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Article

Impact of COVID-19 Pandemic on Food Purchasing, Food Packaging, and Food Wastage

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Abstract: Despite the negative impacts caused by the drawn-out COVID-19 pandemic on the usual way of life and health of billions around the world, the pandemic's particular disruption of Hong Kong's supply chain was revealed to have impacted food purchasing habits during the pandemic. It brought about increased health and environmental awareness through the increased purchasing of healthier food choices, home food preparation and the increased usage of reusable bags. However, despite these shifts, the residents' behavioural attitudes towards food wastage or the use of plastic bags and containers did not change. The original finding in this study seems to suggest that food wastage behaviour in Hong Kong is not influenced by external drivers, such as strict COVID-19 containment measures, nor is it affected by increased environmental awareness. Food-waste management strategies aimed at reducing food wastage at the consumer level of the food supply chain should, therefore, focus on targeting engrained behavioural habits and not simply raising awareness on the matter. Our aim is to investigate whether pandemic restrictions have led to a shift towards less-frequent food purchases in larger quantities and how such changes may affect food wastage generation. Survey data were collected from 253 Hong Kong residents. The study mainly adopted various quantitative research methods, including descriptive statistics, reliability tests, *t*-tests, ANOVA, and non-response bias. The Statistical Package for Social Science (SPSS) version 28 was used to investigate the useable data gathered from the respondents of this study. Results suggested that Hong Kong residents preferred supermarket and online food purchases during the COVID-19 pandemic to their usual offline/wet market purchasing habits before the pandemic. Also, the food purchasing rate was principally self-reported as infrequent and at high volumes during the COVID-19 pandemic. While an increased preference for home-prepared meals took precedence over consuming meals at restaurants, no significant change in food wastage habits was observed due to pandemic measures. Interestingly, although an increasing usage of reusable bags was observed, resident behaviour toward plastic bag usage was not affected by the COVID-19 pandemic containment measures.

Keywords: COVID-19 pandemic; food supply chain; food purchasing; food wastage; food packaging



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1. Introduction

Over 60% of worldwide food waste is created at the household level. Consumer food waste is determined by the association between consumers' inclination towards consuming based on perceived-freshness or freshness and their willingness to waste food. In general, there are four primary classifications of factors that accelerate consumer food waste, including (1) broader values (i.e., feelings about wasted food); (2) the unfolding challenges of daily life (i.e., predetermined portion sizes and shopping behaviours); (3) controlling stock in

households (i.e., food storage); and (4) material factors relevant to both the properties and material of packaging and food (i.e., food safety risk) [1]. The 21st century has witnessed its first global pandemic, disrupting the lives of billions worldwide, from strict travelling restrictions, lockdowns, and social distancing to enforced immunisation programs [2–5]. Since the first confirmed cases in 2019, the COVID-19 virus and associated mutants have infected close to 0.52 billion people and claimed the lives of more than 6.2 million worldwide [6]. The fear of a further uncontrollable spread of infections led to an immediate global response by spearheading global initiatives for its containment and mitigation through academic research and political means [7,8]. The pandemic significantly impacted industries worldwide, including, but not limited to, travel restrictions and temporary closures of countries, public facilities, and businesses, leading to economic strain, layoffs, and stringent health and safety precautions. Government-imposed lockdowns worldwide, some lasting for months and causing all kinds of implications, resulted in a shift in consumer behaviour and habits [3,9]. The COVID-19 pandemic lockdown measures induced consumers to stay home, leading to a higher chance of panic buying at grocery stores, which may generate food waste [10].

Despite recording its first COVID-19 cases in early 2020, Hong Kong was among the last places globally to experience the full brunt of infection waves caused by the flu viruses. Transmission patterns were correlated with densely populated public venues such as eateries and places of entertainment [11]. Although most efforts were centred on containment strategies through social-distancing orders, stringent border control, and app-based contact tracing [11,12], few reports investigated the underlying impacts of these containment policies on Hong Kong's food vulnerability, despite it being entirely dependent on its food imports. Apart from the public health crisis, the COVID-19 pandemic had a detrimental impact on the socio-economic landscape, with changes in the economy, tourism, travel, employment, education disruptions, mental health, and well-being. Strict social-distancing measures were applied to public gatherings, closure of entertainment venues, and restricted dining establishments. Such changes directly impacted the operations of businesses and restaurants, which resulted in a heavy reliance on the takeout or to-go culture.

To a certain extent, behavioural and social-science research was inclined toward health and preventive behaviour, whereas consumer behaviour received less attention before the COVID-19 pandemic. Also, the previous theoretical efforts generated a general and global viewpoint of consumer behaviour based on disruptive incidents and crises like natural disasters, war, and other pandemics [13]. In addition, Perera et al. (2021) conducted a systematic review related to consumer buying behaviour during the COVID-19 pandemic. Many researchers only concentrated on specific themes like panic- and online-buying behaviour. To the authors' knowledge, research on food wastage has not been carried out during COVID-19 in Hong Kong. However, there are scientific reports on waste management in other Asian countries, such as general waste management in India, biomedical waste in Bangladesh, and clinical waste in Malaysia [14].

Regarding food packaging, most of the previous research studies highlighted packaging materials during the pre-COVID-19 period and addressed food packaging's functional role in food storage and preservation [15]. Nevertheless, the contexts relevant to the COVID-19 pandemic are usually included in the state agenda and the media reports. The Literature reviews reveal that limited studies interpret and examine food consumption and purchase activities [16]. Hitherto, a literature review has indicated that few research studies have investigated the critical changes in consumers' behaviour toward purchasing food and food wastage during the COVID-19 pandemic [17], notably in Hong Kong.

Hong Kong's high population density and limited land availability have resulted in heavy reliance on food exports. Most of the population patronise restaurants or utilise takeout services for their meals, with only a tiny fraction cooking daily. These characteristics, coupled with COVID-19-related restrictions imposed on the hospitality sector, make Hong Kong an ideal case study for investigating the impact of the pandemic on food purchasing,

packaging, and wastage habits. To this end, we surveyed the Hong Kong population to determine how their food purchasing habits have changed during the pandemic. This shift in purchasing behaviour may lead to changes in the types of purchased foods, such as increased demand for non-perishable items and a decrease in fresh produce.

Additionally, food safety and hygiene concerns may influence purchasing decisions, with consumers opting for packaged and processed foods over fresh items. These changes in food purchasing behaviour may have long-term effects on the food industry and the overall food system. We aimed to investigate both whether pandemic restrictions have led to a shift towards less-frequent food purchases in larger quantities and how such changes may affect food wastage generation. The current study's findings provide valuable information for policymakers, government workers, food industry stakeholders, and researchers to mitigate the negative impacts of the pandemic conditions that may help design and implement new strategies and tools in the post-COVID-19 pandemic era.

2. Literature Review

2.1. *Impact of COVID-19 Pandemic on Food Purchasing and Food Packaging Habits*

The COVID-19 pandemic has profoundly impacted various sectors globally, including health, education, transportation, and the economy. The pandemic has led to widespread disruptions in supply chains, manufacturing, and trade, resulting in economic slowdowns and job losses. In addition, the pandemic has accentuated pre-existing inequalities and vulnerabilities, especially among marginalised communities. The hospitality sector has been particularly hard hit, with significant reductions in travel and tourism, restaurant closures, and job losses, leading to severe economic impacts [18,19]. Governments and businesses worldwide have had to implement various measures to mitigate the pandemic's impact on the hospitality sector, such as financial support, policy interventions, and innovative business models. The hospitality sector plays a significant role in shaping food purchase habits, providing consumers with a range of options for dining out and takeout meals. The pandemic-related restrictions on the hospitality industry have forced consumers to modify their food purchase habits, with a greater reliance on home-cooked meals and takeout options.

Hong Kong's food vulnerability was tested after confirming positive COVID cases among lorry drivers supplying Hong Kong with imported foods from mainland China. Although government officials reassured the public about the containment of the situation and sufficient food stocks, the public's response was that of panic, as it feared a food shortfall [20]. As in most world crises, the fear of food shortages can lead to panic buying, resulting in emptying shelves of food-staple items. Although such runs on supermarkets and food markets have been reported in the early aftermath of the COVID-19 pandemic [21,22], it is still not clear to what extent the resulting food wastage of staples of low shelf-life can be attributed to consumer behaviour; more specifically, the unnecessary wastage associated with the pandemic situation in Hong Kong influenced by poor stock rotation and management. While the observed food hoarding behaviour may be an engrained collective consumer panic response generated by the COVID-19 pandemic, the resulting impacts on food security, food sustainability, and the disruption to inventory planning and control in the food retail sector are yet to be fully elucidated. Since food wastage attributed to poor stock rotation or planning can be considered avoidable, its negative impacts can be regarded as severe, since the wastage of food carries a financial constraint on the consumer and exhausts natural resources put into growing and transporting food [23], as well as further deteriorating the environment [24,25]. The true extent of food wastage cannot be fully elucidated during the COVID-19 pandemic. This can be attributed to our limited understanding of consumer behaviour and habits, especially concerning consumers' food-wastage self-awareness in this period.

As recently reported, the current COVID-19 pandemic can negatively impact food safety. Food safety in supply chain management addresses a significant concern for the community, government, policymakers, and health specialists [26]. This is especially

relevant in the case of Hong Kong, which imports its food from the rest of the world [27,28]. Appropriate attention, particularly at every phase of the food supply chain, from farm to fork, is needed to meet food safety standards vis-à-vis COVID-19. In other words, food production, processing, and distribution are closely related to consumers' health concerns [29]. Since contaminated raw materials can pose a significant risk of spreading pathogens throughout the food supply chains [30], necessary precautions are required at the food life-cycle consumer stage. COVID-19 has recently been shown to contaminate food packaging or fresh food products (e.g., fruits, fish, vegetables, meat) from an infected person. Consequently, transmission routes of the virus directly by contaminated foods are also possible and should not be ignored [31].

Several studies have shown that COVID-19 has impacted food habits [32]. The pandemic in Spain reduced shopping frequency, but no changes in shopping locations were observed. The frequency and quantity of different food types have also been shown to vary. The sale and consumption of products such as pasta and flour increased, whereas fresh, easily perishable foods such as fish and seafood decreased [33]. In addition to changes in the quantity and type of food consumed during COVID-19, changes in food consumed outside households have been suggested in several studies. One recent study observed an increase in online food-delivery-related searches just at the pandemic's start in March 2020 [34]. In association with changes in food consumption habits, a few lines of evidence indicate increases in household waste products [11,35]. Such studies show that food waste and plastic packaging have increased drastically during the pandemic.

2.2. Impact of COVID-19 Pandemic on Food Wastage

Generally, food waste from the food service industry, retail establishments, and households totals 931 million tonnes annually. Almost 570 million tonnes of food waste is generated at the household level. Also, the worldwide average of food waste each year has reached 74 kg per capita. In Hong Kong, food waste is recorded at 3353 tonnes per day, the equivalent weight of 233 double-decker buses. Specifically, supermarkets dispose of 29 tonnes of edible food daily, wet markets waste 14 tonnes of food every day, and Hong Kong residents individually throw away around 71kg of household food waste annually [36]. The global household food-waste data are summarised in Table 1. Sustainable Development Goal 12.3 strives to minimise food loss, halve food waste, and mitigate the food crisis before 2030 [37]. The rationales for differences in food waste per capita in different countries are due to weaknesses in transport and storage infrastructure and harvesting techniques.

Table 1. Summary of Household Food Waste Data in the Country.

| Region | Name of Country | Study Area | Food Waste Estimate (kg/capita) | |
|--------|-----------------------------|----------------------------------|---------------------------------------|-----|
| Africa | Ethiopia | Laga Tafo Laga Dadi town, Oromia | 92 | |
| | Ghana | Nationwide | 84 | |
| | Kenya | Nairobi | 100 | |
| | Nigeria | Sapele | 189 | |
| | Rwanda | Kigali | 164 | |
| | South Africa | | Richards Bay, Dundee, and Harrismith | 18 |
| | | | Johannesburg | 12 |
| | | | Nationwide | 134 |
| | United Republic of Tanzania | | Kinondoni municipality, Dar es Salaam | 119 |
| | Zambia | | Ndola | 78 |

Table 1. Cont.

| Region | Name of Country | Study Area | Food Waste Estimate (kg/capita) |
|---------------------------------|--------------------------|-------------------------|---------------------------------|
| Latin America and the Caribbean | Belize | Belize City | 34 |
| | | Caye Caulker | 45 |
| | | San Ignacio/Santa Elena | 95 |
| | | San Pedro | 36 |
| | Brazil | Nationwide | 60 |
| Colombia | Bogota | 70 | |
| Mexico | Nationwide | 94 | |
| Asia and the Pacific | Australia | Nationwide | 102 |
| | Bangladesh | Chittagong | 74 |
| | China | Beijing | 59 |
| | | Suzhou | 67 |
| | | Shandong | 21 |
| | | Hong Kong | 101 |
| | India | Dehradun | 73 |
| | | Rajam, Andhra Pradesh | 58 |
| | Indonesia | Surabaya | 20 |
| | Japan | Nationwide | 64 |
| | Malaysia | Nationwide | 112 |
| | | Bandar Baru Bangi | 71 |
| | New Zealand | Nationwide | 61 |
| | Pakistan | Gujranwala (urban) | 88 |
| | | Gujranwala (rural) | 60 |
| | Sri Lanka | Jaffna | 118 |
| | | Nuwara Eliya | 95 |
| | | Kataragama | 95 |
| | | Thamankaduwa | 79 |
| Katunayake | | 78 | |
| Moratuwa | | 75 | |
| Kesbewa | | 75 | |
| Dehiwala Mt Lavinia | | 75 | |
| Kurunegala | | 47 | |
| Trincomalee | | 21 | |
| Vietnam | Mekong Delta | 85 | |
| | Da Nang | 67 | |
| Bahrain | Nationwide | 132 | |
| Georgia | Kutaisi | 101 | |
| West Asia | Iraq | Baghdad | 75 |
| | | Mosul | 85 |
| | | Karbala | 142 |
| | | Al-Kut City | 138 |
| | | Nassiriya | 163 |
| Israel | Haifa | 94 | |
| | Nationwide | 105 | |
| Lebanon | Beirut | 105 | |
| Saudi Arabia | Nationwide | 105 | |
| North America | Canada | Nationwide | 79 |
| | United States of America | Nationwide | 139 |

A study in North Macedonia explored food shopping, consumption, and waste habits during the COVID-19 pandemic. It found that 85% of survey respondents did not waste any food they bought during the lockdown. [38]. The majority, 94.16%, expressed high awareness of food wastage, but the study found that the main reason for discarding food in households was the consequences of bad food management during COVID-19. Participants tended to buy a surplus of food to stock up but needed to be more aware. As per the study, 51.99% of participants purchased the same amount as usual during COVID-19, whereas 32.10% bought more than usual, showing the change in the extent of daily purchasing habits. In turn, for 57.20%, the household food waste has not changed, whereas for 34.70%, food waste was more than before the pandemic. Some respondents may be buying more than usual, due to either panic buying or stockpiling or concerns about the virus, and they would prefer to bulk shop to avoid shopping often. Other studies on food wastage estimate that the average household food waste is associated with gender, household income, and education.

To summarise the relationships of key variables (i.e., COVID-19, food purchasing behaviour, food wastage, and food packaging habits), we have illustrated the framework in Figure 1. Figure 1 also elaborates on the purchasing behaviour of consumers of whole foods and the purchasing decision process under abnormal and chaotic situations of the COVID-19 pandemic. As such, the figure provides an overview of the key factors influencing consumer impulse food-buying behaviour in such disruptive settings. In addition, the figure offers valuable information for marketers to help them develop effective marketing strategies to convince consumers during a pandemic or similar crises.

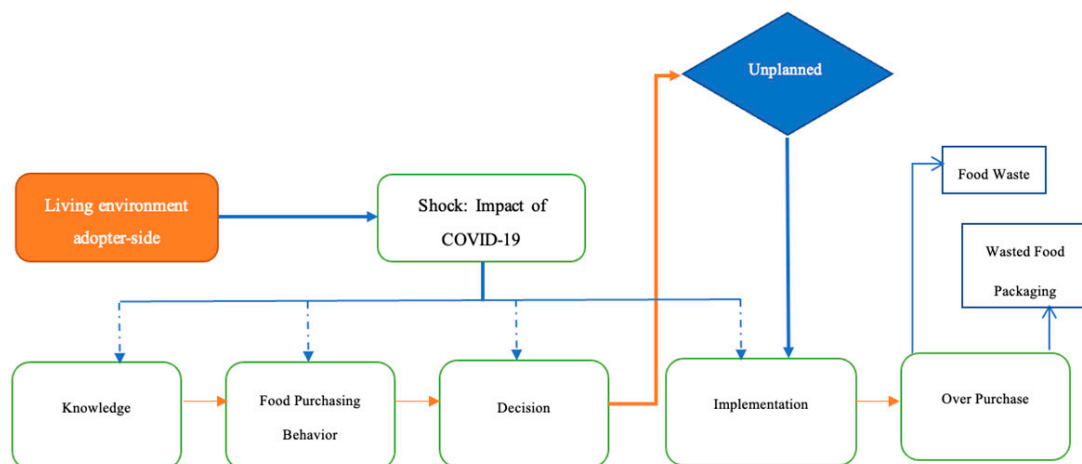


Figure 1. Framework of the Relationships between COVID-19, Food Purchasing Behaviour, Food Wastage, and Food Packaging Habits.

3. Materials and Methods

Hong Kong's high population density and limited land availability have resulted in heavy reliance on food exports. Most of the population patronises restaurants or utilises takeout services for their meals, with only a tiny fraction cooking daily. These characteristics, coupled with COVID-19-related restrictions imposed on the hospitality sector, make Hong Kong an ideal case study for investigating the impact of the pandemic on food purchasing, packaging, and wastage habits. To this end, we surveyed the Hong Kong population to determine how their food purchasing habits have changed during the pandemic. This shift in purchasing behaviour may lead to changes in the types of purchased foods, such as increased demand for non-perishable items and a decrease in fresh produce.

The quantitative approach can minimise the influence of subjectivity and escape, misleading participants during the statistical process. Also, it enhances the researcher's ability to examine questions from various perspectives. Thus, an online questionnaire survey was adopted in this study, which can improve the flexibility of respondents in

filling out the questionnaire in remote areas and offer flexible time. Furthermore, the COVID-19 lockdown policy prevented the proper execution of face-to-face research surveys. Nevertheless, online surveying still made it possible to reach a more diverse pool of respondents with various demographic characteristics. Lastly, online surveying made it possible to ensure better privacy, in which participants would be more inclined to provide accurate answers, thereby increasing the data's reliability [39,40].

As part of the research design, we gathered data using a survey questionnaire following the processes of Iacobucci and Churchill [34]. The processes involved (I) determining the purpose of the questionnaire and identifying the required information from the literature; (II) deciding on the principal method of questionnaire distribution and question classification; (III) establishing the content and design of each question; (IV) determining the form of response of each question; (V) adopting precise wording for each question; (VI) establishing the proper sequence of questions; (VII) revising the questionnaire; and (VIII) the testing and distribution of the finalised survey questionnaire.

The questionnaire survey was split into four key sections. The first section asked the participants to provide demographic information based on age group, gender, living area, the number of family members in the household, and educational level. The second section focused on the consumer's pre- and during-COVID-19 pandemic purchasing habits of basic food staples such as fruits and vegetables, meat and seafood, and dry products like rice, pasta, grains, and lentils. Previous studies asked participants to answer eighteen close-ended questions to determine behavioural habits [21,22]. The third section focused on the participants' pre- and during-COVID-19 pandemic habits related to food packaging. In this study, food packaging refers to primary or secondary food packaging. A five-point Likert scale was employed, from 1 = 'strongly disagree' to 5 = 'strongly agree' [41,42]. The fourth section used a five-point Likert scale to identify the participants' habits relevant to food waste before and during the COVID-19 pandemic [24,25]. Food waste is defined in this study as discarded foods resulting from past-expiry dates, following leftover meals, or food scraps following meal preparations. As expected, the design of the questionnaire is based on the intended research study objectives.

An online questionnaire survey was conducted for Hong Kong resident participants from May to August 2021. An electronic questionnaire was produced on Google (<https://surveys.google.com/your-surveys>), one of the world's most popular online survey platforms. A QR code and questionnaire link were disseminated via multi-functional layers secured with popular social media platforms (i.e., Whatsapp and WeChat) through the multidisciplinary research team's networks. This study mainly adopted varied sampling approaches, including snowball and convenience sampling. The QR code or link to the questionnaire was distributed via our professional and personal network of contacts in the initial round, followed by further distribution to targeted respondents by individuals in this network. A pilot survey with 25 participants was initially conducted to identify appropriate question content and design. The intended survey respondents provided constructive feedback to ensure the survey instruments' correctness and enrich the content's validity. In particular, unclear wording and double-barrelled questions have been entirely eliminated. Additionally, we selected a convenience sampling approach to choose suitable population participants to participate in our research study. A total of 253 valid samples were collected ($N = 253$), accordingly. These 253 valid samples have performed well in food purchasing in Hong Kong for several years and have been used in the COVID-19 pandemic in the Hong Kong context.

The study mainly used quantitative research methods containing descriptive statistics, reliability tests, *t*-tests, ANOVA, and non-response bias. The Statistical Package for Social Science (SPSS) version 28 was employed to examine the usable data gathered from the respondents of this study. Cronbach's alpha was also used to assess the reliability of the technique intended for carrying out surveys. The values of Cronbach's alpha created in the study were larger than the suggested minimum of 0.70. In other words, the reliability of the research instrument is acceptable [43].

Furthermore, the main approach of non-response bias analysis is an independent *t*-test to investigate the differentiation between early and late respondents. This is an analysis of the mean value of the two groups. This study performed a *t*-test to explore any differentiation in all scale items between the two groups. The *p*-value is lower than 0.05 for all the constructs. This indicates no significant difference between the two groups, and the difference is less than 5% for all constructs [44]. Such procedural and statistical remedies address the validity of the research instrument.

4. Results

4.1. Participants

Out of the 253 valid questionnaire responses (Table 2), 170 were females (67.2%), and 83 were males (32.8%). In terms of age group, the largest age group is 18–30 years (29.6%), followed by 31–40 years (20.9%), 51–60 years (19.0%), 41–50 years (16.6%), and above 61 years (13.9%). Regarding the living district, 140 respondents (55.3%) were from New Territories, 74 respondents (29.2%) were from Kowloon, and 33 respondents (13.0%) were from Hong Kong Island. The remaining six respondents (2.5%) were from outlying islands. Most of the respondents (90.9%) had attained the tertiary education level. It was revealed that most participants (39.9%) lived in households of four people.

Table 2. Profile of Survey Respondents.

| Items | Number of Respondents | Percentage |
|---|-----------------------|------------|
| <i>Gender</i> | | |
| Males | 83 | 32.8 |
| Females | 170 | 67.2 |
| <i>Education level</i> | | |
| Primary school level | 1 | 0.4 |
| Secondary school level | 22 | 8.7 |
| Tertiary education level | 230 | 90.9 |
| <i>Age</i> | | |
| 18–30 years | 75 | 29.6 |
| 31–40 years | 53 | 20.9 |
| 41–50 years | 42 | 16.6 |
| 51–60 years | 48 | 19.0 |
| Above 61 years | 35 | 13.9 |
| <i>Living district</i> | | |
| Hong Kong Island | 33 | 13.0 |
| Kowloon | 74 | 29.2 |
| New Territories | 140 | 55.3 |
| Outlying Islands | 6 | 2.5 |
| <i>Number of family members in household (including yourself)</i> | | |
| 1 | 4 | 1.6 |
| 2 | 33 | 13.0 |
| 3 | 61 | 24.1 |
| 4 | 101 | 39.9 |
| 5 | 38 | 15.0 |
| 6+ | 16 | 6.4 |

4.2. Food Purchasing

According to Figure 2, more survey respondents indicated buying fresh vegetables once to four times per week during COVID-19. In contrast, survey respondents bought vegetables up to five-to-seven times per week before COVID-19. Generally, most survey respondents acknowledged their reduced level of fresh vegetable purchases during the COVID-19 pandemic. Since comparing the result with the purchasing pattern before COVID-19, a smaller number of the respondents purchased vegetables five-to-seven times

per week, and this statistic shows a higher preference for purchasing more vegetable portions and reducing the number of runs to markets. Since the macro-environment changed, people were aware of the risks of becoming infected when purchasing food at markets. Compounded by rumours of a potential food shortage caused by an unstable supply chain, residents reacted by reducing the frequency of runs to the markets and increasing the volume of vegetables purchased.

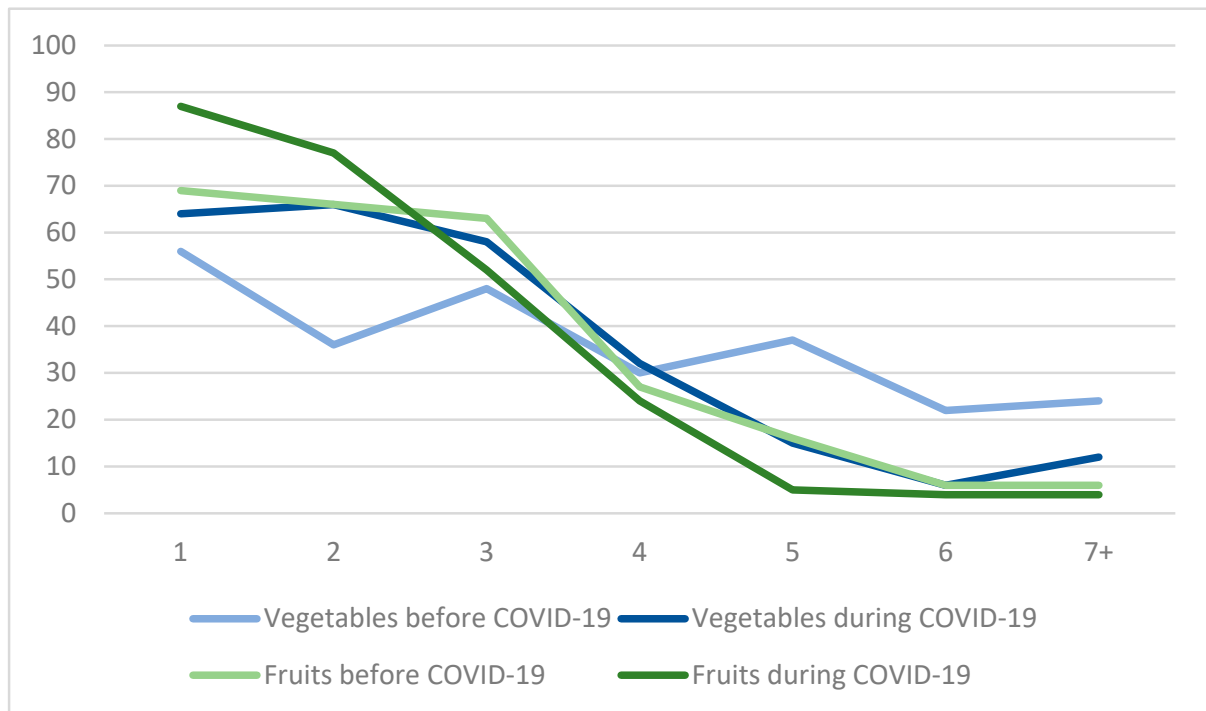


Figure 2. The weekly frequency of purchasing vegetables.

While the number of survey respondents who bought one-to-two vegetables was reduced (Figure 3) during the pandemic, respondents indicated purchasing more than three-to-six vegetables during the same period, indicating an increased demand for vegetable variety. Buying different types of vegetables can ensure they can obtain a wide range of essential nutrients for good health, as they contain various vitamins, minerals, and antioxidants [45]. The restrictions on travel and dine-in restaurants led to increased buying locally, home food preservation, and takeaway activities. These measures resulted in people purchasing more vegetables and fruits, in volume and diversity, to preserve them for future use. Additionally, with people spending more time at home, there is a growing interest in eating healthy and maintaining a balanced diet. These could also contribute to the observed increase in respondents purchasing more types of vegetables during COVID-19.

As shown in Figure 2, the number of survey respondents who purchased fruits once to twice a week increased during COVID-19 compared to pre-COVID-19. Meanwhile, no differences in new weekly purchases above six times were reported by respondents before or during the COVID-19 period. Fruit-purchasing frequency trends were not highly affected during the COVID-19 pandemic. The high level of purchased fruit during the pandemic may be linked to the rumoured food supply shortage associated with the city's lockdown and the pandemic's outbreak.

Based on the resulting pattern, no changed trends were observed in the number of purchased types of fruits between COVID-19 periods (Figure 3), with most respondents purchasing two types of fruits. Many survey respondents would buy two-to-three types of fruits before and during the pandemic. This observation suggests that respondents' attitudes and habits about their fruit preference were not affected by the pandemic; they

chose non-perishable fruits that can be easily stored, to ensure and maintain nutrients and enhance immunity. They did this by obtaining fruits that promote a healthier lifestyle.

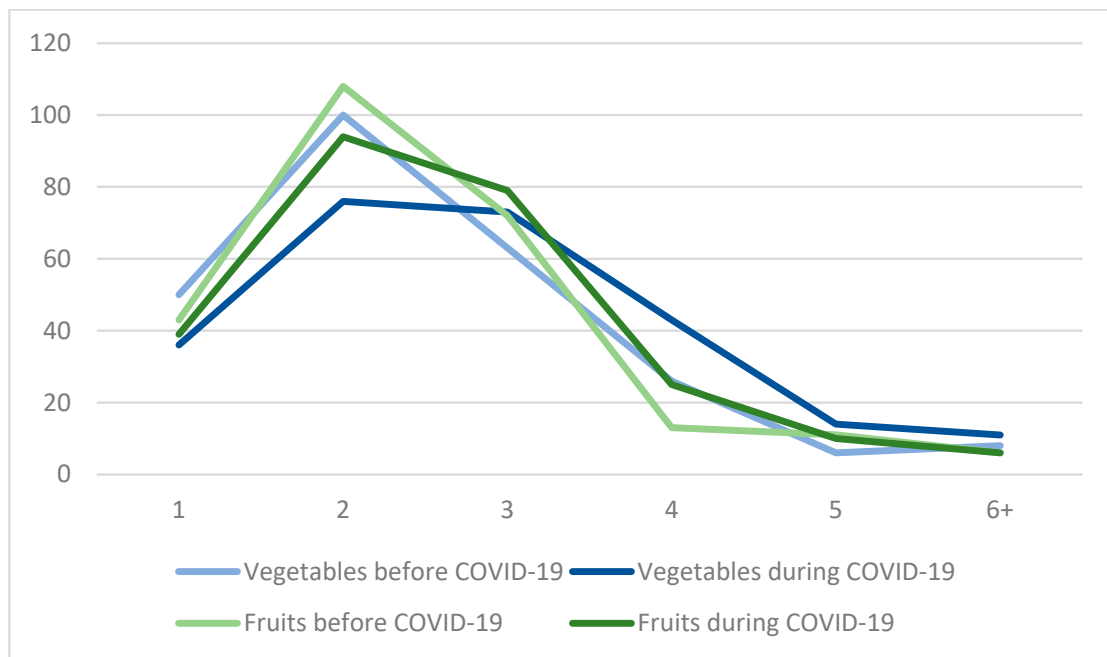


Figure 3. The number of fruit and vegetable types in a purchase.

According to where these fruits and vegetables were purchased (Figure 4), more respondents made their purchases in supermarkets, something which increased by 16% as a result of the COVID-19 pandemic. Assets in fresh markets decreased by 20% because of the pandemic. Interestingly, ten survey respondents have changed their shopping habits from offline to online.

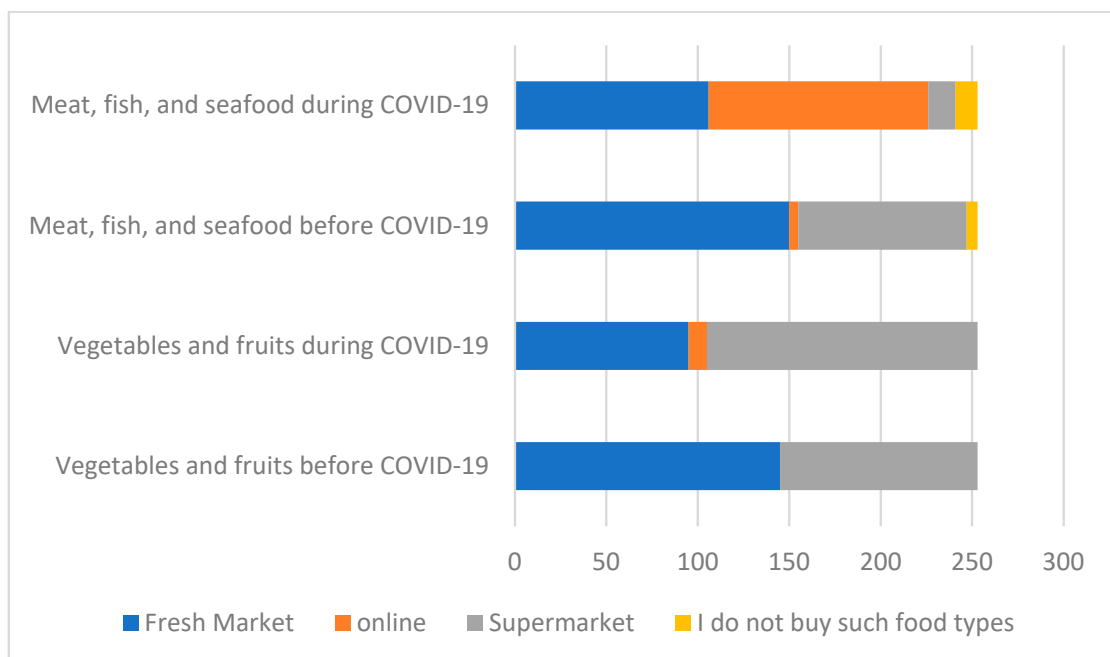


Figure 4. The number of survey respondents buying fruits and vegetables in fresh markets, supermarkets, and online.

The purchase of meat and seafood revealed significant changes in the purchasing behaviour of respondents, as shown in Figure 5. Fresh market purchases decreased by 17.3%, from 59.2% to 41.9%, before and during the COVID-19 pandemic. Supermarket purchases decreased by 30.4% for respondents, due to the pandemic. Online purchases increased from 1.9% to 47.4% before and during the COVID-19 pandemic. Interestingly, the pandemic made respondents decide not to buy meat, a figure doubling from 2.3% to 4.7%.

The pandemic changed respondents' preferences based on the type of meat purchased (Figure 5). Respondent's purchasing habits for fresh meat decreased by 20.5% but increased for frozen meats by the same margin. Before COVID-19, most survey respondents preferred fresh rather than frozen meat and fish. However, after the pandemic, they bought more frozen than fresh products. While the purchasing behaviour of respondents in the pre-COVID-19 period for frozen fish was generally lower than that of fresh fish, the COVID-19 pandemic has led to a 12.7% increase in frozen foods and a decrease in fresh seafood by the same margin. Although a preference for purchasing fresh ingredients was noted among respondents, the COVID-19 pandemic led to a change in purchasing patterns, favouring frozen meat and seafood due to their extended storage potential.

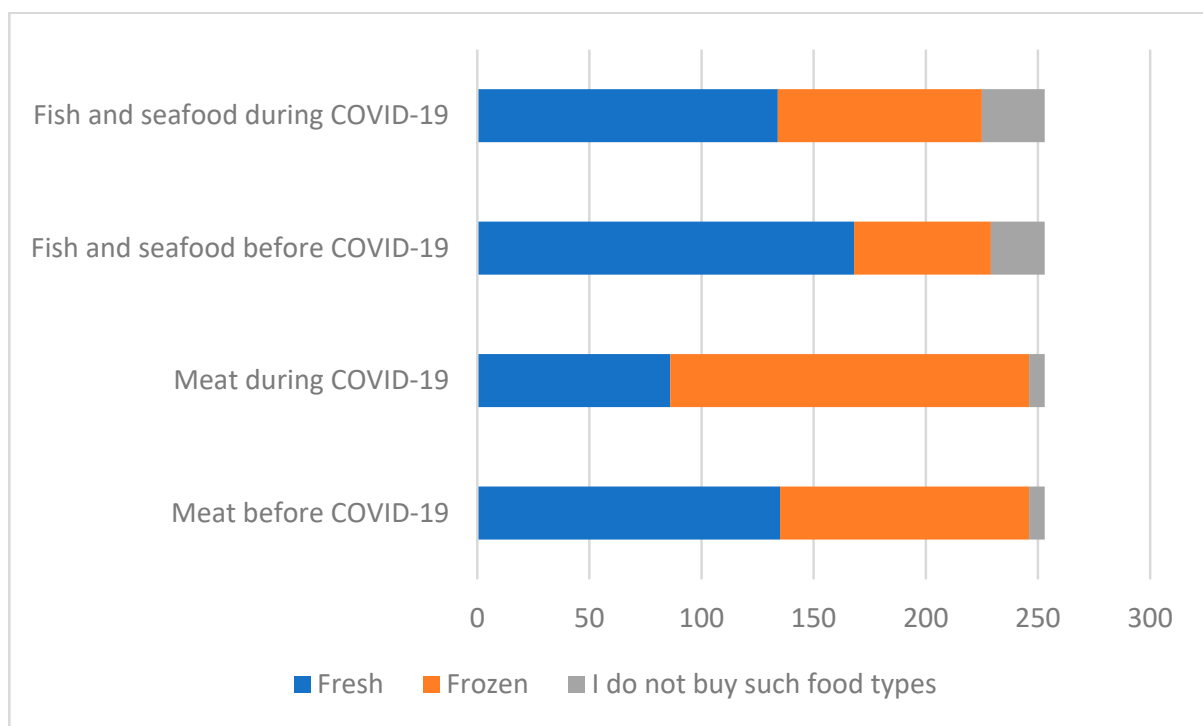


Figure 5. The number of storage types in a purchase.

There are several reasons why people may prefer frozen over fresh during the COVID-19 pandemic. Firstly, the COVID-19 virus has been detected on the surface of fresh food, including meat and fish, which has raised concerns about the potential for transmission through contaminated food. On the other hand, frozen products are less likely to be infected, as the virus can only survive for up to 30 days on frozen meat and fish. The COVID-19 pandemic has also impacted meat and fish production and the supply chain, caused by a severe socio-economic crisis worldwide. As a result, people may choose to buy frozen meat and fish due to its longer shelf-life and lower price than fresh products. However, practising rigorous safe food practices when handling and preparing frozen meat and fish is still essential to prevent contamination.

Most survey respondents bought dry products in large plastic packaging (111 respondents) during the pandemic instead of the dry products in small plastic packaging (142 respondents) bought before the pandemic (Figure 6). However, the number of survey

respondents who preferred reusable packaging dropped slightly, from 37 to 34. Most interviewees would choose small packages before the pandemic, but the situation changed during the pandemic, and most mainly purchased food in plastic packaging. These data can point out the case during the COVID-19 pandemic; people may prefer to purchase more significant portions of food, for various reasons. Firstly, the pandemic has led to concerns about food supply chain disruptions, and people may be buying more food to ensure they have an adequate supply at home [46]. Additionally, there is a perception that more significant portions may be more cost-effective and provide better value for money during economic uncertainty.

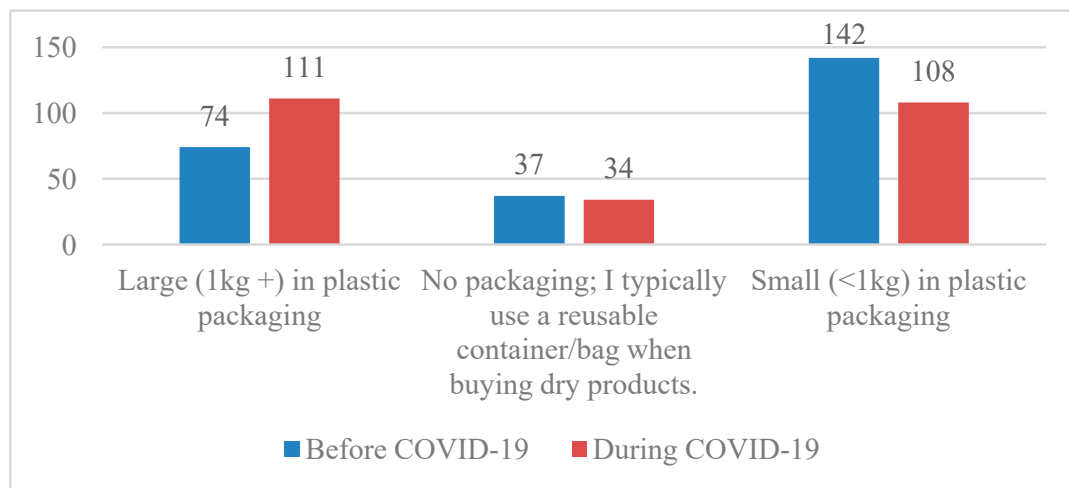


Figure 6. The size and packaging of dry products in a purchase.

4.3. Food Packaging

The *t*-test results from the five-point Likert scale questions comparing the respondents' habits related to food packaging in the survey respondents before and during COVID-19 are presented in Table 3. Also, the full details of Table 3 are attached in Appendix A. Almost all items show higher mean scores during COVID-19, except for one statement: "I had the habit of storing the food packaging material to conduct recycling activities". According to Table 3, the participants indicated that their habits toward food packaging have significantly changed, due to the COVID-19 pandemic.

Table 3. The Comparison of Habits Regarding Food Packaging of the Survey Respondents Before and During COVID-19.

| Items | Mean (during COVID-19) | Mean (before COVID-19) |
|---|------------------------|------------------------|
| I used extra plastic bags to wrap items such as fruits or vegetables. | 3.0316 | 2.9249 |
| I carried a reusable bag(s) to the fresh market and supermarket. | 3.6364 | 3.3755 |
| I brought my box to buy the food at the restaurant. | 2.1818 | 2.0593 |
| I preferred to cook the meal myself rather than buy food outside for breakfast. | 3.4269 | 3.0632 |
| I preferred to cook the meal myself rather than buy food outside for lunch. | 3.3043 | 2.7549 |
| I preferred to cook the meal myself rather than buy food outside for dinner. | 3.4941 | 3.0040 |
| I preferred to buy the meal in a full-set package (e.g., starter, main course, drink, and dessert). | 3.0356 | 3.0119 |
| I had the habit of storing the food packaging material to conduct recycling activities. | 3.0237 | 3.0395 |
| I would select the "plastic-and-disposable-free" option when ordering a takeaway. | 3.0751 | 2.9921 |

Remarks: 1 = Strongly Disagree; 3 = Neutral; 5 = Strongly Agree.

Regarding the statement, “I used extra plastic bags to wrap items such as fruits or vegetables”, there is a slight increase in the number of using plastic bags to pack products. The use of plastic packaging has increased during the COVID-19 pandemic due to concerns about contamination and hygiene reasons. Shops and supermarkets have widely implemented using single-use materials to wrap vegetables and fruits. Shoppers have also reportedly shown a greater demand for packaged food and takeout due to the perceived risk of infection. Although there was a push to reduce single-use plastic bags and packaging before the pandemic, the current situation has made single-use plastic necessary to reduce the risk of infection.

4.4. Food Wastage

Table 4 presents the *t*-test results of the five-point Likert scale questions comparing the respondents’ habits related to food wastage before and during the COVID-19 pandemic. The full details of Table 4 are attached in Appendix B. Most items showed lower mean scores before COVID-19, except for two statements: “I discarded rotting fruits and vegetables” and “I applied stock-rotation principles when purchasing meat.” In other words, the participants show that their food wastage habits were altered during COVID-19.

Table 4. The Comparison of Habits Regarding Food Wastage of the Survey Respondents Before and During COVID-19.

| Items | Mean (during COVID-19) | Mean (before COVID-19) |
|--|------------------------|------------------------|
| I discarded rotting fruits and vegetables. | 3.9644 | 3.9723 |
| I separated my waste/compost food waste. | 2.4190 | 2.3004 |
| I applied stock-rotation principles when purchasing fruits and vegetables. | 3.1107 | 3.0119 |
| I discarded unused meat. | 3.9565 | 3.9526 |
| I applied stock-rotation principles when purchasing meat. | 3.1344 | 3.1423 |
| I discarded unused dry products. | 3.7510 | 3.6877 |
| I applied stock-rotation principles when purchasing dry products. | 3.1107 | 3.0830 |

Remarks: 1 = Strongly Disagree; 3 = Neutral; 5 = Strongly Agree.

More people separated their waste/composted food waste during COVID-19. There are several reasons explaining the pattern changes. For one, many people have become more environmentally conscious during this time and are looking for ways to reduce their carbon footprint. Separating waste and composting food waste can help reduce the amount of waste in landfills, which can positively impact the environment. Additionally, many people are spending more time at home during the pandemic and may have more time to separate their waste and compost their food waste. Composting is a great way to produce nutrient-rich soil that can be used to grow plants, which can be a fun and rewarding activity for people who are spending more time at home. Finally, some people may be motivated to separate and compost their food waste to save money. Composting can help reduce the amount of money spent on fertilisers and other soil amendments, while separating waste can help reduce the amount spent on garbage disposal fees.

4.5. Dining Habit Change

The mandated containment measures also led the majority of Hong Kong restaurants to abruptly stop or suspend their dine-in operations. As a result, residents preferred eating at home rather than going out for a meal, which may have affected consumer behaviour. Based on the result, a one-way ANOVA was performed to compare the dining habits before and during the COVID-19 pandemic (Table 5).

Based on the results presented in Tables 3 and 4, it was revealed that there was a statistically significant difference comparing pre-COVID-19 and COVID-19 pandemic groups. The table below shows three of the most important statements answered by respondents, indicating a significant preference in dining behaviour, favouring meal preparation at home

rather than eating out ($F = (1,504) = [11.227/28.793/23.847]$, $p \leq 0.01$). In addition to the benefits of saving money, eating healthily, and feeling good, people preferred to cook for themselves during the COVID-19 pandemic because of the greater sense of control over their food choices and the ingredients they used, while limiting the risk of COVID-19 exposure associated with dining out in public.

Table 5. ANNOVA Analysis.

| Description | | Sum of Squares | df | Mean Square | F | Sig. |
|--|----------------|----------------|-----|-------------|--------|--------|
| I preferred to cook the meal myself rather than buying food outside for breakfast. | Between Groups | 16.727 | 1 | 16.727 | 11.227 | <0.001 |
| | Within Groups | 750.885 | 504 | 1.490 | | |
| | Total | 767.613 | 505 | | | |
| I preferred to cook the meal myself rather than buying food outside for lunch. | Between Groups | 38.184 | 1 | 38.184 | 28.793 | <0.001 |
| | Within Groups | 668.372 | 504 | 1.326 | | |
| | Total | 706.555 | 505 | | | |
| I preferred to cook the meal myself rather than buying food outside for dinner. | Between Groups | 30.387 | 1 | 30.387 | 23.847 | <0.001 |
| | Within Groups | 642.237 | 504 | 1.274 | | |
| | Total | 672.625 | 505 | | | |

5. Discussion

Although the SARS flu outbreak at the turn of our century has left Hong Kong with deep scars, the current COVID-19 pandemic has re-opened these collective wounds, with Hong Kong residents now readjusting their daily lives for over two years. To prevent the transmission and spread of COVID-19, the Hong Kong government has implemented containment policies [47] that may have exacerbated residents' perceived anxiety, stress, nervousness, and fear of contracting the COVID-19 virus. Consequently, residents demonstrated demotivation or an unwillingness to go out, as they worried about losing their lives [48]. The risk-severity level during the COVID-19 pandemic and the residents' risk susceptibility were relatively high [49]. Moreover, most Hong Kong restaurants were forced to suspend their dine-in service or adopt early closure because of the imposed containment restrictions. As such, residents preferred home cooking over dining out, which may have led to changes in consumer behaviours. Residents reduced their weekly food-purchasing runs and increased the volume and variety of their purchased foods for every run. Such behaviour and management habits can be described as 'infrequent purchases with large quantities', linked to the current pandemic dispensation. Bender and Badiger [50] explained that such a scenario is described as "lower shopping frequencies but higher volumes of purchase per shopping trip". This reflects the household's high resilience level in response to disturbances, shocks, and mobility restrictions [2,50].

The survey results suggest that Hong Kong residents may have been more inclined to purchase food from supermarkets and the internet during the pandemic, indicating a preference for safer food in supermarkets and online. The COVID-19 pandemic's ground zero was argued to have originated from a fresh market in Wuhan, China [51]. Despite the many other hypotheses pointing to the lack of evidence of the true origins of the pandemic, the public's opinion on the food safety of fresh markets may have already been tarnished. Fresh markets are typically food processing areas with a large diversity of dead and live animals kept in constricted zones and a high density of prospective customers. To a certain extent, this creates an ideal environment and the emergence of zoonotic pathogens that can be easily spread from animals to humans. The animals are typically slaughtered and skinned in front of observing customers, an operation that can deliver particles, transferring infectious material into the surrounding air. The unsanitary conditions in which the animals may be held and the typically crowded environments of such a fresh market may favour the efficient transfer and spread of viruses and other zoonotic pathogens. Results from our

study also indicated a change in purchasing habits from the wet market to the supermarket, as well as offline to online purchases, due to the social restrictions brought about by the pandemic.

Interestingly, the pandemic period did not affect the purchase of fruits and vegetables. According to Abate-Kassa and Peterson [52], fresh produce from local farmers' markets is often grown organically, without pesticides, antibiotics, or genetic modification, making it a healthier option for consumers. Besides being a more environmentally sustainable choice by reducing the carbon emissions associated with transportation, locally grown fruits and vegetables purchased from farmers' markets are often fresher and tastier, as they can ripen fully before being sold. Additionally, shopping at fresh markets supports local farmers and promotes diversity in agriculture, while providing consumers with a greater variety of produce. Moreover, fresh local markets can provide additional market services and develop trust-based relationships with their buyers to create better market access for local foods, which was not highly affected by the pandemic; most respondents would prefer purchasing from fresh markets.

Meanwhile, purchasing from supermarkets can offer a wider variety of produce, making it easier to find specific items. Additionally, supermarkets often have a more consistent supply of produce throughout the year, regardless of seasonal availability. This makes it easier to plan meals and purchase items in bulk. Supermarkets also offer lower prices on produce, especially when buying in bulk or during sales [53]. However, it is worth mentioning that fresh produce sold at supermarkets carries a heavier carbon footprint and is most likely found in specialised modified atmospheric packaging or corrugated packaging meant to improve the shelf life and reduce food loss associated with handling- and transportation-incurred damage. Nonetheless, the fresh-produce supply chain remained robust, since people were aware of maintaining a healthy lifestyle before or during the COVID-19 pandemic [46,54].

Moreover, based on the limited information, Hong Kong residents mainly purchase frozen food via supermarkets and online shopping. The likelihood of accumulating extra packaging material increases from supermarkets, and online purchases protect and preserve foods which residents perceive as safer than non-packaged fresh or non-processed foods. Also, supermarkets and online shops offer 'door-to-door' delivery services. Such convenience services may encourage the residents to order large sizes and eat anytime. The reasons and factors influencing purchasing decisions behind the growing popularity of online food shopping are not clearly defined. However, based on the findings in this study, the reasons for increased online-food purchases may have been shaped by the changes in consumption and lifestyle patterns due to the pandemic. Ellison and McFadden [55] pointed out that online shopping can fundamentally reshape access and food choice in the short- and long-term by providing more options.

Moreover, the present study observed that the residents were less aware of stock-rotation principles when purchasing food. To this end, some food may become 'dead stock', going past expiration dates and causing food wastage. The pandemic has shaped consumer lifestyles by adding extra packages to ensure the quality of goods and showing a high awareness of epidemic prevention [56].

The survey results show that more residents prefer using extra plastic bags to wrap food items during the COVID-19 pandemic to improve food hygiene and storage efficiency. Besides food safety, residents were also concerned about a healthy diet during the COVID-19 pandemic. In response, the residents may have altered their food purchasing habits by buying processed meals in a complete package containing a starter, main course, drink, and dessert, to maintain a healthier immune system. However, restaurants in pre-COVID times would typically provide a separate container for the starter, main course, drink, and dessert. In this sense, the volume of food packaging may have dramatically increased during the pandemic. The study further provided additional information on the residents' passive and indifferent attitude, compounded by their limited recycling knowledge, toward practical means of reducing food- and packaging-wastage, through the use of food boxes for storing

excess food at restaurants or storing food at home, to selecting the 'plastic-and-disposable-free' option when ordering a takeaway meal. As such, the government attempted to create wastage awareness among its population through different communication channels such as billboards, the internet, television, radio, public service advertisements, slogans, posters, and leaflets. It was shown in a previous study that promotional approaches helped improve residents' involvement and awareness of recycling [57]

Younger generations prefer using innovative and trendy technological tools to share preliminary information or receive updated news or messages, through social media platforms such as Facebook, YouTube, WhatsApp, Instagram, WeChat, and Twitter. In doing so, social media will be a helpful manner of promoting recycling [58]. In addition, convenience plays a crucial role in recycling behaviour. DiGiacomo and Wu [59] explained that inconvenience is a barrier to recycling. The concept of convenience is "the state of being able to proceed with something without difficulty", as expressed by Siu and Xiao [60]. In this sense, even the appropriate location and access to bins may help improve recycling efforts to facilitate recycling among residents; recycling bins may need a large storage capacity and need to be placed in an easily accessible area. For residents, identification and information about recycling locations and processes must be observable and straightforward. Hence, the recycling location and disposal process must be justified, clarified, and suitable to encourage incentive measures that must be considered in the future.

Concerning food wastage, residents typically discarded more unused food during COVID-19, which may be explained by purchasing more food than the average demand to overcome the COVID-19 lockdown or restriction-testing declarations. To this end, producers may invest in shelf-life-extension technologies to enable perishable foods to last longer. As expected, the residents may decrease food waste during the purchasing phase. Based on the findings in this study, residents need more knowledge of food-waste management, such as stock-rotation principles and the separation and composting of food waste. In response, the government may develop food-wastage management programmes to educate the citizens on relevant food-storage approaches, food labelling, sustainable diet, and the use of food waste.

Moreover, the government may support local food producers, retailers, and non-governmental organisations in collecting food waste. In the meantime, the government may increase food recycling facilities in local communities by motivating residents to participate in food recycling activities. Such an adequately systematic closed-loop food waste recycling process is the underlying condition for applying sustainable development activities in Hong Kong. Besides building a robust food-waste collection system, food producers may adopt an upcycling method that employs new food instead of composting or landfilling it. Food-production byproducts or surplus food can eventually be valuable ingredients for another food product, through upcycling. This mitigates food wastage and improves the food supply during the COVID-19 pandemic.

6. Conclusions

This study generates vital information on how researchers, policymakers, food industry stakeholders, and the general public can efficiently transfer knowledge to cities or countries within different geographical and cultural contexts and demonstrate how the response and decision-making process to sudden, large-scale pandemic outbreaks, such as COVID-19, can be effectively improved. In turn, this encourages collaboration between countries and cities to improve the quality of decision-making. Furthermore, this study offers scholars, practitioners, policymakers, and other food industry stakeholders a rare opportunity to work together and thoroughly understand how to collaborate and develop food policies effectively. Developing food policies aligns with the "2030 Agenda for Sustainable Development", establishing 17 Sustainable Development Goals (SDGs) to build a fairer and healthier world. In response, "ensuring sustainable consumption and production patterns" (Goal 12) and "ending hunger" (Goal 2) may integrate with the existing study to further extend consumer-habits research studies in the future [61]. Moreover,

it was found that the food-wastage behaviour in Hong Kong is not influenced by external drivers, such as strict COVID-19 containment measures, nor does increased environmental awareness affect it. Food-waste management strategies aimed at reducing food wastage at the consumer level of the food supply chain should, therefore, focus on targeting engrained behavioural habits rather than raising awareness on the matter. Food-waste management is a roadmap for long-term resilience and immediate sustainability gains to disruptions [4].

Nevertheless, the COVID-19 pandemic made Hong Kong residents feel anxious, confused, isolated, and depressed. Indeed, fears of food price increases and interruptions in the food supply chain have increased the type and quantity of food household purchases. Thus, COVID-19 has considerably impacted people's mental and physiological health, food habits, lifestyles, and daily routines [26]. Most Hong Kong residents exhibit 'infrequent purchase with large quantities' during the COVID-19 pandemic to maintain mental and physical health. It was revealed that the consumer's lack of proper meal plans or grocery shopping planning increases the likelihood of food wastage, often exacerbated by the erroneous storage of purchased foods [62]. As such, food stores and supermarkets must intentionally re-plan their supply chain to promise a reliable supply of food products at competitive prices [47].

This study encountered limitations that may further be addressed in subsequent research studies. Firstly, self-reported data on survey respondents' awareness of food-waste management and food packaging were used, which may be subject to the pre-determined idea related to the tendency to respond and report precisely. Hong Kong residents are hesitant about identifying natural food-waste management and food-packaging behaviour due to limited food-waste management and food-packaging knowledge, and there is a possibility of legal action against them by the potential individual or public authorities. In addressing the limitations, we may gather data from stakeholders like environmentalists, food producers, policymakers, food distributors, food retailers, and food-scrap composters or recyclers through semi-structured, in-depth, face-to-face interviews, to obtain broader viewpoints and produce inclusive data for complete analysis. Combining qualitative and quantitative research methods can neutralise the weakness of a pure-qualitative or -quantitative approach. Secondly, this study is focused on Hong Kong. To generalise the research study, we may consider other cities in the Greater Bay Area. Thirdly, the following research study may further enlarge other discipline areas, such as climate change, psychological distance, and food safety. Finally, the research study was mainly situated before or during the pandemic time-frame; the scope of the present study may be further expanded to include the behavioural changes in food wastage in a post-pandemic era.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. *t*-Test Results for the Comparison of the Habits Regarding Food Packaging of the Survey Respondents before and during COVID-19

1. I used extra plastic bags to wrap items such as fruits or vegetables.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.031620553 | 2.924901186 |
| Variance | 1.31645649 | 1.27608382 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.623355884 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 1.717637749 | |
| p (T ≤ t) one-tail | 0.043545584 | |
| t Critical one-tail | 1.650922755 | |
| p (T ≤ t) two-tail | 0.087091168 | |
| t Critical two-tail | 1.969422365 | |

2. I carried a reusable bag(s) to the fresh market and supermarket.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|--------------------------|-----------------|
| Mean | 3.636363636 | 3.375494071 |
| Variance | 1.168831169 | 1.489397076 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.68436294 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 4.49453109 | |
| p (T ≤ t) one-tail | 5.31788×10^{-6} | |
| t Critical one-tail | 1.650922755 | |
| p (T ≤ t) two-tail | 1.06358×10^{-5} | |
| t Critical two-tail | 1.969422365 | |

3. I brought my own box to buy the food at the restaurant.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 2.181818182 | 2.059288538 |
| Variance | 1.077922078 | 1.05599473 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.625876484 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 2.181152389 | |
| p (T ≤ t) one-tail | 0.015048452 | |
| t Critical one-tail | 1.650922755 | |
| p (T ≤ t) two-tail | 0.030096905 | |
| t Critical two-tail | 1.969422365 | |

4. I preferred to cook the meal myself rather than buy food outside for breakfast.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|--------------------------|-----------------|
| Mean | 3.42687747 | 3.063241107 |
| Variance | 1.396417592 | 1.583286279 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.590253023 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 5.227189692 | |
| p (T ≤ t) one-tail | 1.80691×10^{-7} | |
| t Critical one-tail | 1.650922755 | |
| p (T ≤ t) two-tail | 3.61×10^{-7} | |
| t Critical two-tail | 1.969422365 | |

5. I preferred to cook the meal myself rather than buy food outside for lunch.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.304347826 | 2.754940711 |
| Variance | 1.371290545 | 1.280977477 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.553514996 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 8.027611376 | |
| $p(T \leq t)$ one-tail | 1.89761E-14 | |
| t Critical one-tail | 1.650922755 | |
| $p(T \leq t)$ two-tail | 3.79521E-14 | |
| t Critical two-tail | 1.969422365 | |

6. I preferred to cook the meal myself rather than buy food outside for dinner.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|---------------------------|-----------------|
| Mean | 3.494071146 | 3.003952569 |
| Variance | 1.250956773 | 1.297603363 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.605815207 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 7.776929301 | |
| $p(T \leq t)$ one-tail | 9.51227×10^{-14} | |
| t Critical one-tail | 1.650922755 | |
| $p(T \leq t)$ two-tail | 1.90245×10^{-13} | |
| t Critical two-tail | 1.969422365 | |

7. I preferred to buy the meal in a full-set package (e.g., starter, main course, drink, and dessert).

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.035573123 | 3.011857708 |
| Variance | 1.13761842 | 1.003827091 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.656875451 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 0.439239079 | |
| $p(T \leq t)$ one-tail | 0.330432355 | |
| t Critical one-tail | 1.650922755 | |
| $p(T \leq t)$ two-tail | 0.66086471 | |
| t Critical two-tail | 1.969422365 | |

8. I had the habit of storing the food packaging material to conduct recycling activities.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.039525692 | 3.023715415 |
| Variance | 1.434939457 | 1.428006776 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.659115503 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 0.254558896 | |
| $p(T \leq t)$ one-tail | 0.399635707 | |
| t Critical one-tail | 1.650922755 | |
| $p(T \leq t)$ two-tail | 0.799271415 | |
| t Critical two-tail | 1.969422365 | |

9. I would select the “plastic-and-disposable-free” option when ordering a takeaway.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.075098814 | 2.992094862 |
| Variance | 1.530052074 | 1.317397578 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.749490348 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 1.556725395 | |
| p ($T \leq t$) one-tail | 0.060395328 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.120790655 | |
| t Critical two-tail | 1.969422365 | |

Appendix B. *t*-Test Results for the Comparison of the Habits Regarding Food Wastage of the Survey Respondents before and during COVID-19

1. I discarded rotting fruits and vegetables.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.972332016 | 3.964426877 |
| Variance | 0.947644143 | 1.105872388 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.727790767 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 0.167513577 | |
| p ($T \leq t$) one-tail | 0.433550157 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.867100315 | |
| t Critical two-tail | 1.969422365 | |

2. I separated my waste/compost food waste.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 2.418972332 | 2.300395257 |
| Variance | 1.538051321 | 1.441150637 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.802701195 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 2.457433984 | |
| p ($T \leq t$) one-tail | 0.00733384 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.01466768 | |
| t Critical two-tail | 1.969422365 | |

3. I applied stock-rotation principles when purchasing fruits and vegetables.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.110671937 | 3.011857708 |
| Variance | 1.194052324 | 1.154620742 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.72887622 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 1.969256995 | |
| p ($T \leq t$) one-tail | 0.025009547 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.050019094 | |
| t Critical two-tail | 1.969422365 | |

4. I discarded unused meat.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.956521739 | 3.95256917 |
| Variance | 1.216356108 | 1.315201707 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.792130795 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 0.086540748 | |
| p ($T \leq t$) one-tail | 0.465552644 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.931105288 | |
| t Critical two-tail | 1.969422365 | |

5. I applied stock-rotation principles when purchasing meat.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.14229249 | 3.134387352 |
| Variance | 1.265386787 | 1.172344564 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.753141748 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 0.161908929 | |
| p ($T \leq t$) one-tail | 0.435753656 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.871507312 | |
| t Critical two-tail | 1.969422365 | |

6. I discarded unused dry products.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.750988142 | 3.687747036 |
| Variance | 1.338540686 | 1.334650856 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.838212021 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 1.529573559 | |
| p ($T \leq t$) one-tail | 0.063688295 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.12737659 | |
| t Critical two-tail | 1.969422365 | |

7. I applied stock-rotation principles when purchasing dry products.

| Parameters | During COVID-19 | Before COVID-19 |
|------------------------------|-----------------|-----------------|
| Mean | 3.110671937 | 3.083003953 |
| Variance | 1.170242801 | 1.155781417 |
| Observations | 253 | 253 |
| Pearson Correlation | 0.780268354 | |
| Hypothesised Mean Difference | 0 | |
| df | 252 | |
| t Stat | 0.615558676 | |
| p ($T \leq t$) one-tail | 0.26937068 | |
| t Critical one-tail | 1.650922755 | |
| p ($T \leq t$) two-tail | 0.538741361 | |
| t Critical two-tail | 1.969422365 | |

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