Understanding Ethnic Differences in Diabetes Prevalence: Effects of Personal Information and Communication Technologies

Kanayo Umeh,

School of Natural Sciences & Psychology, Liverpool John Moores University, Byrom Street, L3 3AF. Email: f.k.umeh@ljmu.ac.uk Tel :(+44)1519036310

Michael Mackay,

School of Computer Science, Liverpool John Moores University, Byrom Street, L3 3AF. Email: M.I.Mackay@ljmu.ac.uk Tel:(+44)1512312121

Stephanie Le-Brun Davis,

School of Natural Sciences & Psychology, Liverpool John Moores University, Byrom Street, L3 3AF. Email: S.E.DavisLeBrun@ljmu.ac.uk Tel: (+44)1519036310

<u>Corresponding Author</u>

Kanayo F Umeh

School of Natural Sciences & Psychology, Liverpool John Moores University, Byrom Street, L3 3AF. Email: f.k.umeh@ljmu.ac.uk Tel :(+44)1519036310

(Email f.k.umeh@ljmu.ac.uk; Tel +441519036310)

<u>Word count</u>

3720

KEY POINTS

- Ethnic differences in diabetes prevalence were qualified by uptake of information and communication technologies, specifically mobile phones and home computers
- Presence of a home computer was implicated in better tobacco control in South Asian diabetes cases
- Absence of a home computer was associated with better tobacco control in Caucasian diabetes sufferers
- Dependence on mobile phones was characteristic of South Asian diabetes cases from low income families

KEY WORDS

Technology; Mobile Phone; Home Computer: Ethnicity

ACKNOWLEDGEMENTS

This project was funded by a research grant (Project P44232) from the Sustainable Society Network based at Imperial College of Science, Technology and Medicine.

ABSTRACT

Background: Uptake of information and communication technologies (ICTs) by individuals with diabetes can assist nursing care delivery, and improve patient outcomes. However, it is unclear how such uptake relates to ethnic differences in diabetes risk.

Aims: To assess the moderating effects of ICT uptake on the South Asian excess diabetes prevalence over a specific elapsed time frame, accounting for selected environmental, socio-economic, and behavioural risk factors.

Methods: Archived data from a UK Office for National Statistics household survey 2006-2011 (120,621 partly non-orthogonal participant records) was analysed using hierarchical binary logistic regression analyses.

Results: ICT uptake qualified ethnic differences in diabetes prevalence. Non-smoking diabetes cases living in terrace housing with a home computer were more likely to be South Asian than Caucasian. By contrast, such cases were more likely to be Caucasian if a computer was unavailable (OR, 0.61; CI, 0.43-0.86; $P = 0.005$). Furthermore, diabetes cases from low income mobile-dependent homes were probably South Asian (OR = 0.05, CI = 0.00 – 0.50; $P = 0.012$).

Conclusions: Home computing was linked to better tobacco control amongst South Asians with diabetes living in terrace properties. Mobile phone dependence was pronounced in those that received income support. Implications for nursing care are considered.

INTRODUCTION

Information and communication technology (ICTs) is increasingly used in diabetes care (Pal et al., 2014, Pal et al., 2013). Patient access to ICTs can assist the care provided by diabetes specialist nurses (DSN's), and other professionals involved in diabetes management (Holtz and Lauckner, 2012). For example, a desktop computer at home can negate the need for travel, improve patient monitoring, and offer more options for communication between patients and health care providers (e.g., text, email, video chat) (Peate, 2013).

There is uncertainty regarding how ICT uptake affects ethnic differences in diabetes risk (Schwartz et al., 2015, Khunti et al., 2013). For example, it has been suggested that not all diabetes patients benefit from access to mobile phones and computers (Holtz and Lauckner, 2012, Pal et al., 2013). Although diabetes prevalence is highest in South Asians (Bakker et al., 2013) it is unclear how ICT uptake affects this surplus risk. The implication is that health providers can't be sure this population will, for example, benefit more from mobile-phone delivered rather than computer-based interventions, or vice versa, and which risk factors will be mostly affected (e.g., diet, smoking, home blood monitoring) (Pal et al., 2013). As evidence suggests South Asian diabetes patients regard diabetes care staff, particularly nurses, as an important source of information (Singh et al., 2012), investigating the role of ICT's in diabetes care can help DSNs determine what technologies to exploit when providing indirect services (e.g., telephone or email advice on self-care skills, sign-posting) to patients from a particular ethnic group, and what risk factors to target (Peate, 2013).

Some evidence suggests greater enthusiasm for handheld devices (e.g., mobile phones, tablets) amongst young people, particularly those from ethnic minority groups (EMGs) (Office of Communications, 2013). Unlike desktop computers, mobile devices have added conveniences (e.g., portability, size, privacy) that may augment their impact on diabetes rates and risk factor control (Holtz and Lauckner, 2012). However, most individuals with diabetes are aged over 50 (Winkley et al., 2013), and patients who are more frail and elderly may prefer the physical keyboard and large screen of a desktop computer (Office of Communications, 2011), partly due to usability problems associated with the small size of mobile devices, and declining motor abilities (Zhou et al., 2012). For example, text-entry using the on-screen keyboards on mobile devices requires fine pressure control, to avoid duplicate entries; Older people tend to press on-screen keys too heavily, and experience shaking hands, producing text errors (Wright et al., 2000). Thus, while desktop computer uptake has seen a 13% decline in young people since 2012, the falloff has been slower in over 55's (6%) (Office of Communications, 2014). Moreover, laptop ownership has remained stable since 2012, actually showing a slight increase in ownership amongst over 55's by 2014 (Office of Communications, 2014).

DSN's may be required to provide indirect care (e.g., telephone or email advice on diet/weight control) to patients using ICTs (James et al., 2009, Peate, 2013). Thus, some understanding of the impact of technology on diabetes risk across ethnic groups may help improve care delivery. For example, if mobile phone use is associated with a reduced excess diabetes risk in South Asians, a DSN working with this community can heavily exploit mobile phone functions such as text messaging to respond to patient requests for advice, provide signposting to specific health services, or arrange personal consultations (Holtz and Lauckner, 2012). Such 'eHealth' services may also apply to Caucasians, or any other ethnic group for whom ICT uptake is implicated in improved diabetes outcomes (Peate, 2013).

However, there are potential confounded factors. For example, the role of ICT use may partly depend on socio-economic disparities (LaVeist et al., 2009, Link and McKinlay, 2009), neighbourhood environment (e.g., terrace housing, traffic noise) (Weng et al., 2000, Mezuk et al., 2013, Cox et al., 2007, Gariepy et al., 2013, Ludwig et al., 2011), and behavioural risk factors(Gujral et al., 2013). Thus, it is necessary to account for such factors when assessing the link between technology uptake and diabetes rates.

The aim of this study was to assess the moderating effects of ICT uptake on diabetes rates in South Asians and Caucasians, using large archived population datasets. A secondary goal was to account for the confounding effects of selected environmental, socio-economic, and behavioural risk factors. The study examines data collected from 2006 to 2011. The focus on this time frame was partly based on two considerations. Firstly, the period marks several key developments in ICT usage, including arrival of the iPhone (launched in 2007), and mobile phone uptake exceeding fixed-line phone ownership (in 2008)(Office of Communications, 2011). Secondly, the era saw a sharp increase in diabetes prevalence (from circa 2003), combined with notable fluctuations (from 2009 to 2011) in the rates of both diagnosed and undiagnosed diabetes (Moody, 2012). Amongst males in general, there was a marked decline in diabetes cases from 2009 to 2010, followed by sharp rise in diagnosed cases from 2010 to 2011. In females there was a noticeable increase in diagnosed cases from 2009 to 2011(Moody, 2012). While these fluctuations may partly reflect methodological irregularities (e.g., sampling bias), they might also denote genuine variations in morbidity, triggered by risk factor fluxes, and/or wider societal changes, including transformations in the uptake of technology, such as mobile phones (Holtz and Lauckner, 2012). Thus, authors felt any associations between ICT uptake and diabetes prevalence may be especially apparent during this period of increased variability in morbidity rates and technological developments.

METHOD

Design, sample

The GHS/GLF (General Household/Lifestyle Survey) is a multi-purpose annual survey conducted in Britain since 1971 and managed by the UK Office for National Statistics (ONS) (Office for National Statistics, 2013). The survey targets all adults aged 16 or over living in UK households. From 2005 the survey adopted a prospective design, so that approximately75% of the same households were sampled annually. Data collection was conducted weekly by trained researchers recruited following meticulous selection procedures, and attendance at an initial training program. All recruits were supervised either through monitoring by a TIU ('Telephone Interviewing Unit') supervisor, or an accompanying Field Manager (Office for National Statistics, 2010). Data was collected via face-to-face standardised interviews whereby all adult (aged 16 or over) household members answered structured questions from the survey, in person. The study reported here analysed combined survey data covering the 2006 to 2011 period. The annual sample size ranged from 18,367 to 30,069, amounting to a total of 120,000 partly non-orthogonal participant records. The mean age for Caucasians ranged from 40.6 (SD=23.2) years in 2006 to 43.2 (SD = 24.1) years by 2011. The average age for South Asians varied between 29 (SD=19.8) years in 2006 and 31.1 (SD=21.1) years in 2011. Gender distribution for Caucasians ranged from 48.6% to 48% male (in 2008 and 2009, respectively). The South Asian sex distribution varied between 54.3% and 48.9% male (for 2009 and 2010, respectively). Ethics approval for the analysis reported here was given by the Liverpool John Moores University Research Ethics Committee (reference 14/NSP/031).

Survey methods

Details of the GHS/GLS survey questionnaire have been published by the ONS (Office for National Statistics, 2013).

ICT uptake: The survey assessed household telecommunications, including mobile phone and computer uptake. We derived two technology variables; 'Mobile-only' (Yes=1/No=0), and 'Home Computer' (Yes=1/No=0). 'Mobile-only' was defined as total dependence on a mobile phone (i.e., has a mobile phone, but no landline). This strict definition was due to perceived overlap in the use of mobile and fixed-line phones, a potential source of confounding. Many households still have access to landline phones for making/receiving calls, internet access (Office of Communications, 2014), functions that overlap with mobile phone utilities (Peate, 2013). As it was important to isolate mobile phone dependence specifically, given the prominence of this device in diabetes self-management (Holtz and Lauckner, 2012), individuals with a landline or no phone were not considered mobile dependent.

Ethnicity: respondents were classified into up to fifteen ethnic groups, based on their indicated ethnicity'. They were classified as either '*Caucasian*' ('White British', 'any other White background') coded '1' or '*South Asian*' ('Pakistani', 'Indian', 'Bangladeshi' descent), coded '0'.

Diabetes: respondents were asked if they had any long-standing illness, disability, or infirmity. The term 'long-standing' was defined as 'anything that has troubled you over a period of time, or that is likely to affect you over a period of time'. They were then asked 'What is the matter with you?'. The researcher noted the number of illnesses, and recorded the six illnesses that the respondent considered most important. For the purpose of this study, respondents were coded as '1' (diabetes case) if diabetes was mentioned as one of the six illnesses, and '0' (non-case) if diabetes wasn't mentioned at all.

Additional variables: The data was stratified on *housing type* (terrace/detached) and *income support* (HRP [Household Reference Person] and/or partner receives or does not receive income support). *Age* (16+), *gender* (male/female), *education* (highest educational qualification of the HRP), *occupation* (manual/non-manual) and *year* of data collection (2007-2011) were treated as 'control' variables. *Cigarette smoking* status was assessed using two categories; 'smoker' (scored '1') and 'nonsmoker' (scored '0'). A 'smoker' was defined as someone smoking 0 to 20+ cigarettes per day/week, while a 'non-smoker' comprised 'ex-smokers', or people who had 'never smoked'.

Data analysis

The data was analysed using hierarchical binary logistic regression, controlling for confounding variables. *Diabetes status* (case versus non-case) was the outcome variable. Data analysis was first performed on the overall sample. *Educational level, occupation, gender*, *age,* and *year of data collection,* were first entered in the regression model as confounding factors (Step 1), followed by *ethnicity, mobile-only, home computer,* and *smoking status* (Step 2), then three two-way Ethnicity x ICT interaction terms (*Ethnicity x Mobile phone*, *Ethnicity x Computer*, *Ethnicity x Smoking*) (Step 3). Finally two three-way interaction terms (*Ethnicity x Smoking x Mobile phone*, and *Ethnicity x Smoking x Computer*) were added (Step 4). This analysis was repeated across stratifications based on *housing type* (terrace/detached) and *income support* (HRP receiving/not receiving). Significant interactions were explored graphically, using predicted probabilities from each model. To reduce the likelihood of false positives (*type* 1 errors) we performed both Bonferroni and FDR (False Discovery Rate) corrections for all regression models. All analysis was performed using SPSS version 21.

RESULTS

Determinants of diabetes prevalence for overall sample

The odds ratios presented in *Table* 1 show that the likelihood of developing diabetes was significantly higher in respondents from poorly educated backgrounds, manual workers, males, older respondents, and in later years. There was an excess risk in South Asians, who were 2.9 times (i.e., 1/0.34) more likely to have diabetes compared with Caucasians. This ethnic disparity was not moderated by ICT variables or cigarette smoking.

Table 1 – Diabetes prevalence as a function of ethnicity, ICTs, and Ethnicity x ICT interactions in the overall sample

	Diabetes Odds
	Overall sample
Predictors	**OR (CI), *P***
Educational	1.18 (1.08-1.29)1[ab]
Occupation	1.29 (1.20-1.40)[ab]
Sex	0.79 (0.73-0.84)[ab]
Age	1.05 (1.04-1.05)[ab]
Year	1.12 (1.09-1.14)[ab]
Ethnicity	0.34 (0.22-0.52)[ab]
Mobile	1.20 (0.50-2.86)
Computer	0.85 (0.53-1.35)
Smoking	1.04 (0.55-1.96)
Ethnicity x Mobile	1.00 (0.41-2.47)
Ethnicity x Computer	1.19 (0.74-1.91)
Ethnicity x Smoking	1.00 (0.52-1.94)
Ethnicity x Mobile x Smoking	0.81 (0.53-1.24)
Ethnicity x Computer x Smoking	0.92 (0.74-1.15)

Superscript indicates statistical significance; [a]Bonferonni adjustment, $\alpha = 0.004$, [b]Benjamini & Hochberg (1995) FDR adjustment, $\alpha = 0.02$.

Table 2 – Diabetes prevalence as a function of ethnicity, ICTs, and Ethnicity x ICT interactions, across housing type category

	Diabetes Odds	
	Detached housing	**Terrace Housing**
Predictors	**OR (CI), *P***	**OR (CI), *P***
Educational	1.21 (1.08-1.34)[ab]	1.11 (0.95-1.30)
Occupation	1.37 (1.24-1.50)[ab]	1.09 (0.95-1.25)
Sex	0.74 (0.68-0.81)[ab]	0.89 (0.78-1.01)
Age	1.05 (1.04-1.05)[ab]	1.05 (1.05-1.06)[ab]
Year	1.12 (1.09-1.15)[ab]	1.09 (1.06-1.14)[ab]
Ethnicity	0.33 (0.17-0.65)[ab]	0.33 (0.18-0.62)[ab]
Mobile	0.92 (0.22-3.94)	1.47 (0.48-4.54)
Computer	0.87 (0.43-1.74)	0.85 (0.44-1.63)
Smoking	0.73 (0.25-2.13)	1.43 (0.64-3.18)
Ethnicity x Mobile	1.14 (0.26-5.07)	0.94 (0.29-3.04)
Ethnicity x Computer	1.09 (0.54-2.22)	1.49 (0.77-2.92)
Ethnicity x Smoking	1.21 (0.40-3.64)	0.92 (0.39-2.14)
Ethnicity x Mobile x Smoking	0.99 (0.53-1.87)	0.68 (0.38-1.23)
Ethnicity x Computer x Smoking	1.16 (0.86-1.55)	0.61 (0.43-0.86)[b]

Superscript indicates statistical significance; [a]Bonferonni adjustment, α = 0.002, [b]Benjamini & Hochberg (1995) FDR adjustment, α = 0.02.

Table 3 – Diabetes prevalence as a function of ethnicity, ICTs, and Ethnicity x ICT interactions, across income support category

	Diabetes Odds	
	Not receiving income support	**Receiving income support**
Predictors	**OR (CI), *P***	**OR (CI), *P***
Educational	1.18 (1.08-1.30)[ab]	0.79 (0.53-1.19)
Occupation	1.28 (1.18-1.38)[ab]	1.13 (0.77-1.65)
Sex	0.78 (0.72-0.83)[ab]	0.80 (0.55-1.17)
Age	1.05 (1.04-1.05)[ab]	1.07 (1.06-1.09)[ab]
Year	1.12 (1.10-1.15)[ab]	0.98 (0.88-1.10)
Ethnicity	0.35 (0.22-0.57)[ab]	0.60 (0.11-3.18)
Mobile	0.86 (0.31-2.44)	12.40 (1.31-117.69)
Computer	0.87 (0.53-1.44)	1.46 (0.29-7.27)
Smoking	0.92 (0.44-1.88)	1.52 (0.33-7.08)
Ethnicity x Mobile	1.49 (0.51-4.34)	0.05 (0.00-0.50)[b]
Ethnicity x Computer	1.15 (0.69-1.91)	0.96 (0.17-5.42)
Ethnicity x Smoking	1.05 (0.50-2.23)	1.29 (0.23-7.24)
Ethnicity x Mobile x Smoking	0.59 (0.35-0.99)	1.26 (0.43-3.68)
Ethnicity x Computer x Smoking	0.92 (0.73-1.17)	0.64 (0.27-1.55)

Superscript indicates statistical significance; [a]Bonferonni adjustment, α = 0.002, [b]Benjamini & Hochberg (1995) FDR adjustment per model, α = 0.014.

Determinants of diabetes prevalence by housing type

Predicted odds ratios show that, regardless of housing type, South Asians were 3 times (i.e., 1/0.33) more likely to develop diabetes compared with Caucasians (*Table* 2). There were no interactions between variables in detached house dwellers. However, amongst *terrace* house dwellers ethnic differences in diabetes probability were moderated by home computing. *Figure* 1 shows that, amongst respondents living in terrace housing *without* a home computer, the proportion of individuals with diabetes who did *not* smoke cigarettes was higher in Caucasians than South Asians (predicted probabilities = 0.65 vs 0.051). By contrast, the opposite was true for respondents *with* a computer at home; the proportion of non-smoking people with diabetes was higher in South Asians compared with Caucasians (predicted probabilities = 0.0.039 vs. 0.027). No other interactions were observed.

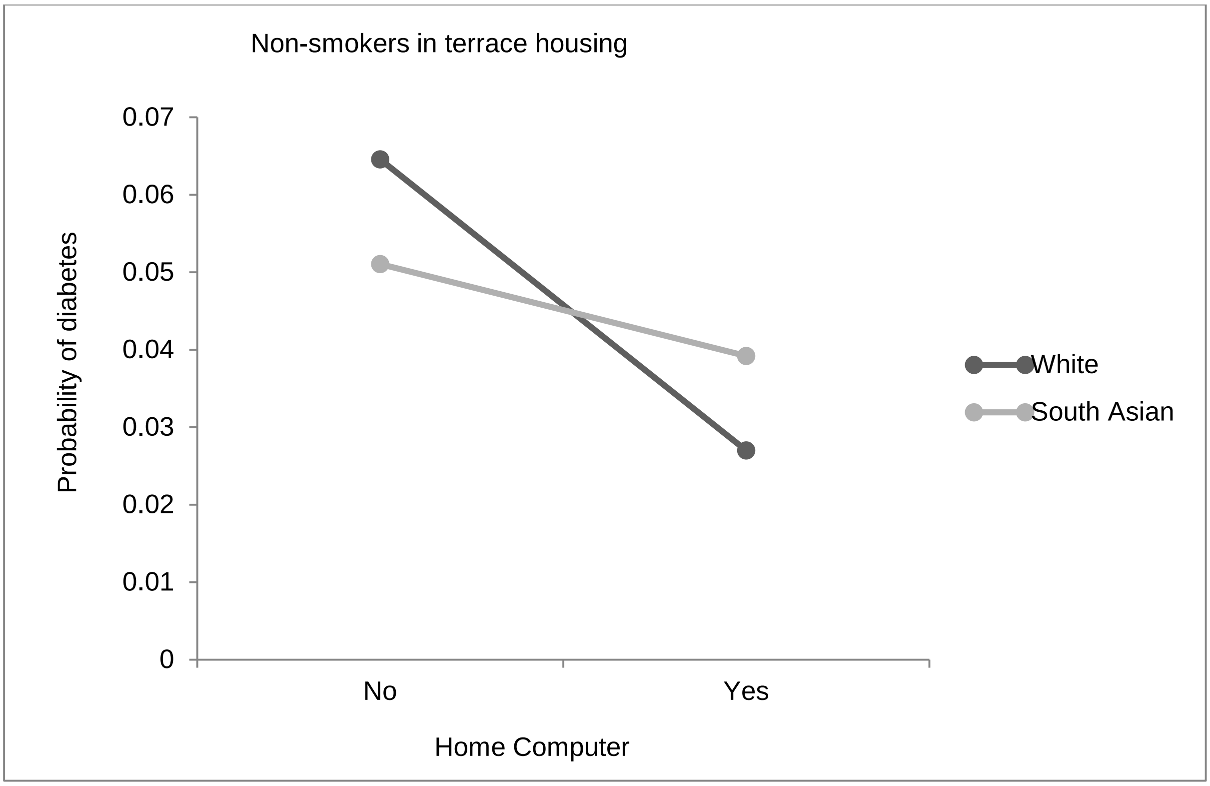

Figure 1: Home computer x Smoking x Ethnicity interaction in predicting diabetes prevalence by

housing type stratification

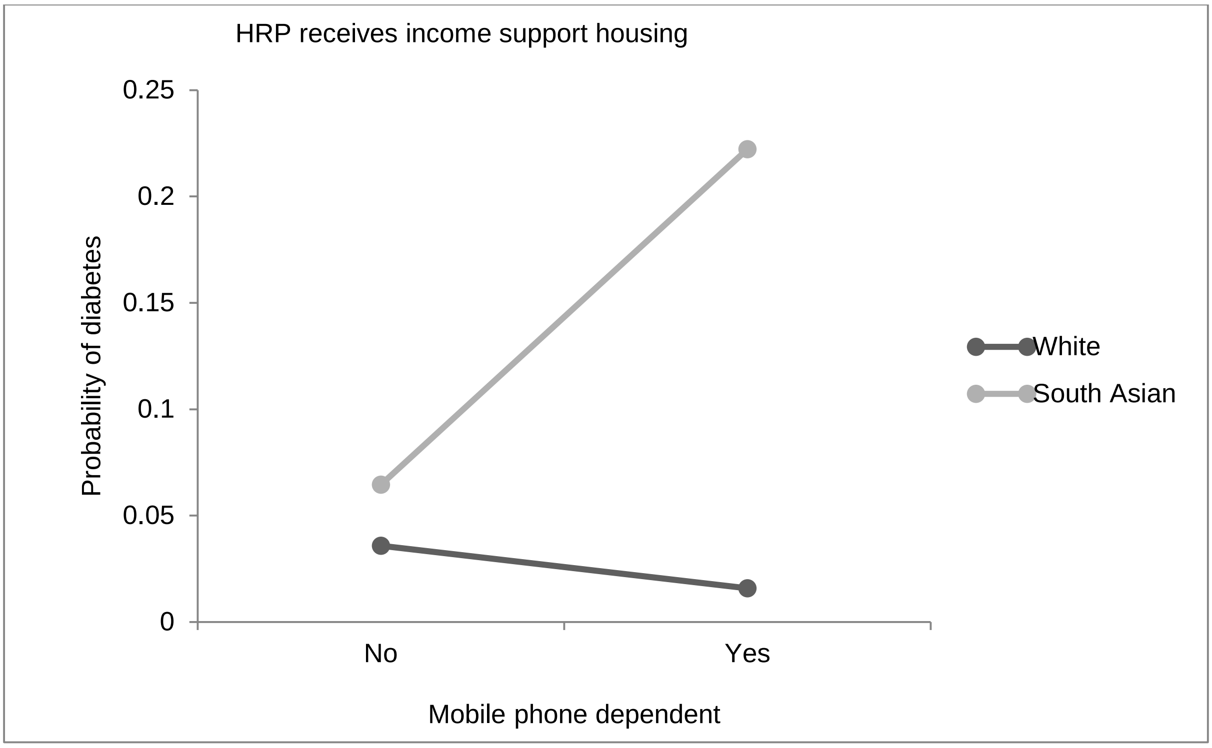

Figure 2: Mobile phone x Ethnicity interaction in predicting diabetes prevalence by income support stratification

Determinants of diabetes prevalence by income status

Ethnic disparity in diabetes rates was only observed in respondents from households *not* on income support (*Table* 3); South Asians were 2.86 times (i.e., 1/0.35) more likely to have diabetes. The association between mobile dependence and diabetes risk approached significance in low income respondents. Mobile dependents were 12.4 times more likely to have diabetes. There were no variable interactions in respondents not subject to income support. However, in the low-income group, ethnic differences in diabetes prevalence were moderated by mobile phone use. *Figure* 2 indicates an amplified ethnic disparity in mobile-only respondents, with South Asians showing a surplus risk compared to Caucasians (predicted probabilities = 0.22 vs 0.016). The ethnic inequality in adults not dependent on a mobile phone was less pronounced, albeit South Asians still showed an excess risk (predicted probabilities = 0.065 vs. 0.036). Thus, *Figure* 2 also highlights divergence in ethnic differences based on mobile phone reliance.

DISCUSSION

Non-smoking individuals with diabetes were more likely to be South Asian, but only in households equipped with a *computer*. This ethnic difference was reversed in respondents from homes not equipped with a computer (i.e., non-smoking cases were more likely to be Caucasian). In both scenarios living in terrace housing was an additional requirement. Overall, home computing was implicated in ethnic disparities in risk factor (i.e., tobacco) control. Another notable finding is the higher dependence on mobile phones of South Asian cases from low-income families.

A computer at home signifies better socio-economic circumstances (Carroll et al., 2005), a factor that partly accounts for ethnic variations in diabetes risk (Link and McKinlay, 2009, LaVeist et al., 2009). However, technology may play a unique role that transcends socio-economic privilege. Research indicates Caucasians are more inclined to seek health information online (Laz and Berenson, 2013, Miller et al., 2007). An internet-enabled computer may denote easier and more frequent contact with hospital or community DSNs (Peate, 2013), and hence better awareness of risk factor control, including the importance of not smoking cigarettes (James et al., 2009). The higher probability of *non-smoking* South Asian cases from computer-equipped homes suggests more engagement with information technology by this ethnic group than previously thought (Laz and Berenson, 2013, Miller et al., 2007). This can be exploited by DSNs in order to support home-bound South Asian patients susceptible to cigarette smoking, for example by promoting computer-based anti-smoking programs (Pal et al., 2013).

That non-smoking cases without home computers were probably Caucasian seemed curious at first. Smoking contributes to the elevated risk in South Asians (Tillin et al., 2013). It increases visceral fat and insulin resistance (Cena et al., 2011), two conditions that seem to explain the excess prevalence in South Asians (Tillin et al., 2013). Thus, non-smoking diabetes patients should be significantly more prevalent in the South Asian community (Bakker et al., 2013). However, evidence suggests Caucasians with diabetes are more likely to avoid smoking, indicating better risk factor control (Chowdhury et al., 2006). This disparity may be amplified in disadvantaged communities since diabetes patients living in deprived areas are predominantly Caucasian (Weng et al., 2000). Terrace housing and computer poverty might simply be proxy indicators of the underlying deprivation (Carroll et al., 2005, Cox et al., 2007).

The importance of income support echoes previous research on the role of socio-economic factors in the South Asian surplus risk (Link and McKinlay, 2009, LaVeist et al., 2009). However, our data suggests *mobile phone* dependence was amplified in South Asian homes receiving income support. This may denote more *severe* economic deprivation in the South Asian community, whereby fewer diabetes patients (or their families) are able to afford a fixed-line phone. In the UK EMG households (18%) are more likely to lack a fixed-line phone compared to the White population (11%). By contrast, 17 to 20% of South Asian families have at least 5 mobile phones in the household, compared to 4% of Caucasians (Office of Communications, 2013). Complete dependence on mobile phones may enable DSNs rely more heavily on text-messaging when working with low-income South Asian patients. This can be more convenient for patients who are less able to afford travel expenses for frequent face-to-face consultations (Holtz and Lauckner, 2012). It also means community DSNs can engage more frequently with patients between home visits (Peate, 2013).

Clinical implications

The use of technology is an increasingly important aspect of nursing care (Peate, 2013). However, *patient* uptake of ICTs is critical (Pal et al., 2013). In a Cochrane Database systematic review of literature on the effects of computer-based interventions in diabetes self-care (Pal et al., 2013), it was noted that reliance on technology for care delivery runs the risk of excluding patients who haven't got access to such technology. Regardless, certain population subgroups may benefit more than others (e.g., vulnerable patient groups with high ICT uptake), and further research is needed to identify these subgroups. The present findings seem to implicate home computing in improved risk factor (tobacco) control amongst South Asian cases from less privileged housing. This suggests DSNs can specifically highlight the issue of cigarette smoking when providing computer-based care (e.g., video conferencing, internet-based support group, chat room) to this particular community. Nevertheless, how computer-based care can be promoted in instances where illiteracy is present is open to question (Vida Estacio et al., 2015). Although research suggests Caucasians and EMGs are equally proficient in ICT activities such as word processing and using spreadsheets, the former group performs better in using email. This discrepancy is partly attributed to language differences: people for whom English isn't their first spoken language (67% come from EMGs) perform poorer on ICT some tasks (e.g., using the Internet) compared with individuals who speak English as their first language (Department for Business Innovation and Skills, 2011). These discrepancies may be amplified amongst older adults, particularly over-55s (61% of this group exhibit the lowest levels of technological knowledge and confidence) (Office of Communications, 2014). Finally, the heavy reliance on mobile phones by South Asians on low incomes provides additional care options for DSN's beyond the aforementioned text-messaging. These include increased use of automatic reminders, notification apps, and video conferencing, where appropriate (Peate, 2013).

Conclusions

To conclude, ICT exposure qualified ethnic inequalities in diabetes risk, subject to other conditions. Home computing was linked to better risk factor control amongst South Asians with diabetes living in terrace properties, while mobile phone dependence was characteristic of cases receiving income support. To the best of our knowledge this is the first study to shed light on the qualifying effect of ICT uptake on ethnic variations in diabetes risk, and implications for nursing care. Cigarette smoking may be an especially important topic when delivering diabetes care to South Asian cases from computer-equipped terrace homes.

This study has several limitations. The data precedes the arrival of tablet computers, which are now ubiquitous (Office of Communications, 2014). Moreover, the term ‘home computer’ as used in the GHS/GLS survey is ambiguous. We have no way of knowing if it denotes a desktop computer, laptop, or other computing device. Although desktop computers have become less popular, laptop ownership has remained stable since 2012, and actually shown a slight increase in ownership amongst over 55’s by 2014 (Office of Communications, 2014). As stated earlier, most diabetes patients are over 50 (Winkley et al., 2013), and may be more sceptical of mobile devices, such as tablets (Zhou et al., 2012). Another problem is that from 2005 the GHS/GLS adopted a partly longitudinal design, whereby some households were sampled repeatedly, every year. Thus, the year-on-year data analysed here is partly non-orthogonal. While we treated year of data collection as a confounding factor (partialled out prior to testing the key variables), the non-orthogonality in the data necessitates caution when interpreting the findings. Furthermore, the classification of respondents smoking ‘0-20’ cigarettes per day/week as smokers is questionable, since this may include people smoking ‘0’ cigarettes per day/week. Nevertheless, we suspect most of the latter self-identified as ‘ex-smokers’ or ‘never smokers’. Finally, we had no way of distinguishing *type* 1 and *type* 2 diabetes cases, as this detail wasn't incorporated in the GHS/GLS survey. Although approximately 90% of diabetes cases in England are *type* 2 (Moody, 2012) this ambiguity may nevertheless be a muddling factor.

REFERENCES

Bakker, LE, Sleddering, MA, Schoones, JW, Meinders, AE & Jazet, IM 2013. Pathogenesis of type 2 diabetes in South Asians. *Eur J Endocrinol,* 169**,** R99-R114.

Carroll, AE, Rivara, FP, Ebel, B, Zimmerman, FJ & Christakis, DA 2005. Household computer and Internet access: The digital divide in a pediatric clinic population. *AMIA Annu Symp Proc***,** 111-5.

Cena, H, Fonte, ML & Turconi, G 2011. Relationship between smoking and metabolic syndrome. *Nutr Rev,* 69**,** 745-53.

Chowdhury, TA, Lasker, SS & Mahfuz, R 2006. Ethnic differences in control of cardiovascular risk factors in patients with type 2 diabetes attending an Inner London diabetes clinic. *Postgrad Med J,* 82**,** 211-5.

Cox, M, Boyle, PJ, Davey, PG, Feng, Z & Morris, AD 2007. Locality deprivation and Type 2 diabetes incidence: a local test of relative inequalities. *Soc Sci Med,* 65**,** 1953-64.

Department for Business Innovation and Skills. 2011. *Skills for life survey: a survey of literacy, numeracy and ICT levels in England* [Online]. London: Department for Business Innovation and Skills. Available: https://www.gov.uk/government/publications/2011-skills-for-life-survey [Accessed 17 August 2015].

Gariepy, G, Smith, KJ & Schmitz, N 2013. Diabetes distress and neighborhood characteristics in people with type 2 diabetes. *J Psychosom Res,* 75**,** 147-52.

Gujral, UP, Pradeepa, R, Weber, MB, Narayan, KM & Mohan, V 2013. Type 2 diabetes in South Asians: similarities and differences with white Caucasian and other populations. *Ann N Y Acad Sci,* 1281**,** 51-63.

Holtz, B & Lauckner, C 2012. Diabetes management via mobile phones: a systematic review. *Telemedicine and e-Health,* 18**,** 175-185.

James, J, Gosden, C, Winocour, P, Walton, C, Nagi, D, Turner, B, Williams, R & Holt, RI 2009. Diabetes specialist nurses and role evolvement: a survey by Diabetes UK and ABCD of specialist diabetes services 2007. *Diabet Med,* 26**,** 560-5.

Khunti, K, Morris, DH, Weston, CL, Gray, LJ, Webb, DR & Davies, MJ 2013. Joint prevalence of diabetes, impaired glucose regulation, cardiovascular disease risk and chronic kidney disease in South Asians and White Europeans. *PLoS One,* 8**,** e55580.

Laveist, TA, Thorpe, RJ, Jr., Galarraga, JE, Bower, KM & Gary-Webb, TL 2009. Environmental and socio-economic factors as contributors to racial disparities in diabetes prevalence. *J Gen Intern Med,* 24**,** 1144-8.

Laz, TH & Berenson, AB 2013. Racial and ethnic disparities in internet use for seeking health information among young women. *J Health Commun,* 18**,** 250-60.

Link, CL & Mckinlay, JB 2009. Disparities in the Prevalence of Diabetes: Is It Race/Ethnicity or Socioeconomic Status? Results from the Boston Area Community Health (Bach) Survey. *Ethnicity & Disease,* 19**,** 288-292.

Ludwig, J, Sanbonmatsu, L, Gennetian, L, Adam, E, Duncan, GJ, Katz, LF, Kessler, RC, Kling, JR, Lindau, ST, Whitaker, RC & Mcdade, TW 2011. Neighborhoods, obesity, and diabetes--a randomized social experiment. *N Engl J Med,* 365**,** 1509-19.

Mezuk, B, Chaikiat, A, Li, X, Sundquist, J, Kendler, KS & Sundquist, K 2013. Depression, neighborhood deprivation and risk of type 2 diabetes. *Health Place,* 23**,** 63-9.

Miller, EA, West, DM & Wasserman, M 2007. Health information Websites: characteristics of US users by race and ethnicity. *J Telemed Telecare,* 13**,** 298-302.

Moody, A. 2012. *Diabetes and hyperglycaemia* [Online]. Leeds: The Health and Social Care Information Centre. Available: www.hscic.gov.uk/catalogue/PUB09300/HSE2011-Ch4-Diabetes.pdf [Accessed 24 April 2015 2015].

Office for National Statistics. 2010. *General Lifestyle Survey - Technical Appendices 2010* [Online]. London: Office for National Statistics. Available: http://www.ons.gov.uk/ons/search/index.html?newquery=general+lifestyle+survey [Accessed 17 August 2015].

Office for National Statistics. 2013. *An introduction (General Lifestyle Survey Overview - a report on the 2011 General Lifestyle Survey)* [Online]. London: Office for National Statistics. Available: http://www.ons.gov.uk/ons/rel/ghs/general-lifestyle-survey/2011/rpt-introduction.html [Accessed 24 April 2015].

Office of Communications. 2011. *Communications Market Report: UK* [Online]. London: Office of Communications. Available: http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr11/tv-audio-visual/ [Accessed 24 April 2015].

Office of Communications. 2013. *Ethnic Minority Groups and Communication Services: An Ofcom Special Report* [Online]. London: Office of Communications. Available: http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/ethnic-minority-groups-comms/ [Accessed 24 April 2015].

Office of Communications. 2014. *Communciations Market Report* [Online]. London: Office of Communications. Available: http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr14/uk/ [Accessed 24 April 2015].

Pal, K, Eastwood, SV, Michie, S, Farmer, A, Barnard, ML, Peacock, R, Wood, B, Edwards, P & Murray, E 2014. Computer-based interventions to improve self-management in adults with type 2 diabetes: a systematic review and meta-analysis. *Diabetes Care,* 37**,** 1759-66.

Pal, K, Eastwood, SV, Michie, S, Farmer, AJ, Barnard, ML, Peacock, R, Wood, B, Inniss, JD & Murray, E 2013. Computer-based diabetes self-management interventions for adults with type 2 diabetes mellitus. *Cochrane Database Syst Rev,* 3**,** CD008776.

Peate, I 2013. Technology, health and the home: eHealth and the community nurse. *Br J Community Nurs,* 18**,** 222, 224-7.

Schwartz, N, Nachum, Z & Green, MS 2015. The prevalence of gestational diabetes mellitus recurrence-effect of ethnicity and parity: a metaanalysis. *Am J Obstet Gynecol*.

Singh, H, Cinnirella, M & Bradley, C 2012. Support systems for and barriers to diabetes management in South Asians and Whites in the UK: qualitative study of patients' perspectives. *BMJ Open*, 2.

Tillin, T, Hughes, AD, Godsland, IF, Whincup, P, Forouhi, NG, Welsh, P, Sattar, N, Mckeigue, PM & Chaturvedi, N 2013. Insulin Resistance and Truncal Obesity as Important Determinants of the Greater Incidence of Diabetes in Indian Asians and African Caribbeans Compared With Europeans The Southall And Brent REvisited (SABRE) cohort. *Diabetes Care,* 36**,** 383-393.

Vida Estacio, E, Mckinley, RK, Saidy-Khan, S, Karic, T, Clark, L & Kurth, J 2015. Health literacy: why it matters to South Asian men with diabetes. *Prim Health Care Res Dev,* 16**,** 214-8.

Weng, C, Coppini, DV & Sonksen, PH 2000. Geographic and social factors are related to increased morbidity and mortality rates in diabetic patients. *Diabet Med,* 17**,** 612-7.

Winkley, K, Thomas, SM, Sivaprasad, S, Chamley, M, Stahl, D, Ismail, K & Amiel, SA 2013. The clinical characteristics at diagnosis of type 2 diabetes in a multi-ethnic population: the South London Diabetes cohort (SOUL-D). *Diabetologia,* 56**,** 1272-81.

Wright, P, Bartram, C, Rogers, N, Emslie, H, Evans, J, Wilson, B & Belt, S 2000. Text entry on handheld computers by older users. *Ergonomics,* 43**,** 702-16.

Zhou, J, Rau, PLP & Salvendy, G 2012. Use and Design of Handheld Computers for Older Adults: A Review and Appraisal. *International Journal of Human-Computer Interaction,* 28**,** 799-826.