found that nephropathy was associated with higher glycosylated haemoglobin (OR=1.2) and longer duration of diabetes (OR=1.03).

Recommendations

- Screening and diagnostic test for prediabetes and type 2 diabetes should be performed in overweight and obesity (BMI $\geq$ 25kg/m^2), and anyone who has at least one risk factor for diabetes as mentioned above. Those who have normal test results should be repeat tested within 3 years at minimum (ADA, 2019).

- For diabetic patients, blood pressure checks should be carried out in every clinical visit and they should monitor their blood pressure at home (ADA, 2019). In Thailand, according to the Thai guideline, to reduce the risk of developing diabetic nephropathy and delay diabetic complications, diabetic patients should keep blood pressure lower than 140/90 mmHg (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess

Maha Chakri Sirindhorn, 2017). However, blood pressure targets should be based on clinical status to maximise benefits and avoid adverse events. In diabetic patients living with hypertension and stable coronary disease, the ideal target blood pressure may be between 120/70 and 130/80 mmHg (Shen et al., 2019).

- Urinary albumin should be assessed in all type 1 diabetic patients and type 2 diabetic patients with duration ≥5 years (ADA, 2019). In the case of urinary albumin greater than 30 mg/g, Creatinine or eGFR less than 50 mL/min/1.73m^2, they should monitor their renal function at least a couple times a year (ADA, 2019). In Australia, type 2 diabetic patients were recommended to screen for albuminuria and eGFR annually (The Royal Australian College of General Practitioners, 2016). The prevalence of diabetic nephropathy and CKD amongst type 2 diabetes in Thailand was around 37- 49% (Krairittichai et al., 2011; Sriwijitkamol et al., 2011; Krairittichai et al., 2013).

- Diabetic patients who are not treated using lipid-lowering drugs should be measured for a lipid profile once they have been diagnosed as diabetic, at an initial medical evaluation and every 5 years. The lipid profile test should be performed, every 4-12 weeks once diabetic patients received any lipid lowering drugs, or change in the lipid lowering drug dosage, and annually (ADA, 2019).

-International guidelines adopted in Thailand recommend that Diabetic patients should have an eye examination at least once a year. In addition, adults with type 1 diabetes should have an initial dilated and comprehensive eye examination by an ophthalmologist or optometrist within 5 years of the onset of diabetes, (Zimmerman, 2016; Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; ADA, 2019) with a further follow-up on an annual or biannual basis (ADA, 2019). However, according to the General practice management of type 2 diabetes: 2016-18 (The Royal

Australian College of General Practitioners, 2016), a dilated fundus examination and visual acuity assessment should be performed in all diabetic patients on the first day once they have been diagnosed as diabetic and at least every 2 years. In addition, this guideline also recommended those who have poor glycaemic control, and patients who have longer duration of diabetes, to undergo an eye examination at least once a year.

- Annual comprehensive eye examination is also recommended for older people with diabetes (age ≥65 years), to detect retinal disease (LeRoith et al., 2019). Diabetic patients showing signs of diabetic retinopathy should receive repeat eye examinations more frequently (Zimmerman, 2016; ADA, 2019). A retrospective study by Singalavanija et al (2012) amongst 133 Thais living with diabetes who registered in a visual rehabilitation clinic, reports that approximately 85% of visual disability (impairment or blindness) was caused by diabetic retinopathy. As above, diabetic retinopathy screening was essential (Singalavanija et al., 2012). However, only approximately 45% of Thai diabetic patients living in Public Health Regional Service Provider 6th covering 8 provinces got their eyes tested (Nitikarun and Bunyong, 2018). The prevalence of diabetic retinopathy amongst Thais was around 24% (Krairittichai et al., 2013).

- Patients with T1DM should be assessed for peripheral neuropathy within 5 years of diagnosis (ADA, 2019). While other diabetic patients should be screened upon diagnosis and a repeat assessment should be undertaken annually (ADA, 2019). The assessment should include testing ankle reflex, checking the temperature sensation (cold and warm) placed on the dorsum of the foot or pinprick sensation test. In addition, a 128- Hertz (Hz) tuning fork that is placed on the dorsum of the first toe at the bony prominence should be used to check vibration sensation (Bril et al., 2018). Moreover, patients are advised to check their feet for reduced sensation using a 10-g monofilament at various sites of the sole of the feet (Baraz et al., 2014). A study by Krairittichai et al (2013), reports that more than 15% of diabetic

patients in Thailand live with foot ulcers. These findings show that diabetic complications especially foot ulcer-related diabetes are not uncommon. Krairittichai and colleagues (2013), also highlight the burden of diabetes complications in Thailand which still exist and have not improved over the past decade.

Diabetic foot ulcers can lead to amputation amongst diabetic patients, therefore people living with diabetes are recommended to obtain foot screening at least once a year. However, the frequency of meeting an expert for foot examination is varied based on the level of risk. The foot ulcer risk can be classified into three groups, low, intermediate and high risk. According to the Guidelines for screening and managing foot complications in people with diabetes published in 2015 by Department of Disease Control, Ministry of Public Health, those diabetic patients without history of foot ulcer, amputation, no foot deformity and have normal sensation are classified as low risk. Although diabetic patients without a history of foot ulcer or previous amputation will be classified as an intermediate risk if they have foot numbness (abnormal sensation), or pulse deficit. Finally, those who have foot deformity, abnormal pulse or sensation or have a history of foot ulcer or foot amputation are classified as a high-risk group. As mentioned earlier, diabetic patients with different risk levels require different levels of care, however, all diabetic patients are recommended to inspect their feet regularly and control their blood sugar. In the low-risk group, they should keep their blood sugar, lipid levels and blood pressure in range and should quit smoking with foot examination being performed once a year (Department of Disease Control, 2015). While those in the intermediate group should receive a foot examination twice a year (Department of Disease Control, 2015). The high-risk group are prescribed special footwear which will support their foot anatomy. They are also recommended to receive a complex foot examination by an expert every 3 months (Department of Disease Control, 2015). Although foot ulcers are found amongst diabetic patients in Thailand, and it can cause serious

conditions, wearing proper shoes is important and can prevent or delay diabetic neuropathy, a recent study reported that most of the diabetic patients (study participants) (93%) still wore inappropriate footwear (slipper) when going outdoors (Kosachunhanun et al., 2012). The HV can play a role here in educating patients.

3.8 Treatment

The HV is a key person living in the community who provides care for people in their neighbourhood. In chapter 2 the readers were introduced to the HVs' role regarding proactive and reactive diabetes management which included both healthy people and people living with diabetes. Diabetics are recommended to modify their lifestyle and some are also prescribed drugs to manage their diabetes at home. To avoid unwanted harmful complications and maintain effective diabetic management, it is necessary for the HVs to have sufficient knowledge about the conventional treatments and target blood sugar range which are shown below.

Target for glycaemic control

As discussed in chapter 2, to avoid potential diabetic complications, the patients should be regulating their blood sugar range. The HVs have a responsibility to perform finger pricks and interpret the blood sugar results as well as monitoring the patient's blood sugar level. Hence, they should be knowledgeable regarding the target blood sugar.

Diabetes is a chronic illness and people require continuous care following diagnosis (Ontha, 2016). Several diabetic guidelines recommend diabetic patients regulate their blood sugar to delay/avoid its complications, reduce medical costs and improve the patient's quality of life (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; Diabetes Canada Clinical Practice

Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019). Target glycaemic control differs between guidelines. The recommended value for a fasting blood sugar (FBS) in the Thailand guideline (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017) and other international guidelines (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019) is between 3.8-7.2 mmol/L. Optimum HbA1C for the majority of guideline is recommended to be <6.5% (< 47 mmol/mol) (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019) or <7% (<53mmol/mol) in people who frequently experience hypoglycemia (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes Association, 2019)

However, several pieces of evidence suggest that diabetic patients are unable to independently control their blood sugar (Ovatakanont, 2011; Ngwogu et al., 2012; Viana et al., 2013; Ashur et al., 2016; Mahmood et al., 2016; Mauricio et al., 2017; Noor et al., 2017; Li et al., 2018; Afroz et al., 2019; Biesman-Simons et al., 2019; Chetoui et al., 2020; Viengthong and Arkhom Bunloet, 2020; Cedrick et al., 2021; Oluma et al., 2021). The

prevalence of poor glycaemic control is common, ranging from 50-85% in international diabetic patients. In Thailand, between 73.7% to 76.4% of diabetics could not keep their blood sugar within range (Ovatakanont, 2011; Suwattanakul, 2018; Viengthong and Arkhom Bunloet, 2020). This statistic is similar to other countries in South America, Africa and Asia, including China (50%) (Li et al., 2018), Malaysia (68%) (Mahmood et al., 2016) and Bangladesh (82%) (Afroz et al., 2019, Nigeria (62%) (Ngwogu et al., 2012), Morocco (66.3%) (Chetoui et al., 2020), South Africa (75%) (Biesman-Simons, et al., 2019), Congo (78%) (Cedrick et al., 2021), Libya (78.2%) (Ashur et al., 2016), and Sudan (85%) (Noor et al., 2017) and Brazil (74%) (Viana et al., 2013). However, the number of diabetic patients who were unable to control their blood sugar within target recommendations was also noted in developed countries (Mauricio et al., 2017). A retrospective longitudinal analysis of medical records in European countries and the USA by Mauricio and colleagues (2017) reported that less than one-third of 40,627 patients who were treated by basal insulin achieved target blood glucose levels (HbA1C=<7%). To overcome these issues, some have suggested that a home visit is needed to provide the patient with education and support (Kanyakan et al., 2019). The benefits of a home visit for diabetic patients in controlling blood sugar have been shown previously (Depinta, 2010; Sirithanawutichai et al., 2010). The home visit is viewed as an effective method for keeping blood sugar under control, it is also shown to improve the diabetic patient's quality of life and lowers the risk for heart disease (Han et al., 2017). It allows two-way communication between patients and healthcare providers (Depinta, 2010) allowing the healthcare professional to assess the patient's knowledge and remedy any deficit (Depinta, 2010). Home Visits are beneficial in diabetes management in Thailand (Depinta, 2010).

Hypoglycaemia treatment

In Thailand, treatment for hypoglycaemia is similar to the international guidelines as hypoglycaemia is mainly treated by fast-acting oral carbohydrate such as 15 g carbohydrate equivalent to three to four glucose tablets, 1/2 cup fruit juice, half cup of soft drink or a cup of milk, while glucagon or 50% intravenous glucose is used in severe hypoglycaemia. However, Glucagon 1 Mg solution is not widely available in Thailand due to the high cost (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017). The Thai guidelines also include information about the preventions of hypoglycaemia by highlighting the importance of educating patients, their relatives and the care giver about the associated risk factors of hypoglycaemia. In addition, the patients are supported to perform SMBG and monitor their blood sugar regularly. Glycaemic target is adjusted to avoid hypoglycaemia (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017).

3.8.1 Non-pharmacological treatment

Diet

As mentioned previously, the HVs provide a piece of advice about diet to the patients in the community that the patients should consume more fibre and low fat and try to avoid salt, sweet food, and alcohol. This means adequate knowledge about diet for diabetes is very important for the HVs.

Each patient should have their diet reviewed and a meal planner provided (ADA, 2019). To achieve the patient's glycaemic target and weight management, the health professional should recommend that the patient should control their food portions and include healthy foods such as vegetables (ADA, 2019) which was mentioned earlier in risk factors section.

Exercise

As above, doing exercise regularly is beneficial for diabetic management. The HVs have a responsibility to provide suitable advices about exercise for the patients. They must have optimal knowledge regarding this topic.

Adult diabetic patients should undertake a regular exercise programme in line with the current recommendations that are outlined earlier in the chapter. Whilst this earlier section focussed on the prevention of diabetes there is also good evidence for the use of exercise in the management of established diabetes.

Diabetes self-management education

In this section, the researcher will discuss diabetes self-management education that the HVs used to educate patients to manage thrive diabetes.

Self-management is seen as the holy grail of long-term chronic care. Patients learn how to manage themselves and the health provider learns how to provide appropriate support to the patient (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017). It is therefore essential that all patients receive information when first diagnosed and this education is ongoing with each patient agreeing a diabetic treatment goal (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017). According to the Thailand clinical practice guideline for diabetes (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017), essential learning topics for diabetic patients include: general knowledge about diabetes, diet, physical activity, diabetic drugs and their effects, blood sugar assessment at home and the blood sugar result evaluation, diabetic complications, daily self-care, foot care and self-care in special circumstances, such

as self-care when ill. Each diabetic patient's understanding and their need for diabetes self-management education and support should be assessed upon diagnosis, at annual review, during transition of care services and when they develop diabetic complications (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; ADA, 2019).

There is some evidence that such interventions are effective in reducing the complications of the condition. Welch et al (2011) and Tshiananga et al (2012) reported that following enrolment in a self-management education programme diabetic patients HbA1c results improved. Indeed, Steinsbekk et al (2012) found that following access to a group-based diabetes self-management programme, Type 2 diabetic patients' knowledge about diabetes, self-management skill and glycaemic control (HbA1C and fasting blood sugar were significantly reduced) all improved. Similarly, Chai et al (2018) found that newly diagnosed type 2 diabetic patients' glycosylated haemoglobin and fasting blood glucose reduced following a 6 months diabetes self-management programme. In addition, Healy et al (2013) reported reduced readmissions in diabetic patients with previous poor glycaemic control following the receipt of training delivered by a certified diabetes educator or trainee. El Toony et al (2018) showed that Muslim diabetic patients receiving individual diabetic education sessions prior to Ramadan reduced their glycaemic risk and cholesterol levels.

3.8.2 Pharmacological treatment

According to chapter 2, the HVs' role regarding diabetes is to assess the patient's health and to ensure that they are managing their condition effectively. This includes their diet, exercise, and medication use. They contact and ask the patient to continue the blood sugar lowering drug and meet with the doctor regularly. They also provide diabetic medical advice to the patients. If patients could not go to the hospital, the HVs deliver diabetic drugs from the

healthcare facility to the patients directly. Therefore, the HVs must pose sufficient knowledge of the pharmacological treatment. In this section, the researcher will describe the current diabetic drugs which are recommended by the diabetes guidelines.

All the international guidelines that have been discussed previously recommend that lifestyle modification should be attempted before prescribing medication in type 2 diabetes

Type 2 diabetes can be treated by tablet or insulin injection or a combination of both (ADA, 2019). Metformin is recommended as the first-line treatment for type 2 diabetes in all eight diabetic guidelines and previous studies (NICE, 2015; McGuire et al., 2016; LeRoith et al., 2019). In addition, dual therapy using a combination of Metformin with a DPP-4 inhibitor or pioglitazone or sulfonylurea is appropriate if the HbA1c is not controlled by taking Metformin. Employing triple therapy (treatment with 3 non-insulin drugs or any treatment combination with insulin) is also considered when the HbA1c levels are not controlled using dual drug therapy. Indeed, the National Institute for Health and Care Excellence (NICE) in the UK recommend insulin-based treatment for type 2 diabetic patients who did not succeed in controlling HbA1c levels by the use of oral drug therapy (NICE, 2015; McGuire et al., 2016).

There are several factors that should be considered when selecting pharmacologic treatment, such as diabetic complications, hypoglycaemic risk, side effects, weight, cost and patient preference (ADA, 2019).

As mentioned previously, type 1 diabetes is caused by ß -cell destruction and absolute insulin deficiency. It is therefore necessary to receive external insulin (Otto-Buczkowska and Jainta, 2018). Insulin is therefore a primary treatment for the patient with type 1 diabetes (Freeland and Farber, 2016). The majority of type 1 diabetics require multiple daily insulin injections (Freeland and Farber, 2016; ADA, 2019). The insulin dosage is based on each patient's

weight, which increases if the person becomes ill or pregnant (ADA, 2019). There are various forms of insulin available, characterised by their mode of action (Ahmad, 2014) and concentration (Freeland and Farber, 2016). Rapid-acting insulin has a rapid onset of action, around 15-30 minutes and a short activity duration of around 4-5 hours. The peak action occurring between 30 and 90 minutes (Ahmad, 2014). Short-acting insulin has an action onset of around 30- 60 minutes, peak action of around 2-4 hours and has an activity duration of approximately 6-8 hours. Intermediate-acting insulin has an action onset, activity duration and peak duration greater than the rapid and short-acting insulin. Its onset action occurs within 1-2 hours, peak action between 6-10 hours and a working duration of around 10-16 hours. Long-acting insulin has the longest functional duration (over 36 hours) when compared with other kinds of insulin. This form of insulin possesses an onset action of around 2 hours and a peak time of between 6-20 hours (Ahmad, 2014).

Beck et al (2017) state that using injected insulin can cause severe hypoglycaemia in type 1 diabetic patients. Moreover, Terauchi et al (2016) reported that type 2 diabetic patients who were treated with concentrated insulin (glargine 300 Units per millilitre (U/mL) and glargine 100 U/mL) experienced hypoglycaemia. These findings are supported by the results of a study by Emral et al (2017) that was undertaken to study insulin treated diabetic patients across 9 countries. The authors reported that hypoglycaemia was a common complication of insulin treated diabetes, reporting incidence of 97.4% and 95.3% in type 1 and type 2 diabetes respectively.

It is therefore clear that injected insulin is not without its difficulties such as hypoglycaemia, weight gain and psychological stress (Priya and Kalra, 2018). Inhaled insulin is now an alternative to injected insulin (Nuffer and Trujillo, 2016) as it can be used to fulfil the gap of using conventional insulin injections such as needle phobia or incorrect injection

technique (Oleck et al., 2016). However, unlike injected insulin, inhaled insulin is subject to the efficiency of lung function hence a pulmonary function test should be performed before initial prescription, after 6 months and annually thereafter (Freeland and Farber, 2016). In addition, inhaled insulin is not recommended in smokers (Mikhail, 2017). Moreover, inhaled insulin can increase the risk of lung cancer (Oleck et al., 2016).

Oral-noninsulin drugs can be used as an adjunctive treatment to insulin therapy (Otto-Buczkowska and Machnica, 2009; Otto-Buczkowska and Jainta, 2018). Biguanides are the first adjunctive treatment option (Otto-Buczkowska and Jainta, 2018). Metformin is introduced with an aim of lowering insulin resistance and reducing insulin dosage, maintaining weight and reducing risk of diabetic complications (Priya and Kalra, 2018). Al Khalifah et al (2017) found that the addition of Metformin to T1DM patients produced a reduction of BMI and total insulin daily dose. However, whilst Konrad et al (2015) also found that the addition of metformin can reduce BMI, the use of metformin as an adjunctive treatment did not improve blood sugar levels or insulin requirement in type 1 diabetic patients. Although, Al Khalifah et al's (2017) sample was similar to that of Konrad et al (2015) (type 1 diabetic adolescent and children), they employed different study designs. Al Khalifah et al (2017) undertook a systematic review and meta-analysis that included six high quality randomised control trials (RCT) (included RCTs were assessed for quality and the risk of bias) that compared patients using both insulin and additional Metformin with those who received placebo alone. While Konrad et al (2015), compared participants using insulin and additional metformin with patients receiving only insulin.

Dapagliflozin is a Sodium-Glucose Co- Transporter 2 Inhibitor (SGLT-2 Inhibitors). Wilding et al (2012) reports the use of this drug in reducing HbA1c levels, daily insulin dose and body weight in type 2 diabetic patients. These results are congruent with a similar study

focussed on T1DM patients (Henry et al., 2015). The combination of injected insulin and a SGLT-2 Inhibitor (sotagliflozin) was also associated with the reduction in blood sugar levels, weight, insulin dose and SBP in patients with T1DM (Garg et al., 2017).

As mentioned previously, diabetes is increasing in Thailand, possibly due to a change in dietary pattern and unhealthy lifestyle including lack of exercise, high consumption of sugar and a lack of fruit and vegetables caused by urbanisation. Although, sugary drink taxation has been introduced; it has not been officially started in Thailand. Numerous strategies and healthcare services have been launched by the government to reduce the prevalence of diabetes including health promotion and disease prevention (Chavasit et al., 2017). Disease screening and monitoring is seen as one means of early detection and managing risk. The nurse and HVs are key to the success of this approach (Chavasit et al., 2017).

3.9 Conclusion

This chapter provides an overview of the complications, assessments and treatments associated with diabetes that are underpinned by the current international guidelines. It is clear from the literature that much of the prevention and management of diabetes is related to the reduction of factors that are associated with increased risk for those in the pre diabetes stage whilst reducing and managing risk in those with a confirmed diagnosis of diabetes. It is evident that ongoing assessment and support are crucial to the reduction of both morbidity and mortality of diabetic patients. This level of support is often dictated by the healthcare infrastructure in different countries both within the developed and developing world.

As mentioned previously, HVs are involved in numerous healthcare services in the community including health promotion, diabetes prevention and diabetes management. In the primary care setting, the HVs perform screening for diabetes. They monitor the patient's

blood pressure, blood sugar levels and diabetes complications. They also provide advice about healthy lifestyle and to see if the patient is taking responsibility for their health and are following the treatment guidelines. They then report the results and refer the patients to see the healthcare staff if they require advanced health services. Therefore, it is essential that the HVs possess adequate knowledge about diabetes and on the associated risks.

Based on the literature, although Thailand launch UHC with the aim of expanding the healthcare service to cover all areas, diabetes management in Thailand still has several issues, especially screening and diagnosis for new diabetic patients which may due to the financial problems and the healthcare worker shortage. The high volume of the patients, waiting for the service in a public hospital affects the accessibility of some patients especially in remote areas. Therefore, the previous study highlighted the investment in primary health care sector, which is the initial healthcare service before distributing the patients to the upper levels. As we have seen in chapter 2, the HVs received formal trainings regarding diabetes, however, the literature pointed that existing training may not adequate for the HVs, and the HVs require additional training before providing the service regarding diabetes. The literature also recommended that regular training should be offered to the HVs to improve knowledge and skills.

In Thailand, the HVs play a key role in supporting the nurse to care for people with diabetes in the community. However, they have little training and work only a few days per month. Furthermore, little is known about their knowledge of diabetes care or how they have generated this knowledge. To ensure that patients receive accurate information and are adequately supported it is essential to better understand the HVs knowledge of diabetes and how and where this knowledge is generated. In order to do this, I will familiarise the reader with seven commonly used learning theories, including Experiential learning theory,

Constructivism learning theory, Transformative learning theory, Social-cognitive learning theory, Cognitive learning theory, and Behaviourist learning theory.

Reflexibility (the researcher point of view)

Although there are many public health campaigns or policies in Thailand to reduce the number of cases and control the loss of life or disability, it seems to be ineffective as there are more and more people with diabetes. Diabetics are patients who need ongoing care and strictly control their sugar levels. This can be seen from the large number of new and old patients queuing for treatment. Many of those went to see a doctor once their prognosis get worse and was sometimes unable to heal in time. Many people in the community are not receiving systemic treatment. On the other hand, the limited availability of healthcare staff makes it impossible to provide complete care to patients. In the view of the researcher who is a nurse, it will be better to prevent patients from gathering at the hospital. These groups of people should be screened and educated on how to take care of themself and only referred to the doctor when necessary to reduce overclouded. They should have been treated early in the community where they spent most of their lives. A hospital is just a temporary health care facility where patients come to receive treatment or complex care. After that, patients must return to their homes in the community. Therefore, diabetes care should begin at home and in the community as opposed to hospital-based. Visiting patients at home gives us a glimpse into the real condition of the patient, diet, self-care, medication storage, environment, caregivers, social support, finance, or even the limitations of health care. This allows us to provide appropriate care to patients. Nevertheless, with a limited number of personnel and many people with diabetes in the community. Nurses are also required to provide health care services other than diabetes, which may result in inadequate care. The personnel do not live in the community, so each time they enter the patient's property

requires an appointment in advance. The fact that nurses are not part of the community causes a delay in receiving the news. Sometimes on home visits, it is found that the patient has already passed away. Sometimes, they visit patients and only see their relatives because the patient is busy and goes to work, making it impossible to follow up with the patient regularly.

Therefore, HV is considered an important person in helping nurses to access the health of patients in the community because the HV lives in the community and is familiar with the people in the community. They can quickly disseminate information and public health policies to the community and be a leader in community health activities. They are also able to report patient health status at any time. In addition, the power and relationship of the HV with the community facilitates the nurses working in the community to be collaborative and gain the trust of the community. Even with the requirement that the HV works only 1 day a week. But because the HVs live in the community and the people that they take care of are in nearby areas or neighbours, making they meet almost every day. Many times, it is found that the HV reports and consults the patient's symptoms more than once a week. In addition, the HV also deliver medicine on behalf of the patient in case the patient is unable to come by themself. The HV also knows the movements of the people in the community as can be seen that the HV knows the household detail including how many family members are in each house, and who get ill with any disease, prognosis, lifestyle as well as health behaviour. This allows the nurses to have in-depth access to patient information to use as a guideline for further service planning. Volunteers help the nurses save time and allow the nurses to focus on complex tasks. The information obtained from the HV allows the nurses to approach the patients quickly. By using the information provided by the HV, the patient will receive the care in time and obtain continuous service with no need to waste time in the queue at the hospital again.

Perrin (2015: 43) suggests that "Voluntary choice involves an agreement to participate in research after individuals understand every aspect of the study, and they must be free of coercion and undue influence". Coercion occurs when the participants were forced to participate in the study or sign consent form by those in power (Perrin, 2015). The power imbalance in research has been reported in past studies (Anyan, 2013; Redman-MacLaren et al., 2014; Byrne et al., 2015; Wood et al., 2019). This asymmetric power of research parties may be influenced by socioeconomic status, educational attainment, gender, and ethnic and occupational background. Therefore, several studies attempted to minimize the power imbalance in research (Redman-MacLaren et al., 2014; Byrne et al., 2015; Wood et al., 2019) by employing strategies such as peer interviewing (Byrne et al., 2015), building rapport (Wood et al., 2019) and co-interviewing across culture and gender (Redman-MacLaren et al., 2014). However, these methods have some limitations, for example Byrne et al. (2015) found that the interviewees showed guarded responses as they felt uncomfortable when being interviewed by their peer. The interviewees feared being judged by their peers. Byrne et al. (2015) also found that culture and gender match were important, but it would be impossible to match all cultural backgrounds for all parties, matching only common characteristics was deemed to be useful. Although gender matching may help to reduce the power imbalance between parties, it would only benefit some female participants (Byrne et al., 2015). In this study, the researcher was a female nurse, while the participants were mainly female HVs who were lay people. In this instance the researcher's educational and professional background may produce a potential power difference thus while gender matching took place power differentials may still exist. Therefore, to ensure that my position did not affect the research relationship with the HVs and their future role, the researcher made it clear that participating in the study was voluntary and the HVs were free to decide if they want to take part in the study without any negative consequences to their role.

In addition, the researcher distributed the participant information sheet which explained the purpose of the study and outlined the expectations of the HV, if they chose to participate in the study. HVs were made aware that they have the right to withdraw from the study at any time without the need for an explanation.

Chapter 4 Learning theory

4.1 Introduction

As this study aimed to assess the HVs' knowledge of diabetes and their learning experiences, it was essential to understand the different learning theories that underpin these experiences. In addition, having a greater understanding of these theories can help the educator to choose, apply and design the approach to learning and an assessment which is suitable for the learner (Aliakbari et al., 2015) thus enhancing the learner's experiences (Mukhalalati and Taylor, 2019). This chapter will describe and discuss seven predominant learning theories as well as the benefits and limitations of different learning theories namely, Experiential learning theory, Constructivism learning theory, Transformative learning theory, Social-cognitive learning theory, Cognitive learning theory, Behaviourist learning theory and adult learning theory.

4.2 Experiential learning theory

David Kolb developed Experiential learning theory (ELT), which was influenced by the work of Dewey, Lewin and Piaget (McCarthy, 2010). Kolb (1984, p. 38) describes ELT as a "process whereby knowledge is created through the transformation of experience". To successfully engage in the learning process, the learner must experience all four elements of the learning cycle, namely Concrete experience (CE), Reflective observation (RO), Abstract conceptualization (AC) and Active experimentation (AE) (McCarthy, 2010). The roles of teacher can be classified into facilitator, subject expert, evaluator and coach. The teacher's role is to help the learner to reflect then connect to the knowledge. They set the knowledge requirement and the activities that help the learner to meet the standard of performance required. They can employ a variety of strategies to help the learner achieve their goal (Kolb and Kolb, 2017). ELT develops the student's thinking and problem-solving skills (Akella,

2010; Krbec and Currie, 2010). ELT also promotes teamwork and develops the student's communication skills and listening skills (Krbec and Currie, 2010). ELT was used as a framework to support the learning of 15 multidisciplinary teams in a study focused on Creutzfeldt-Jakob disease by D'Amour and Guimond (2010). The findings showed that the teams worked effectively and increased their knowledge and skills whilst encouraging reflective practice. However, ELT has been criticised for focusing solely on experience and individual knowledge development and ignoring the social context of experience (Mukhalalati and Taylor, 2019). In addition, this learning process does not take the unconscious learning process and defence mechanism into consideration (Akella, 2010).

4.3 Constructivism learning theory

Constructivism learning theory (CLT) refutes the idea that the learner is the passive recipient and argues that the learner constructs, and develops new knowledge based on their previous learning (Bada and Olusegun, 2015). Supporters of CLT believe the learner constructs their knowledge by interacting with the environment then adjusts their mental structure based on existing knowledge (Kay and Kibble, 2016). John Dewey and Jean Piaget are considered as the most influential constructivism learning theorists (Bada and Olusegun, 2015). Piaget pointed out that people added new information to their schema of existing knowledge where the learner constructs their knowledge (Yilmaz, 2011; Alanazi, 2016). Meaning that the learner develops and constructs their knowledge based on their individual experience and prior knowledge (Alanazi, 2016). While John Dewey argued that children discover by doing, he supported hands-on learning as it allows the student to learn a new skill (Sikandar, 2016). The learner is a sense maker, not a simple recorder, as cognitivists claim, (Kay and Kibble, 2016). CLT advocates that the learner is an active learner (Kay and Kibble, 2016) and the approach is therefore student-centred (Hartle et al., 2012). The teacher acts as a facilitator

providing essential tools and situations for learners to construct their knowledge through problem- solving (Kay and Kibble, 2016). Knowledge is shared between the student and teacher (Bada and Olusegun, 2015).

CLT promotes social and communication skills via collaboration and exchange of ideas. The learner learns more when they are actively involved in the class (Bada and Olusegun, 2015). A study by Zain et al (2012) employed a student-centred approach in a mathematics classroom. The results showed that where the learners were less passive, they were responsible for their studies both in and out of the classroom. In addition, they felt comfortable sharing ideas with the team members in a non-threatening environment (Zain et al., 2012).

4.4 Transformative learning theory

Transformative learning theory (TL) is adult learning and education which was developed by Jack Meziro (Biasin, 2018). TL supporters believe that learning takes place when the learner forms and reforms, meaning (Bouchard, 2018), in TL the learners making sense of their experiences (Rahman and Hoque, 2017). TL is the process of critical reflection that challenges and transforms the learner's assumptions (frame of reference) (Mezirow, 1997). The role of a teacher is to provide an opportunity for the learner to effectively participate in the discussion and help the learner to be more critical of their assumption, while the learner's role is to actively participate in the discourse (Rahman and Hoque, 2017). However, TL has some limitations, as it is heavily focused on building critical reflection, but ignores the role of long term and unconscious memory (implicit memory) that can influence behaviour (Mukhalalati and Taylor, 2019). In addition, as TL is an adult learning theory, it may not be applied in childhood, children learn differently from adults, young people's learning depends on modelling activities, environmental interactions, scaffolding and observation, while adult

learning is distinguished by different patterns such as life experiences and transformation (Edosomwan, 2016). The benefits of TL were reported by Jackson et al (2013), Bernard, (2019) and Gwon and Thongpriwan (2019). Gwon and Thongpriwan (2019) used TL to structure a teaching project using Photovoice with 96 pre-nursing students in the US. Students were divided into a small group and asked about the US health care system. The findings showed that TL benefits on both teaching and learning aspects, as it enhanced teaching effectively, and optimised the learner's learning outcome. TL was also employed in sensitive topic teaching; Jackson et al (2013) performed a one-day workshop (e.g. personal stories, autobiography, film) with 56 Australian postgraduate students including nursing and health-related fields. Those students were grouped and engaged with learning material and other students by the facilitators as the aim to enhance personal and group critical reflexibility through the wide range of learning approaches developed based on TL. The learners described the workshop as positive, feeling transformed by the workshop content, a safe environment, and they felt more appreciative of another worldview.

4.5 Social cognitive learning theory

Social cognitive learning theory (SCT) believes that the environment shaping the learner's behaviour, and the learner's response are the results of vicarious reinforcement such as modelling (Kay and Kibble, 2016). Learning was defined as an increase, decrease, or maintaining the level of identified observable behaviours (Kay and Kibble, 2016). SCL can be called observational learning, as people learn through observing their model (Dodhi, 2017, p. 51). Bandura introduced four principles of social learning including, attention, retention, reproduction and motivation (Dodhi, 2017, p. 51). As four factors mentioned earlier, people pay attention to the model, and then remember what the model has done, then they imitate their model's behaviour, and are motivated to imitate behaviour when they see

their model being rewarded or punished based on the consequence of behaviour (Dodhi, 2017, p. 51). This theory emphasizes internal aspects rather than external aspects (Aliakbari et al., 2015). In this theory, the teacher acts as a facilitator to provide a supportive learning environment for the learner (Taylor and Hamdy, 2013) while the learner responds to the environmental stimuli and repeats desired behaviours and minimises undesirable behaviours (Kay and Kibble, 2016). A study by Shojaei et al (2017) developed an educational programme on low back pain (LBP) following Social cognitive learning theory (SCT) for the health care workers in Iran; those 125 participants were separated into intervention (N=63) and control group (N=62). The intervention group received an educational programme, while the control group did not receive any programme. Several methods such as guide practice, reward, verbal persuasion, goal setting as well as promoting self-efficacy were used in the study. The findings show the intervention group had a better condition of low back pain when compared with the control group. The use of SCT showed effective results (Toruner and Savaser, 2010). As SCT defines human behaviour as personal factors, social behaviour, and environmental interactions (Bandura,1986), the study of Toruner and Savaser (2010) performed a controlled evaluation of school-based obesity prevention in fourth-grade children from two elementary schools in Turkey, the author employed the SCT concept including personal, behavioural, and environmental components to design the school-based weight management programme which included seven training session about self-recognition, self-expression, healthy nutrition, physical exercises, the negative effects of a sedentary life, and goal setting issues. These activities were performed through game methods and short messages relating to the issues in classroom lessons for the intervention group during a two and a half month period (each session took around 1-2 hours), in addition, two training sessions about causes and factors of obesity, the effects of obesity on health, and effective action plans against obesity, personal advice regarding the organization of the

lifestyle such as diet, activity, and screen time of children and parents within the family were designed and given to the parents of the intervention group. Both the intervention group (41 pupils with obese/overweight) and control group (40 pupils with obese/overweight) were evaluated for Body Mass Index (BMI) using percentile curves developed specifically for Turkey by Bundak et al (2006), self-assessment of healthy life behaviour, pre-test and post-test the understanding of obesity, obesity-related health problems, awareness of healthy living, nutrition, and physical activity habits. The results showed that the BMI of the intervention group was significantly lower than the control group. In addition, the intervention group had a higher post-test score than the control group. Although the findings of the study of Toruner and Savaser (2010) showed the positive aspects of employing SCT to structure the weight management programme, there were limitations as the study did not assess other factors such as school diet which can affect the participant's BMI, in addition, as BMI was measured by the criteria which were developed for Turkey, hence the finding may not be universal and may not be applied to other ethnic groups who used different assessment tools. Furthermore, the study stated that the child's family is vital as they are involved in the children's health promotion such as encouraging physical activity, providing the children's diet and being a role model of healthy living, hence the lack of engagement of the parents of the intervention group in the training sessions (only 44%, only 18 parents out of 41), may affect the study results.

4.6 Cognitive learning theory

Cognitive learning theory contends that learning occurs in the mind and psychological processes rather than behaviour (Aliakbari et al., 2015). This learning theory focuses on consciousness, thinking, understanding, and organising (Aliakbari et al., 2015), and highlights what the people know, how they obtain the information and relate to existing

knowledge rather than what they do (Yilmaz, 2011). Cognitive theorists dispute the main tenets of behaviourism arguing that learning cannot be observed directly as people need time to change their behaviour (Aliakbari et al., 2015). Cognitivism challenges behaviourism as human behaviour is always based on cognition instead of rewards or reinforcement (Muhajirah, 2020). Piaget's Theory of Cognitive Development and Vygotsky's Social Cognitivism are the two significant cognitive learning theories. A literature review by Mukhalalati and Taylor (2019), focussing on learning theories employed in healthcare education found that cognitive learning theory was limited as it did not consider learning as a social construct.

In cognitive learning theory, the learner plays a role as an information processor, collects information, and stocks it in memory. People learn through the acquisition of knowledge. Cognitive learning theory is teacher-centred as the teacher prepares the learning programme to encourage the learner to integrate new information with prior knowledge (Clark, 2018). As a result, the learner can develop an understanding level such as long-term memory and deep learning (Kay and Kibble, 2016). The learners are responsible for being active agents in the learning process, as they have to stay active to continue and reproduce their knowledge and skills (Kay and Kibble, 2016; Clark, 2018). According to this learning theory the learner relates new information to their existing knowledge; learning strategies such as summary, reading prompts, note-taking and questions were employed to relate new information to prior information (Hunt and Chalmers, 2012).

4.7 Behaviourist learning theory

Behaviourism is a theory that explains that learning takes place through observing behaviour (Kay and Kibble, 2016). Learning is defined as the acquisition of new behaviour (Dodhi, 2017, p. 48). Behaviourist theorists explain how the environment modifies people's

behaviours (Dodhi, 2017, p. 50), and believe that the environment shapes the learner's response leading to a learned behaviour acquired through an interaction with the environment/stimulus (Aliakbari et al., 2015). Behaviourists believe that reinforcement and rewards from the environment control human behaviour (Muhajirah, 2020). Positive reinforcement can increase the probability of an activity being repeated (Aliakbari et al., 2015). Whereas punishment or negative reinforcement results in behaviour avoidance (Kay and Kibble, 2016). Ivan Pavlov, first reported the principle of the behaviourist theory classical conditioning, (Aliakbari et al., 2015). Pavlov's experiment showed that dogs present an unconditioned response to an unconditioned stimulus and present a conditional response to a conditioned stimulus. Another famous influencer is Skinner, who introduced an operant conditioning. Skinner set an environment box for a rat that received food when it pressed a bar. His findings showed that the rats repeated the behaviour when they gained pleasant effects (food), on the other hand, their behaviours were less likely to be repeated if their action had unpleasant effects (Dodhi, 2017, p. 49). The probability of the behaviour was influenced by consequences of actions; therefore, reinforcement and punishment are two key concepts of the Pavlov's classical condition (Dodhi, 2017, p. 49). Behaviourists highlight reinforcement in the learning process (Goodluck, 2010), as it may influence the learner's motivation or willingness to take part in certain behaviours (Goodluck, 2010). Reinforcement is an important tool in behaviourism because it increases the desirable behaviours (Goodluck, 2010). In addition, it is easy to apply in numerous settings and can be used in both adult and young learners (Goodluck, 2010)

In Behaviourist learning theory the teacher is seen as key to the promotion of learning (Hunt and Chalmers, 2012; Kay and Kibble, 2016). The teacher provides the appropriate stimuli and reinforcement, as well as controlling the learning environment (Aliakbari et al., 2015). The teacher is the owner of knowledge, while the learner is seen simply as a passive recipient

(Hunt and Chalmers, 2012) of the environmental stimulus (Aliakbari et al., 2015; Kay and Kibble, 2016).

Behaviourism employs practice and repetition to reinforce skills and memory association, in addition, the use of rewards, incentives and penalties (Hunt and Chalmers, 2012). However, whilst the theory emphasises the change in observable behaviour, it does not acknowledge the cognitive or affective components (Kay and Kibble, 2016). Although behaviourists highlight and observe the human's habits, they ignore the human's memory and refuse to explain why humans store or recall their habits (York and Ertmer, 2016) which is different from cognitive learning theory which focusses on how people receive, store and organise information (learning process) (York and Ertmer, 2016). This learning theory does not pay attention to mental aspects such as feelings, interests and intelligence (Muhajirah, 2020), and has limitations as this learning theory is reliant on the learner, whose behaviour is reliant on reinforcement, hence the whole process is time consuming and slow (Aliakbari et al., 2015). As this learning is driven by reinforcement and punishment, it means that learning does not occur without stimulus or reinforcement (Rostami and Khadjooi, 2010) and that the behaviour can regress once the stimulus or reinforcement is removed. In addition, behavioural theory has a lack of clarity about the best method to assess the outcomes, and this learning theory ignores the social aspects of learning (Mukhalalati and Taylor, 2019). Finally, the use of this learning is limited as it cannot be applied to explain the acquisition of high-level skills (York and Ertmer, 2016).

4.8 Adult learning theory

Adult learning theory or andragogy was developed by Malcolm Knowles (Merriam, 2017). This theory aims to show how adults learn and it is distinct from children's learning (Cochran and Brown, 2016). Andragogy and pedagogy are learning theory, however, the student in

pedagogy is dependent on the teacher for knowledge, while andragogy is learner centred (Cochran and Brown, 2016) with the teacher playing the role of facilitator. There were 6 main assumptions of Knowles's adult learning theory namely the need to know, self-concept, adult learner prior experience, readiness to learn, the orientation of learning, and motivation to learn. Adults have unique learning needs unlike children (Rodrigues, 2012). Adults need to know why they must learn before starting learning (Falasca, 2011; Rodrigues, 2012; Merriam, 2017). Adults have an existing knowledge base and life experience, they accumulate and reservoir their experience which becomes their learning resource (Rodrigues, 2012). Adults learn better from their experiences and their past knowledge (Falasca, 2011). They seek out continuous learning based on personal interests, wants, and needs (Falasca, 2011). The learners (adults) may have different backgrounds, motivations, learning styles and needs, therefore, it is necessary to take these factors into the consideration in the learning process (Rodrigues, 2012). For example, to provide a classroom atmosphere where the learner can share their experience through collaboration (Rodrigues, 2012). Adults are motivated to learn if they realise what they learn will apply to their work or their life (Knowles, et al., 2005). Adults are motivated to learn by internal factors rather than external ones (Falasca, 2011; Merriam, 2017). Adults are likely to have more motivation to learn which helps them to solve the problem or to achieve internal or external rewards (Rodrigues, 2012). Time constraints and attitudes toward learning are barriers which can obstruct internal motivators (Rodrigues, 2012). However, andragogy has been criticised as the focus is solely on how individuals learn and ignores the social and political context in which the learning takes place (Merriam, 2017). In addition, the effects of ageing including loss of vision and hearing is likely to affect the capacity for learning of adults who take part in informal adult education (Falasca, 2011). In addition, the changes in health from acute and chronic illnesses, leaves adults with little energy or motivation to engage in learning activities

(Falasca, 2011). The change in family roles and work roles affect adult learning (Falasca, 2011).

Most of the HVs in Thailand are aged 40 and over, therefore the principles of adult learning theory may dominate the HVs learning, for example, adults may want to know the reason why they have to learn, therefore the purpose of learning should be provided for the HVs before starting the training. In chapter 2 I reported how the HVs came from a variety of educational backgrounds, therefore, they may reservoir information and experience, and then use their prior experience and knowledge to facilitate their learning. In addition, the HVs may be motivated to learn and ready to learn to improve their work tasks, however, physical function, the family role and the job role may negatively affect their learning.

The HVs have provided service within the community for several decades. They are involved in a variety of disease management programmes including diabetes. They may learn about diabetes through experience or by observing the nurse.

In addition, the HVs attend formal training which is mainly taking place in the classroom. The learning environment and the training strategies are also affecting and facilitating the HVs learning. As mentioned above, the use of teacher centre and learner centre may have consequences on the learning of the HVs.

In the literature, the incentive was a key factor for HVs to engage with the activity and was related to retention in other countries. In Thailand, although the HVs earn compensation, it may be too little when compared with the cost of living. In addition, as the HVs are voluntary and most of the HVs are employed in other jobs, it is challenging for HVs to meet for training. A previous study conducted in another area in Thailand reported that the HVs require monetary incentives for joining the diabetes project. Therefore, the role of reinforcement and incentive may affect the HVs' engagement in the diabetes training.

This is a pragmatic mixed methods study and the findings are designed to provide insight into the knowledge levels and learning experience of the HVs. The learning theories are discussed to enable the reader to understand the traditional thinking and we then relate our findings to these theories.

4.9 Conclusion

There were numerous learning theories employed in education, however, it was not clear which learning theories are the most helpful for the learner. Although the advantage of using these learning theories was mentioned, the limitations of each theory were also discussed.

The learning theories can be separated into groups based on the learning process, as behaviourist learning theory and social cognitive learning theory focus on the external factors that influence behaviour such as positive, negative, and vicarious reinforcement and constructivism learning theory, cognitive learning theory, experiential learning theory, and transformative learning theory highlight the internal factors of the learning process. However, behaviourist and cognitive learning theory are teacher-centred, while other learning theories are student-centred and the teacher plays the role as facilitator to provide a learning environment and help the student to achieve the learning goal. Prior knowledge and experience are vital for the learning process of some theories, as learners construct their knowledge based on prior knowledge (Constructivism learning theory), or relate new information to existing knowledge (Cognitive learning theory), hence it seems that these learning theories are more suitable to some individuals than others.

In addition, according to the learning theories mentioned above, there were several influential factors that affected the learning achievement of the learners, including reinforcement, the learning environment, prior knowledge, model, collaboration, critical

reflection and problem solving. Unfortunately, as mentioned in the previous chapter, the HVs only obtained two formal training sessions regarding to diabetes, including the first registration and the refresher course which mainly relies on classroom lecture. Therefore, employing the traditional training may not be suitable for the present HVs learning context and it may affect their learning achievement. The HVs in Thailand are voluntary, come from various backgrounds, have other commitments, and possess different educational levels and subsequent personal prior knowledge levels. All of these factors need to be considered when designing future curricula.

This chapter described the learning theories employed in recent healthcare education; in the next chapter the researcher will explain the research paradigm and study method.

Chapter 5 Research paradigms and methodology

5.1 Introduction

The previous chapter described the study background and the need to adequately assess HVs' knowledge of diabetes and their learning experience. The aim of this chapter was to reveal and discuss the philosophical underpinning of three main research paradigms; positivism, interpretivism and pragmatism, as well as the justification of the author to choose the particular paradigms, methodologies and approaches to design this study.

5.2 Research paradigms

According to Babbie and Mouton (1998, p. 645), research paradigms are "models or frameworks for observation and understanding, which shape both what we see and how we understand it" Within this chapter three research paradigms: positivism, interpretivism and pragmatism, are discussed and a justification for the use of pragmatism within this study is provided.

Ontology can be defined as "the nature of reality" while epistemology is defined as "how reality is known" (Alharahsheh and Pius, 2020). Epistemology is also called "the nature of knowledge and how it is acquired" (Al-Saadi, 2014). A paradigm is made up by the assumption of ontology and epistemology (Mack, 2010). Different paradigms make different assumptions of ontology and epistemology regarding reality and knowledge (Alharahsheh and Pius, 2020).

5.2.1 Positivism

Ontologically Positivists believe that there is one single reality or truth. Reality is objective and is external to the researcher (Scotland, 2012). In addition, reality can be predicable and

can be captured (Mack, 2010). Epistemologically they believe that this reality is stable and can be observed (Grey, 2009, p.18; Rahi, 2017) and measured from an objective viewpoint (Levin, 1988). Sometimes it is called empirical science, post positivism, quantitative research (Rahi, 2017) or scientific research (Creswell, 2009, p. 6; Kivunja and Kuyini, 2017), because everything in the world can be verified through experiments, observation and mathematical statistics (Creswell, 2009, p. 6; Antwi and Hamza, 2015). The previous studies also describe positivism's epistemological assumption that "Knowledge can and must be developed objectively, without the values of the researchers or participants influencing its development" (Park et al., 2020). While Mark (2010), outlined that knowledge is objective, and it is produced deductively from hypothesis or theory. In addition, Saunders et al (2009, p.119) described positivism's epistemology as "only observable phenomena can provide credible data, facts". In addition, positivism tends to reduce concepts to a small scale or to categorise the data in order to test such elements as independent and dependent variables (Creswell, 2009, p.7). Positivists believe that reality is acquired via observational and experimental study, hence methodologically, positivists choose scientific methods to establish knowledge (Asghar, 2013; Rahi, 2017). Quantitative methods are preferred for data collection and, analysis (Kivunja and Kuyini, 2017) because they involve logic, and an objective stance (Al Riyami, 2015). Quantitative data are collected via experiment, quasi experiment, standardized tests and closed ended questionnaire (Rehman and Alharthi, 2016), which produce reliable data (Al Riyami, 2015) to support or deny a hypothesis (Asghar, 2013; Rehman and Alharthi, 2016). Reliable and valid tools are the basic quality standard of positivism; hence positivists dedicate time to develop and test their research tools or utilise standardized questionnaires to measure what is observed (Al Riyami, 2015).

5.2.2 Interpretivism

This paradigm can also be called constructivism, social constructivism or qualitative research paradigm (Rahi, 2017). Interpretivists believe ontologically that there is no single truth or reality, and that reality is socially constructed and derived from individuals' views, background and experiences (Yanow and Schwartz-Shea, 2011; Rahi, 2017) and therefore reality must be interpreted. Their focus is on the meanings, which are not fixed; they can be readjusted and changed by subjective experiences (Grey, 2009, p. 22) such as the individual's learning experiences. Furthermore, this philosophy looks for the complexity of views more than minimising or shaping the information into small categories as in positivism (Creswell, 2009, p. 8). Mack (2010) and Scotland (2012) argue that Interpretivist ontology should be described as subjective which is indirectly constructed based on individual interpretation. Mark (2010) also pointed out that there are several viewpoints on one incident. Humans make their own meaning of events, and events are specific and are unable to be generalised (Mark, 2010). There are several interpretivist epistemology assumptions, for example knowledge is seen as subjective and unique (Al-Saadi, 2014). Knowledge emerges through specific events and is irreducible to a simplistic interpretation (Mack, 2010; Scotland, 2012), and knowledge is gained via personal experience (Mack, 2010).

Interpretative researchers listen to people talking about their experiences from their point of views (Ritchie et al., 2013, p. 22). The major purpose of interpretivism is to gain insight (Thanh and Thanh, 2015) into the phenomenon being explored. Thanh and Thanh (2015) report that, interpretive researchers prefer seeking individual's perception and experiences rather than numbers of statistics (Thanh and Thanh, 2015) which is in contrast to quantitative researchers as they view the world in numbers and measures (Thanh and Thanh, 2015). Hence, loosely structured approaches are favoured to encourage the participant to express

their story, memory, belief and worldviews (Magnusson and Marecek, 2015, p. 2). Within this paradigm there are methodologies including Phenomenology, Ethnography, Grounded Theory, Discourse Analysis and Action research. The methods adopted include interviews, focus groups, textual or visual analysis (Marshall and Rossman, 2011). Interpretivism is therefore heavily based on interviews and observation (Kankam, 2019). Data collection via interview is the most commonly used research method, especially within health research (Gill et al., 2008). As this method allows the researcher to explore a particular subject (Sutton and Austin, 2015), it also helps to clarify any points and it can be used in order to understand the individual experience of the participants (Sutton and Austin, 2015).

5.2.3 Pragmatism

The third research paradigm is pragmatism. Ontologically, Pragmatists believe that reality is constantly re-negotiated and debated in light of its usefulness (Crotty, 1998; Kaushik and Walsh, 2019). Creswell and Creswell (2018, p.11) describes pragmatism by stating "pragmatists believe in an external world independent of the mind as well as that lodged in the mind". Hence, pragmatism is not committed to the positivist or interpretivist paradigm (Polit and Beck, 2017, p. 578). Epistemologically it focuses on the research question and has the freedom to use the methodology that best helps to understand the issues (Rahi, 2017; Creswell and Creswell, 2018, p.11). For example, two approaches can be used in one study, starting with a focus group (qualitative) and then using the findings to develop a questionnaire to assess the participants' knowledge. This mixed methods approach focuses on the research question and then adopts the pluralist approach to acquire knowledge about the problem (Tashakkori and Teddlie, 1998). Hence this paradigm attempts to combine qualitative and quantitative techniques in order to answer the question posed (Rahi, 2017).

This paradigm situates itself between positivism and interpretivism as it believes that there is no single appropriate philosophy (Al-Ababneh, 2020). In another words, a pragmatist embraces a plurality of methods which allows for the choice of an appropriate research method from qualitative and/ or quantitative methods (Kaushik and Walsh, 2019).

In summary, positivists tend to employ a scientific method, and are likely to state the question or hypothesis beforehand and then test under a controlled set of conditions (Yen, 2011). While interpretivists recognise that reality is constructed and interpreted by individuals. Their approach therefore more inductive seeking the individual's perception and experiences rather than numbers or statistics. On the other hand, as mentioned, pragmatists have the freedom to use the methodology that best helps them to understand the research problems, therefore pragmatist is likely to involve both qualitative and quantitative methods in study design.

5.3 Mixed Methods

Mixed methods approach, founded on the principles of pragmatism (Holloway and Galvin, 2017, p. 274; Polit and Beck, 2017, p. 578), involves data collection and data analysis of both quantitative and qualitative research within a single study (Creswell, 2009). In addition, pragmatism allows the data integration to occur at one or more stages in the research process in order to support each other and permit for a more robust analysis (Creswell, 2009). Mixed methods have been defined in several ways. According to Creswell (2009), mixed methods combine quantitative and qualitative research methods in a single research study, using one approach to explain or build on the results of the other approach in order to obtain a better understanding of the research question. Tashakkori and Creswell (2007) defined mixed methods as "research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods

in a single study or a programme of inquiry". Moreover, they also highlight "integration" as the key concept of Mixed Methods (Tashakkori and Creswell, 2007). The reason for mixing quantitative and qualitative methods is to use the strength of each method; when combined together, quantitative and qualitative methods can support each other and allow a more robust analysis. Conversely, it is not always possible to capture the trends and details of a situation using quantitative or qualitative methods alone (Tashakkori and Teddlie, 1998). Boswell and Cannon (2017, p. 149) described how researchers who employed mixed methods try to blend the strong supplemental points of both methods (qualitative and quantitative) and remove the non-imbricated weaknesses. Grafton et al (2011) described the benefit of using mixed methods as combining both qualitative and quantitative approaches to produce a research outcome that is stronger than using a single method. Grafton also stated that both numbers and words convey meanings, both are needed if the researcher wants to understand the world. In addition, the benefits of using mixed methods were reported in previous studies (Migiro and Magangi, 2011; Ponterotto et al., 2013; Almalki, 2016; McKim, 2017), as being flexible and rigorous (Almalki, 2016). This method also allows the researcher to better understand the phenomenon (Ponterotto et al., 2013; McKim, 2017). Polit and Beck (2017, p. 578) described the advantages of Mixed Methods research in several ways including complementary, practical, incremental, enhancing validity and collaboration. Mixed methods allow the researcher to explore a broad question providing method and paradigmatic freedom (Velez, 2008; Migiro and Magangi, 2011).

However, Mixed Methods studies can have disadvantages. Yvonne Feilzer (2010) and Sparkes (2015), argue that such studies do not always fully integrate and are therefore just separate studies. In addition, as they involve multiple steps, they can be time consuming and resource intensive (Creswell et al., 2011; De Silva, 2011; Malina et al., 2011; Migiro and Magangi, 2011; Miller et al., 2013; Holloway and Galvin, 2017, p. 282; Polit and Beck,

2017, p. 579). Conducting mixed methods research can be challenging; the researcher must have a clear reason for using mixed methods and know how to appropriately combine the two distinct approaches (Velez, 2008). The researchers have to consider mixing research questions and paradigms and their interpretation; therefore, the researchers should ask themselves how they can integrate the results and how to connect the methods in one study (Clark and Creswell, 2008). Weighting is also important; in some studies; the weight given to each phase might be equal, while other studies may allocate more weight to either the quantitative or qualitative study phase. Additionally, the researcher has to consider the sequence of data collection and data analysis, (Clark and Creswell, 2008; Creswell, 2009) as it relies on the research question (Wood and Haber, 2018, p. 193). In mixed methods studies, the researchers may perform qualitative data collection at the same time as quantitative data, or start by using either quantitative or qualitative first (Wood and Haber, 2018, p. 193).

There are three main mixed methods designs widely used in social and healthcare namely convergent mixed methods, explanatory sequential mixed methods and exploratory sequential mixed methods (Creswell and Creswell, 2018, p.15). Convergent mixed methods: in this design, the researcher collects and analyses quantitative and qualitative data separately in a single phase and then compares both sets of results (Fetters et al., 2013). Although both studies provide distinct types of information, quantitative studies provide numerical data whilst qualitative studies provide text of the participant's viewpoint, actions or interactions, Andrew and Halcomb (2009, p. 43) and Holloway and Galvin (2017, p. 277) stated that the purpose of this design is to validate the results which were posed by each method by using evidence launched by the other.

Explanatory sequential mixed methods studies include two-phase studies, with the quantitative study occurring first (Andrew and Halcomb, 2009, p. 41; Holloway and Galvin,

2017; Polit and Beck, 2017, p. 585; Almeida, 2018). The researcher collects and analyses quantitative data and then uses the results to plan or guide the type of participants and the type of questions, which will be used in the second study phase. Qualitative findings supplement the initial findings of the quantitative study (Subedi, 2016), the aim of this method is to use qualitative data to explain more in-depth the quantitative results (Subedi, 2016; Holloway and Galvin, 2017, p. 276; Polit and Beck, 2017, p. 585). As the quantitative and qualitative data analysis is performed separately, the integration of this design occurs when the researcher connects the quantitative results to the qualitative data collection (the intermediate state) (Subedi, 2016). The interpretation will be reported through how the qualitative results help to explain and contextualise the quantitative findings (Andrew and Halcomb, 2009, p. 41). Qualitative approaches have been employed in previous studies to further investigate initial findings of quantitative results and to expand and delve deeper into the participant's experiences (Bowen and Pilkington, 2017), points of view (Frantál and Kunc, 2011), perception (Warren and McFadyen, 2010), and attitudes (Schaefer et al., 2012). Therefore, it is not recommended to perform direct comparison of the overall results for both quantitative and qualitative studies in this design (Creswell and Creswell, 2018, p. 223).

Lastly, exploratory sequential mixed methods, uses a qualitative study prior to undertaking a quantitative study (Onwuegbuzie et al., 2010; Polit and Beck, 2017, p. 586; Almeida, 2018). This method is similar to explanatory sequential mixed methods, however the first phase begins with the qualitative study (Andrew and Halcomb, 2009, p. 42; Polit and Beck, 2017, p. 586), the results of which will be used to inform the second phase. This approach is useful when for example, a qualitative study is used to generate the questions for a questionnaire. As the qualitative and quantitative study results are drawn from different populations, there is no intention to compare the results from both studies (Creswell and Creswell, 2018, p. 224).

5.3.1 Rational for selecting Mixed Methods

An Explanatory Sequential Mixed Methods design, was chosen, in order to explore the HVs' knowledge of diabetes. This design involves two phases; a quantitative phase followed by a qualitative phase. The initial quantitative questionnaire provides an assessment of the HVs' knowledge levels while the in-depth qualitative interviews provide greater insight into their learning journey. This approach is considered challenging: as it mixes both research methodologies in one piece of research.

5.4 Research design

This study employed a sequential explanatory mixed method design including two phases; a quantitative phase followed by a qualitative phase. The study consists of a questionnaire followed by in-depth interviews. The questionnaire provided a general picture of the HVs' knowledge regarding diabetes (numerical data), while interviews provided an in-depth explanation (text data) of how they had gained this knowledge. The study was approved by Liverpool John Moores University's Ethics Committee for human research and the Bangkok Metropolitan Administration Ethics Committee.

Data collection and analysis

Quantitative study

The researcher distributed the questionnaire, a consent form and a participant information sheet to 504 potential participants. The sample size calculation was shown in table 11, chapter 7. The participants were asked to complete the survey which included their demographic data and a knowledge test developed by the researcher. To investigate the first research question, diabetes knowledge levels were classified based on Bloom's taxonomy into three groups based on the participant's score (≥80% was classified as "high knowledge

level", 60-79% "moderate knowledge level" and <60% was deemed to be "low knowledge level"). In addition, those participants who were interested in participating in phase 2 of the study were asked to add their contact details to the end of the questionnaire. Quantitative data were shown as frequency and percentage for categorical variables and minimum, maximum and mean for continuous variables.

Qualitative data

Of the 390 HVs who completed the survey in the quantitative study, 330 participants agreed to participate in the interviews which was designed to explore their experience of learning about diabetes. Purposive sampling was employed based on the knowledge score acquired from the quantitative data. Five HVs from each knowledge group were selected to participate in the interviews, giving a total of 15 participants. The semi-structured interviews were used with open-ended questions to ask the HVs about their learning experience. Audio recording was employed to enable verbatim transcription of the responses. The transcriptions were delivered to the supervisory team and coded independently. The team then discussed codes until they reached a consensus. Thematic analysis was applied to identify patterns of meaning within qualitative data. The initial findings quantitative and qualitative were shown separately and then integrated. The integration of quantitative and qualitative is shown below.

Ethical consideration

This thesis is composed of two studies; quantitative questionnaire followed by qualitative interviews. The participants in study two were a subset of those in study one. The respondents of study one was asked to provide their contact details if they were willing to participate in study two. The researcher protected the respondent's personal information as described below.

In the recruitment process, the researcher made it clear that the HVs were free to choose to take part in the study without any pressure, and there would be no negative consequence to their job if they declined to participate. In addition, all participants were informed that the researcher utilized several methods to secure their data. All information was stored in a password-protected university computer which was only accessed by the research team. In addition, the HVs had the right to withdraw from the study without the need for an explanation. Additional details will be provided in chapter 7.

5.5 The integration of Quantitative and Qualitative research within this study

1. Integration at the study level (Fetters et al., 2013); this study employed an explanatory sequential design, the researcher conducted an initial survey of the HVs' knowledge of diabetes that was followed by an in-depth interview to explore their learning journey.

2. Integration at the method level; there were clear links between the two phases of the study. Those HVs who completed a quantitative questionnaire were categorised according to a knowledge score which was used as a sampling framework for the second qualitative phase (Fetters et al., 2013)

3. Integration in the interpretation stage (Clark and Creswell, 2008). The results of both phases of the study are considered in unison. Whilst the results of each phase of the study are reported separately initially, they are subsequently discussed together to gain an overview of the learning journey within a single report (Fetters et al., 2013). The findings from the quantitative study will be supported by the qualitative results.

The researcher applied the integration at the design level via the use of an explanatory sequential design. The aim of using this design was to assess the knowledge of the HVs

regarding diabetes and their learning journey. This study includes a 2-phase design which starts with the collection and analysis of the diabetes knowledge questionnaire followed by the collection and analysis of interviews. In the quantitative phase, the participants were asked to complete the questionnaire developed and tested by the researcher. They were then classified into three groups, namely high, moderate and low knowledge level based on their score. In the follow up qualitative phase purposive sampling was employed to select the participants who were subsets of the quantitative phase. Participants were interviewed to gain insight into their learning journey and a thematic analysis was performed to gain a thematic pattern in order to explain the findings of the quantitative phase.

The researcher also applied integration at the method level connecting one type of data to another via the sampling frame. In this study, the researcher used the data from the first phase to purposefully sample participants for the follow-up interviews. The researcher performed purposive sampling to select the participants from each knowledge group which was classified based on the questionnaire score. On this basis, 330 individuals from three knowledge groups were identified (330 HVs from the total 390 were willing to participate the interview by leaving their contact number with the questionnaire in phase 1). The researcher randomly selected five HVs from each knowledge group to take part the interviews.

5.6 Conclusion

This chapter described the paradigms underpinning the programme of research, and the rationale behind decisions to undertake a sequential explanatory mixed method. I found that my own philosophical views were aligned with pragmatism. I believe that there is no one single appropriate approach, thus the researcher can employ more than one philosophy (Al-Ababneh, 2020). I believe that it is difficult to capture reality by using a single approach.

I also agree that reality is constantly re-negotiated and debated in light of its usefulness. My research is to explore the diabetes knowledge level and learning journey of the HVs. Although some constructs can be measured with an appropriately validated tool such as knowledge levels, their experiences are more nuanced, constructed based on individual interpretation (subjective), and require a qualitative approach. Therefore, the nature of pragmatism that focus on problem centre and pluralistic approach allows the researcher to employ a mixed methods approach (Creswell and Plano Clark, 2011, p.41), instead of committing to one methodology. Therefore, pragmatism is the dominant paradigm of this study as it is practical and focuses on the research questions and allows the use of a mixed methods approach, enabling the use of both qualitative and quantitative methods within a single study.

In mixed methods research the two phases of the study are meant to provide greater insight into the phenomena being explored. The first phase provides evidence of the knowledge levels and the second phase provides insight into the experiences and the learning journey. Mixed methods research enables us to triangulate both phases to provide an overall understanding. The study is not meant to be two separate studies but is designed to be complimentary.

The following chapter will describe the identification and Critical Appraisal of an existing Diabetic Knowledge Questionnaire.

Chapter 6 Identification and critical appraisal of existing diabetic knowledge questionnaires

6.1 Introduction

This aim of this chapter is to describe the process of developing and validating a questionnaire which will include a review of the existing questionnaires relating to diabetes knowledge, item generation for inclusion into the questionnaire, and questionnaire validation methods. Whilst it is not uncommon for researchers to use non-validated questionnaires, the merit of the results can be questioned if the researcher is unable to demonstrate that the measurement tool has been subject to a rigorous process of validation. Bolarinwa (2015) suggests that "validity expresses the degree to which a measurement measures what it purports to measure'. It would therefore be reasonable to ensure that the questionnaire is subject to such testing within a Thai context to enable the questionnaire to be generalised within the wider HV population in Thailand. Context plays a key role in the validity of the tool and so it would be essential to undertake further validation if used outside this context.

6.2 Review of existing questionnaires

Aims

To identify and critically appraise existing questionnaires that have measured the diabetic knowledge levels of respondents.

Electronic Searching

The researcher performed a literature search which included an extensive examination of current published materials (Grant and Booth, 2009). A review of the literature was undertaken to identify whether an existing instrument existed. The following databases were searched in June 2017: Cumulative Index to Nursing and Allied Health Literature (CINAHL)

Plus with Full Text (January 2000 to June 2017); Medical Literature Analysis and Retrieval System Online (MEDLINE) (January 2000 to June 2017); Scopus (2000 to 2017) and Thailis were searched using the search term: (diabetes AND knowledge AND questionnaire). Furthermore, a Thai National Research Repository (TNRR) and Thai thesis database for the year 2000 to 2017 were also searched. The aim of the search was to identify all questionnaires that measured the diabetes knowledge levels of patients, health volunteers or healthcare professionals. Whilst not exclusive to Thailand it was thought helpful to add a second search that focussed specifically on the role of the HV in Thailand. Due to the nomenclature of terms used in different countries the search terms were quite broad with more scrutiny added at the review stage.

The following inclusion criteria were used:

- Questionnaire that measured diabetes knowledge
- Respondents were either health volunteers, healthcare professionals or patients
- 2000-2017
- Questionnaires were available in English or Thai

Exclusion Criteria

- Questionnaires where diabetes knowledge formed only a section of the overall questionnaire

A total of 30 questionnaires were found that assessed the level of diabetic knowledge for either health care professionals or patients (El-Deirawi and Zuraikat, 2001; Garcia et al., 2001; Findlow et al., 2002; Wongwiwatthananukit et al., 2004; Rothman et al., 2005; Wagner et al., 2005; Derr et al., 2007; Rubin et al., 2007; Huizinga et al., 2008; Modic et al., 2009; Al-Qazaz et al., 2010; Collins et al., 2011; Koontz et al., 2010; Adibe et al., 2011; Eaton-Spiva and Day, 2011; Eigenmann et al., 2011; Guo et al., 2012; Saleh et al., 2012;

Luevano-Contreras et al., 2013; Schmitt et al., 2013; Amin and Chewning, 2014; Yacoub et al., 2014; Hernandez and Hernandez, 2015; Navarro-Flores et al., 2015; Weeks et al., 2015; Ahmedani et al., 2016; Alhaiti et al., 2016; Alotaibi et al., 2017; Beshyah et al., 2017; Zainudin et al., 2017). Whilst some studies developed a new questionnaire or employed an existing questionnaire to measure knowledge of village health volunteers in Thailand, many of these did not assess diabetes knowledge and they were therefore excluded as they fell outside the review criteria. In addition, there were other studies that explored the diabetes knowledge of community health workers in other countries, however, they were also excluded as they were either unavailable in English or Thai, or were unavailable to view.

6.3 Questionnaire development

The process of questionnaire development and testing of the current study was guided by the five steps of Radhakrishna (2007) as it was widely cited by several researchers and it was clearly explained step by step including:

Step 1 Background

Step 2 Questionnaire Conceptualisation

Step 3 Format and Data Analysis

Step 4 Establishing Validity

Step 5 Establishing Reliability

Step 1 Background

Step 1 determines the purpose, objective and audience as well as the audience background of the instrument.

The purpose of this study was to assess the diabetes knowledge of Thai HVs. HVs are responsible for providing community care for people with diabetes including providing continuous care, risk management, blood sugar monitoring, health education and advice for all patients and caregivers in the patient environment (Kanhachin and Limtragool, 2010; Kasemsuk and Koshakri, 2015; Nakrukamphonphatn et al., 2019). As mentioned previously, knowledge is an important factor that can influence performance. Although HVs are trained in diabetes care in Thailand there is little evidence to help us to understand the knowledge that they possess.

Prior to the commencement of this thesis there was no valid tool to assess the HVs knowledge of diabetes. The only studies that were found examined the knowledge of

professional care providers and/or patients. (El-Deirawi and Zuraikat, 2001; Garcia et al., 2001; Findlow et al., 2002; Wongwiwatthananukit et al., 2004; Rothman et al., 2005; Wagner et al., 2005; Derr et al., 2007; Rubin et al., 2007; Huizinga et al., 2008; Modic et al., 2009; Collins et al., 2011; Koontz et al., 2010; Adibe et al., 2011; Eaton-Spiva and Day, 2011; Eigenmann et al., 2011; Saleh et al., 2012; Luevano-Contreras et al., 2013; Schmitt et al ., 2013; Amin and Chewning, 2014; Yacoub et al., 2014; Hernandez & Hernandez., 2015; Navarro-Flores et al., 2015; Weeks et al., 2015; Ahmedani et al., 2016; Alhaiti et al.,2016; Beshyah et al., 2017; Zainudin et al., 2017). These studies identified key knowledge areas believed to be important for both patients and carers. However, the difference in context, the key knowledge areas, measurement aim, type of population, role and training, make it is impossible to use these questionnaires to assess the HVs. However, reviewing the existing literature was not without benefit. The researcher used the knowledge gained to better understand the questionnaire development strategies as well as the way that they validated their questionnaire. Therefore, the researcher used and applied this knowledge to develop the tool as seen below.

This paragraph describes the existing questionnaires, which have been developed to assess the diabetic knowledge of patients and health professionals. Whilst our participants were neither patients nor qualified healthcare providers, the areas of knowledge that were assessed remained relevant and were therefore included in our questionnaire

As mentioned previously, there were no questionnaires that specifically assessed the diabetes knowledge of HVs. Therefore, developing and validating a robust questionnaire for this purpose was essential. Jenn (2006) suggested that good assessment tools (questionnaire) ought to be valid and reliable. The use of assessment tools affects the quality of study results and the trustworthiness of the data. Reliability is referred to as the stability of findings, whereas validity represents the truthfulness of findings [Altheide and Johnson, 1994].

Therefore, employing credible tools (validated and reliable tools) are likely to produce credible results (Singh, 2014). This instrument will help the researcher to understand the current knowledge of the HVs. One study (Wongwiwatthananukit et al., 2004) that measured the diabetes knowledge of Thai diabetic patients, demonstrated good content validity and good reliability Cronbach α=0.8154, and was chosen to be adapted for use with the HV's. In Wongwiwatthananukit et al's study (2004), the authors explained the process of the survey development which included three steps; instrument development, expert review of the tool and testing of the questionnaire. The initial 40 items were obtained from the literature and interviews with healthcare professionals who had experience working with diabetic patients. After that, the items were reviewed by eight experts in the diabetes field, who then made comments on the items, and subsequently there were no items removed from this process. In the last step, the question was pre-tested with 15 patients to detect any possible issues of using the questionnaire, the result showed that the participants understood the questions in the survey. The questionnaire was then distributed to 811 diabetic patients across 21 hospitals. Item analysis was employed as the criterion for removing items. The items were removed if 1) the difficulty index was not in range of 0.1-0.90, 2) the Kuder Richardson lower than 0.70, and 3) the corrected item-total correlation value less than 0.30. Nineteen items were eliminated as those items failed to reach the study criterion.

The researcher (JC) contacted Professor Dr. Supakit Wongwiwatthananukit to request permission to make amendments. After gaining permission and suggestions from the author, one question was adopted, fifteen questions were modified and nine questions were newly developed based on the original five domains included in the new questionnaire.

Wongwiwatthananukit et al's (2004) diabetes knowledge questionnaire was developed to assess the knowledge of diabetic patients, to assess the knowledge of the HVs who have received training from nurses and are responsible for taking care of the patients in

community, the questions were modified and developed to fit the health volunteers. The researcher used terms that are commonly understood by the HVs, considering the difference in terminology between patients and HVs, the role of the HVs as well as their training. In addition, the questions were guided by the Thailand clinical practice guideline for diabetes (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017) and international guidelines (e.g. Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019).

Step 2 Questionnaire Conceptualisation

Radhakrishna's (2007) questionnaire development guide, suggests that information derived from the literature or theoretical framework is transformed to questions. Radhakrishna's (2007) suggests that the researcher should state the aim of the questionnaire measurement such as to assess the respondent's knowledge, attitude, behaviour or perceptions. The aim of this questionnaire was to measure the HVs knowledge of diabetes in Thailand, however no specific knowledge test is available for Thai HVs. Therefore, the researcher generated questionnaire items based on the literature and those of Wongwiwatthananukit's measurement tool. The researcher also used descriptions of the HVs' roles, their training and current diabetes guidelines as the criteria for key knowledge about diabetes of the HVs. Therefore, diabetes knowledge items were based on five topics including general knowledge about diabetes, diabetic medications, diabetic complications, self-care when well and self-care when getting sick.

Questionnaire generation and reduction

As the target population of the original questionnaire developed by Wongwiwatthananukit et al (2004) was different to the target population of this study the questionnaire had to be revised accordingly for the HV population.

Wongwiwatthananukit et al (2004) stated that their survey might not be able to capture information about general knowledge about diabetes, hence the researcher reviewed the original questionnaire (Wongwiwatthananukit et al., 2004) and updated the questions based on HVs' job role, their training and current diabetic guidelines (Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019). Twenty-five questions were included in the new questionnaire, one question (item number 2) was adopted from the existing questionnaire, whilst fifteen questions included item numbers 4,7,8,9,10,12,13,17,18,20,21,22,23,24 and 25 were modified and a further nine questions were newly developed (item numbers 2,3,5,6,11,14,15,16 and 19) as shown in Table 5.

Items were removed from the original questionnaire

As mentioned previously, the researcher developed the questionnaire based on the HV's role, training and Wongwiwatthananukit's tool. However, Wongwiwatthananukit's questionnaire was developed to assess the knowledge of patients while the aim of this study was to measure HVs knowledge of diabetes. Although the testing showed that the Wongwiwatthananukit's questionnaire was valid for assessing patient's knowledge of diabetes, the focus of measurement in this study sat outside the questionnaires original scope. As I had changed the context it was important that I reviewed the tool in detail. Consequently, I amended the questions to ensure it reflected the HVs role and their training. Some questions (Table 4) included in Wongwiwatthananukit's questionnaire were not suitable for the HVs as they were focussed on a lay person rather than someone who was responsible for community care and who had received additional training.

Items modified from original questionnaire

The researcher took question number 2 from the original tool- 'Insulin is created by the kidneys' and modified it slightly to become 'Insulin is produced by the kidneys' before adding to the new questionnaire. This question was adopted from the existing questionnaire to test the HVs general knowledge of diabetes, whether they able to recall facts but was amended to reflect different levels of language.

Adjusted items

Fifteen questions were adapted based on the original tool, to make it more specific and suitable for the HVs based on their role and training. These were example questions which were modified from Wongwiwatthananukit et al (2004): the item 'Diabetic patients should inspect their feet daily' was changed to 'Diabetic patients should be encouraged to check their feet for abnormalities' in the new questionnaire, and the question 'If you forget to take diabetes medication you should not take a double dose in next meal' was changed to 'If a diabetic patient forgets to take their diabetes medication in the morning, they should not take a double dose in the evening', and 'Drinking alcohol can affect your diabetes drug's properties' was changed to 'Drinking alcohol enhances the effect of diabetes medication'. In addition, nine new items were created by the researcher from literature reviews and of Wongwiwatthananukit's recommendation on his questionnaire development.

New items

Nine questions were developed and added to the new questionnaire that were based on updated or new guidelines. Three questions including blood sugar testing at home, type of lipids and blood pressure control for diabetic patients were added to the questionnaire pool. Examples questions include 'LDL cholesterol is known as 'good' cholesterol' and 'Diabetic patients should keep their blood pressure below 140/90 mmHg'.

In addition, two questions regarding diabetic complications were included in the questionnaire as they were not present in the original tool but appeared in the guidelines. These include; ‘Diabetics are at an increased risk of developing retinopathy’ and ‘Diabetic ketoacidosis is a life-threatening emergency’.

Finally, four questions about medications were included in the item pool as the original tool included only oral medication. These include: ‘Insulin is essential in the treatment of type 1 diabetes’, ‘Short-acting insulin begins to work 15-30 minutes after injection’, ‘Diabetic patients can discontinue their diabetes medication when they feel their condition has improved’ and ‘Diabetics can share their diabetes drugs with other diabetic patients’. The full details are shown in Table 5.

Table 4 The original items

Item number	Question	The consideration of removing or adding into the new questionnaire
1	Diabetes can be cured	Removed as it is too easy
2	Insulin created by the kidneys	Adopted
3	Normal fasting blood sugar level between 90-130 mg/dl	Adjusted to be more updated
4	Stress can cause blood sugar to increase	Removed as it is too easy
5	Genetic is diabetes cause	Removed as it is too easy
6	Sweating, blurred vision and racing heart are common symptoms of hypoglycaemia	Removed as it is too easy
7	Diabetes increases the risk of coronary artery disease	Adjusted
8	Poor blood sugar control can cause foot and hand numbness	Removed as it is too easy
9	Poor blood sugar control can cause kidney failure	Adjust
10	Regulating blood sugar can delay and reduce the risk of diabetic complications	Removed as it is too easy
11	Consuming beverages such as whiskey and wine affect blood sugar level	Adjusted
12	The diabetic patients must continue doing exercise even they get ill or have chest pain symptom	Adjusted
13	Diabetic patients should inspect their feet daily	Adopted
14	Blood sugar will increase when the patient gets infected	Adjusted
15	Illness patients should consume lots of water and should not skip their meal	Removed as it too general not specific
16	It is unnecessary to take diabetic drugs when the patient gets ill as the blood sugar is already low	Adjusted

Item number	Question	The consideration of removing or adding into the new questionnaire
17	The patient should take diabetic drug as soon as possible when they realise they forgot to take diabetic medications, however if time is too close to the next meal, they can skip this dose and then take the drug at the next meal, not take a double dose.	Adjusted as this question is too long
18	If you have any symptoms of hypoglycaemia during the treatment with diabetic drugs, you should consume sugary food such as sugary drinks to relieve the symptoms and report to the doctor to adjust the diabetic dose.	Adjusted
19	If you do not eat after taking a pre-meal diabetic drug, your blood sugar will be lower than normal	Adjusted
20	Consuming beverages such as whiskey and wine can affect the diabetic drug property	Adjusted
21	The patients taking diabetes drugs, but continuing to eat sweet desserts such as flower egg yolk tart and round egg yolk tart can cause poor blood sugar control	Adjusted

Table 5 Item generation

Items number	Questions	Condition
1	Insulin is produced by the kidneys.	Adopted
2	Insulin is essential in the treatment of type 1 diabetes.	New
3	Short-acting insulin begins to work 15-30 minutes after injection	New
4	Normal fasting blood sugar is between 70-100 mg/dl.	Adapted
5	LDL cholesterol is known as ‘good’ cholesterol.	New
6	Diabetic patients should keep their blood pressure below 140/90 mmHg.	New
7	Diabetic ketoacidosis is a potential risk with	Adapted

Items number	Questions	Condition
	Blood sugar levels between 70-125 mg/dl.	
8	Diabetics are at an increased risk of developing heart disease.	Adapted
9	14 units of alcohol equals: 7 cans of beer (5% alcohol) size 330 ml.	Adapted
10	Diabetics are at an increased risk of developing foot complications.	Adapted
11	Urine testing is the best method for home glucose testing.	New
12	Diabetics are at an increased risk of developing kidney failure.	Adapted
13	If a diabetic patient forgets to take their diabetes medication in the morning, they should take a double dose in the evening.	Adapted
14	Diabetics are at an increased risk of developing retinopathy.	New
15	Diabetic patients can discontinue their diabetes medication when they feel their condition has improved.	New
16	Diabetic ketoacidosis is a life-threatening emergency.	New
17	Drinking alcohol enhances the effect of diabetes medication.	Adapted
18	Drinking more than 14 units of alcohol per week can increase blood sugar levels.	Adapted
19	Diabetics can share their diabetes drugs with other diabetic patients.	New
20	Diabetics should exercise for a minimum of 20-30 minutes per session, 5 days per week.	Adapted
21	Diabetic patients should be encouraged to check their feet for abnormalities.	Adapted
22	The presence of infection can cause an increase in blood sugar levels.	Adapted

Items number	Questions	Condition
23	When diabetics are ill, they should test their blood glucose more often.	Adapted
24	Adding coconut milk to food will result in poor blood sugar control in diabetics.	Adapted
25	Drinking sweetened drinks increases blood sugar levels.	Adapted

Table 6 All 50-item list

Item	Opposite question	Question
1	32	Insulin is produced by the kidneys.
2	23	Insulin is essential in the treatment of type 1 diabetes.
3	47	Short-acting insulin begins to work 60 minutes after injection.
4	25	Normal fasting blood sugar is between 70-100 mg/dl.
5	34	LDL cholesterol is known as ‘good’ cholesterol.
6	27	Diabetic patients should keep their blood pressure below 140/90 mmHg.
7	45	Diabetic ketoacidosis is a potential risk with blood sugar levels between 70-125 mg/dl.
8	29	Diabetics are at an increased risk of developing heart disease.
9	49	14 units of alcohol equals: 7 cans of beer (5% alcohol) size 330 ml.
10	31	Diabetics are at an increased risk of developing foot complications.
11	36	Urine testing is the best method for home glucose testing.
12	21	Diabetics are at an increased risk of developing kidney failure.

Item	Opposite question	Question
13	38	If a diabetic patient forgets to take their diabetes medication in the morning, they should take a double dose in the evening.
14	37	Diabetics are at an increased risk of developing retinopathy.
15	43	Diabetic patients can discontinue their diabetes medication when they feel their condition has improved.
16	39	Diabetic ketoacidosis is a life-threatening emergency.
17	35	Drinking alcohol enhances the effect of diabetes medication.
18	40	Drinking more than 14 units of alcohol per week can increase blood sugar levels.
19	41	Diabetics can share their diabetes drugs with other diabetic patients.
20	44	Diabetics should exercise for a minimum of 20-30 minutes per session, 5 days per week.
21	12	Diabetics are NOT at an increased risk of developing kidney failure.
22	46	Diabetic patients should be encouraged to check their feet for abnormalities.
23	2	Insulin is NOT essential in the treatment of type 1 diabetes.
24	33	The presence of infection can cause an increase in blood sugar levels.
25	4	Normal fasting blood sugar is between 126 -250 mg/dl.
26	48	When diabetics are ill, they should test their blood glucose more often.
27	6	Diabetic patients should keep their blood pressure above140/90 mmHg.
28	50	Adding coconut milk to food will result in poor blood sugar control in diabetics.
29	8	Diabetics are NOT at an increased risk of developing heart disease.
30	42	Drinking sweetened drinks increases blood sugar levels.

Item	Opposite question	Question
31	10	Diabetics are NOT at an increased risk of developing foot complications.
32	1	Insulin is produced by the pancreas.
33	24	The presence of infection can cause a reduction in blood sugar levels.
34	5	HDL cholesterol is known as ‘good’ cholesterol
35	17	Drinking alcohol reduces the effect of diabetes medication.
36	11	Blood testing is the best method for home glucose testing.
37	14	Diabetics are NOT at an increased risk of developing retinopathy.
38	13	If a diabetic patient forgets to take their diabetes medication in the morning, they should NOT take a double dose in the evening.
39	16	Diabetic ketoacidosis is NOT a life-threatening emergency.
40	18	Drinking more than 14 units of alcohol per week can reduce blood sugar levels.
41	19	Diabetics CANNOT share their diabetes drugs with others diabetic patients.
42	30	Drinking sweetened drinks does NOT increase blood sugar.
43	15	Diabetic patients must NEVER discontinue their diabetes medication without discussing it with a doctor.
44	20	Diabetics should exercise for a maximum of 20-30 minutes per session, 3 days a week.
45	7	Diabetic ketoacidosis is a potential risk with blood sugar levels >250 mg/dl.
46	22	Diabetic patients should be discouraged from checking their feet for abnormalities.
47	3	Short-acting insulin begins to work 15-30 minutes after injection.
48	26	When diabetics are ill, they do NOT need to test their blood glucose more often.

Item	Opposite question	Question
49	9	14 units of alcohol equals: 11 cans of beer (5% alcohol) size 330 ml.
50	28	Adding coconut milk to food will NOT affect blood sugar control in diabetics.

Step 3 Format and Data Analysis

The main aim of this process is to select appropriate scales of measurement, questionnaire format and layout as well as the question order.

The item development includes three approaches; adopting and adapting items from the existing questionnaire and generating new items that were based on literature reviews and current diabetes guidelines. The pool of items was written in English and they related to the knowledge of diabetes (as mentioned above), with responses 'yes', 'no' and 'do not know'. Closed questions such as yes-no questions benefit both administration and data analysis (Pasek and Krosnick, 2010; Sansoni, 2011), as it is easy to administer and analyse (Hyman and Sierra, 2016). It also saves time and gives a higher sampling rate (Pellicer-Sánchez and Schmitt, 2012). Employing the yes-no or true-false options in tests allows the respondents to complete the questionnaire easily (University of Waterloo, n.d, Callegaro et al., 2015; Sansoni, 2011; Hyman and Sierra, 2016). It can be used to test knowledge of a broad range of content areas (University of Waterloo, n.d, Pellicer-Sánchez and Schmitt, 2012; Hyman and Sierra, 2016), within a short length of time (Sansoni, 2011; Pellicer-Sánchez and Schmitt, 2012). Therefore, it provides a high sampling rate when compared with other formats (Pellicer-Sánchez and Schmitt, 2012). This type of response makes the questionnaire easy to mark (University of Waterloo, n.d) and code (Callegaro et al., 2015; Hyman and Sierra, 2016). However, Tsang et al (2017) pointed out that the whilst closed ended response questionnaire are easy to administer and analyse when compared with the open-ended responses, this type of response limits the response option, and the respondent cannot clarify their response.

In addition, using closed response format can cause bias as the respondent can answer the question whether they have knowledge or not (Sansoni, 2011). Furthermore, response bias

has been found in a previous study where respondents were likely to choose yes or true options (acquiescent response bias) that can cause systemic deformation (Bogner and Landrock, 2016). To reduce or control this bias, the designer should balance the scale by creating pairs of questionnaire items -half items require a positive answer and the latter require a negative answer (Bogner and Landrock, 2016). Therefore, the researcher created 25 items and reversed wording was used to diminish acquiescent response bias (Rattray and Jones, 2007; Bogner and Landrock, 2016).

Step 4 Establishing Validity

Validity is established using an expert panel and a field test in the subject not included in the sample, items adjustment based on the expert's opinion and field test (Radhakrishna, 2007).

Instrument validity: The validity is important as it reflects the quality of the questionnaire development. In addition, validity refers to whether this tool can measure what it is intended to measure Bolarinwa (2015). There are three common measures of validity that were reported from recent studies, namely face or content validity, concurrent validity, and predictive validity. As mentioned previously, although the validity is essential for the questionnaire, several studies did not report this information. In order to ensure the questionnaire quality, this study formally statistically validated the content validity as can be seen below.

Face and Content validity

Face and content validity are an essential element of developing the questionnaire, which can be generated by field experts (Rattray and Jones, 2007). The content validity of this questionnaire was established by eight validators. The content validity index (CVI) developed by Waltz and Bausell (1981) was used to gain the experts' opinion on the content

of the items because it is suited to multidimensional questionnaires (Tuner and Carlson, 2003)

Four Endocrinologists and four diabetic nurse specialists, who had experience of caring for people with diabetes for a minimum of five years, and/or have undertaken diabetes research were invited by email to participate in the validation process. The experts were either from the UK or Thailand.

The experts were asked to rate the score on each question (Sangoseni et al., 2013); 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant and 4 = highly relevant. I-CVI was computed by counting validators who gave 3 or 4 on the item divided by the total number of validators. The Scale Content Validity Index (S-CVI) is the level of agreement for all items in the questionnaire. The rating score given by eight experts was shown in table 7.

In general, I-CVI should not be lower than 0.78 (Polit et al., 2007; Sangoseni et al., 2013; Sing et al., 2015; Dikken et al., 2016; Masuwai and Saad, 2016; Vrbnjak et al., 2017; Davies et al., 2018; Kovacic, 2018) whilst, two studies stated that I-CVI 0.8 or over was acceptable (Rubio et al., 2003; Paul et al., 2016). Regarding to the S-CVI, the criterion of 0.8 was the lower limit of acceptability (Sing et al., 2015)

Table 7 Experts' rating score on the items.

Item	Expert in agreement	I-CVI
1	8/8	**1**
2	8/8	**1**
3	8/8	**1**
4	8/8	**1**
5	8/8	**1**

Item	Expert in agreement	I-CVI
6	8/8	1
7	7/8	**0.875**
8	8/8	**1**
9	6/8	**0.75**
10	8/8	**1**
11	7/8	**0.875**
12	7/8	**0.875**
13	8/8	**1**
14	8/8	**1**
15	8/8	**1**
16	7/8	**0.875**
17	7/8	**0.875**
18	6/8	**0.75**
19	8/8	**1**
20	8/8	**1**
21	8/8	**1**
22	8/8	**1**
23	8/8	**1**
24	8/8	**1**
25	8/8	**1**
26	8/8	**1**

Item	Expert in agreement	I-CVI
27	8/8	**1**
28	5/8	**0.625**
29	8/8	**1**
30	8/8	**1**
31	8/8	**1**
32	8/8	**1**
33	7/8	**0.875**
34	8/8	**1**
35	7/8	**0.875**
36	8/8	**1**
37	8/8	**1**
38	8/8	**1**
39	8/8	**1**
40	6/8	**0.75**
41	8/8	**1**
42	8/8	**1**
43	7/8	**0.875**
44	8/8	**1**
45	8/8	**1**
46	8/8	**1**
47	8/8	**1**

Item	Expert in agreement	I-CVI
48	8/8	**1**
49	6/8	**0.75**
50	5/8	**0.625**
	(50 items) Mean I-CVI (S-CVI/Ave)= 0.945, S-CVI/UA=0.72, Mean expert proportion=0.945 **(44 items, after removing 6 items) Mean I-CVI= 0.98, S-CVI/UA=0.81, Mean expert proportion=0.98** **S-CVI/Ave= Scale Level Content Validity Index/average** **S-CVI/UA =Scale Level Content Validity Index/Universal Agreement**	

6.4 Results

Content validity index (I-CVI) scores of 50 items ranged between 0.625-1 with a mean I-CVI= 0.945. The six items that scored lower than 0.8 were eliminated (items 9, 18, 28, 40, 49, 50) as suggested by previous authors (Polit et al., 2007; Sangoseni et al., 2013; Sing et al., 2015; Paul et al., 2016). The validators advised that question number 9 (14 units of alcohol equals 7 cans of beer (5% alcohol) size 330 ml) and question number 49 (14 units of alcohol equals 11 cans of beer (5% alcohol) size 330 ml) were too difficult and not suitable for the health volunteers. Item number 18 (drinking more than 14 units of alcohol per week can increase blood sugar levels) and item number 40 (drinking more than 14 units of alcohol per week can reduce blood sugar levels.) were removed because it was felt that this might lead the diabetic patients to have less concern about the amount of alcohol consumed. The remaining questions that were removed included “adding coconut milk to food will result in poor blood sugar control in diabetics.” and “adding coconut milk to food will NOT affect

blood sugar control in diabetics." The experts recommended that blood sugar level is not a direct effect of consuming lipid food, so both of them should be removed.

This resulted in a final list of 44 items with a I-CVI of each item greater than 0.8 (0.875-1) S-CVI/Ave was 0.98 and S-CVI/UA was 0.81. According to the criterion of 0.8 as the lower limit of acceptability for an S-CVI, it would be concluded that the content validity of the 44 items was adequate using the S-CVI/UA approach (0.81), and S-CVI/Ave approach (0.98) (Sing et al., 2015) Once the content validity was established, the questionnaire was forward translated into a Thai version and back-translated into English by five translators in line with the WHO recommendations (as below)

Item translation

Process of translation and adaptation of instruments

This questionnaire was forward-translated and back-translated following the WHO's (2017) guideline, including 4 steps:

1. Forward translation
2. Expert panel back translation
3. Pre-testing and cognitive interviewing
4. Final version

The items were translated into Thai by one expert. After that, the Thai version of the questionnaire was sent to an expert panel to review the translated version (three experts including the original translator). Once agreement was reached by the expert panel, the draft was back translated by two translators; one translator kept all of the concepts of the questionnaire while two items (question number 20 and 42) from another translator needed an adjustment and approval again. Finally, the approved version was compared with the

original English version, and all items matched the original. The translators' characteristics are shown in the table below.

The requirements for the questionnaire translators followed the guidelines of Maxwell (1996)

1. A good knowledge of English
2. An excellent knowledge of the target language
3. Experience in both languages and culture
4. Experience with the target population
5. Skill in test development

Table 8 The translators' characteristics.

Translator characteristics (Maxwell, 1996)	**Forward translator +Expert panel**	**Expert panels**		**Backward translator 1**	**Backward translator 2**
A good knowledge of English	✓	✓	✓	✓	✓
An excellent knowledge of the target language	✓	✓	✓	✓	✓
Experience in both languages and culture	✓	✓	✓	✓	✓
Experience with the target population (health volunteer)	✓	✓	✓	✓	✓

Translator characteristics (Maxwell, 1996)	Forward translator +Expert panel	Expert panels		Backward translator 1	Backward translator 2
Skill in test development	✓	✓	✓	-	✓

Pre-testing and cognitive interviewing

The aim of piloting questionnaire items with the intended respondent was to identify items which lacked clarity or which were inappropriate for the respondent (Rattray, 2007). Pre-testing of the current tool was carried out with 10 HVs. The clarity of the words, the accuracy of the questions and the time taken to complete the items were recorded and developed. The HVs were asked to complete the questionnaire and to ask about any word or phrase they did not understand, and to state whether or not they understood the question. Alternative words or their own expressions were recorded. The respondents were also asked to provide the reason why they chose the answer. These questions were repeated for each item. In addition, the HVs were observed by the interviewer to see how they completed the questionnaire, and to uncover any problems with the questionnaire's structure. Information about font size, question order, and the number of words in each question was asked for layout improvement. All 10 participants were able to complete the questionnaire within 10 minutes, and they confirmed that the questionnaire's instructions and layout were easy to follow. However, there were three problems categorised from the feedback that the researcher had to adjust. Firstly, the HVs did not know the technical term 'type 1 diabetes' and 'diabetic ketoacidosis,' hence alternative words were used, and four questions regarding diabetic ketoacidosis were collapsed into two questions as they contained repetitive information. In addition, the HVs gave an answer without paying attention to the words 'maximum' and

‘minimum’ exercise. Improvement was made by highlighting both words to make them stand out. Finally, some people were confused by the words ‘blood testing’, as they thought it was the blood taken from the veins, so this was changed to ‘a finger prick blood sugar test’. After that, the adjusted items were translated following the translation process until a satisfactory result was reached.

Step 5 Establishing Reliability

The last step was establishing reliability using a pilot test with 41 HVs not included in the sample.

It is essential to demonstrate the reliability of the questionnaire as this value refers to the stability, item consistency and the quality of the questionnaire (Rattray and Jones, 2007). There are many types of reliability such as test-retest, equivalent reliability and internal consistency reliability. As test-retest assesses by using same test to the same group at different times, this method can pose the memory reactivity effect (Devon et al., 2007) as the respondents can remember the questions if the gap time between the first and second test is not long enough. In contrast, the respondent’s knowledge would be changed if the second test was performed long after from the initial assessment. In this study, the researcher assessed internal consistency based on a pragmatic view (to deal with something based on practical consideration). This mixed methods study traverses two opposing paradigms choosing a research design that can provide the researcher with a measurement of the HVs knowledge levels and a deeper insight into their learning journey. Developing a valid and reliable tool to measure the respondent’s knowledge scores is a fundamental aspect of this chosen design and is therefore is not only appropriate but essential

Internal consistency reliability

Convenience sampling was used to recruit participants. The sample included 41 HVs who live in rural areas, including males and females (the required number for piloting should be 20 or more, as a smaller number would be uninformative (Bruce et al., 2018, p. 162)). A pilot test was undertaken in the room of the health centre, the HVs who came to the health centre for the monthly meeting were invited to take part in the pilot test, the recruitment process was separated into two parts, before and after the monthly meeting. Before the monthly meeting time, HVs who arrived at the health centre early were invited to take part. The researcher informed them of the purpose of the pilot test. Once, verbal consent had been obtained from the HVs, they were asked to complete the questionnaires, the time was also recorded. The recruitment then started again after the monthly meeting end. As many people agreed to take part in the pilot test, some of those asked the researcher to perform the pilot test and came back to the health centre the day after the meeting as they were not available at the meeting date. Hence, the researcher made an appointment with the HVs and came back to the health centre the next day. Finally, 41 HVs participated in the pilot test and each of HVs spent around 10-15 minutes to complete the survey (mean=11 minutes).

After that, the data was put into the SPSS program by the researcher; 1 and 0 were representative of each item score, choosing the correct answer was allocated 1, and incorrect answers and 'do not know' were allocated 0, and then the responses were analysed. I chose internal consistency for testing the reliability because I tested the instrument one time with one group. Furthermore, I used the Kuder Richardson (KR 20) because it was suitable for the dichotomous options (yes=1, no=0). As a result, 5 items were removed as they had negative correlation among the items (Q17, Q20, Q31, Q34 and Q39). The corrected item-total correlations were -.298, -.059, -.184, -.163 and -.061 respectively. And I reran the KR20

again; the overall Kuder Richardson was 0.830, and 37 items remained (as shown in Tables 9 and 10).

Table 9 Item total statistic (42 items)

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
K1	28.5366	27.955	.405	.761
K2	28.5610	28.702	.260	.768
K3	28.6341	27.988	.401	.761
K4	28.3659	28.538	.329	.765
K5	28.7317	27.651	.493	.757
K6	28.3415	29.180	.204	.770
K7	28.5122	27.406	.515	.756
K8	28.1951	28.961	.364	.765
K9	28.0976	29.690	.385	.768
K10	28.5854	26.699	.653	.749
K11	28.1951	29.061	.336	.766
K12	28.2195	29.876	.094	.774
K13	28.1220	29.660	.279	.769
K14	28.2439	28.539	.414	.762
K15	28.6829	30.022	.019	.779
K16	28.2683	28.201	.471	.760
K17	28.2683	31.551	-.298	.788

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
K18	28.4146	28.249	.370	.763
K19	28.0976	30.290	.032	.774
K20	28.7317	30.451	-.059	.782
K21	28.4878	30.106	.003	.780
K22	28.3902	28.044	.422	.761
K23	28.4634	29.505	.116	.774
K24	28.4146	27.899	.442	.760
K25	28.2683	28.601	.375	.764
K26	28.0976	30.190	.090	.773
K27	28.2195	27.976	.599	.757
K28	28.3415	29.030	.235	.769
K29	28.4146	28.449	.330	.765
K30	28.6829	28.822	.246	.769
K31	28.5610	31.152	-.184	.788
K32	28.2683	29.951	.059	.775
K33	28.2195	28.426	.476	.761
K34	28.3415	30.980	-.163	.785
K35	28.1951	29.361	.250	.769
K36	28.2683	28.251	.459	.760
K37	28.0976	30.340	.003	.774

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
K38	28.9512	30.098	.045	.775
K39	28.4878	30.456	-.061	.782
K40	28.2927	28.562	.364	.764
K41	28.2927	29.062	.250	.768
K42	28.4390	28.302	.353	.764
Cronbach's Alpha =.773, N of item 42				

Table 10 Items total statistic (37 items)

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
K1	25.5610	30.202	.474	.821
K2	25.5854	31.349	.262	.828
K3	25.6585	30.630	.397	.824
K4	25.3902	31.144	.337	.826
K5	25.7561	30.389	.467	.821
K6	25.3659	31.588	.258	.828
K7	25.5366	29.905	.534	.819
K8	25.2195	31.576	.377	.825
K9	25.1220	32.360	.397	.827
K10	25.6098	29.194	.666	.814

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
K11	25.2195	31.826	.309	.827
K12	25.2439	32.589	.091	.832
K13	25.1463	32.278	.309	.828
K14	25.2683	31.251	.398	.824
K15	25.7073	32.462	.068	.835
K16	25.2927	31.012	.429	.823
K17	25.4390	31.052	.338	.826
K18	25.1220	33.060	.003	.832
K19	25.5122	32.606	.041	.836
K20	25.4146	30.649	.425	.823
K21	25.4878	31.856	.178	.831
K22	25.4390	30.652	.415	.823
K23	25.2927	31.162	.394	.824
K24	25.1220	32.910	.087	.831
K25	25.2439	30.689	.573	.820
K26	25.3659	31.488	.278	.827
K27	25.4390	31.002	.347	.825
K28	25.7073	31.362	.268	.828
K29	25.2927	32.662	.058	.833
K30	25.2439	31.039	.482	.822

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
K31	25.2195	32.176	.214	.829
K32	25.2927	30.762	.487	.821
K33	25.1220	33.060	.003	.832
K34	25.9756	32.974	.002	.834
K35	25.3171	31.222	.361	.825
K36	25.3171	31.622	.274	.827
K37	25.4634	30.755	.388	.824
Cronbach's Alpha =.830, N of item 37				

6.5 Discussion

The questionnaire development took approximately 12 months as this questionnaire was developed specifically for assessing the HVs' role. All procedures were carefully undertaken to ensure content validity. The final version had content validity and high reliability. The questionnaire was well developed following standard questionnaire developing guidelines and translating process guidelines (WHO, 2010). The content validity was reviewed by eight field specialists from the UK and Thailand. The number of the expert panel was in line with two recent studies which recruited eight experts to be the content validators of the questionnaire (Vrbnjak et al., 2017; Kovacic, 2018), and followed the recommendation of at least five and not over than 10 (Zamanzadeh et al., 2015). The overall content validity was good (S-CVI 0.98); I-CVI was between 0.875 and 1. Regarding the content validity, it reached the standard, I-CVI and S-CVI were widely used to evaluate the content validity

index. The content validity index (CVI) was employed to measure the validity of the questionnaire about diabetes for nurses (Modic et al., 2009; Yacoub et al, 2014), and the content validity was 0.90 and 0.94 respectively. The content validity of the instrument was considered excellent because I-CVI was greater than 0.78 (Sangoseni et al., 2013; Sing et al., 2015). In addition, the study of Rubio et al. (2003) and Paul et al. (2016) reported that the I-CVI should not be less than 0.8. This was similar to the study of Polit et al. (2007) which states that I-CVI higher than 0.7 is excellent. The process of translation was time-consuming, five highly qualified translators who met the standard criteria were used. The researcher used a forward and back translation procedure that was in the line with recent studies regarding the diabetes knowledge test (Al-Qazaz et al., 2010; Saleh et al., 2012; Schmitt et al., 2013). According to the article of the University of Alberta, the minimum number of the translators needs to include two bilinguals, one to translate forward and another to translate back (Regmi et al., 2010). Similarly, the process of translation and adaptation of instruments of the WHO (2010) presented that, the number of translators might be different and the translators include the forward translator, expert panel and the back-translator. In this study five translators were used, two forward translators, three expert panels and two back translators. The translation process followed the WHO guidelines (WHO, 2010). In the face validity test, in-depth interviews were conducted with 10 participants in order to gain information on the readability and suitability of the items and to make necessary adjustments. Similar to the previous studies about the diabetes knowledge test which performed cognitive testing in the related sample to assess the clarity and understandability (Huizinga et al., 2008; Koontz et al., 2010; Adibe et al., 2011; Navarro-Flores et al., 2015; Weeks et al., 2015), the reliability of the instrument was good (KR 20=0.830). Reference to the report of El-Uri and Malas (2013) showed that the Kuder Richardson score greater than 0.8 was acceptable reliability, in line with the new developed

diabetes knowledge test in patients (Huizinga et al., 2008; Koontz et al., 2010; Adibe et al., 2011; Guo et al., 2012; Schmitt et al., 2013; Navarro-Flores et al., 2015; Weeks et al., 2015). However, the acceptable value of Cronbach's alpha (internal consistency reliability) in previous studies about diabetes knowledge test can be lower than 0.8 (Rubin et al., 2007; Collins et al., 2011; Al-Qazaz et al., 2010), and the criteria for accepting Cronbach's alpha > 0.6 were shown in questionnaire development about the diabetes knowledge test in Muslim patients of Zainudin et al (2017). Hence, it could explain that the value of Cronbach's alpha for internal consistency reliability of this instrument was an acceptable value. The final version, in total consisted of 5 domains and 37 closed-ended items: diabetic complications 9 items, medication use 9 items, general knowledge about diabetes 8 items, self-care when well 7 items, care required when becoming ill 4 items. This questionnaire had validity and reliability, and it was therefore ready to use for the evaluation of the diabetes knowledge of HVs.

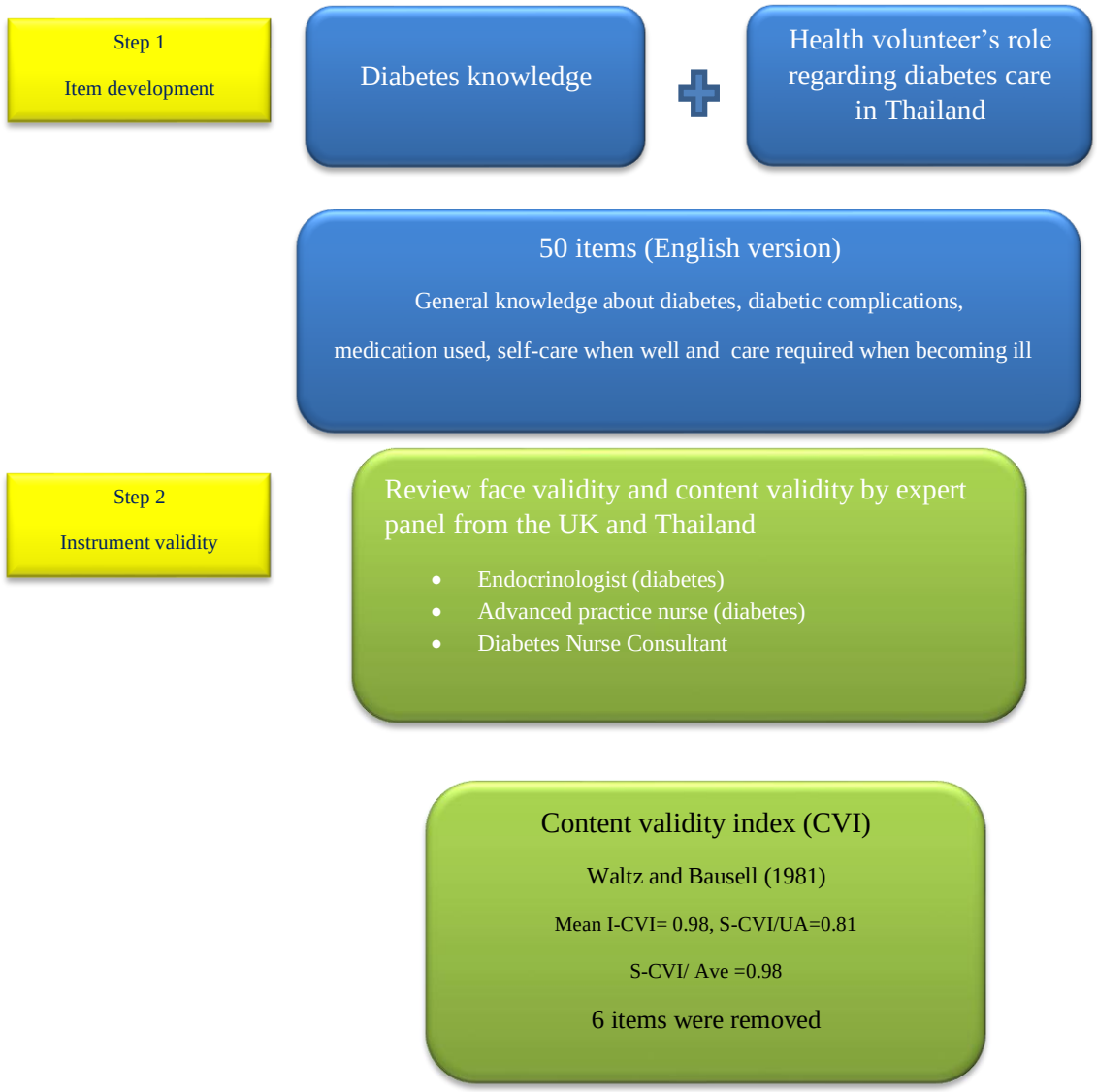
Mohajan (2017) claimed that reliability and validity are the most important and fundamental factors that support rigorous research. All quantitative studies, even those within a mixed methods design are required to be both valid and reliable. Without these tests, the results are meaningless. The above paragraphs provide details of how these concepts were included in the development of the tool and the scores provided demonstrate that the tool developed is both valid and reliable.

6.6 Conclusion

This newly developed questionnaire provides the researcher with a valid and reliable tool that can be used to measure the HVs current knowledge of diabetes in Thailand. However, it should be acknowledged that the tool is based on the current Thai guidelines and as new

evidence, the role of the HV and training develops that further testing and additional amendments may be required in the future.

Figure 2 Questionnaire development chart



Step 3

Questionnaire translation

Forward and backward translation by 5 experts who meet criteria (Maxwell, 1996)

1. A good knowledge of English
2. An excellent knowledge of the target language
3. Experience in both languages and culture
4. Experience with the target population
5. Skill in test development

1. Forward translation (WHO, 2017)

-Questionnaire was translated into Thai by one expert

-Thai version was reviewed and approved by expert panels

2. Backward translation (WHO, 2017)

-Thai version was translated into English by 2 experts

- 2 drafts from 2 translators were compared and 2 items were adjusted and returned to the translators for gaining approval

- English version was approved from both translators

3. To compare the translated version with original version,

new items can keep all concepts of the original version

4. Pre-test with 10 health volunteers, using in-depth interview

The items with technical term words, and cause of the confusion were adjusted

Step 4

Questionnaire reliability

5. Pilot the questionnaire

Item piloting was performed in 41 health volunteers, KR 20 value is 0.83, 5 items were discarded, it was total 37 items

Chapter 7 Quantitative Study

7.1 Introduction

In the previous chapter, I described the paradigm underpinning the study and the research designs considered for the two distinct phases of this research study, namely quantitative and qualitative. The questionnaire development has been described in chapter 3. In this chapter, I describe study one (quantitative study) of the research, which explored the health volunteers' (HVs) knowledge of diabetes using the newly developed and validated questionnaire. This chapter includes the method, recruitment strategy, questionnaire distribution, data collection, data analysis, study results and the discussion.

Phase 1 Quantitative study:

7.2 Study Aim

The aim of phase 1 of the study was to assess the HVs' knowledge of diabetes, using the HVs diabetic-knowledge questionnaire.

7.3 Research question

1. What are the Health Volunteers' levels of knowledge regarding diabetes in Thailand?

7.4 Sampling

Population and sample:

Current HVs located across three different community settings (Inner City, Urban Fringe and Suburban areas) within the Bangkok region were invited to complete the questionnaire. Exclusion criteria included:

i) Unable to read or write in Thai;

ii) Worked less than one year as a HV.

A multi-stage sampling method was employed for selecting the study participants (as shown in Table 12). To calculate the study sample size the Taro Yamane technique (1967) was employed. This technique uses total population size and likely response rates. Information on the total population of HVs working in Bangkok (12, 439) was obtained from the Health Department, Bangkok Metropolitan Administration (2016).

We envisaged that our response rates could be low due to the single method of postal distribution. We considered alternative, web based, approaches but believed that postal distribution was still likely to yield the highest response rate within this target population. Whilst web-based surveys are popular for data collection due to the cost and time saving (Touvier et al., 2010) in 2016, only 47.5% of the total population of Thailand (age 6 years and over) can access the internet (National Statistical Office, 2016). Taking into account the low educational levels and socioeconomic status of HVs (Chuengsatiansup and Suksit, 2007), the percentage of HVs with internet access is likely to be even lower. It was therefore deemed appropriate to pursue a postal approach with the recognition that response rates may be low. Previous studies have demonstrated typical response rates of around 30% (Fincham, 2008).

Postal surveys have been used in Thailand for several years with response rates varying between 8 - 90%. When classifying response rates based on the year of publication it is clear that response rates are higher in more contemporary studies. Studies published between 2015-2017 received between 18-40% of responses (Setthasakko, 2015; Chonsilapawit and Rungpragayphan, 2016; Thanakitprapa et al., 2017), while more recent studies secured response rates of up to 90% (Pooripussarskul et al., 2018; Donsamak et al., 2021; Panya and

Chowwanapoonpohn, 2021; Rakhab et al., 2021). This excluded the study by Chinwong and Chinwong (2018) which got around 8% response rate.

The means in which response rates were maximised in these studies included increasing the sample size (Chonsilapawit and Rungpragayphan, 2016; Thanakitprapa et al., 2017; Panya and Chowwanapoonpohn 2021; Rakhab et al., 2021), and using a telephone call or email to reminder for participants who have not returned the surveys (Chinwong and Chinwong, 2018; Pooripussarskul et al., 2018). Nevertheless, incorrect telephone numbers and email addresses were not uncommon limiting the effectiveness of this approach. Some authors have attempted to explain reasons for low response rate which may include; the survey dealing with sensitive issues (Setthasakko 2015), lack of time to complete the survey (Thanakitprapa et al 2017), not fully understanding the survey questions (Thanakitprapa et al 2017) and participants not having the experience to answer the questions (Chinwong and Chinwong 2018). We had to factors these potential issues into our survey by completing a validation exercise and ensuring strict inclusion criteria thus ensuring the questions were clear and those answering the questions possessed the relevant knowledge and experience.

As above, in view of this anticipated response rate our sample size was estimated to be 504 (the sample calculation is shown in Table 11).

Table 11 Using Taro Yamane methodology to calculate sample size (Yamane, 1967)

The sample size was calculated from a total population of 12,439 Health Volunteers working in Bangkok in 2016 (The Health Department, Bangkok Metropolitan Administration, 2016)
$n = \frac{N}{1+Ne^2}$
n= the sample size

N= the population size

e= the acceptable sampling error (5%)

$$n = \frac{12439}{1+12439(0.05^2)}$$

$$n=\frac{12439}{(1+12439(0.0025)}$$

$$n=\frac{12439}{(1+31)}$$

$$n=\frac{12439}{(32)}$$

n=388 (the minimum sample size of this study is 388)

however, the researcher decided to add 30% to ensure adequate sample size

n = 388, adding 30%

$$388x \frac{30}{100} = 116$$

388+116= 504

The total number of health volunteers in the study was 504.

Therefor the total number of HVs that were invited to participate in the study was 504.

Once the sample size was obtained, the researcher selected the potential participants by using a multi-stage sampling strategy. This strategy included three stages: cluster sampling followed by two simple random sampling methods. Three health centres were included and 168 HVs were selected from each health centre, giving a total number of 504, the participant's selection process is shown in Table 12.

Table 12 Participant selection consisting of two phases

Phase 1

A multi- stage sampling method was used in this quantitative study, which was separated into three parts.

Part 1

Cluster sampling was used, dividing Bangkok into three locations (area cluster sampling)

1. Inner City areas have 21 sections and 3,884 health volunteers
2. Urban Fringe areas have 18 sections and 4,326 health volunteers
3. Suburban areas have 11 sections and 4,229 health volunteers

Part 2

We used simple random sampling from within the previously sampled clusters to select health centres

- 1 from Inner City areas
- 1 from Urban Fringe areas
- 1 from Suburban areas

Part 3

We used simple random sampling to select 504 participants from a list of health volunteers, from three areas selected in Part 2, which was equal to 168 people per section. Each HV was represented by a number such as 1,2,3….and the researcher pulled the number out of three boxes until 504 names were reached.

- 168 participants from Inner City areas
- 168 participants from Urban Fringe areas

- 168 participants from Suburban areas

Therefor the total number of HVs that were invited to participate in the study was 504.

Ethical considerations

Liverpool John Moores University's Ethics Committee for human research (17/NAH/022) and the Bangkok Metropolitan Administration Ethics Committee (E012q/60_EXP) approved this study.

Informed Consent

A consent form and participant information sheet (PIS) were attached to each questionnaire. The PIS explained the purpose of the study and outlined the expectations of the HV, if they chose to participate in the study. In addition, HVs were made aware that they have the right to withdraw from the study at any time without the need for explanation.

7.5 Methods

Data Collection

The researcher posted 504 questionnaires, with supporting information to the health centres included in the study. The supporting information contained a consent form, a PIS and details of the second stage of the study. For those who wished to participate with the second stage, participants were asked to provide contact details so they could be invited to participate in an interview. Data collection occurred over a two-month period between 1 December 2017 and 31 January 2018. Following questionnaire distribution, the researcher attended monthly HV meetings to discuss the study. This provided an opportunity for the researcher to answer any participant queries and to encourage questionnaire completion.

7.6 Data Analysis

Collected data was stored in a password protected university computer. This data was subsequently analysed using SPSS software, version 21. Diabetes knowledge levels were classified into three groups based on the participant's score. (Bloom et al., 1971). ≥80% was classified as "high knowledge level", 60-79% "moderate knowledge level" and <60% was deemed to be "low knowledge level". These categories were based on Bloom's taxonomy and have recently been replicated by Bagweneza et al (2019) who explored the diabetes knowledge of qualified nurses using the same markers. Data were shown as frequency and percentage for categorical variables and minimum, maximum and mean were shown for continuous variables.

7.7 Research Findings

504 questionnaires were distributed and 390 completed questionnaires were returned; a response rate of 77.38%. 390 completed questionnaires exceeded the study's minimum sample size of 388 (Table 11). Hence, the response rate is sufficient to enable the results to be generalised to the greater population.

Table 13 Description of the health volunteers (n=390)

Variable	Frequency(n)	Percentage (%)
-Age		
aged 20-40	12	3.1
aged 41-60	162	41.5
age 61-80	204	52.3
aged >80	12	3.1

Variable	Frequency(n)	Percentage (%)
Average score = 61.86 ± 10.17, minimum = 28, Maximum = 91		
-Gender		
Female	311	79.7
Male	79	20.3
-Marital status		
Single	58	14.9
Married	204	52.3
Divorced/Separated	30	7.7
Widowed	88	22.6
Prefer not to answer	10	2.6
-Educational levels		
Grade school	137	35.1
High school	141	36.2
Vocational certificate	35	9
High vocational certificate	32	8.2
Undergraduate + postgraduate	45	11.6
-Years of experience as a health volunteer		

Variable	Frequency(n)	Percentage (%)
1-5	77	19.7
6-10	108	27.7
11-15	106	27.2
16-20	74	19.0
20+	25	6.4
-Employment status		
Unemployed	221	56.7
Employed	169	43.3
-Family's monthly income		
< 26, 946 Baht	390	87.95
≥26, 946 Baht	47	12.05
Average income =15,828.86 ±11,678.46, minimum =600, Maximum = 100,000		
-Area of working		
Inner City area	125	32.1
Urban Fringe area	99	25.4
Suburban area	166	42.6

Demographic data

Nearly four fifths of the health volunteer were female (n=311 (79.7 %)). More than half were aged between 61 and 80 years (n=204 (52.3 %)) with a further 41.5% (n=162) aged between 41 and 60 years old. Approximately half of HVs were married (n= 204 (52.3%)). The average household income per month was 11,678.46± 15,828.86 Baht, and the majority graduated from high school (n=141(36.2%)). 27.7% (n=108) of the HVs have worked as a health volunteer for between 6 and 10 years, and over half of them (n=221(56.7%)) were unemployed. 42.6% (n=166) worked in a Suburban area (Table 13).

Table 14 The number and the percentage of health volunteers classified by the knowledge levels (n=390)

Knowledge level regarding diabetes	**Number of participants with scores within these parameters**	**Percentage of participants with scores within these parameters**
Low (score 0-22)	100	25.6
Moderate (score 23-29)	186	47.7
High (score 30-37)	104	26.7
Average score = 25.80 ± 4.67, minimum =14, Maximum =34		

Table 15 Description of the ages of the health volunteers classified according to knowledge levels (n=390)

Variable	**Responses**	**Knowledge levels**			**Total**
		Low knowledge	**Moderate knowledge**	**High knowledge**	
Age	Aged 20-40	2 (16.7%)	5 (41.7%)	5 (41.7%)	12 (100.0%)
	Aged 41-60	39 (24.1%)	82 (50.6%)	41 (25.3%)	162 (100.0%)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
	Age 61-80	55 (27.0%)	95 (46.6%)	54 (26.5%)	204 (100.0%)
	Aged >80	4 (33.3%)	4 (33.3%)	4 (33.3%)	12 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)
Average age= 61.86, minimum = 28, Maximum = 91					

Age

The younger HVs had higher knowledge levels than the older participants with nearly half (n=5(41.7%) of the HVs age 20-40 possessing moderate or high knowledge levels (Table 15).

Table 16 Description of the gender of the health volunteers classified according to knowledge levels (n=390)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
Gender	Female	78 (25.1%)	148 (47.6%)	85 (27.3%)	311 (100.0%)
	Male	22 (27.8%)	38 48.1%	19 (24.1%)	79 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)

Gender

Females performed better than males with 27.3% (n=85) of HVs female demonstrating high knowledge levels, while 24.1% (n=19) of males had high knowledge levels (Table 16).

Table 17 Description of the marital status of the health volunteers classified according to knowledge levels (n=390)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
Marital status	Single	13 (22.4%)	30 (51.7%)	15 (25.9%)	58 (100.0%)
	Married	54 (26.5%)	92 (45.1%)	58 (28.4%)	204 (100.0%)
	Divorced/Separated	7 (23.3%)	16 (53.3%)	7 (23.3%)	30 (100.0%)
	Widowed	22 (25.0%)	43 (48.9%)	23 (26.1%)	88 (100.0%)
	Prefer not to answer	4 (40.0%)	5 (50.0%)	1 (10.0%)	10 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)

Marital status

Married HVs were more likely to have higher knowledge levels than HVs with other marital status. 28.4 % (n=58) of those married HVs had high knowledge levels which was the highest percentage when compared with other marital status groups (Table 17).

Table 18 Description of the educational levels of the health volunteers classified according to knowledge levels (n=390)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
Educational levels	Grade school	40 (29.2%)	73 (53.3%)	24 (17.5%)	137 (100.0%)
	High school	40 (28.4%)	72 (51.1%)	29 (20.6%)	141 (100.0%)
	Vocational certificate	8 (22.9%)	15 (42.9%)	12 (34.3%)	35 (100.0%)
	High vocational certificate	6 (18.8%)	13 (40.6%)	13 (40.6%)	32 (100.0%)
	Undergraduate + postgraduate	6 (13.3%)	13 (28.9%)	26 (57.8%)	45 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)

Educational levels

HVs who had higher education levels tended to perform better than those participants with lower educational levels. Over half of those with undergraduate and post-graduate qualifications (n=26 (57.8%) scored highly and there appears to be a general increase in scores with an increase in educational levels as shown in Table 18.

Table 19 Description of the working experience of the health volunteers classified according to knowledge levels (n=390)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
Years of experience as a health volunteer	1-5	22 (28.6%)	31 (40.3%)	24 (31.2%)	77 (100.0%)
	6-10	23 (21.3%)	49 (45.4%)	36 (33.3%)	108 (100.0%)
	11-15	32 (30.2%)	49 (46.2%)	25 (23.6%)	106 (100.0%)
	16-20	12 (16.2%)	49 (66.2%)	13 (17.6%)	74 (100.0%)
	21+	11 (44.0%)	8 (32.0%)	6 (24.0%)	25 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)
Average year=10.98, minimum = 1, Maximum = 23					

Years of experience

According to the data in table 19, HVs with less experience recorded higher knowledge scores than those with more experience Over 30% of the HVs with less than 10 years' experience as a HVs demonstrated high knowledge compared to less than 25% in all remaining categories.

Table 20 Description of the employment status of the health volunteers classified according to knowledge levels (n=390)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
Employment status	Unemployed	57 (25.8%)	104 (47.1%)	60 (27.1%)	221 (100.0%)
	Employed	43 (25.4%)	82 (48.5%)	44 (26.0%)	169 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)

Employment status

Unemployed HVs recorded higher knowledge levels (27.1%, n=60) compared to those who were employed (26%, n=44). However, the difference was negligible (As shown in Table 20).

Table 21 Description of the knowledge levels of the health volunteers classified according to household income (n=390)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
Household income/ month *	< 26, 946 Baht	92 (26.8%)	167 (48.7%)	84 (24.5%)	343 (100.0%)
	≥26, 946 Baht	8 (17.0%)	19 (40.4%)	20 (42.6%)	47 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)
Average income =11,678.46, minimum =600, Maximum = 100,000					

***An average Thailand's household income 2017 was** 26,946 **Baht per month (National statistical office, 2018)**

Household income

The results presented in table 21 show that, HVs with higher income were likely to have better knowledge levels than those with lower income. Nearly half (n=20, 42.6%) of the HVs with income that was greater than the average Thai household (≥26, 946 Baht) recorded high knowledge levels, while only 24.5% (n=84) of those with household income less than 26, 946 Baht demonstrated high knowledge levels.

Table 22 Description of the knowledge levels of the health volunteers classified according to working area (n=390)

Variable	Responses	Knowledge levels			Total
		Low knowledge	Moderate knowledge	High knowledge	
Area of working	Inner City area	34 (27.2%)	58 (46.4%)	33 (26.4%)	125 (100.0%)
	Urban Fringe area	29 (29.3%)	52 (52.5%)	18 (18.2%)	99 (100.0%)
	Suburban area	37 (22.3%)	76 (45.8%)	53 (31.9%)	166 (100.0%)
	Total	100 (25.6%)	186 (47.7%)	104 (26.7%)	390 (100.0%)

Area of working

HVs living in Suburban areas tended to have higher knowledge levels compared with the HVs working in other areas. 31.9% (n=53) of those HVs working in Suburban areas recorded high knowledge levels (Table 22).

The health volunteers' knowledge levels regarding diabetes.

According to the number and the percentage of health volunteers classified by their knowledge levels (Table 14), only a quarter of the sample possessed high knowledge levels (26.7% (104), while three quarters recorded either poor or moderate knowledge levels

((25.6% (100) and 47.7% (186), respectively). A mean score of 25.80 was recorded for the total sample. The lowest was 14. and the highest score was 34

Knowledge levels were higher among females, married, unemployed, younger age, higher education levels and those with household income greater than the average national household income. In addition, knowledge was greater in HVs working in suburban areas. However, those with less work experience were more likely to have high knowledge than other groups. In reality many of the variables are likely to be inter-dependent with higher educational levels, suburban working and household income providing one example.

Table 23 The number and the percentage of health volunteers who chose the correct answer broken down by individual questions (n=390)

Item	Question	The number of people who chose the correct answer (N=390)	The number of people who chose the incorrect answer (N=390)
1	Insulin is produced by the kidneys.	159 (40.77%)	231 (59.23%)
2	Injectable insulin is only essential in the treatment of insulin-dependent diabetes.	229 (58.72%)	161 (41.28%)
3	Short-acting insulin begins to work 60 minutes after injection.	127 (32.56%)	263 (67.44%)
4	Normal fasting blood sugar is between 70-100 mg/dl.	229 (58.72%)	161 (41.28%)

Item	Question	The number of people who chose the correct answer (N=390)	The number of people who chose the incorrect answer (N=390)
5	LDL cholesterol is known as 'good' cholesterol.	111 (28.46%)	279 (71.54%)
6	Diabetic patients should keep their blood pressure below 140/90 mmHg.	279 (71.54%)	111 (28.46%)
7	Blood sugar levels between 70-125 mg/dL is a life-threatening emergency.	244 (62.56%)	146 (37.44%)
8	Diabetics are at an increased risk of developing heart disease.	351 (90%)	39 (10%)
9	Diabetics are at an increased risk of developing foot complications.	367 (94.10%)	23 (5.90%)
10	Urine testing is the best method for home glucose testing.	165 (42.31%)	225 (57.69%)
11	Diabetics are at an increased risk of developing kidney failure.	333 (85.38%)	57 (14.62%)

Item	Question	The number of people who chose the correct answer (N=390)	The number of people who chose the incorrect answer (N=390)
12	If a diabetic patient forgets to take their diabetes medication in the morning, they should take a double dose in the evening.	349 (89.49%)	41 (10.51%)
13	Diabetics are at an increased risk of developing retinopathy.	382 (97.95%)	8 (2.05%)
14	Diabetic patients can discontinue their diabetes medication when they feel their condition has improved.	294 (75.38%)	96 (24.62%)
15	Drinking alcohol enhances the effect of diabetes medication.	154 (39.49%)	236 (60.51%)
16	Diabetics can share their diabetes drugs with other diabetic patients.	354 (90.77%)	36 (9.23%)
17	Diabetics are **NOT** at an increased risk of developing kidney failure.	260 (66.67%)	130 (33.33%)

Item	Question	The number of people who chose the correct answer (N=390)	The number of people who chose the incorrect answer (N=390)
18	Diabetic patients should be encouraged to check their feet for abnormalities.	343 (87.95%)	47 (12.05%)
19	The presence of infection can cause an increase in blood sugar levels.	275 (70.51%)	115 (29.49%)
20	Normal fasting blood sugar is between 126 -250 mg/dl.	243 (62.31%)	147 (37.69%)
21	When diabetics are ill, they should test their blood glucose more often.	344 (88.21%)	46 (11.79%)
22	Diabetic patients should keep their blood pressure above140/90 mmHg.	252 (64.62%)	138 (35.38%)
23	Diabetics are **NOT** at an increased risk of developing heart disease.	297 (76.15%)	93 (23.85%)
24	Drinking sweetened drinks increases blood sugar levels.	252 (64.62%)	138 (35.38%)

Item	Question	The number of people who chose the correct answer (N=390)	The number of people who chose the incorrect answer (N=390)
25	Diabetics are **NOT** at an increased risk of developing foot complications.	314 (80.51%)	76 (19.49%)
26	Insulin is produced by the pancreas.	277 (71.03%)	113 (28.97%)
27	The presence of infection can cause a reduction in blood sugar levels.	246 (63.08%)	144 (36.92%)
28	HDL cholesterol is known as 'good' cholesterol	212 (54.36%)	178 (45.64%)
29	Finger-prick blood testing is the best method for home glucose testing.	348 (89.23%)	42 (10.77%)
30	Diabetics are **NOT** at an increased risk of developing retinopathy.	303 (77.69%)	87 (22.31%)
31	Diabetics **CANNOT** share their diabetes drugs with other diabetic patients.	294 (75.38%)	96 (24.62%)

Item	Question	The number of people who chose the correct answer (N=390)	The number of people who chose the incorrect answer (N=390)
32	Drinking sweetened drinks does **NOT** increase blood sugar.	285 (73.08%)	105 (26.92%)
33	Diabetic patients must **NEVER** discontinue their diabetes medication without discussing it with a doctor.	340 (87.18%)	50 (12.82%)
34	Diabetics should exercise for a maximum of 20-30 minutes per session, 3 days a week.	41 (10.51%)	349 (89.49%)
35	Diabetic patients should be discouraged from checking their feet for abnormalities.	255 (65.38%)	135 (34.62%)
36	Short-acting insulin begins to work 15-30 minutes after injection.	265 (67.95%)	125 (32.05%)
37	When diabetics are ill, they do **NOT** need to test their blood glucose more often.	300 (76.92%)	90 (23.08%)

Table 23 highlights that the three highest scores (highlighted in green) were item 13 **“**Diabetics are at an increased risk of developing retinopathy” 97.95% (382), item 9 “Diabetics are at an increased risk of developing foot complications” 94.10% (367) and item 16 “Diabetics can share their diabetes drugs with other diabetic patients” 90.77% (354)

The three lowest scores (highlighted in yellow) were item 34 **“**Diabetics should exercise for a maximum of 20-30 minutes per session, 3 days a week” 10.51% (41), item 5 “LDL cholesterol is known as ‘good’ cholesterol” 28.46% (111) and item 3 “Short-acting insulin begins to work 60 minutes after injection” 32.56% (127).

7.8 Discussion

This study is the first of its kind to assess HV’s knowledge of diabetes. The findings here show that the HVs had insufficient knowledge about many core aspects of diabetes. Almost half (47.7%) of the HVs had an overall moderate knowledge level, only 26.7 % of all HVs had a high level of knowledge about diabetes. This finding is in keeping with those studies that have previously assessed the knowledge levels of both qualified healthcare professionals (Rubin et al., 2007; Van Zyl and Rheeder, 2008; Cheekati et al., 2009; Jansink et al., 2010; Livingston and Dunning, 2010; Peimani et al., 2010; Park et al., 2011; Shiu and Wong, 2011; Ahmed et al., 2012; Olsen et al., 2012; Wellard et al., 2013; Oyetunde and Famakinwa, 2014; Yacoub et al., 2014; Beliard et al., 2016) and patients (Upadhyay et al., 2008; Al-Adsani et al., 2009; Shah et al., 2009; Ardeňa et al., 2010; Al-Qazaz et al., 2011; Kheir et al., 2011; Odili et al., 2011; Al-Sarihin et al., 2012; Al-Maskari et al., 2013; Hu et al., 2013, Fatema et al., 2017; Zowgar et al., 2018) but is contrary to others (Mutea and Baker, 2008; Unadike and Etukumana, 2010; Khan et al., 2011, Almalki et al., 2018, Yalamala and Suh, 2018). In a study by Bagweneza et al (2019) the majority of nurses had very poor knowledge about diabetic care all scoring <45% (using Bloom’s taxonomy (Bloom et al., 1971)). The reasons

for these poor knowledge levels amongst the nurses were not clearly reported. However, the study was limited by both sample size (51 nurses) and sites (one hospital).

Another study conducted in Sri Lanka by Kumarasinghe et al (2018) reported similar findings. The author performed a cross-sectional study to assess diabetic wound care knowledge amongst 147 nurses by using a newly developed questionnaire with the findings illustrating that over half of the participants possessed good knowledge levels. However, this study classified the knowledge levels of Sri Lankan nurses according to the McDonald's standard learning outcome criteria (McDonald,2002); knowledge score ≥ mean was "good knowledge," while knowledge score <mean was "poor knowledge" (Kumarasinghe, 2018). Consequently, the knowledge levels were norm rather than criterion referenced and may not be directly comparable to the present study due to the difference in classification criteria of knowledge level, the contents in the questionnaire and the difference in population. Furthermore, the results of the study cannot be used to generalise the finding to all Sri Lankan nurses as the study was undertaken only in one province.

When looking at the HVs knowledge of diabetes in term of different characteristics, the current study also found that females were more likely to have higher knowledge than males. People age between 20-40 years had higher knowledge than other age groups. Married HVs are likely to have better knowledge than those who were single or other marital status. HVs with higher educational levels were more knowledgeable than those with lower levels of education. In addition, the high knowledge group were likely to have less working experience, unemployed and had household income greater than the national average. Furthermore, HVs working in Suburban areas were more likely to be more knowledgeable than other areas.

Employment status

HVs who were unemployed were likely to have higher scores than those in employment. Time constraints may explain these findings, as in Thailand, Health Volunteering is by definition not a full-time job. Nearly half of the respondents of this study are employed and working more than one job (not only a HV's role). However, to function in their role as a HV, they are required to attend essential training classes provided by the health centre and other healthcare organisations. Based on employment status, the unemployed may well organise their time to join the classes, and have plenty of time for seeking information about diabetes from numerous resources while those who are employed (have a full-time job) may struggle with time management if the HV's meetings were set on the same day as their full-time job. As a result, the employed may miss classes and information, including diabetes. This finding is supported by recent studies in the Netherlands (Van Ingen and Dekker, 2011; Van Ingen and Wilson, 2017). These studies indicated that unemployed people are likely to dedicate more hours to volunteering than full-time workers as they have extra free time. Those in employment spend fewer hours volunteering than those who have retired (Erlinghagen, 2010; McNamara and Gonzales, 2011; Principi et al., 2012; Sherman and Shavit, 2012; Van den Bogaard et al., 2014).

Employed people dedicate less time to volunteering, especially women. Rafnsdóttir and Heijstra (2013) highlighted that woman struggled balancing their work and family responsibilities. They viewed their daily life as "too little time and too many tasks." Attending regular diabetes training has been shown (Hu et al., 2013; Jasper et al., 2014; Zhou et al., 2020). Zhou et al (2020) to improve participants knowledge of diabetes. However, whilst the educational classes provided a source of information, Cantaro et al (2016) found that people gained knowledge from several sources, including the internet, radio, newspapers, television, dietitians, educational materials, and other patients. Although we

found that the unemployed tended to have higher scores about diabetes, this was not supported by Ardeňa et al (2010) who found that respondents who have jobs were likely to have higher scores on diabetes than those without jobs. Whilst we have posited that time available to study could impact the knowledge levels, it is equally feasible that those with jobs possess higher educational ability. Unemployed HVs may have more motivation to work in the community due to a loss of social interaction. a feeling of unimportance and the financial benefit. Payment was noted as important for community workers in previous studies (Schneider et al., 2008; Shankar et al., 2009; Mpembeni et al., 2015). Although the HVs gain few benefits when compared with the cost of living, as mentioned in chapter 2, the HVs obtained compensation and the opportunity to access healthcare resources. In addition, the unemployed may lose social connections. Being a HV may facilitate these people to stay connected, as they met community members and worked with multidisciplinary healthcare professionals. Furthermore, the unemployed may feel more important when functioning as a HV as they are involved in many community projects, they were assigned to take care of people in the community and have a connection with senior healthcare professionals. Moreover, being a community change agent may enhance the HVs self-value. These were supported by previous studies mentioned in chapter 2, there were several factors making community workers more active in their role including job satisfaction, meeting new friends, a desire to help people and sufficient supervision (Low et al., 2007; Rahman et al., 2010; Greenspan et al., 2013).

However, we cannot say conclusively why the unemployed HVs had a higher score. This should be explored further in a qualitative study. Based on the information above, a lack of knowledge amongst the HVs with full-time jobs should be highlighted. The training creator should organise flexible training times and stay connected with those HVs who are

employed, to ensure that they understand and stay updated on the lessons regularly. Motivation and incentive should be highlighted as well.

Age

In this study the younger respondents tended to have a higher knowledge of diabetes, a finding similar to previous studies (Al-Adsani et al., 2009; Ardeňa et al., 2010; Al-Qazaz et al., 2011; Arora et al., 2011; Feleke et al., 2013; Jasper et al., 2014; Shrestha et al., 2015; Zowgar et al., 2018). Zowgar et al (2018) conducted a study in Saudi Arabia and found that the younger respondents were likely to have a better score on a diabetic knowledge test. One potential explanation for having poor knowledge in older age was a decline in cognitive function and memory impairment (Burke and Barnes, 2010; Grady, 2012; Bartsch and Wulff, 2015; Gray and Barnes, 2015), when scrutinising, more than half of the HVs in this study were over 60 years. Age-related cognitive function and memory impairment may be responsible for the poor knowledge amongst older age HVs. This idea is supported by Ardeňa et al (2010), who stated that older people were likely to have a lower overall diabetic knowledge score due to unavailability of sources of information and the reduction in physical functions such as cognitive decline and impaired hearing. In addition, the hippocampus which is associated with learning and memory was mentioned in previous studies (O'Shea et al., 2016; Assonov and Bozhuk, 2017; Bettio et al., 2017) as being affected by aging in humans (Burke and Barnes, 2010; Penner et al., 2010; Grady, 2012; Benayoun et al., 2015; Bartsch and Wulff, 2015; Gray and Barnes, 2015; Delgado-Morales et al., 2017; Katsimpardi and Lledo, 2018). Although several studies have shown that cognitive and memory decline when people become older, there were several strategies such as calorie restriction, engagement in educational and occupational activities, physical exercise and taking

medication that can be used to prevent or slow down age-related cognitive decline (Dahan et al., 2020).

A study by Fatema et al (2017) reported that participants aged less than 50 years old were likely to have higher knowledge than other age groups over 50 years. The use of differing survey tools, the difference in participants' characteristics, and the way to categorise the variable, may cause the differences in study findings.

Although it was unclear why younger age participants possessed better knowledge than older HVs, being older may influence the physical and cognitive function. The findings point highlight the need to consider age when creating material and choosing teaching methods. An assessment should also be performed to assess the HVs current knowledge levels.

Educational levels

HVs who have higher education levels tend to have greater knowledge than those with lower educational level. These findings are supported by the results of previous studies using different participants and assessment tools (Al-Adsani et al., 2009; Marks et al., 2010; Al-Qazaz et al., 2011; Okuyan et al., 2012; Alkatheri and Albekairy, 2013; Feleke et al., 2013; Jasper et al., 2014; Mohammed et al., 2015; Shrestha et al., 2015; Poulimeneas et al., 2016; Fatema et al., 2017; Zowgar et al., 2018; Asmelash et al., 2019). The finding is also consistent with a study of nurses with a bachelor's degree in nursing by Amsalu and colleagues (2021) who reported better knowledge levels compared to nurses with a diploma in nursing. One possible explanation was that nurses who had a bachelor's degree in nursing were equipped with the professional knowledge they have learned and improved their knowledge of older adult care (Amsalu et al., 2021). Another study in Bangladesh by Islam et al (2015) stated that good knowledge of diabetes was higher among those type 2 diabetics with higher education, however the author classified the educational level into only four

groups including no education, primary education, secondary education and high secondary education, while in this study the researcher divided the educational level into five levels namely grade school, high school, vocational certificate, high vocational certificate, undergraduate and postgraduate, hence it may affect the findings.

However, one study (Odili et al., 2011) found that Nigerian diabetic patients who had no formal education had the highest diabetes knowledge scores when compared with those with higher educational levels. However, the respondents may have acquired self-care knowledge and experience over several years managing their own diabetes. Current study findings contrast with the study by Odili et al (2011), as the Nigerian with diabetes who had no formal education had the highest knowledge score about diabetes when compared with other people who have higher educational levels, the author stated that the results may be caused by their experiences and disciplines in diabetes self-care.

Our findings provide no explanation for this difference as this will be explored in the second phase of the thesis but we hypothesise that those with greater educational attainment may possess a greater existing knowledge of diabetes. In Constructivism learning theory, the learner constructs their knowledge by interacting with the environment, then adjusts their mental structure based on existing knowledge (Kay and Kibble, 2016), meaning that the learner develops and constructs their knowledge based on their individual experience and prior understanding (Alanazi, 2016).

In addition, having high educational levels may increase the HV's desire to learn about diabetes. Their previous experiences and access to education may facilitate access to a whole array of resources such as international resources thus not limiting their reading only to Thai literature. These findings were supported by Irdianto and Putra (2016), who performed a study to examine the influence of education as well as economic background on the

participant's motivation and study results in Indonesia. They found that people with higher education levels motivate themselves to learn and get to know more about what they have learned. They actualise themselves by following the training to reach the maximum outcome, to study and develop skills by using the available opportunity via non-formal education which provides several kinds of vocational training. Irdianto and Putra (2016) also found that educational background influenced the participants' study results. The participants with higher education levels had more study experience, skills and knowledge than those with lower educational backgrounds. They also had more confidence in completing the training tasks, while those with lower educational levels had insufficient basic knowledge which influenced their learning outcome. Fatema et al (2017) reported that participants with and without diabetes who had higher education levels may be likely to have higher knowledge about diabetes than those with lower education levels.

Although we cannot draw a conclusion based on this finding, the possible explanation based on evidence from previous studies and literature, suggests that the HVs with a high educational background may be equipped by their formal educational knowledge and improve their knowledge about diabetes. In addition, motivation to learn may influence the knowledge of the HVs. The findings highlight existing knowledge acquired via formal education and the need for enhanced education amongst those who have a low educational background.

Gender

In this study, female HVs were more likely to record better knowledge of diabetes than male respondents. Therefore, we can assume that female HVs may provide better advice on diabetes for patients. The findings seem positive, as almost all HVs (approximately 80%) in this study were female. These findings are consistent with previous studies conducted in

different populations that reported that females were more likely to achieve better scores regarding diabetes (Al-Mahrooqi et al., 2013; Demaio et al., 2013; Dos Santos et al., 2014; Kumar et al., 2017). A cross-sectional study by Dos Santos and colleagues (2014), collecting data from 178 Brazilian adults, reported that women were likely to achieve better scores regarding diabetes than men. This may also be partly explained by the care giving role that many females adopt (Green, 1990; Anderson et al., 1993; Eknithiset et al., 2018). A study by Eknithiset et al (2018) stated that Thai females with diabetes were better able to regulate their blood sugar and had better access to knowledge about diabetes care when compared with males.

The findings contrast with the previous studies that were carried out in patient groups (Mohammed et al., 2015; Obirikorang et al., 2016; Shahzad et al., 2018). Shahzad et al (2018) found that there was no major difference in basic diabetes knowledge amongst male and female diabetic patients. However, men were likely to have greater knowledge about the harms of smoking in diabetic patients. The possible explanation was that smoking was uncommon in Pakistani women. Additionally, Obirikorang et al (2016), who studied diabetic patients in Ghana found that more men had knowledge about diabetic complications when compared with women. There was a gap about the knowledge between gender, as males performed better on the knowledge test than females in both diabetic and non-diabetic patients (Fatema et al., 2017). The use of differing survey tools, the difference in participants' characteristics, and the way to categorise the variable, may cause the difference in study findings. In addition, Islam et al (2015) found that males were more likely to have higher knowledge than females, the difference in participant and knowledge test mentioned previously may cause the difference in the findings.

One explanation for this increased level of knowledge in the female HV population in Thailand is prior understanding and experience. Once again, we draw upon the principles of constructivism learning theory. Here the learner develops and constructs their knowledge based on their individual experience and prior knowledge (Alanazi, 2016). According to previous studies, older people often require family members to provide care support at home (Etters et al., 2008; Papastavrou et al., 2009). Many of the informal care givers are women (Prince, 2009; Akpınar et al., 2011; Del-Pino-Casado et al., 2012; Tang et al., 2013; Scerri, 2014). Although men can also adopt a role as caregiver, the role is predominantly undertaken by women (Bookman and Kimbrel, 2011; Scerri, 2014; Chappell et al., 2015). In Thailand, a combination of cultural and religious tradition serves as the basis for the care giving role being undertaken mostly by females (Arpanantikul, 2018). This female dominated role is influenced by sociocultural construction and religious beliefs which have been conveyed to younger generations (Arpanantikul, 2018). Thai women are prepared to become the family caregiver from a young age and they are therefore expected to leave their paid job to care for a family member if they become unwell. Based on the Buddhist belief, women believe that caring for their family member was a good thing and they will be rewarded in return (Arpanantikul, 2018). The Wannasiri (2016), study in Thailand illustrated the role of the wife in diabetes care in that the wife supervised the husband's diet and reminded him to take his drugs regularly. Whilst both parties managed their diabetes, the wife was more likely to closely manage her diabetes, and have greater glucose control (Wannasiri, 2016). Koipuram et al (2020), conducted a study with South Asian caregivers who had parents diagnosed with diabetes and noted the difference in task-related caregiving roles between females and males which as has been stated previously may influence diabetes knowledge. Females deal with tasks that require greater knowledge regarding the disease process and treatment than males. Females performed many tasks including meal preparation, insulin administration as well as

diabetes complication management. While males took responsibility for driving their parents following diabetes appointments and financial management. However, the findings were not further explored due to the limitation of participants' data.

Cultural norms and family roles as the main family caregiver may influence the knowledge of diabetes in Thai females. Although the number of male HVs in Thailand is small when compared with females, male HVs are important as well, because all HVs were assigned to take care of people in the community. Therefore, education should be highlighted in Male HVs to enhance diabetes knowledge and diabetes management in the community.

Marital status

Married HVs recorded greater knowledge of diabetes compared with other marital groups. This aligns with evidence of other studies which stated that knowledge about diabetes is good amongst people who are married (Islam et al., 2015; Mohammed et al., 2015; Shrestha et al., 2015). Mohammed et al's (2015) study found that married Bangladeshi diabetic patients were likely to have greater knowledge of diabetes compared with those who were single. Conversely, Obirikorang et al (2016) found that those who were single tended to have greater knowledge of diabetic complications than those who were married. While Shrestha et al (2015) found that marital status was one factor associated with Nepalese diabetic knowledge, and married participants were more likely to have a higher score on the diabetic test than widowed, the numbers of widowed participants was very small (N=4), and the marital status was divided into only two classes: married and widowed, possibly influencing the study results. The study by Pal et al (2020) stated that married people were likely to have higher knowledge levels because they gained additional knowledge from spouses. However, Pal's study cannot be compared with this study due to the difference in participants and the assessment tool which was focussed on Covid 19 knowledge) rather than diabetes.

As evidenced above, it was not universal that being married equated with having better knowledge. However, previous studies draw a potential explanation that married respondents gain knowledge from their spouse. It is still unclear why married HVs in the present study achieved a higher knowledge score and therefore we will explore this in more detail during the forthcoming qualitative part of the study.

Working experiences

HVs with less time-served recorded a higher knowledge level than those with more experience in the role. Our findings are not aligned with several studies performed in other groups, as these studies stated that less experienced healthcare staff were likely to have less knowledge (Engström and Fagerberg, 2011; Elebiary and Hend Elshenewy, 2018; Amsalu et al., 2021). The reasons for having high knowledge among those with higher levels of experience may come from the opportunity to access up-to-date information via observation and practice (Argaw et al., 2019). In addition, the findings also contrast with the experiential learning theory, as this theory believes that knowledge is created via the transformation of experiences (Kolb, 1984, p. 38). So based on this theory, we can assume that those who have more experience with working tasks may have more knowledge because they gain more practical contact with and observation of evidence about diabetes care in the community than those who have less experience.

However, knowledge is not solely gained from experience, the HVs may learn via other methods. The HVs may acquire knowledge via attending the diabetes training as mentioned in the previous chapter. In addition, although the HVs have worked for several years, the role is multifaceted and therefore it does not mean that they have more experience of managing diabetic patients. Again, the HV in Thailand is not required for a 5-day week. Instead, they work at least one day a week, or four days per month undertaking the assigned

activities with multiple duties. They were assigned to take care of 10-15 local households, with potential less chance of contacting the diabetic patients. Therefore, experience may not be the key factor in gaining knowledge about diabetes amongst the HVs.

It is important to recognise that new HVs possessed high levels of motivation whereas the motivation levels of HVs who had worked for several years were reduced. As mentioned in chapter 2 the HVs receive compensation of around 22 pounds a month if they work at least one day a week, or four days per month. This was a fixed cost and all HVs receive the same amount. Even if the HVs work for several years, they get the same compensation as the new workers. Although all HVs obtained the same compensation, they had additional benefits when admitted to the hospital which were slightly different and varied with the year of experience. The HVs with experience of 10 years and over get free access to the private room and free food when admitted to the public hospital, while the HVs who work less than 10 years get 50 % discounts for the room and food cost (full details can be viewed in chapter 2). All HVs gain the same amount of payment from the government, therefore it means experience doesn't matter for gaining benefits of working as the HVs. It differs from other paid jobs as the employee with more experience should get better profits than those with less experience. Although there were some different benefits among those with an experience of more than 10 years and less than 10 years, e.g free admission to a private room in the public hospital. It may be inadequate for maintaining motivation to engage or work as a HV. The lack of consistency of benefits once HVs work for many years (stop at 10 years). Therefore, the new HVs will have short time motivation to engage in the activities until they reach the full package benefits and then their motivation has declined as they will not gain anymore. Motivation was also considered important for work in a study by Szabo and colleagues (2020) who determined that demotivation amongst the medical staff was influenced by both monetary and nonmonetary incentives. The main motivation was reward, income, training

and recognition in the workplace from supervisors and colleagues. While discouraging factors included low pay and unsatisfied working conditions. The HVs in this current study received the same payment regardless of experience which may demotivate the HVs from learning or engaging in their role, especially those who have served for over 10 years. More specifically, once the HVs work for longer than 10 years, they earn the same compensation and benefits as those with less experience. This explanation was not drawn without the evidence from the findings. According to the data in table 19, the HVs in this study who had worked in the role for 1-5, and 6-10 years had better knowledge scores than their peers who had worked for more than 10 years. However, we cannot say that this relates to motivation.

Motivation may deteriorate over time, as the new HVs may be excited and be willing to learn the new tasks and adjust to the new organisation, however, they may lose their motivation over future years. This idea is supported by Grusec and Hastings (2014), who pointed out that new employees are information and feedback seekers Besides attending the formal and informal training related to essential tools and job tasks, newcomers were more likely to engage and collect information about their work role and environment from their supervisors and colleagues. In addition, supervisor and co-worker feedback can help the newcomer reduce uncertainty regarding their new role.

Although we cannot find a clear explanation why the HVs with less experience have a higher score on diabetes tests than those with longer time-served we feel it is important to acknowledge the difference between experience of delivering the same care and time within a role. We believe that this should be explored in more detail.

Household income

HVs with household income greater than the national average had higher knowledge levels compared with those whose household income was below the mean. The findings align with

the results of Fatema et al (2017)'s study where participants who had high monthly family income had a better knowledge score than those with lower family monthly income. This finding is a serious concern for our patients, a large portion of the HVs (around 87%) in our study had family income below the average national household income. Thus, incentives and benefits should be offered for the HVs who attend the training regularly to make the role more attractive.

Area of work

The study found that HVs living in Suburban areas have a higher diabetes knowledge when compared with their peers living in other areas. Fatema et al (2017), noted that city dwellers tended to have a greater understanding of diabetes compared to countryside residents. Our findings contradict Fatema and colleagues (2017) but without greater exploration it is difficult to understand why this might be the case. Those in suburban areas may have reduced access to the internet, the job market and family income. A study in India by Pal et al (2020) reported that people living in urban areas were more likely to access awareness campaigns via social or print media, so they were likely to have higher knowledge score than those living in remote.

However, direct comparisons with other studies are problematic with other studies focussing on rural and urban settlements whereas this study divided areas into the Inner City, Urban Fringe and Suburban areas. Furthermore, this study was mainly conducted in only one province in the capital city of Thailand, the density of humans, structure, resources, employment and education in the Inner-City area, Urban Fringe area and Suburban area may not be radically different areas. However, living in close knit communities people may be more likely to adopt the caring role and may therefore have generated knowledge from

experiential learning. The second phase of the study will provide greater insight into this difference.

Adequate knowledge

The participants in this study were more knowledgeable about the complications of diabetes compared to other topics. This is unsurprising given the dominance of diabetic complications in several diabetic guidelines including Thai and international guidelines. Furthermore, as diabetic complications are mostly displayed in diabetic patients with poor glycaemic control, the HVs may have experience of caring for these patients in the community. However, this suggests that rather than being pro-active the HVs are focusing on managing complications rather than overall well-being. A greater understanding of the local agenda is needed to explain this approach.

HVs are lay people receiving training from healthcare professionals to work in the community. Although Thai HVs work proactively, they were also responsible for referring the patients, especially those with serious conditions to access higher level healthcare facilities. The finding indicates that the HVs are able to recognise and detect the diabetes complications. Early detection can prevent the forthcoming serious complications and reduce the mortality rate (Herman et al., 2015; ADA, 2019). Consequently, the patients who develop the complication will be referred to see an expert and allow timely treatment.

When scrutinising the results of this current study more closely it was evident that whilst the majority of respondents achieved a moderate score for the questionnaire as a whole, their knowledge of the complications associated with diabetes was greater, meaning that their knowledge in other areas was significantly weaker. Such findings are in keeping with those of three previous studies that explored the diabetes knowledge levels of qualified health professionals (Ogbera et al., 2013; Kumarasinghe et al., 2018) and patients (Mashige et al.,

2008) but are contrary to the results of others (Livingston and Dunning, 2010; Peimani et al., 2010; Unadike and Etukumana, 2010; Smide and Nygren, 2013) and also differ from those studies that studied patients (Shah et al., 2009; Kheir et al., 2011; Islam et al., 2015). It will therefore be essential to explore this in more detail during the qualitative phase of the study.

Whilst Mashige et al (2008) reported that DM patients were knowledgeable about diabetic retinopathy complications they surveyed only 106 diabetic patients in two community health facilities and one eye clinic of an urban area in South Africa. The author does not demonstrate the sample size calculation; hence, it is difficult to determine the sample size required for the study. In addition, when considering diabetic complications Mashige (2008) focus was far too narrow, focussing solely on diabetic retinopathy failing to consider neuropathy, nephropathy, and cardiovascular disease.

The findings of this study contrast with Livingston and Dunning's (2010) cross-sectional study that employed a newly developed questionnaire, administered to 21 practice nurses (PNs) located in one health region in north-central Victoria, Australia. The results showed that the PNs had insufficient knowledge about diabetic complications except for diabetic retinopathy. Although the author developed a questionnaire specific for the PNs, only content and face validity were reported, the questionnaire's reliability was absent, which may affect the findings of the study. As the study does not provide details about the sample size calculation, and all respondents of this study were female with limited response rate (33% response rate), it may not be appropriate and may not be representative of the PN population. Similarly, Peimani et al (2010) undertook a cross-sectional study to assess knowledge, attitude and diabetes practice in 69 Iranian physicians, using questionnaires. The results showed that only 29% of those participants had good knowledge about diabetes and

its complications. However, the study has a limitation that may affect the study findings, as the study does not provide details about the knowledge assessment tool. Although the final questionnaire was based on the expert's comments, it does not report the questionnaire's validity and reliability. As the diabetic complications item considered only neuropathy and nephropathy, it cannot justify the claims that those physicians had insufficient knowledge about other diabetic complications. As the study does not present the sample size required, 69 physicians might not be representative of the physician population.

Inadequate knowledge

Whilst most of the participants in this study were able to demonstrate a high level of knowledge about the complications of diabetes, the results showed that they were less knowledgeable about the health promotion advice that they should be providing to diabetic patients. Their knowledge of exercise, blood glucose monitoring, cholesterol types and diabetes medications (especially insulin) was poor. These findings are aligned with those of a number of recent reports exploring the professional groups. (Rubin et al., 2007; Van Zyl and Rheeder, 2008; Jansink et al., 2010; Park et al., 2011; Ahmed et al., 2012; Oyetunde and Famakinwa, 2014; Bagweneza et al., 2019) but are also replicated in studies of patient groups (Al-Adsani et al., 2009; Ardeňa et al., 2010; Odili et al., 2011; Hu et al., 2013). It is therefore clear from both this study and previous works exploring patient and qualified staff that neither patients nor care providers possess sufficient knowledge to enable healthy behaviour change, which could be putting diabetes patients at risk (Wellard et al., 2013).

The findings of the current study indicate that the HVs had inadequate knowledge regarding diabetes management. The HVs have been recognized as a key part of Thailand's primary health care for several decades, they should be able to perform standard care for people in the community. The lack of knowledge amongst the healthcare providers may affect diabetes

management. The study findings indicate that the HVs had a lack of knowledge in many topics including basic information, however, the key findings recognized from this study are shown below.

Exercise

The current study indicated that the HVs had a lack of knowledge about the importance of exercise for diabetes management. This indicates that the HVs may not be well-equipped in terms of providing advice about exercise. The HVs may advise the patient to do regular exercise, however, they may not be able to provide specific advice about the amount of exercise. The HVs should have sufficient knowledge of this topic as it is included in the training course. Based on the findings, it was unclear why the HVs had a lack of knowledge about exercise.

The findings are similar to a qualitative study by Jansink et al (2010) who undertook in-depth interviews with 12 nurses in the Netherlands and found that they have a lack of knowledge about lifestyle counselling including physical activity and diet advice and that they perceived that dietary advice was the dietician's task. Oyetunde and Famakinwa (2014) also reported that most nurses had poor knowledge of nutrition, exercise and glucose monitoring. Additional evidence is provided by a cross-sectional study by Bagweneza et al (2019), who assessed the knowledge of nurses in Rwanda. The authors reported nurses possessed poor knowledge about blood glucose monitoring, physical activity, nutrition and medication in the majority of the participants. However, only 51 nurses were included from one hospital, hence it may not be generalized to other populations.

When looking closely at studies conducted in diabetic patients, a cross-sectional study by Ardeňa et al (2010) provides some insight. They employed the American Association of Clinical Endocrinologist (AACE) Knowledge Evaluation Form to assess the knowledge of

156 type 2 diabetic patients. Ardeňa and colleagues (2010) found that patients in the Philippines had a lack of knowledge about exercise, diet, and self-monitoring. Another study by Hu et al (2013), performed a cross-sectional study in older adults with type 2 diabetes in Beijing, China. The authors used the diabetes knowledge questionnaire developed by Garcia et al (2001) to assess the knowledge of 108 participants. More than 70% of the respondents answered incorrectly in the item about the effect of exercise on glycaemic control and diabetic drugs.

Based on the findings, it is necessary to highlight the importance of exercise in the HVs education particular the maximum and minimum amount of exercise recommended.

Insulin

Despite insulin production being covered in their training, the respondents lacked a basic understanding of where insulin is produced. The HVs were lay people with no health professional background, around 70% of the HVs of this study were in high school and lower, therefore it may be considered difficult for them to link anatomy and physiology and the insulin production process. However, there was a diversity of educational backgrounds amongst the HVs and possessing such knowledge is key to diabetes support. The training creator should provide an overview of the related anatomy and link the insulin production process for the HVs.

Insulin action time

Despite this being included in several diabetic guidelines, the HVs were unaware of the action times of insulin. Whilst there are many types of injected insulins, it is the responsibility of the HV to be familiar with these different insulins and their usage as they

are responsible for supporting diabetic patients who are treated with these insulins in the community

The findings align with a previous study by Ahmed et al (2012) who conducted a cross-sectional study in 381 doctors and nurses in 5 tertiary hospitals in Karachi, Pakistan. Over half of the participants had a knowledge shortage about the peak action of regular insulin. This finding is similar to a study by Rubin et al (2007) conducted in America. Rubin et al (2007), developed a knowledge test to assess nurses and residents in surgery, internal medicine, and family practice in a cross-sectional study in Philadelphia. They found that amongst 163 participants, more than half were lacking in knowledge about the peak time of insulin.

Van Zyl and Rheeder, (2008), conducted a cross-sectional study to assess the knowledge of diabetes inpatient management of both medical and nursing staff in South Africa, using the Diabetes Knowledge Questionnaire developed by O'Brien et al (2003). The questionnaire comprised 11 sections (six items per section), covering diabetes topics such as physiology, blood glucose monitoring, medications, hypoglycaemia, insulin use, hyperglycaemia, complications, diet, screening/ prevention, surgery, and a general section. The results showed that 115 health care providers (54 doctors and 61 nurses) have insufficient knowledge about medication, insulin and dietary management (with median score 1 out of 6, 2 out of 6 and 3 out of 6, respectively). The study of Van Zyl and Rheeder used different assessment tools from this study and focused on only inpatient management, and did not demonstrate the sample size required for the study, these may affect the study results.

Finally, a cross-sectional study by Al-Adsani et al (2009) performed on 5,114 type 2 diabetic patients in Kuwait using the Michigan diabetic knowledge test (Arabic version) also reported similar findings.

These studies collectively highlight that healthcare professionals and HVs are unaware of the action time of one of the main treatments for diabetes.

The findings contrast with that of Yosef (2019), who studied type 1 diabetic patients in Ethiopia. Yosef (2019) found that participants had good knowledge levels in many aspects of insulin administration, the difference in findings may be influenced by the use of a different assessment tool, the difference in study settings and the participants' characteristics. The HVs in this thesis were assessed on insulin action time, whereas this item was not included in Yosef's study. In addition, one study in Thailand by Supachaipanichpong et al (2018) found that diabetic patients increased their knowledge score and were likely to have a good understanding of medication use ($\bar{x}$ =12.64 out of 15) following a medication education intervention which was delivered by health professionals. The knowledge assessment that Supachaipanichpong and colleagues used covered several aspects of medication use such as type, dose, time of medication as well as side effects and management of its side effects, however, the author did not detail questionnaire items.

It may be assumed based on these findings that the HVs may be unable to advise the patients about the insulin and meal schedule due to the lack of knowledge about the insulin action time. Therefore, the trainer should highlight the importance of advising conventional injected insulin, action time and meal schedule in the training. Assessment is also needed to ensure the current knowledge of the HVs so that correct information is provided. In addition, once the training session ends, the information should be available for the HVs to access such as through aide memoirs, posters, mobile application and a training manual. Allowing the HVs the opportunity to consult the health professional to avoid confusion due to the diversity of insulin types is also crucial. Therefore, the training creator should demonstrate and keep updating the prescribed injected insulin that the patients use in the community via

case study discussion or training sessions, and allow the HVs to experience hands-on learning.

Diabetic drugs and alcohol interaction

The findings showed that the HVs lacked knowledge about the interaction between diabetic drugs and alcohol. The HVs should know about this topic as it was included in the training course, one possible explanation was the HVs did not develop deeper learning once they had taken part in the training, thus they may forget what they have learned. Lecture-based learning may cause superficial learning. Deep learning was driven by intrinsic motivation, the learner intends to understand the content and meaning (in-depth understanding of the concept) of what they study, while surface learning is rote learning and utilizes memorising techniques (Dolmans et al., 2016). A previous study by Mirghani and colleagues (2014) found that junior students are prone to adopt a superficial approach when compared to senior students. The explanation for the difference in the Mirghani' study was the type of teaching. Students who mainly learned via lecture adopted a more superficial approach when compared with the seniors who were mainly taught through a problem-based learning approach. The idea that problem-based learning enhanced deeper learning was also reported in a review of deep and surface learning in problem-based learning by Dolmans and colleague (2016), the author stated that PBL enhances deep learning as it increases the student's learning and intrinsic motivation, but PBL did not have an effect on surface learning. Based on the evidence above and being aware that the HVs were mainly trained about diabetes using lecture then it is reasonable to assume that they may adopt superficial learning or rote learning. Moreover learning is externally driven and mainly involves memory (Mirghani et al, 2014). Therefore, if the HVs are not interested in the topic, they may forget what they learned, once the training ends. More research needs to be completed in this area.

When reviewing the Thai and international guidelines, there is little emphasis on this area of care despite the risks involved. Such a lack of visibility could be placing patients at risk. Further evidence can be seen below.

According to the Thailand Clinical Practice Guideline for Diabetes 2017, diabetic patients are advised to quit or limit their alcohol intake (women can have 1 drink per day while men can have 2 drinks per day, in line with the recommended amount by ADA). In addition, this guideline also recommends that patients should not drink alcohol on an empty stomach as it may cause hypoglycaemia and they should not consume carbohydrates while drinking alcohol, as it may increase blood sugar levels. However, this Thai guideline does not provide information about the interaction between drugs and alcohol. Whereas the information about the interaction of diabetic drugs with alcohol was included in the ADA recommendation (ADA, 2014; ADA, 2019) and other recent studies (Gotardelo et al., 2015; Sharma et al., 2015). People with diabetes should drink alcohol with caution and follow the guidelines, especially those who are treated with injected insulin and oral medication such as sulfonylureas and meglitinides as they reduce blood sugar levels (ADA, 2014). Sharma et al (2015) who reviewed drug-drug and drug-food interaction in diabetes, states that people living with diabetes should avoid consuming alcohol during diabetes treatment as it has negative effects on glycaemic control and causes hypoglycaemia. Likewise, Gotardelo et al (2015) conducted a study with an elderly population in Brazil and noted potential diabetic drugs-alcohol interactions (eg. Insulin, Metformin and Glibenclamide,) which were considered dangerous requiring urgent medical intervention.

Being the healthcare provider, the HVs should recognise the interaction between glycaemic lowering drugs and alcohol. It is necessary to integrate the information about the interaction between drugs and alcohol into the monthly meeting. Assessment should be done regularly

to ensure that they reach optimal knowledge. In addition, it is necessary to highlight the HVs' memory and motivation to learn which influences the learning outcome of the HVs. Although it was unclear why the HVs had suboptimal knowledge about the interaction between drugs and alcohol, this should be further explored.

Cholesterol

The HVs knowledge of LDL lipid profile was limited. These findings are in line with a previous study, as HDL and LDL are less recognized when compared with triglyceride and total cholesterol (TC) amongst Thais (Nantsupawat et al., 2019). In Thailand, the screening for lipid profile varies based on the persons type of health insurance and age, for example, cholesterol and triglyceride are only measured for those aged≥ 35 years who work for the government (the government employee). While the Thai Social Security Scheme measure TC and HDL-C for people aged >20. Whilst UHC covers a large portion of the Thai population it does not include screening for dyslipidemia in its package (Nantsupawat et al., 2019). The patients must meet the doctor before deciding on further lab tests.

Nevertheless, the HVs should know about this topic because of their regular use and its impact on diabetes complications. They should be familiar with HDL and Triglyceride as these items are included in the screening form for diabetes. The HVs use this form to screen people who are aged ≥ 35 years of age in the community which would suggest they are recording information without understanding its use or merit.

Cholesterol management is included in several guidelines (IDF, 2012; Ministry of Health, Singapore, 2014; NICE, 2015; The Royal Australian College of General Practitioners, 2016; Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn, 2017; Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; ADA, 2019; Committee of Clinical Practice Guidelines, and Korean Diabetes

Association, 2019). However, it was unclear how many HVs had access to these guidelines due to the language barriers and capacity to access reliable health resources. Less than 30% of the HVs within this study received schooling beyond secondary school. The high proportion of HVs with low education levels and limited second language skills may have influenced the numbers of people accessing the health resource, which were often published in a foreign language.

The findings reflect the lack of understanding about lipid profile amongst the HVs. The HVs may be unable to interpret the lab results and they may be unable to give proper advice such as dietary and exercise to patients. It is necessary to highlight these areas specifically before creating teaching material and assessing the HVs' knowledge to enhance diabetes care in the community.

Blood sugar monitoring

The HVs in this study perceived that a urine test is the best method to test the sugar levels in diabetic patients. A urine test at home may not be an effective method to monitor blood sugar levels, as this method does not reflect the actual blood sugar level. Consequently, diabetic patients may not be able to keep their blood sugar in range, and the patient then may develop diabetic complications. The possible explanation for this issue is the lack of understanding of the blood sugar measurement methods and its limited use in some areas.

Although home blood glucose monitoring is recommended in several diabetic guidelines, this is not always feasible and urine tests are used as a surrogate. Measuring sugar in the urine is convenient and the patient can do it at home (National Center for Biotechnology Information, 2020). However, this approach is limited to the detection of high blood sugar levels. If diabetic patients have slightly high blood sugar, their body will not release sugar via urine (National Center for Biotechnology Information, 2020). In addition, urine testing

was not included in the Thailand Clinical Practice Guideline for Diabetes 2017, but refers only to SMBG and evaluation of the test results.

The patient should be recommended to use the SMBG, as this method has been found in international studies to be beneficial for diabetic patients in helping them to achieve glycaemic control (Poolsup et al., 2009; Bunker and ADA, 2010; Chidum et al., 2011; Schnell et al., 2014). The natural approach here would be to suggest that HVs should provide SMBG education for their patients but as has been stated earlier the HVs in this study lacked the knowledge themselves and they would therefore be unable to undertake this role. Therefore, based on the findings, the HVs should be introduced to the type of blood sugar measurement, its benefits and the limitations of each method. Assessment should be also undertaken to ensure that the HVs know about this topic, as it was important for diabetes management.

The lack of diabetes knowledge among health professionals, which is likely to affect both HVs and patients, may come from a deficiency in their professional preparation (Ahmed et al., 2012) where some diabetes topics are emphasised at the expense of others (Ogbera et al., 2013; Oyetunde and Famakinwa, 2014). Other possible contributory factors include; a lack of health resources (Mutea and Baker, 2008; Hollis et al., 2014); using unreliable and outdated health information sources (formal and informal sources) (Livingston and Dunning, 2010; Kumarasinghe et al., 2018), and obtaining less specific diabetes training (Rubin et al., 2007; Nash, 2009; Buloala et al., 2018; Kumarasinghe et al., 2018). As mentioned previously, the cross-sectional study of Kumarasinghe et al (2018) report that while over half of nurses (57.8%) had sufficient knowledge about diabetic foot ulcer, the gap in knowledge among the nurses who had inadequate knowledge may be caused by a lack of interest in the topic, insufficient training and a lack of knowledge updating. Similar to the

study of Buloala et al (2018), as the nurses who had no training about diabetic foot care had poor knowledge of diabetic foot care.

7.9 Limitation of the study

This study used self-administered questionnaires to assess HVs' knowledge of diabetes. There is a possibility that participants could have searched for answers using resources, such as textbooks or the internet. This could affect the validity of the results. In addition, as the study was mainly conducted in the population of only one province, the results of the study cannot be used to generalise the findings to Thailand's health volunteer population as a whole. Furthermore, as the current studies classified the knowledge levels about diabetes into high, moderate and low knowledge based on Bloom's criteria, the results may differ from the other studies using different criteria.

7.10 Conclusion

This study illustrated the knowledge of diabetes amongst the HVs. The evidence showed that the HVs have inadequate knowledge in many aspects of diabetes. Although nearly half of the HVs achieved moderate knowledge, only a quarter of the participants had high knowledge. The HVs were knowledgeable about diabetic complications, while they had a lack of knowledge about exercise, diet, blood glucose monitoring, cholesterol types, and diabetes medications which were basic information. Therefore, the current knowledge of the HVs might not be adequate to control diabetes in the community. HVs who were older, working as HVs over than 10 years and living in inner city areas and urban fringe areas should be highlighted, educated and reviewed on their knowledge especially of those topics. However, there are several factors influencing the HVs' learning outcome, hence it is essential to emphasise and explore their learning, to improve the diabetes education in order to improve the HVs' knowledge about diabetes and enhance the care of diabetic patients in

the community. This study captured the current situation of diabetes knowledge of the HVs working in the capital city of Thailand. As a result of continued task shifting HVs play a key role in the care of patients in the community. These findings suggest that while HVs have the requisite knowledge to monitor diabetic patients for the complications of the disease their knowledge of other topics including, promoting exercise, drug usage and interactions is insufficient to provide an adequate level of support. These findings can be used to inform future training programmes.

This study provides preliminary findings that will be further explored in the qualitative study in the next chapter, to gain a more complete comprehension of HVs' learning experiences about diabetes.

The following chapter will explore the learning experiences of the HVs in more depth by using semi-structured interviews.

Chapter 8 Qualitative study

8.1 Introduction

Chapter 8 is concerned with phase 2 of this mixed methods study and is built upon the findings of the Phase 1 questionnaire. In this chapter, I will discuss the interview preparation, participant recruitment, data collection, data analysis, study findings and discuss the relevance of this work.

8.2 Study aim

The aim of phase two of the study was to explore the HVs' experience of learning about diabetes. Although all HVs receive training about diabetes very little is known about their learning journey. The first phase of the study identified HVs will markedly differently levels of knowledge but whilst these data were able to demonstrate knowledge levels, they do not provide any insight into the ways in which knowledge is gained and what barriers and influencers impact this knowledge. If we are to understand the needs of the HV and facilitate learning it is essential that we are able to identify both the areas of learning that need to be addressed and the ways in which learning can be supported. These findings will inform decision making, as we can take the findings into consideration to create effective teaching and learning environments that suit the HVS.

8.3 Research question

1. What is the HVs' experience of learning about diabetes?

8.4 Data collection – semi-structured interviews

The Interview is the most commonly used method of data collection in qualitative research, especially within health research (Gill et al., 2008). This method allows the researcher to explore a particular subject (Sutton and Austin, 2015), it also helps to clarify any points and

can be used to understand the individual experience of the participants (Sutton and Austin, 2015). The purpose of the interview is to access the interviewee's mind including their views, experiences, beliefs and motivations of a specific event (Pickard, 2013, p. 196; Adhabi and lash, 2017). Interview techniques allow interaction between the researcher and the participants, who are allowed to give the response in their own terms and within their own linguistic parameters (Pickard, 2013, p.196). The success of the interview also depends on the interviewer. Bolderston (2012) highlighted the importance of the interviewer's listening skills when undertaking an interview. He found there were a number of mistakes, which interviewers made when performing interviews such as educating, correcting or pointing out the participant's error amid the interview as it affects the flow of interview. However, if the interviewer detects major misunderstanding which may affect the participants' health, the interviewer can correct the participants once the interview is over. Another pitfall for the interviewer during the interview is not paying attention to the interviewees. The interviewer should listen attentively and follow the participant's expression; hence they can detect when the participant is going off track and then help them get back to the interview topics. There is a risk that the interviewer turns the interview into a counselling session, although it is useful, it can distract the flow of the interview and can influence future responses. Next, the interviewer is afraid of silence; during the interview the respondents need time to think, so the interviewer should allow time before saying anything. Lastly, the interviewer is may introduce both positive or negative bias when responding to the participant's responses. It can affect the interview direction and the interviewee response (Bolderston, 2012).

Qualitative interviews can be separated into two, unstructured and semi-structured. The choice of interview type is influenced by the study's underlying methodology, the available time and the number of respondents (Pickard, 2013:198). The unstructured interview

provides the flexibility (Ryan et al., 2009; Qu and Dumay, 2011; Alsaawi, 2014) similar to that of a conversation (Alsaawi, 2014). The interviewees are allowed to talk freely about the topics without the use of pre-planned questions (Alsaawi, 2014). This form of interview provides a huge amount of data focused on a specific phenomenon (Alsaawi, 2014). This type of interview may use an interview guide but is based on a theme rather than specific questions (Ryan et al., 2009). The limitations of using this technique are that it is time intensive, difficult to analyse and may produce a series of interview transcripts, which are difficult to compare and integrate (Rowley, 2012). In addition, the unstructured interview requires a very high level of concentration and the ability to be very reflective and reflexive (Pickard, 2013, p. 199) which is not recommended for novice researchers (Pickard, 2013).

In contrast, the structured interview is the opposite of the method mentioned above as it is a controlled way to obtain information from the respondents (Alsaawi, 2014). In other words, all participants are questioned with a limited set of response categories (Ryan et al., 2009; Qu and Dumay, 2011; Pickard, 2013, p. 199). The key feature of the structured interview is in the pre-planning of the questions asked (Alsaawi, 2014). Structured interviews are considered easy to administer (Pickard, 2013, p. 199) and provide less bias (Qu and Dumay, 2011). However, structured interviews can limit the richness of the data collected (Alsaawi, 2014).

There are two forms of structured interviews: closed fixed response interview and open-ended interview (Pickard, 2013, p. 198). In a closed fixed response interview, the respondents are asked the same questions and choose the answer from a set of categories (Pickard, 2013, p.199).

On the other hand, participants in an open-ended interview are allowed to respond without limitation (Pickard, 2013, p.199). Based on the kind of response and the basis of the level of

structure (Rowley, 2012; Adhabi and Lash, 2017) of the open-ended interview, some authors describe this as a semi-structured interview and categorise this technique as one of the interview methods (Ryan et al., 2009; Turner, 2010; Qu and Dumay, 2011). The semi-structured interview is a mix of the structured and unstructured interview (Alsaawi, 2014). Its questions are partially pre-planned (Alsaawi, 2014) and the participants may be asked the same question pattern but not as rigidly (Ryan et al., 2009). The respondents have a chance to explain a particular point with open-ended questions (Alsaawi, 2014). This method is appropriate to a researcher who has an overview of their topic so that they can ask questions (Alsaawi, 2014).

Semi-structured interviews allow the interviewer to prepare the question lists before conducting interviews and do not fix the informant's response. In this thesis, the interviews were used to explore the findings of the questionnaire (first phase) in more depth. The interview questions were therefore generated based on the findings of the questionnaire. Semi-structured interviews enabled the researcher to probe into the details of their phase one responses and allowed the participants to respond using their own words and in a way, they think fit (Qu and Dumay, 2011). In addition, during the interview, the researcher asked the interviewee to provide any interesting points about their learning journey to gain more insightful information. Hence, the semi-structured interview allowed the researcher to produce a richness of data using an inductive approach. Interviews can be both inductive and deductive, as it depends on the purpose. It can be deductive when it is used to test hypothesis (Woiceshyn and Daellenbach, 2018). In contrast, it can be inductive if data are collected to develop hypothesis (Woiceshyn and Daellenbach, 2018).

In recent studies, it has been noted that researchers tend to divide the interview into 3 phases: pre-interview, intra-interview and post-interview (Prairie Research Associates, n.d; Whiting, 2008; Ryan et al, 2009; Jacob and Furgerson, 2012; Mitchell, 2015; Guest et al, 2017).

However, some authors state that the interview consists of more than 3 phases (Boyce and Neale, 2006; Kvale, 2007). According to Boyce & Neale (2006), the interview includes 6 stages: plan, develop the instrument, train data collector, collect data, analyse data and disseminate findings. Kvale (2007) separates the interview into 7 phases: thematising, designing, interviewing, recording, transcribing, analysing and reporting.

Interview mode

Different interview modes could have been used in this study, these included face-to-face interviews, telephone interviews, and online interviews. There are advantages and disadvantages of using each method. Face to face interviews enable non-verbal cues including voice, intonation, and body language, which can supplement verbal data (Opdenakker, 2006; Holt 2010; Lechuga 2012; Mealer and Jones 2014), promote rapport (Holt 2010; Lechuga 2012; Mealer and Jones 2014), and allow the interviewer to directly respond to the interviewee, thereby helping the researcher to probe and elicit richer data (Opdenakker, 2006). In addition, the interviewers have the opportunity to create a good interview atmosphere for the interviewee, which may not be seen in other types of interviews such as telephone interviews and online interviews (Opdenakker, 2006). However, this method is time consuming and financially expensive when interviewing participants spread across a large geographical area (Block and Erskine, 2012). Telephone and online interviews allow access to respondents regardless of geography (Block and Erskine, 2012; Given and Saumure, 2015). They are also suitable for those who are unable to perform face-to-face interviews (Block and Erskine, 2012) due to work or family commitments or those living in a sensitive area such as war zones or widespread disease zones (Opdenakker, 2006). Drawbacks of using telephone interviews include lack of non-verbal cues, limited rapport (Lechuga 2012; Ward et al. 2015) and lack of opportunity to arrange a good interview atmosphere (Opdenakker, 2006).

Internet video calls such as Skype, FaceTime and Google Hangouts have been used to interview previously (Weller, 2015). The use of Skype interviews is increasing as it has several advantages such as inexpensive methods, geographically flexible and recording features (Given and Saumure, 2015). In addition, using Skype enables verbal and non-verbal cues similar to face-to-face interviews (Sullivan, 2012). However, there are limitations of using Skype such as a time lag during the interview, which can affect the flow of conversation (Given and Saumure, 2015). In addition, stability of technology including internet disconnection (Given and Saumure, 2015), speed of connection (Sullivan, 2012), sound quality (Sullivan, 2012), equipment malfunction (Sullivan, 2012), and quality of computer (Sullivan, 2012) can all lead to the loss of data (Given and Saumure, 2015).

Internet use in Thailand has more than doubled in recent years, increasing from 22.4% of the population in 2010 to 56.8% in 2018. However, a significant proportion of the population are still unable to access the internet (National Statistical Office, Ministry of Digital Economy and Society 2018). In 2018, the same report noted that whilst 91.4% of 15-24 years used the internet, only 21.2% of those over the age of 50 were internet users. The lack of internet access for older Thais was considered in a cross-sectional study of 385 people age ≥ 60 years in one province in Thailand (Loipha, 2014). Whilst internet use was low in those over the age of 60 (19.3%), it was non-existent in those over the age of 70 yrs. Loipha (2014) found that visual issues, lack of technical skill and no home computer were the main reasons for not using the internet in older residents. Krouwel et al (2019) in an exploratory comparative analysis study compared face-to-face interviews and Skype interviews in UK residents with irritable bowel syndrome. They found that face-to-face interviews tended to produce better data. Although both methods provided a similar number of codes, face-to-face interviews provided more words and more statements compared to Skype. In addition, other issues arose when doing a Skype interview such as dropped calls and software

upgrades being needed in one interview. The percentage of HVs with access to the internet was considered low. Limitations of technology that are available for online interviews and lack of visual cues in telephone interviews would limit the provision of rich data. Consequently, it was decided that, whilst more time consuming, face-to-face interviews would be undertaken to ensure the depth of data needed for this study.

Interviewer training

Interview training has benefits for both novice and more experienced researchers as it can improve the interviewer's self-efficacy and reminds them of important elements of the interview that they may have forgotten (Goodell et al., 2016). In this study, the researcher applied Goodell and colleagues (2016) interviewer training protocol

The 5-phase protocol of Goodell et al (2016) includes ethics training, review of qualitative research methods and data collection procedures, mock interviews with a previously recorded interview, mock interviews within the research team and mock interviews within the participant or closely related population.

1. Ethics training: To maintain ethical standards and ensure safety and rights of the research participant, the researcher attended ethics training provided by Liverpool John Moores University and followed the regulations of the Bangkok Metropolitan Administration Ethics Committee. Liverpool John Moores University Ethics Committee for human research (17/NAH/022) and the Bangkok Metropolitan Administration Ethics Committee (E012q/60_EXP) approved this study.
2. Review of qualitative research methods and data collection procedures: The researcher reviewed the tenets of qualitative study, types of data collection and the purpose of each interview type. Interview techniques (e.g. probe and prompt) and the

role of the interviewer such as the appropriate demeanour were also reviewed and discussed with the supervisory team.

3. A mock interview using a previously recorded interview: The aim of this process is to allow the interviewer to become familiar with the sound and flow of an interview and it prepares the interviewer to practise note-taking and develop their summarising skills.
4. Mock interviews within the research team: In this phase, the researcher conducted a face-to-face interview with a colleague who was familiar with the study and who role-played as a health volunteer. The interview took place in a private room using an interview guide developed by the researcher. During the interview, the mock participant tried to stray off topic, requiring the interviewer to pull the interviewee back to the topic. The interview was digitally recorded and lasted 46 minutes. Once the interview finished, the interviewer asked the interviewee to provide feedback and comments on the questions and the interviewer. Subsequently, the voice recording was reviewed and discussed with the lead supervisor who noted that the researcher had not used probes and prompts sufficiently to explore interesting points. In addition, repetitive questions were highlighted. This had occurred because the interviewer could not remember the answer that the interviewee provided to a previous question. Changes were made to the interview schedule in response to the feedback. The researcher found it difficult to both listen to the interviewee and think about the next question. Therefore, the researcher arranged a second mock interview with a colleague who was familiar with the study. The interview took place in a quiet room, the interview was digitally recorded and lasted 32 minutes. The research team then reviewed the recording once the interview was complete. Issues that had been highlighted in the first mock interview had now been eradicated. The question order

was more relaxed and flexible within the interview guide and the interviewer employed a variety of probes and prompts. There were no repetitive questions as the interviewer took notes during the interview. Practising the mock interview with colleagues allowed the researcher to become familiar with the questions and develop a variety of probes to ask the interviewee to delve deeper into the information that specifically addressed the research objective.

5. Mock interviews were completed with two randomly selected HVs who were subsequently not included as actual participants in the study. These mock interviews allowed the researcher to test the interview questions and ensure that the HVs understood the questions asked. In addition, the researcher was able to estimate the time for each interview, and observed for potential issues during the interviews. Verbal consent was obtained from the participants. Whilst the main interviews were to be recorded in person, the mock interviews were performed using SKYPE. The researcher was studying in the U.K. and was returning to Thailand to undertake the main interviews. It was not feasible to travel to Thailand to complete two mock interviews and therefore an alternative method of piloting the interviews were required.

The interviews were transcribed verbatim and translated to English and then reviewed. Although, the contents were in keeping with those used in previous interviews, the first of the interviews lasted 70 minutes, longer than expected. This was caused by 1) the interviewee going off topic several times 2) poor time management with the researcher spending too much time on some questions 3) inflexible with the researcher trying to ask every question in the interview guide and not exploring some interesting points. 4) Interview interrupted by poor internet connection. These issues were discussed with the researcher's supervisor and then

adjusted for the second mock interview. The second interview was more flexible, the researcher linked one topic to the next by listening to the respondent carefully and thinking how the answers linked to other discussion topics and skipping any repetitive questions. When the interviewee spoke outside the research scope, the researcher responded politely such as nod or ah ha to the discussion and then quickly guided the respondent back to the interview. Lastly, although poor internet connection was one issue from the first mock interview, the internet connection got better in the second mock interview, highlighting the issues with internet-based interviews and reinforcing the need to undertake face-to-face interviews in the main study.

8.5 Sample

A sample size of 15 was agreed based on the findings of previous studies that have suggested a minimum number of 12 participants is required to reach data saturation (Guest et al., 2006; Martins, 2008). Guest et al (2006) conducted an experiment to assess how many interviews were needed for data saturation and variability, using semi-structured opened ended interviews. Although Guest et al (2006) performed interviews with 60 participants; data saturation was reached after 12 interviews. Martins (2008) conducted interviews with 15 homeless people in the United States to explore their experience of the healthcare system and also found that data saturation was reached after 12 interviews. In addition, the number of participants within this thesis was also guided by the recommendation that when exploring a phenomenon with a group who have experienced this same phenomenon a sample size may vary from 3-15 (Creswell and Poth (2018, p. 76). Therefore, the sample of 15 was deemed adequate for this study.

This study aimed to explore the HVs' learning experiences of diabetes. Although there are several kinds of sampling in qualitative research, such as purposive sampling, snowball sampling, quota sampling and convenience sampling, purposive sampling was employed to recruit participants with specific characteristics. The researcher creates the sampling framework and recruits' participants with the desired characteristics. Quota sampling recruits the sample from the subgroup. The researcher creates categories, decides how many people are included from each group and then collects data from these people. This is a useful method particularly, when the researcher is unable to acquire a probability sample (Sharma, 2017). "Snowball sampling" recruits participants referred by previous participants (Acharya et al., 2013; Etikan et al., 2016). This is useful when the researcher seeks to recruit hard to reach participants where it can be difficult to access people who may not normally engage in such activities (Etikan et al., 2016; Sharma, 2017). Finally, convenience sampling: recruits participants based on the ability to access potential respondents at a particular time (Acharya et al., 2013; Taherdoost, 2016). In this study, the researcher wanted to explore the HVs learning journey, with a particular focus on those with differing levels of knowledge of diabetes which was based on the questionnaire score in chapter 7. Those interested in participating in this phase of the study had already provided their contact details at the end of the questionnaire and therefore was already available.

Therefore, 15 HV's, who completed the phase 1 questionnaire were selected for face-to-face interviews by purposive sampling. The sample consisted of 5 HVs who scored ≥80% (high knowledge level) overall diabetes knowledge score, 5 who scored between 60 and 79% indicating moderate knowledge levels and a further five who scored less than 60%, indicating a low knowledge level (Bloom et al., 1971). The process of selecting participants is detailed in the participant recruitment section. By sampling across all levels of knowledge, it was envisaged that this would provide a broad range of experiences and data.

8.6 Participant recruitment

As discussed in chapter 5, all participants who completed the phase 1 questionnaire and provided their contact details were eligible to participate in study 2. 340 out of the 390 phase 1 respondents provided their contact details. These 340 HVs were classified as high (n=100), medium (n=144) or low knowledge (96) level and their names were placed into a box reflecting their level of knowledge. Five names were randomly drawn from each box providing a total sample of 15 people for stage 2 of the thesis. The researcher then made direct contact with each randomly selected HV by telephone to ask whether they were still willing to take part in study 2. The interviews took place one year after study one was completed. This delay occurred as a result of the time taken to analyse the questionnaire, develop and pilot the interviews and organize and to travel to Thailand. The recruitment process took around 1 month to reach the target 15 participants. The researcher, who was the interviewer, contacted the participants to make an appointment before undertaking an interview. The interview took place between March and May 2019. Interviews were carried out at a place of mutual convenience and safety (the room of a public health centre), and the interviews were completed within 40-60 minutes. Interviews were audio recorded, which allowed the researcher to review the data several times (Alshenqeeti, 2014). All participants were given a case number that only the researcher had access to and any identifiers were removed. All data were stored in a password-protected computer.

8.7 Conducting interviews

In the pre-interview stage, the researcher initially generated three open-ended questions. Each main question had bullet points of possible prompts and probe questions. Supervisors reviewed the interview schedule and minor adjustments were made (see appendix 2 for final interview schedule). The interviewer became familiar and tested all recording equipment.

The participants who had all previously participated in phase one of the study were asked to consent to participate in this second stage during the inter-interview stage. Introductory questions such as 'How did you become a HV?' were designed to place the participant at ease and build rapport during this stage and were supplemented by follow-up questions, such as 'Can you explain more about it?' or 'Can you give an example of this? Which allowed more in-depth exploration.

Although the researcher prepared the lists of interview questions, to maintain the flow of the interview, follow up questions and probing were based on the interviewee's answer (Kallio et al., 2016). However, it was essential that the researcher possessed the necessary skills and knowledge prior to undertaking the interviews.

Study Participants

Demographic data

Almost all HVs were female 93.3% (14). More than half of the participants had secondary school level education 53.3 % (8). They were all aged between 51-71 years old and the participants had worked as a HV between 4 and 22 years. Over a half of the HVs were married 53.3% (8), as shown in the table below.

Table 24 Interview sample characteristics

No	Knowledge levels	Age (year)	Sex	Marital status	Educational levels	HV's work experience	Interview length (minutes)
1	moderate	55	Female	Widowed	primary school	17 years	54
2	high	55	Female	Married	secondary school	11 years	58

No	Knowledge levels	Age (year)	Sex	Marital status	Educational levels	HV's work experience	Interview length (minutes)
3	moderate	58	Female	Married	secondary school	10 years	50
4	low	74	Male	Married	primary school	16 years	55
5	high	60	Female	Married	vocational certificate	12 years	60
6	moderate	64	Female	Widowed	secondary school	18 years	52
7	low	61	Female	Married	secondary school	17 years	57
8	low	62	Female	Married	primary school	4 years	54
9	low	63	Female	Single	undergraduate	10 years	58
10	low	58	Female	Widowed	secondary school	11 years	53
11	moderate	51	Female	Divorced	secondary school	10 years	57
12	moderate	53	Female	Married	secondary school	7 years	55
13	high	59	Female	Divorced	secondary school	14 years	52
14	high	68	Female	Married	high vocational certificate	3 years	56
15	high	61	Female	Widowed	undergraduate	22 years	58

8.8 Data Analysis

8.8.1 Translating the data

The researcher transcribed fifteen interviews verbatim and a professional translator translated all transcripts. When undertaking cross-cultural research, translation can influence the research findings (Van Nes et al., 2010). Moreover, language differences may have consequences as concepts in one language may be perceived differently in another language (Lopez et al., 2008; Van Nes et al., 2010; Kashgary, 2011). The use of another language can significantly change the participant's response (Lopez et al., 2008; Van Nes et al., 2010). The respondent's real voice and meaning can be lost due to translations (Crane et al., 2009). Qualitative research tends to hear and see the world from the person's perspective and then report the findings for others to read and learn from (Sutton and Austin, 2015). Language differences can cause considerable barriers for cross-language research when the intended meaning of a participant's words in one language cannot be accurately conveyed in another (Lopez et al., 2008; Crane et al., 2009; Kashgary, 2011).

The purpose of using an interview was to explore the participant's learning journey in more depth. However, it was extremely challenging because I conducted the interviews with the participants who are monolingual. Interviews were translated into English. I therefore had to ensure that their voice, ideas and attitude, as well as the implicit and explicit expressions were kept and the loss of meaning was avoided (Regmi et al., 2010).

After reviewing the literature, there are three main kinds of translation from source language to English (Nurjannah et al., 2014); before data analysis, within data analysis and after data analysis. Each method has its advantages and disadvantages and will be described below.

1. **Translate before data analysis**: The researcher immediately converts source language (Non-English) to target language (English) after interviewing (Nurjannah et al., 2014). The interviews (the respondent's voice) are transcribed into English. This approach is widely used when the researcher does not speak the same language

as the participants (Nurjannah et al., 2014). This technique allows the research team to participate in the data analysis process (Suh et al., 2009; Santos Jr et al., 2015). However, this approach is limited because the researchers may lose the respondent's non-verbal expression (Suh et al., 2009). Moreover, some studies have shown that, transcription errors might be caused by translation (Witcher, 2010). As a result, the findings may be questioned due to a loss of the participant's implicit expression (Lopez et al., 2008), during the translation process.

2. **Translate during analysis**: Transcription and initial coding are performed in the source language and the code is subsequently translated into English (Nurjannah et al., 2014). It has been used when the researchers or at least one researcher is able to speak the same language as the participants (Nurjannah et al., 2014). As this method will maintain the authenticity of the findings (Suh et al., 2009) it can ensure that the data are accurate in the process of data gathering, transcribing and coding (Van Nes et al., 2010). In addition, the research team can be involved in the data analysis and data interpretation processes (Suh et al., 2009) for example, the research team can analyse data once the codings are translated into the target language.
3. **Translate after data analysis**: The researcher translates the study findings into English (Nurjannah et al., 2014) when the researcher wants to publish their research in an English language journal (Nurjannah et al., 2014). All processes are completed in the source language. This option allows the research members who speak the same language as the participants to be involved in every process of the study (Suh et al., 2009; Nurjannah et al., 2014). However, it can cause translation problems when the researcher cannot find the equivalent word or phrases in English to express the findings (Squires, 2008; Suh et al., 2009; Kashgary, 2011; Nurjannah et al., 2014). Consequently, the research findings may not be correctly reported (Suh et al., 2009).

The researcher therefore conducted interviews and transcribed the data in the participants' own language (Thai) to keep the respondents' original expressions (Suh et al., 2009). Then the researcher employed an experienced professional translator who translated the transcript, all interviews remained confidential. During, the translation process, I worked with the translator in order to decide the possible words for the best translation (Van Nes et al., 2010). Ethical approval was gained by two sources including Liverpool John Moores University and the Bangkok Metropolitan Administration Ethics Committee.

Using only one translator can keep the translations consistent and enhances the reliability of the data analysis (Squires, 2008; Al-Amer et al., 2015). Although the researcher employed the WHO translation protocol in chapter 6 on page 137, the researcher did not use backward and forward translation here. Using backward and forward translation in qualitative interviews is time-consuming and labour intensive (Squires, 2008; Croot et al., 2011), as it requires one or two translators and translated instruments from source language to target language, then an expert panel to review the translation. In addition, it does not improve the credibility of the results more than review by the bilingual independent translator (Squires, 2008).

Once the translation process was over, the researcher and supervisory team coded the transcripts independently and discussed the findings together.

8.8.2 Thematic data analysis

Data was analysed using thematic analysis (TA) consisting of six steps as detailed by Braun and Clarke, (2006). Thematic analysis is widely used for qualitative study due to its flexibility and inductive approach (Braun and Clarke, 2006; Vaismoradi et al., 2013). In addition, the strong point of TA is that it can collect the key concepts from a large amount of data (Braun and Clarke, 2006) and possesses theoretical freedom as TA does not commit

to a particular theory, it therefore can be applied across epistemological and ontological standpoints (Braun and Clarke, 2006; Vaismoradi et al., 2013).

Details of how the six stages of TA were applied are presented below.

Stage 1 Familiarising with data

To provide familiarity with the data, the researcher listened to the interview recordings several times. All fifteen recordings which were transcribed by the researcher were read and re-read repeatedly. This process (including transcribing) took around 3 months to be completed.

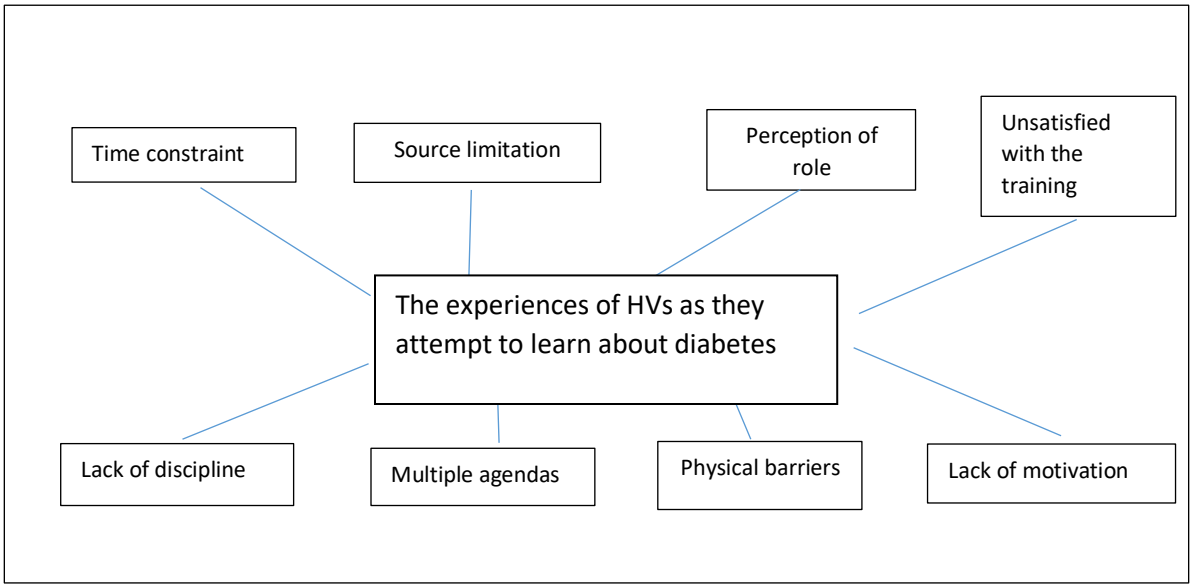
Stage 2 Generating with initial code

All transcripts were printed in hard copy, the researcher and supervisory team coded the transcripts by hand (manually). The researcher and supervisory team highlighted and wrote potential codes on a text in different colours line by line. Data driven analysis was employed in data coding. Once data coding was complete, the codes were continuously reviewed; overlapping codes were merged and renamed. (As shown in appendix section)

Stage 3 Searching for themes

Themes were generated to address the aim and research question using codes from stage 2. Mind maps of themes, which showed the relationship between each sub theme, were generated. Eight themes initially emerged from this stage (Figure 3).

Figure 3 Example theme emerged from stage 3



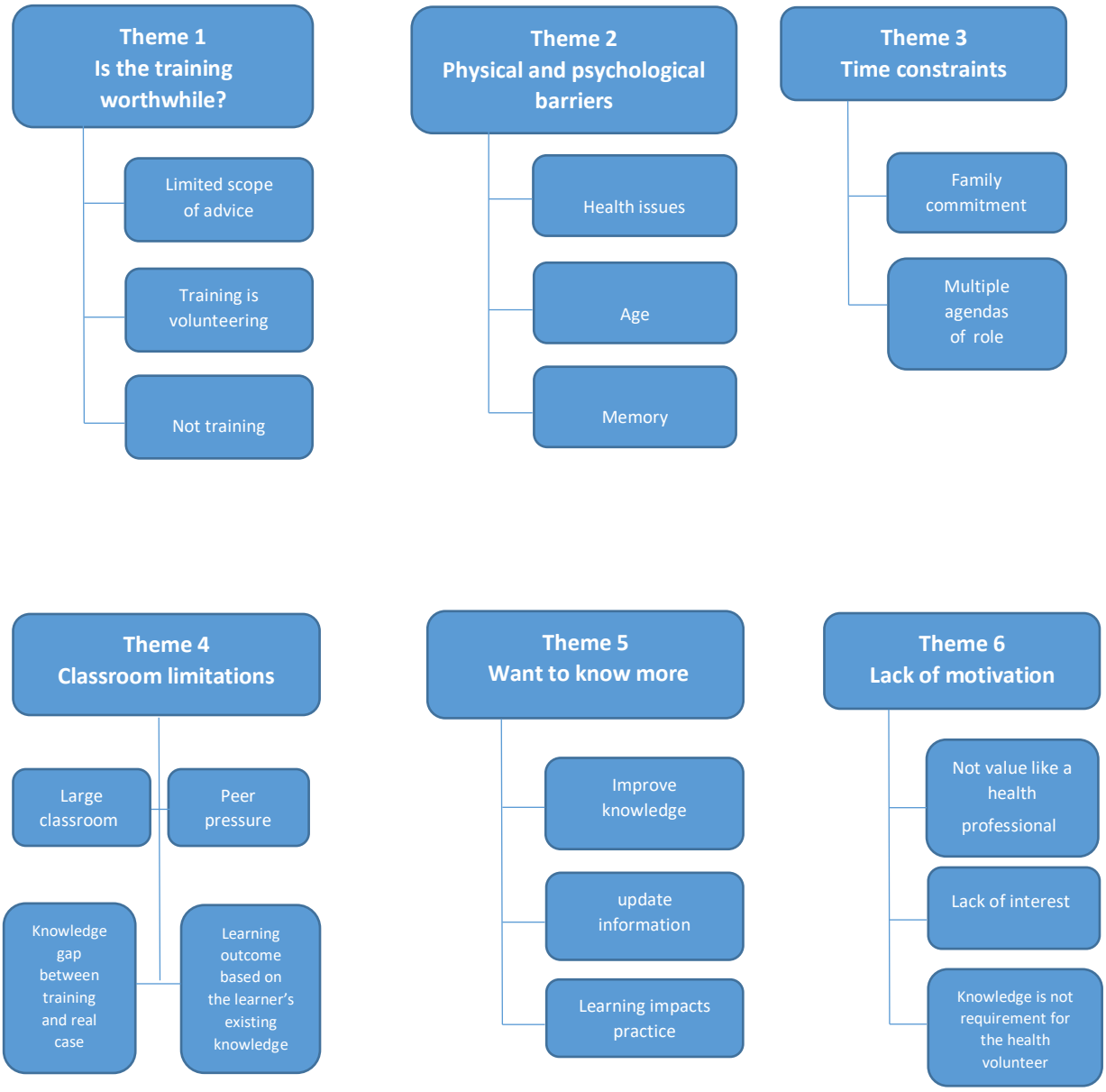
Stage 4 Reviewing themes

Once initial themes emerged from stage 3, the researcher reviewed and revised the themes by referring back to the entire code and data set to ensure all themes and sub themes represented the meaning of the HVs' learning experiences. The 8 initial themes were reviewed and 6 themes emerged with sub-themes that adequately captured what the HVs' experiences were (see Figure 4). The researcher reviewed and checked the themes that were interpreted in stage 3 by reading through all extracts that related to the codes to see if they supported the themes. Especially contradictions and overlap as the data within theme should (stick together) be coherent, while the data between themes should be distinct from others. Some codes were moved to the other theme as a better fit. The researcher read and checked if any data had not been coded, so all data were coded within a theme. The researcher kept doing this until the relevant data had been coded and coherent themes which represented data were provided. These data were reviewed by the supervisor team independently.

Stage 5 Defining and naming themes

In this stage, the researcher reviewed the themes in relation to the overall study. Sub themes of each theme were reviewed to identify what aspect of each theme they talked about. The scope of content per theme was also discussed. Finally, one theme was renamed from 'Unsatisfied with the training provided by health centre' to 'want to learn more' and another theme was renamed from 'Physical barriers' to 'Physical and psychological barriers' as the new terms were more representative than the initial name.

Figure 4 Example of themes after reviewing



Stage 6 Producing the report

The findings were presented during this stage of the process using verbatim excerpts from the interviews. The discussion provided an opportunity to interpret and compare the findings with related literature in the field.

8.9 Results

Six themes emerged from the interviews (as shown in Figure 4). Further cross-analyses showed that five themes emerged from both the high knowledge and low knowledge group, while the moderate group had four themes. Although all knowledge groups have four similar themes namely, 'Is the training worthwhile?', 'Physical barriers', 'Time constraints', and 'Classroom limitation', however, the theme 'wanted to learn more' emerged only from the high knowledge group, while the theme 'lack of motivation' was found only in the low knowledge group (as shown in Table 25)

These themes could be explained by several learning theories, but the principles of adult learning theory are more clearly aligned to individual and collective themes.

1) Is the training worthwhile? According to adult learning theory, adults must see a reason or a benefit of learning so that they may motivate themselves to learn (Falasca, 2011). Here the HVs demonstrate a lack of understanding of the importance and value of the training programme which resulted in poor attendance. The HVs perceived voluntary training as meaningless for their role and subsequently chose not to attend.
2) Physical and psychological barriers: In adult learning theory there is a recognition that ageing impacts a person's ability to retain and comprehend information. In this study there was evidence of physical decline due to ageing with resultant hearing and vision loss. The effects of these impairments reduce the capacity for learning

(Falasca, 2011). In addition, adult learning theory recognises that the presence of acute and chronic disease can negatively impact a person's ability to retain learn. Some of the HVs in this study highlighted that they could not attend the training due to the physical effects of ageing and suffering from their own ill health. They also reported that when able to attend that they were unable to retain all the information provided.

3) Time constraints: In adult learning theory, changes in family and work roles are recognised as barriers to learning (Falasca, 2011). Time constraint which occur as a consequence of family roles and work roles is not uncommon in more mature workers. The HVs in this study reported how they were unable to attend the training sessions due to family and work commitments.
4) Wanted to learn more: In adult learning theory, adults look for continuous learning based on personal interests, wants, and needs. This theme illustrated some HVs desire to learn. In this study, the HVs explained that they wanted to learn and attended the training on their own accord. This supports the theory that adults seek learning based on their interests.
5) Lack of motivation: Adult learning theory reveals that adults are motivated to learn by internal factors rather than external factors (Falasca, 2011). This theme illustrates the lack of interest in the learning topic (intrinsic motivation) and the lack of extrinsic motivation (not valued by the community). In this study, the HVs have no both intrinsic and extrinsic motivation to learn, and they perceive that it does not matter whether to learn about diabetes or not. The theme refuses the idea motivated to learn by internal factors rather than external, as both intrinsic and extrinsic motivation may have a positive influent on the HVs in this study. The HVs view the training as unnecessary for their job and were not interested in diabetes. In addition, the HVs

were not valued by the community. The combination leads the HVs to have a lack of motivation to learn.

6) Classroom limitations: This can be explained by adult learning theory and Constructivism learning theory. Adult learning is viewed that a positive and friendly classroom environment that keeps adults involved and motivated to learn, and adults learn better from their experiences and their past knowledge (Falasca, 2011). Constructivism learning theory report that the learner develops and constructs their knowledge based on their experience and prior knowledge (Alanazi, 2016). Learner learns more when they are actively involved in the class (Bada and Olusegun, 2015). This theme illustrated the inappropriate classroom atmosphere, the lack of engagement in class due to the large class size and the diversity of experience and prior knowledge. In this study, the HVs were discouraged to involve in the class by peers and inappropriate class environment (noisy class) which leads them to lack motivation. In addition, the existing knowledge was mentioned by the HVs as they have different existing knowledge, which may affect the learning outcome, therefore it highlights and supports that HVs learn better from their prior knowledge.

Table 25 Theme classified based on similarity and difference among three knowledge groups

Similar theme among three groups	Different theme among three group
Is the training worthwhile?	Wanted to learn more (high knowledge only)
Physical and psychological barriers	Lack of motivation (low knowledge only)
Time constraints	
Classroom limitations	

Four similar themes emerged from across all of the interviews**:** 'Is the training worthwhile?', 'Physical barriers', 'Time constraints', and 'Classroom limitation'. They are discussed below.

Theme 1 Is the training worthwhile?

The HVs questioned the value of the training, viewing it as worthless because advice about diabetes was limited for the HVs, they can advise only basic. As they were not health professionals. The training was not what they expected.

Many HVs perceived that the training was limited in relation to giving advice about diabetes:

> *-I can only advise about food; to tell the patient to avoid sugary food and eat more vegetables. I gave a piece of advice to the patients after receiving training, however, I can only provide basic advice to the patient as I am not a doctor. I have a limited scope of advice that the nurse told us to do. (Case 4, low knowledge)*
>
> *-The HVs learned only basic about diabetes, we did not learn complex contents as we cannot provide much care or advice for the patients. The main aim of learning about diabetes was to take care of ourselves and our family. (Case 1, moderate knowledge)*
>
> *-I don't want to learn more about diabetes as I am not a doctor, I will learn only basic what I can do as a HV if I learn more it will push myself too hard at work. (Case 11, moderate knowledge)*

Two HVs perceived that their role in advising patients about diabetic medication was limited, feeling that this was beyond the scope of the HV having the limitation of advising on diabetic medication as it is beyond the HV:

-I cannot advise the patients about the diabetic drug as it is the doctor's job, it is too advance for us (HV). (Case 2, high knowledge)

-I do not know about diabetic drugs, I only tell the patients to take medication regularly. Advising about the diabetic drug is complicated and completely beyond the HV. (Case 8, low knowledge)

However, the topic about the diabetic drug was not seen as a limitation by another HV with high knowledge:

- I advise diabetic patients to continue diabetic drugs and take the drug regularly on time, as the medication is important for them. (Case 5, high knowledge)

Although HVs from all knowledge levels stated that they have limitations of providing advice for the patient, two HVs who have low knowledge perceived that most diabetic patients are knowledgeable as they are already educated by the health staff in hospital:

- When I gave health education on how wound dressing to patients. they would say that they already learned from health staff at the hospital. I think the benefit of health education in the community would be recognized by the people, who did not go to the hospital. However, most people go to the hospital now. (Case 7, low knowledge)

- The patients are more knowledgeable than the HVs as they already educated by doctors. Hence, they will fall trust and do not cooperate with us. (Case 10, low knowledge)

The HVs with moderate and low knowledge pointed out that the training was only voluntary:

-Attending the training was volunteering, we weren't forced to attend the training; the nurse will ask the HVs in advance if they are willing to attend the training programme. (Case 1, moderate knowledge)

- As the training is not paid and it is volunteering so, I need time to do my full-time job. If I was given a chance to choose to attend the training or work, I would have chosen to work to earn money over joining the class. (Case 11, moderate knowledge)

- The training is volunteering not compulsory so I will attend if I am available, for me my family is the priority, I will attend the training once all the housework was done. (Case 8, low knowledge)

Although all of the interviewees viewed the training as voluntary, two HVs with high knowledge decided to take part in the training of their own accord:

-It is my own accord. I want to learn more and would like to improve my knowledge about diabetes, so I attend the training. (Case 15, high knowledge)

-I got training about diabetes from the hospital, where only people who were interested in the diabetic topic to attend the session. Although this training was volunteering, I decided to take part in the training because I was interested in diabetic care. (Case 2, high knowledge)

Some HVs did not perceive the training as actual training:

-(Deep breathing) it was not a training. Every year, the nurse talked about diabetes at the monthly meeting around 2-3 times. The topic included foot care, diabetic diet and medication. The meeting was 2 hours long, but the nurse talked about diabetes around 10-15 minutes. It seems like a short announcement. (Case 15, high knowledge)

-It was not training; it like general talking as the nurse did not teach about diabetes in deep, and it was a tiny part of the monthly meeting. (Case 1, moderate knowledge)

-It was not training it was general advice from the nurses as in the monthly meeting the nurses allowed us to ask how to provide the care for cases in our community. (Case 9, low knowledge)

Theme 2 Physical and psychological barriers

The HVs across all three knowledge levels stated that physical health and ageing such as illness, being older and memory can affect their learning capacity.

Some of the HVs reported that they could not attend the training due to illness:

-I could not attain the training due to my illness, I am frequently admitted to the hospital, so it makes me miss the training. (Case 5, high knowledge)

-I missed the training as I have comorbid chronic conditions and have to meet many doctors. (Case 7, low knowledge)

While a HV with moderate knowledge said she stopped learning when she was stressed:

-When I stress, I stopped doing anything even learning or attending the training because I want to relax. (Case 11, moderate case)

One of the HVs described that getting old is one learning barrier of the HVs as the older people require different teaching methods from the younger:

-I would like the health centre to set the training about diabetes and would also like them to teach us how to care of diabetes patients and provide a picture and example food for us to see, do not just only talk because we are not a teenager: we are 50, 60 or 70 years old. (Case 15, high knowledge)

- I learned and memorised quicker when I was young, however my cognition declines when I get old. (Case 7, low knowledge).

-I cannot clearly see the slides during the class because of my eyesight changes as I get older. (Case 6, moderate knowledge)

In addition, memory plays as the key role of people learning:

-I cannot learn multiple things at once as I have limited memory, I can learn better if I learn only one subject a day. (Case 5, high knowledge)

- I am 60 now, my memory is getting worse, so I forget what I have learned from the health centre. (Case 11, moderate knowledge)

In addition, two HVs described how the memory affected the job:

-I could not remember what I have learned from the health centre, as I have a bad memory, so I have to read the book every time before advising the diabetic patient. (Case 14, high knowledge)

-My barrier to learning and providing advice to the patient is memory. I often forgot the information I learned. It will be effective if you can remember what you have learned and conveyed it to the patients if you can't you still look silly as you weren't sure about the information. You can only advise them to go to the doctor. (Case 7, low knowledge)

Theme 3 Time constraints

HVs across all of the interviews admitted that time constraints due to family commitments affected their learning as family is the first priority of the HVs: Some of them report that they missed the training as they had to take care of their relatives. In addition, some HVs needed to leave the class early as they had to pick up their family member.

-I used to take part in every training but currently, I cannot attain the training as I have to take care of my grandson. The nurse already let me know in advance, however, I cannot come, as I am busy. (Case 2, high knowledge)

-One or two-hour training session is fine for me but I cannot make it if the training takes a whole day or two days because I have to take care of my sister. (Case 5, high knowledge)

-In the afternoon session (1 pm to 4 pm), many HVs left the meeting early around 3 pm as they had to pick their grandchildren up from the school. (Case 10, low knowledge)

- I sometimes didn't go to the monthly meeting as my husband had to go to the doctor and I came with him. (Case 12, moderate knowledge)

Some HVs explained that their failure to attend the training occurred because they were undertaking multiple roles. They described their roles in the home, as a HV and as being employed in other full or part time jobs. They described how they found it difficult to carry out multiple tasks simultaneously, as the following excerpts shows:

-To be honest, the people who work as HVs come from different background, some of them have full time job and multiple agenda of role, so they cannot fully attend the training provided by the health centre. (Case 1, moderate knowledge)

- I have a lack of time as I was busy, there were lots of things to do. I had many responsibilities and I had to go with my husband. (Case 12, moderate knowledge).

-Last month I missed the training as I had another meeting in my community, I do many jobs in the community. (Case 14, high knowledge)

- Besides working as a HV, I have also worked for several volunteer projects that make me busy, so I cannot attend all training. (Case 8, low knowledge)

Despite the time constraint that the women HVs experience, the one man did not have this problem:

-Although I have multiple roles, I can manage it and I still have some spare time to attend the class. (Case 4, low knowledge)

Training duration is one reason that HVs provided that influenced their decision to attend the class. One HV reported that she could not to take part in the extended training as she was busy and felt tired when she got back from the training:

- I have lots of things to do at home. I am the only lady in the house, the others are men, they didn't do the house job. I can attend one or two days of training; however, I won't be able to attend a 3-4 days training course. Previously, I ever took part in a 3-4 days training, but I feel tired after I backed from this event. (Case 3, moderate knowledge)

Theme 4 Classroom limitations

The HVs across all of the interviews indicated that a large classroom caused a loss of attention in the training:

-In a monthly meeting, as there were many HVs in the class, and those people kept talking during the session. I therefore sometimes lost concentration at the information the nurse informed us. It would be great if the nurse set the meeting in a small class as it is easy for class management. (Case 7, low knowledge)

Some of the HVs experienced classroom pressure/ peer pressure during attending the class. Interestingly, one HV explained that peer pressure prohibited her classroom engagement:

-(Laughing) Firstly during the meeting, if I didn't understand I will ask the nurse, but the people around me said that it is wasting time, they want to go home on time. This is the point that I wouldn't ask the question again. (Case 12, moderate knowledge)

Many HVs from all knowledge levels pointed out that there was a knowledge gap between training and real cases:

-When I finished training, I found a complicated case in the community and had to consult with the nurse every time as it did not appear in the training course. (Case 9, low knowledge)

Some of the HVs pointed out that the learning outcome was based on the learner's existing knowledge background:

-We were well educated by the nurse however, the learning outcome was based on the individual, for me, I think that I got the diabetes knowledge from the nurse preceptor less than others who already have more knowledge. (Case 1, moderate knowledge)

Two themes emerged from the analysis that was not common to all of the three groups: 'wanted to learn more' and 'Lack of motivation'.

Theme 5 wanted to learn more

The majority of the high knowledge HVs described various reasons why they wanted to learn more such as to improve knowledge, to update information and for their learning to impact practice.

Almost all wanted to learn more because they wanted to improve their knowledge as they felt that they learned **only a few topics** about diabetes from the health centre:

-I want to learn more and would like to improve my knowledge about diabetes, as I learned only a few topics about diabetes from the health centre. (Case 15, high knowledge)

Almost all those who had high knowledge levels wanted to learn more as learning impacts practice:

-I want to learn more about the topics that I have never learned from the health centre and want to have a deep understanding as if I clearly understand, I can provide correct advice for the patients. (Case 13, high knowledge)

-If I learn more about the cause of diabetes, I will have the confidence to advise the patients and their families as I am knowledgeable. Hence, we can reduce the incidence of diabetes in our community. (Case 5, high knowledge)

Furthermore, one HV wanted to learn more to update information because information from social media was more up to date than the current training:

-I often search for information about diabetes from YouTube as contents on YouTube were more updated than the books and the training, so I want to learn more to update my knowledge. (Case 13, high knowledge)

Among those with high knowledge levels who stated that they wanted to learn more, one of them preferred self-learning due to family commitments:

- I have to take care of my sister. It would be better if I can learn at home by reading a book. (Case 5, high knowledge)

Theme 6 Lack of motivation

The majority of the low knowledge group stated that they have a lack of motivation to learn about diabetes**.**

The majority of the low knowledge group stated that learning does not matter to their work:

> *-I will do only what I can do. We trained like this and went to teach people like this. Not more than I have taught. Currently, I can advise the patient, if I know more, I still cannot advise more. I can only advise the same as now because I am not a nurse or doctor. The patient will not believe me even though I got more training about diabetes. I can only provide a little advice. (Case 4, low knowledge)*

> *-In the past, knowledge didn't matter for the HVs, they focused on the service and volunteering mind to help the people in the community and you could be the HV if you can read or write Thai. So, some of the HVs failed to provide sufficient advice to the patients as they have lack of knowledge. In addition, the patients are more knowledgeable than the HVs as they already educated by doctors. Hence, they will lose trust and do not cooperate with us. (Case 10, low knowledge)*

Many of those with low knowledge did not feel that they were valued like a health professional:

> *-When I advise the patient, some people refused my advice and said you are not a doctor, do not give me advice. (Case 4, low knowledge).*

> *-The people in the community follow the nurse's advice, but they did not accept the HV's advice. (Case 10, low knowledge)*

In addition, two HVs admitted that they lacked interest in diabetes:

> *- I did not pay attention to what the nurse taught about diabetes in the class because I was not interested in this topic. As a result, I have limited knowledge of diabetes. (Case 10, low knowledge)*

-The training topic does not base on me; all HVs must approve the topics. If most people are not interested in diabetes, they will not vote for it. (Case 4, low knowledge)

8.10 Discussion

This study explored the HVs' learning experience about diabetes. Six themes emerged from the interviews including, the question of whether the training is worthwhile, physical and psychological barriers, time constraints, classroom limitation, wanted to learn more and lack of motivation to learn. These themes will be discussed below making reference to relevant existing literature.

Theme 1 Is the training worthwhile?

The findings showed that the HVs have a negative perception towards their learning which is reflected under the theme 'is the training worthwhile?' All knowledge groups stated that although they received the training on diabetes, they could provide advice only on what the nurse leading the training had instructed them on, inevitably this limited the HVs' advice giving to patients. The findings illustrated the HVs as having a **"dependent role"** with a lack of freedom to give advice regarding diabetes to the patients. The scope of advice mainly came from the **training in the classroom** which they described as **learning only basic topics** about diet. This finding can be seen to support the study one results as the HVs performed well in the topic about diet. Interestingly, the HVs in the current study viewed the benefit of learning about diabetes as being limited to "**Domestic**" situations, noting that they are only able to provide advice about diabetes to their family members, because their role is not valued by the general population.

The majority of the HV's viewed their role as "a supporter" of medication management. Due to them having a lack of knowledge about diabetic drugs, they could only tell patients to follow the doctor's order. These findings supplement the findings from the survey in study

one, where the results showed the HVs had a lack of knowledge about diabetic drug properties. This finding is also in line with the report of Hartzler et al (2018), where community health workers (CHW) had limited advice about medication. Hartzler et al (2018) performed a systematic review regarding the role and function of CHWs working in primary care in the US, and found that although the role functions of the CHWs can be classified into 12 sections, the medication management function of the CHWs was defined as "provides limited medication reconciliation without making recommendations", hence these people can advise patients on medication adherence based on the physician-approved guideline. This limitation may be due to the CHWs having not acquired any formal medication education.

The findings support the adult learning theory because adults need to know why they have to learn before starting learning (Falasca, 2011; Rodrigues, 2012; Merriam, 2017). And they tend to have more motivation to learn which helps them to solve the problem or to reach internal or external rewards (Rodrigues, 2012). In this study, the HVs showed that they have a lack of understanding of the importance and value of the training programme which resulted in poor attendance. In addition, the HVs perceived voluntary training as meaningless for their role, and as the result they opt out of the training.

As mentioned in the previous chapter, the HVs' role in supporting people with diabetes multi-dimensional including giving advice, screening, monitoring, taking care of the patients, reporting results, and referring patients for further examination. However, the participants of this study indicated that they only provide basic advice which they have learned from their training. They believed that it was outside the scope of their role to provide a high level of treatment. The HV is lay person who has received training and have responsibilities to take care of the people in the community, they learned essential topics. However, the findings not only reflect the perception of the HVs on their role (limited scope),

but it also reflects the purpose of the HV's exiting training. All HVs who completed the compulsory training can give basic advice to the patients and then refer the patients for advance treatment. Therefore, the HVs may need further training if they are expected to function at a more advanced level. The role description, training and the HV expectations appear to be conflicting which could impact the success of the HV programme and will therefore be considered in detail within the discussion chapter of the thesis.

The study findings highlight the disconnection between what the HVs see as their role and what the Government think of the role. It was not new, it was similar to the findings of the Kowitt et al (2015), as the HVs described the protocol and require activities as "decreased the flexibility with which they were able to provide support in accordance with their understanding of community needs." And the HV also highlighted that sometimes the government's commands are not suitable for the community. It is not the role of HVs. For example, in the childcare protocol, the HVs have responsible to ask the mother to read to their children, however they found that the community people were annoyed by the HVs' activities (repetitive question). Therefore, the increase protocol in that case impeded the HVs' ability to tailor information to the people in community. As above, although there is existing protocol, the HVs did not see it was their role. It highlights the importance of clarifying the job description and role of the HVs regarding diabetes care. In addition, the job role and protocol should be recognised by the HVs to ensure that all HVs understood. Therefore, it is important ensure synergy between what is expected by all parties.

The HVs in the current study perceived that most of the patients were knowledgeable, as they had learned from the doctors, few patients required advice from the HV. Some diabetic patients claim to have more knowledge about the biomedical aspects of diabetes and possess greater practical information than their doctor and nurse, so they avoid seeing less specialist healthcare professionals (Snow et al., 2013). Whilst this can be the case, the patients in Snow

and colleague's study attended and graduated from the "Dose Adjustment for Normal Eating" (DAFNE) course, a patient education programme, these patients were taught to become independent and empowered patients. When scrutinising the HVs job role and training, although the HVs in this study were trained about diabetes, they could not become the expert in every complex condition. In addition, we did not know the patients' educational background and how much expertise they possessed. It is possible that the patients were more knowledgeable than the HVs in some details and it would therefore seem sensible to advise the HVs on how to deal with these situations and what additional support they can provide. However, several previous studies have shown that the diabetic patients still have a lack of knowledge in many aspects (Upadhyay et al., 2008; Al-Adsani et al., 2009; Shah et al., 2009; Ardeňa et al., 2010; Al-Qazaz et al., 2011; Kheir et al., 2011; Odili et al., 2011; Al-Sarihin et al., 2012; Al-Maskari et al., 2013; Hu et al., 2013, Fatema et al., 2017; Zowgar et al., 2018). Hence, the findings indicate that the HVs should be informed that although the patients received diabetes education from the health professionals, deficits in knowledge can remain and advice is needed.

Training is voluntary

The impact of effective training on job performance and knowledge has been reported in other studies (Gill et al., 2011; Hamer et al., 2012; Miller et al., 2012; Greenspan et al, 2013; Puett et al., 2013; Atan et al., 2015; Momanyi et al., 2016). A study in Kenyan health workers of Momanyi et al., (2016) highlighted the importance of the training as it improved the worker's performance. However, in the current study the HVs perceived that the training was voluntary and as such, could be missed. Although all groups viewed the training as voluntary, the HVs with high knowledge levels kept attending the training regularly of their own accord as they were interested in the topic and wanted to improve their knowledge, whilst the HVs with moderate and low knowledge would miss the training, sometimes due

to financial reasons, a time overlap with a full-time job or family commitments. Financial concerns may be one motivating factor for deciding to attend or leave the training in these HVs. HVs in Thailand already obtain compensation of around 26 GBP (1000 Baht) a month from the government (Notification of the Ministry of Public Health, 2019), however, it is a small amount when compared with their living expenses. This finding builds upon the findings of study one, as most of the participants (88%) had a household income less than the national average household income. Therefore, the HVs prioritised their paid job instead of attending the training. According to the findings in study 1, nearly half of the HVs (43.3%) were employed, hence those people would be missing from the training if work time and class time overlap.

This finding is in line with a study in Cambodia in which Chlea and colleagues (2010) found that financial incentive was important for the health workers (e.g. nurse, physician's assistant, pharmacist's assistant, laboratory technician) to their role and performance as well as participating in training. The compensation the HVs received might be too small to make a difference whereas Chlea and colleagues (2010) demonstrated that paying health workers helped to improve their performance, The HVs in this study said that they cannot attend the training class because they have other work that they need to maintain due to financial need. It is also similar to a study in community health workers in Bangladesh, with the majority of the community health workers stating that receiving a financial incentive was one factor to undertake their role (Rahman et al., 2010). Conversely, attending the training was not always driven by finance, Greenspan et al (2013) reported that community health workers were motivated to attended training because they desired to educate society, which could compare to the HVs of high knowledge who appeared to be more motivated learning-wise.

Although the HVs stated that it is unnecessary to attend the trainings as they are voluntary, the Ministry of Public Health Notification (2017) clearly state that, to gain compensation,

the HVs are required to work at least once a week or four days a month. And they should attend either monthly meetings or attend training to increase knowledge from public health officials at least 1 time per month. This means that the HV does not have to attend every meeting.

However, it is not so strict that if any volunteer is unable to attend meetings or training to increase knowledge in that month, they still get paid if they inform the public health officials of the reason for absent, then follow up and read the information of the meeting when he did not attend the meeting.

Only two main trainings that the HVs must attend are the first training and the refresher training. As these are mandatory course. It is essential that the people who apply for this job position attended the first training course as shown in the previous chapter, otherwise they could not be the HVs. In addition, after the HVs have worked for 6 or 12 months, they are offered to take part the refresher course which includes content about diabetes, distributed by the health centre staff.

This study supported the findings of Kowitt et al (2015), as the HVs in Thailand perceived that the increases in the number of meetings in protocol make them less flexible and lead to contention. The HVs in the study of Kowitt et al (2015), found that their job and meetings are much more than previously. They used to have not to attend the meeting every month, currently, they have to meet every month and get more job responsibilities. This finding highlighted a disconnection between the government expectation and the HVs' expectations regarding attending the training. Although, the government include attending at least a training per month into the criteria for gaining compensation, however, it is still flexible for those who were unable to make it, as they can let the nurse to know that why they cannot attend the class, therefore it may cause misunderstanding because the HVs perceive that

attending the training is voluntary and unnecessary to take part. This was supported by the previous study, the HVs report that they were not informed about the purpose of attending the monthly meeting (Kowitt et al., 2015). This finding stated that it is necessary to inform the HVs about the purpose of attending the training and the requirement and consequences of unattended training. The nurse and healthcare personnel should follow up with the HVs who are absent from the training/monthly meeting to ensure that they do not miss any important points. The training material should be available for the HVs to access.

Not training

Most HVs saw the training as not actual training, they reflected on the training in terms of "general talking, short announcements, or general advice from the nurse about diabetes" in the monthly meeting. They received information about diabetes in a limited time as this section was included in the general monthly meeting. This finding was supported by a scoping review undertaken by Egbujie et al (2018), to examine how the CHWs worldwide have been utilised and prepared to support diabetes self-management as well as the way to supervise them to function in their role. Egbujie et al (2018) found that although the training about diabetes was provided to the CHWs by several educators such as a local health authority, certified diabetes educators and a research expert, the training duration about diabetes was varied from a few hours to several months, and there were no criteria about how the duration of diabetic training was decided. Egbujie and colleagues also showed that only 24% of those studies reviewed stated that the CHWs received updated training, while 16% of the studies showed that the CHWs did not obtain ongoing training, and 65% did not report whether updated training was provided for the CHWs. The review by Egbujie et al (2018) indicated the lack of training criteria and training updates about diabetes in CHWs employing globally over the past 15 years, however as the search strategies were limited to

studies published in English, it may not capture the whole CHWs preparation regarding diabetes self-management.

The HVs based their learning on individual and personal background thereby supporting a constructivist learning approach (Bada and Olusegun, 2015). The learner constructs their knowledge by interacting with the environment then adjusts this based on existing knowledge (Kay and Kibble, 2016).

Theme 2 Physical and psychological barriers

Physical health and ageing such as illness, being older and memory can affect learning capacity. The HVs in the current study viewed age as a learning barrier as cognitive and physical decline affects their learning. Interestingly, the participants of the current study stated that those who are older learn differently from those of a younger age. Some participants in this thesis claimed that they had limited memory due to old age, a hypothesis that is supported by a study of older adults in the UK. Kobayashi et al (2015) found that cognitive decline affected health literacy in ageing British adults However; memory problems are not solely age-related. Physical health such as chronic ill-health is also believed to affect learning, even in the young (Crump et al., 2013; A'Bear, 2014; Hoffmann et al., 2018). The current study also found that HVs had learning limitations due to limited memory, however this finding contrasts with a study by Imlach et al. (2017), conducted in Australian older people aged 50-79 years old, the author reported that age was not a barrier to academic achievement in older learners and a lifetime engaging in cognitively stimulating activities can help the older learners improve academic performance. A meta-analysis by Gegenfurtner and Vauras (2012) explored whether age increase leads to a decrease in motivation to learn and the transfer of training in adult continuing education. The findings

showed that motivation to learn and knowledge transfer did not decrease, it remained at a high level with age increase.

In the current study, the HVs stated that being admitted to hospital and time overlap between training and doctor's appointments led them to miss classes. This finding not only illustrated that illness is an important learning barrier in HVs, it can also reflect that the HVs fail to stay connected to the training lesson. However, the previous studies employed technology to connect and engage with ill learners to minimise psychosocial and educational disadvantages (Wilkie and Jones, 2010; A'Bear, 2014), but the scope of study was limited to mandatory courses rather than voluntary ones as was the case in the current study.

The physical and psychological barriers of the current study also support the adult learning theory, which explains that the consequence of ageing such as physical and memory impairment impacts the learner's capacity to learn. The HVs in this study pointed out that it is difficult to follow the lesson and retain information because they have physical and memory limitations. These findings highlight the necessity to take the HV's physical and psychological limitations into consideration to provide available resources and suitable training for the HVs.

Theme 3 Time constraints

The female HVs reported time constraints due to family commitments. The conflict between work and the home life has been reported elsewhere in both Western (Gallie and Russell, 2009; Tammelin et al., 2017) and Asian countries (Gani and Ara, 2010; Ahmad et al., 2011; Herdiyanti, 2018; Liao and Paweenawat, 2018). In Thailand, Kaithong, and Sawangdee (2018) reported that the role and function of Thai women has changed in recent times. This advancement is seen in terms of socio-culture, economic and politics, evolving from submissive housewives to working women. However, as Buddhism is influential in Thai

society and is mainly driven by men, women are forbidden to touch or be higher than a monk, and can only be responsible for food preparation and cleaning. Accordingly, some men still consider Thai women to be inferior (Kaithong and Sawangdee, 2018).

Gani and Ara, (2010), Herdiyanti (2018) and Liao and Paweenawat (2018) report that even though Asian women work outside their home they are not separated from their commitment to their family. Although these studies were conducted with different samples, ethnicities and time, the conflict of working woman and home maker is clear. In Thailand, Liao and Paweenawat (2018) studied the labour supply of married women between 1985- 2016 and found that the labour supply of Thai women was influenced by their spouse and children. Married women tended to work more when they had more children as a consequence of increased expense. They also spent more time on household work than those without children. In addition, married women intend to decrease their working hours when their own and spouses' wage increase. Similarly, Gani and Ara (2010) reported that Indian women who work outside the home continued to care for their spouse and children as well as other family members. In order to balance their dual role, they had to be more pragmatic and work within a strict schedule. They felt guilty when their home, husband, and child were left unattended (Gani and Ara (2010). These findings are similar to this current study, as some women HVs experienced competing demands on their time and attempted to balance their roles in taking care of their family members negatively affecting their experience of learning.

These findings align with the adult learning theory, which described that adults experience time restraint due to the changes in family and work roles which affect their learning (Falasca, 2011). These changings also demotivate the adult's motivation to learn (Rodrigues, 2012). The HVs in this study point out that they could not attend the training sessions due to family and work commitments. Therefore, the findings call the teaching creator's attention to provide a teaching course which is appropriate and flexible for the HVs' time availability.

In addition, as mentioned above, the change in work and family roles can lead the adult's demotivation to learn. The HVs may feel exhausted and lose their study motivation after a long day of work and family duty. Therefore, it emphasises the necessary to employ strategy to keep the HVs motivated.

Theme 4 Classroom limitations

It was evident from the present study results that the HVs were not happy with the current educational environment. The HVs experienced several learning barriers such as a large classroom, peer pressure, the knowledge gap between training and real cases, and learning outcomes based on the trainer's existing knowledge, as reflected in the theme classroom limitations.

Large class sizes (more than 100 HV's) were another theme that impacted HVs experience. This finding is congruent with previous studies that have explored students and teachers in Asia (Harfitt, 2012; Bahanshal et al., 2013) and Africa (Yelkpieri et al., 2012). Yelkpieri et al (2012) explored how teachers and students in Ghana believed that class size affected learning and teaching in a university setting. Interestingly, the findings showed that there was a mismatch between the teachers' and students' views. The students argued strongly that big class sizes affected their quality of learning, assessments and time available with the teacher. Conversely, the teachers did not believe that large class sizes affected their teaching and assessment of students' learning. Bahanshal et al (2013) in a study of English teachers in Saudi Arabia noted that due to large class sizes teachers had fewer opportunities to assess student's achievement. Harfitt (2012) conducted a study in a language learning classroom in secondary schools in Hong Kong. They found that students felt more confident when learning in a smaller size class and they feared evaluation from their peers and teachers in a large classroom. Although these studies explored learning in a large class, they defined a large class in different ways. Bahanshal et al (2013) considered large class size to be greater

than 36, Harfitt (2012) 38-41 students and Yelkpieri et al (2012) defined a large class size as ≥100 students. The HVs in this thesis pointed out that they lacked knowledge but faced pressure from a large number of their peers when attempting to ask questions in the classroom with hundreds of HVs.

Peer support has been shown as an influential factor in the students' motivation to learn and academic achievement in several studies (Lee and Shute, 2010; Zain et al., 2012; Kiefer et al, 2015). Lee and Shute (2010) reviewed 150 studies that were focused on academic achievement of grade K-12 American students and found that peer influence was linked to the students' academic achievement. In a mixed-method study, Kiefer et al (2015) stated that peer support had benefits on learning in adolescents studying in middle school, in the United States (US), as it promoted classroom engagement and academic motivation of the learners, in addition, the learners felt they obtained academic and emotional support from a classmate. This is similar to the study of Zain et al (2012), who employed a student-centred approach in a mathematics classroom among pre-university students age between 18-19 years in Malaysia, the results showed that the learners are less passive, they are responsible for their study in class and out of the classroom by planning their lesson and their learning. In addition, they felt comfortable to share ideas with their team members and teachers in an unthreatening classroom (Zain et al., 2012). The collaboration between peers in the classroom was mentioned as a positive aspect of constructive learning theory, as social and communication skills are promoted via collaboration and the learners exchange their ideas, the learner learns more when they are actively involved in the class (Bada and Olusegun, 2015). However, one of the findings of this current study found that peers had a negative impact on the learning of the HVs, as peers were described as inhibitors who reduce the other HVs' classroom engagement with the content and teacher. Similar to the study of Harfitt (2012), the author stated that secondary school students felt uncomfortable when answering

question in an English class as the classmates treated them harshly if they made a mistake. They also described classmates in a large classroom as being unfamiliar or not trusting of one another. In contrast, the learners felt secure and less anxious about receiving negative feedback from their peers when they studied in smaller classes. Although previous studies in Western and Eastern classrooms showed the positive and negative impact of peer learning, these studies were conducted in students age ≤19 years, and it therefore cannot be generalised to the HV population because of its different sample age, learning subjects and cultural background.

Classroom organisation also appeared to be a barrier to learning in this study. Dişlen et al (2013) reported similar findings when investigating 9th grade students in Turkey. The authors note that students showed a lack of interest and lack of motivation in lessons with peers talking too much in the classroom. They also found that learning repetitive topics resulted in the students losing interest. In this current study HVs' engagement was often prohibited by their peers.

The knowledge gap between training and real cases was mentioned by the HVs in this study. The HVs found they were faced with more complicated cases in practice than what they learnt in class, as a result they sought advice from the nurse who was the main learning source of the HVs. The gap between learning and practice was also mentioned in the studies in nurses (Ajani and Moez, 2011; Al Awaisi et al., 2015; Lee and Sim, 2020). However, these studies cannot be compared with this study due to the difference in sample and learning subjects.

Although there are many studies focused on the teaching process and how it impacts upon knowledge, this current study found that learning was based on the HVs existing knowledge. The HVs stated that although they were educated by the nurse, their learning was based on

their own individual and background knowledge. Whilst the HVs were taught the same topics by the nurse in the same class, their learning was not comparable but was instead dependent upon their existing knowledge base. The respondents felt that colleagues who were initially knowledgeable learned more whereas those with less knowledge at the outset were likely to learn less. As mentioned in the study results on page 234, one HV observed that “we were well educated by the nurse however, the learning outcome was based on the individual, for me, I think that I got the diabetes knowledge from the nurse preceptor less than others who already have more knowledge”. This can be explained by constructivism learning theory in which prior learning plays a key role in the process of learning, the learner constructs, and develops new knowledge based on their previous learning (Bada and Olusegun, 2015).

This study's findings can be also explained by the adult learning theory, as this theory mention a positive and friendly classroom environment can keep adults engaged and motivated to learn, and adults tend to learn better from their experiences and their past knowledge (Falasca, 2011). The current study illustrated the unsuitable classroom atmosphere, including large class sizes, noisy classes and peer pressure that discourage the HVs to involve in the class. These findings highlight the importance of employing strategies which can help the teaching organiser to manage the classroom atmosphere and handle negative peer pressure. In addition, although the adult learning theory views the benefits of existing knowledge and experiences as it facilitating adult learning. It may raise the question about the learning outcome and how to educate the people with different experiences and knowledge backgrounds, particular the HVs who are lay people with a variety of knowledge and experiences. The HVs in this study also point out that the different prior knowledge leads to different learning outcomes. Therefore, this study highlights the importance of

diversity in the classroom. In addition, this study points out the necessity to design the teaching activity and module that the HVs from various backgrounds can follow.

Theme 5 wanted to learn more

HVs with high knowledge scores 'Wanted to learn more'. These HVs had greater motivation to learn due to the impact that the increased knowledge had on their practice and to update information about diabetes. The findings were similar to community health workers in other studies, as training increased their knowledge or performance (Gill et al., 2011; Hamer et al., 2012; Miller et al., 2012; Greenspan et al, 2013; Puett et al., 2013).

Greenspan et al (2013) found findings like those of our high knowledge volunteers when exploring the views of community health workers in Tanzania. Greenspan and colleagues' (2013) participants viewed the training as a motivator as it was a way to improve their knowledge helping them to perform their job and gain money. Although Greenspan et al (2013) conducted semi-structured interviews with community health workers, the current study focuses specifically on diabetes training, while Greenspan and colleagues adopted a more generic stance. In addition, the findings are also in line with other studies of community health workers in Africa (Gill et al., 2011; Hamer et al., 2012) and Asia (Miller et al., 2012; Puett et al., 2013), whose knowledge and/or performance improved following training.

The HV also reported that they wanted to learn at home preferring the self-directed learning because they experienced barriers to learning, many of which are outlined previously. Robinson and Persky, 2020) argue that this type of learning is profitable and allows the learner to set a goal, choose the time and structure their learning around their needs (Loeng, 2020; Robinson and Persky, 2020). However, this learning requires the learner to be motivated, (Robinson and Persky, 2020) to take responsibility for their own learning (Loeng,

2020) and possess the skills to order their learning. Murad and colleagues (2010) conducted a systematic review about the effectiveness of self-directed learning (SDL) in health professions education, and they found that SDL was associated with a moderate improvement in knowledge when compared with traditional learning methods. In addition, they found that the SDL was recommended for adult learners, advanced learners, and the context in which the learner had limited to access the academic institution or teachers. It could also be used as a supplementary method of learning if the learning content was large (Murad et al., 2010). To develop the SDL for the learner, the learner should be involved in selecting their learning methods, resources and the way to access resources which are suitable for their learning style (Murad et al., 2010). However, whilst these results are promising it should be recognized that the HV sample studied in this thesis differs greatly from the qualified professionals included in Murad's study. It would therefore be essential to undertake work with the HV population prior to any roll out of SDL.

The adult learning theory can provide a possible explanation for this theme as this theory pointed out that adults seek continuous learning formulated on personal interests, wants, and needs (Falasca, 2011). The HVs of this study pointed out that attending the continuous training was driven by their own accord, desire to update and improve knowledge as they perceive the training are beneficial for their job. The study also supports that the HVs' learning was driven by internal motivation.

This study informs the HVs' course creator to highlight the importance of the internal desire to learn and look for a way to create the HVs' desire to learn. The findings also highlight the importance of providing continuous support and resources for the HVs for updating and continuing their learnings.

Theme 6 Lack of motivation

Lack of motivation to learn was found solely in the low knowledge group, the HVs describe the reasons behind the lack of motivation as learning does not matter in their job, they were not valued like the health professionals and there was a lack of interest surrounding the topic of diabetes. These feelings of reduced value are likely to reduce the HVs internal motivation (Falasca, 2011). Indeed, Falasca (2011) found that doubting the value of learning and having concern about the negative results of learning creates a barrier to learning. The findings were similar to the study of Eisen et al (2015) where medical students in the US who were not interested in a learning topic (dermatology course) tended to have poorer scores than those who were interested in the learning topic. The lack of motivation to learn was also found in a study by Dişlen et al (2013) conducted in a high school in Turkey, which demonstrated the rationale behind the lack of motivation to learn in students and what makes them get motivated. These students had lack of motivation when: they cannot keep concentration, having health problems, shortage of material, while they felt motivated toward: start of a new subject, attractive equipment, communication, positive reinforcement. Community trust, prestige and recognition were identified as non-financial incentives that can increase community health workers' motivation, self-esteem and performance (Amare, 2009; Chibanda et al., 2011; Alam et al., 2012; Dil et al., 2012; Razee et al., 2012; Smith et al., 2013). However, HVs with low knowledge in this study seemed to lack motivation due to the shortage of non-financial incentives, as they said that they were not valued by the community.

The findings refuse the idea motivated to learn by internal factors rather than external which is described by the adult learning theory. Although the findings support that intrinsic motivation influent the HVs' motivation to learn. Only those with high knowledge levels were motivated intrinsically; whereas, others were not. It can be seen that the high knowledge group were motivated by a desire to learn, while the other knowledge groups

were motivated by extrinsic reward such as monetary incentive, especially the HVs with low knowledge group as they were not motivated by intrinsic motivation.

The findings also reject that the HVs motivated to learn by internal factors rather than external, as both intrinsic and extrinsic motivation may have a positive influent on the HVs in this study. This thesis has added further evidence that the HVs were motivated by internal and external factors.

The HVs in this study described barriers to learning including questioning the merit of the learning itself using terms such as 'Is the training worthwhile? They describe 'Physical barriers', 'Time constraints', 'Classroom limitations', 'wanting to learn more' and a 'lack of motivation'. In this study overall HVs experienced several barriers of learning about diabetes which reflected the current training which may possibly affect their learning outcome. However, high knowledge participants were motivated to learn whereas low knowledge participants lacked this motivation. As with the current study, motivation has also been noted in other studies as a factor influencing the learning outcomes of learners (Cavas, 2011; Kusurkar et al, 2013; Chan and Norlizah, 2017). Cavas (2011) and Chan and Norlizah (2017) have both reported similar findings reporting that those with a high motivation to learn demonstrated higher levels of achievement compared to those with less motivation. It is worth noting that these results are comparable despite the difference in the sample, age, subject, tool, achievement classification, and the study methods.

Motivation can be classified into intrinsic and extrinsic motivation (Legault, 2016). Intrinsic motivation (IM) is the motivation that emerges from inside such as being satisfied, joyful, and interested, while extrinsic motivation (EM) is the motivation that arises from an external (outside) or social force such as reward and incentive (Legault, 2016). In this study, the low knowledge group showed the lack of IM to learn about diabetes as they viewed learning

about diabetes as uninteresting, does not matter to their jobs, and useless as they thought the patients were already educated by the health professionals. They also had a limited role of giving advice about diabetes. In contrast, in the high knowledge group, they had IM to learn about diabetes as they viewed learning about diabetes as knowledge improvement and impact on their job role and useful. In addition, the IM relies on the social environment to perceive competence which can be minimised and maximised, e.g. positive feedback and verbal praise can increase their IM (Legault, 2016). Therefore, the lack of motivation in the low knowledge group could possibly be due to obtaining negative feedback on their competency from the patients in the community as they were not valued like the health professionals hence it may possibly explain why the low knowledge group had lack of motivation to learn about diabetes.

As explained above, IM that is based on personal feelings toward the learning topics by engaging the learning when they feel joyful, satisfied, and interested. Nevertheless, how does one motivate HVs to learn if they did not want to learn about diabetes? Extrinsic motivation should be employed to keep promote learning, as this type of motivation is gained completely externally (reward from outside), and can sometimes help to promote the behaviour which is not acquired from IM (Legault, 2016). This type of motivation can be compared with behaviourist learning theory, as reinforcement is used to help increase the probability of repeating the desired action (Aliakbari et al., 2015). In this study there was a lack of reinforcement which for some affected their motivation. Although all HVs groups stated that attending the training was voluntary and not mandatory, in the low knowledge group they viewed the training as ‘could be missed’ due to it being ‘unpaid’, whilst in the high knowledge group they attended the training of their own accord. Based on findings, the lack of positive reinforcement (e.g., financial reward, incentive) and the lack of penalty in not attending the training, may explain the lack of motivation to learn in the low knowledge

group. The finding showed that as the low knowledge group had a lack of internal motivation, they require external motivation to motivate their learning, however, they did not achieve this due to there being a shortage of EM in attending the training, hence they had a lack of both IM and EM, which may possibly explain the lack of knowledge in the low knowledge group. This contrasts with the high knowledge group where learning motivation was solely driven by IM.

This finding can again be explained by behaviourist learning theory. The learner plays the role of the respondent to the environmental stimuli (Kay and Kibble (2016). This learning theory used positive reinforcement and sanction to shape the desired behaviour, and as this learning is driven by reinforcement and punishment, it means that learning does not happen without stimulus (Rostami and Khadjooi, 2010). In this study, the HVs perceived training as voluntary, with no reward or punishment if they left class early, or missed the class. In addition, the low knowledge group perceived that the knowledge did not matter for their job (no reward or punishment), and they were not valued by the community (non-financial incentives), while high knowledge group viewed knowledge as essential for their job, hence reward and punishment could play a key role as the learning motivation in this study group. This finding is in line with the previous study of Hoque (2013) who conducted experiments to compare test results amongst 100 students with and without learning reinforcement in five schools in India. The author found that students that received positive reinforcement (praise, grades, medals, pens and trophies) recorded higher average scores than those whose actions were not reinforced. Students in the reinforced group had a high level of interest, satisfaction and were willing to volunteer answers and ask questions when compared with students whose actions had not been reinforced. In contrast this group were less willing to participate and interact with the class. However, Hoque's study (2013) results cannot be directly compared with this study due to a difference in the population, teaching and learning system.

Hoque's study (2013) was conducted in schools where students received compulsory education, while this study focused on volunteers educated about diabetes by health centre staff.

According to the findings, it is therefore clear that those in the high knowledge group had a greater motivation to learn than other knowledge groups, suggesting that motivation to learn is vital to the learner's success.

8.11 Conclusion

This study was conducted to explore the HV's learning experience about diabetes. The findings indicated a conflict between job and family roles amongst the female HVs. They articulated how they were unable to balance their domestic tasks and work responsibilities due to family commitments and felt that this conflict affected their learning The participants also explained how their memory and illness caused them to be absent from class; hence they were unable to follow the lesson when they missed the class. In addition, the large class size influenced their willingness to engage with the lesson and the increased noise meant they could not concentrate. While the HVs with high knowledge scores stated that they were motivated to learn to impact practice, those in the low knowledge group voiced their lack of motivation, feeling of being valued and interest in the topic. The findings of this study provide a greater insight into the learning journey that the health volunteers experience. Whilst stage 1 of the study provided an understanding of the HVs knowledge levels, stage 2 provides a clearer insight into why these knowledge levels differed. Recommendations for future research from this study are discussed in the next chapter.

Chapter 9 Integrated Findings and Discussion

9.1 Introduction

As described in the previous chapter, the author employed an explanatory sequential mixed method design to assess the HVs' knowledge of diabetes. A questionnaire based quantitative study assessed the knowledge levels of the health volunteers. The origin of these levels of knowledge and the learning journey was explored with semi-structured interviews in phase 2. This chapter will discuss the integration of the findings of both studies.

This integration process is concentrated on how the qualitative interviews that focussed on the learning experience of HVs with different levels of knowledge helps to explain how this knowledge was gained and the perceived barriers.

9.2 Discussion of the findings

The HVs' diabetes knowledge level

Quantitative study: Three quarters of respondents possessed either low (N= 100, 25.6%) or moderate levels of diabetes knowledge (N=186, 47.7%). The remaining quarter were noted to possess high knowledge levels (N=104, 26.7%).

Qualitative study: The HVs from all knowledge levels reported that they experienced learning barriers including physical and psychological barriers, time constraints, classroom-teaching and knowledge limitations. Furthermore, they seemed to doubt the value of the training. However, despite these barriers, the high knowledge group appeared to have the motivation to learn, while those with low knowledge appeared to lack motivation to learn.

Data integration: The qualitative study suggests that learning barriers may affect the knowledge levels of the HVs, leading to a knowledge deficit among some HVs. However,

the study was not designed to test such a hypothesis and it is therefore unwise to draw such conclusions without further investigation. Nevertheless, motivated HVs were able to achieve greater knowledge levels despite some learning barriers, highlighting the important role that intrinsic and extrinsic motivation play in education. As has been stated, the study was not designed to investigate the impact of these additional variables on educational outcome but the qualitative insight, whilst interesting in its own right, has created a hypothesis for future work.

Discussion: Most of the HVs in this study lacked sufficient knowledge of diabetes (moderate and low knowledge groups). The HV is required to have sufficient knowledge to advise and care for people with diabetes in the community. In addition HVs act as the first point of triage upon which additional services are stratified. As has been stated earlier in the thesis, The health system is Thailand is classified into three levels; Primary, secondary and tertiary. The three levels of medical care are connected through a referral system. Primary medical care as the name suggests is the first contact point for all beneficiaries. Patients are not allowed to progress to secondary or tertiary medical care without referral from primary care. If the HV who is the first point of contact in the community and the gatekeeper to subsequent care has sub-optimal knowledge, then the triage process becomes flawed and patients who require earlier interventions are likely to be missed. This outcome is likely to negatively impact the patient but will also increase healthcare costs. This finding is in line with a Kenyan study by Irwin et al (2015), who employed a 15-item test to assess rural community health workers' knowledge of diabetes. One hundred and thirty-three community health workers participated, achieving a mean percentage grade of 52%. However, the respondents' scores varied across subject areas. The participants achieved a percentage score of 37%, 53% and 68% when their general pathology, diabetes treatment/management and risk factors/ complications were assessed respectively. Unfortunately, Irwin did not detail

the validity and reliability of the questionnaire used and I am therefore cautious when comparing the findings with this thesis, given the difference in the sample, study context, and assessment tools used. In addition, Irwin and colleagues (2015) presented only mean scores and percentage scores for each topic, whereas the current study reports the percentage of people choosing correct and incorrect answers and classified the HVs knowledge levels into high, moderate and low knowledge based on the Bloom's taxonomy (Bloom et al., 1971).

Contrary to the findings in this thesis, previous Thai studies that have explored HVs knowledge of diabetes have shown high levels of knowledge (Prombutr et al., 2015; Srijompon and Muktabhant, 2018). Quasi-experimental research by Prombutr et al (2015) conducted with 30 Village Health Volunteers (VHVs) living in northeast Thailand, reported that the majority of the participants possessed high knowledge of diabetes and hypertension (70%). These knowledge levels were increased to 93.3% following an educational programme. However, the classification criteria for the knowledge group were different from the current study, the author used a different tool which was comprised of 19 knowledge-test items of hypertension and diabetes care. In addition, the content validity of Prombutr's survey was only 0.62 and the reliability value using the Kuder Richardson 21 tool (KR- 21) was 0.77 which is below the minimal acceptable value. Moreover, Srijompon, and Muktabhant (2018), completed a study with 151 HVs in which the authors found that around 68% of HVs possessed high knowledge levels, and they employed a similar classification criterion for diabetes knowledge level based on Bloom's Taxonomy. Srijompon and colleagues (2018) recommend that, regular training should be provided for the HVs to enhance their knowledge and confidence in their practice. They stated that the HVs had high knowledge of blood sugar testing due to the formal education, and the HVs can access to the information once they completed the training. However, around one-fifth of the participants

had not received formal training of the topics, as they were new HVs. They learned from their peers and the health staff. Hence, the difference in the type of knowledge tested and previous teaching exposure may explain the difference between both sets of findings.

The findings of this thesis suggests that the HVs' lack of knowledge may have been affected by a number of barriers, which include both internal and external influences. These barriers can be classified into three groups: before class, during class and after class.

Before class

Some HVs did not attend regular training due to illness and role conflict. This was especially relevant for females. Training was also viewed as voluntary and was therefore not valued. Interestingly, whilst the results of previous studies also report regular classroom absence, they note the use of numerous online platforms to increase engagement. (Wilkie and Jones, 2010). The findings contrast with this thesis where the HVs did not appear to value the training: they were regularly absent, were often late to class and left early. However, they cite role conflict as a major factor. The contrasting findings may have been caused by the different emphasis placed on the learning by the employer and the HVs' individual perceptions. The training in this current study was undertaken on a voluntary basis, and was described as unimportant, not impacting on the HVs' role and was therefore not prioritised. Conversely, the training described in Wilkie and Jones' (2010) study was compulsory, absence from class may have affected the students' learning outcome and educational progress. Therefore, students prioritised their learning. This finding can be explained by Behaviourist learning theory, as learning is driven by reward and penalties (Hunt and Chalmers, 2012), and learning does not happen without stimulus (Rostami and Khadjooi, 2010). In the current study, the HVs received no reward for attendance and were not punished if they left class early, or missed the class, hence many did not attend the training.

This finding highlights the importance of arranging, making and sustaining connection with those who fail to attend the training by using reward and punishment to motivate the HVs to attend the class. However, this reward does not always need to be monetary. The sessions themselves were not valued, demotivating the HV further. Undertaking a simple training needs assessment and delivering sessions that are perceived as valuable to the HV role could act as a motivator without any additional resource.

During class

The HVs considered the large class sizes of around 100 HVs as a barrier to learning. Regular interruptions from noisy class mates reduced their ability to concentrate and demotivated the HV's further. In addition, the HVs experienced pressure from peers not to ask questions thus limiting the learning time and opportunities to engage. Moreover, older HVs reported a limited ability to concentrate arguing that there was a need for more flexible teaching methods.

A number of previous educational studies have reported the negative impact of large class sizes on the students' learning (Harfitt, 2012; Yelkpieri et al., 2012; Bahanshal et al., 2013). In addition, our HVs reported the impact of classroom noise on the quality of their learning, a finding which is supported in university students (Braat-Eggen et al 2017), primary school (Bulunuz et al 2017) and in elementary school (Bhang et al 2018). Bulunuz and colleagues (2017) conducted a study in private and public primary schools in Turkey and found that students from both settings experienced noise pollution emanating from inside and outside the schools. They reported that they were annoyed by noise from students shouting, screaming and other noise from physical movement during the lesson. Therefore, the students thought these noises impacted on their achievement. The results of the present study also align with the work of Bhang et al (2018) which was conducted in a Korean elementary

school, however, the main sources of noise came from road traffic. Similarly, Braat-Eggen's study which performed the survey in the 496 students studying in university in the Netherlands, they reported that students were distracted by noise when carrying out cognitive tasks. As a result, over half (57%) of the participants used earbuds when they heard the noise. However, Braat-Eggen and colleagues' participants were not classroom based. They focused on informal learning spaces referred to as "Open Plan Study Environments" such as a library where students performed individual and group study activities.

Peer support has been shown to both encourage (Lee and Shute, 2010; Zain et al., 2012; Kiefer et al, 2015) and discourage (Harfitt, 2012) learning. The protagonists of constructive learning theory argue that collaboration between students and peers in the classroom enhances learning (Bada & Olusegun, 2015). Several studies previously discussed in chapter 8 have shown that peer support promotes engagement in the classroom and positively influences academic performance (Lee and Shute, 2010; Zain et al., 2012; Kiefer et al, 2015). However, the findings of the current study indicate that the opposite is also true. The HVs were subjected to peer pressure inhibiting their classroom learning. This finding aligns with those of Harfitt (2012), who noted the negative impact of peers in the classroom, the students felt discomfort and poor treatment from their peers when they made mistakes in the class. The current study highlights the importance of classroom management and the important of creating an environment where positive peer support can enhance learning.

After class

It was found that some older HVs were unable to retain information and reported differences in prior knowledge compared to younger participants. In addition, HVs highlighted a theory-practice gap, noting a lack of relevance of the classroom sessions to their real cases. They therefore felt unable to advise their patients.

This study emphasises that memory and existing knowledge levels impact on the HVs' learning outcomes. The effect of prior knowledge and memory on the learning can be explained by two learning theories: constructivism (Alanazi, 2016) and cognitive learning theory (Yilmaz, 2011). Both theories describe prior knowledge as the key role in the learning process. In constructivism learning theory, the learner constructs and reconstructs their knowledge, based on their prior knowledge (Alanazi, 2016). While in cognitive learning theory, the learner collects new information and then connects this information to their existing knowledge base (Yilmaz, 2011). The theories have been supported in previous real-world studies that have assessed the effect of prior knowledge on the learners' attitude to learning, behaviour, and learning performance (Song et al., 2016; Li, 2019). These studies found that learners who possessed high prior knowledge and a more positive attitude to learning, performed more successfully than those with low prior knowledge (Li, 2019). Moreover, Song et al (2016) conducted a study with medical students and found that their prior knowledge influenced the knowledge recall, comprehension and clinical reasoning. Song and colleagues (2016) also stated that those with high prior knowledge tended to have higher self-efficacy, value the learning task and seek satisfactory outcomes in learning compared with those with lower prior knowledge. In addition, Taub et al (2014), reported that learners with high prior knowledge dedicate significantly more time to engage with self-regulated learning than those with low prior knowledge. Based on these learning theories and previous studies it is indicated that, the difference in the HVs' prior knowledge about diabetes may have affected their learning and led to the difference in knowledge levels. This study's findings support the learning theories and previous studies, and further accommodate the importance of existing knowledge in learning among the HVs. It is necessary to assess the HVs' prior knowledge to find out the gap of knowledge and identify weaknesses before creating lessons.

In addition, as mentioned above, a theory-practice gap was found in the current study. The HVs could not always integrate the knowledge they learned from class with their practice. Therefore, they could not provide effective care for the diabetic patients in community. The theory-practice gap is not a unique issue for the HVs, and has been found in previous studies with healthcare professionals (Roshan Essani and Ali, 2011; Mahmoud, 2014; Bouchlaghem and Mansouri, 2018; Mahmudi, 2018; Safazadeh et al., 2018; Kerthu & Nuuyoma, 2019; Salifu et al., 2019; Lee and Sim, 2020).

The HVs within this study felt that the classroom teaching did not prepare them to work in the community. They have been taught only basic content which was not enough to perform effective care for diabetic patients. The HVs could not handle the more complex cases as they have not had the required training. This finding was highlighted in a study by Roshan Essani and Ali (2011), who stated that paediatric nurses in a tertiary care hospital in Pakistan perceived that they had a gap in their knowledge and practice as they had not been taught some topics in schools. They also expressed that they could not apply taught skills to patients across varying ages. Therefore, they could not provide effective care for their patients. Hence, the nurses were anxious about their performance as they could not educate the children and parents. The gap between college education and clinical practice was also shown in newly graduated nurses in South Korea (Lee and Sim, 2020). The nurses in a study by Lee and colleagues found that college education was not sufficient to transition the nurses to work in clinical practice. They learned only fundamental skills and some nurses could not apply what they learned in college to their practice. They also noted that some skills were taught on the ward that were not considered in the college. Recognising this gap between theory and practice, the authors recommended changing the teaching methods to use scenarios based on actual cases.

A lack of teaching and practice time in the classroom were highlighted in this study. According to the Health Department of Thailand (2008), the HVs were taught about hypertension and diabetes for approximately three hours in their first training programme. As mentioned in the previous chapter, the HVs in Thailand were lay persons who volunteer to work in the community. However, they were expected to attend monthly training sessions at the health centre. However, with multiple agendas and limited time, the HVs stated that they rarely obtained information about diabetes in the meetings because diabetes contents were not included in all monthly meeting agendas. Therefore, they learned about diabetes around 2-3 time a year. In Thailand, diabetes is not the core content of the initial course of the HVs, but diabetes was one part of the non-communicable disease content (Primary Health Care Division, 2007; The Health Department, 2008). Therefore, the practical time for diabetes training is quite short. In addition, as the training is lecture based, it was not sufficient to prepare the HVs for the real situations they experience in practice. This study's findings are in line with the study of Salifu et al. (2019). Nurses in poor resourced areas of Ghana perceived that the education programme did not support the learner's clinical practice (Salifu et al.,2019). The school lacked tools to demonstrate essential concepts and skills, it provided only theory. The nurses felt that the clinical practice activities demonstrated were routine and limited, and failed to generate interest. In addition, the time for clinical placement was limited as they practised in the hospital only once a week, thus it did not promote clinical learning. The nurses felt that school teaching promoted rote learning and did not encourage the nurse to develop their problem-solving skills. Limited-time in clinical practice was also highlighted as an issue for student nurses in a Namibian study (Kerthu and Nuuyoma, 2019).

The theory-practice gap results in limited practical knowledge which inhibits the learners' performance, this is exacerbated when it is accompanied by a lack of experience in clinical

practice. According to the experiential learning theory, a person develops their knowledge through experiences (Kolb, 1984, p. 38). This theory develops the learner's thinking and problem-solving skills (Akella, 2010; Krbec and Currie, 2010), hence, knowledge does not happen without experience. Based on ELT, the theory-practice gap may cause a lack of knowledge of the HVs, if the HVs have not had experience or have not been practising some skills in the classroom. They will have difficulty providing healthcare for the patients in the community. However, the theory-practice gap can be reduced by developing the curriculum, creating collaboration between the education faculty and nurses, and producing a standard clinical guideline (Shoghi et al., 2019). The nurse experts in a study by Shoghi and colleagues stated that the contents in the nursing curriculum should be adjusted and reformed adding clinical theory to the curriculum. In addition, an essential aspect of practice experiences should be discussed in the classroom when performing theoretical instruction. Furthermore, it is the responsibility of the education faculty and research centre to develop guidelines from available global guidelines and then include them in the academic curriculum. Roshan Essani and Ali (2011) recommended increasing clinical hours in the curriculum to enhance learning in the final year. Roshan Essani and colleagues also advise that the nursing school should collaborate with the nursing service to develop the curriculum. The nurses should be more educated about reality-based clinical aspects, and the educators should monitor and re-evaluate the curriculum to affirm that the essential skills and knowledge for practice were achieved. Importantly, the nurse students and new nurses should take responsibility to be adult learners. They should learn on their own by using available resources. In addition, the educator was reported as the key person to help the student overcome the theory-practice gap (El Hussein and Osuji, 2016). El Hussein and colleagues concluded that the educator should apply theory and construct learning activities to support the learners to link theory knowledge (the idea) to the real situation. A report by

Wall and colleagues (2014) showed the benefits of simulation in reducing the theory-practice gap in Australian undergraduate nurses, as simulation reinforces the student's critical thinking and self-reflection. This strategy also allows the students to practise clinical skills in controlled environments. From the findings and evidence, the implication is that the context curriculum about diabetes for HV's should be adjusted and based on real cases and practice. Essential experiences should be included in the classroom teaching. In addition, simulation should be applied in classroom teaching to prepare the HVs for community service. To bridge the gap, whilst the educator or curriculum developer should be involved in this process, the HVs should also take responsibility to learn on their own from available health information resources to enhance their knowledge and skills. However, this can only be achieved with appropriate motivation and value.

The difference between high and low knowledge

Motivation can be classified into intrinsic and extrinsic motivation (Legault, 2016). The HVs in this study received no extrinsic motivation and only those in the high knowledge groups were intrinsically motivated by the value of learning, while low knowledge groups received negative feedback and were not valued by the community, which may have acted to demotivate them.

Motivation to learn has been described in numerous theories including expectancy value theory, attribution theory, social cognitive theory, goal orientation theory and self-determination theory (Cook and Artino (2016). According to Cook and Artino (2016), 'motivation is a function of the expectation of the success and perceived value' in the expectancy value theory. While Weiner (1972) stated that motivation in future tasks was driven by attribution; high achievers had different motivation from low achievers. The success amongst high achievers was attributed to high ability and effort, whereas low

achievers believe that their failure was caused by a lack of ability (Weiner (1972). In addition, social cognitive theory explains that learning is the result of an interaction between personal, behavioural and environmental factors and self-efficacy, which drives motivation (Cook and Artino, 2016). Self-determination theory describes optimal performance as a result of intrinsic and extrinsic motivation (Cook and Artino, 2016). Finally, the goal orientation theory explains that the learner takes part in a task focused on goal mastery, which stimulates the learner's interest and deep learning (Cook and Artino, 2016).

The HVs with low knowledge lacked motivation as they felt learning didn't matter and was irrelevant to their role as in their view, patients had optimal knowledge and learned from the health professional. Indeed, they believed that the patients did not value the HVs' opinions. These findings indicate that the HVs with low knowledge viewed learning as futile and were helpless. Learned helplessness inhibits motivation and occurs as a result of the reinforcement process which is described in the attribution theory and motivation of Harvey and Martinko (2009). They argue that if people believe that effort is pointless, success and recognition in their job or their organization cannot be obtained. Harvey and Martinko also described the phrase "why bother trying?" as the consequence of expecting to fail, if people believe that their effort is going to fail, they do not need to try, hence they show a lack of interest and have little value for their work. People are motivated to repeat behaviour if this behaviour leads to a desired outcome, however, motivation will be lost if they do not achieve their desired outcome (Harvey and Martinko (2009).

Knowledge enhancement and gaining information updates were two motivating factors identified for HVs with high knowledge. To date, no study has explored the learning experiences of CHWs who possess different levels of diabetes knowledge. However, some recent studies have stated that CHWs with higher motivation levels were found to improve

their knowledge levels (Greenspan et al., 2013; Winn et al., 2018). There was evidence in Winn's study that a personal desire to help the community, gaining knowledge and experience, community appreciation and a monetary incentive were motivating factors to engage in a training programme for CHWs in Western Kenya. Whereas, being recognized and respected by the community, and to obtain financial support were vital motivators for community health workers living in Tanzania in Greenspan's study. In addition, according to Greenspan and colleagues, who used semi-structured interviews to elicit data, CHWs describe the training as a way of receiving essential information (gain knowledge) to function in their role and educate the community.

Knowledge of diabetes topics

Quantitative study: The vast majority of the HVs possessed adequate knowledge of diabetic complications including heart disease (N=351, 90%), foot complications (N=367, 94%), kidney disease (N=333, 85.38%) and diabetic retinopathy (N=382, 97.95%). However, the HVs lacked knowledge of many others aspects of diabetes. These include exercise (N=41, 10.51%), diabetic drugs (N=127, 32.56%), cholesterol (N=111, 28.46%) and glucose monitoring at home (N=165, 42.31%). These results suggest that their knowledge base and possibly their training programmes have focused more on the potential impact of diabetes rather than the prevention and management of the condition.

Qualitative study: To manage diabetes requires adequate staff and financial resources. Thailand is a middle-income country with a limited budget and a limited healthcare workforce. With these limitations, HVs have been introduced and were identified as the foundation stone of primary health care in Thailand for many decades. Management of diabetes is undertaken mostly in the community and HVs play a key role in prevention, detection and treatment of patients. Consequently, HVs receive formal training to function

in this role but our findings have demonstrated the HVs experience multiple learning barriers that impacts their role. These barriers limit the HVs from gaining the knowledge required to function effectively in their role. Subsequently, many HVs are not sufficiently knowledgeable to carry out this role and patients may be placed at risk.

Data integration: This mixed methods sequential design has enabled the researcher to provide greater insight into HVs' knowledge of diabetes whilst providing an explanation of why some HVs were knowledgeable and others less so.

Discussion: The findings of study-one indicate that the HVs lacked knowledge in several topics but possessed adequate knowledge of the complications of diabetes. Although study two showed that HVs were taught about diabetic diet, exercise, diabetic complications and diabetic medications, the sessions were considered too short and consequently they learned only basic content. They also viewed the topic of medication as complicated and beyond their role. In addition, the learning barriers that have been highlighted previously may impact on the HVs' ability to understand more complex concepts.

In Thailand, HVs are taught about diabetes prevention, management and complications in their initial training (Primary Health Care Division, 2007; The Health Department, 2008). In addition, follow-up training is delivered and covers topics such as diabetes (Department of Health Service and Support, 2013). The content is created by the Primary Health Care Division, Ministry of Public Health and includes general knowledge about diabetes, risk factors, basic screening, symptoms, complications, diabetes prevention, diet, exercise and foot care (Primary Health Care Division, 2012).

Once the HVs receive their training, they can also access a digital copy of the content (Department of Health Service Support, 2021). Access to online resources is seen as a means of supplementing fundamental training with availability of numerous health resources such

as, the mobile app, DoctorMe, the Thai CV risk score (Department of Health Service Support, 2021), the HVs can communicate with their supervisor, share pictures and ask for a recommendation from their supervisor via apps (Ministry of Public Health, 2021). The HVs can learn either by attending a workshop or follow a step-by-step online guideline (Ministry of Public Health, 2021). Currently, according to the website Or Sor Mor. Com, around 300,000 HVs in Thailand registered to use the SMART Or Sor Mor mobile application, nevertheless, only a few HVs in the current study were registered to use this resource (Department of Health Service Support, 2021). Benefits of using Mobile Health (mHealth) have been reported in previous studies (Lemay et al., 2012; Surka et al., 2014), Use of mHealth amongst the CHWs worldwide were reviewed by Early et al (2019) who found that there were several countries, including developed and developing countries, that employed mHealth in their CHWs' projects because mHealth had numerous benefits such as it is inexpensive, can be used with and without a broadband connection, it can be accessed in various areas and increases the self-efficacy of the CHWs. However, the limitations of using mHealth were also presented, noting that it relies on some technical knowledge and access to cell phone technology (Early et al., 2019). Moreover, most mHealth apps were not culturally relevant to some parts of the globe (Early et al., 2019). For example, in India, the study by Ilozumba et al (2018) found that the Mobile for Mother (MfM) mHealth app influenced the maternal literacy, however, this app was developed for regular use, it fails to overcome the Indian cultural context including the Indian social class system.

9.3 Conclusion

HVs within this study lacked knowledge of diabetes, with only one third achieving a suitable knowledge score. This suboptimal knowledge of diabetes occurred for numerous reasons, many of which are interlinked. An inability to attend training sessions as a consequence of

additional commitments, linked with a poor learning experience will no doubt have contributed to the poor knowledge levels. However, the HVs placed little value on the training, which when combined with inadequate financial reward and a perception of a restricted role resulted in limited educational development.

The current findings indicate that, although, there are several resources available for HVs who wish to learn about diabetes, classroom training continues to be the predominant mode of delivery. HVs in Thailand lack access to online resources. Those HVs who were able to attend class-based training possessed higher knowledge levels compared to those whose attendance was limited.

However, classroom-based sessions were not without their problems. HVs experienced several learning barriers as a consequence of large student numbers, such as interruptions, loss of attention due to noisy classes, unfavourable current teaching strategy, peer pressure, and limited physical function. In addition, personal memory, prior knowledge and the gap between the training and the real-world practice inhibited the HVs from learning effectively. Nevertheless, those with high knowledge were likely to be motivated whereas those with low knowledge levels were less motivated, highlighting the need to consider additional ways of motivating this workforce.

Chapter 10 Recommendation and Conclusion

10.1 Introduction

This final chapter will summarise the findings and outlines how these findings provide a contribution to the research literature. The study limitations and future recommendations will also be considered.

10.2 Thesis conclusion

This research aimed to assess the HVs' knowledge of diabetes, using the HVs diabetic-knowledge questionnaire and to explore their learning journey to provide insight into the barriers and facilitators to learning. Based on a mixed method approach, it can be concluded that HVs knowledge regarding diabetes is limited in some areas and should be enhanced to enable them to fulfil the requirements of their role. However, several barriers exist that impede learning. These barriers include doubting the value of the training, physical and psychological barriers, time constraints and classroom limitations.

It is essential that these barriers are reduced to ensure that those wishing to develop their knowledge can fulfil their true potential. Reduced intrinsic and extrinsic motivation included monetary and nonmonetary incentives. Volunteers are likely to be not paid. Although the HVs can claim compensation this may not be enough to cover the cost of living. In addition, not all HVs were valued by the community which could impact their desire to learn.

To our knowledge, this is the first study to explore the learning experience of HVs caring for people with diabetes in Thailand. Previous literature suggested that HVs in Thailand were knowledgeable about diabetes, especially blood sugar tests. However, in the first study within this thesis it was demonstrated that while the HVs possessed good knowledge of diabetic complications their knowledge was suboptimal in several other topics (e.g.exercise,

diabetic drugs, cholesterol and glucose monitoring at home). The findings are worrisome because the literature suggests that diabetic patients also lack knowledge in these same areas. Although, previous studies have reported that HVs knowledge of diabetes increased post training, these studies have been undertaken with a select group of staff who were party to a defined intervention. This thesis has provided evidence of the current real-world knowledge of HVs, and through qualitative exploration has provided greater insight into how this learning was acquired.

Our study two found that organised classroom-based training was the primary source of learning for the HVs. Absence from training is likely to contribute to poor knowledge levels and yet due to means of education for those HVs who experience difficulties in balancing their time.

In addition, we also highlight the influence of motivation on the HVs' learning. Monetary and non-monetary incentives may be useful as a motivation for HVs to learn about diabetes, financial reward may be especially welcome for those with low family income. This study added evidence from the literature that although volunteering is likely to be an unpaid job, the incentive is important and necessary for motivating the Thai HVs' engagement in the training and maintaining cooperation. These findings align with the principles of behaviour learning theory where reinforcement is seen to influence the learner's motivation and may be a key driver in supporting a volunteer workforce. Our findings illustrate the role that the HVs' prior knowledge plays in their learning. Constructive and Cognitive Learning theory argue that learners create new knowledge by linking new information to their prior knowledge. Hence, the learner's prior knowledge should be taken into consideration, before creating a teaching session. Whilst, this may be problematic, given the large numbers of students and different knowledge levels, it may be possible to divide HVs based on previous

knowledge. The training sessions could then be delivered at a level that is suitable for their learning.

The findings from study-two also highlight the importance of memory in recalling information. The HVs perceived that poor memory may be caused by ageing, which is partially supported by the literature. However, learning should go beyond simple recall and should provide the HVs with a deep understanding rather than superficial recollection.

In addition to personal barriers, the classroom was identified as a learning barrier. The previous study reported that although the HVs attend the formal training, they have inadequate knowledge, however, it does not detail or find out why the HVs had insufficient knowledge once taking part in the formal training. This study document and provide evident support regarding the training context as well as the classroom organisation and class atmosphere which were believed as the HVs' learning barriers. Learning in large volumes in a noisy classroom distracted the HVs, making learning more difficult. Moreover, the HVs described peer discouragement. Pressure from peers resulted in limited opportunities for discussions and deeper learning. The HVs described how they were afraid of asking for further information during class for fear of reprisals from other HVs. These findings highlight the need for greater classroom organisation and positive peer support. Finally, the study revealed that the limited length of training and repetition of topics negatively affected the HVs ability to develop. The HVs' diabetes knowledge was focussed on complications resulting in large knowledge gaps in other important areas of diabetes care.

This thesis has added further evidence that providing regular training is essential and beneficial for the HVs in Thailand as it enhances the HVs knowledge of diabetes, as this finding highlights the need to develop a more formal training programme that is sufficiently extensive to enable the HVs to cover a wide range of topics in genuine detail.

This thesis provided further evidence that the HVs perceive training as optional, they prioritise the paid job first. In addition, the HVs could not attend the training due to time constraints from family responsibilities. This highlights the limitation and challenges to the sustainability of employing volunteers to work in the healthcare system, particularly in chronic diseases which require continuous care. During this study, there were several studies published and recommended developing and providing the training course for the HVs to increase the HVs knowledge and performance. However, it was not universal as some study stated that the increase in trainings and filling the report were not preferred by the HVs, as it reduced their flexibility. Therefore, the take-home message from this thesis is although afford have been paid for developing the training course, it will be valueless if it is not created based on the volunteering context. Therefore, this study support that the learning course should be flexible for the HVs. In addition, it is needed for the healthcare personnel to monitor the HVs learning outcome and performance regularly.

This thesis also adds evidence regarding learning theory which is essential for curriculum design. Learning theory allows the teacher to better understand how the learner learns, enabling them to develop learning strategies which are suitable for the learners.

Based on this study's findings, we report that learning may be influenced by a combination of the four major learning theories including constructivism, cognitive learning, behaviorist learning and adult learning theory.

Knowledge levels may be partially influenced by prior knowledge and experience of diabetes care, a factor relevant to adult learning, cognitive learning and constructivism learning theory where existing knowledge plays a key role in the learning process. This study's findings not only add new information about the current knowledge base of the HVs regarding diabetes, it also adds evidence that existing knowledge is essential for learning

and achievement, as it affects knowledge acquisition and application for problem-solving. In addition, our reservoir of experience and knowledge provides a foundation upon which we build. Whilst the lay HVs within this study came from different backgrounds, most of them had lower educational levels. It is therefore necessary to build a curriculum that meets these needs and enables deep learning and understanding. Surface or rote learning is based on memorization and can lead to a knowledge deficit where memory is impaired or not used frequently. The HVs report that poor memory causes a lack of knowledge about diabetes which suggests the latter approach may have been adopted.

In constructivist learning theory, the student learns better through collaboration and problem-solving. Lack of participation in the classroom may limit learning. This lack of engagement and failure to focus on learning due to classroom noise and peer pressure may negatively impact the HVs ability to learn. However, learning does not just happen in the classroom, learning experiences outside of the classroom are also important, especially within a practice-based role. Consequently, the group of highly knowledgeable volunteers sought outside resources to enhance their learning.

This thesis also adds evidence that reinforcement and reward influences the learner's motivation to take part in certain behaviours. Financial and family commitments limited some HVs ability to attend regular training sessions. This is not unreasonable given the voluntary nature of the role. In addition, the value placed on the training, the perceptions of the role by the |HV and others, and the poor learning environment also negatively affected the learner's willingness to attend the training sessions. Increased financial reward, improved learning provision and flexibility, and increased esteem may improve the motivation to learn. In this study, the HVs whose experience was not valued by the community were demotivated to learn and perceived that learning was not important to their role.

No single learning theory can be used to underpin and explain the HVs' learning and their knowledge deficit. This thesis provides evidence that the HVs learning is influenced by several factors such as physical condition, ageing, personal motivation, work benefits, prior knowledge and experiences, and available time. In addition, female HVs prioritized their family and work role over education. Consequently, they missed the training classes. Despite these factors, many health visitors were motivated to learn, building on their previous experiences and more research should be undertaken to better understand this positive deviance.

As above, this thesis has not only provided statistical evidence that supports the previous literature regarding the areas of diabetes care where HVs have ample knowledge, but our findings highlight important deficiencies that have not been studied by others. Identifying areas of limited knowledge and the learning barriers should underpin future training strategies. However, there were some limitations that are reported below

10.3 Study limitations

Although the study has enabled greater insight into both the knowledge levels and the learning journeys of HVs caring for people with diabetes in Thailand, some limitations are acknowledged. Firstly, the study was limited to one province of Thailand, Bangkok. This province was chosen due to its high prevalence of diabetes and its varying topography, including Inner City, Urban Fringe and Suburban areas. However, we accept that our findings may differ if the study was to be repeated in rural areas of Thailand.

The second limitation was the data collection method used to measure HVs' knowledge of diabetes in study one (quantitative study). Participants were asked to complete a self-administered questionnaire. Whilst this method was chosen to gain a large volume of data from a large number of respondents, there is a possibility that participants could have

searched for answers using resources, such as textbooks or the internet. This could affect the validity of the results. To avoid this issue, the HVs should complete the questionnaire within a controlled environment.

Thirdly, although the study provides evidence that the HVs were unable to access the training due to family commitments and time constraints, almost all the participants were women. The role of women in the family in Thailand may have affected the study results.

Fourthly, although this study provided additional evidence regarding the HVs' knowledge, it also raises the question of the relationship between knowledge and practice. As mentioned previously, knowledge is fundamental to deciding or solving problems in any situation. Therefore, adequate knowledge may support appropriate judgment. However, this study did not test the relationship between knowledge and practice. It highlights the importance of the further study to explore more.

Finally, the study has been impacted by the global pandemic of 2020-21. Whilst this did not influence the study design or data collection, analysis and dissemination have been negatively affected. The researcher would have welcomed an opportunity to present the findings of this study to the participant groups and to an academic community where feedback could have stimulated further discussion and debate.

10.4 Recommendations

This is the first study to address the diabetes knowledge and learning experience of Thai HVs. HVs play a significant role in caring for diabetic patients in the community in Thailand and many other countries across Asia. Consequently, it is important that they possess sufficient knowledge to function in this role and help the patient to minimise future illness. Consequently, research studies with larger sample sizes covering wider geographical areas should now be considered. Moreover, studies that include multiple data collection tools such

as classroom observations, combined with controlled knowledge tests may provide an alternative account of HVs' knowledge levels and an increased understanding of the HVs' learning experience. The translation and cross-cultural adaptation of the knowledge tool undertaken within this study provides a valid and reliable tool from which the data can be generated when assessing knowledge levels.

Furthermore, it would be helpful to explore the nurse trainers' perceptions of the different teaching strategies that they employ and their understanding of the HVs' learning needs. The findings from my interviews indicate that large class sizes inhibit the HVs' learning. Therefore, a study comparing the outcomes of small versus large class sizes would provide further insight into the impact of the classroom size on the HVs' achievement.

Finally, the findings of this study indicate that the HVs' prior knowledge affected their learning. Therefore, it is essential to assess prior knowledge before starting a new topic and educational provision is built on this knowledge base. Whilst currently online learning is not widespread within Thailand, internet access is destined to improve over the coming years and this approach may enable a more bespoke training programme for small groups of HVs thus ensuring that their limited time is focused on meaningful learning and a more knowledgeable workforce is produced.

References

A'Bear, D. (2014). Supporting the learning of children with chronic illness. *The Canadian Journal of Action Research*, 15(1), pp. 22-39.

Acharya, A.S., Prakash, A., Saxena, P. and Nigam, A. (2013). Sampling: Why and how of it. Indian *Journal of Medical Specialties*, 4(2), pp.330-333.

Adhabi, E. and Anozie, C. B. (2017). Literature review for the type of interview in qualitative research. *International Journal of Education*, 9(3), pp. 86-97.

Adhikary, M., Chellaiyan, V. G., Chowdhury, R., Daral, S., Taneja, N. and Das, T. K. (2017). Association of risk factors of type 2 diabetes mellitus and fasting blood glucose levels among residents of rural area of Delhi: a cross sectional study. *International Journal of Community Medicine and Public Health*, 4(4), pp.1005-1010.

Adibe, M.O., Aguwa, C.N. and Ukwe, C.V. (2011). The construct validity of an instrument for measuring type 2 diabetes self-care knowledge in Nigeria. *Tropical Journal of Pharmaceutical Research*, 10(5), pp.619-629.

Aekplakorn, W., Chariyalertsak, S., Kessomboon, P., Assanangkornchai, S., Taneepanichskul, S. and Putwatana, P. (2018). Prevalence of diabetes and relationship with socioeconomic status in the Thai population: National Health Examination Survey, 2004–2014. *Journal of diabetes research*, 2018.

Afroz, A., Ali, L., Karim, M., Alramadan, M.J., Alam, K., Magliano, D.J. and Billah, B. (2019). Glycaemic control for people with type 2 diabetes mellitus in Bangladesh-an urgent need for optimization of management plan. *Scientific reports*, 9(1), pp.1-10.

Agustina, R., Dartanto, T., Sitompul, R., Susiloretni, K.A., Achadi, E.L., Taher, A., Wirawan, F., Sungkar, S., Sudarmono, P., Shankar, A.H. and Thabrany, H. (2019). Universal

health coverage in Indonesia: concept, progress, and challenges. *The Lancet*, 393(10166), pp.75-102.

Ahasan, H.N., Islam, M.Z., Alam, M.B., Miah, M.T., Nur, Z., Mohammed, F.R., Khan, M.A.I., Hossain, H.T. and Mahbub, M.S. (2011). Prevalence and risk factors of type 2 diabetes mellitus among Secretariat employees of Bangladesh. *Journal of Medicine*, 12(2), pp.125-130.

Ahmad, K. (2014). Insulin sources and types: a review of insulin in terms of its mode on diabetes mellitus. *Journal of Traditional Chinese Medicine*, 34(2), pp. 234-237.

Ahmad, M. S., Fakhr, Z. and Ahmed, J. (2011). Working women work-life conflict. *Business strategy series.*

Ahmed, A., Jabbar, A., Zuberi, L., Islam, M. and Shamim, K. (2012). Diabetes related knowledge among residents and nurses: a multicenter study in Karachi, Pakistan. *BioMed central Endocrine Disorders*, 12(1), p. 18.

Ahmedani, M. Y., Hashmi, B. Z. and Ulhaque, M. S. (2016). Ramadan and diabetes-knowledge, attitude and practices of general practitioners; a cross-sectional study. *Pakistan journal of medical sciences*, 32(4), p. 846.

Aithal, A. and Jha, A. (2017). Task shifting: a need for current health care system. *Saudi Journal of Medicine and Pharmaceutics*, ISSN, pp.2413-4910.

Ajani, K. and Moez, S. (2011). Gap between knowledge and practice in nursing. *Procedia-Social and Behavioral Sciences*, 15, pp. 3927-3931.

Akella, D. (2010). Learning together: Kolb's experiential theory and its application. *Journal of Management & Organization*, 16(1), pp. 100-112.

Akpınar, B., Küçükgüçlü, Ö. and Yener, G. (2011). Effects of gender on burden among caregivers of Alzheimer's patients. *Journal of nursing scholarship*, 43(3), pp.248-254.

Al-Ababneh, M.M. (2020). Linking ontology, epistemology and research methodology. *Science & Philosophy*, 8(1), pp.75-91.

Al-Adsani, A.M.S., Moussa, M.A.A., Al-Jasem, L.I., Abdella, N.A. and Al-Hamad, N.M. (2009). The level and determinants of diabetes knowledge in Kuwaiti adults with type 2 diabetes. *Diabetes & metabolism*, 35(2), pp.121-128.

Al-Amer, R., Ramjan, L., Glew, P., Darwish, M. and Salamonson, Y. (2015). Translation of interviews from a source language to a target language: Examining issues in cross-cultural health care research. *Journal of Clinical Nursing*, 24(9-10), pp.1151-1162.

Alam, K., Tasneem, S. and Oliveras, E. (2012). Performance of female volunteer community health workers in Dhaka urban slums. *Social science & medicine*, 75(3), pp. 511-515.

Al-Amer, R., Ramjan, L., Glew, P., Darwish, M. and Salamonson, Y. (2015). Translation of interviews from a source language to a target language: Examining issues in cross-cultural health care research. *Journal of Clinical Nursing*, 24(9-10), pp. 1151-1162.

Alanazi, A. (2016). A critical review of constructivist theory and the emergence of constructionism. *American Research Journal of Humanities and Social Sciences,* (2), pp. 1-8.

Al Awaisi, H., Cooke, H. and Pryjmachuk, S. (2015). The experiences of newly graduated nurses during their first year of practice in the Sultanate of Oman–A case study. *International journal of nursing studies*, 52(11), pp. 1723-1734.

Alhaiti, A. H., Alotaibi, A. R., Jones, L. K., DaCosta, C. and Lenon, G. B. (2016). Psychometric evaluation of the revised michigan diabetes knowledge test (V. 2016) in Arabic: translation and validation. *Journal of diabetes research*, *2016*.

Alharahsheh, H.H. and Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. Global Academic *Journal of Humanities and Social Sciences*, 2(3), pp.39-43.

Aliakbari, F., Parvin, N., Heidari, M. and Haghani, F. (2015). Learning theories application in nursing education. *Journal of education and health promotion*, 4.

Alkatheri, A.M. and Albekairy, A.M. (2013). Does the patients' educational level and previous counseling affect their medication knowledge?. *Annals of thoracic medicine*, 8(2), p.105.

Al Khalifah, R. A., Alnhdi, A., Alghar, H., Alanazi, M. and Florez, I. D. (2017). The effect of adding metformin to insulin therapy for type 1 diabetes mellitus children: a systematic review and meta-analysis. *Pediatric diabetes*, 18(7), pp. 664-673.

Al-Mahrooqi, B., Al-Hadhrami, R., Al-Amri, A., Al-Tamimi, S., Al-Shidhani, A., Al-Lawati, H., Al-Ismaili, A., Al-Hooti, K. and Al-Ghafri, T. (2013). Self-reported knowledge of diabetes among high school students in Al-Amerat and Quriyat, Muscat Governate, Oman. *Sultan Qaboos University Medical Journal*, 13(3), p.392.

Almalki, S. (2016). Integrating Quantitative and Qualitative Data in Mixed Methods Research--Challenges and Benefits. *Journal of education and learning*, 5(3), pp. 288-296.

Almalki, T. M., Almalki, N. R., Balbaid, K. and Alswat, K. (2018). Assessment of diabetes knowledge using the Michigan brief diabetes knowledge test among patients with type 2 diabetes mellitus. *Journal of Endocrinology and Metabolism*, 7(6), pp. 185-189.

Al-Maskari, F., El-Sadig, M., Al-Kaabi, J. M., Afandi, B., Nagelkerke, N. and Yeatts, K. B. (2013). Knowledge, attitude and practices of diabetic patients in the United Arab Emirates. *Public Library of Science One*, 8(1), e52857.

Almeida, F. (2018). Strategies to perform a mixed methods study. *European Journal of Education Studies*.

Alotaibi, A., Gholizadeh, L., Al-Ganmi, A. and Perry, L. (2017). Examining perceived and actual diabetes knowledge among nurses working in a tertiary hospital. *Applied nursing research*, 35, pp.24-29.

Al-Qazaz, H.K., Sulaiman, S.A., Hassali, M.A., Shafie, A.A., Sundram, S., Al-Nuri, R. and Saleem, F. (2011). Diabetes knowledge, medication adherence and glycemic control among patients with type 2 diabetes. *International journal of clinical pharmacy*, 33(6), pp.1028-1035.

Al-Qazaz, H. K., Hassali, M. A., Shafie, A. A., Sulaiman, S. A. S. and Sundram, S. (2011). Perception and knowledge of patients with type 2 diabetes in Malaysia about their disease and medication: A qualitative study. *Research in Social and Administrative Pharmacy*, 7(2), pp.180-191

Al Riyami, T. (2015). Main approaches to educational research. *International Journal of Innovation and Research in Educational Sciences*, 2(5), pp. 412-416.

Al-Rubeaan, K., Al Derwish, M., Ouizi, S., Youssef, A. M., Subhani, S. N., Ibrahim, H. M. and Alamri, B. N. (2015). Diabetic foot complications and their risk factors from a large retrospective cohort study. *PloS one*, 10(5), e0124446.

Al-Saadi, H. (2014). Demystifying Ontology and Epistemology in research methods. *Research gate*, 1(1), pp.1-10

Alsaawi, A. (2014). A critical review of qualitative interviews. *European Journal of Business and Social Sciences*, 3(4).

Al-Sarihin, K., Bani-Khaled, M., Haddad, F. and Althwabia, I. (2012). Diabetes knowledge among patients with diabetes mellitus at King Hussein Hospital. *Journal of Research in Medical Sciences*, 19(1), pp. 72-77.

Alshenqeeti, H. (2014). Interviewing as a data collection method: A critical review. *English Linguistics Research*, 3(1), p.39.

Altheide, D. L., and Johnson, J. M. (1994). *Criteria for assessing interpretive validity in qualitative research*. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (pp. 485–499). Sage Publications, Inc.

Amare, Y. (2009). Non-financial incentives for voluntary community health workers: a qualitative study. *Addis Ababa Ethiopia JSI Research and Training Institute Last Ten Kilometers Project [L10K], 2009.*

American Diabetes Association. (2019). *Diabetes symptoms*. [online] Available at: https://www.diabetes.org/diabetes/type-1/symptoms [Accessed: 2nd May 2020]

American Diabetes Association. (2019). Standards of medical care in diabetes—2019. *Diabetes care*, Vol 42, Supplement 1. [online] Available at: https://care.diabetesjournals.org/content/42/Supplement_1 [Accessed: 2nd March 2019]

Amin, M. E. and Chewning, B. (2014). Community pharmacists' knowledge of diabetes management during Ramadan in Egypt. *International journal of clinical pharmacy*, 36(6), pp. 1213-1221.

Amour, A.A., Chamba, N., Kayandabila, J., Lyaruu, I.A., Marieke, D., Shao, E.R. and Howlett, W. (2019). Prevalence, Patterns, and Factors Associated with Peripheral

Neuropathies among Diabetic Patients at Tertiary Hospital in the Kilimanjaro Region: Descriptive Cross-Sectional Study from North-Eastern Tanzania. *International Journal of Endocrinology, 2019*.

Amsalu, E. T., Messele, T. A. and Adane, M. (2021). Exploring the effect of professional experience on knowledge towards geriatric care among nurses working in adult care units. *BMC geriatrics*, 21(1), pp.1-9.

Andersen, S.T., Witte, D.R., Dalsgaard, E.M., Andersen, H., Nawroth, P., Fleming, T., Jensen, T.M., Finnerup, N.B., Jensen, T.S., Lauritzen, T. and Feldman, E.L. (2018). Risk factors for incident diabetic polyneuropathy in a cohort with screen-detected type 2 diabetes followed for 13 years: ADDITION-Denmark. *Diabetes Care*, 41(5), pp.1068-1075.

Anderson, R.M., Fitzgerald, J.T. and Oh, M. (1993). The relationship between diabetes-related attitudes and patients' self-reported adherence. *The Diabetes Educator*, 19(4), pp.287-292.

Andrew, S. and Halcomb, E. (Eds.). (2009). *Mixed methods research for nursing and the health sciences.* Wiley-Blackwell Pub.

Angermann, A. and Sittermann, B. (2010)**.** Volunteering in the European Union-An Overview. *Observatory for Sociopolitical Developments in Europe*, 2**,** p**.**18**.**

Antwi, S. K. and Hamza, K. (2015). Qualitative and quantitative research paradigms in business research: A philosophical reflection. *European journal of business and management*, 7(3), pp. 217-225.

Anunta, P., and J. Tonganake. (2010). The effectiveness of home visit and training program in village health volunteers in Khwao, Selaphum, RoiEt. *Journal of the office of DPC **6** Khonkaen*, 20**(**1**)**, pp.1-8.

Anyan, F. (2013). The influence of power shifts in data collection and analysis stages: a focus on qualitative research interview. *Qualitative Report*, 18, p. 36.

Apidechkul, T. (2018). Prevalence and factors associated with type 2 diabetes mellitus and hypertension among the hill tribe elderly populations in northern Thailand. *BMC public health*, 18(1), pp.1-17.

Aravinda, J. (2019). Risk factors in patients with type 2 diabetes in Bengaluru: A retrospective study. *World Journal of Diabetes*, 10(4), p. 241.

Ardeňa, G. J. R. A., Paz-Pacheco, E., Jimeno, C. A., Lantion-Ang, F. L., Paterno, E. and Juban, N. (2010). Knowledge, attitudes and practices of persons with type 2 diabetes in a rural community: phase I of the community-based Diabetes Self-Management Education (DSME) Program in San Juan, Batangas, Philippines. *Diabetes Research and Clinical Practice*, 90(2), pp.160-166.

Aregbeshola, B. S. (2018). A Tax-based, Noncontributory, Health-Financing System Can Accelerate Progress toward Universal Health Coverage in Nigeria. *MEDICC review*, 20, pp. 40-45.

Argaw Z, Tamiru S, Ayalew Y and Habte T. (2019). Knowledge and Attitude towards Care of Elder Patients and Associated Factors among Nurses Working in Government Hospitals in Addis Ababa, Ethiopia. *International Journal of Scientific and Engineering Research*, 9(12), pp.1-14.

Ärnlöv, J., Sundström, J., Ingelsson, E. and Lind, L. (2011). Impact of BMI and the metabolic syndrome on the risk of diabetes in middle-aged men. *Diabetes care*, 34(1), pp. 61-65.

Arora, S., Marzec, K., Gates, C. and Menchine, M. (2011). Diabetes knowledge in predominantly Latino patients and family caregivers in an urban emergency department. *Ethnicity & disease*, 21(1), pp. 1-6.

Arpanantikul, M. (2018). Women's perspectives on home-based care for family members with chronic illness: An Interpretive phenomenology study. *Nursing & Health Sciences*, 20(4), pp.494-501.

Arugu, G.M. and Maduka, O. (2017). Risk factors for diabetes mellitus among adult residents of a rural District in Southern Nigeria: Implications for prevention and control. *Nigerian journal of clinical practice*, 20(12), pp.1544-1549.

Asghar, J. (2013). Critical Paradigm: A preamble for novice researchers. *Life Science Journal*, 10(4), pp.3121-3127.

Ashur, S.T., Shah, S.A., Bosseri, S., Fah, T.S. and Shamsuddin, K. (2016). Glycaemic control status among type 2 diabetic patients and the role of their diabetes coping behaviours: a clinic-based study in Tripoli, Libya. *Libyan Journal of Medicine*, 11(1).

Asmelash, D., Abdu, N., Tefera, S., Baynes, H. W. and Derbew, C. (2019). Knowledge, attitude, and practice towards glycemic control and its associated factors among diabetes mellitus patients. *Journal of diabetes research, 2019.*

Assonov, D. O. and Bozhuk, B. S. (2017). Role of the hippocampus in memory functioning: modern view. *Запорожский медицинский журнал*, 19(6), pp. 833-838.

Atan, J.B., Raghavan, S. and Mahmood, N.H.N. (2015). Impact of training on employees' job performance: A case study of Malaysian small medium enterprise. *Review of Knowledge Management*, 5(1/2), p.40.

Australia, V. **(**2005)**.** *Definitions and principles of volunteering*. Melbourne: Volunteering Australia.[online]Available at: https://skillsalliance.com.au/wp-content/uploads/import_files/8d-volunteers-and-staffing-some-uploaded-to-web/definitions-and-principles-of-volunteering.pdf. [Accessed at: 3rd January 2022].

Ayhan, H. Ö. and Işiksal, S. (2005). Memory recall errors in retrospective surveys: A reverse record check study. *Quality and Quantity*, 38(5), pp. 475-493.

Aynalem, S. B. and Zeleke, A. J. (2018). Prevalence of diabetes mellitus and its risk factors among individuals aged 15 years and above in Mizan-Aman town, Southwest Ethiopia, 2016: a cross sectional study. *International journal of endocrinology*, *2018.*

Babbie, E. and Mouton, J. (1998). *The practice of social science research*. Cape Town: Oxford University Press.

Bada, S. O. and Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education*, 5(6), pp. 66-70.

Bagweneza, V., Musabirema, P., Mwiseneza, M. J., Collins, A. and Bhengu, B. R. (2019). Diabetes health education: nurses' knowledge of essential components at a Rwandan hospital. *Rwanda Journal of Medicine and Health Sciences*, 2(2), pp. 172-177.

Bahanshal, D. A. (2013). The Effect of Large Classes on English Teaching and Learning in Saudi Secondary Schools. *English Language Teaching*, 6(11), pp. 49-59.

Bala, P., Kaur, T. and Kaur, M. (2017). Study on effectiveness of lecture and smart class method of teaching on academic achievements among upper primary school students. *International Letters of Social and Humanistic Sciences*, 76, pp.25-29.

Baraz, S., Zarea, K., Shahbazian, H. B. and Latifi, S. M. (2014). Comparison of the accuracy of monofilament testing at various points of feet in peripheral diabetic neuropathy screening. *Journal of Diabetes & Metabolic Disorders*, 13(1), p. 19.

Bartsch, T. and Wulff, P. (2015). *The hippocampus in aging and disease: from plasticity to vulnerability.*

Beck, R.W., Riddlesworth, T., Ruedy, K., Ahmann, A., Bergenstal, R., Haller, S., Kollman, C., Kruger, D., McGill, J.B., Polonsky, W. and Toschi, E. (2017). Effect of continuous glucose monitoring on glycemic control in adults with type 1 diabetes using insulin injections: the DIAMOND randomized clinical trial. *Jama*, 317(4), pp.371-378.

Beliard, R., Muzykovsky, K., Vincent III, W., Shah, B. and Davanos, E. (2016). Perceptions, barriers, and knowledge of inpatient glycemic control: a survey of health care workers. *Journal of pharmacy practice*, 29(4), pp. 348-354.

Benayoun, B.A., Pollina, E.A. and Brunet, A. (2015). Epigenetic regulation of ageing: linking environmental inputs to genomic stability. *Nature reviews Molecular cell biology*, 16(10), pp.593-610.

Bergenstal, R.M., Tamborlane, W.V., Ahmann, A., Buse, J.B., Dailey, G., Davis, S.N., Joyce, C., Peoples, T., Perkins, B.A., Welsh, J.B. and Willi, S.M. (2010). Effectiveness of sensor-augmented insulin-pump therapy in type 1 diabetes. *New England Journal of Medicine*, 363(4), pp.311-320.

Bernard, R. O. (2019). Nurse educators teaching through the lens of transformative learning theory. *Journal of Nursing Education*, 58(4), pp. 225-228.

Beshyah, S. A., Farooqi, M. H., Farghaly, M., Abusnana, S., Al Kaabi, J. M. and Benbarka, M. M. (2017). Management of Diabetes during Ramadan Fasting: A Comprehensive Survey

of Physicians' Knowledge, Attitudes and Practices. *Ibnosina Journal of Medicine and Biomedical Sciences*, 9(2), pp. 28-36.

Bennett, S., George, A., Rodriguez, D., Shearer, J., Diallo, B., Konate, M., Dalglish, S., Juma, P., Namakhoma, I., Banda, H. and Chilundo, B. (2014). Policy challenges facing integrated community case management in S ub-S aharan A frica. Tropical Medicine & International Health, 19(7), pp.872-882.

Bettio, L.E., Rajendran, L. and Gil-Mohapel, J (2017). The effects of aging in the hippocampus and cognitive decline. *Neuroscience & Biobehavioral Reviews*, 79, pp.66-86.

Bhang, S.Y., Yoon, J., Sung, J., Yoo, C., Sim, C., Lee, C., Lee, J. and Lee, J., (2018). Comparing attention and cognitive function in school children across noise conditions: A quasi-experimental study. *Psychiatry investigation*, 15(6), p.620.

Bhupathiraju, S. N., Pan, A., Malik, V. S., Manson, J. E., Willett, W. C., van Dam, R. M. and Hu, F. B. (2013). Caffeinated and caffeine-free beverages and risk of type 2 diabetes. *The American journal of clinical nutrition*, 97(1), pp. 155-166.

Biasin, C. (2018). Transformative Learning: Evolutions of the adult learning theory. *Phronesis*, 7(3), pp.5-17.

Biesman-Simons, T., Conradie, W.S., Nejthardt, M., Roodt, F., Davids, J., Pretorius, T., Davies, G., Cloete, E., Fullerton, Z., Roos, J. and Flint, M. (2019). A multicentre prospective observational study of the prevalence and glycaemic control of diabetes mellitus in adult non-cardiac elective surgical patients in hospitals in Western Cape Province, South Africa. *South African Medical Journal*, 109(10), pp.801-806.

Block, E. S. and Erskine, L. (2012). Interviewing by telephone: Specific considerations, opportunities, and challenges. *International journal of qualitative methods*, 11(4), pp. 428-445.

Bloom, B.S., Hastings, J.T., and Madaus, G.F. (1971). *Handbook on formative and summative evaluation of student learning*. New York: MacGraw-Hill.

Bloom, D.E., Khoury, A. and Subbaraman, R. (2018). The promise and peril of universal health care. *Science, 361*(6404).

Bogner, K. and Landrock, U. (2016). *Response biases in standardised surveys*. GESIS survey guidelines.

Bolarinwa, O. A. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Nigerian Postgraduate Medical Journal*, 22(4), p. 195.

Bolderston, A. (2012). Conducting a research interview. *Journal of Medical Imaging and Radiation Sciences*, 43(1), pp. 66-76.

Bonds, D.E., Miller, M.E., Bergenstal, R.M., Buse, J.B., Byington, R.P., Cutler, J.A., Dudl, R.J., Ismail-Beigi, F., Kimel, A.R., Hoogwerf, B. and Horowitz, K.R. (2010). The association between symptomatic, severe hypoglycaemia and mortality in type 2 diabetes: retrospective epidemiological analysis of the ACCORD study. Bmj, 340.

Bookman, A. and Kimbrel, D. (2011). Families and elder care in the twenty-first century. *The Future of Children*, pp.117-140.

Boonpleng, W., Bormann, S, V., Thongpat, S., Ritruechai, S., Thanadkit, G. and Khamwong, W. (2020). Experiences of village health volunteers in 'Three Millions-Three Years Anti-smoking Project'. *The Public Health Journal of Burapha University*. 15 (2).

Boswell, C. and Cannon, S. (2017). *Introduction to nursing research: Incorporating Evidence-based Practice*. 4th ed. Massachusetts: Jones & Bartlett Learning.

Bouchard, J. (2018). Transformative Learning. Transformative Learning - *Research Starters Education*, 1-12.

Bouchlaghem, M. A. and Mansouri, H. (2018). Exploration of the Gap between Theory and Practice in Tunisia Nurse Education System: A Cross-Sectional Descriptive Study with a Focus on Hand Hygiene. *International Journal of Nursing*, 5(1), pp. 10-24.

Bowen, P., Rose, R. and Pilkington, A. (2017). Mixed methods-theory and practice. Sequential, explanatory approach. *International Journal of Quantitative and Qualitative Research Methods*, 5(2), pp. 10-27.

Boyce, C. and Neale, P. (2006). *Conducting in-depth interviews: A guide for designing and conducting in-depth interviews for evaluation input*.

Braat-Eggen, P.E., van Heijst, A., Hornikx, M. and Kohlrausch, A. (2017). Noise disturbance in open-plan study environments: A field study on noise sources, student tasks and room acoustic parameters. Ergonomics, 60(9), pp.1297-1314.

Braham, R., Robert, A. A., Mujammami, M., Ahmad, R. A., Zitouni, M., Sobki, S. H. and Al Dawish, M. A. (2016). Double diabetes in Saudi Arabia: A new entity or an underestimated condition. *World journal of diabetes*, 7(20), p. 621.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3 (2), pp. 77-101.

Bril, V., Breiner, A., Perkins, B. A. and Zochodne, D. (2018). Neuropathy. *Canadian journal of diabetes*, 42, pp. S217-S221.

Bruce, N., Pope, D. and Stanistreet, D. (2018). *Quantitative methods for health research: a practical interactive guide to epidemiology and statistics.* John Wiley & Sons.

Bucheli, J. R., Manshad, A., Ehrhart, M. D., Camacho, J and Burge, M. R. (2017). Association of passive and active smoking with pre-diabetes risk in a predominantly Hispanic population. *Journal of Investigative Medicine*, 65(2), pp. 328-332.

Buloala, L. W. R. and John, M. E. (2018). Knowledge of Diabetic Foot Care among Nursing Practitioners in Rivers State, Nigeria. *Texila International Journal of Nursing*, 4 (2).

Bulunuz, N., Bulunuz, M., Orbak, A.Y., Mulu, N. and Tavşanlı, Ö.F. (2017). An evaluation of primary school students' views about noise levels in school. *International Electronic Journal of Elementary Education*, 9(4), pp.725-740.

Bundak, R., Furman, A., Gunoz, H., Darendereliler, F., Bas, F. and Neyzi, O. (2006). Body mass index references for Turkish children. *Acta Paediatrica*, 95, pp. 194-198.

Bunker, K. and American Diabetes Association (2010). Consumer guide. Blood glucose meters. *Diabetes Forecast*, 63(1), pp.32-41.

Burger, K.N., Beulens, J.W., van der Schouw, Y.T., Sluijs, I., Spijkerman, A.M., Sluik, D., Boeing, H., Kaaks, R., Teucher, B., Dethlefsen, C. and Overvad, K. (2012). Dietary fiber, carbohydrate quality and quantity, and mortality risk of individuals with diabetes mellitus. *PLoS One*, 7(8), p.e43127.

Burke, V., Zhao, Y., Lee, A.H., Hunter, E., Spargo, R.M., Gracey, M., Smith, R.M., Beilin, L.J. and Puddey, I.B. (2007). Predictors of type 2 diabetes and diabetes-related hospitalisation in an Australian Aboriginal cohort. *Diabetes research and clinical practice*, 78(3), pp.360-368.

Burke, S.N. and Barnes, C.A. (2010). Senescent synapses and hippocampal circuit dynamics. *Trends in neurosciences*, 33(3), pp.153-161.

Byrne, E., Brugha, R., Clarke, E., Lavelle, A., and McGarvey, A. (2015). Peer interviewing in medical education research: experiences and perceptions of student interviewers and interviewees. *BMC research notes*, 8(1), pp. 1-11.

Callegaro, M., Murakami, M.H., Tepman, Z. and Henderson, V. (2015). Yes–no answers versus check-all in self-administered modes: A systematic review and analyses. *International Journal of Market Research*, 57(2), pp.203-224.

Cantaro, K., Jara, J.A., Taboada, M. and Mayta-Tristán, P. (2016). Association between information sources and level of knowledge about diabetes in patients with type 2 diabetes. *Endocrinología y Nutrición (English Edition)*, 63(5), pp. 202-211.

Cao, A. H., Sun, L. Z. and Cui, J. W. (2011). Effects of A Low-Carbohydrate Diet and A Low-Fat Diet on Weight and Glycemic Control in Type 2 Diabetics Mellitus. Chin. *Gener. Pract*, 14, pp. 52-56.

Carter, P., Gray, L.J., Troughton, J., Khunti, K. and Davies, M.J. (2010). Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. *Bmj*, p. 341.

Castillo, A., Giachello, A., Bates, R., Concha, J., Ramirez, V., Sanchez, C., Pinsker, E. and Arrom, J. (2010). Community-based diabetes education for Latinos. *The Diabetes Educator*, 36(4), pp.586-594.

Cavas, P. (2011). Factors affecting the motivation of Turkish primary students for science learning. *Science Education International*, 22(1), pp. 31-42.

Cedrick, L.M., Lubaki, J.P.F., Francois, L.B., Gboyega, O.A. and Philippe, L.N. (2021). Prevalence and determinants of poor glycaemic control amongst patients with diabetes followed at Vanga Evangelical Hospital, Democratic Republic of the Congo. *African Journal of Primary Health Care & Family Medicine*, 13(1), pp.1-6.

Chaichanan, V. (2009). *Health Problems and Health needs of diabetes Mellitus Patients at Saghaban Publict Health center, Doi Saket District, Chiang Mai Province*. Master of Public Health. Chiang Mai University.

Chai, S., Yao, B., Xu, L., Wang, D., Sun, J., Yuan, N., Zhang, X. and Ji, L. (2018). The effect of diabetes self-management education on psychological status and blood glucose in newly diagnosed patients with diabetes type 2. *Patient education and counseling*, 101(8), pp.1427-1432.

Chamberlain, J. J., Rhinehart, A. S., Shaefer, C. F. and Neuman, A. (2016). Diagnosis and management of diabetes: synopsis of the 2016 American Diabetes Association Standards of Medical Care in Diabetes. *Annals of internal medicine*, 164(8), pp. 542-552.

Chan, Y.L. and Norlizah, C.H. (2017). Students' Motivation towards Science Learning and Students' Science Achievement. *International Journal of Academic Research in Progressive Education and Development*, 6(4), pp.2226-6348.

Chatchaiphan, P., Junprasert, S. and Rattanagreethakul, S. (2016). Effects of Village Health Volunteers Empowerment on Perceived Self-efficacy and Caring Behavior for Persons with Diabetes in Community. *The Journal of Faculty of Nursing Burapha University*, 24 (3), pp. 83-93.

Chanthong, P., Abrishami, A., Wong, J., Herrera, F. and Chung, F. (2009). Systematic review of questionnaires measuring patient satisfaction in ambulatory anesthesia. *The Journal of the American Society of Anesthesiologists*, 110(5), pp.1061-1067.

Chatterjee, S., Riewpaiboon, A., Piyauthakit, P., Riewpaiboon, W., Boupaijit, K., Panpuwong, N. and Archavanuntagul, V. (2011). Cost of diabetes and its complications in Thailand: a complete picture of economic burden. *Health & social care in the community*, 19(3), pp.289-298.

Chavasit, V., Kriengsinyos, W., Photi, J. and Tontisirin, K. (2017). Trends of increases in potential risk factors and prevalence rates of diabetes mellitus in Thailand. *European journal of clinical nutrition*, 71(7), pp.839-843.

Chavitranurak, M. and Jewjinda, C. (2020). Comparative Role and Function of Village Health Volunteers's model case study Kantang Trang and Bangrakpattana Nonthaburi. *Journal of Administrative and Management*, 8 (1).

Chappell, N.L., Dujela, C. and Smith, A. (2015). Caregiver well-being: Intersections of relationship and gender. *Research on Aging*, 37(6), pp.623-645.

Cheekati, V., Osburne, R. C., Jameson, K. A. and Cook, C. B. (2009). Perceptions of resident physicians about management of inpatient hyperglycemia in an urban hospital. *Journal of Hospital Medicine, 4*(1).

Chetoui, A., Kaoutar, K., Elmoussaoui, S., Boutahar, K., El Kardoudi, A., Chigr, F. and Najimi, M. (2022). Prevalence and determinants of poor glycaemic control: a cross-sectional study among Moroccan type 2 diabetes patients. *International Health*, 14(4), pp.390-397.

Chhea, C., Warren, N. and Manderson, L. (2010). Health worker effectiveness and retention in rural Cambodia. *Rural and remote health*, 10(3), pp.1-14.

Chibanda, D., Mesu, P., Kajawu, L., Cowan, F., Araya, R. and Abas, M. A. (2011). Problem-solving therapy for depression and common mental disorders in Zimbabwe: piloting a task-shifting primary mental health care intervention in a population with a high prevalence of people living with HIV. *BMC public health,* 11(1), pp. 1-10.

Chidum, E., Agbai, D., Fidelis, O., Teppany, S., Martina, R., Rian, E., Verdine, D., Alida, S., Hasina, M. and Altheia, J. (2011). Self-monitoring of blood glucose improved glycaemic control and 10-year coronary heart disease risk profile of type 2 diabetic patients. *Chinese medical journal*, 124(2), pp.166-171.

Chinwong, S. and Chinwong, D. (2018). A national survey of community pharmacists on smoking cessation services in Thailand. *Pharmacy*, 6(3), p.101.

Chilundo, B.G., Cliff, J.L., Mariano, A.R., Rodríguez, D.C. and George, A. (2015). Relaunch of the official community health worker programme in Mozambique: is there a sustainable basis for iCCM policy?. *Health policy and planning*, 30(suppl_2), pp.ii54-ii64.

Chonsilapawit, T. and Rungpragayphan, S. (2016). Skills and knowledge of informatics, and training needs of hospital pharmacists in Thailand: A self-assessment survey. *International Journal of Medical Informatics*, 94, pp.255-262.

Chuengsatiansup, K. and Suksit, P. (2007). *Health volunteers in the Context of Changes: Potentials and Developmental Strategies* [online] Available at: http://www.shi.or.th/upload/volunteer.pdf [Accessed: 20th June, 2016]

Clair, C., Bitton, A., Meigs, J. B. and Rigotti, N. A. (2011). Relationships of cotinine and self-reported cigarette smoking with hemoglobin A1c in the US: results from the National Health and Nutrition Examination Survey, 1999–2008. *Diabetes care,* 34(10), pp. 2250-2255.

Clark, K.R. (2018). *Learning theories: cognitivism*.

Clark, V. L. P. and Creswell, J. W. (2008). *The mixed methods reader*. Los Angeles: Sage.

Clayton, D., Woo, V. and Yale, J.F., (2013). Hypoglycémie. *Canadian journal of diabetes*, 37, pp. S437-S440.

Cochran, C. and Brown, S. (2016). *Andragogy and the adult learner*. In Supporting the success of adult and online students. CreateSpace.

Collins, D. (2015). *Cognitive interviewing: origin, purpose and limitations*. Cognitive interviewing practice. London: SAGE Publications Ltd

Collins, G. S., Mughal, S., Barnett, A. H., Fitzgerald, J. and Lloyd, C. E. (2011). Modification and validation of the revised diabetes knowledge scale. *Diabetic Medicine*, 28(3), pp. 306-310.

Committee of Clinical Practice Guidelines, and Korean Diabetes Association. (2019). 2019 Clinical practice guidelines for type 2 diabetes mellitus in Korea. *Diabetes and Metabolism Journal*, 43(4), pp. 398-406. [online] Available at: https://doi.org/10.4093/dmj.2019.0137 [Accessed: 22nd August 2019]

Cook, D.A. and Artino Jr, A.R. (2016). Motivation to learn: an overview of contemporary theories. *Medical education*, 50(10), pp.997-1014.

Corcóstegui, B., Durán, S., González-Albarrán, M.O., Hernández, C., Ruiz-Moreno, J.M., Salvador, J., Udaondo, P. and Simó, R. (2017). Update on diagnosis and treatment of diabetic retinopathy: a consensus guideline of the Working Group of Ocular Health (Spanish Society of Diabetes and Spanish Vitreous and Retina Society). *Journal of ophthalmology, 2017*.

Crane, L. G., Lombard, M. B. and Tenz, E. M. (2009). More than just translation: Challenges and opportunities in translingual research. *Social Geography*, 4(1), pp. 39-46.

Creswell, J.W. (2009). *Research design*. 3th ed. London: Sage Publications, Inc.

Creswell, J. W. and Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. 5th ed. Thousand oaks: Sage publications.

Creswell, J. W., Klassen, A. C., Plano Clark, V. L. and Smith, K. C. (2011). Best practices for mixed methods research in the health sciences. *Bethesda (Maryland): National Institutes of Health, 2013*, pp. 541-545.

Creswell, J.W. and Plano Clark, V.L. (2011). Designing and conducting mixed methods research (2nd ed). Los Angeles, CA: Sage Publications.

Creswell, J.W. and Poth, C.N. (2018) *Qualitative Inquiry and Research Design Choosing among Five Approaches*. 4th ed, Thousand Oaks: SAGE Publications.

Croot, E.J., Lees, J. and Grant, G. (2011). Evaluating standards in cross-language research: A critique of Squires' criteria. *International journal of nursing studies*, 48(8), pp.1002-1011.

Crotty, M. (1998). *The foundations of social research*: Meaning and perspective in the research process. Thousand Oaks, CA: Sage.

Crump, C., Rivera, D., London, R., Landau, M., Erlendson, B. and Rodriguez, E. (2013). Chronic health conditions and school performance among children and youth. *Annals of epidemiology*, 23(4), pp. 179-184.

Dahan, L., Rampon, C. and Florian, C. (2020). Age-related memory decline, dysfunction of the hippocampus and therapeutic opportunities. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, p.109943.

Daivadanam, M., Absetz, P., Sathish, T., Thankappan, K.R., Fisher, E.B., Philip, N.E., Mathews, E. and Oldenburg, B. (2013). Lifestyle change in Kerala, India: needs assessment

and planning for a community-based diabetes prevention trial. *BioMed Central Public Health*, 13(1), pp.1-16.

D'Amour, R. and Guimond, P. (2010). An experiential learning model applied to nurses working with patients with Creutzfeldt-Jakob disease. *Canadian journal of neuroscience nursing*, 32(2), pp.34-39.

Dechakul, M. (2021). The Role of Community Nurse Practitioner in Diabetes Elderly Care. *Thai Red Cross Nursing Journal*, 14 (1), pp 82-94.

Deepa, M., Bhansali, A., Anjana, R.M., Pradeepa, R., Joshi, S.R., Joshi, P.P., Dhandhania, V.K., Rao, P.V., Subashini, R., Unnikrishnan, R. and Shukla, D.K. (2014). Knowledge and awareness of diabetes in urban and rural India: the Indian Council of Medical Research India diabetes study (phase I): Indian Council of Medical Research India diabetes 4. *Indian journal of endocrinology and metabolism*, 18(3), p.379.

Delgado-Morales, R., Agís-Balboa, R.C., Esteller, M. and Berdasco, M. (2017). Epigenetic mechanisms during ageing and neurogenesis as novel therapeutic avenues in human brain disorders. *Clinical epigenetics*, 9(1), p.67.

Deller, B., Tripathi, V., Stender, S., Otolorin, E., Johnson, P. and Carr, C. (2015). Task shifting in maternal and newborn health care: key components from policy to implementation. *International Journal of Gynecology & Obstetrics*, 130, pp.S25-S31.

Del-Pino-Casado, R., Frías-Osuna, A., Palomino-Moral, P.A. and Ramón Martínez-Riera, J. (2012). Gender differences regarding informal caregivers of older people. *Journal of Nursing Scholarship*, 44(4), pp.349-357.

Demaio, A.R., Otgontuya, D., De Courten, M., Bygbjerg, I.C., Enkhtuya, P., Oyunbileg, J. and Meyrowitsch, D.W. (2013). Exploring knowledge, attitudes and practices related to

diabetes in Mongolia: a national population-based survey. *BMC Public Health*, 13(1), pp.1-7.

Deo, S. and Singh, P. (2021). Community health worker-led, technology-enabled private sector intervention for diabetes and hypertension management among urban poor: a retrospective cohort study from large Indian metropolitan city. *BMJ open*, 11(8), p.e045246

Depinta, C. (2010). Effect of home health care among diabetes mellitus patients of Thawangpha hospital, Nan province. *Lanna Public Health Journal*, 6(3), pp 279-286.

Department of Disease control (2019). *AorSorMor Online*. [online] Available at: https://ddc.moph.go.th/dvb/news.php?news=9728&deptcode=dvb [Accessed at: 10th Jan 2021]

Department of Disease Control, Minitry of public health. (2015). *Guidelines for screening and treating foot complications in people with diabetes*. Nonthaburi: Department of Disease Control, Minitry of public health.

Department of Health Service Support (2011). *The Modern Village Health Volunteer Handbook*. [online] Available at: http://phc.moph.go.th/www_hss/data_center/ifm_mod/nw/NewOSM-1.pdf [Accessed at: 10th May 2015]

Department of Health Service support. (2019). *How to use SMART OrSorMor application*. [online] Available at: http://xn--y3cri.com/videos/view/488 [Accessed at: 10th Jan 2021]

Department of Health Service support. (2021). *Recommended Health Apps*. [online] Available at: http://xn--y3cri.com/categories/view/7 [Accessed at: 10th Jan 2021]

Department of Health Service Support, Ministry of Public Health. (2013). *Standard training course for village health volunteer: Fasting blood glucose screening by using a*

blood glucose meter. [online] Available at: http://110.164.147.155/kmhealth_new/Documment/diabetes/knowledge/16.pdf [Accessed: 10th May 2015]

Department of Health Service Support, Ministry of Public Health (2013). *Village Health Volunteer: Community health management*. Bangkok. The Agricultural Co- Operative Federation of Thailand Publishing. [online] Available at: http://www.nakhonphc.go.th/datacenter/doc_download/osm19356.pdf [Accessed at: 1st September, 2014]

Department of Health Service Support. (2021). *Village Health Volunteer.* [online] available at: http://xn--y3cri.com/defaults/registered. Accessed at: 25th April 2021.

Derr, R.L., Sivanandy, M.S., Bronich-Hall, L. and Rodriguez, A. (2007). Insulin-related knowledge among health care professionals in internal medicine. *Diabetes Spectrum*, 20(3), pp.177-185.

De Silva, T. A. (2011). Mixed methods: a reflection of its adoption in environmental reporting. *Qualitative Research in Accounting & Management*.

DeVon, H.A., Block, M.E., Moyle-Wright, P., Ernst, D.M., Hayden, S.J., Lazzara, D.J., Savoy, S.M. and Kostas-Polston, E. (2007). A psychometric toolbox for testing validity and reliability. *Journal of Nursing scholarship*, 39(2), pp.155-164.

Dhatariya, K.K. and Vellanki, P. (2017). Treatment of diabetic ketoacidosis (DKA)/hyperglycemic hyperosmolar state (HHS): novel advances in the management of hyperglycemic crises (UK versus USA). *Current diabetes reports*, 17, pp.1-7.

Dhatariya, K, Savage, M, Claydon, A, Dyer, P, Evans, P, Khan, A, Kilvert, A, Leech, N, Levy, N, Rayman, G, Rees, A, and Sinclair-Hammersley, M. (2013). *Joint British Diabetes*

Societies Inpatient Care Group. The management of diabetic ketoacidosis in adults. Second Edition. Update: September 2013.

Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn (2017). *Clinical Practice Guideline for Diabetes 2017*. [online] available at: https://www.dmthai.org/index.php/knowledge/healthcare-providers/cpg/443-guideline-diabetes-care-2017 [Accessed: 2nd April 2017]

Diabetes Canada Clinical Practice Guidelines Expert Committee. (2018). Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2018; 42(Suppl 1):S1-S325. [online] Available at: http://guidelines.diabetes.ca/docs/cpg-2018-full-en.pdf [Accessed:10th May 2018]

Dikken, J., Hoogerduijn, J.G., Kruitwagen, C. and Schuurmans, M.J. (2016). Content validity and psychometric characteristics of the "knowledge about older patients quiz" for nurses using item response theory. *Journal of the American Geriatrics Society*, 64(11), pp.2378-2383.

Dil, Y., Strachan, D., Cairncross, S., Korkor, A. S. and Hill, Z. (2012). Motivations and challenges of community-based surveillance volunteers in the northern region of Ghana. *Journal of community health*, 37(6), pp. 1192-1198.

DiNicolantonio, J. J. and OKeefe, J. H. (2017). *Added sugars drive coronary heart disease via insulin resistance and hyperinsulinaemia: a new paradigm*.

Dişlen, G., Ve, Ö., İfadeleri, Ö., Motivasyon, I. and Sosyal, A. (2013). The reasons of lack of motivation from the students' and teachers' voices.

Division of Noncommunicable Diseases. (2019). *Noncommunicable diseases mortality between 2016- 2018*. [online] Available at: http://thaincd.com/2016/mission/documents-detail.php?id=13653&tid=32&gid=1-020 [Accessed: 24th October 2019]

Dodhi, J, K. (2017). *Comprehensive Textbook of Nursing Education.* New Delhi: Jaypee brothers medical publishers (P) LTD.

Doetsch, J., Pilot, E., Santana, P. and Krafft, T. (2017). Potential barriers in healthcare access of the elderly population influenced by the economic crisis and the troika agreement: a qualitative case study in Lisbon, Portugal. *International Journal for Equity in Health*, 16(1), pp.184-200.

Dokken, B. B. (2008). The pathophysiology of cardiovascular disease and diabetes: beyond blood pressure and lipids. *Diabetes Spectrum*, 21(3), 160-165.

Dolmans, D.H., Loyens, S.M., Marcq, H. and Gijbels, D. (2016). Deep and surface learning in problem-based learning: a review of the literature. *Advances in health sciences education*, 21(5), pp.1087-1112.

Donsamak, S., Weiss, M.C. and John, D.N. (2021). Evaluation of antibiotic supply decisions by community pharmacists in Thailand: a vignette study. *Antibiotics*, 10(2), p.154.

Dos Santos, P.F.L., Dos Santos, P.R., Ferrari, G.S.L., Fonseca, G.A.A. and Ferrari, C.K.B. (2014). Knowledge of diabetes mellitus: does gender make a difference? *Osong public health and research perspectives*, 5(4), pp.199-203.

Drass, J. A., Muir-Nash, J., Boykin, P. C., Turek, J. M. and Baker, K. L. (1989). Perceived and actual level of knowledge of diabetes mellitus among nurses. *Diabetes Care*, 12(5), pp. 351-356.

Early, J., Gonzalez, C., Gordon-Dseagu, V. and Robles-Calderon, L. (2019). Use of mobile health (mHealth) technologies and interventions among community health workers globally: a scoping review. *Health promotion practice*, 20(6), pp. 805-817.

Eaton-Spiva, L. and Day, A. (2011). Effectiveness of a computerized educational module on nurses' knowledge and confidence level related to diabetes. *Journal for Nurses in Professional Development*, 27(6), pp. 285-289.

Eboh, C. and Chowdhury, T. A. (2015). Management of diabetic renal disease. *Annals of translational medicine*, 3(11), p. 154.

Edosomwan, S. O. (2016). Childhood Learning vs. Adulthood Learning: The Theory of Pedagogy and Andragogy. *US-China Education Review*, 6(2), pp. 115-123.

Egbujie, B. A., Delobelle, P. A., Levitt, N., Puoane, T., Sanders, D. and van Wyk, B. (2018). Role of community health workers in type 2 diabetes mellitus self-management: A scoping review. *PloS one*, 13(6), e0198424.

Egger-Rainer, A. (2019). Enhancing validity through cognitive interviewing. A methodological example using the Epilepsy Monitoring Unit Comfort Questionnaire. *Journal of advanced nursing*, 75(1), pp.224-233.

Eigenmann, C. A., Skinner, T. and Colagiuri, R. (2011). Development and validation of a diabetes knowledge questionnaire. *Practical Diabetes International*, 28(4), pp. 166-170d.

Eisen, D. B., Schupp, C. W., Isseroff, R. R., Ibrahimi, O. A., Ledo, L. and Armstrong, A. W. (2015). Does class attendance matter? Results from a second-year medical school dermatology cohort study. *International journal of dermatology*, 54(7), pp. 807-816.

Eknithiset, R., Samrongthong, R. and Kumar, R. (2018). Factors associated with knowledge, perception, and practice toward self-care among elderly patients suffering from Type 2

diabetes mellitus in rural Thailand. *Journal of Ayub Medical College, Abbottabad*, 30(1), pp.107-10.

El-Deirawi, K. M. and Zuraikat, N. (2001). Registered nurses' actual and perceived knowledge of diabetes mellitus. *Journal of Vascular Nursing*, 19(3), pp. 95-100.

El Din, U. A. S., Salem, M. M. and Abdulazim, D. O. (2017). Diabetic nephropathy: Time to withhold development and progression-A review. *Journal of advanced research*, 8(4), pp. 363-373.

Elebiary, H., and Hend Elshenewy, S. (2018). Knowledge and attitudes of nurses towards caring of elderly people in health care sitting. *Journal of Nursing and Health Sciences*, 7(3), pp.76-84.

El Toony, L. F., Hamad, D. A. and Omar, O. M. (2018). Outcome of focused pre-Ramadan education on metabolic and glycaemic parameters in patients with type 2 diabetes mellitus. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 12(5), pp. 761-767.

Emdin, C. A., Anderson, S. G., Woodward, M. and Rahimi, K. (2015). Usual blood pressure and risk of new-onset diabetes: evidence from 4.1 million adults and a meta-analysis of prospective studies. *Journal of the American College of Cardiology*, 66(14), pp. 1552-1562

Emral, R., Pathan, F., Cortés, C.A.Y., El-Hefnawy, M.H., Goh, S.Y., Gómez, A.M., Murphy, A., Abusnana, S., Rudijanto, A., Jain, A. and Ma, Z. (2017). Self-reported hypoglycemia in insulin-treated patients with diabetes: Results from an international survey on 7289 patients from nine countries. *Diabetes research and clinical practice*, 134, pp.17-28.

Engberg, S., Glümer, C., Witte, D. R., Jørgensen, T. and Borch-Johnsen, K. (2010). Differential relationship between physical activity and progression to diabetes by glucose tolerance status: the Inter99 Study. *Diabetologia*, 53(1), pp. 70-78.

Engström, G., and Fagerberg, I. (2011). Attitudes towards older people among Swedish health care students and health Sare professionals working in elder care. *Nursing Reports*, 1(1), pp.2-6.

Einarson, T.R., Acs, A., Ludwig, C. and Panton, U.H. (2018). Prevalence of cardiovascular disease in type 2 diabetes: a systematic literature review of scientific evidence from across the world in 2007–2017. *Cardiovascular diabetology*, 17(1), pp.1-19.

Erlinghagen, M. (2010). Volunteering after retirement: evidence from German panel data. *European Societies*, 12(5), pp. 603-625.

Ethisan, P., Somrongthong, R., Ahmed, J., Kumar, R. and Chapman, R. S. (2017). Factors related to physical activity among the elderly population in rural Thailand. *Journal of Primary Care & Community Health*, 8(2), pp. 71-76.

Etikan, I., Alkassim, R. and Abubakar, S. (2016). Comparision of snowball sampling and sequential sampling technique. *Biometrics and Biostatistics International Journal*, 3(1), p.55.

Etters, L., Goodall, D. and Harrison, B.E. (2008). Caregiver burden among dementia patient caregivers: a review of the literature. *Journal of the American Academy of Nurse Practitioners*, 20(8), pp.423-428.Faber, J. and Fonseca, L. M. (2014). How sample size influences research outcomes. *Dental press journal of orthodontics*, 19(4), pp. 27-29.

Falasca, M. (2011). Barriers to adult learning: Bridging the gap. *Australian Journal of Adult Learning*, 51(3), pp.583-590.

Farrokhi, F., Klindukhova, O., Chandra, P., Peng, L., Smiley, D., Newton, C., Pasquel, F., Fereira, M.E. and Umpierrez, G. (2012). Risk factors for inpatient hypoglycemia during subcutaneous insulin therapy in non-critically ill patients with type 2 diabetes.

Fatema, K., Hossain, S., Natasha, K., Chowdhury, H.A., Akter, J., Khan, T. and Ali, L. (2017). Knowledge attitude and practice regarding diabetes mellitus among Nondiabetic and diabetic study participants in Bangladesh. *BMC public health*, 17(1), pp.1-10.

Feleke, S. A., Alemayehu, C. M., Adane, H. T., Onigbinde, A., Akindoyi, O. and Faremi, F. (2013). Assessment of the level and associated factors with knowledge and practice of diabetes mellitus among diabetic patients attending at FelegeHiwot hospital, Northwest Ethiopia. *Journal of Clinical Medicine Research*, 2(6), p. 110.

Fetters, M. D., Curry, L. A., and Creswell, J. W. (2013). Achieving integration in mixed methods designs—principles and practices. *Health services research*, 48(6pt2), pp. 2134-2156.

Fincham, J.E. (2008). Response rates and responsiveness for surveys, standards, and the Journal. *American journal of pharmaceutical education*, 72(2).

Findlow, L.A. and McDowell, J.R. (2002). Determining registered nurses' knowledge of diabetes mellitus. (Nurses' Knowledge). *Journal of Diabetes Nursing*, 6(6), pp.170-176.

Forbes, J. M. and Cooper, M. E. (2013). Mechanisms of diabetic complications. *Physiological reviews*, 93(1), pp. 137-188.

Frank, L. A. and Solomon, A. (2016). Hyperglycaemic hyperosmolar state. *British Journal of Hospital Medicine*, 77(9), pp. C130-C133.

Frantál, B. and Kunc, J. (2011). Wind turbines in tourism landscapes: Czech experience. *Annals of tourism research*, 38(2), pp. 499-519.

Freeland, B. and Farber, M. S. (2016). A review of insulin for the treatment of diabetes mellitus. *Home healthcare now*, 34(8), pp. 416-423.

French, E.K., Donihi, A.C. and Korytkowski, M.T. (2019). Diabetic ketoacidosis and hyperosmolar hyperglycemic syndrome: review of acute decompensated diabetes in adult patients. *Bmj*, 365, p.l1114

Fretts, A.M., Howard, B.V., Kriska, A.M., Smith, N.L., Lumley, T., Lee, E.T., Russell, M. and Siscovick, D. (2009). Physical activity and incident diabetes in American Indians: The Strong Heart Study. *American journal of epidemiology*, 170(5), pp.632-639.

Gallie, D. and Russell, H. (2009). Work-family conflict and working conditions in Western Europe. *Social Indicators Research*, 93(3), pp. 445-467.

Gani, A. and Ara, R. (2010). Conflicting worlds of working women: findings of an exploratory study. *Indian journal of industrial relations*, pp.61-73.

Garcia, A. A., Villagomez, E. T., Brown, S. A., Kouzekanani, K. and Hanis, C. L. (2001). The Starr County Diabetes Education Study: development of the Spanish-language diabetes knowledge questionnaire. *Diabetes care*, 24(1), pp. 16-21.

Garg, S.K., Henry, R.R., Banks, P., Buse, J.B., Davies, M.J., Fulcher, G.R., Pozzilli, P., Gesty-Palmer, D., Lapuerta, P., Simó, R. and Danne, T. (2017). Effects of sotagliflozin added to insulin in patients with type 1 diabetes. *New England Journal of Medicine*, 377(24), pp.2337-2348.

Gautam, A., Bhatta, D.N. and Aryal, U.R. (2015). Diabetes related health knowledge, attitude and practice among diabetic patients in Nepal. *BMC endocrine disorders*, 15(1), pp.1-8.

Gaziano, T., Abrahams-Gessel, S., Surka, S., Sy, S., Pandya, A., Denman, C.A., Mendoza, C., Puoane, T. and Levitt, N.S. (2015). Cardiovascular disease screening by community

health workers can be cost-effective in low-resource countries. *Health Affairs*, 34(9), pp.1538-1545.

Gegenfurtner, A. and Vauras, M. (2012). Age-related differences in the relation between motivation to learn and transfer of training in adult continuing education. *Contemporary Educational Psychology*, 37(1), pp. 33-46.

Gheith, O., Farouk, N., Nampoory, N., Halim, M.A. and Al-Otaibi, T. (2016). Diabetic kidney disease: worldwide difference of prevalence and risk factors. *Journal of nephropharmacology*, 5(1), p.49.

Gilakjani, A.P. (2012). A match or mismatch between learning styles of the learners and teaching styles of the teachers. *International Journal of Modern Education and Computer Science*, 4(11), p.51.

Gill, C.J., Phiri-Mazala, G., Guerina, N.G., Kasimba, J., Mulenga, C., MacLeod, W.B., Waitolo, N., Knapp, A.B., Mirochnick, M., Mazimba, A. and Fox, M.P. (2011). Effect of training traditional birth attendants on neonatal mortality (Lufwanyama Neonatal Survival Project): randomised controlled study. *Bmj*, 342, p.d346.

Gill, P., Stewart, K., Treasure, E. and Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British Dental Journal*, 204(6), pp.291-295.

Gilroy, K. and Winch, P. (2006). *Management of sick children by community health workers. Intervention models and programme examples*.

Given, L. M. and Saumure, K. (2015). Using Skype as a research tool: Lessons learned from qualitative interviews with distance students in a teacher-librarianship Program. Cross-cultural interviewing: *Feminist experiences and reflections*, pp. 116-124.

Goodell, L.S., Stage, V.C. and Cooke, N.K. (2016). Practical qualitative research strategies: Training interviewers and coders. *Journal of nutrition education and behavior*, 48(8), pp.578-585.

Goodluck, K. K. U. (2010). Reinforcement and Its Educational Implications. *International Journal of Education*, 33(3), pp. 27-36.

Gosmanov, A.R., Gosmanova, E.O. and Kitabchi, A.E. (2018). Hyperglycemic crises: diabetic ketoacidosis (DKA), and hyperglycemic hyperosmolar state (HHS). *Endotext [Internet]*.

Gotardelo, D.R., Lopes, L.N., de Melo Meira, A.M., da Costa, C.K.M., Masson, E.R., Fonseca, L.S., Toledo, V.N., Faioli, M.A. and Andrade, R.B.L. (2015). Alcohol consumption and alcohol-drug interactions in the elderly attended at the Family Health Strategy. *Rev Med Minas Gerais*, 25(3), pp.349-354.

Goudge, J., Chirwa, T., Eldridge, S., Gómez-Olivé, F.X.F., Kabudula, C., Limbani, F., Musenge, E. and Thorogood, M. (2018). Can lay health workers support the management of hypertension? Findings of a cluster randomised trial in South Africa. *BMJ global health*, 3(1), p.e000577.

Government Gazette. (2021). Notification from the Ministry of Public Health in relation to the compensation and duty payment of the village health volunteer in 2021. [online] Available at: https://ratchakitcha.soc.go.th/search-result. [Accessed at: 10th Jan 2022]

Grady, C. (2012). The cognitive neuroscience of ageing. Nature *Reviews Neuroscience*, 13(7), pp.491-505.

Grafton, J., Lillis, A. M., Malina, M. A., Nørreklit, H. S. and Selto, F. H. (2011). Lessons learned: advantages and disadvantages of mixed method research. *Qualitative Research in Accounting & Management.*

Grant, M. J., and Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health information & libraries journal*, 26(2), pp. 91-108.

Gray, D. E. (2009). *Doing research in the real world (2nd ed.).* Thousand Oaks, California: SAGE Publications Inc.

Gray, D. T. and Barnes, C. A. (2015). Distinguishing adaptive plasticity from vulnerability in the aging hippocampus. *Neuroscience,* 309, pp. 17-28.

Green, K.E. (1990). Common illnesses and self-care. *Journal of Community Health*, 15(5), pp.329-338.

Greenspan, J. A., McMahon, S. A., Chebet, J. J., Mpunga, M., Urassa, D. P. and Winch, P. J. (2013). Sources of community health worker motivation: a qualitative study in Morogoro Region, Tanzania. *Human resources for health*, 11(1), p. 52.

Grøntved, A., Pan, A., Mekary, R. A., Stampfer, M., Willett, W. C., Manson, J. E. and Hu, F. B. (2014). Muscle-strengthening and conditioning activities and risk of type 2 diabetes: a prospective study in two cohorts of US women. *PLoS medicine*, 11(1).

Grusec, J.E. and Hastings, P.D. eds. (2014). *Handbook of socialization: Theory and research*. Guilford Publications.

Guest, G., Bunce, A., and Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods*, 18(1), 59-82.

Guest, G., Namey, E., and Mitchell, M. (2017). *In-depth interviews*. SAGE Publications, Ltd.

Guo, X.H., Li, Y.U.A.N., Lou, Q.Q., Li, S.H.E.N., Sun, Z.L., Fang, Z.H.A.O., Xia, D.A.I., Huang, J., Yang, H.Y. and Chinese Diabetes Education Status Survey Study Group. (2012). A nationwide survey of diabetes education, self-management and glycemic control in patients with type 2 diabetes in China. *Chinese medical journal*, 125(23), pp.4175-4180.

Gwon, S. H. and Thongpriwan, V. (2019). PhotoVoice in a Prenursing Health Care Systems Course. *Journal of Nursing Education*, 58(1), pp. 64-64.

Gyawali, B., Mishra, S. R., Neupane, D., Vaidya, A., Sandbæk, A. and Kallestrup, P. (2018). Diabetes management training for female community health volunteers in Western Nepal: an implementation experience. *BMC public health*, 18(1), p. 641.

Hadaegh, F., Bozorgmanesh, M., Safarkhani, M., Khalili, D. and Azizi, F. (2011). Predictability of body mass index for diabetes: affected by the presence of metabolic syndrome?. *BMC public health*, 11(1), p. 383.

Halcomb, E. J. and Andrew, S. (2009). Practical considerations for higher degree research students undertaking mixed methods projects. *International Journal of Multiple Research Approaches*, 3(2), pp. 153-162.

Hamer, D.H., Brooks, E.T., Semrau, K., Pilingana, P., MacLeod, W.B., Siazeele, K., Sabin, L.L., Thea, D.M. and Yeboah-Antwi, K. (2012). Quality and safety of integrated community case management of malaria using rapid diagnostic tests and pneumonia by community health workers. *Pathogens and Global Health*, 106(1), pp.32-39.

Han, L., Ma, Y., Wei, S., Tian, J., Yang, X., Shen, X., Zhang, J. and Shi, Y. (2017). Are home visits an effective method for diabetes management? A quantitative systematic review and meta-analysis. *Journal of diabetes investigation*, 8(5), pp.701-708.

Haque, M. N., Soonthorndhada, K., Hunchangsith, P. and Kanchanachitra, M. (2016). Active ageing level in Thailand: a comparison between female and male elderly. *Journal of Health Research*, 30(2), pp. 99-107.

Harfitt, G. J. (2012). Class size and language learning in Hong Kong: The students' perspective. *Educational Research*, 54(3), pp. 331-342.

Harper, S. (2014). Economic and social implications of aging societies. *Science*, 346(6209), pp. 587-591.

Hartle, R. T., Baviskar, S. and Smith, R. (2012). A field guide to constructivism in the college science classroom: four essential criteria and a guide to their usage. *Bioscene: Journal of College Biology Teaching*, 38(2), pp. 31-35.

Hartzler, A. L., Tuzzio, L., Hsu, C. and Wagner, E. H. (2018). Roles and functions of community health workers in primary care. *The Annals of Family Medicine*, 16(3), pp. 240-245.

Harvey, P. and Martinko, M.J. (2009). Attribution theory and motivation. *Organizational behavior, theory and design in health care*, pp.143-158.

Hatthachote, P., Rangsin, R., Mungthin, M. and Sakboonyarat, B. (2019). Trends in the prevalence of obesity among young Thai men and associated factors: from 2009 to 2016. *Military Medical Research*, 6(1), pp.1-8.

He, J., Irazola, V., Mills, K.T., Poggio, R., Beratarrechea, A., Dolan, J., Chen, C.S., Gibbons, L., Krousel-Wood, M., Bazzano, L.A. and Nejamis, A. (2017). Effect of a community health

worker–led multicomponent intervention on blood pressure control in low-income patients in Argentina: a randomized clinical trial. *Jama*, 318(11), pp.1016-1025.

Heale, R. and Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-based nursing*, 18(3), pp. 66-67.

Healy, S. J., Black, D., Harris, C., Lorenz, A. and Dungan, K. M. (2013). Inpatient diabetes education is associated with less frequent hospital readmission among patients with poor glycemic control. *Diabetes care*, 36(10), pp. 2960-2967.

Henry, R.R., Rosenstock, J., Edelman, S., Mudaliar, S., Chalamandaris, A.G., Kasichayanula, S., Bogle, A., Iqbal, N., List, J. and Griffen, S.C. (2015). Exploring the potential of the SGLT2 inhibitor dapagliflozin in type 1 diabetes: a randomized, double-blind, placebo-controlled pilot study. *Diabetes care*, 38(3), pp.412-419.

Herdiyanti, H. (2018). Role of Career Women in Families:(Study of the Existence of Career Women in Families in Balunijuk Village). *Society*, 6(1), pp. 1-7.

Herman, W. H., Ye, W., Griffin, S. J., Simmons, R. K., Davies, M. J., Khunti, K., Rutten, G. E., Sandbaek, A., Lauritzen, T., Borch-Johnsen, K., Brown, M. B., and Wareham, N. J. (2015). Early Detection and Treatment of Type 2 Diabetes Reduce Cardiovascular Morbidity and Mortality: A Simulation of the Results of the Anglo-Danish-Dutch Study of Intensive Treatment in People With Screen-Detected Diabetes in Primary Care (ADDITION-Europe). *Diabetes care*, 38(8), pp. 1449–1455.

Hernandez, D. A. and Hernandez, C. A. (2015). Weighing in on the Body Knowledge Questionnaire: Initial development and pilot testing. *The Diabetes Educator*, 41(3), pp. 369-376.

Hoffmann, I., Diefenbach, C., Gräf, C., König, J., Schmidt, M.F., Schnick-Vollmer, K., Blettner, M., Urschitz, M.S. and ikidS Study Group (2018). Chronic health conditions and school performance in first graders: A prospective cohort study. *PloS one*, 13(3).

Hollis, M., Glaister, K. and Anne Lapsley, J. (2014). Do practice nurses have the knowledge to provide diabetes self-management education?. *Contemporary Nurse*, 46(2), pp.234-241.

Holloway, I. and Galvin, K. (2017). *Qualitative research in nursing and healthcare*. 4th ed. New York: John Wiley & Sons.

Holt, A. (2010). Using the telephone for narrative interviewing: a research note. *Qualitative research*, 10(1), pp. 113-121.

Hoque, R. (2013). Effect of reinforcement on teaching–learning process. *IOSR Journal of Humanities and Social Science*, 7(1), pp. 13-16.

Hsu, M., Huang, X. and Yupho, S. (2015). The development of universal health insurance coverage in Thailand: Challenges of population aging and informal economy. *Social Science & Medicine*, 145, pp. 227-236.

Hu, J., Gruber, K.J., Liu, H., Zhao, H. and Garcia, A.A. (2013). Diabetes knowledge among older adults with diabetes in Beijing, China. *Journal of clinical nursing*, 22(1-2), pp.51-60.

Hu, M., Wan, Y., Yu, L., Yuan, J., Ma, Y., Hou, B., Jiang, X. and Shang, L. (2017). Prevalence, Awareness and Associated Risk Factors of Diabetes among Adults in Xi'an, China. *Scientific reports*, 7(1), p.10472.

Huizinga, M.M., Elasy, T.A., Wallston, K.A., Cavanaugh, K., Davis, D., Gregory, R.P., Fuchs, L.S., Malone, R., Cherrington, A., DeWalt, D.A. and Buse, J. (2008). Development and validation of the Diabetes Numeracy Test (DNT). *BioMed Central Health Services Research*, 8(1), p.96.

Hunt, L. and Chalmers, D. (2012). *University Teaching in Focus: A Learning-centred Approach*. Victoria, Australia: ACER Press

Hussein, M.H. and Osuji, J. (2017). Bridging the theory-practice dichotomy in nursing: The role of nurse educators. *Journal of Nursing Education and Practice*, 7(3), pp.20-25.

Hyman, M.R. and Sierra, J.J. (2016). Open-versus close-ended survey questions. *Business Outlook*, 14(2), pp.1-5.

Ilozumba, O., Van Belle, S., Dieleman, M., Liem, L., Choudhury, M. and Broerse, J. E. (2018). The effect of a community health worker utilized mobile health application on maternal health knowledge and behavior: a quasi-experimental study. *Frontiers in public health*, 6, p. 133.

Imlach, A.R., Ward, D.D., Stuart, K.E., Summers, M.J., Valenzuela, M.J., King, A.E., Saunders, N.L., Summers, J., Srikanth, V.K., Robinson, A. and Vickers, J.C. (2017). Age is no barrier: predictors of academic success in older learners. *npj Science of Learning*, 2(1), pp.1-7.

International Diabetes Federation (2015). *Diabetes estimates excel tables*. [online]

Available at: http://www.idf.org/node/23640 [Accessed: 15th September 2015]

International Diabetes Federation. (2012). Global Guideline for Type 2 Diabetes. Clinical Guidelines Task Force of IDF, 2012. [online]

Available at: https://www.iapb.org/wp-content/uploads/Global-Guideline-for-Type-2-Diabetes-IDF-2012.pdf [Accessed: 15th September 2015]

International labour office (2016). Universal Health-care Coverage Scheme: Thailand. [online] Available at: https://www.social-

protection.org/gimi/gess/RessourcePDF.action?ressource.ressourceId=54059 [Accessed: 10th May 2017]

Inzucchi, S., Rosenstock, J. and Umpierrez, G. (2016). Diabetic neuropathy. *The Journal of Clinical Endocrinology*, 97(5), pp.35A-35A.

Irdianto, W. and Putra, A.B.N.R. (2016). The influence of education and economic background towards the training participants' motivation and study result of UPT-PK Singosari Malang. *In AIP Conference Proceedings* (Vol. 1778, No. 1, p. 030061). AIP Publishing LLC.

Irwin, T., Ashbaugh, S. J. and Mehta, K. (2015). Knowledge of diabetes mellitus among community health workers in rural Kenya. *Annals of Global Health*, 81(1).

Islam, S. M. S., Niessen, L. W., Seissler, J., Ferrari, U., Biswas, T., Islam, A. and Lechner, A. (2015). Diabetes knowledge and glycemic control among patients with type 2 diabetes in Bangladesh. *SpringerPlus*, 4(1), p. 284.

Jackson, D., Power, T., Sherwood, J. and Geia, L. (2013). Amazingly resilient Indigenous people! Using transformative learning to facilitate positive student engagement with sensitive material. *Contemporary Nurse*, 46(1), pp. 105-112.

Jacob, S. A. and Furgerson, S. P. (2012). Writing interview protocols and conducting interviews: tips for students new to the field of qualitative research. *Qualitative Report*, 17, p. 6.

Jaikong, N., Thammapreecha, J.,Siriprasertchok, R. and Pimoljinda, T.(2020). Management Policy and the Shortage of Professional Nurses. *Hatyai Academic Journal*, 18(2), pp. 241-259.

Jansink, R., Braspenning, J., van der Weijden, T., Elwyn, G. and Grol, R. (2010). Primary care nurses struggle with lifestyle counselling in diabetes care: a qualitative analysis. *BioMed Central Family Practice*, 11(1), p. 41.

Jasper, U. S., Ogundunmade, B. G., Opara, M. C., Akinrolie, O., Pyiki, E. B. and Umar, A. (2014). Determinants of diabetes knowledge in a cohort of Nigerian diabetics. *Journal of Diabetes & Metabolic Disorders*, 13(1), p. 39.

Javanparast, S., Windle, A., Freeman, T. and Baum, F. (2018). Community health worker programs to improve healthcare access and equity: Are they only relevant to low-and middle-income countries?. *International journal of health policy and management*, 7(10), p. 943.

Jee, S. H., Foong, A. W., Hur, N. W. and Samet, J. M. (2010). Smoking and risk for diabetes incidence and mortality in Korean men and women. *Diabetes care*, 33(12), pp. 2567-2572.

Jenkins, D.J., Kendall, C.W., Augustin, L.S., Mitchell, S., Sahye-Pudaruth, S., Mejia, S.B., Chiavaroli, L., Mirrahimi, A., Ireland, C., Bashyam, B. and Vidgen, E. (2012). Effect of legumes as part of a low glycemic index diet on glycemic control and cardiovascular risk factors in type 2 diabetes mellitus: a randomized controlled trial. *Archives of internal medicine*, 172(21), pp.1653-1660.

Jenn, N.C. (2006). Designing a questionnaire. *Malaysian family physician: the official journal of the Academy of Family Physicians of Malaysia*, 1(1), p.32.

Jithitikulchai, T. (2020). Area-based Network Allocations: A Solution to Mitigate the Shortage of Health Workforce. *Journal of Health Systems Research*, 14(3), pp. 243-273.

Jitnarin, N., Kosulwat, V., Rojroongwasinkul, N., Boonpraderm, A., Haddock, C.K. and Poston, W.S. (2011). Socioeconomic status and smoking among Thai adults: results of the

National Thai Food Consumption Survey. *Asia Pacific Journal of Public Health*, 23(5), pp.672-681.

Jopang, Y., Petchmark, S., Jetsrisuparb, A., Sanchaisuriya, K., Sanchaisuriya, P. and Schelp, F.P. (2015). Community participation for thalassemia prevention initiated by village health volunteers in northeastern Thailand. *Asia Pacific Journal of Public Health*, 27(2), pp.NP2144-NP2156.

Joshi, R., Alim, M., Kengne, A.P., Jan, S., Maulik, P.K., Peiris, D. and Patel, A.A. (2014). Task shifting for non-communicable disease management in low- and middle-income countries–a systematic review. PloS one, 9(8), p.e103754.

Joshi, R., Chow, C.K., Raju, P.K., Raju, K.R., Gottumukkala, A.K., Reddy, K.S., MacMahon, S., Heritier, S., Li, Q., Dandona, R. and Neal, B. (2012). The Rural Andhra Pradesh Cardiovascular Prevention Study (RAPCAPS) A Cluster Randomized Trial. *Journal of the American College of Cardiology*, 59(13), pp.1188-1196.

Jukchai, P., Khuneepong, A. and Changkaew, W. (2017). Factors affecting the performance of village health volunteers (VHVs) of family care teams, Pathum Thani Province. *Journal of Public Health Nursing*, 31(1), pp. 16-28.

Kaithong, B. and Sawangdee, Y. (2018). Transforming Roles and Functions of Women in the Northeast Region of Thailand. *Journal of Community Development Research (Humanities and Social Sciences)*, 11(2), pp. 27-41.

Kallio, H., Pietilä, A. M., Johnson, M. and Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of advanced nursing*, 72(12), pp. 2954-2965.

Kamlungdee, U., Bunmusik, P. and Watcharawiwat, A. (2017). The Development of Home Visit Guidelines for Patients with Type 2 Diabetes Mellitus or Hypertension Run by Family Care Team. *The Southern College Network Journal of Nursing and Public Health*, 4s, pp. 34-45.

Kanhachin, H. and Limtragool, P. (2020). Improvement of care for Patients with Diabetes Mellitus at a Health Promoting Hospital in Phibun Rak District, Udon Thani Province. *Journal of Nursing and Health Care*, 38(3), pp. 186-195

Kankam, P.K. (2019). The use of paradigms in information research. *Library & Information Science Research*, 41(2), pp.85-92.

Kanyakan, K., Chareonyut, N., Kosalvitr, T. and Bunyaniwarawat, N. (2019). Self -care behaviors of patients with uncontrolled diabetes mellitusat Dongbang Sub-district Health Promoting Hospital, Muang District, UbonRatchathani Province. *UBRU Journal for Public Health Research*, 8(2), pp.32-42.

Kar, S.S., Thakur, J.S., Jain, S. and Kumar, R. (2008). Cardiovascular disease risk management in a primary health care setting of north India. *Indian heart journal*, 60(1), p.19.

Kasemsuk, W. and Koshakri, R. (2015). The need to improve of Health Volunteer's ability in Home Visit for Diabetes People in Communities. *Journal of the Royal Thai Army Nurses*. 16(2), pp.59-68.

Kashgary, A. D. (2011). The paradox of translating the untranslatable: Equivalence vs. non-equivalence in translating from Arabic into English. *Journal of King Saud University-Languages and Translation*, 23(1), pp. 47-57.

Katewongsa, P., Pongpradit, K. and Widyastari, D.A. (2021). Physical activity level of Thai children and youth: Evidence from Thailand's 2018 report card on physical activity for children and youth. *Journal of Exercise Science & Fitness*, 19(2), pp.71-74.

Katewongsa, P., Sawangdee, Y., Yousomboon, C. and Choolert, P. (2014). Physical activity in Thailand: The general situation at national level. *Journal of Science and Medicine in Sport*, 18, pp. e100-e101.

Katsimpardi, L. and Lledo, P.M., 2018. Regulation of neurogenesis in the adult and aging brain. *Current opinion in neurobiology*, 53, pp.131-138.

Kaushik, V. and Walsh, C. A. (2019). Pragmatism as a research paradigm and its implications for social work research. *Social Sciences*, 8(9), p. 255.

Kay, D. and Kibble, J. (2016). Learning theories 101: application to everyday teaching and scholarship. *Advances in physiology education*, 40(1), pp.17-25.

Keiwkarnka, B. (2014). Health Volunteers Forge Better Care in Thailand's Villages. Kokusai Hoken Iryo (*Journal of International Health*), 29(2), pp.136-138.

Kerthu, H. S. and Nuuyoma, V. (2019). Theory-Practice Gap: Challenges Experienced by Nursing Students at the Satellite Campus of a Higher Education Institution in Namibia. *International Journal of Higher Education*, 8(5), pp. 21-28.

Khan, A. T., Lateef, N. A., Khamseen, M. A. B., Alithan, M. A. A., Khan, S. A. and Ibrahim, I. (2011). Knowledge, attitude and practice of ministry of health primary health care physicians in the management of type 2 diabetes mellitus: A cross sectional study in the Al Hasa District of Saudi Arabia, 2010. *Nigerian Journal of Clinical Practice*, 14(1). pp. 52-59.

Kheir, N., Greer, W., Yousif, A., Al Geed, H. and Al Okkah, R. (2011). Knowledge, attitude and practices of Qatari patients with type 2 diabetes mellitus. *International Journal of Pharmacy Practice*, 19(3), pp. 185-191.

Khunkaew, S., Tungpunkom, P., Sim, J. and Fernandez, R. (2018). The Experiences of people in Northern Thailand living with Diabetic Foot Ulcers: A descriptive qualitative study. *Pacific Rim International Journal of Nursing Research*, 22 (4), 304-318.

Khunthar, A. (2014). The impacts and solutions to nursing workforce shortage in Thailand. *Nursing Science Journal of Thailand*, 32(1), pp.81-90.

Khunti, K., Davies, M., Majeed, A., Thorsted, B. L., Wolden, M. L. and Paul, S. K. (2015). Hypoglycemia and risk of cardiovascular disease and all-cause mortality in insulin-treated people with type 1 and type 2 diabetes: a cohort study. *Diabetes care*, 38(2), pp. 316-322.

Kiefer, S. M., Alley, K. M. and Ellerbrock, C. R. (2015). Teacher and peer support for young adolescents' motivation, engagement, and school belonging. *Rmle Online*, 38(8), 1-18.

Kimberlin, C.L. and Winterstein, A.G. (2008). Validity and reliability of measurement instruments used in research. *American journal of health-system pharmacy*, 65(23), pp.2276-2284.

Kindarara, D.M. and Silva, G.E. (2019). Prevalence and Associated Risk Factors of Diabetes in the African Immigrant Population of Sacramento County, California. *The Diabetes Educator*, 45(2), pp.225-239.

Kirkman, M.S., Briscoe, V.J., Clark, N., Florez, H., Haas, L.B., Halter, J.B., Huang, E.S., Korytkowski, M.T., Munshi, M.N., Odegard, P.S. and Pratley, R.E. (2012). Diabetes in older adults: consensus report. *Journal of the American Geriatrics Society*, 60(12), p.2342.

Kittithaworn, A., Dy, R., Hatthachote, P., Rangsin, R., Mungthin, M., Narindrarangkura, P. and Piyaraj, P. (2019). Incidence and associated factors of Type 2 diabetes: a community-based cohort study in the central region of rural community in Thailand. *Asia Pacific Journal of Public Health*, 31(1), pp.72-83.

Kivunja, C. and Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of higher education*, 6(5), pp. 26-41.

Knowles, M.S., Holton, E. and Swanson, R. (2005). *The adult learner: the definitive classic in adult education and human resource development (6th)*. Burlington, MA: Elsevier.

Kobayashi, L. C., Wardle, J., Wolf, M. S. and von Wagner, C. (2015). Cognitive function and health literacy decline in a cohort of aging English adults. *Journal of general internal medicine*, 30(7), pp.958-964.

Koba, S. and Hirano, T. (2011). Dyslipidemia and atherosclerosis. Nihon rinsho. *Japanese journal of clinical medicine*, 69(1), pp.138-143.

Koipuram, A., Carroll, S., Punthakee, Z. and Sherifali, D. (2020). Diabetes knowledge, risk perception, and quality of life among South Asian caregivers in young adulthood. *BMJ Open Diabetes Research and Care*, 8(2), p.e001268.

Kolb, A. Y. and Kolb, D. A. (2017). Experiential learning theory as a guide for experiential educators in higher education. *ELTHE: A Journal for Engaged Educators*, 1(1), pp. 7-44.

Kolb, D.A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Prentice-Hall, Inc. Englewood Cliffs, NJ.

Konrad, K., Datz, N., Engelsberger, I., Grulich-Henn, J., Hoertenhuber, T., Knauth, B., Meissner, T., Wiegand, S., Woelfle, J., Holl, R.W. and German/Austrian DPV Initiative. (2015). Current use of metformin in addition to insulin in pediatric patients with type 1

diabetes mellitus: an analysis based on a large diabetes registry in Germany and Austria. *Pediatric diabetes*, 16(7), pp.529-537.

Koontz, M. B., Cuttler, L., Palmert, M. R., O'Riordan, M., Borawski, E. A., McConnell, J. and Kern, E. O. (2010). Development and validation of a questionnaire to assess carbohydrate and insulin-dosing knowledge in youth with type 1 diabetes. *Diabetes Care*, 33(3), pp. 457-462.

Kosachunhanun, N., Tongprasert, S. and Rerkasem, K. (2012). Diabetic foot problems in tertiary care diabetic clinic in Thailand. *The International Journal of Lower Extremity Wounds*, 11(2), pp.124-127.

Koshakri, R., Kasemsuk, W. and Rerkluenrit, J. **(**2016). The outcomes of program for improvement of Health Volunteer's Abilityin Educational Home Visit for Diabetes People without Complicationin Communities. *Journal of The Royal Thai Army Nurses*, 17 (1), pp.141-147**.**

Kovacic, D. (2018). Using the content validity index to determine content validity of an instrument assessing health care providers' general knowledge of human trafficking. *Journal of human trafficking*, 4(4), pp. 327-335.

Kowitt, S. D., Emmerling, D., Fisher, E. B. and Tanasugarn, C. (2015). Community health workers as agents of health promotion: analyzing Thailand's village health volunteer program. *Journal of community health*, 40(4), pp. 780-788.

Krairittichai, U., Jongsareejit, A., Sattaputh, C. and Arunratanachote, W. (2013). A 4-year prospective study on long-term complications of type 2 diabetic patients: the Thai DMS diabetes complications (DD. Comp.) project. *Journal of the Medical Association of Thailand*, 96(6), pp.637-43.

Krairittichai, U., Potisat, S., Jongsareejit, A. and Sattaputh, C. (2011). Prevalence and risk factors of diabetic nephropathy among Thai patients with type 2 diabetes mellitus. *Journal of the Medical Association of Thailand= Chotmaihet Thangphaet*, 94, pp. S1-5.

Krbec, D. and Currie, D. (2010). Advantages of experiential learning in development of international economics and business study programs. *Economic research-Ekonomska istraživanja*, 23(3), pp.121-133.

Krouwel, M., Jolly, K. and Greenfield, S. (2019). Comparing Skype (video calling) and in-person qualitative interview modes in a study of people with irritable bowel syndrome–an exploratory comparative analysis. *BMC Medical Research Methodology*, 19(1), p. 219.

Kulshrestha, M., Seth, S., Tripathi, A., Seth, A. and Kumar, A. (2015). Prevalence of complications and clinical audit of management of type 2 diabetes mellitus: a prospective hospital based study. *Journal of clinical and diagnostic research: JCDR*, 9(11), p. OC25.

Kumar, I.U., Murthy, J.P., Upadya, U. and Venkatesh, M. (2017). Gender differences in awareness of diabetes mellitus among the rural population. *Asian Journal of Medical Sciences*, 8(2), pp.44-49.

Kumarasinghe, S. A., Hettiarachchi, P. and Wasalathanthri, S. (2018). Nurses' knowledge on diabetic foot ulcer disease and their attitudes towards patients affected: A cross-sectional institution-based study. *Journal of clinical nursing*, 27(1-2), pp. e203-e212.

Kum-oo, S., Orntha, R., Kaewmuang, C., Boonjarern, S., and Katasa, M. (2014). The outcome of teaching the village health volunteers on fingerstick glucose procedure at Ratsamran health promotion community hospital. *Sanpasitthiprasong Medical Journal*, 35(1), pp.29-41.

Kusurkar, R. A., Ten Cate, T. J., Vos, C. M. P., Westers, P. and Croiset, G. (2013). How motivation affects academic performance: a structural equation modelling analysis. *Advances in health sciences education*, 18(1), pp. 57-69.

Kvale, S. (2007). Planning an interview study. *Doing interviews*, 1, pp. 34-51.

Lechuga, V. M. (2012). Exploring culture from a distance: The utility of telephone interviews in qualitative research. *International Journal of Qualitative Studies in Education*, 25(3), pp. 251-268.

Lee, D. C., Park, I., Jun, T. W., Nam, B. H., Cho, S. I., Blair, S. N. and Kim, Y. S. (2012). Physical activity and body mass index and their associations with the development of type 2 diabetes in Korean men. *American journal of epidemiology*, 176(1), pp.43-51.

Lee, J. and Shute, V. J. (2010). Personal and social-contextual factors in K–12 academic performance: An integrative perspective on student learning. *Educational Psychologist*, 45(3), pp. 185-202.

Lee, J. E. and Sim, I. O. (2020). Gap between college education and clinical practice: Experience of newly graduated nurses. *Nursing Open*, 7(1), pp. 449-456.

Legault, L. (2016). *Intrinsic and extrinsic motivation*. In V. Zeigler-Hill and T. Shackelford (Eds.), Encyclopedia of Personality and Individual Differences. New York, NY: Springer. http://link.springer.com/referenceworkentry/10.1007/978-3-319-28099-8_1139-1

Lemay, N.V., Sullivan, T., Jumbe, B. and Perry, C.P. (2012). Reaching remote health workers in Malawi: baseline assessment of a pilot mHealth intervention. *Journal of health communication*, 17(sup1), pp.105-117.

Leon, B. M. and Maddox, T. M. (2015). Diabetes and cardiovascular disease: Epidemiology, biological mechanisms, treatment recommendations and future research. *World journal of diabetes*, 6(13), p.1246.

LeRoith, D., Biessels, G.J., Braithwaite, S.S., Casanueva, F.F., Draznin, B., Halter, J.B., Hirsch, I.B., McDonnell, M.E., Molitch, M.E., Murad, M.H. and Sinclair, A.J. (2019). Treatment of diabetes in older adults: an endocrine society clinical practice guideline. *The Journal of Clinical Endocrinology & Metabolism*, 104(5), pp.1520-1574.

Levin, D. M. (1988). *The opening of vision: Nihilism and the postmodern situation*. London: Routledge

Li, J., Chattopadhyay, K., Xu, M., Chen, Y., Hu, F., Chu, J. and Li, L. (2018). Glycaemic control in type 2 diabetes patients and its predictors: a retrospective database study at a tertiary care diabetes centre in Ningbo, China. *BMJ open*, 8(3), p.e019697.

Li, L.Y. (2019). Effect of prior knowledge on attitudes, behavior, and learning performance in video lecture viewing. *International Journal of Human–Computer Interaction*, 35(4-5), pp.415-426.

Li, M., Fan, Y., Zhang, X., Hou, W. and Tang, Z. (2014). Fruit and vegetable intake and risk of type 2 diabetes mellitus: meta-analysis of prospective cohort studies. *BMJ open*, 4(11).

Li, S., Guo, S., He, F., Zhang, M., He, J., Yan, Y., Ding, Y., Zhang, J., Liu, J., Guo, H. and Xu, S. (2015). Prevalence of diabetes mellitus and impaired fasting glucose, associated with risk factors in rural Kazakh adults in Xinjiang, China. *International journal of environmental research and public health*, 12(1), pp.554-565.

Liao, L. and Paweenawat, S. W. (2018). Labour Supply of Married Women in Thailand: 1985-2016. *PIER Discussion Papers*, *88*.

Library of Congress-Federation Research Division (2007). *Country Profile: Thailand.* [online] Available at: https://www.loc.gov/rr/frd/cs/profiles/Thailand [Accessed: 10th February 2018]

Lima, V.C., Cavalieri, G.C., Lima, M.C., Nazario, N.O. and Lima, G.C. (2016). Risk factors for diabetic retinopathy: a case–control study. *International journal of retina and vitreous*, 2(1), p.21.

Linn, N.Y.Y., Kathirvel, S., Das, M., Thapa, B., Rahman, M.M., Maung, T.M., Kyaw, A.M.M., Thi, A. and Lin, Z. (2018). Are village health volunteers as good as basic health staffs in providing malaria care? A country wide analysis from Myanmar, 2015. *Malaria journal*, 17(1), p.242.

Lin, Y. Y., Hsu, C. W., Sheu, W. H. H., Chu, S. J., Wu, C. P. and Tsai, S. H. (2010). Risk factors for recurrent hypoglycemia in hospitalized diabetic patients admitted for severe hypoglycemia. *Yonsei medical journal*, 51(3), p. 367.

Livingston, R. and Dunning, T. (2010). Practice nurses' role and knowledge about diabetes management within rural and remote Australian general practices. *European Diabetes Nursing*, 7(2), pp. 55-62.

Loeng, S. (2020). Self-directed learning: A core concept in adult education. *Education Research International*, 2020.

Loipha, S. (2014). Thai elderly behavior of internet use. *Procedia-Social and Behavioral Sciences*, 147, pp. 104-110.

Lopez, G. I., Figueroa, M., Connor, S. E. and Maliski, S. L. (2008). Translation barriers in conducting qualitative research with Spanish speakers. *Qualitative health research*, 18(12), pp. 1729-1737.

Low, N., Butt, S., Ellis, P. and Davis Smith, J. (2007). *Helping out: a national survey of volunteering and charitable giving*. London: Cabinet Office.

Luevano-Contreras, C., Durkin, T., Pauls, M. and Chapman-Novakofski, K. (2013). Development, relative validity, and reliability of a food frequency questionnaire for a case-control study on dietary advanced glycation end products and diabetes complications. *International journal of food sciences and nutrition*, 64(8), pp. 1030-1035.

Luo, J., Rossouw, J., Tong, E., Giovino, G.A., Lee, C.C., Chen, C., Ockene, J.K., Qi, L. and Margolis, K.L., (2013). Smoking and diabetes: does the increased risk ever go away? *American journal of epidemiology*, 178(6), pp.937-945.

Machingura, P. I., Chikwasha, V., Okwanga, P. N. and Gomo, E. (2017). Prevalence of and factors associated with nephropathy in diabetic patients attending an outpatient clinic in Harare, Zimbabwe. *The American journal of tropical medicine and hygiene*, 96(2), pp. 477-482.

Mack, L. (2010). *The philosophical underpinnings of educational research.* (19). 5-11.

Magnusson, E. and Marecek, J. (2015) *Doing Interview-based Qualitative Research: A Learner's Guide*, Cambridge, Cambridge University Press.

Mahmood, M.I., Daud, F. and Ismail, A. (2016). Glycaemic control and associated factors among patients with diabetes at public health clinics in Johor, Malaysia. *Public health*, 135, pp.56-65.

Mahmoud, M. H. (2014). Practical learning and theory practice gap as perceived by nursing students. *International Journal of Current Research*, 6(2), pp. 5083-5093.

Mahmudi, A. (2018). The gap between theory and practice: A qualitative study on Medical Assistant program in Malaysia. *European Journal of Education Studies*.

Malby, R., Boyle, D. and Crilly, T. (2017). Can Volunteering Help Create Better Health and Care. *An evidence review*.

Malina, M. A., Nørreklit, H. S. and Selto, F. H. (2011). Lessons learned: advantages and disadvantages of mixed method research. *Qualitative Research in Accounting & Management*, 8(1), pp. 59-71.

Mantovani, A.M., Fregonesi, C.E., Palma, M.R., Ribeiro, F.E., Fernandes, R.A. and Christofaro, D.G. (2017). Relationship between amputation and risk factors in individuals with diabetes mellitus: a study with Brazilian patients. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 11(1), pp.47-50.

Marks, J.R., Schectman, J.M., Groninger, H. and Plews-Ogan, M.L. (2010). The association of health literacy and socio-demographic factors with medication knowledge. *Patient education and counseling*, 78(3), pp.372-376.

Marshall, C and Rossman, G (2011). *Designing Qualitative Research*. 5th ed. London: SAGE Publications Ltd.

Martins, D. C. (2008). Experiences of homeless people in the health care delivery system: a descriptive phenomenological study. *Public health nursing*, 25(5), pp. 420-430.

Mashige, K. P., Notshweleka, A., Moodley, S., Rahmtoola, F. H., Sayed, S. B., Singh, S. and Sardiwalla, Z. (2008). An assessment of the level of diabetic patients' knowledge of diabetes mellitus, its complications and management in Durban, South Africa. *African Vision and Eye Health*, 67(3), pp. 95-105.

Masuwai, A.M. and Saad, N.S. (2016). Evaluating the face and content validity of a Teaching and Learning Guiding Principles Instrument (TLGPI): A perspective study of Malaysian teacher educators. *Geografia*, 12(3), pp, 11-21.

Maxwell, B. (1996). Translation and cultural adaptation of the survey instruments. *Third international mathematics and science study (TIMSS) technical report*, 1, pp.159-169.

Mauricio, D., Meneghini, L., Seufert, J., Liao, L., Wang, H., Tong, L., Cali, A., Stella, P., Carita, P. and Khunti, K. (2017). Glycaemic control and hypoglycaemia burden in patients with type 2 diabetes initiating basal insulin in Europe and the USA. *Diabetes, Obesity and Metabolism*, 19(8), pp.1155-1164.

McCarthy, M. (2010). Experiential learning theory: From theory to practice. *Journal of Business & Economics Research (JBER)*, 8(5).

McDonald, M. (2002). *Systematic assessment of learning outcomes: Devel-oping multiple-choice exams*. Boston: Jones & Bartlett Publishers.

McGuire, H., Longson, D., Adler, A., Farmer, A. and Lewin, I. (2016). Management of type 2 diabetes in adults: summary of updated NICE guidance. *Bmj*, 353, p.i1575.

McKim, C. A. (2017). The value of mixed methods research: A mixed methods study. *Journal of Mixed Methods Research*, 11(2), pp. 202-222.

McNamara, T. K. and Gonzales, E. (2011). Volunteer transitions among older adults: The role of human, social, and cultural capital in later life. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 66(4), pp. 490-501.

Mealer, M. and Jones, J. (2014). Methodological and ethical issues related to qualitative telephone interviews on sensitive topics. *Nurse researcher*, 21(4).

Mendoza Montano, C., Fort, M., deRamirez, M., Cruz, J. and Ramirez-Zea, M. (2015). Evaluation of a pilot hypertension management programme for Guatemalan adults. *Health Promotion International*, 31(2), pp.363-374.

Merger, S.R., Kerner, W., Stadler, M., Zeyfang, A., Jehle, P., Mueller-Korbsch, M., Holl, R.W., DPV Initiative and German BMBF Competence Network Diabetes mellitus. (2016). Prevalence and comorbidities of double diabetes. *Diabetes research and clinical practice*, 119, pp.48-56.

Merriam, S.B. (2017). Adult learning theory: Evolution and future directions. *PAACE Journal of Lifelong Learning*, (26), pp.21-37.

Mezirow, J. (1997). Transformative learning: Theory to practice. *New directions for adult and continuing education*, 1997(74), pp. 5-12.

Migiro, S. O. and Magangi, B. A. (2011). Mixed methods: A review of literature and the future of the new research paradigm. *African journal of business management*, 5(10), pp. 3757-3764.

Mikhail, N. (2017). Safety of technosphere inhaled insulin. *Current drug safety*, 12(1), pp. 27-31.

Miller, P.C., Rashida, G., Tasneem, Z. and ul Haque, M. (2012). The effect of traditional birth attendant training on maternal and neonatal care. *International Journal of Gynecology & Obstetrics*, 117(2), pp.148-152.

Miller, W. L., Crabtree, B. F., Harrison, M. I. and Fennell, M. L. (2013). Integrating mixed methods in health services and delivery system research. *Health Services Research*, 48(6 Pt 2), p. 2125.

Ministry of education Thailand (2016). *2016 EDUCATIONAL STATISTICS*. [online] Available at: http://www.en.moe.go.th/enMoe2017/index.php/educational-statistics/educational-statistics-2016 [Accessed: 7th August 2018]

Ministry of Health. (2013). *Blood Glucose Training course*. [online]Available at:http://phc.moph.go.th/www_hss/data_center/ifm_mod/nw/file954.pdf [Accessed:10th January 2020]

Ministry of Health, Singapore (2014). *Ministry of health clinical practice guidelines* 1/2014: diabetes mellitus. [online] available at: https://www.moh.gov.sg/hpp/doctors/guidelines/GuidelineDetails/cpgmed_diabetes_mellitus [Accessed: 4th February 2019]

Minister of Public Health. (2011). Thailand Health Profile Report 2008-2010. Bangkok. Bureau of Policy and Strategy, Ministry of Public Health.

Mirattanaphrai, S., Cooney, N., Preechachaiyavit, P., Udomchairat, R., Khonlaeaid, S. and Potisat, S. (2014). Diabetic Foot Care Service for Diabetic Patients–A National Survey Study of Community and General Hospitals in Thailand. *Journal of Health Science*, 23 (4), pp. 659-666.

Mirghani, H.M., Ezimokhai, M., Shaban, S. and van Berkel, H.J. (2014). Superficial and deep learning approaches among medical students in an interdisciplinary integrated curriculum. *Education for Health*, 27(1), p.10.

Mishra, B. K., Shukla, P., Aslam, M., Siddiqui, A. A. and Madhu, S. V. (2018). Prevalence of double diabetes in youth onset diabetes patients from east Delhi and neighboring NCR region. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 12(6), pp. 839-842.

Mitchell, G. (2015). Use of interviews in nursing research. *Nursing Standard* (2014+), 29(43), p. 44.

Mock, J., McPhee, S.J., Nguyen, T., Wong, C., Doan, H., Lai, K.Q., Nguyen, K.H., Nguyen, T.T. and Bui-Tong, N. (2007). Effective lay health worker outreach and media-based

education for promoting cervical cancer screening among Vietnamese American women. *American Journal of Public Health*, 97(9), pp.1693-1700.

Modic, M. B., Albert, N. M., Nutter, B., Coughlin, R., Murray, T., Spence, J. and Brosovich, D. (2009). Diabetes teaching is not for the faint of heart: are cardiac nurses up to the challenge? *Journal of Cardiovascular Nursing*, 24(6), pp. 439-446.

Mohajan, H.K. (2017). Two criteria for good measurements in research: Validity and reliability. Annals of Spiru Haret University. *Economic Series*, 17(4), pp.59-82.

Mohammed, S., Islam, S., Niessen, L.W., Seissler, J., Ferrari, U., Biswas, T., Islam, A. and Lechner, A. (2015). Diabetes knowledge and glycemic control among patients with type 2 diabetes in Bangladesh. *SpringerPlus*, 4(1), p.1

Mohamed, S.F., Mwangi, M., Mutua, M.K., Kibachio, J., Hussein, A., Ndegwa, Z., Owondo, S., Asiki, G. and Kyobutungi, C. (2018). Prevalence and factors associated with pre-diabetes and diabetes mellitus in Kenya: results from a national survey. *BMC public health*, 18(3), p.1215

Momanyi, G. O., Adoyo, M. A., Mwangi, E. M. and Mokua, D. O. (2016). Value of training on motivation among health workers in Narok County, Kenya. *Pan African Medical Journal*, 23(1).

Mottalib, A., Kasetty, M., Mar, J. Y., Elseaidy, T., Ashrafzadeh, S. and Hamdy, O. (2017). Weight management in patients with type 1 diabetes and obesity. *Current diabetes reports*, 17(10), p. 92.

Mpembeni, R.N., Bhatnagar, A., LeFevre, A., Chitama, D., Urassa, D.P., Kilewo, C., Mdee, R.M., Semu, H., Winch, P.J., Killewo, J. and Baqui, A.H. (2015). Motivation and satisfaction

among community health workers in Morogoro Region, Tanzania: nuanced needs and varied ambitions. *Human resources for health*, 13(1), p.44.

Muhajirah, M. (2020). Basic of Learning Theory:(Behaviorism, Cognitivism, Constructivism, and Humanism). *International Journal of Asian Education*, 1(1), pp. 37-42.

Mukhalalati, B. A. and Taylor, A. (2019). Adult Learning Theories in Context: A Quick Guide for Healthcare Professional Educators. *Journal of medical education and curricular development*, 6, 2382120519840332.

Muktabhant, B., Sanchaisuriya, P., Trakulwong, M., Mingchai, R. and Schelp, F.P. (2015). A first-degree relative with diabetes mellitus is an important risk factor for rural Thai villagers to develop type 2 diabetes mellitus. *Asia Pacific Journal of Public Health*, 27(4), pp.385-393.

Mullan, F. and Frehywot, S. (2007). Non-physician clinicians in 47 sub-Saharan African countries. The Lancet, 370(9605), pp.2158-2163.

Murad, M.H., Coto-Yglesias, F., Varkey, P., Prokop, L.J. and Murad, A.L. (2010). The effectiveness of self-directed learning in health professions education: a systematic review. *Medical education*, 44(11), pp.1057-1068.

Mustapha, W., Hossain, Z. S. and O'Loughlin, K. (2014). Management and impact of diabetes on quality of life among the Lebanese community of Sydney: A quantitative study. *Journal of Diabetes and Metabolic disorders*, 5(329), p.2.

Mutea, N. K. and Baker, C. M. (2008). Kenyan nurses' involvement in managing hospitalized diabetic patients. *International Journal of Nursing Practice*, 14(1), pp. 40-46.

Naburi, H., Ekström, A.M., Mujinja, P., Kilewo, C., Manji, K., Biberfeld, G., Sando, D., Chalamila, G. and Bärnighausen, T. (2017). The potential of task-shifting in scaling up

services for prevention of mother-to-child transmission of HIV: a time and motion study in Dar es Salaam, Tanzania. *Human resources for health*, 15(1), pp.1-11.

Nakrukamphonphatn, S., Suwannakoot, N. and Natason, A. (2019). Experienced of Village Health Volunteer to Take Care for Patients in The Community. *Journal of Science & Technology, Ubon Ratchathani University*, 21. January-April 2019.

Nam, S., Chesla, C., Stotts, N. A., Kroon, L. and Janson, S. L. (2011). Barriers to diabetes management: patient and provider factors. *Diabetes research and clinical practice*, 93(1), pp. 1-9.

Namjaidee, R. (2014). Choice of Benefits Use at Point-of-services by Patients with Thai Health Insurance. *Academic Services Journal, Prince of Songkla University*, 25(2), pp.74-82.

Nantsupawat, N., Booncharoen, A., Wisetborisut, A., Jiraporncharoen, W., Pinyopornpanish, K., Chutarattanakul, L. and Angkurawaranon, C. (2019). Appropriate Total cholesterol cut-offs for detection of abnormal LDL cholesterol and non-HDL cholesterol among low cardiovascular risk population. *Lipids in health and disease*, 18(1), pp.1-8.

Nash, M. (2009). Mental health nurses' diabetes care skills–a training needs analysis. *British Journal of Nursing*, 18(10), pp.626-630.

National Center for Biotechnology Information. (2020). *Type 2 diabetes: Measuring sugar levels in blood and urine yourself*. [online] Available at: https://www.ncbi.nlm.nih.gov/books/NBK279508/ [Accessed: 4th November 2020]

National Institute for Health and Care Excellence. (2015). *Type 2 diabetes in adults: management.* [online] Available at: https://www.nice.org.uk/guidance/ng28 [Accessed: 6th April 2019]

National Statistical Office. (2019). *Religion, Art and Culture*. [online] Available at: http://www.nso.go.th/sites/2014en [Accessed: 8th May 2020]

National Statistical Office, Ministry of Digital Economy and Society (2018). *The 2018 Household Survey on the Use of Information and Communication Technology*. [online] Available at: http://www.nso.go.th/sites/2014en [Accessed: 8th May 2020]

National Statistical Office Thailand. (2012). *Number of populations aged 11 years and over by playing sport or exercise, age group, sex, area*: 2004, 2007 and 2011. [online] Available at: http://www.nso.go.th/sites/2014en [Accessed: 8th May 2020]

Navarro-Flores, E., Morales-Asencio, J. M., Cervera-Marín, J. A., Labajos-Manzanares, M. T. and Gijon-Nogueron, G. (2015). Development, validation and psychometric analysis of the diabetic foot self-care questionnaire of the University of Malaga, Spain (DFSQ-UMA). *Journal of tissue viability*, 24(1), pp. 24-34.

Ngwogu, K.O., Mba, I.E.K. and Ngwogu, A.C. (2012). Glycaemic control amongst diabetic mellitus patients in Umuahia Metroppolis, Abia State, Nigeria. *International Journal of Basic, Applied and Innovative Research*, 1(3), pp.98-104.

Nickerson, H. D. and Dutta, S. (2012). Diabetic complications: current challenges and opportunities. *Journal of cardiovascular translational research*, 5(4), pp. 375-379.

Nisar, M.U., Asad, A., Waqas, A., Ali, N., Nisar, A., Qayyum, M.A., Maryam, H., Javaid, M. and Jamil, M. (2015). Association of diabetic neuropathy with duration of type 2 diabetes and glycemic control. *Cureus*, 7(8).

Nitikarun, P. and Bunyong, R. (2018). Coverage of Diabetic Retinopathy Screening and Prevalence of Diabetic Retinopathy in Public Health Regional Service Provider 6th,

Thailand 2016. *The Journal of Prapokklao Hospital Clinical Medical Education Center*, 35(2), pp.16-25.

Noor, S.K., Elmadhoun, W.M., Bushara, S.O., Almobarak, A.O., Salim, R.S., Forawi, S.A., Awadallah, H., Elwali, E.S. and Ahmed, M.H. (2017). Glycaemic control in Sudanese individuals with type 2 diabetes: Population based study. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 11, pp.S147-S151.

Nooseisai, M., Wang, Y.F., Hongsranagon, P. and Munisamy, M. (2016). Medical tourism within the medical hub policy: reviewing the need of a balanced strategy for health inequality reduction in a Thai context. *Journal of Health Research*, 30(6), pp.445-450.

Nopphonkrang, C., Siridhara, S. and Limanond, T. (2015). Analysis of accessibility index of primary healthcare service for diabetic patients: a case study in Chiang Mai. *The Public Health Journal of Burapha University*, 10(1), pp. 77-86.

Notification of the Ministry of Public Health: The Village Health Volunteer's compensation. (2019). *Ratchakitcha.* No. 137. [online] Available at: http://www.ratchakitcha.soc.go.th/DATA/PDF/2562/E/070/T_0007.PDF [Accessed: 7th March 2020]

Novo Nordisk (2013). *The diabetes epidemic and its impact on Thailand*. Bangkok: Novo Nordisk.

Nuffer, W. and Trujillo, J. (2016). The Role of Inhaled Insulin in the Management of Type 2 Diabetes. *Pharmacology & Pharmacy*, 7(04), p. 162.

Nurjannah, I., Mills, J., Park, T. and Usher, K. (2014). Conducting a grounded theory study in a language other than English: procedures for ensuring the integrity of translation. *Sage Open*, 4(1), 2158244014528920.

Obirikorang, Y., Obirikorang, C., Anto, E.O., Acheampong, E., Batu, E.N., Stella, A.D., Constance, O. and Brenya, P.K. (2016). Knowledge of complications of diabetes mellitus among patients visiting the diabetes clinic at Sampa Government Hospital, Ghana: a descriptive study. *BMC public health*, 16(1), p.637.

O'Brien, S. V., Michaels, S. E. and Hardy, K. J. (2003). A comparison of general nurses' and junior doctors' diabetes knowledge. *Professional Nurse (London, England)*, 18(5), pp. 257-260.

Odili, V.U., Isiboge, P.D. and Eregie, A. (2011). Patients' knowledge of diabetes mellitus in a Nigerian city. *Tropical Journal of Pharmaceutical Research*, 10(5), pp.637-642.

Office of National Health Examination Survey. (2016). *National Health Examination Survey 2014*. Bangkok: Health System Research Institute.

Office of the National Economic and Social Development Board (1977). The Forth National Economic and Social Development Plan (1977-1981) [online]. Available at: http://www.nesdb.go.th/nesdb_en/ewt_w3c/ewt_dl_link.php?filename=develop_issue&nid=3779 [Accessed: 20th December 2019]

Ogbera, O. A., Adeyeye, O., Odeniyi, I. A. and Adeleye, O. (2013). Knowledge of diabetes mellitus in tuberculosis amongst healthcare workers in Nigeria. *Indian journal of endocrinology and metabolism*, 17(4), p. 704.

Okuyan, B., Sancar, M. and Izzettin, F.V. (2013). Assessment of medication knowledge and adherence among patients under oral chronic medication treatment in community pharmacy settings. *Pharmacoepidemiology and drug safety*, 22(2), pp.209-214.

Oleck, J., Kassam, S. and Goldman, J. D. (2016). Commentary: why was inhaled insulin a failure in the market? *Diabetes Spectrum*, 29(3), pp. 180-184.

Olsen, M., Granath, A., Wharén, P., Blom, T. and Leksell, J. (2012). Perceived knowledge about diabetes among personnel in municipal care: a qualitative focus group interview study. *European Diabetes Nursing*, 9(2), pp. 52-55.

Oluma, A., Abadiga, M., Mosisa, G. and Etafa, W. (2021). Magnitude and predictors of poor glycemic control among patients with diabetes attending public hospitals of Western Ethiopia. PloS one, 16(2), p.e0247634.

Oluwatayo, J. A. (2012). Validity and reliability issues in educational research. *Journal of educational and social research*, 2(2), pp. 391-400.

Ong, W. M., Chua, S. S. and Ng, C. J. (2014). Barriers and facilitators to self-monitoring of blood glucose in people with type 2 diabetes using insulin: a qualitative study. *Patient preference and adherence*, 8, p. 237.

Ontha, R., Moolsart, S. and Pitchayapinyo, P. (2016). The Development of a Home Visit Model based on Participation between Professional Nurses and Village Health Volunteers for Type II Diabetes. *Journal of Nursing and Health Care*, 34 (4).

Onwuegbuzie, A. J., Bustamante, R. M. and Nelson, J. A. (2010). Mixed research as a tool for developing quantitative instruments. *Journal of mixed methods research*, 4(1), pp. 56-78.

Opdenakker, R. (2006). Advantages and disadvantages of four interview techniques in qualitative research. In *Forum qualitative sozialforschung/forum: Qualitative social research*, 7 (4).

O'Shea, A., Cohen, R., Porges, E.C., Nissim, N.R. and Woods, A.J. (2016). Cognitive aging and the hippocampus in older adults. *Frontiers in aging neuroscience*, 8, p.298.

Otsu, K. and Shibayama, K. (2016). Population aging and potential growth in Asia. *Asian Development Review*, 33(2), pp. 56-73.

Otto-Buczkowska, E. and Machnica, L. (2009). The perspectives of adjunctive drugs usage in the treatment of glucose metabolism disturbances in adolescent patients. *Pediatric Endocrinology Diabetes and Metabolism*, 15(4), pp. 260-5.

Otto-Buczkowska, E. and Jainta, N. (2018). Pharmacological Treatment in Diabetes Mellitus Type 1–Insulin and What Else? *International journal of endocrinology and metabolism*, 16(1).

Ovatakanont, P., (2011). The outcome of diabetes care and factors associated with poor glycemic control among type 2 diabetic patients in Saimun Hospital. *Srinagarind Med J* [internet], 26(4), pp.339-349.

Owek, C., Abong'o, B., Oyugi, H., Oteku, J., Kaseje, D., Muruka, C. and Njuguna, J. (2013). Motivational factors that influence retention of community health workers in a Kenyan district. *Public Health Res*, 3(5), 109-115.

Oyetunde, M. O. and Famakinwa, T. T. (2014). Nurses' knowledge of contents of diabetes patient education in Ondo–state, Nigeria. *Journal of Nursing Education and Practice*, 4(4), p.91.

Paek, S. C., Meemon, N. and Wan, T. T. (2016). Thailand's universal coverage scheme and its impact on health-seeking behavior. *Springerplus*, 5(1), p. 1952.

Pagaiya, N., Kongkam, L. and Sriratana, S. (2015). Rural retention of doctors graduating from the rural medical education project to increase rural doctors in Thailand: a cohort study. *Human resources for health*, 13(1), p. 10.

Pagaiya, N. and Noree, T. (2009). Thailand's health workforce: a review of challenges and experiences.

Paisansirikul, A., Ketprayoon, A., Ittiwattanakul, W. and Petchlorlian, A. (2020). Prevalence and Associated Factors of Drug-Related Problems Among Older People: A Cross-Sectional Study at King Chulalongkorn Memorial Hospital in Bangkok. *Drugs-real world outcomes*, pp. 1-12.

Pal, R., Yadav, U., Grover, S., Saboo, B., Verma, A. and Bhadada, S.K. (2020). Knowledge, attitudes and practices towards COVID-19 among young adults with Type 1 Diabetes Mellitus amid the nationwide lockdown in India: A cross-sectional survey. *Diabetes research and clinical practice*, 166, p.108344.

Panya, K. and Chowwanapoonpohn, H. (2021). Operational Performance of Medicine Procurement in Community Hospital under Price Control Mechanism using Medicine Estimated Cost. *Thai Pharmaceutical and Health Science Journal*, 15(4), pp.251-258.

Papastavrou, E., Tsangari, H., Kalokerinou, A., Papacostas, S.S. and Sourtzi, P. (2009). Gender issues in caring for demented relatives. *Health Science Journal*, 3(1), pp.41-53.

Papier, K., D'Este, C., Bain, C., Banwell, C., Seubsman, S.A., Sleigh, A. and Jordan, S. (2017). Consumption of sugar-sweetened beverages and type 2 diabetes incidence in Thai adults: results from an 8-year prospective study. *Nutrition & diabetes*, 7(6), pp.e283-e283.

Papier, K., Jordan, S., Catherine, D.E., Bain, C., Peungson, J., Banwell, C., Yiengprugsawan, V., Seubsman, S.A. and Sleigh, A. (2016). Incidence and risk factors for type 2 diabetes mellitus in transitional Thailand: results from the Thai cohort study. *BMJ open*, 6(12).

Park, K. A., Cho, W. I., Song, K. J., Lee, Y. S., Sung, I. S. and Choi-Kwon, S. M. (2011). Assessment of nurses' nutritional knowledge regarding therapeutic diet regimens. *Nurse Education Today*, 31(2), pp.192-197.

Park, Y.S., Konge, L. and Artino, A.R. (2020). The positivism paradigm of research. *Academic Medicine*, 95(5), pp.690-694.

Pasek, J. and Krosnick, J.A. (2010). Optimizing survey questionnaire design in political science: Insights from psychology. *Oxford handbook of American elections and political behavior*, pp.27-50.

Patrick, D.L., Burke, L.B., Gwaltney, C.J., Leidy, N.K., Martin, M.L., Molsen, E. and Ring, L. (2011). Content validity—establishing and reporting the evidence in newly developed patient-reported outcomes (PRO) instruments for medical product evaluation: ISPOR PRO Good Research Practices Task Force report: part 2—assessing respondent understanding. *Value in Health*, 14(8), pp.978-988.

Pattharapinyophong, W. (2019). The opportunities and challenges for Thailand in becoming the medical tourism hub of the ASEAN region. *Journal of Management Sciences Suratthani Rajabhat University*, 6(1), pp.1-16.

Paul, F., Connor, L., McCabe, M. and Ziniel, S. (2016). The development and content validity testing of the Quick-EBP-VIK: a survey instrument measuring nurses' values, knowledge and implementation of evidence-based practice. *Journal of Nursing Education and Practice*, 6(5), p.118.

Payne, J., Razi, S., Emery, K., Quattrone, W. and Tardif-Douglin, M. (2017). Integrating community health workers (CHWs) into health care organizations. *Journal of community health*, 42(5), pp. 983-990.

Pedro, R. A., Ramon, S. A., Marc, B. B., Juan, F. B. and Isabel, M. M. (2010). Prevalence and relationship between diabetic retinopathy and nephropathy, and its risk factors in the North-East of Spain, a population-based study. *Ophthalmic epidemiology*, 17(4), pp. 251-265.

Peimani, M., Tabatabaei-Malazy, O., Heshmat, H., Sanjari, M. and Pajouhi, M. (2010). Knowledge, Attitude and Practice of physicians in the field of diabetes and its complications; A pilot study. *Journal of Diabetes and Metabolic Disorders*, 9, p.10.

Pellicer-Sánchez, A. and Schmitt, N. (2012). Scoring Yes–No vocabulary tests: Reaction time vs. nonword approaches. *Language Testing*, 29(4), pp.489-509.

Peltzer, K., Pengpid, S., Puckpinyo, A. and Viripiromkool, S. (2015). Obesity and lifestyle factors in male hospital out-patients in Thailand. *Gender and Behaviour*, 13(2), pp.6668-6674.

Penner, M.R., Roth, T.L., Barnes, C. and Sweatt, D. (2010). An epigenetic hypothesis of aging-related cognitive dysfunction. *Frontiers in aging neuroscience*, 2, p.9.

Perrin, K. M. (2015). *Principles of evaluation and research for health care programs*. Burlington, MA: Jones & Bartlett Learning.

Perry, H. B., Zulliger, R., and Rogers, M. M. (2014). Community health workers in low-, middle-, and high-income countries: an overview of their history, recent evolution, and current effectiveness. *Annual review of public health*, 35, pp. 399-421.

Petersmann, A., Nauck, M., Müller-Wieland, D., Kerner, W., Müller, U.A., Landgraf, R., Freckmann, G. and Heinemann, L. (2018). Definition, classification and diagnosis of diabetes mellitus. *Experimental and Clinical Endocrinology & Diabetes*, 126(07), pp.406-410.

Piboon, K., Methaphat, C., Ouppawongsapat, D., Chaiklongkit, K., Arunrat, P. and Sukthong, N. (2020). Predicting Factors of Physical Activity among University Students, Thailand. *The Bangkok Medical Journal*, 16(1), pp.33-33.

Pickard, A. (2013). *Research Methods in Information*. 2nd edition. London: Facet.

Polit, D. F. and Beck, C. T. (2017). *Nursing research: Generating and assessing evidence for nursing practice*. (10th ed). Wolters Kluwer.

Polit, D.F., Beck, C.T. and Owen, S.V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in nursing & health*, 30(4), pp.459-467.

Ponterotto, J. G., Mathew, J. T. and Raughley, B. (2013). The value of mixed methods designs to social justice research in counseling and psychology. *Journal for Social Action in Counseling & Psychology*, 5(2), pp. 42-68.

Poolsup, N., Suksomboon, N. and Rattanasookchit, S. (2009). Meta-analysis of the benefits of self-monitoring of blood glucose on glycemic control in type 2 diabetes patients: an update. *Diabetes technology & therapeutics*, 11(12), pp.775-784.

Pooripussarskul, S., Riewpaiboon, A., Bishai, D., Tantivess, S. and Muangchana, C. (2018). Identifying Important Factors Impacting the Adoption of New Vaccines in Thailand by Using a Best-Worst Scaling. *Journal of Health System Research*, 12(1), pp. 137-149.

Pronvarin, J., Kenggranpanich, M., Kenggranpanich, T. and Benjakul, S. (2012). Predicting Factors to Smoking Behaviour Among Workers in Thailand Tobacco Monopoly (TTM). *Journal of Health Education*, 35(122), pp.16-29.

Poulimeneas, D., Grammatikopoulou, M.G., Bougioukli, V., Iosifidou, P., Vasiloglou, M.F., Gerama, M.A., Mitsos, D., Chrysanthakopoulou, I., Tsigga, M. and Kazakos, K. (2016).

Diabetes knowledge among Greek type 2 diabetes mellitus patients. *Endocrinología y Nutrición (English Edition),* 63(7), pp.320-326.

Pozzilli, P., Guglielmi, C., Caprio, S. and Buzzetti, R. (2011). Obesity, autoimmunity, and double diabetes in youth. *Diabetes Care, 34(Supplement 2),* pp. S166-S170.

Prairie Research Associates, (n.d) *The in-depth interview*. [online] available at: https://gregorymason.ca/wp-content/uploads/2016/03/indepth_e.pdf [Accessed: 8th September 2019]

Price, P. C., Jhangiani, R. S. and Chiang, I. C. A. (2015). *Reliability and validity of measurement.* Research methods in psychology.

Primary Heath Care Division. (2012). *A proficient Village Health Volunteer training course 2012*. [online] Available at: http://phc.moph.go.th/www_hss/data_center/ifm_mod/nw/Y55_2_21_2.pdf. [Accessed: 2nd April 2021].

Primary Heath Care Division (2017). *Village health volunteer database*. [online] Available at: http://www.thaiphc.net/thaiphcweb/index.php?r=staticContent/show&id=1[Accessed 15th September, 2016]

Primary Health Care division **(**2019). *Village Health volunteer*. [online] Available at: https://www.thaiphc.net/new2020/content/1. [Accessed at: 8th February 2022].

Primary Health Care Division, Department of Health service, Ministry of Public Health. (2007). *Standard training course for village health volunteer*. [Online] Available at: https://www.nakhonphc.go.th/datacenter/doc_download/p1524.PDF [Accessed: 18th May 2016]

Prince, M.J. (2009). The 10/66 dementia research group-10 years on. *Indian Journal of psychiatry*, 51(Suppl1), p.S8.

Principi, A., Lindley, R., Perek-Bialas, J. and Turek, K. (2012). Volunteering in older age: An organizational perspective. *International Journal of Manpower*.

Priya, G. and Kalra, S. (2018). A review of insulin resistance in type 1 diabetes: is there a place for adjunctive metformin? *Diabetes Therapy*, 9(1), pp. 349-361.

Prombutr, P., Sookpool, A., Phinyo, K. and Phinyo, P. (2015). The effect of self-efficacy program toward knowledge and self-efficacy of village health volunteers in diabetic and hypertention patient care in community in Northeast Province. *Songklanagarind Journal of Nursing*, 35(2), pp. 113-128.

Puett, C., Coates, J., Alderman, H. and Sadler, K. (2013). Quality of care for severe acute malnutrition delivered by community health workers in southern Bangladesh. *Maternal & Child Nutrition*, 9(1), pp.130-142.

Punthakee, Z., Goldenberg, R. and Katz, P. (2018). Definition, classification and diagnosis of diabetes, prediabetes and metabolic syndrome. *Canadian journal of diabetes*, 42, pp. S10-S15.

Qu, S.Q. and Dumay, J. (2011). The qualitative research interviews. *Qualitative research in accounting & management.*

Radhakrishna, R. B. (2007). Tips for developing and testing questionnaires/instruments. *Journal of extension*, 45(1), pp. 1-4.

Rafnsdóttir, G.L. and Heijstra, T.M., 2013. Balancing work–family life in academia: The power of time. *Gender, Work & Organization*, 20(3), pp.283-296.

Rahi, S. (2017). Research design and methods: A systematic review of research paradigms, sampling issues and instruments development. *International Journal of Economics & Management Sciences*, 6(2), pp. 1-5.

Rahman, M. M. and Hoque, A. M. (2017). Transformative Learning: A Concept and Powerful Vision for Adult Education. *Anwer Khan Modern Medical College Journal*, 8(2), pp. 128-131.

Rahman, S.M., Ali, N.A., Jennings, L., Seraji, M.H.R., Mannan, I., Shah, R., Al-Mahmud, A.B., Bari, S., Hossain, D., Das, M.K. and Baqui, A.H. (2010). Factors affecting recruitment and retention of community health workers in a newborn care intervention in Bangladesh. *Human resources for health*, 8(1), p.12.

Rakhab, A., Jackson, C., Nilmanat, K., Butterworth, T. and Kane, R. (2021). Factors supporting career pathway development amongst advanced practice nurses in Thailand: A cross-sectional survey. *International Journal of Nursing Studies*, 117, p.103882.

Rask-Madsen, C. and King, G. L. (2013). Vascular complications of diabetes: mechanisms of injury and protective factors. *Cell metabolism*, 17(1), pp. 20-33.

Rattray, J. and Jones, M.C. (2007). Essential elements of questionnaire design and development. *Journal of clinical nursing*, 16(2), pp.234-243.

Razee, H., Whittaker, M., Jayasuriya, R., Yap, L. and Brentnall, L. (2012). Listening to the rural health workers in Papua New Guinea–the social factors that influence their motivation to work. *Social science & medicine*, 75(5), pp. 828-835.

Redman-MacLaren, M. L., Api, U. K., Darius, M., Tommbe, R., Mafile'o, T. A., and MacLaren, D. J. (2014). Co-interviewing across gender and culture: expanding qualitative research methods in Melanesia. *BMC Public Health*, 14(1), pp. 1-7.

Regmi, K., Naidoo, J. and Pilkington, P. (2010). Understanding the Processes of Translation and Transliteration in Qualitative Research. *International Journal of Qualitative Methods*, 9(1), pp.16-26.

Rehman, A.A. and Alharthi, K. (2016). An introduction to research paradigms. *International Journal of Educational Investigations,* 3(8), pp.51-59.

Reutrakul, S. and Deerochanawong, C. (2016). Diabetes in Thailand: status and policy. *Current diabetes reports,* 16(3), p. 28.

Riewpaiboon, A., Chatterjee, S., Riewpaiboon, W. and Piyauthakit, P. (2011). Disability and cost for diabetic patients at a public district hospital in Thailand. *International Journal of Pharmacy Practice, 19(2),* pp. 84-93.

Ritchie, J., Lewis, J., Nicholls, C. M. and Ormston, R. (Eds.). (2013). Qualitative research practice: A guide for social science students and researchers. 2 ed. sage.

Robinson, J.D. and Persky, A.M. (2020). Developing self-directed learners. *American Journal of Pharmaceutical Education,* 84(3).

Rodrigues, K.J. (2012). It Does Matter How We Teach Math. *Journal of Adult Education*, 41(1), pp.29-33.

Rostami, K. and Khadjooi, K. (2010). The implications of Behaviorism and Humanism theories in medical education. *Gastroenterology and Hepatology from bed to bench*, 3(2).

Roshan Essani, R. and Ali, T. S. (2011). Knowledge and practice gaps among pediatric nurses at a tertiary care hospital Karachi Pakistan. *International Scholarly Research Notices*, 2011.

Rothman, R.L., Malone, R., Bryant, B., Wolfe, C., Padgett, P., DeWalt, D.A., Weinberger, M. and Pignone, M. (2005). The spoken knowledge in low literacy in diabetes scale. *The Diabetes Educator, 31(2), pp.215-224.*

Rowley, J. (2012). Conducting research interviews. *Management research review*.

Ruangrattanatrai, W. and Sawaengdee, K. (2019). Financial Compensation for Professional Nurses Working in Hospitals under Ministry of Public Health in 8 Provinces. *Journal of Health Science*, 28, pp.S177-S187.

Rubin, D., Moshang, J. and Jabbour, S. (2007). Diabetes knowledge: are resident physicians and nurses adequately prepared to manage diabetes? *Endocrine Practice*, 13(1), pp.17-21.

Rubio, D.M., Berg-Weger, M., Tebb, S.S., Lee, E.S. and Rauch, S. (2003). Objectifying content validity: Conducting a content validity study in social work research. *Social work research*, 27(2), pp.94-104.

Ryan, F., Coughlan, M. and Cronin, P. (2009). Interviewing in qualitative research: The one-to-one interview. *International Journal of Therapy and Rehabilitation*, 16(6), pp. 309-314.

Sachayansrisakul, N. (2012). Sufficiency economy: a reasonable approach for Thailand's future. *NIDA Development Journal*, 49(2), pp. 1-22.

Saeed, A. A. (2012). Association of tobacco products use and diabetes mellitus-results of a national survey among adults in Saudi Arabia. *Balkan medical journal*, 29(3), p. 247.

Safazadeh, S., Irajpour, A., Alimohammadi, N. and Haghani, F. (2018). Exploring the reasons for theory-practice gap in emergency nursing education: A qualitative research. *Journal of education and health promotion*, 7.

Sakboonyarat, B., Pornpongsawad, C., Sangkool, T., Phanmanas, C., Kesonphaet, N., Tangthongtawi, N., Limsakul, A., Assavapisitkul, R., Thangthai, T., Janenopparkarnjana, P.

and Varodomvitaya, P. (2020). Trends, prevalence and associated factors of obesity among adults in a rural community in Thailand: serial cross-sectional surveys, 2012 and 2018. *BMC public health*, 20(1), pp.1-9.

Sakurai, M., Nakamura, K., Miura, K., Takamura, T., Yoshita, K., Nagasawa, S.Y., Morikawa, Y., Ishizaki, M., Kido, T., Naruse, Y. and Suwazono, Y. (2014). Sugar-sweetened beverage and diet soda consumption and the 7-year risk for type 2 diabetes mellitus in middle-aged Japanese men. *European journal of nutrition*, 53(1), pp.251-258.

Saleh, F., Mumu, S. J., Ara, F., Begum, H. A. and Ali, L. (2012). Knowledge and self-care practices regarding diabetes among newly diagnosed type 2 diabetics in Bangladesh: a cross-sectional study. *BMC public health*, 12(1), pp. 1-8.

Salifu, D. A., Gross, J., Salifu, M. A. and Ninnoni, J. P. (2019). Experiences and perceptions of the theory-practice gap in nursing in a resource-constrained setting: A qualitative description study. *Nursing open*, 6(1), pp. 72-83.

Sangoseni, O., Hellman, M. and Hill, C. (2013). Development and validation of a questionnaire to assess the effect of online learning on behaviors, attitudes, and clinical practices of physical therapists in the United States regarding evidenced-based clinical practice. *Internet Journal of Allied Health Sciences and Practice*, 11(2), p.7.

Sanguanprasit, B., Leerapan, P. and Taechaboonsermsak, P. (2016). Village health volunteers as peer supports for glycemic control among type 2 diabetes patients in Thailand. *Journal of Public Health and Development*, 14(2), pp. 49-60.

Sansoni, Janet E. (2011). "Questionnaire design and systematic literature reviews". *Australian Health Services Research Institute*. 120.

Santos Jr, H. P., Black, A. M. and Sandelowski, M. (2015). Timing of translation in cross-language qualitative research. *Qualitative health research*, 25(1), pp. 134-144.

Sasiwongsaroj, k. and Burasit, Y. (2019). *Managing Thailand's Ageing Population*. © ISEAS Yusof Ishak Institute. Available at: http://hdl.handle.net/11540/9989. [Accessed: 20th May 2019]

Saunders, M., Lewis, P. and Thornhill, A. (2009). *Research methods for business students*. Pearson education.

Scerri C. (2014). The curvy side of dementia: the impact of gender on prevalence and caregiving. *Journal of the Malta College of Pharmacy Practice*, 20, pp. 37–39.

Schaefer, M. S., Lloyd, B. and Stephenson, J. R. (2012). The suitability of a feed-in tariff for wind energy in New Zealand—A study based on stakeholders' perspectives. *Energy Policy*, 43, pp. 80-91.

Schmitt, A., Gahr, A., Hermanns, N., Kulzer, B., Huber, J. and Haak, T. (2013). The Diabetes Self-Management Questionnaire (DSMQ): development and evaluation of an instrument to assess diabetes self-care activities associated with glycaemic control. *Health and Quality of Life Outcomes*, 11(1), p.138.

Schneider, H., Hlophe, H. and van Rensburg, D. (2008). Community health workers and the response to HIV/AIDS in South Africa: tensions and prospects. *Health policy and Planning*, 23(3), pp. 179-187.

Schnell, O., Hanefeld, M. and Monnier, L. (2014). Self-monitoring of blood glucose: a prerequisite for diabetes management in outcome trials. *Journal of diabetes science and technology*, 8(3), pp. 609-614.

Scotland, J. (2012). Exploring the philosophical underpinnings of research: Relating ontology and epistemology to the methodology and methods of the scientific, interpretive, and critical research paradigms. *English language teaching*, 5(9), pp.9-16.

Sen, P., Shah, P.P., Nativio, R. and Berger, S.L. (2016). Epigenetic mechanisms of longevity and aging. *Cell*, 166(4), pp.822-839.

Setthasakko, W. (2015). The adoption of environmental management accounting in Thailand. *Journal of the Accounting Profession*, 11, pp.99-109.

Sevene, E., Boene, H., Vidler, M., Valá, A., Macuacua, S., Augusto, O., Fernandes, Q., Bique, C., Macete, E., Sidat, M. and von Dadelszen, P. (2021). Feasibility of task-sharing with community health workers for the identification, emergency management and referral of women with pre-eclampsia, in Mozambique. *Reproductive Health*, 18(1), pp.1-16.

Shah, V. N., Kamdar, P. K. and Shah, N. (2009). Assessing the knowledge, attitudes and practice of type 2 diabetes among patients of Saurashtra region, Gujarat. *International Journal of Diabetes in Developing Countries*, 29(3), pp. 118-122.

Shahzad, A., Ahmad, M.M., Anwer, I., Ijaz, N., Shahzad, M. and Usman, M. (2018). Gender-specific Knowledge of Diabetes and Its Management Among Patients Visiting Outpatient Clinics in Faisalabad, Pakistan. *Cureus*, 10(8).

Sharma, G. (2017). Pros and cons of different sampling techniques. *International journal of applied research*, 3(7), pp.749-752.

Shankar, A.V., Asrilla, Z., Kadha, J.K., Sebayang, S., Apriatni, M., Sulastri, A., Sunarsih, E. and Shankar, A.H. (2009). Programmatic effects of a large-scale multiple-micronutrient supplementation trial in Indonesia: using community facilitators as intermediaries for behavior change. *Food and nutrition bulletin*, 30(2_suppl2), pp. S207-S214.

Sharma, G., Harikumar, S. L. and Navis, S. (2015). A review on drug-drug and drug-food interactions in patients during the treatment of diabetes mellitus. *International Journal of Pharmacology and Clinical Sciences*, 4(4).

Shen, Y., Dai, Y., Wang, X.Q., Zhang, R.Y., Lu, L., Ding, F.H. and Shen, W.F. (2019). Searching for optimal blood pressure targets in type 2 diabetic patients with coronary artery disease. *Cardiovascular diabetology*, 18(1), pp.1-13.

Sherman, A. and Shavit, T. (2012). How the lifecycle hypothesis explains volunteering during retirement. *Ageing and society*, 32(8), p. 1360.

Shi, L., Shu, X.O., Li, H., Cai, H., Liu, Q., Zheng, W., Xiang, Y.B. and Villegas, R. (2013). Physical activity, smoking, and alcohol consumption in association with incidence of type 2 diabetes among middle-aged and elderly Chinese men. *PloS one*, 8(11).

Shiu, A.T.Y. and Wong, R.Y.M. (2011). Diabetes foot care knowledge: a survey of registered nurses. *Journal of Clinical Nursing*, 20(15-16), pp.2367-2370.

Shoghi, M., Sajadi, M., Oskuie, F., Dehnad, A. and Borimnejad, L. (2019). Strategies for bridging the theory-practice gap from the perspective of nursing experts. *Heliyon*, 5(9), p. e02503.

Shojaei, S., Tavafian, S. S., Jamshidi, A. R., Wagner, J. and Sepahvandi, M. R. (2017). Social Cognitive Theory-Based Intervention and Low Back Pain among Health Care Workers in Qom Hospitals of Iran. *International Journal of Musculoskeletal Pain Prevention*, 2(1), pp. 193-201.

Shrestha, N., Yadav, S. B., Joshi, A. M., Patel, B. D. P., Shrestha, J. and Bharkher, D. L. (2015). Diabetes knowledge and associated factors among diabetes patients in Central Nepal.

International *Journal of Collaborative Research on Internal Medicine & Public Health*, 7(5), 0-0.

Sieverdes, J. C., Sui, X., Lee, D. C., Church, T. S., McClain, A., Hand, G. A. and Blair, S. N. (2010). Physical activity, cardiorespiratory fitness and the incidence of type 2 diabetes in a prospective study of men. *British journal of sports medicine*, 44(4), pp. 238-244.

Sikandar, A. (2016). John Dewey and his philosophy of education. *Journal of Education and Educational Development*, 2(2), pp. 191-201.

Singalavanija, A., Luangsawang, K., Chotikavanich, S., Tanterdtham, J. and Samsen, P. (2012). Causes of visual impairment in Thai diabetic patients in the visual rehabilitation clinic. *Journal of the Medical Association of Thailand,* 95(Suppl 4), pp.S24-S29.

Sirithanawutichai, T., Wongsauwasup, A., Nophuan, W. and Krueanak, T. (2010). The effectiveness of village health volunteers in Muang District, Mahasarakham Province making visits to the homes of diabetes mellitus patients. *Journal of Science and Technology Mahasarakham University*, 29(4), pp.439-445.

Smide, B. and Nygren, U. (2013). A pilot study to determine levels of diabetes knowledge among health care workers in nursing homes. *European Diabetes Nursing*,10(1), pp.13-18.

Smith, T. J. (2013). Designing learning environments to promote student learning: Ergonomics in all but name. *Work*, 44(Supplement 1), pp. 39-60.

Snow, R., Humphrey, C. and Sandall, J. (2013). What happens when patients know more than their doctors? Experiences of health interactions after diabetes patient education: a qualitative patient-led study. *BMJ open*, 3(11), p.e003583.

Sodhi, J. K. (2017). *Comprehensive Textbook of Nursing education*. Jaypee brothers Medical Publishers. New Delhi.

Solis-Herrera, C., Triplitt, C., Reasner, C., DeFronzo, R. A. and Cersosimo, E. (2018). *Classification of diabetes mellitus*. In Endotext [Internet]. MDText. com, Inc.

Solomon, S.D., Chew, E., Duh, E.J., Sobrin, L., Sun, J.K., VanderBeek, B.L., Wykoff, C.C. and Gardner, T.W. (2017). Diabetic retinopathy: a position statement by the American Diabetes Association. *Diabetes care*, 40(3), pp.412-418.

Song, H.S., Kalet, A.L. and Plass, J.L. (2016). Interplay of prior knowledge, self-regulation and motivation in complex multimedia learning environments. *Journal of Computer Assisted Learning*, 32(1), pp.31-50.

Sparkes, A. C. (2015). Developing mixed methods research in sport and exercise psychology: Critical reflections on five points of controversy. *Psychology of Sport and Exercise,* 16, pp. 49-59.

Squires, A. (2008). Language barriers and qualitative nursing research: methodological considerations. *International nursing review*, 55(3), pp. 265-273.

Sranacharoenpong, K. and Hanning, R. M. (2012). Diabetes prevention education program for community health care workers in Thailand. *Journal of community health*, 37(3), pp. 610-618.

Srijompon, J. and Muktabhant, B. (2018). Association between Knowledge and Attitude and Practice of Village Health Volunteer in Capillary Blood Glucose Checking for Diabetic Patients living in Wiangkum Subdistrict, Kumpawapi District, Udonthani Province. *Journal of Sakon Nakhon Hospital*, 21 (2), pp. 79-87.

Srisuphan, W. and Sawaengdee, K. (2012). Recommended policy-based solutions to shortage of registered nurses in Thailand. *Thai journal of nursing council*, 27(1), pp.5-12.

Sriwijitkamol, A., Moungngern, Y. and Vannaseang, S. (2011). Assessment and prevalences of diabetic complications in 722 Thai type 2 diabetes patients. *Journal of the Medical Association of Thailand*, 94(2), p.168.

Stallwood, L. (2006). Relationship between caregiver knowledge and socioeconomic factors on glycemic outcomes of young children with diabetes. *Journal for Specialists in Pediatric Nursing*, 11(3), pp. 158-165.

Statista (2019). *Employment by economic sector in Thailand 2018*. [online] Available at: https://www.statista.com/statistics/332341/employment-by-economic-sector-in-thailand/ [Accessed: 10th November 2019]

Steinsbekk, A., Rygg, L., Lisulo, M., Rise, M. B. and Fretheim, A. (2012). Group based diabetes self-management education compared to routine treatment for people with type 2 diabetes mellitus. A systematic review with meta-analysis. *BMC health services research*, 12(1), p. 213.

Subedi, D. (2016). Explanatory sequential mixed method design as the third research community of knowledge claim. *American Journal of Educational Research*, 4(7), pp. 570-577.

Suh, E. E., Kagan, S. and Strumpf, N. (2009). Cultural competence in qualitative interview methods with Asian immigrants. *Journal of Transcultural Nursing*, 20(2), pp. 194-201.

Sullivan, J. R. (2012). Skype: an appropriate method of data collection for qualitative interviews? *The Hilltop Review*, 6(1), p.10.

Sumriddetchkajorn, K., Shimazaki, K., Ono, T., Kusaba, T., Sato, K. and Kobayashi, N. (2019). Universal health coverage and primary care, Thailand. *Bulletin of the World Health Organization*, 97(6), pp. 415–422.

Supachaipanichpong, P., Vatanasomboon, P., Tansakul, S. and Chumchuen, P. (2018). An Education Intervention for Medication Adherence in Uncontrolled Diabetes in Thailand. *Pacific Rim International Journal of Nursing Research*, 22(2), pp. 144-155.

Surka, S., Edirippulige, S., Steyn, K., Gaziano, T., Puoane, T. and Levitt, N. (2014). Evaluating the use of mobile phone technology to enhance cardiovascular disease screening by community health workers. *International journal of medical informatics*, 83(9), pp.648-654.

Sutton, J. and Austin, Z. (2015). Qualitative research: data collection, analysis, and management. *The Canadian journal of hospital pharmacy*, 68(3), pp.226-231.

Suwattanakul, T., (2018). Factors related to blood sugar control among diabetes mellitus type 2 patients. *Journal of Health-System Research*, 12(3), pp.515-522

Syed, S.T., Gerber, B.S. and Sharp, L.K. (2013). Traveling towards disease: transportation barriers to health care access. *Journal of Community Health*, 38(5), pp.976-993.

Sylvia, L. G., Bernstein, E. E., Hubbard, J. L., Keating, L. and Anderson, E. J. (2014). Practical guide to measuring physical activity. *Journal of the Academy of Nutrition and Dietetics*, 114(2), pp. 199-208.

Szabo, S., Mihalčová, B., Lukáč, J., Gallo, P., Čabinová, V. and Vajdová, I. (2020). Demotivation of medical staff in the selected health facility in Slovakia.

Taherdoost, H. (2016). Sampling methods in research methodology; how to choose a sampling technique for research. How to Choose a Sampling Technique for Research (April 10, 2016).

Taherdoost, H. (2016). Validity and reliability of the research instrument; how to test the validation of a questionnaire/survey in a research. *How to Test the Validation of a Questionnaire/Survey in a Research* (August 10, 2016).

Tammelin, M., Malinen, K., Rönkä, A. and Verhoef, M. (2017). Work schedules and work–family conflict among dual earners in Finland, the Netherlands, and the United Kingdom. *Journal of Family Issues*, 38(1), pp. 3-24.

Tang, B., Harary, E., Kurzman, R., Mould-Quevedo, J.F., Pan, S., Yang, J. and Qiao, J. (2013). Clinical characterization and the caregiver burden of dementia in China. *Value in health regional issues*, 2(1), pp.118-126.

Tangcharoensathien, V., Patcharanarumol, W., Prakongsai, P., Jongudomsuk, P., Srithamrongsawat, S. and Thammathataree, J., (2010). *Thailand health financing review 2010*. [online] Available at SSRN 1623260.

Tangcharoensathien, V., Witthayapipopsakul, W., Panichkriangkrai, W., Patcharanarumol, W. and Mills, A. (2018). Health systems development in Thailand: a solid platform for successful implementation of universal health coverage. *The Lancet*, 391(10126), pp. 1205-1223.

Tashakkori, A. and Creswell, J. W. (2007). The new era of mixed methods. *Journal of Mixed Methods Research*, p. 3-7.

Tashkkori, A. and Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

Taub, M., Azevedo, R., Bouchet, F. and Khosravifar, B. (2014). Can the use of cognitive and metacognitive self-regulated learning strategies be predicted by learners' levels of prior

knowledge in hypermedia-learning environments? *Computers in Human Behavior*, 39, pp.356-367.

Tay, J., Thompson, C.H., Luscombe-Marsh, N.D., Wycherley, T.P., Noakes, M., Buckley, J.D., Wittert, G.A., Yancy Jr, W.S. and Brinkworth, G.D. (2018). Effects of an energy-restricted low-carbohydrate, high unsaturated fat/low saturated fat diet versus a high-carbohydrate, low-fat diet in type 2 diabetes: A 2-year randomized clinical trial. *Diabetes, Obesity and Metabolism*, 20(4), pp.858-871.

Taylor, D.C. and Hamdy, H. (2013). Adult learning theories: implications for learning and teaching in medical education: AMEE Guide No. 83. *Medical teacher*, 35(11), pp.e1561-e1572.

Teddlie, C., and Tashakkori, A. (2009). *Foundations of Mixed Methods Research: Intergrating quantitative and qualitative approaches in the social and behavioural sciences.* Thousand Oaks, CA: Sage.

Terauchi, Y., Koyama, M., Cheng, X., Takahashi, Y., Riddle, M. C., Bolli, G. B. and Hirose, T. (2016). New insulin glargine 300 U/ml versus glargine 100 U/ml in Japanese people with type 2 diabetes using basal insulin and oral antihyperglycaemic drugs: glucose control and hypoglycaemia in a randomized controlled trial (EDITION JP 2). *Diabetes, Obesity and Metabolism*, 18(4), pp. 366-374.

Thanakitprapa, P., Jaratrasamee, A. and Pachimsawat, P. (2017). Autoclave monitoring and packaging in Bangkok dental offices, Thailand. *Mahidol Dental Journal*, 37, pp.173-82.

Thanh, N.C. and Thanh, T.T. (2015). The interconnection between interpretivist paradigm and qualitative methods in education. *American Journal of Educational Science*, 1(2), pp.24-27.

The Health Department, Bangkok Metropolitan Administration. (2008). *The New Village Health Volunteer orientation course 2008.* Bangkok: New Thammada Press (Thailand) Co., Ltd.

The Health Department, Bangkok Metropolitan Administration (2016). *Number of Health Volunteer in Bangkok year 2016*. [Print document]

The National Council for Voluntary Organisations. (n.d). *Volunteer*. [online] Available at: https://www.ncvo.org.uk/policy-and-research/volunteering-policy. [Accessed at: 15th May 2022].

The Policy and Strategy Section, Bureau of Non-Communicable Disease, Ministry of Public Health. (2017).*5-Year National NCDs Prevention and Control Strategic and Action Plan (2017-2021*). 1st ed. Bangkok: Emotion Art Co., Ltd.

The Royal Australian College of General Practitioners. (2016). General practice management of type 2 diabetes: 2016–18. East Melbourne, Vic: RACGP, 2016.

The World Bank (2019). *Population in Thailand*. [online]. Available at: https://datacommons.org/place/country/THA?utm_medium=explore&mprop=count&popt=Person&hl=en [Accessed: 20th December 2019]

The World Bank. (2021). Physicians (per 1,000 people) - Thailand. [online]. Available at: https://data.worldbank.org/indicator/SH.MED.PHYS.ZS?locations=TH [Accessed: 13rd March 2021]

Thomas, R.L., Dunstan, F.D., Luzio, S.D., Chowdhury, S.R., North, R.V., Hale, S.L., Gibbins, R.L. and Owens, D.R. (2015). Prevalence of diabetic retinopathy within a national diabetic retinopathy screening service. *British Journal of Ophthalmology*, 99(1), pp.64-68.

Thungthong, J., Waleekhachonloet, O., Chanasopon, S., Aewsuwan, K., Limwattananon, S., Limwattananon, C. and Tangcharoensathien, V. (2017). Utilization and Unmet Healthcare Need for Outpatient and Inpatient Services of Popula-tion Living in Bangkok Metropolitan in 2015. *Journal of Health Systems Research*, 11(3), pp, 378-390.

Tian, M., Ajay, V.S., Dunzhu, D., Hameed, S.S., Li, X., Liu, Z., Li, C., Chen, H., Cho, K., Li, R. and Zhao, X. (2015). A cluster-randomized, controlled trial of a simplified multifaceted management program for individuals at high cardiovascular risk (SimCard trial) in rural Tibet, China, and Haryana, India. *Circulation*, 132(9), pp.815-824.

Toruner, E. K. and Savaser, S. (2010). A controlled evaluation of a school-based obesity prevention in Turkish school children. *The Journal of School Nursing*, 26(6), pp. 473-482.

Touvier, M., Méjean, C., Kesse-Guyot, E., Pollet, C., Malon, A., Castetbon, K. and Hercberg, S. (2010). Comparison between web-based and paper versions of a self-administered anthropometric questionnaire. *European Journal of Epidemiology*, *25*(5), pp.287-296.

Trading Economic (2019). *Thailand GDP*. [online] Available at: https://tradingeconomics.com/thailand/gdp [Accessed 9th November 2019]

Tsang, S., Royse, C. F., and Terkawi, A. S. (2017). Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. *Saudi journal of anaesthesia,* 11(Suppl 1), pp. S80–S89.

Tshiananga, J.K.T., Kocher, S., Weber, C., Erny-Albrecht, K., Berndt, K. and Neeser, K. (2012). The effect of nurse-led diabetes self-management education on glycosylated hemoglobin and cardiovascular risk factors: a meta-analysis. *The Diabetes Educator*, 38(1), pp.108-123.

Turner, R.C. and Carlson, L. (2003). Indexes of item-objective congruence for multidimensional items. *International journal of testing*, 3(2), pp.163-171.

Umpierrez, G. and Korytkowski, M. (2016). Diabetic emergencies—ketoacidosis, hyperglycaemic hyperosmolar state and hypoglycaemia. *Nature Reviews Endocrinology*, 12(4), p. 222.

University of Waterloo (n.d). *Exam Questions: Types, Characteristics, and Suggestions.* [online]Available at: https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/developing-assignments/exams/questions-types-characteristics-suggestions. [Accessed at: 20th March 2022].

Unadike, B.C. and Etukumana, E.A. (2010). Nurses' understanding about diabetes in a Nigerian tertiary hospital. *Pakistan Journal of Medical Sciences,* 26(1), pp.217-222.

Upadhyay, D. K., Palaian, S., Shankar, P. R., Mishra, P. and Pokhara, N. (2008). Knowledge, attitude and practice about diabetes among diabetes patients in Western Nepal. *Rawal Medical Journal*, 33(1), pp. 8-11.

Vaismoradi, M., Turunen, H. and Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & health sciences*, 15(3), pp.398-405.

Van den Bogaard, L., Henkens, K. and Kalmijn, M. (2014). So now what? Effects of retirement on civic engagement. *Ageing & Society*, 34(7), pp. 1170-1192.

Van Ingen, E. and Dekker, P. (2011). Changes in the determinants of volunteering: Participation and time investment between 1975 and 2005 in the Netherlands. *Nonprofit and Voluntary Sector Quarterly*, 40(4), pp.682-702.

Van Ingen, E. and Wilson, J. (2017). I volunteer, therefore I am? Factors affecting volunteer role identity. *Nonprofit and Voluntary Sector Quarterly*, 46(1), pp.29-46.

Van Nes, F., Abma, T., Jonsson, H. and Deeg, D. (2010). Language differences in qualitative research: is meaning lost in translation?. *European journal of ageing*, 7(4), pp. 313-316.

Van Zyl, D. G. and Rheeder, P. (2008). Survey on knowledge and attitudes regarding diabetic inpatient management by medical and nursing staff at Kalafong Hospital. *Journal of Endocrinology, Metabolism and Diabetes of South Africa*, 13(3), pp. 90-97.

Varela, C., Young, S., Mkandawire, N., Groen, R.S., Banza, L. and Viste, A. (2019). Transportation barriers to access health care for surgical conditions in Malawi a cross sectional nationwide household survey. *BMC public health*, 19(1), p.264.

Velez, A. M. (2008). Evaluating research methods: Assumptions, strengths, and weaknesses of three educational research paradigms. *Academic Exchange—Extra*, *9*.

Viana, L.V., Leitão, C.B., Kramer, C.K., Zucatti, A.T., Jezini, D.L., Felício, J., Valverde, A.B., Chacra, A.R., Azevedo, M.J. and Gross, J.L. (2013). Poor glycaemic control in Brazilian patients with type 2 diabetes attending the public healthcare system: a cross-sectional study. *BMJ open*, 3(9), p.e003336.

Viengthong, P. and Bunloet, A. (2020). Prevalence and Associated Factors of Poor Glycemic Control among Type 2 Diabetes Elderly Patients in a Community Hospital, Khon Kaen Province. *Srinagarind Medical Journal*, 35(4), pp.476-483.

Volmer-Thole, M. and Lobmann, R. (2016). Neuropathy and diabetic foot syndrome. *International journal of molecular sciences*, 17(6), p. 917

Vrbnjak, D., Pahor, D., Nelson, J. W. and Pajnkihar, M. (2017). Content validity, face validity and internal consistency of the Slovene version of Caring Factor Survey for care

providers, caring for co-workers and caring of managers. *Scandinavian journal of caring sciences*, 31(2), pp. 395-404.

Waehayi, H., Siripornpibul, T. and Pannarunothai, S. (2020). Smoking Behavior among youth in the Deep South of Thailand. *Journal of Yala Rajabhat University*, 15(1), pp.97-104.

Wagner, J., Lacey, K., Chyun, D. and Abbott, G. (2005). Development of a questionnaire to measure heart disease risk knowledge in people with diabetes: The Heart Disease Fact Questionnaire. *Patient education and counseling*, 58(1), p. 82-87.

Wall, P., Andrus, P. and Morrison, P. (2014). Bridging the theory practice gap through clinical simulations in a nursing under-graduate degree program in Australia. *International Journal of Learning, Teaching and Educational Research*, 8(1).

Waltz, C. and Bausell, R. (1981). *Nursing research: Design, statistics, and computer analysis*, FA Davis Company.

Wang, C., Li, J., Xue, H., Li, Y., Huang, J., Mai, J., Chen, J., Cao, J., Wu, X., Guo, D. and Yu, L. (2015). Type 2 diabetes mellitus incidence in Chinese: contributions of overweight and obesity. *Diabetes research and clinical practice*, 107(3), pp.424-432.

Wang, F., Zhang, J., Yu, J., Liu, S., Zhang, R., Ma, X., Yang, Y. and Wang, P. (2017). Diagnostic accuracy of monofilament tests for detecting diabetic peripheral neuropathy: a systematic review and meta-analysis. *Journal of diabetes research*, *2017*.

Wang, L.L., Wang, Q., Hong, Y., Ojo, O., Jiang, Q., Hou, Y.Y., Huang, Y.H. and Wang, X.H. (2018). The effect of low-carbohydrate diet on glycemic control in patients with type 2 diabetes mellitus. *Nutrients*, 10(6), p.661.

Wang, S. Y., Andrews, C. A., Herman, W. H., Gardner, T. W. and Stein, J. D. (2017). Incidence and risk factors for developing diabetic retinopathy among youths with type 1 or type 2 diabetes throughout the United States. *Ophthalmology*, 124(4), pp. 424-430.

Wang, W. and Lo, A.C. (2018). Diabetic retinopathy: pathophysiology and treatments. *International journal of molecular sciences*, 19(6), p.1816.

Wannasiri, T. (2016). Families Relationship in Self-Care Promotion for Uncontrolling Blood Sugar in Type 2 Diabetes. *Kuakarun Journal of Nursing*, 23(2), pp. 31-50.

Ward, K., Gott, M. and Hoare, K. (2015). Participants' views of telephone interviews within a grounded theory study. *Journal of advanced nursing*, 71(12), pp.2775-2785.

Warren, C. R. and McFadyen, M. (2010). Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland. *Land use policy*, 27(2), pp. 204-213.

Weeks, D. L., French, B. F., Davis, A. D. and Towle, L. A. (2015). Development and validation of the Diabetes Knowledge Assessment Test for use in medical rehabilitation. *Disability and rehabilitation*, 37(9), pp. 802-811.

Weiner, B. (1972). Attribution theory, achievement motivation, and the educational process. *Review of educational research*, 42(2), pp.203-215.

Welch, G., Zagarins, S. E., Feinberg, R. G. and Garb, J. L. (2011). Motivational interviewing delivered by diabetes educators: does it improve blood glucose control among poorly controlled type 2 diabetes patients? *Diabetes research and clinical practice*, 91(1), pp. 54-60.

Wellard, S. J., Rasmussen, B., Savage, S. and Dunning, T. (2013). Exploring staff diabetes medication knowledge and practices in regional residential care: triangulation study. *Journal of clinical nursing*, 22(13-14), pp. 1933-1940.

Weller, S. (2015). *The potentials and pitfalls of using Skype for qualitative (longitudinal) interviews.*

Whelton, P.K., Carey, R.M., Aronow, W.S., Casey, D.E., Collins, K.J., Himmelfarb, C.D., DePalma, S.M., Gidding, S., Jamerson, K.A., Jones, D.W. and MacLaughlin, E.J. (2018). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Journal of the American College of Cardiology*, 71(19), pp. e127-e248.

Whiting, L. S. (2008). Semi-structured interviews: Guidance for novice researchers. *Nursing standard*, 22(23).

Wibulpolprasert, S., Sirilak, S., Ekachampaka, P. and Wattanamano, N. (2011). *Thailand health profile report 2008-2010*. Nonthaburi: WVO Office of Printing Mill.

Witcher, C. S. (2010). Negotiating transcription as a relative insider: Implications for rigor. *International Journal of Qualitative Methods*, 9(2), pp. 122-132.

Wikipedia (2021). *Outline of Thailand.* [online] Available at: https://en.wikipedia.org/wiki/Outline_of_Thailand. [Accessed: 8th April 2021].

Wilding, J. P., Woo, V., Soler, N. G., Pahor, A., Sugg, J., Rohwedder, K. and Parikh, S. (2012). Long-term efficacy of dapagliflozin in patients with type 2 diabetes mellitus

receiving high doses of insulin: a randomized trial. *Annals of internal medicine*, 156(6), p. 405-415.

Wilkie, K. and Jones, A. (2010). School ties: Keeping students with chronic illness connected to their school learning communities. In Proceedings of the New Developments in ICT and Education Conference. *Amiens: International Federation for Information Processing*.

Willis, G.B. and Miller, K. (2011). Cross-cultural cognitive interviewing: Seeking comparability and enhancing understanding. *Field methods*, 23(4), pp.331-341.

Wing, R.R., Lang, W., Wadden, T.A., Safford, M., Knowler, W.C., Bertoni, A.G., Hill, J.O., Brancati, F.L., Peters, A., Wagenknecht, L. and Look AHEAD Research Group. (2011). Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. *Diabetes care*, 34(7), pp.1481-1486.

Winn, L.K., Lesser, A., Menya, D., Baumgartner, J.N., Kirui, J.K., Saran, I. and Prudhomme-O'Meara, W. (2018). Motivation and satisfaction among community health workers administering rapid diagnostic tests for malaria in Western Kenya. *Journal of global health*, 8(1).

Wirojratana, V., Amnatsatsue, K., Sasat, S., Malathum, P. and Narongsak, J. (2014). Improvement of healthcare services for dependent elders. *Thai Journal of Nursing Council*, 29(3), pp. 104-115.

Woiceshyn, J. and Daellenbach, U. (2018). Evaluating inductive vs deductive research in management studies: Implications for authors, editors, and reviewers. Qualitative Research in Organizations and Management: *An International Journal*.

Wonglimpiyarat, J. and Tripipatkul, R. (2017). Economic innovation challenges: lessons learnt from the major financial crises in Asia. *International Journal of Business Innovation and Research*, 12(2), pp. 189-205.

Wongwiwatthananukit, S., Krittiyanunt, S. and Wannapinyo, A. (2004). Development and validation of an instrument to assess the general knowledge of patients with diabetes. *Thai Journal of Pharmacology Science*, 28(1-2), pp.17-29.

Wood, C. I., Daley-Moore, N., and Powell, R. (2019). Using interviewing in public health research: Experiences of novice researchers. *The Qualitative Report*, 24(10), pp. 2441-2452.

Wood, G. L. and Haber, J. (2018). *Nursing research: Methods and critical appraisal for evidence-based practice*. (9th ed). Missouri: Mosby Elsevier.

Woratanarat, T., Woratanarat, P., and Lekthip, C. (2017). *Primary health care systems: case study from Thailand.*

World Health Organization (1989). *Strengthening the performance of community health workers in primary health care*. Report of a WHO Study Group. Geneva, World health Organization (WHO Technical Report Series, No. 780)

World Health Organization (2016). *Diabetes country profiles*. [online] Available at: http://www.who.int/diabetes/country-profiles/tha_en.pdf [Accessed 25th August 2016]

World Health Organization. (2016). *Global report on diabetes*. [online] Available at: https://www.who.int/publications/i/item/9789241565257 [Accessed at: 8th July 2016].

World Health Organization (2017) *Primary health Care Systems (Primasys) case study from Thailand*.

World Health Organization. (2017). Process of translation and adaptation of instruments. [online] Available at: http://www.who.int/substance_abuse/research_tools/translation/en/. [Accessed at: 14th June 2017].

World Health Organization. (2017). *Thailand's physical activity drive is improving health by addressing NCDs*. [online] Available at: https://www.who.int/news-room/feature-stories/detail/thailand-s-physical-activity-drive-is-improving-health-by-addressing-ncds. [Accessed at: 15th August 2020].

World Health Organization (2019) *diabetes*. [online] Available at: https://www.who.int/news-room/fact-sheets/detail/diabetes [Accessed: 20th August 2019]

World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. [online] Available at: https://apps.who.int/iris/rest/bitstreams/1315866/retrieve. [Accessed at: 3rd Jan 2021]

World Health Organization. (2021). Diabetes. [online] Available at: https://www.who.int/health-topics/diabetes#tab=tab_1 [Accessed at: 1st March 2021]

Wu, L., Han, L., Zhan, Y., Cui, L., Chen, W.A., Ma, L., Lv, J., Pan, R., Zhao, D. and Xiao, Z. (2018). Prevalence of gestational diabetes mellitus and associated risk factors in pregnant Chinese women: a cross-sectional study in Huangdao, Qingdao, China. *Asia Pacific journal of clinical nutrition*, 27(2), p.383.

Yacoub, M.I., Demeh, W.M., Darawad, M.W., Barr, J.L., Saleh, A.M. and Saleh, M.Y. (2014). An assessment of diabetes-related knowledge among registered nurses working in hospitals in J ordan. *International Nursing Review*, 61(2), pp.255-262.

Yalamala, S. and Suh, E. (2018). The Level of Diabetes Knowledge and Related Factors among Patients with Diabetes Mellitus in Hyderabad, India. *Korean Journal of Adult Nursing*, 30(4), pp. 447-454.

Yamada, Y., Uchida, J., Izumi, H., Tsukamoto, Y., Inoue, G., Watanabe, Y., Irie, J. and Yamada, S. (2014). A non-calorie-restricted low-carbohydrate diet is effective as an alternative therapy for patients with type 2 diabetes. *Internal medicine*, 53(1), pp.13-19.

Yamane, T. (1967). *Statistic,* an *introductory analysis*, (2nd ed). New York: bHarper and row.

Yan, L.D., Hanvoravongchai, P., Aekplakorn, W., Chariyalertsak, S., Kessomboon, P., Assanangkornchai, S., Taneepanichskul, S., Neelapaichit, N. and Stokes, A.C. (2020). Universal coverage but unmet need: national and regional estimates of attrition across the diabetes care continuum in Thailand. *PloS one*, 15(1), p.e0226286.

Yang, C.P., Li, C.I., Liu, C.S., Lin, W.Y., Hwang, K.L., Yang, S.Y., Li, T.C. and Lin, C.C. (2017). Variability of fasting plasma glucose increased risks of diabetic polyneuropathy in T2DM. *Neurology*, 88(10), pp.944-951.

Yanow, D. and Schwartz-Shea, P. (2011). *Interpretive Approaches to Research Design: Concepts and Processes*. Netherlands: Routledge.

Yau, J.W., Rogers, S.L., Kawasaki, R., Lamoureux, E.L., Kowalski, J.W., Bek, T., Chen, S.J., Dekker, J.M., Fletcher, A., Grauslund, J. and Haffner, S. (2012). Global prevalence and major risk factors of diabetic retinopathy. *Diabetes care*, 35(3), pp.556-564.

Yelkpieri, D., Namale, M., Esia-Donkoh, K. and Ofosu-Dwamena, E. (2012). Effects of Large Class Size on Effective Teaching and Learning at the Winneba Campus of the UEW (University of Education, Winneba), Ghana. *Online Submission*.

Yen, C.L. (2011). A discussion of paradigms and research methods. *Journal of Wufeng University*, 19, pp.357-368.

Yilmaz, K. (2011). The cognitive perspective on learning: Its theoretical underpinnings and implications for classroom practices. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 84(5), pp. 204-212.

York, C. S. and Ertmer, P. A. (2016). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, 29(2), pp.169-192.

Yosef, T. (2019). Knowledge and Attitude on Insulin Self-Administration among Type 1 Diabetic Patients at Metu Karl Referral Hospital, Ethiopia. *Journal of Diabetes Research*, *2019*.

Yvonne Feilzer, M. (2010). Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of mixed methods research*, 4(1), pp.6-16.

Zachariah, R., Ford, N., Philips, M., Lynch, S., Massaquoi, M., Janssens, V. and Harries, A.D. (2009). Task shifting in HIV/AIDS: opportunities, challenges and proposed actions for sub-Saharan Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 103(6), pp.549-558.

Zain, S. F. H. S., Rasidi, F. E. M. and Abidin, I. I. Z. (2012). Student-centred learning in mathematics-constructivism in the classroom. *Journal of International Education Research*, 8(4), p. 319.

Zainudin, S. B., Ang, D. Y. and Soh, A. W. E. (2017). Knowledge of diabetes mellitus and safe practices during Ramadan fasting among Muslim patients with diabetes mellitus in Singapore. *Singapore medical journal*, 58(5), p. 246.

Zakirman, Z., Lufri, L. and Khairani, K. (2019). January. Factors Influencing the Use of Lecture Methods in Learning Activities: Teacher Perspective. *In 1st International Conference on Innovation in Education* (ICoIE 2018) (pp. 4-6). Atlantis Press.

Zamanzadeh V, Ghahramanian A, Rassouli M, Abbaszadeh A, Alavi-Majd H, Nikanfar AR. (2015). Design and Implementation Content Validity Study: Development of an instrument for measuring Patient-Centered Communication. *Journal of Caring Sciences,* Jun 1;4(2), pp.165-78.

Zhang, G., Chen, H., Chen, W. and Zhang, M. (2017). Prevalence and risk factors for diabetic retinopathy in China: a multi-hospital-based cross-sectional study. *British Journal of Ophthalmology*, 101(12), pp. 1591-1595.

Zhou, W., Huang, J., Yang, L., Qiu, T., Zhang, Y., Liu, F. and Zhou, Z. (2020). Long-term training in diabetes-related knowledge, attitudes, and self-reported practice among diabetes liaison nurses. *Journal of International Medical Research*, 48(2), p.0300060519882838.

Zimmerman, R. S. (2016). *Diabetes mellitus: management of microvascular and macrovascular complications*. [online] Available: http://www. clevelandclinicmeded. com/medicalpubs/diseasemanagement/endocrinology/dia betes-mellitus. [Accessed: 2nd February 2017]

Zowgar, A.M., Siddiqui, M.I. and Alattas, K.M. (2018). Level of diabetes knowledge among adult patients with diabetes using diabetes knowledge test. *Saudi medical journal*, 39(2), p.161.

Appendices

Appendix 1 Questionnaire

Part 1 Diabetes knowledge

Item	Question	True	False	Do not know
1	Insulin is produced by the kidneys.			
2	Injectable insulin is only essential in the treatment of insulin-dependent diabetes.			
3	Short-acting insulin begins to work 60 minutes after injection.			
4	Normal fasting blood sugar is between 70-100 mg/dl.			
5	LDL cholesterol is known as ‘good’ cholesterol.			
6	Diabetic patients should keep their blood pressure below 140/90 mmHg.			
7	Blood sugar levels between 70-125 mg/dL is a life-threatening emergency.			
8	Diabetics are at an increased risk of developing heart disease.			
9	Diabetics are at an increased risk of developing foot complications.			
10	Urine testing is the best method for home glucose testing.			
11	Diabetics are at an increased risk of developing kidney failure.			
12	If a diabetic patient forgets to take their diabetes medication in the morning, they should take a double dose in the evening.			
13	Diabetics are at an increased risk of developing retinopathy.			
14	Diabetic patients can discontinue their diabetes medication when they feel their condition has improved.			

Item	Question	True	False	Do not know
15	Drinking alcohol enhances the effect of diabetes medication.			
16	Diabetics can share their diabetes drugs with other diabetic patients.			
17	Diabetics are **NOT** at an increased risk of developing kidney failure.			
18	Diabetic patients should be encouraged to check their feet for abnormalities.			
19	The presence of infection can cause an increase in blood sugar levels.			
20	Normal fasting blood sugar is between 126 -250 mg/dl.			
21	When diabetics are ill, they should test their blood glucose more often.			
22	Diabetic patients should keep their blood pressure above140/90 mmHg.			
23	Diabetics are **NOT** at an increased risk of developing heart disease.			
24	Drinking sweetened drinks increases blood sugar levels.			
25	Diabetics are **NOT** at an increased risk of developing foot complications.			
26	Insulin is produced by the pancreas.			
27	The presence of infection can cause a reduction in blood sugar levels.			
28	HDL cholesterol is known as ‘good’ cholesterol			
29	Finger-prick blood testing is the best method for home glucose testing.			
30	Diabetics are **NOT** at an increased risk of developing retinopathy.			
31	Diabetics **CANNOT** share their diabetes drugs with other diabetic patients.			

Item	Question	True	False	Do not know
32	Drinking sweetened drinks does **NOT** increase blood sugar.			
33	Diabetic patients must **NEVER** discontinue their diabetes medication without discussing it with a doctor.			
34	Diabetics should exercise for a maximum of 20-30 minutes per session, 3 days a week.			
35	Diabetic patients should be discouraged from checking their feet for abnormalities.			
36	Short-acting insulin begins to work 15-30 minutes after injection.			
37	When diabetics are ill, they do **NOT** need to test their blood glucose more often.			

Part 2: Demographic data

Please complete the following questions.

1. Age ☐ years ☐ months

Please mark (√) (choose ONE only)

2. What is your gender?
   - ☐ Female
   - ☐ Male
   - ☐ Transgender
   - ☐ Prefer not to answer

3. What is your current marital status?
   - ☐ Single
   - ☐ Married
   - ☐ Divorced/Separated
   - ☐ Widowed
   - ☐ Prefer not to answer

4. What is the highest level of education you have completed?
   - ☐ Grade school
   - ☐ High school
   - ☐ Vocational certificate
   - ☐ High vocational certificate
   - ☐ Bachelor degree
   - ☐ Master degree
   - ☐ Doctorate degree
   - ☐ Other (please state) ……..……

5. How long have you been working as a Health Volunteer?

   (please state) ……..

6. Are you employed elsewhere?

   ☐ No

   ☐ Yes (please state)…….

7. Your family's monthly income ☐ Baht
8. What health centre do you work for?

   ……..

9. Any other comments

Thank you for taking part in this survey.

I will also be conducting face to face interview, the purpose of the interview is to discuss with you your knowledge about diabetes and the preventions of its complications (you can find the full details in a participant information sheet for interview that was added with the same package of this questionnaire)

If you would be interested in being interviewed please leave your contact details (phone and email address or your home address) and I will contact you at a later date to see if you would like to be interviewed or not.

Phone:

Email:

Address:

Please put only completed questionnaire and your contact details (if you prefer to join face to face interview) in the stamped addressed envelope that I prepared for you and return it via post by 10 January 2018.

Appendix 2 Interviewed guide

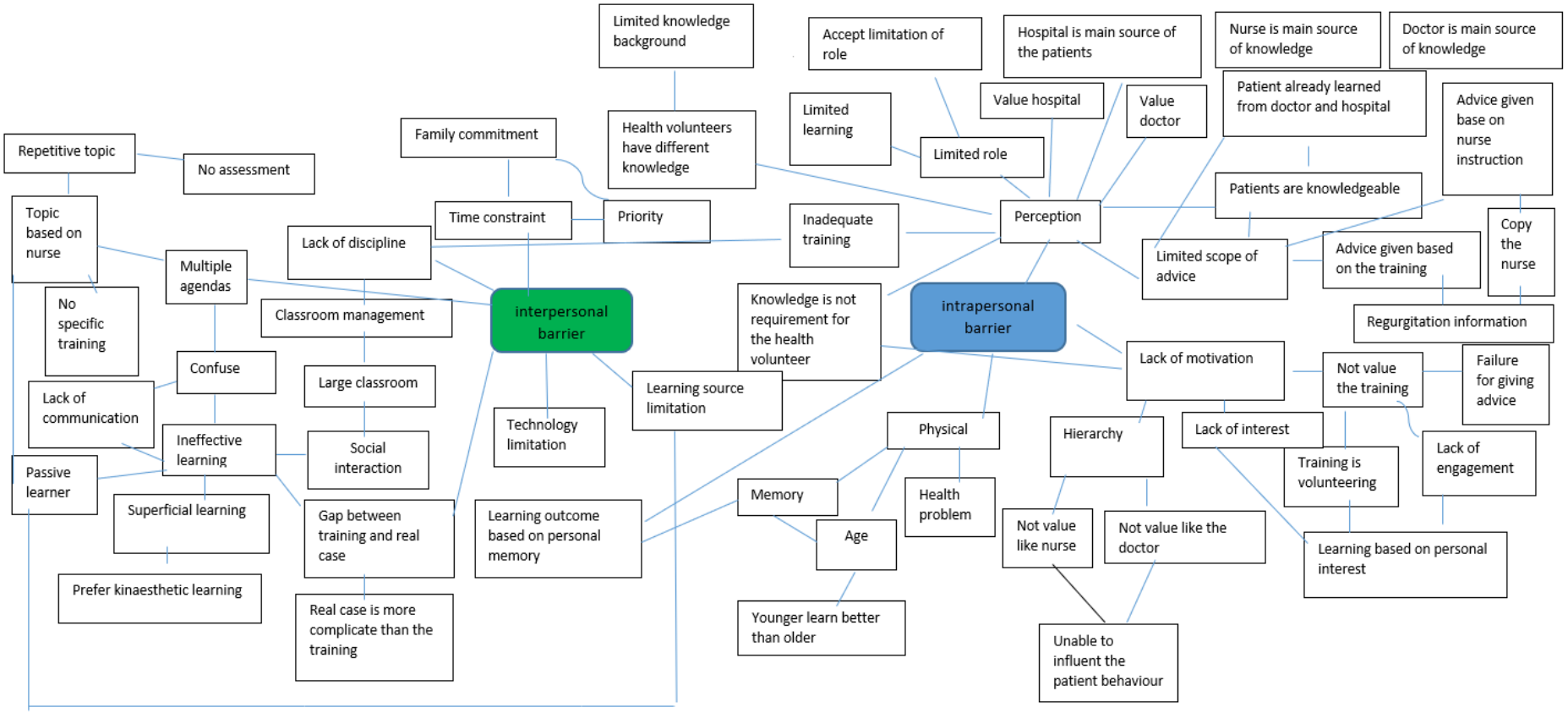
Introduction key components: • Thank you • The interviewer name • Purpose • Confidential • Duration • How interview will be conducted • Opportunity for questions Signature of consent	Hello, how are you? Thank you for taking the time to meet me today. My name is Jiraporn Chonmasuk, I am a PhD student of Liverpool John Moores University. I am currently undertaking a research study to look at the development of health volunteer's knowledge to enhance the care of older people living with diabetes in the community in Thailand. You are invited to interview because you are a health volunteer that meet the criteria. Your participation is voluntary and you free withdraw from the interview at any point without giving a reason. The interview should take no longer than 60 minutes. There are no right or wrong answers to the questions. If there are any questions that you do not wish to answer that is fine. The interview will be recorded and I may make some written notes in addition. All responses will be kept confidential. This means that your interview responses will only be shared with research team members and we will ensure that any information we include in our report does not identify you as the respondent. Do you have any questions about any aspect of the study before we start?	-Conduct Interview once the interviewee signs consent

	(Have they already signed the consent form? If not they could do this now) Are you happy to proceed with the interview?	
Research objective: to explore the HVs' experience of learning about diabetes. • Ask factual before opinion • Use prompts as needed	• Why did you become a health volunteer?	**Prompt** -Could you explain more? -Is there another reason why you became a health volunteer?
	• Tell me about your role as a health volunteer and what this involves.	**Prompt** -Can you describe your role? -What skill did you need to learn to do that role? -Anything else?
	• What training did you have to undertake to become a health volunteer? (formal and informal)	
	• Please tell me about any training you have had specific to diabetes and its management?	**Prompts** -Who provided the training? -What did the training include? -Was there any type of assessment? -Do you have any training updates? -Is there anything about the training that could have been included or improved? -Has this influenced the way in which you deliver care/ manage diabetes? If yes in what way?
	• Have you learned about diabetes and its management from any other sources?	-Did the information agree with what you were taught in your HV training?

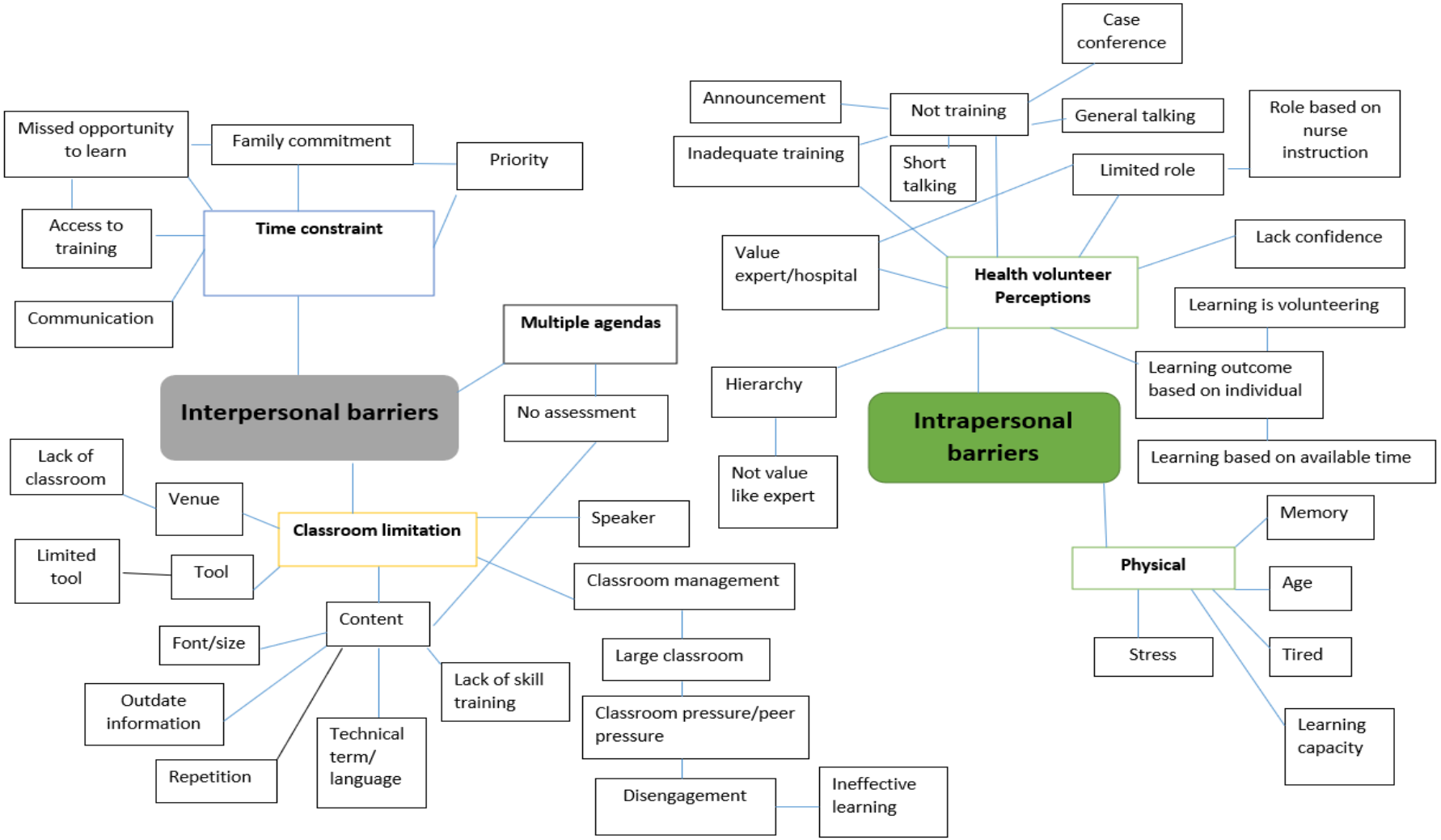
		-What do you think of the quality of the information provided from this source? -How do you know that the information quality is good/bad? -Has this influenced the way in which you deliver care/ manage diabetes? If yes in what way?
	• What diabetic topic would you like to learn about?	-Why? -Can you give an example? - What you concern most of learning diabetes?
	• Is there anything else that could help you to learn about diabetes?	
	• How does your knowledge of diabetes help you to improve your patient care?	
Closing key component • Additional comments • Thank you	• Is there anything more you would like to add? This is the end of our interview, thank you very much for allowing me to interview today. I will be analysing the information you gave me. I will be happy to send you a copy to review at the time, if you are interested. Thank you for your time	

Appendix 3 Initial code

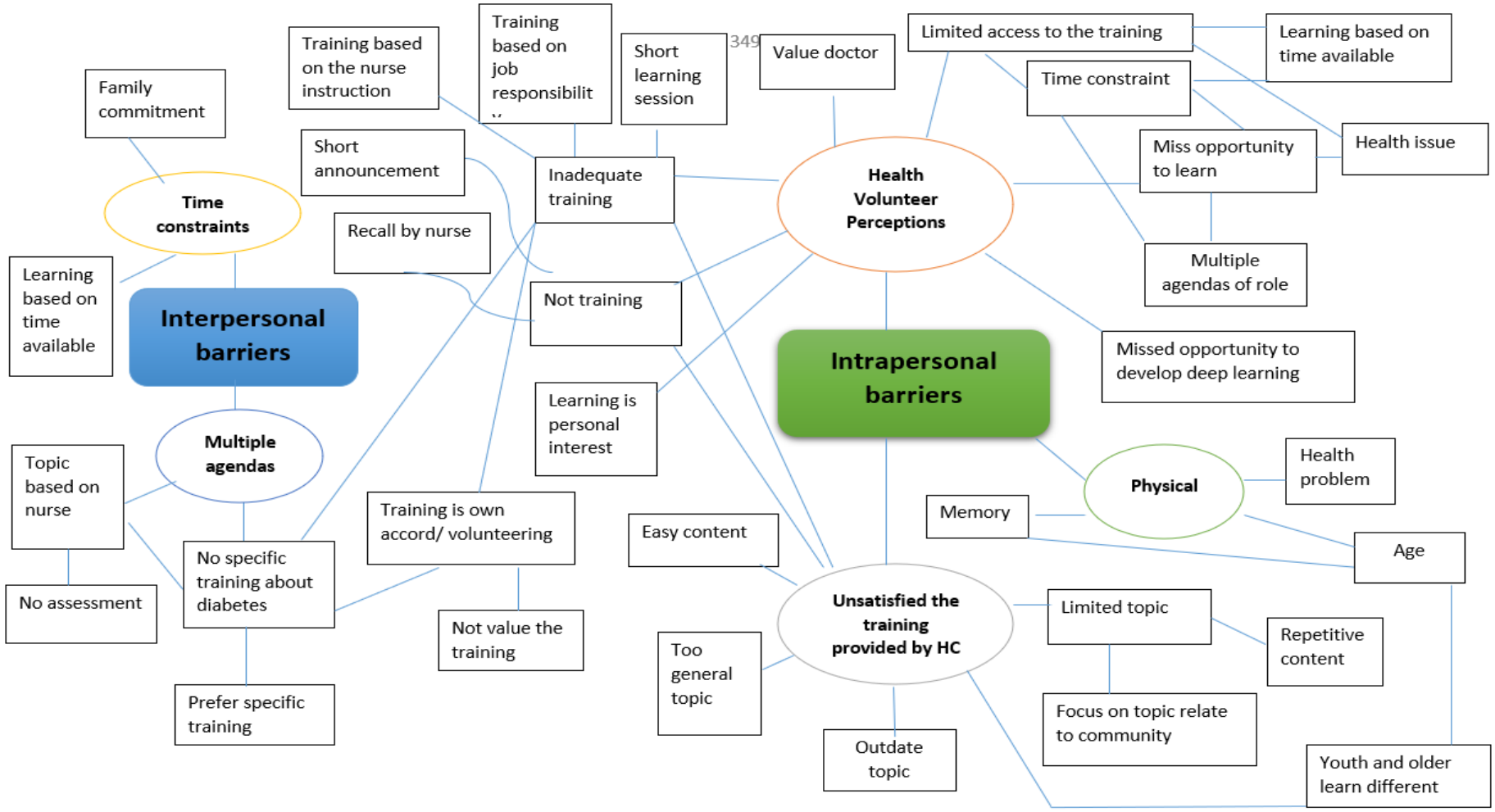
Initial code of low knowledge



Initial code of Moderate knowledge



Initial code of High knowledge



Appendix 4 Permission to use and adapt the instrument from the originated author

The Daniel K. Inouye College of Pharmacy
Department of Pharmacy Practice

UNIVERSITY of HAWAI'I HILO

April 11, 2018

Jiraporn Chonmasuk, BNS, MSc (Public Health Nursing)
PhD student
Liverpool John Moores University
70 Mount Pleasant, Liverpool L3 5UA, UK

Dear Jiraporn,

With references to your emails dated September 1, 2016 and April 11, 2018 regarding permission to use the instrument to assess the general knowledge of patients with diabetes that was published in the *Thai Journal of Pharmaceutical Sciences*, 2004, 28(1-2), 17-29 for your dissertation research entitled: "*The development of Health Volunteer's knowledge to enhance the care of older people living with diabetes in the community in Bangkok*", I am pleased to grant my permission to use the instrument you requested and include in your dissertation.

I wish you all the best with your project and dissertation and good luck with your future endeavors.

Sincerely yours,

Supakit Wongwiwatthananukit, PharmD, MS, PhD
Professor of Pharmacy Practice

200 West Kawili Street
Hilo, Hawai'i 96720-4091
Telephone: (808) 933-2927 Fax: (808) 933-2974
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An Equal Opportunity/Affirmative Action Institution

Appendix 5

Target Population of Included Questionnaires

There were no studies exploring the knowledge levels of diabetes of non-professional staff. Eleven questionnaires were developed for health care professionals whilst nineteen questionnaires were developed for patient use (Table 6).

Diabetic diet

Several studies included an assessment of dietary knowledge (n=9). Five studies included dietary questions in the patient questionnaires and four healthcare professional questionnaires included a measurement of dietary knowledge.

Medication (oral and insulin) (n=8), Assessment of medication knowledge was included in both patient and healthcare professional questionnaires, this content was more likely to be found in health professionals than patients (n=5 and 3, respectively).

Blood sugar monitoring (n=6) knowledge was measured in both patient and health professional questionnaires. However, this was heavily weighted towards the health professional with four out of six studies focussing on the professional group.

Exercise (n=5) knowledge was included in five studies; three studies were focussed on the health professionals' diabetes knowledge whilst two studies were directed at patients.

Diabetic complications (n=5) knowledge was measured five studies, however, most studies (4 in 5) were focussed on patients, while one study was used to assess knowledge of the professional.

Symptom (n=4) knowledge was measured in both patients and professionals, but ¾ of these questionnaires were focussed health professional's knowledge levels (n=3), only one was used with patients.

Knowledge of Blood sugar range (n=2) was measured equally in both patient and health professionals

Validity of the tools used

According to Bolarinwa (2015), 'validity expresses the degree to which a measurement measures what it purports to measure'. Validity can be assessed as face validity, content validity, criterion-related validity and construct validity (Taherdoost, 2016). Some studies only focussed on three basic types of validity namely: face validity, content validity, and criterion validity (Price et al., 2015). While some studies classified validity into construct validity, content validity, and criterion-related validity (Kimberlin and Winterstein, 2008). 'Content validity addresses how well the items developed to operationalize a construct provide an adequate and representative sample of all the items that might measure the construct of interest' (Kimberlin and Winterstein, 2008). This validity relates to the degree to which the tool fully measures the construct of interest (Sangoseni et al., 2013). Kimberlin and Winterstein (2008), explained that due to the lack of a statistical test to determine if a measure represents a construct and covers a content area, this validity is based on the expert's judgment, however, Sangoseni et al (2013) showed that the experts in the research subject not only reviewed the clarity and readability of the items, they also rated their judgment on the item via the content validity index (CVI) which was the statistical evaluation among those raters. The Criterion-related validity measures how the questionnaire results go against

or predict other instruments' findings (Bolarinwa, 2015), this type of validity includes concurrence validity and predictive validity (Taherdoost, 2016).

The majority of studies (n=20) used a panel of experts in the diabetes field to evaluate the content validity of the survey (El-Deirawi and Zuraikat, 2001; Findlow et al., 2002; Wongwiwatthananukit et al., 2004; Rothman et al., 2005; Wagner et al., 2005; Derr et al., 2007; Huizinga et al., 2008; Modic et al., 2009; Al-Qazaz et al., 2010; Collins et al., 2011; Koontz et al., 2010; Eaton-Spiva and Day., 2011; Eigenmann et al., 2011; Schmitt et al., 2013; Yacoub et al., 2014; Navarro-Flores et al., 2015; Weeks et al., 2015; Ahmedani et al., 2016; Alhaiti et al.,2016; Alotaibi et al., 2017). Among those studies, six studies included the target participant to be the content validators (Modic et al., 2009; Al-Qazaz et al., 2010; Eaton-Spiva and Day, 2011; Schmitt et al., 2013; Yacoub et al., 2014; Weeks et al., 2015).

Pre-test and cognitive interview

Cognitive interviewing enhances a questionnaire's validity (Egger-Rainer, 2019). The benefits of cognitive interviews were reported in Egger-Rainer's study, as the author claimed that "cognitive interviewing turned out to be a valuable approach for revealing problems in an instrument, which would, otherwise, remain undetected and threaten validity". Although it is time consuming to perform cognitive interviews, it is a valuable process to undertake a pre-test on a small sample. This method allows the developers to detect any possible unclear items (Tsang et al., 2017), any problems with the items, completeness and its user friendliness (Egger-Rainer, 2019), and assess the necessary modifications that might make the question easier to answer (Patrick et al., 2011; Willis and Miller, 2011; Collins, 2015). This process is especially important, when using or translating a questionnaire from another language, as cognitive interviews are recommended to ensure that the translated version can

retain the same meaning and no words have become confused due to the translation (Tsang et al., 2017). In the process, the respondents are asked to provide responses (verbally or open-ended question) on each item, whether they understood or not (Tsang et al., 2017). They are also asked, to suggest any possible item' s for improvement, then the questions are adjusted or revised based on the recommendation (Tsang et al., 2017).

The findings from literature reviews showed that six studies undertook pre-testing (Findlow et al., 2002; Derr et al., 2007; Koontz et al., 2010; Adibe et al., 2011; Saleh et al., 2012; Hernansdez and Hernandez, 2015) and four studies undertook cognitive interviewing in the target group (Wongwiwatthananukit et al., 2004; Huizinga et al., 2008; Amin and Chewning, 2014; Navarro-Flores et al., 2015). Consequently, some questions were further refined due to being unclear or poorly understood. Three studies measured the readability by the readability test tool (Wagner et al., 2005; Koontz et al., 2010; Eigenmann et al., 2011). Although pre-testing and cognitive interviewing can help the researcher detect some items being unclear, two studies did not undertake any pre-testing or cognitive interviewing (Ahmedani et al., 2016; Zainudin et al., 2017). Furthermore, a questionnaire was developed to assess the physician and nurse, however, the pilot test was not undertaken with the nurse (Derr et al., 2007).

Reliability

Reliability is defined as a consistency of the measure. The reliability of the tools is the consistency of the tools to pose the same results when applied to same person at different times (Chanthong et al., 2009). The latter part of this statement recognises the limitations of such testing in that reliability when measured in one context cannot be assumed to be stable within another. It is therefore vital that testing is undertaken with a small sample of

respondents who meet the study criteria. Reliability can be divided into three main types namely test-retest reliability (consistent over time), internal consistency (consistent across items) and inter-rater reliability (consistent across different researchers) (Kimberlin and Winterstein, 2008; Price et al., 2015). As the test-retest reliability is consistent over time, hence a good tool should produce the same results over time (Price et al., 2015). The test-retest was conducted by using the same tool with the same group at different times and then comparing results from both assessments. High test-retest correlation means the measure is consistent over time (Price et al., 2015). Internal consistency is the consistency of people's responses across the item on the tool items. Generally, all items should reflect the same underlying construct, and the people's score on those items should be correlated with each other. The internal consistency can be measured by a split-half correlation, Kuder Richardson coefficient (KR) and Cronbach α (Heale and Twycross, 2015); a split-half assumes that the items in the questionnaire can be divided into two groups and each half of the question is expected to match the other half (Oluwatayo, 2012). The split-half correlation is performed by separating the survey items into two groups and then computing for the correlation between two groups, if the correlation is .80 or greater, it can be described that this survey has good internal consistency (Price et al., 2015). KR is a more complex version of the split-half test and more accurate than split-half test, however, it can only be used with dichotomous responses such as yes, no questions (Heale and Twycross, 2015). While Cronbach α is widely used to determine the internal consistency of an instrument (Heale and Twycross, 2015). Cronbach α is the mean of all possible split-half correlations for a set of items, the value of .80 or above can be considered as good internal consistency (Price et al., 2015). Finally, inter-rater reliability, it can be performed by different researchers or

observers to rate their judgment into the same event or situation, it can be called inter-observer agreement (Kimberlin and Winterstein, 2008), hence those researchers should establish equivalent rating or judgment when using this tool (Price et al., 2015).

The majority of studies (n=20) employed the Kuder Richardson 20 formula and Cronbach's Alpha to measure an internal reliability (El-Deirawi and Zuraikat, 2001; Garcia et al., 2001; Wongwiwatthananukit et al., 2004; Rothman et al., 2005; Wagner et al., 2005; Rubin et al., 2007; Huizinga et al., 2008; Al-Qazaz et al., 2010; Collins et al., 2011; Koontz et al., 2010; Adibe et al., 2011; Eaton-Spiva and Day, 2011; Eigenmann et al., 2011; Guo et al., 2012; Schmitt et al., 2013; Navarro-Flores et al., 2015; Yacoub et al., 2014; Weeks et al., 2015; Alhaiti et al.,2016; Zainudin et al., 2017). In addition, eight studies performed Cronbach's Alpha with other kinds of testing such as test-retest reliability (n=8) (Wagner et al., 2005; Rubin et al., 2007; Al-Qazaz et al., 2010; Eaton-Spiva and Day, 2011; Eigenmann et al., 2011; Alhaiti et al.,2016; Alotaibi et al., 2017; Zainudin et al., 2017), split-half correlation (n=1) (Koontz et al., 2010) and inter-rater reliability (n=1) (Navarro-Flores et al., 2015).

Translation

In the case of cross-cultural translation, four previous studies employed a forward-backward and back translation procedure to translate the questionnaire from source language to target language (Al-Qazaz et al., 2010; Saleh et al., 2012; Schmitt et al., 2013; Alhaiti et al.,2016). One study, the researcher translated the source language (English) to the target language (Malay) by using the forward translation technique (Zainudin et al., 2017).

Response items

The yes/no or true/false and do not know response types were used in eleven studies (Garcia et al., 2001; Wongwiwatthananukit et al., 2004; Wagner et al., 2005; Modic et al., 2009; Collins et al., 2011; Adibe et al., 2011; Guo et al., 2012; Weeks et al., 2015; Ahmedani et al., 2016; Beshyah et al., 2017; Zainudin et al., 2017). Eleven studies, the survey included multiple-choice items (El-Deirawi & Zuraikat, 2001; Findlow et al., 2002; Derr et al., 2007; Al-Qazaz et al., 2010; Koontz et al., 2010; Eigenmann et al., 2011; Navarro-Flores et al., 2015; Amin and Chewning, 2014; Yacoub et al., 2014; Alhaiti et al., 2016; Alotaibi et al., 2017), Likert scale (Schmitt et al., 2013), Open-ended response (Rothman et al., 2005), while the remaining studies did not report the type of answer response.

Limitation of existing questionnaire

Item generation

There were a number of limitations with the included questionnaires relating to how they were developed. For example, three questionnaires did not describe the process of items' identification (Yaacob et al., 2007; Ahmedani et al., 2016; Beshyah et al., 2017). The number of total items can affect the questionnaire reliability as the questionnaire with more items can generate higher reliability value (Francisco, 2013), however, one questionnaire had only three questions due to the participant's time constraint and pharmacist's busy schedule (Amin and Chewning, 2014).

In addition, two questionnaires were too narrow; only comprising questions on foot self-care (Navarro-Flores et al., 2015), or heart disease risk (Wagner et al., 2005). Some questionnaires were developed for specific age groups, as they could only be used with

young people with diabetes (Koontz et al., 2010). Four questionnaires were too specific, only asking questions on diabetic management during Ramadan (Yaacob et al., 2007; Amin and Chewning, 2014; Ahmedani et al., 2016; Zainudin et al., 2017).

The lack of reported validity and reliability

Validity and reliability were not reported in two studies (Saleh et al., 2012; Beshyah et al., 2017). Two studies did not report the validity (Robin et al., 2007: Zainudin et al., 2017). Six studies, where the questionnaire was not formally statistically validated, only reported that the tool was reviewed by experts (Findlow et al., 2002; Derr et al., 2007; Saleh et al., 2012; Amin and Chewning., 2014; Ahmedani et al., 2016; Beshyah et al., 2017). In addition, the reliability was been reported in five questionnaires (Findlow et al., 2002; Derr et al., 2007; Modic et al., 2009; Saleh et al., 2012; Amin and Chewning., 2014)

Appendix 6 Characteristics of included studies

Author	Type/ response	Target population	validity	reliability	comment
Professional					
El-Deirawi and Zuraikat (2001). Use Diabetes Basic Knowledge Test (DBKT) of Drass 1989 The Diabetes Knowledge Test (DKT) modified base on the DKT to update information and adjust following the recommendation of DKT's author	A 45 items multiple choice questionnaire of Drass (1989) DBKT was modified from DKT-Diabetes Knowledge-Test of Scheiderich (1983)	Nurse	Content validity construct and tool's format were reviewed by 6 experts in the field of diabetes education	Cronbach's alpha was 0.79	
Findlow et al (2002) A revised questionnaire	A 45 items multiple choice questionnaire was modified from DBKT of Drass (1989)	Nurse	Reviewed content validity by expert panel	Pilot with 27 RN then no amendment **But did not report reliability procedure**	This questionnaire was revised due to the concern of outdated information and American jargon words
Derr et al (2007) A newly developed questionnaire based on the recent literature and updated ADA guidelines	A 20 multiple-choice items questionnaire Topic includes insulin nomenclature, duration of action and other characteristics of specific insulin types, insulin dosing in type 1 diabetes, and insulin use during hospitalizations.	Doctor and nurse	Content validity was reviewed by several Endocrinology Department faculty and fellows with expertise in diabetes Pilot test with 15 medicine Residents, medical students and fellows **did not formally statistically validate the questionnaire**	Reliability was not reported	Did not pilot with nurse

Author	Type/ response	Target population	validity	reliability	comment
Rubin et al (2007) A newly developed survey to assess the diabetes knowledge of nurses and residents in surgery, internal medicine, and family practice	A 21 items questionnaire fill in the blank created based on ADA guideline	Physician and nurse	Not reported	Cronbach's alpha was 0.78 Test-retest reliability was 0.71	
Modic et al (2009)	20 items with true, false response covered 5 topics: diet, blood sugar monitoring, symptom management, insulin, oral diabetic drugs	Nurse	Content validity was reviewed and performed statistically validate the tool by expert panel (1pharmacist, 8 nurses) CVI=0.90	Not reported	
Eaton-Spiva and Day (2011)	5 questions with 5 points Likert scale Consisted of diet, sign and symptoms, target ADA ranges, medication, exercise	Nurse	Item generated by 3 nurses	Cronbach's alpha was 0.91 Test-retest was 0.95	
Amin and Chewning (2014) The three items were new developed based on expert clinical opinion and clinical studies (previous studies) This study examines Egyptian pharmacists' knowledge regarding management of diabetes	3 questions with multiple choices The survey included three knowledge questions relevant to counselling diabetic patients during Ramadan. Questions covered the recommended timing and dosing for metformin and insulin as well as the safe blood glucose	Community pharmacists	conducted standard cognitive testing of all questionnaire items with six community pharmacists from Alexandria, Egypt who were representative of the target population -Revised and then pre-testing was done in 17 community pharmacies in Alexandria, all were	Reliability was not reported	**Limitation** A tool comprised only 3 questions due to the pharmacist's busy schedule.

Author	Type/ response	Target population	validity	reliability	comment
during Ramadan. **Egypt Language**	range required for diabetic patients to safely continue their fast.		asked to provide feedback on the item clarity.		
Yacoub et al (2014) The Modified Diabetes Basic Knowledge Test (MDBKT) was a revised version of DBKT which was developed by Drass et al (1989) to evaluate nurses' basic knowledge of diabetes. The Modified Diabetes Basic Knowledge Test (MDBKT) was adapted to ensure congruency with current established guidelines	45 questions with multiple choice	Nurse in Jordan	Content validity was tested by consulting a panel of experts in diabetes and diabetes education (a nurse, diabetes educator and an endocrinologist) All of the 45 questions present in the MDBKT achieved a minimum agreement required among content experts. The final **content validity index (CVI) was calculated at 0.94.**	Reliability was test with 30 RN and Cronbach's alpha coefficient for internal consistency on the MDBKT=0.77	
Ahmedani et al (2016) A new developed questionnaire included 25 questions to assess knowledge, attitude and practices of General practitioners (GPs) regarding Ramadan and diabetes.	25 questions with yes, no, don't know response that were structured according to three categories such as Ramadan specific knowledge, diet and physical activity and treatment modification related knowledge and practices of GPs	General practitioners in Pakistan	This questionnaire was developed by expert panel, however, the process of developing and testing the questionnaire was not shown. In addition, the expert's qualification was not reported. Validity was not reported	Reliability was not reported	
Beshyah et al (2017)	The 16	Physicians in United Arab	Validity was not reported	Reliability was not reported	Specific only one occasion 'Ramadan'

Author	Type/ response	Target population	validity	reliability	comment
A new questionnaire to assess the Physicians' Knowledge, Attitudes, and Practices	questions were based on a literature review and the current good practice guidelines (six on demographics; three on knowledge, three on attitudes and four on practices). Three questions regarding diabetes knowledge are multiple true false and require that the participants responded either true or false to each five or six lettered options for each item.	Emirates UAE			
Alotaibi et al (2017) 45 items were adopted from a Diabetes Basic Knowledge questionnaire developed by Drass et al (1989) and four items from other validated questionnaires (O'Brien et al., 2003; Modic et al., 2009)	49 questions with multiple choice	Nurse working in Saudi Arabia	Content validity was reviewed by four experts and content validity index was 0.98	Test-retest reliability was 0.727	
Patients					
Garcia et al (2001) Adjusted from 60 items of Villagomez (1989)	24 items with yes, no and I don't know response This is a short version of Villagomez (1989) questionnaire	Type 2 diabetic Mexican American	Construct validity The score on the 60 and 24 items were well correlation (r=0.85)	Cronbach's alpha was 0.78	Although the criteria of removing an item based on the item performance less than 0.25, however some were included if:

Author	Type/ response	Target population	validity	reliability	comment
A shortened version was created as an original 60 items was lengthy. The survey was available in English and Spanish	The questionnaire adjustment was based on the item performance such as item discrimination (item to total correlation) and item difficulty ≥0.25 The content validity of the original 60 items established by expert in diabetes, and reliability r=0.88				Reflect content critical to the intervention, had little variability or demonstrated sensitivity to the intervention in at least one of the subgroups
Wongwiwatthananukit et al (2004) This questionnaire was newly developed due to the lack of existing questionnaires which was developed following the methodological research	21 items with Yes, no, don't know response Item created by literature review and interviewed expert from related field Include 5 domains General knowledge, complications, medications, daily self-care	The questionnaire was developed for pharmacists and other health care professionals to assess the knowledge of the diabetic patients	Content validity reviewed by 8 experts Psychometric test with 15 type 1 and 2 diabetic patients	Test with 811 Diabetic patients from 21 hospitals in Thailand Reviews based on item analysis Included Kuder–Richardson Formula (KR) 20, corrected item total correlation between 0.20-0.52 KR= 0.82	Limitation: did not cover all general information about diabetes Recommend: should include diabetic cause and diabetic complication prevention
Rothman et al (2005) A newly developed tool: the Spoken Knowledge in Low Literacy patients with Diabetes (SKILLD)	10-items with open ended response designed by a team of clinical pharmacists and general internists in diabetes field and literature reviewed based on ADA Clinical Practice Recommendations year	Diabetic patients	Content validity was reviewed by experts Construct validity was performed by using factor analysis	Kuder-Richardson coefficient was 0.72	

Author	Type/ response	Target population	validity	reliability	comment
	2000 and previous diabetes knowledge (the Diabetes Knowledge Test, and the DKN				
Wagner et al (2005) A new questionnaire The Heart Disease Fact Questionnaire (HDFQ) assess heart disease risk knowledge in people with diabetes	25-items with true false and don't know response generated from review literature based on three sources: ADA, the American Heart Association, and the National Diabetes Education Program	Diabetic patients	Content validity and face validity, item clarity and readability reviewed by expert in the field of diabetes and heart disease good criterion related validity	Kuder–Richardson-20 formula was 0.77 Test -retest reliability (n=13, r=0.89)	The HDFQ is readable to average 13 years old
Huizinga et al (2008) The Diabetes Numeracy Test (DNT) A newly developed tool was developed by an expert panel in diabetes, literacy and numeracy which included diabetologists, certified diabetes educators, primary care providers, registered dietitians, behavioural researchers in diabetes, and literacy and numeracy experts.	43 items covered five diabetes self-management areas such as nutrition, exercise, glucose monitoring, oral medication and insulin skills that patients may encounter during daily diabetes self-management.	Diabetic patients	Content validity reviewed by experts Construct validity was examined through the a priori construct model and expected correlations as determined by the expert panel Cognitive test by 40 individuals without diabetes to assess understandability	Kuder-Richardson coefficient (KR-20) was 0.95	A shortened, 15-item version of this instrument demonstrated strong psychometric properties while covering all the skills tested by the 43-item version.
Al-Qazaz et al (2010) Translate the Michigan Diabetes Knowledge Test	A 14 multiple choices questionnaire of Michigan	Diabetic patients	Content and face validity were performed in 20 Malaysian patients	Cronbach's alpha was 0.72 item total correlation was between (0.23-0.41)	

Author	Type/ response	Target population	validity	reliability	comment
developed by the Michigan Diabetes Research Training Center (MDRC) to Malaysia version Employing forward and backward translation			Construct validity was performed by using known group validity among high moderate and low knowledge group	Test-retest reliability was 0.894	
Collins et al (2011) A simplified true, false response format of the Revised Diabetes Knowledge Scale	17 items original revised Diabetes Knowledge Scale with multiple choice was replaced by true, false response	Diabetic patients	Scale was developed in consultation with the Diabetes Specialist Nurse Team, Asian Link Workers, Warwick Diabetes Care Service Users group and the author of original tool (Michigan)	Cronbach's alpha was 0.71, Item correlations with the total knowledge test score ranged from 0.26 to 0.58	True false version is easier to complete than multiple choice versions, however, there was statistically different between revised and simplified version, hence it is not recommender to use interchangeably
Koontz et al (2010) A newly developed questionnaire to assess carbohydrate and Insulin-Dosing Knowledge as the existing questionnaire did not address content about carbohydrate and those only validate in adults	78 items with multiple choices generated by 14 expert panel	Youth with type 1 diabetes	Content validity reviewed and revised by experts Construct validity test by known case validity Readability of the test questions, measured by Flesh-Kincaid grade level, is 6th grade Pre-tested in 13 youths with type 1 diabetes or their parents for clarity	Cronbach's alpha was 0.88 Correlation of split half reliability was 0.59	
Adibe et al (2011) New developed questionnaire	30 items with true false responses Created base on STGs of Nigeria	Type 2 diabetic patients	Construct validity test by factor analysis was 0.87	Cronbach's alpha was 0.89	

Author	Type/ response	Target population	validity	reliability	comment
			Pilot test with 47 patients and then adjust the items		
Eigenmann et al (2011) Diabetes Knowledge Questionnaire (DKQ) is new developed questionnaire to assess knowledge about diabetes as a lack of an up-to-date, validated instrument	15 items multiple choice (12 first item for both type1 and 2, item 13, 14 for diabetic patients who treated by oral diabetic drug or insulin, item 15 for the type 1 patient only) was established through literature review, Delphi survey and an opinion derived from a workshop of Australian Diabetes Educators	Type 1 and 2 diabetic patients	Content validity reviewed by expert Delphi survey of 52 opinion leaders and a workshop of Australian Diabetes Educators The readability of the questionnaire was assessed by using the Flesch Reading Ease score	Cronbach's alpha of first 12 items was 0.73, 14 first items was 0.76, and first 12 items +items number 15=0.79 Test-retest showed good reliability with no evidence of change over time (t=1.73; df=56; p<0.85), and a correlation of 0.62.	
Guo et al (2012) The difference between western and Chinese culture led the author to develop a new questionnaire to assess the knowledge about diabetes	111 items with true false and do not know options Develop by reviewing current literature	Diabetic patient in China	The content validation index was 0.923	Cronbach's alpha index was 0.909	Did not describe the process of testing validity and reliability
Saleh et al (2012) This study modified the Diabetes Knowledge Test (DKT) questionnaire of the University of Michigan following the local guideline of Diabetes Association of Bangladesh	35 knowledge questions were divided into basic (13 items) and technical sections (22 items), correct response was assigned a score of 1, while incorrect was 0	Newly diagnosed type 2 diabetic patients	Pre-test was performed Did not report the process and type of test validity	Not report	The authors explained that their knowledge question consisted of 35 items which were adapted from a brief DKT of Michigan, which has only 23 items, so the author did not report the source of the other items

Author	Type/ response	Target population	validity	reliability	comment
Employed forward and backward translation					
Luevano-Contreras et al (2013) The dietary data from 30 subjects from a previously published research study were used	A newly developed food frequency questionnaire comprised of 90 food items	Type 2 diabetic patients	Validity of the food frequency questionnaire (FFQ) was evaluated when compared to the 7-day food record (7-dFR), both for total Advanced glycation end products (AGEs) content and types and amounts of food eaten.	A test–retest The Spearman's correlation coefficient was 0.89 (p50.01), and the intraclass correlation coefficient was 0.98 with 95% CI (0.95, 0.99)	
Schmitt et al (2013) A newly developed Diabetes Self-Management Questionnaire (DSMQ)	16 items with 4-point Likert scale was created from the literature	Diabetic patients	Content validity was reviewed by the group of experts including 5 psychologists, 3 diabetologists and 15 diabetic patients. Construct validity was performed by using known group validity Convergent validity by comparison with another measuring tool	Cronbach's alpha was 0.84 Item analysis mean of inter item correlation was 0.25	The original version was German, the developer employed forward and backward translation
Hernandez and Hernandez (2015) Adopted from previous studies	The 27 items of the Body Knowledge Questionnaire (BKQ) were developed through review of the literature on integration and weight management/obesity	Adults with and without type 2 diabetes	Content validity was established by using the The Diabetes Questionnaire (TDQ) and literature on obesity and weight management as sources for questionnaire items	Scale reliability analysis was used to determine the internal consistency	The content validity are usually established and reviewed by the experts, however, this author stated that as this questionnaire items were drawn from previous studies the authors of

Author	Type/ response	Target population	validity	reliability	comment
			Exploratory factor analysis was used to assess the construct validity Criterion-related validity was established through discriminant function analysis and logistic regression Pilot tested with 4 groups of individuals with and without type 2 diabetes		each previous study were experts *Although this study performed EFA factor analysis to assess the construct validity by using a 32 sample size. According to several previous studies the minimum sample size should be 50 (Comrey (1973; Gorsuch, 1974; Comrey and Lee, 1992), 100 sample Gorsuch, 1983; Kline, 1994) and 200 (Guilford, (1954; Cattel,1978)
Navarro-Flores et al (2015) The new diabetic foot self-care questionnaire (Spanish language)	16 items multiple choice generated by literature review on Health-related quality of life (HRQoL), pain and functionality instruments for foot care questionnaires	Diabetic patients	Face and content validity reviewed by 3 experts **performed statistically validate the questionnaire** Cognitive interviewed with 30 diabetic patients Construct validity The Kaiser-Meyer-Olkin was 0.89, and the Bartlett's test of sphericity was significant ($p < 0.001$) Criterion validity was	Cronbach's alpha was 0.89. Inter-item correlations Between 0.06-0.74 Inter-rater reliability conducted by two independent researchers Construct validity used factor analysis	Limitation Did not included patient with amputation of the lower limbs

Author	Type/ response	Target population	validity	reliability	comment
			analysed using correlation coefficients between the questionnaire and HbA1c, and glucose (low score inverse correlate with high blood sugar levels)		
Weeks et al (2015) New developed questionnaire	A 32 true false don't know response questionnaire generated by certified diabetes educators, dietitians, physiatrists, nurses, therapists and other health care providers practising in the medical rehabilitation environment	Diabetes and non-diabetes	Content validity established by 9 health professionals and 2 diabetic patients Construct validity -Known group validity -Confirmatory factor analysis Cognitive test by 9 health professionals and 2 diabetic patients	Cronbach's alpha for the 32 items was 0.817	The test was written at an average reading level of 6th grade on the Flesch-Kincaid Grade Level Index.
Alhaiti et al (2016) Translate the revised Michigan Diabetes Knowledge Test version 2016 (DKT-2) to Arabic	A 14 multiple choices questionnaire	Type 2 diabetic patients in Saudi Arabia	Content validity reviewed by 6 experts and Item - level content validity index (I-CVI was between 0.83-1), Scale – level content validity index (S-CVI=0.96)	Test-retest reliability was 0.90 Cronbach's alpha 0.75	The questionnaire was translated to Arabic version following the WHO process for the translation
Zainudin et al (2017) A new developed questionnaire was available in both English and Malay developed and modified by the author	Questionnaire included 44 items which were divided into 4 sections: Section 1, A modified, 16 multiple choices version of the validated Michigan Diabetes	Muslim patient with diabetes	Validity was not report This questionnaire included both languages, however the author did not perform cognitive test for clarity and readability of the questions	Cronbach's alpha -Test-retest reliability	Did not report the process of validating and testing reliability of the questionnaire and the value of reliability, however the criteria for accepting

Author	Type/ response	Target population	validity	reliability	comment
	Knowledge Test (MDKT) to suit were modified to better suit the Singapore population (16 items). Section 2-4 include 28 items with yes, no, don't know options based on the recommend of ADA management of DM during Ramadan 2010				Cronbach's alpha was a score > 0.6. The questionnaire first developed in English and the translated to Malay by using forward translation technique