Exploring relationships between changing food environments, food consumption behaviour, attitudes and nutrition outcomes for urban Vietnam

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Abstract

Food systems in Vietnam are transforming due to economic development, urbanisation, increasing disposable incomes and related changes in consumer food purchasing and consumption behaviour. As a result, the food retailing sector in Vietnam has been undergoing a rapid growth in the number of modern food retail outlets, including hypermarkets, supermarkets, and mini-markets or convenience stores. Design of effective policy approaches to address potential adverse nutrition outcomes related to these changes requires an understanding of the interrelationships between urban food market environments, food shopping and consumption behaviour, attitudes and concerns about food safety and nutrition, and nutrition outcomes. This thesis attempts to empirically disentangle these relationships for urban Vietnam.

The main empirical chapters of this thesis use a novel primary dataset from the Vietnamese Urban Food Consumption and Expenditure Study (VUFCES), which includes individual-level information from 1,700 urban households in the two largest cities of Vietnam: Hanoi and Ho Chi Min City. The VUFCES was conducted in 2016 – 2017 by a team of researchers, including the author of this thesis. Data collection methods included a household survey and 24-hour food diaries of the food and beverages consumed by each household member.

The first study explores the relationship between urban households' choice of food retail format, household income and time constraints, and household food quality and safety concerns. No significant relationship is found between concerns about food safety and food expenditure shares at different retail outlets. Concerns about food prices and freshness are negatively associated with food expenditure shares at modern retail outlets.

The second study examines the relationships between three dimensions of food access (affordability, accessibility, acceptability), caloric (energy) intake and share of calories from

carbohydrates, protein and fat for individual adults. Increasing disposable income is associated with higher caloric intake; possibly due to a substitution of carbohydrates with protein and fat. Further distance to wet market is associated with a higher share of calories from fat for individuals from lower income households. Greater nutrition concern is associated with lower caloric intake and a lower share of calories from fat.

In the third study, we provide insight on the interrelationships between nutrition label use, health concerns, and consumption of food and beverages with added sugars for adults and adolescents. Nutrition label use and health concerns about sugar are significantly associated with a lower share of calories from sugars.

Policies aiming to improve food safety through food market modernisation are likely to have heterogenous, and perhaps unintended consequences for different subgroups of the urban Vietnamese population. Rather than encouraging food market modernisation, the Vietnamese Government should focus on improving the market conditions of traditional outlets and increasing their competitive position relative to modern retail outlets. Providing good market access, is necessary to maintain an adequately balanced diet. Finally, nutrition labelling could also be an effective policy mechanism to reduce the negative health impacts of increasing availability and consumption of food and beverages with added sugars.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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"And, when you want something, all the universe conspires in helping you to achieve it."

― Paulo Coelho, The Alchemist

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Chapter 1: Introduction

1.1 Background

The food retailing sector in Vietnam, as in other Asian developing countries, has been undergoing transformation where urban areas are experiencing a rapid growth in the number of modern food retail outlets, including hypermarkets, supermarkets, and mini-markets or convenience stores (Mergenthaler et al. 2009; Ruel et al. 2017; Rupa et al. 2019). This growth of modern food retailers, referred to in the literature as the "supermarket revolution" (Reardon et al. 2003; Reardon et al. 2012), is driven by income growth, urbanization, and shifting consumer preferences that increasingly favour the convenience, choice, and some quality attributes offered by modern markets relative to traditional food outlets[1] (Gorton et al. 2011; Mergenthaler et al. 2009; Qaim 2017; Umberger et al. 2015).

The potential benefits from increased penetration of modern food retail outlets include improved access to non-traditional food products (e.g. imported, new, and processed foods) and enhanced food safety (Mergenthaler et al. 2009; Minot et al. 2015; Reardon et al. 2010). Modern retailers also offer consumers a one-stop grocery shopping experience that is also considered to be convenient for urban consumers who may have a higher opportunity cost of time (i.e. middle-income and upper-income segments), since they stock both food and non-food products, and can be accessed by both public and private vehicles (Gorton et al. 2011).

Traditional food retail outlets (e.g. wet markets, street stalls), on the other hand, usually offer lower prices for fresh foods as compared to modern food outlets (Harris et al. 2020; Jabbar et al. 2010; Schipmann & Qaim 2011). Some traditional retail formats (e.g. informal street markets and peddlers) are easily accessible for urban consumers since they provide time-saving services and are available at the doorstep in most neighbourhoods and often accessible at early

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[1] In this study, the traditional retail outlet refers to the various formats of local markets including formal wet markets, informal street markets, semi-permanent stands, traditional family shops, and peddlers.

hours in the morning (Minot et al. 2015; Wertheim-Heck & Raneri 2019). Importantly, most food purchases and expenditures on food in urban Vietnam and other Asian developing countries are still made through traditional markets (Ruel et al. 2017; Wertheim-Heck et al. 2015).

In Vietnam, growing food safety concerns are influencing food retailing policies in resulting in a growth of modern food retail outlets (e.g. supermarkets, hypermarkets, mini-markets). The assumption of these policies is that modernisation of food retail outlets can improve food safety and efficiency of food supply chains and ultimately improve social welfare (Maruyama et al. 2016; Wertheim-Heck et al. 2015). However, there are emerging concerns that traditional food retailers are being displaced by modern food retailers (Rupa et al. 2019; Toiba et al. 2015; Wertheim-Heck & Raneri 2019; Wertheim-Heck et al. 2019). Whilst this transformation can lead to improved social welfare (e.g. through greater choice and improved perceptions of food safety), there are also concerns that rapid and unconstrained growth of more highly centralised modern markets delivers benefits to wealthy consumers and may generate significant costs to lower income segments of the population. Potential issues of concern include potential higher food prices, more difficult access to nutritious fresh food products, particularly fresh foods that have been part of the traditional Vietnamese diet (fruits and vegetables, meat, fish and seafood), (Ruel et al. 2017; Rupa et al. 2019; Toiba et al. 2015; Wertheim-Heck & Raneri 2019; Wertheim-Heck et al. 2019).

The changes in the food environment also have the potential to significantly impact individuals' nutrition and ultimately their health outcomes. Recent studies have found that these changes are contributing to a diet and nutrition transition in urban Asian settings that is characterized by increasing consumption of energy-dense and processed foods, which are often high in saturated and trans-fats, salt and sugar, and relatively low in carbohydrates (Kelly 2016; Pingali 2007; Reardon & Timmer 2014; Toiba et al. 2015; Umberger et al. 2020). This diet and

nutrition transition combined with more sedentary lifestyles are contributing to the growing prevalence of non-communicable diseases (NCDs), such as cardiovascular disease, obesity, type II diabetes and some types of cancer, in many Asian developing countries (Afshin et al. 2019; Gaziano et al. 2010; Harris et al. 2020; Mozaffarian 2016; Popkin et al. 2020).

In Vietnam, the diet and nutrition transition is emerging as Vietnamese diets, traditionally low in fat, and rich in carbohydrates and vitamins, due to consumption of relatively small amounts of meat and fish, with large amounts of rice and vegetables (Thang & Popkin 2004), evolve towards a modern diet higher in energy, protein and fats (Nguyen & Hoang 2018). Although these changes can improve dietary diversity and contribute to a reduction in some types of malnutrition (e.g. calorie deprivation, micronutrient deficiencies), it is concerning that this nutrition transition towards more energy-dense but lower nutrient intakes can lead to obesity and other non-communicable diseases in the future, especially among the younger population in urban areas of Vietnam (Ha et al. 2011; Trinh et al. 2018).

While the topics of diet and nutrition transition and related health impacts have been examined broadly in the developing country context (Kelly 2016), more research is needed to understand how individuals' food access, measured using multiple dimensions, and their various concerns about food quality (e.g. safety and nutrition concerns), can affect dietary intake and diet quality. This insight is needed for Vietnam to assist policy decisions to facilitate nutrition improvement in developing economies undergoing these significant food system changes.

Further, a main concern of the diet transition occurring in these countries is increasing consumption of non-traditional highly processed foods which contain high amounts of added sugars[2] (Aurino et al. 2017; Drewnowski et al. 2019; Kelly 2016; Umberger et al. 2015). In

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[2] Added sugars are defined as all sugars and syrups (monosaccharides and disaccharides) eaten separately or used as ingredients in processed or prepared foods (Sigman-Grant & Morita 2003).

particular, higher consumption of foods with added sugars has been shown to be associated with excess energy intake and poorer diet quality (Bailey et al. 2018; Vartanian et al. 2007), a heightened risk of NCDs, particularly overweight and obesity, and type II diabetes (Khan & Sievenpiper 2016; Rippe & Angelopoulos 2016).

Similar to other developing countries, increasing consumption of foods and beverages with added sugars is now a significant public health concern in Vietnam (Luong & Vu 2020; Nguyen & Hoang 2018). In Vietnam, per capita sugar consumption per day is estimated to be 46.5 grams per day (Sugar Industry Report 2017), almost double the maximum level (25 grams per day) recommended by the World Health Organisation (WHO) (World Health Organisation 2015). Overweight and obesity in urban Vietnam has increased rapidly among all age groups. In 2000, only 2% of Vietnamese children (aged five to 19) were estimated to be overweight or obese, however in 2016, the figures were much higher: 15% for boys and 9% for girls (2020 Global Nutrition Report 2020). At the same time, the prevalence of overweight or obesity increased dramatically from 13% and 8% to 23% and 17% for Vietnamese adult females and males, respectively (2020 Global Nutrition Report 2020; Harris et al. 2020). Additionally, the incidence of diabetes is growing at alarming rates and has almost doubled from 3.7% in 2004 to 6% in 2016 (Miyakawa et al. 2017; World Health Organisation 2016).

The growing prevalence of overweight and obesity and diabetes in urban Vietnam, combined with rising per capita consumption of foods with added sugars, suggest that government interventions may be needed to avoid longer-run negative impacts on human health and productivity as Vietnam continues to develop and urbanize. Because of their negative health impacts, reducing the intake of added sugars is often a target for public health interventions. Some policy options that have been considered include imposing an excise tax on sugar-sweetened beverages, raising consumer awareness about the harmful effects of food with high amounts of added sugars, and mandatory nutrition labels on food products (Allcott

et al. 2019; Kessler 2014; Luong & Vu 2020). However, understanding the potential effectiveness of these measures relies on an improved knowledge of the interrelationships between nutrition label use, consumers' health concerns, and the intake of added sugars.

1.2 Research gaps and motivation

Existing studies have identified a set of key factors affecting consumers' choice of food retail formats, including income (Bai et al. 2008; D'Haese et al. 2008; Gorton et al. 2011; Maruyama & Trung 2007; Minot et al. 2015), convenience (as measured by travel time/ distance to retail outlet, (Bekele et al. 2017; Hino 2014; Taylor & Villas-Boas 2016), and consumers' perceptions of retailers' ability to offer food products with certain attributes (e.g. improved or guaranteed food safety, lower price, and increased freshness) (Goldman et al. 2002; Gorton et al. 2011; Maruyama & Trung 2007; Maruyama et al. 2016). With the exception of the Taylor and Villas-Boas (2016) study which evaluates the impact of travel time on consumers' food retail outlet choices in the United States, the majority of the published studies have not accounted for time as a constraint in food retail outlet choice. Additionally, previous research has not considered the possible heterogenous effects of income on food retail outlet choices. This type of study is urgently needed for Vietnam where the food retail landscape is rapidly transforming and the welfare impacts of food modernisation policies are not well understood.

Food access is a concept that links food demand and supply in multiple dimensions. In a systematic review, Caspi et al. (2012) presented a conceptual framework including five dimensions of food access. The five dimensions, or ways in which the local food environment can affect diet, include: availability (adequacy of healthy food supply), accessibility (geographical location of food stores and ease of getting to them), affordability (food prices and people's perception of cost-benefit), acceptability (people's attitudes about the attributes of local food environment) and accommodation (adaptation of food retailers and providers of

food to suit people's needs). While these five food access dimensions are comprehensive, certain adjustments are needed to reflect the unique food environment access characteristics in different contexts. For example, in urban Vietnam, availability of food is usually satisfied because healthy food is easily accessible almost everywhere through traditional wet markets (both formal and informal) as well as modern food outlets (Wertheim-Heck & Raneri 2019; Wertheim-Heck et al. 2015). Neither should accommodation be a concern for most households in Vietnam, because like many other Asian countries, it has a long history of food tradition where food sources are diverse and able to meet various demands with ease (Van Esterik 2008). Therefore, for Vietnamese urban residents, geographical (accessibility), economic (affordability), and acceptability dimensions of food access are relatively more likely to affect diet and nutrition outcomes. We are able to gain deeper insight into this issue by examining the effects of food access (measured through several dimensions), on an individual's caloric (energy) intake and macronutrient (carbohydrates, proteins, and fats) shares. This is highly relevant for policymakers, since it is necessary to ensure that consumers have not only enough energy (calories), but also a balanced diet which includes a wide variety nutritious food.

Food labels which provide nutritional information on packaged foods have been shown to help consumers make healthier food choices (Anastasiou et al. 2019; Cowburn & Stockley 2005; Ikonen et al. 2020). For example, some studies report that nutrition label users are more likely to have higher Healthy Eating Index (HEI) scores, as compared to non-user groups (Kim et al. 2001; Miller et al. 2015; Pérez-Escamilla & Haldeman 2002). Other studies suggest that nutrition label use is associated with higher fiber and iron intakes (Variyam 2008), lower energy intakes from fat, carbohydrates, and sodium (Kim et al. 2016; Kreuter et al. 1997; Neuhouser et al. 1999; Ollberding et al. 2010), and a significant reduction in the share of energy intake from added sugar (Weaver & Finke 2003). However, these studies have not explicitly considered the role of health concerns, a latent factor that could affect both the use of nutrition

labels and dietary intake of certain nutrients such as added sugars. While the current literature has extensively studied the impact of label use on the individual's dietary intake, little is known about how consumers' health concerns may influence their dietary intake. This study therefore not only considers the impact of food label use on an individual's dietary intake, but also explains how consumers' health concerns can affect label use and dietary intake, thereby providing a more comprehensive picture of the mechanisms affecting consumer behaviour with respect to sugary food and beverage intake. While similar studies exist in high-income countries such as the United States or Europe, this is the first study to investigate the impact of nutrition label use on individual caloric intake from food and beverages with added sugars in Vietnam. This insight is urgently needed given the ongoing dietary transition (Aurino et al. 2017).

1.3 Research questions

In order to understand the impact of the ongoing changes in the food environment on Vietnamese urban consumers' food purchasing and consumption behaviours as well as their diet quality, this thesis addresses the following research questions:

i.   Do Vietnamese urban households differentiate their food retail outlet choices based on travel time to market and their food quality and safety concerns? Are choices heterogeneous across household income groups?

ii. Do food access and nutrition concerns affect the caloric (energy) intake and relative proportions of macronutrient (protein, carbohydrates and fat) consumed by urban Vietnamese consumers?

iii. To what extent are nutrition label use and consumer health concerns associated with the share of daily caloric (energy) intake from food and beverages with added sugars among urban Vietnamese consumers?

1.4 Description of data and methods

To test the research questions empirically, the analyses presented in this thesis use a novel primary dataset from the Vietnamese Urban Food Consumption and Expenditure Study (VUFCES), which included individuals from 1,700 urban households in the two largest cities of Vietnam: Hanoi and Ho Chi Min City. The VUFCES was conducted in 2016 – 2017 by a team of researchers from the Centre for Global Food and Resources, at the University of Adelaide, including the author of this thesis.

Data collection methods for the VUFCES included: 1) a household survey, which covered information on both household and individual socio-demographic characteristics, shopping behaviours (i.e. preferences over different retail formats, proximate markets), food and non-food expenditures, nutrition attitudes and food concerns for the household; and 2) multiple rounds of 24-hour food diary recording, where households kept detailed records (diaries) of the food and beverages consumed by each household member over a 24-hour period. The household survey was implemented between December 2016 and March 2017 (with a four-week break during January-February 2017 to avoid fluctuations in food consumption around Tet, the Vietnamese lunar New Year. The dietary intake data were collected on four different days throughout the year to account for seasonal variations in the food consumption pattern. The questionnaires and food diary instrument used to collect data are provided in Appendix 1 and 2, respectively.

The 1,700 households were selected using a two-stage proportional sampling method. In the first stage, wards[3] were selected with proportional sampling strategy where the probability of being selected is proportional to the total population at the ward level (50 wards

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[3] Ward is the lowest administrative unit for urban areas in Vietnam. Officially, Ho Chi Minh City has 259 wards and Hanoi has 177 wards.

in Hanoi and 72 wards in Ho Chi Minh City). In the second stage, 14 to 15 households were randomly picked from each ward.

The surveys were conducted by trained and experienced enumerators contracted from a professional survey company in Vietnam. After initially contacting households and obtaining consent to participate, enumerators arranged face-to-face interviews with the household member who was the main food buyer and preparer of the whole family (respondent). While conducting the interviews, the enumerators entered data directly into an Android tablet-based data collection platform / application, CommCare, which automatically prevented missing entries of key information and included GPS coordinates of the household. This real-time entry of the data allowed the study team (including author) to monitor the data collection and to identify and address issues as soon as data were uploaded to the server.

Socio-demographic characteristics of the individual, including gender, age, education, marital status, religion, and employment status (for adults), were collected for each household member. Also, individual-level information on total hours spent on physical exercises, watching television, videos, or on the Internet, bad habits (e.g. smoking cigarettes), and diet-related health problems were included in the survey.

The survey also collected information on household shopping behaviour. Retail outlet formats were classified into modern and traditional retail outlets. Phone order and online shopping were also included in the outlet choice; however, only a few households purchased from these formats as they were not popular during the survey. Data on geographical access and preferences for different retail outlet formats were collected and used in the different analyses in the following three analytical chapters.

Household food and non-food expenditures were recorded using a food expenditure module, which included 92 different food product categories including staples and animal source foods, fruits and vegetables, processed foods, and drinks. These categories were

determined after several focus-group discussions and piloting of the survey to ensure that categories included all food items that are purchased and/or consumed by urban households in Vietnam. For each product, household respondents indicated the frequency they purchased the product and the average value per each purchase for a typical month. For the non-food expenditure module, respondents answered questions about their average expenditure for each of the 15 items that covered all possible non-food expenses of the households. Monthly household expenditure per capita was used as an indicator of income in chapters 3 and 4.

The survey also collected information on nutrition attitudes and food concerns of the household respondent. The respondents were asked to indicate the most important factor influencing their decision to purchase food in general. They also answered questions related to their nutrition label use (e.g. sugar) and their most important source of nutrition information (e.g. medical professionals). Regarding their nutrition concern, the respondents were asked to indicate their level of agreement with statements related to nutrition and food concerns (e.g. food and drinks with high amount of sugar) that were highly concerning to Vietnamese urban consumers at the survey time.

In addition to the survey, 24-hour food diaries were completed for each individual, from the youngest child to the eldest adult, in the household. When the enumerators visited the household for the household survey, they first mentioned the 24-hour food diary with the household respondent, who was also the food preparer of the household, to ensure that the household was willing to give information on their dietary intake. Then they provided the respondent with a hard copy of the 24-hour food recall diary and a manual (in Vietnamese), which included photos of commonly used Vietnamese kitchen utensils and measuring instructions. The enumerators explained and demonstrated to the respondent how to record the food intake over a 24-hour period. The 24-hour food diary module included detailed

information on the quantity of food or drink consumed, unit of measure, occasion, and place eaten.

The four-day food diaries were divided into two periods. The first period included two consecutive weekdays and one non-consecutive weekend day, and the second period, which was six months after the first period, was given any random day within a week. Only 1,590 households were able to complete the two periods of food diaries, or equivalent to the drop-out rate of 6.47% of the registered households, which was acceptable for a large household survey.

Dietary intake information was collected on 786 food and beverage items that were consumed both at home and away from home. To reduce measurement error, the 24-hour food diary data were double checked by the team supervisors on a daily basis during the data collection period. The paper-based information from the diary generated a huge data set, which demanded several months of data entry and cleaning to produce the raw data in Excel. Data cleaning and data encoding were achieved by the research team, including the author, which required detailed and careful consideration.

1.5 The structure of the thesis

The remaining four chapters of this thesis are as explained in the following paragraphs.

Chapter 2 analyses household-level data from 1,674 households to understand the relationship between urban households' choice of retail format for food purchases, household income and time constraints, and household food quality and safety concerns. A reduced form regression function is estimated with shares of household food expenditures made at each type of retail food outlet as the dependent variable. To further account for heterogeneity we estimate the regression using different subsets of the sample. We find no direct relationship between concerns about food safety and higher household food expenditure shares at modern retail outlets. However, for all households, regardless of income, concerns about food prices and freshness are associated with lower share of food retail expenditures at modern retail outlets.

Additionally, compared to higher income households, relatively poorer households are less able to substitute between modern and traditional food outlets when their travel time to market increased.

By combining the household data with further individual-level food consumption data from multiple rounds of 24-hour food recalls, **Chapter 3** examines the possible effects of food access on individual energy intake and share of caloric intake from macronutrients (protein, carbohydrates and fat) for 4,103 adults from Hanoi and Ho Chi Minh City. The dependent variables for this analysis are individual's total energy intake (in kilocalories) and macronutrient shares (protein, fat, and carbohydrates), defined as the proportion of calories from each macronutrient. Ordinary least squares and multivariate regression methods are used to estimate the empirical model. Subsample analyses are further conducted to test for heterogeneous effects of food access across different income groups. Our empirical results show that food access significantly affects both individual energy intake and macronutrient shares. Regarding economic food access, income significantly increases individual calorie intake a substitution effect: substituting carbohydrates with protein and fat. Furthermore, a higher pork price reduces the share of calories from protein. Geographical food access, has no significant association with caloric intake in the full sample analysis, but it is negatively associated with share of carbohydrates for lower income consumers having to travel a longer distance to wet markets. Moreover, nutrition concern is negatively associated with individual calorie intake and share of calories from fat.

Chapter 4 explores the interrelationship between nutrition label use, health concerns related to sugar consumption, and the share of caloric intake from food and beverages with added sugars for 4,047 adults and 737 adolescents from 1,590 households in Hanoi and Ho Chi Minh City. Simultaneous equation regression models are estimated using three-stage least squares (3SLS) to account for possible endogeneity and the cross-equation correlations. The

dependent variable is the share of daily caloric intake from food and beverages with added sugars for each individual. Empirical results show that nutrition label use is significantly associated with a lower share of caloric intake from food and beverages with added sugars for both Vietnamese adults and adolescents. We find that the variable representing health concerns related to sugar consumption is significantly associated with a lower share of caloric intake from added sugars for female adolescents as compared to adults and male adolescents.

The final chapter of the thesis, **Chapter 5**, provides a summary and general discussion of the findings and the possible implications arising from them. It also provides policy recommendations, research limitations and potential topics for future research on these topics.

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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:
  i.   the candidate's stated contribution to the publication is accurate (as detailed above);
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Chapter 2: Reconsidering food market modernization policies in Vietnam

Abstract

Government policies aiming to improve the food safety and efficiency of supply chains have been a key driver of the modernization of food retailing in urban Vietnam, which often occurs at the expense of traditional food markets. Support for these policies is based on assumptions that urban Vietnamese households perceive modern food retail outlets (e.g. supermarkets) to provide enhanced food safety. Using data from 1,674 urban Vietnamese households, and accounting for household time constraints, we find no direct association between concerns about food safety and higher household food expenditure shares at modern retail outlets. However, for all households, regardless of income, concerns about food prices and freshness are associated with a lower share of food retail expenditures at modern retail outlets. Additionally, compared to higher income households, lower income households are less able to substitute between modern and traditional food outlets. Current policies which seek to replace traditional food retail markets with modern retail outlets are potentially harmful for the urban poor, and are only of minor benefit to relatively wealthy households. Rather, government policies should focus on ensuring safe, fresh and healthy food is accessible for all households by improving the market conditions of traditional outlets and increasing their competitive position relative to modern retail outlets.

Key words: food safety; food market modernization, food outlet choice; developing countries; urban Vietnam

2.1 Introduction

The food retailing sector in Vietnam, as in many other developing countries, has been undergoing transformation where urban areas are experiencing a rapid growth in the number of modern food retail outlets[4], including hypermarkets, supermarkets, and mini-markets or convenience stores (Mergenthaler et al. 2009; Ruel et al. 2017; Rupa et al. 2019). Referred to as the "supermarket revolution" (Reardon et al. 2003; Reardon et al. 2012), from the demand side, these changes are brought about by increasing disposable income, urbanization, and shifting consumer preferences that increasingly favour the convenience, choice, and perceived quality offered by modern markets over traditional food outlets[5] (Gorton et al. 2011; Mergenthaler et al. 2009; Qaim 2017; Umberger et al. 2015). Whilst this transformation can lead to improved social welfare (e.g. through greater choice and improved perceptions of food safety), there are also concerns that rapid and unconstrained growth of more highly centralised modern supermarkets focuses benefits on relatively wealthy consumers and may generate costs to poorer groups associated with greater food costs and more difficult access to traditional sources of nutrition (Ruel et al. 2017; Rupa et al. 2019; Toiba et al. 2015; Wertheim-Heck & Raneri 2019; Wertheim-Heck et al. 2019).

Government policies in Vietnam have been largely supportive of the increasing penetration of modern food retail formats over the last decade, due largely to a combination of real and perceived food safety concerns primarily for the fresh food sector (Cadilhon et al. 2006; Ha et al. 2019; Wertheim-Heck et al. 2019; Wertheim-Heck et al. 2015). In Hanoi, for example, the Government of Vietnam aimed to reduce the current number of permanent traditional markets from 67 in 2010 to 14 in 2020 (MoIT 2009). Modern markets have been

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[4] The term hypermarket is used here for the bigger version of a supermarket, with over 12,000 m^2 of store area (Cadilhon et al. 2006). Supermarkets are medium to large-sized store stores, which are over 500 m^2 in size. Mini-markets or convenience stores are small, usually less than 100 m^2 in surface (Cadilhon et al. 2006).
[5] Traditional food outlets include wet markets (organized bazaar or public market), informal street markets, semi-permanent stands, traditional family shops (or mom-and-pop store), and peddlers (or mobile vendors) (Maruyama & Trung 2007).

considered to be important instruments and drivers of the transformation of the country into a modern society with an efficient and safe food sector (MoIT 2015).

Concerns regarding impacts of the Vietnamese government-supported replacement of traditional markets with modern markets focuses on qualitative evidence regarding regressive impacts – i.e. changes to the food retailing environment that harm relatively poor households (Figuié & Moustier 2009; Wertheim-Heck et al. 2019). This is made more important by the fact that large portions of urban populations in urban Vietnam still live below the poverty line of US$5/person/day (e.g. 40% in Hanoi) and there is qualitative evidence that poor urban households face difficulties in accessing sufficient nutritious foods from modern markets (Wertheim-Heck et al. 2019). Specifically, there is evidence that most urban Vietnamese households, perhaps except for wealthy households, tend to purchase ultra-processed products at modern food retailers (Wertheim-Heck et al. 2019) but continue to purchase fresh produce at traditional markets. Figuié and Moustier (2009) suggest that poor consumers in Vietnam purchase very little from supermarkets due to income and transportation constraints even though they perceive supermarkets to be superior outlets for purchasing quality food products.

The persistence of these abovementioned patterns of behaviour across large portions of urban households implies that the achievement of food market modernisation in Vietnam may well have the implications that: (1) lower income households are unable to easily access a diverse and sufficiently affordable range of nutritious and safe food if access to traditional markets is reduced; and (2) food safety objectives of the market modernisation program may not be met if access to traditional food markets is reduced. Thus, whilst supporting the transformation of modern food markets as platforms to achieve food safety goals, there is a strong possibility that these policies are undermining explicit efforts at achieving inclusive growth outcomes aligned with the United Nations Sustainable Development Goals (SDGs) as outlined in the Vietnamese Government's review of the SDGs (GOVN 2018). Therefore, the

objective of this study is to understand the relationship between households' retail format choice for food purchases, household income and time constraints, and household food quality and safety concerns. We analyse these relationships for a representative sample of urban households from the two largest cities of Vietnam: Hanoi and Ho Chi Minh City.

The study employs a framework that identifies both income and time as constraints in households' retail food outlet choice and seeks to assess these constraints, along with other preference-related drivers, in determining retail food outlet choice. We use a reduced form regression function with shares of household food expenditure made at each type of retail food outlet as the dependent variable. We account for heterogeneity through estimation of the regression function for different subsets of the sample focused on key areas of interest such as income. Our study represents a broadly-based, representative, and quantitative examination of Vietnamese urban households' food expenditure behaviour at modern and traditional retail food outlets, across different income brackets and within the two largest cities of Vietnam.

The research provides three main contributions that inform the literature and policy on food market modernisation in Asia. First, we explicitly account for time constraints in households' choice of retail food outlet while also controlling for budget (income) constraints. The replacement of traditional food retail markets with modern food retail formats will only constitute an inclusive development policy if households are willing and able to substitute traditional food retail outlet use with modern food retail outlet use. However, if households cannot easily substitute in this way, for example, due to a binding constraint or concerns about the general quality and/or safety of food sold at a particular food retail format; then replacement or "crowding out" of traditional food markets with modern ones may generate substantial harm to poorer households and represent a regressive development program exacerbating existing nutritional concerns tied to wealth distribution patterns. By examining the role of both time and

income as constraints in a food outlet choice decision we are able to consider how consumers substitute between cost and convenience for these market outlets.

Second, we investigate the role of household preferences for food attributes (i.e. food safety, price and freshness) on household food outlet choices. Evidence suggests that consumers across the income spectrum are relatively concerned about food safety in Vietnam, and thus, may have a preference toward food produced under certified food safety programs and/or food quality programs (Ha et al. 2019; Liu & Ma 2016). In Vietnam, modern food retail outlets are more likely to be able to provide consumers with "officially guaranteed" food safety assurances (Wertheim-Heck & Raneri 2019) and Wertheim-Heck et al. (2015) found that some Vietnamese consumers perceive modern retail outlets to offer "safer" food products.

Finally, we assess the impact of heterogeneity with respect to income and city, in the hope of better understanding cohort-level and city variation to guide policy recommendations. There are distributional concerns regarding the impact of increasing modern food retail penetration in emerging economies of Asia, thus it is necessary to consider how these factors are related to different target cohorts of the population.

The remainder of this paper is structured as follows. Section Two outlines a conceptual framework and hypotheses. Section Three describes data collection and a summary of statistics in detail, followed by the explanation of the econometric models used in this paper. Section Four presents the empirical results. Section Five concludes with policy implications that arise from our empirical findings.

2.2 Conceptual framework and hypotheses

The food retail market modernisation policies of the Vietnamese Government, combined with stated SDGs regarding inclusive development involve two key assumptions: (1) that modern food markets are perceived to provide for improved food safety outcomes, and; (2) that inclusive development goals can be achieved, or at least are not overly detrimentally

impacted upon, by a drastic change from dominance of traditional food markets to dominance of modern food markets in urban settings.

Our analyses consider household-level choices between modern food retail and traditional food retail outlets. Households may visit both, or only one, of these types of food retail outlets to purchase food for household consumption. The outcome will be reflected by the share of total household food expenditures made at each type of retail format. Choices for one or the other retail format are linked to: (1) consumer preferences for food product attributes, including price, food safety and freshness; and (2) income (budget) and time (convenience) constraints that limit or guide how the household chooses to seek to maximise the perceived return to expenditure and time spent food shopping.

We outline three key hypotheses that provide insights into the nature of choices between traditional and modern food retailing formats with an emphasis on impacts across income/wealth distributions.

Hypothesis 1: Due to time constraints, households will tend to choose food retail outlets that take less time to access, regardless of format, over more distant outlets.

Published studies have suggested that proximity, as measured by the travel time to the nearest food retail outlet, could be an important factor influencing consumers' food retail outlet choices (Hino 2014; Taylor & Villas-Boas 2016). As the cost of buying a product from a particular retail outlet includes the travel cost, this suggests that travel time to a food retail outlet format will be negatively related to the probability of choosing that outlet (Narayan et al. 2015). Travel costs can also have ambiguous effects on which different income groups choose where to shop for food. For example, Taylor and Villas-Boas (2016) evaluate the impact of travel time on consumers' food outlet choices in the United States, and suggest that there are differences among income groups in their willingness travel to shop for food.

In urban areas of Asia, modern retail outlets may be more convenient for higher income consumers since they stock both food and non-food products, and can be accessed by both public and private transportation (Reardon & Hopkins 2006; Schipmann & Qaim 2011). For lower income consumers, budget constraints may mean that they are more likely to choose to spend more time to obtain inexpensive nutritious food (Gibson & Kim 2013). This means that lower income consumers may exchange convenience (in terms of travel time) for money to maintain their food expenditure at traditional retailers. In contrast, higher income consumers are able to switch to modern retailers since they are less constrained by budget, meaning that for them travel time difference is more elastic than lower income consumers. In this case, we further test the distributional effects of travel time on different income groups.

Hypothesis 2: Households that place a relatively high level of importance on price of food, spend a higher share of their total food expenditures at traditional food retail outlets as compared to modern food retail outlets.

Consumers often perceive traditional food retail outlets to offer lower prices than modern food retail formats (Schipmann & Qaim 2011). Therefore, households that are relatively more concerned about the price of food products are expected to spend a lower share of their total household food expenditures at modern food retail outlet. This argument is supported by some studies in urban areas of Vietnam and Malaysia (Chamhuri & Batt 2013; Maruyama & Trung 2007). In contrast, a study in urban China by Maruyama et al. (2016) shows that consumers' perception on price is not a significant factor in their food retail outlet choices. Their study, however, does not consider possible heterogenous behaviour across different household income groups. In developing countries, poor urban households are more likely to face severe budget constraints than non-poor households since their food expenditure accounts for more than one-half of total household expenditure (Ahmed et al. 2007). This

means that the impact of price concerns on food retail outlet choice may have a greater impact on lower income households.

Hypothesis 3: Households that place a relatively high level of importance on food safety, spend a higher share of their total food expenditures at modern food retail outlets as compared to traditional food retail outlets.

Recent studies show that urban consumers in Vietnam are more concerned about the safety of fresh food (i.e. vegetables, fruits, and meat) than rural consumers (Ha et al. 2019) due to their lower perceived control over food safety (Nguyen-Viet et al. 2017; Wertheim-Heck et al. 2019). This means that higher level of concern and importance placed on food safety may be associated with an increased share of food expenditures at modern retailers as modern retailers are better able and more likely to provide consumers with quality and food safety assurances, often through the implementation of private standards (Berdegué et al. 2005; Maruyama & Trung 2007; Schipmann & Qaim 2011; Wertheim-Heck & Raneri 2019). This is only likely to be significant if these consumers perceive modern retailers to offer improved food safety relative to traditional outlets. However, if consumers do not perceive food safety as an advantage of modern outlets over traditional outlets, then this relationship will not be significant (Maruyama et al. 2016).

In addition, freshness may be an important factor influencing consumer choice of food retail outlets (Maruyama & Trung 2007; Maruyama et al. 2016). As compared to modern retail outlets, traditional outlets are seen as major sources of fresh produces for urban consumers (Wertheim-Heck et al. 2019; Wertheim-Heck et al. 2015). Thus, we may expect that consumers who have a concern about freshness, will be more likely to spend more food expenditure at traditional outlets.

2.3 Data and methods

2.3.1 Household survey

As explained earlier, the analyses in this study are based on data collected between December 2016 and April 2017 via a survey of 1,700 urban households located Hanoi and Ho Chi Minh City in Vietnam. Households were selected using a proportional sampling strategy considering ward-level[6] population and income distribution for each city. Income is an important consideration as previous studies found that household income is associated with food purchasing decisions and use of supermarkets (Minot et al. 2015; Rupa et al. 2019).

In both Hanoi and Ho Chi Minh City, income distributions were found to be very close to those in the large-scale Nielsen database[7], the most recent available third-party information at the time of our study. Trained enumerators conducted face-to-face interviews with the member of the household who was responsible for the household's food purchases. Enumerators used Android tablets which included a questionnaire designed using the CommCare app, a major mobile data collection platform that prevents missing entries of key information and includes GPS coordinates of households.

Enumerators collected information on socio-demographic characteristics of all household members (e.g. age, gender, years of education completed), household characteristics (e.g. household size, family composition, income levels, assets, etc.), total household food and non-food expenditures, food shopping behaviour (including where foods were purchased), attitudes and concerns about food products in general (i.e. food safety, price, and freshness), and access to different retail outlet formats (i.e. measured by travel time to the nearest outlet type from home).

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[6] Ward is the lowest administrative unit for urban areas in Vietnam. Officially, Ho Chi Minh City has 259 wards and Hanoi has 177 wards.

[7] For further information, see into the Appendix Table 2.A1. Also see Nielsen (2013)

Detailed household food consumption and expenditure data for a "typical" month was collected for 92 different food products[8]. Respondents answered questions about where they purchased the product (type of food retail outlet), the number of times (frequency) they purchased the product, and the average expenditure on the product for a typical month. This survey instrument and food consumption and expenditure methods are based on similar household research conducted in Indonesia by Umberger et al. (2015).

2.3.2 Empirical estimation

Although hypermarkets/supermarkets[9] (MS) and mini-markets (MM) are classified as modern retail outlets, they are differentiated in terms of capacity, range of products, and market accessibility (Wertheim-Heck & Raneri 2019). While supermarkets are located outside many consumers' immediate residential areas, mini-markets can be found in every corner of the city (Wertheim-Heck et al. 2015). Our data shows that, on average, a household consumer spent about 11 minutes travelling from home to the nearest supermarket, but only 8.5 minutes from home to the nearest mini-market. The travel time to the nearest wet market was about 8 minutes.

Following the choice model proposed by Taylor and Villas-Boas (2016), we start by setting up an indirect utility of choosing food retail outlet j ($j = MS, MM, W$) by:

$$U_{ij} = f(T_{i,j}, A_i, X_i) \qquad (1)$$

Where U_{ij} represents household i's marginal utility from purchasing food from food retail outlet type j. As explained in the conceptual model, the marginal utility of food retail outlet choices is assumed to be correlated with the travel time (T_j) to the respective outlet j, the importance that a household places on food product attributes (A_i), and household

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[8] The 92 food products were selected after conducting twelve focus group discussions (with six to eight participants in each group), and piloting and pretesting the survey with 60 households.
[9] The term *supermarket* will be used as a shorthand for large modern retailers including hypermarket and supermarket.

characteristics (X_i), including household income. The probability that household i chooses alternative j is given as

$$Pr_{i,j} = \exp(U_{ij}) / \sum_{j=1}^{J} \exp(U_{ij}) \qquad (2)$$

As the empirical analogue of probabilities, we use the household shares of food expenditures at food retail outlet j as the dependent variables to estimate equation (2) (Taylor & Villas-Boas 2016). Taking the log of the food expenditure share of household i at a modern outlet (either MS or MM) and subtracting the log of the food expenditure share of household i at a traditional outlet (w) yields two linear equations to which we can apply ordinary least squares (OLS):

$$\ln(S_{i,MS}) - \ln(S_{i,w}) = \alpha_{MS} + \beta_{MS} T_{i,MS} + \gamma_{MS} A_{i,MS} + \sum_{k=1}^{K} \theta_k x_{ik} + \epsilon_{i,MS} \qquad (3.1)$$

$$\ln(S_{i,MM}) - \ln(S_{i,w}) = \alpha_{MM} + \beta_{MM} T_{i,MM} + \gamma_{MM} A_{i,MM} + \sum_{k=1}^{K} \theta_k x_{ik} + \epsilon_{i,MM} \qquad (3.2)$$

In our survey, some lower income households purchased all food items from traditional markets; for these households, share of food expenditures at modern retailers ($j = MS$ and/or MM) is equal to zero. Transforming relative food expenditure shares with a natural logarithm does not work if there are many zero expenditures. This problem is also found in the literature when Burbidge and Robb (1985) used wealth as dependent variable with cross-sectional household data in Canada. In order to handle zero-values of the dependent variables, some researchers dropped values or added a constant to the zero-value (Burbidge et al. 1988). Alternatively, one can use the inverse hyperbolic sine (IHS) transformation (Burbidge et al. 1988; Friedline et al. 2015; Pence 2006; Yen & Jones 1997). The latter is appropriate to our study because, in addition to dealing with skewness, it retains zero values, which allows us to explore sensitive changes in the distribution. In our paper, the IHS transformation method was applied to convert the zero expenditure and is interpreted in the same way as a standard

logarithmic dependent variable. Therefore, in equations 3.1 and 3.2, the two dependent variables are the IHS transformations of expenditure share differences between supermarkets (*SM*) and traditional outlets (*w*) and minimarkets (*MM*) and traditional outlets (*w*), respectively.

The main variables of interest are the distance effect (*T*) estimated by measuring the natural logarithm of difference in travel time to reach the nearest modern outlet (supermarkets or mini-market) and the travel time to the nearest traditional outlets (*Travel Diff SM* and *Travel Diff MM*). By measuring the natural logarithm of time, the estimated coefficients can be interpreted as an elasticity (Taylor & Villas-Boas 2016). In addition, literature suggests that consumers' perceptions (e.g. price, food safety, and freshness) are seen as key factors in explaining consumers' behaviour regarding the use of food retail outlets (Hino 2014; Maruyama & Trung 2007; Maruyama et al. 2016). Therefore, a vector (*A*) of dummy variables: *Price Concern*, *Safety Concern*, and *Freshness Concern*, are included to examine the effects of household concerns about food prices, safety and freshness on their expenditure shares at modern versus traditional food retail outlets.

Other covariates include household characteristics (e.g. *Income Level*, *Household Size*, and *Internet*), socio-demographic characteristics of household respondent (i.e. *Age*, *Gender*, *Education*, and *Hour Job*). These variables have been significant in previous studies which attempted to explain consumers' food retail outlet choices (Hino 2014; Maruyama & Trung 2007; Maruyama et al. 2016; Mergenthaler et al. 2009; Minot et al. 2015; Taylor & Villas-Boas 2016). Finally, a city dummy variable (*Hanoi*) is included to control for unobservable city-level social norms and cultural traditions that have an effect on food expenditure shares (Rupa et al. 2019; Umberger et al. 2015).

The descriptive statistics in Table 2.1 provide detailed information of all variables used in this study. After data cleaning, our final sample consists of 1,674 households.

Table 2.1 Definitions and descriptive statistics for all variables

Variables	Description	Mean	SD	Min	Max
Dependent variables					
Supermarket	IHS of expenditure share difference between Supermarket and Traditional outlets	-0.62	0.30	-0.88	0.88
Minimarket	IHS of expenditure share difference between Mini-market and Traditional outlets	-0.72	0.18	-0.88	0.88
Key explanatory variables					
Travel Diff SM	Log of travel time difference between Supermarket and Traditional outlets	0.47	0.58	-2.30	3.40
Travel Diff MM	Log of difference in travel time between Mini-market and Traditional outlets	0.20	0.65	-2.30	2.71
Price Concern	(= 1 if "price" is the most important factor in purchasing food in general, 0 otherwise)	0.08	0.26	0	1
Safety Concern	(= 1 if "safety" is the most important factor in purchasing food in general, 0 otherwise)	0.49	0.50	0	1
Freshness Concern	(= 1 if "fresh" is the most important factor in purchasing food in general, 0 otherwise)	0.18	0.38	0	1
Other covariates					
Income level	Household monthly income level				
Low income	Less than 4.49 mil. VND/month	0.07	0.25	0	1
Lower-middle income	4.5 to 7.49 mil. VND/month	0.31	0.46	0	1
Upper-middle income	7.5 to 14.9 mil. VND/month	0.41	0.49	0	1
High income	15 mil. or more VND/month	0.21	0.41	0	1
Age	Respondent's age (years)	40.59	10.86	19	71
Gender	Respondent's gender (1=Female, 0=Male)	0.97	0.18	0	1
Education	Years of education completed by respondent	11.11	3.16	1	19
Hour Job	Number of hours the respondent works in paid employment (outside of the household)	27.34	26.16	0	100
Household Size	Size of the household (persons)	3.74	1.14	1	9
Internet	(= 1 if household has access to internet, 0 otherwise)	0.74	0.44	0	1
Hanoi	(= 1 if household lives in Hanoi, 0 otherwise)	0.41	0.49	0	1

Note: Authors' calculation. SD represents standard deviation and Min and Max represent minimum and maximum values of the sample statistics. VND/month is Vietnamese Dong per month. 1 USD = 22,318 VND on December 30, 2016. Reference income is low-income in VND/month.

2.4 Results

Table 2.2 provides an overview of the average household food expenditure shares for traditional and modern retail outlets across all four income groups. Overall, across all four income categories, the average share of food expenditures at traditional outlets is greater than the share of expenditures at modern retail outlets. This means that regardless of household income, traditional food retail outlets continue to be an important source of food for urban Vietnamese households. Although household food expenditure shares at modern outlets appear to generally increase with income, there are marked differences between the two cities, particularly for the low and lower-middle income households. This may be because Ho Chi Minh City has experienced relatively faster economic development and has been more culturally affected by the Western world for several decades (Engholm 1995; Van Dinh et al. 2013; Wertheim-Heck et al. 2015).

Table 2.2 Share of monthly food expenditures per adult male equivalent at different food retail outlets by income groups in Hanoi and Ho Chi Minh City, Vietnam

Outlets	Low income	Lower-Mid. Income	Upper-Mid. income	High income	Total average
Ho Chi Minh City					
Supermarket	19%	20%	15%	27%	19%
Minimarket	1%	2%	3%	3%	3%
Traditional	74%	75%	79%	66%	74%
Hanoi					
Supermarket	2%	7%	7%	10%	8%
Minimarket	3%	3%	4%	6%	4%
Traditional	92%	87%	83%	81%	84%

Note: The sum of the three major food outlets in each column do not sum to 100%. The remaining food retail outlets including online shopping, phone order, restaurants, hotels, cafes, bar and constitute less than 5% of household food expenditures, on average.

The estimation results are presented in three subsections according to the sample or subsamples included in the estimation of the empirical models: 1) full sample, 2) sub-samples for each of the four income cohorts (low income to high income), 3) sub-samples defined by both the four income cohorts and city (Hanoi or Ho Chi Minh City).

2.4.1 Full sample results for food outlet choice model

Before estimating the outlet choice model, the likelihood ratio test (LR test) was used to test the restriction regarding pooling the data of both supermarket (MS) and mini-market (MM). The LR test indicated that the pooling restriction was not valid (test value = 605.12, p-value=0.000) and that separate models should be estimated for: (1) differences in log expenditure shares between supermarkets and traditional markets, and; (2) differences in log expenditure shares between minimarkets and traditional markets.

Table 2.3 presents results for the full-sample supermarket and mini-market expenditure share models, respectively. To further test robustness, three different models with and without control variables are performed. Overall, the signs of estimated coefficients are consistent across specifications (Model 1 to Model 3).

In the full-sample model, the coefficients on the variables that represents the difference in travel time between the nearest modern retail outlet and the nearest traditional retail outlet (*Travel Diff SM* and *Travel Diff MM*) are consistently negative and significant. This indicates that, on average, households consider travel time to food retail outlets when making decisions about where to purchase food. While supporting hypothesis H1, this result means that, on average, a reduction in the density of either modern markets or traditional markets is likely to have a negative impact on social welfare, particularly in the case that all types of markets constitute substantial shares for all consumers (explored further in the next section).

Table 2.3 Estimates for modern retail outlet expenditure share models

Variables	Supermarkets			Mini-markets		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Travel Diff SM[a]	-0.047***	-0.044***	-0.038***			
	(0.012)	(0.012)	(0.011)			
Travel Diff MM[a]				-0.045***	-0.040***	-0.041***
				(0.008)	(0.007)	(0.007)
Price Concern	-0.047*	-0.058**	-0.136***	-0.058**	-0.059***	-0.092***
	(0.026)	(0.026)	(0.025)	(0.015)	(0.014)	(0.014)
Safety Concern	0.013	0.013	0.021	-0.000	0.000	0.003
	(0.019)	(0.018)	(0.016)	(0.011)	(0.011)	(0.010)
Freshness Concern	-0.090***	-0.103***	-0.129***	-0.074***	-0.076***	-0.087***
	(0.018)	(0.018)	(0.016)	(0.010)	(0.010)	(0.010)
Income level						
Lower-middle income		0.058**	0.043*		0.027*	0.020
		(0.027)	(0.024)		(0.015)	(0.015)
Upper-middle income		0.074***	0.047*		0.047***	0.035**
		(0.027)	(0.025)		(0.016)	(0.015)
High income		0.136***	0.094***		0.087***	0.069***
		(0.031)	(0.028)		(0.019)	(0.018)
Age		-0.001	0.001		-0.000	0.000
		(0.001)	(0.001)		(0.000)	(0.000)
Gender		0.022	0.068*		0.011	0.030
		(0.044)	(0.040)		(0.025)	(0.023)
Education		0.006**	0.019***		0.007***	0.013***
		(0.002)	(0.002)		(0.002)	(0.002)
Hour Job		-0.003***	-0.001***		-0.001***	-0.001***
		(0.000)	(0.000)		(0.000)	(0.000)
Household Size		-0.027***	-0.014**		-0.015***	-0.009**
		(0.007)	(0.006)		(0.004)	(0.004)
Internet		0.072***	0.061***		0.030***	0.025**
		(0.016)	(0.015)		(0.010)	(0.010)
Hanoi			-0.278***			-0.118***
			(0.016)			(0.009)
Constant	-0.590***	-0.585***	-0.787***	-0.697***	-0.746***	-0.832***
	(0.016)	(0.075)	(0.070)	(0.008)	(0.044)	(0.042)
No. of observations	1,674	1,674	1,674	1,666	1,666	1,666
R-squared	0.026	0.104	0.253	0.056	0.121	0.193

Note: Robust standard errors in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). [a]A higher Travel Diff means the time to supermarket/mini-market is higher relative to traditional market.

Concerns about the price of food (*Price Concern)* is also a significant factor associated with both food expenditure shares at modern retail outlets (Table 2.3). The negative relationship between *Price Concern* and expenditure shares is consistent for both the supermarket and mini-market models across various specifications. This result indicates that

households concerned about price may perceive traditional food retail outlets to offer better value when shopping for food. These results support the statements in hypothesis H2.

The coefficient on the variable representing that a household places high importance on food safety when purchasing food (*Safety Concern*) is not significant in explaining expenditure shares at modern retail outlets in any of the model specifications (Table 2.3). This result is in contrast to the rationale for the food systems modernisation program in Vietnam, and suggests a rejection of hypothesis H3. Given the prevalence of food safety as a concern in Vietnamese households' general food purchase decisions (49% of households stated food safety is the most important factor when purchasing food), this suggests that consumers may perceive the differences in food safety between modern and traditional food retail formats to be too small to justify changing where they purchase their food. On the other hand, there is a significant effect of concerns regarding freshness on food retail outlet choice, with those stating that freshness is the most important factor when purchasing food spending a significantly lower of household food expenditures at modern retail outlets. These results provide support for the assertion that consumers, on average, do not perceive modern markets to offer a sufficiently safer or higher quality supply of food relative to traditional market formats in order to change behaviour. The result supports the conclusions of Wertheim-Heck et al. (2015) that the restrictiveness of the Vietnamese food market policy, fails to achieve key food-safety objectives, and (combined with H2) indicates that it is likely to generate unintended harmful consequences for households and consumers.

Some of the household socio-demographic characteristics also appear to have significant relationships with the dependent variables. A positive association is found between higher income households and food expenditure shares at modern retail outlets. Also, the household respondent's education is positively associated with the food expenditure shares at modern retailers suggesting that better-educated consumers may have stronger preferences

toward shopping at modern retailers (Mergenthaler et al. 2009). Another positive factor associated with expenditures at modern retailers is having access to the internet. Modern outlets can attract consumers through online promotions and advertisements, and this could explain a positive link between internet access and food expenditures at modern outlets.

Other household factors show a negative relationship with food expenditure shares at modern outlets, such as household size (*Household Size*) and hours worked away from home (*Hour Job*). For a given income, larger households may have less disposable income to spend on more expensive foods (Toiba et al. 2015), so they tend to purchase cheaper foods which are more available at traditional outlets. The negative labour time effects may be explained by the fact that in urban Vietnam, traditional food outlets, particularly informal street markets and peddlers, are in closer proximity to households and tend to have more convenient opening hours (e.g. open early in the morning and late at night) (Wertheim-Heck & Raneri 2019). The estimated coefficients of the Hanoi City dummy are negative and significant, which show that compared with Ho Chi Minh City, consumers in Hanoi spend a lower share of their food expenditures at modern retail outlets.

2.4.2 Heterogeneity by income group

Table 2.4 provides results for the modern market food expenditure share models estimated for each of the four-household income groups. The results show there are significant differences across income cohorts for expenditure shares at both types of food retailers.

Table 2.4 Estimates for modern retail outlet expenditure shares, by income group

Variables	Supermarket				Mini-market			
	Low income	Lower-Mid. Income	Upper-Mid. Income	High income	Low income	Lower-Mid. Income	Upper-Mid. Income	High income
Travel Diff SM[a]	-0.001	-0.031	-0.043**	-0.038				
	(0.036)	(0.020)	(0.017)	(0.027)				
Travel Diff MM [a]					-0.012	-0.019	-0.040***	-0.074***
					(0.023)	(0.012)	(0.010)	(0.017)
Price Concern	-0.211***	-0.150***	-0.111**	-0.118**	-0.144***	-0.095***	-0.069***	-0.093***
	(0.061)	(0.051)	(0.043)	(0.046)	(0.032)	(0.029)	(0.024)	(0.028)
Safety Concern	-0.040	0.018	0.022	0.058	-0.054	0.003	0.004	0.040
	(0.056)	(0.032)	(0.024)	(0.036)	(0.033)	(0.018)	(0.015)	(0.027)
Freshness Concern	-0.095	-0.158***	-0.135***	-0.084**	-0.080*	-0.095***	-0.086***	-0.075***
	(0.069)	(0.032)	(0.024)	(0.035)	(0.041)	(0.018)	(0.015)	(0.024)
Age	-0.001	0.001	0.001	-0.001	0.001	0.000	0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Gender	0.286***	0.148***	-0.045	0.037	0.128***	0.046	-0.012	0.007
	(0.058)	(0.047)	(0.078)	(0.076)	(0.031)	(0.043)	(0.043)	(0.043)
Education	0.016*	0.014***	0.022***	0.022***	0.011**	0.007**	0.016***	0.013***
	(0.008)	(0.005)	(0.004)	(0.005)	(0.005)	(0.003)	(0.002)	(0.004)
Hour Job	-0.000	-0.001	-0.002***	-0.001	-0.000	-0.000	-0.001***	-0.001
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Household size	-0.007	-0.029**	-0.010	-0.003	-0.001	-0.016**	-0.011*	0.002
	(0.020)	(0.012)	(0.009)	(0.013)	(0.013)	(0.007)	(0.005)	(0.009)
Internet	0.037	0.098***	0.043**	0.005	0.014	0.042***	0.024*	-0.026
	(0.047)	(0.025)	(0.021)	(0.045)	(0.027)	(0.014)	(0.014)	(0.042)
Hanoi	-0.244***	-0.284***	-0.255***	-0.332***	-0.099***	-0.126***	-0.112***	-0.120***
	(0.048)	(0.028)	(0.024)	(0.042)	(0.030)	(0.015)	(0.014)	(0.025)
Constant	-0.938***	-0.749***	-0.666***	-0.653***	-0.931***	-0.760***	-0.790***	-0.721***
	(0.201)	(0.114)	(0.125)	(0.150)	(0.107)	(0.075)	(0.069)	(0.120)
No. of observations	115	516	688	355	113	514	685	354
R-squared	0.318	0.260	0.250	0.254	0.258	0.198	0.197	0.195

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). [a]A higher Travel Diff means the time to supermarket/mini-market is higher relative to traditional

Considering the results in Table 2.4, it appears that relatively poorer (low income and lower-middle income) households' food expenditures shares at modern retail outlets (versus traditional markets) are insensitive to travel time. However, it appears that time is a binding constraint for some upper income households. The coefficients on the travel time variables (*Travel Diff SM* and *Travel Diff MM)* are significant and negative in the estimation of food expenditures for both types of modern outlets for the upper-middle income subsample, and for the high income subsample, only the *Travel Diff MM* coefficient is significant and negative. Thus, lower availability/density of traditional food markets are likely to be associated with greater welfare loss for poorer households compared to wealthier households as the former cannot choose to substitute modern markets for traditional markets that have become distant due, in-part, to government market transformation policies.

The coefficient on *Price Concern* is negative and significant in both the supermarket and mini-market expenditure share models for all income groups, but the size of the coefficients is larger in the models for lower income households. Combined, the time-elasticity and price-concern results may suggest that: (1) higher income groups are relatively more sensitive to convenience (as measured by *Travel Diff* variables); (2) lower income groups are relatively more sensitive to price (measured by *Price Concern*), and (3) the lowest income group is more constrained by budget constraints than by time constraints. These results indicate that there are potentially regressive effects associated with the policies which decrease the availability of and access to traditional food retail markets.

As with the full sample model results presented in Table 2.3, the income-cohort models presented in Table 4 show that food safety concerns are not significantly associated with expenditure share differences between supermarkets/minimarkets and traditional markets. Thus, food safety concerns are not a reasonable justification viable the recommendation that to remove traditional food retail outlets because consumers in Vietnam will prefer to shop at

modern food retail outlets due to food safety concerns as support for the removal of traditional markets are rejected by these results for all income cohorts.

On the other hand, freshness concerns are significantly and substantially related to retail format expenditure shares for all groups/formats except for the lowest income groups in consideration of supermarket expenditure shares compared to traditional market expenditure shares. These results show that all consumers prefer to shop at traditional markets when freshness concerns play a role in food expenditure decisions. Thus, for all income groups, the removal of accessibility of traditional markets is likely to create negative impacts on food consumption choices associated with lower consumption of fresh foods, such as nutritious fruits and vegetables, as access to those foods becomes more difficult and more expensive.

Interesting differences in heterogeneity by income groups are also found for some household characteristics. For example, gender was significant and positive in the models estimating supermarket and mini-market food expenditure shares for lower income households only. Some other factors such as household size, hours the respondent works outside of the household, and access to the internet are also significantly associated with food expenditure shares at modern outlets, for only some income sub-groups. For example, upper-middle income consumers tend to reduce their food expenditure share at modern outlets when they spend more time working outside of the household, but we do not find evidence of a significant association for other income groups.

2.4.3 City differences in household expenditures of modern versus traditional outlets

Table 2.5 presents the results of the separate estimations for the Hanoi and Ho Chi Minh City sub-samples.

Table 2.5 Estimates for modern retail outlet expenditure shares, by city

Variables	Supermarket		Mini-market	
	Hanoi	HCMC	Hanoi	HCMC
Travel Diff SM[a]	-0.032***	-0.043***		
	(0.009)	(0.016)		
Travel Diff MM[a]			-0.028***	-0.049***
			(0.007)	(0.010)
Price Concern	-0.036	-0.148***	-0.060***	-0.090***
	(0.022)	(0.030)	(0.023)	(0.017)
Safety Concern	0.020	0.016	-0.008	0.013
	(0.013)	(0.029)	(0.011)	(0.017)
Freshness Concern	-0.072***	-0.153***	-0.077***	-0.087***
	(0.013)	(0.025)	(0.012)	(0.014)
Income level				
Lower-middle income	0.011	0.070*	-0.008	0.043*
	(0.017)	(0.040)	(0.016)	(0.023)
Upper-middle income	0.038**	0.065*	0.020	0.052**
	(0.017)	(0.039)	(0.017)	(0.023)
High income	0.062***	0.129***	0.050***	0.087***
	(0.020)	(0.045)	(0.019)	(0.028)
Age	0.000	0.000	-0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Gender	0.062**	0.068	0.046*	0.015
	(0.028)	(0.060)	(0.024)	(0.033)
Education	0.011***	0.023***	0.011***	0.013***
	(0.003)	(0.003)	(0.002)	(0.002)
Hour Job	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Household size	0.002	-0.021**	0.001	-0.016***
	(0.005)	(0.009)	(0.005)	(0.006)
Internet	0.021*	0.086***	0.008	0.033**
	(0.012)	(0.022)	(0.011)	(0.015)
Constant	-0.974***	-0.810***	-0.925***	-0.831***
	(0.062)	(0.104)	(0.052)	(0.060)
No. of observations	693	981	693	973
R-squared	0.146	0.146	0.162	0.157

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). [a]A higher Travel Difference means the time to supermarket/mini-market is higher relative to traditional market.

For the estimation of food expenditure share at supermarkets or mini-markets versus traditional markets, the point estimates of relative travel time differences are stronger for consumers living in Ho Chi Minh City than in Hanoi. Since consumers in Ho Chi Minh City spend a relatively higher share of their food expenditures at modern retail outlets (Table 2.2), it is perhaps not surprising that they are more responsive to an increase in the relative travel time to nearest modern retail outlet as compared to consumers in Hanoi.

Similar to the full sample and income sub-sample analyses, a high importance placed on price is negatively correlated with the food expenditure share at supermarkets and mini-markets for consumers in Ho Chi Minh City, but interestingly it is not significant in the supermarket share model for the Hanoi subsample. These results indicate the importance of accounting for potential heterogeneity between locations, given that we do not find any evidence for this in the income analysis. This could be because in Hanoi, on average, supermarket expenditures account for only 8% of total food expenditures (Table 2.2), so consumers that use supermarkets may not be as concerned about higher food prices compared to consumers in Ho Chi Minh City. Differences in cultural aspects between two cities is also likely to explain why some household characteristics (e.g. household size, internet) are only significant for consumers in Ho Chi Minh City.

2.5 Policy implications and conclusions

The Vietnamese government has recently initiated policies in urban locations which support the transformation and redevelopment of land and infrastructure where traditional food retail outlets are currently located into modern food retail outlets. One aim of these policies is to provide increase the market efficiency of food supply chains with an ultimate aim to increase food safety and improve consumer welfare. However, the results from our empirical analyses of household-level food expenditure data from 1,674 households in urban Vietnam, which account for time and income constraints, indicate that the assumptions underpinning these policies are likely incorrect. Further, these polices which seek to modernize food retailing are likely to have perverse effects on urban Vietnamese consumers' welfare.

Specifically, we show that, compared to higher income households there is less potential for lower income households to substitute between modern and traditional food outlets when travel time increases. Whilst all households are concerned about food safety, there is no direct association between concerns about food safety and food retail outlet choice. For

all households, regardless of income, price concern is an important factor associated with a lower share of food retail expenditures at modern retail outlets. On average, all households appear to prefer traditional markets as suppliers of fresh produce.

These results imply that policies which seek to increase the presence of modern markets in the Vietnamese urban environment, at the cost of reducing the presence of traditional markets, are potentially harmful to the poor and only of minor benefit to relatively wealthy households. Instead, the government should consider policies to ensure that all households have access to affordable, safe and healthy food, for example by improving the market conditions of traditional retail formats and addressing food safety and quality issues throughout the supply chain.

Some potential research questions may arise from the limitations of this study. First, the study is cross-sectional in nature and therefore we cannot capture the dynamic changes with respect to consumers' food outlet choices and expenditures shares. Second, the focus on the more developed urban areas of Vietnam, whilst representative of key urban populations, may not be representative of food purchasing behaviour for non-urban households or those in smaller urban centres.

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Appendix

Table 2.A1 Percentage of surveyed household income, by income groups and comparison with Nielsen 2013 report

Gross family income per month[a]	Sample (%)	Nielsen 2013[b] (%)
Less than 4.99 million VND (*Less than 201.88 USD*)	7	9
Between 4.5 and 7.49 million VND (*201.89 to 336.46 USD*)	31	34
Between 7.5 and 14.99 million VND (*336.47 to 672.92 USD*)	41	38
15 million VND and above (*672.93 USD and above*)	21	19

Note: (a) Exchange rate 1 USD = 22,291 VND on 1 December 2016; (b) Nielsen 2013 data for urban areas of Hanoi and Ho Chi Minh City only

Chapter 3: Statement of Authorship

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Principal Author

Name of Principal Author (Candidate)	Anh Duc Nguyen		
Contribution to the Paper	Contributed to primary survey, data collection, calories conversion from 24-hour food diaries, data analysis and interpretation, wrote manuscript.		
Overall percentage (%)	65		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	14/10/2020

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:
  iv.   the candidate's stated contribution to the publication is accurate (as detailed above);
   v.   permission is granted for the candidate in include the publication in the thesis; and
  vi.   the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Professor Wendy J Umberger		
Contribution to the Paper	Project leader responsible for conception and design of the Vietnam Urban Food Consumption and Expenditure Study and the manuscript, acquisition of funding for data collection, led design the household questionnaire, guided the development of the manuscript and data analysis, and critically edited the manuscript.		
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Contribution to the Paper	Supervised data collection in the field, guided the development of the manuscript and data analysis, and critically edited the manuscript.		
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Chapter 3: Food access, nutrition concerns and nutrient intakes among urban Vietnamese consumers

Abstract

Food access is an important determinant of food security. This study explores the relationships between three dimensions of food access; caloric intake; and macronutrient shares for 4,103 adults from 1,590 households located in urban Hanoi and Ho Chi Minh City, Vietnam. Ordinary least squares and multivariate regression methods are used to analyse individual-level caloric intake and macronutrient shares obtained from food consumption data collected using 24-hour food diaries. Subsample analyses are conducted to test for heterogeneous relationships across income groups. Increasing disposable income is associated with higher total caloric intake; which appears to be due to a substitution of calories high in carbohydrates with calories relatively higher in protein and fat. Increasing pork price is associated with a lower share of calories from protein, regardless of household income level. A further distance to wet market is associated with a higher share of calories from fat for individuals from low- and middle-income households. Increased household nutrition concern is associated with lower individual caloric intake and a lower share of calories from fat. Policies and programs aiming to improve public health through increasing food and nutrition security, need to be carefully considered as they are likely to have heterogenous, and perhaps unintended consequences for different subgroups of the urban Vietnamese population.

Key words: Food access; Nutrition concern; Nutrient intakes; urban Vietnam; 24-hour food diaries

3.1 Introduction

In many developing countries, the urban food environment and food consumption patterns are changing rapidly due to economic growth and changing lifestyles (Harris et al. 2019; Pingali 2007; Rupa et al. 2019; Toiba et al. 2015; Turner et al. 2018). On the one hand, the urban food environment has been evolving as a result of economic growth and supermarket penetration (Kelly et al. 2014; Wertheim-Heck & Raneri 2019; Wertheim-Heck et al. 2015). On the other hand, increasing household disposable incomes not only make food more affordable, but also implicitly change food preferences (Pingali 2007; Reardon & Timmer 2014). The consequent changes in food consumption patterns, and diet diversification from traditional staple foods towards increasing consumption of processed foods, oil, sugar, and animal source foods, can have mixed implications for diet quality and overall nutrition (Kelly 2016; Popkin et al. 2012; Umberger et al. 2020).

While a more diversified food basket can mean increased intake of some important nutrients (e.g. protein, fibre, vitamins), the increasing consumption of highly processed foods can lead to an unbalanced diet and associated non-communicable diseases resulting from increased overall energy intake and high consumption of added sugars, salt and saturated fats (Bolhuis et al. 2016; Drewnowski & Popkin 1997; Monteiro 2009). Excessive energy intake from highly processed foods, high in low quality fat and carbohydrates, can cause weight gain and eventually increase the prevalence of overweight and obesity, while insufficient calories can limit human growth and cognitive development (Alderman & Fernald 2017; Black et al. 2013). While such dietary transition and its health impacts have been studied extensively, more research is needed to understand how consumers' physical and economic access to foods, as well as their nutrition concerns, are related to total energy intake and the relative proportion of dietary energy from the main macronutrients, carbohydrates, protein and fats, to understand if diets are 'balanced' according to recommendations (Moltedo et al. 2014). Understanding these

relationships will be important in assisting policy decisions that facilitate nutrition improvement in developing economies, which are experiencing dramatic food system changes.

Like many other Asian developing countries, Vietnam is experiencing both food system changes and a related nutrition transition (Thang & Popkin 2004). Specifically, the structure of the Vietnamese diet has shifted from low protein staples (i.e. starchy rice and tubers, vegetables and fruit) to significantly higher consumption of animal-source foods, instant noodles, and sweetened beverages (Harris et al. 2020; Nguyen & Hoang 2018). Although these changes can improve dietary diversity, they are concerning because for some individuals, this transition to energy-dense, poorer quality diets can lead to obesity and other non-communicable diseases. Moreover, these nutrition issues are more likely to occur among the younger population in urban areas of Vietnam (Beal et al. 2020; Trinh et al. 2018b).

3.1.1 Dimensions of food access

Food access is a concept that links food demand and supply in multiple dimensions. In a systematic review, Caspi et al. (2012) presented a conceptual framework with five dimensions of food access, or ways in which the local food environment can affect diet, including availability (adequacy of healthy food supply), accessibility (geographical location of food stores and ease of getting to them), affordability (food prices and people's perception of cost-benefit), acceptability (people's attitudes about the attributes of local food environment) and accommodation (adaptation of food retailers and providers of food to suit people's needs). While these dimensions are comprehensive, certain adjustments are needed in reflecting the food environment characteristics in different contexts.

In urban Vietnam, availability of food is usually satisfied because healthy food is easily accessible in almost all urban areas through traditional wet markets (both formal and informal) as well as modern food outlets (Harris et al. 2020; Wertheim-Heck & Raneri 2019; Wertheim-Heck et al. 2015). Additionally, it is also unlikely that accommodation is a concern because in

Vietnam, both modern and traditional retailers of food have evolved and a number of informal and formal outlets exist to meet various needs of consumers (e.g. opening hours, payment types) (Umberger et al. 2020; Van Esterik 2008). Therefore, for Vietnamese urban residents, geographical (accessibility), economic (affordability), and acceptability dimensions of food access are relatively more likely to affect diet and nutrition outcomes.

Geographical access to food outlets, as measured by the distance to market, is a dimension of food access that can affect a household's nutrition (Stifel & Minten 2017). In particular, geographical access to healthy foods, or exposure to unhealthy foods, can affect nutrient intakes in opposite ways. For example, lack of access to healthy foods (e.g. residents of 'food desert' areas) may be an underlying cause of obesity in developed countries (Bodor et al. 2010; Thomsen et al. 2016; White 2007; Zeng et al. 2019). Developing countries are receiving increasing attention in the literature with respect to this food access dimension and diet and nutritional outcomes. For example, Umberger et al. (2015) found that the combination of high income and a large share of food being purchased at supermarkets is sufficient to change diets, leading to an increased prevalence of overweight and obesity in children in urban Indonesia. Demmler et al. (2018) also showed that supermarket shopping is associated with increasing consumption of processed foods leading to significant increases in body mass index for individuals in urban Kenya.

Most existing studies in developing countries use BMI z-scores as the single nutrition outcome measure (e.g. Demmler et al. 2018; Umberger et al. 2015), however, z-scores do not capture nutrient intakes through food, which are a root cause of body weight changes. To advance this literature, our study therefore aims to formally address the relationship between geographical food access and individuals' macronutrient shares using individual dietary intake data.

Barriers to food access can also arise from the demand-side (e.g. income, food budget, and the spatial patterning of food prices), rather than solely the location of food markets (Breyer & Voss-Andreae 2013). Even when consumers have adequate physical access to food outlets, healthy foods can be economically inaccessible for lower income consumers if food prices are relatively high (Herforth & Ahmed 2015). Therefore, consumers from poor urban households in developing countries may face a greater risk of food and nutrition insecurity (Haddad et al. 1999; Wertheim-Heck & Raneri 2019). Urban consumers' diet quality is more dependent on rising and volatile price levels since urban households need to purchase most of their foods at a market. In the face of higher food prices, poorer households may be forced to reduce both the quantity and quality of the food they consume (Brinkman et al. 2009). For example, consumers may switch to cheaper and less nutritious foods to maintain their energy intake (Ecker & Qaim 2011; Gibson & Kim 2013). Most studies attempting to correlate economic food access and calorie/nutrition intake have been performed using household-level data; therefore, they have not captured the individual-level effects of economic food access on dietary behaviour (Ecker & Qaim 2011; Rupa et al. 2019; Salois et al. 2012; Skoufias et al. 2011; You et al. 2016). Facilitated by a unique data set where we have both household-level characteristics and individual-level food consumption data, our study aims to understand the possible linkages between economic food access and individual macronutrient nutrient intakes for individuals from urban Vietnamese households.

Acceptability of food access refers to the household's level of nutrition concerns and perceptions related to consumption of food with high amounts of fat, cholesterol, sugar, and salt. A number of studies have considered the role of health and nutrition concerns in food demand analysis (Frazao & Cleveland 1994; Jensen et al. 1992; Rimal & Fletcher 2002). Using a consumer attitude and health information index, Jensen et al. (1992) found that consumers with a positive attitude towards calcium in dairy products increased their dairy product

purchases. In contrast, consumers more aware of diet-related diseases were not more likely to meet recommended intakes for fat, saturated fat, or cholesterol (Frazao & Cleveland 1994). Another study by Rimal and Fletcher (2002) also found that the meal planner's nutrition concern had little effect on their food purchase decisions. These studies, provide useful insights, but they fail to account for the potential inter-relationship between macronutrients. In addition, they have only focused on developed countries.

Our study therefore examines the effects of food access, measured using three dimensions (affordability, accessibility, acceptability), on an individual's caloric (energy) intake and share of calories from carbohydrates, protein and fat (macronutrient shares). Our contributions are threefold. First, we consider not only total caloric intake, but to gain deeper insight into the quality of the calories and balance of diet, as we consider the relative proportion of energy from each macronutrient. As Salois et al. (2012) point out, it is important to decompose caloric intake into the key macronutrients to understand the calorie-nutrition relationship. For example, while increasing calories can reduce some types of nutrition, if a larger proportion of calories is from low quality fats, this may lead to other nutritional issues (e.g. overweight and obesity). Second, our study takes advantage of our unique intra-household data set to better capture the *individual-level* effects of food access on nutrition. Our data were derived from a comprehensive study covering 1,590 households in Hanoi and Ho Chi Minh City, Vietnam, which included multiple rounds of 24-hour food diaries which collected food consumption information for 4,103 individuals. Third, subsample analyses were conducted for low-, middle- and high-income urban households to allow us capture the possible heterogenous effects of food access on individuals' total caloric intake and macronutrient shares, thereby allowing us to provide policy insight relevant to different socio-economic segments of the urban Vietnam population.

The remainder of this paper is structured as follows. Section Two proposes an analytical framework between nutrient consumption and food access, followed by the explanation of the econometric models used in this paper. Section Three describes data collection and summary of statistics in detail. Section Four presents empirical results. Section Five concludes with policy implications that arise from our empirical findings.

3.2 Analytical framework

We derive our analytical framework from the household production theory of Becker (1965). In this framework, a household is considered as both a producing and consuming unit, where foods are "produced" (purchased) with income and time inputs and consumed by individuals living in the household. Subject to time and income constraints, the utility maximization process determines individual demands for inputs and nutrients. Specifically, the individual nutrition consumption can be represented as a reduced-form function as follows

$$N_{ijk} = f(E_{jk}, G_{jk}, S_{jk}|X_{ijk}, H_{jk,}u_{ijk}) \tag{1}$$

where N_{ijk} is the outcome variable measuring the total caloric intake or share of total calories from three macronutrients: carbohydrates, protein, and fat for individual i of household j living in ward k. $E_{jk}, G_{jk,}S_{jk}$ represent economic food access (affordability), geographical food access (accessibility) and acceptability (measured by nutrition concern), respectively. These access measures are at the household level as they explain how the household combines the available resources to produce the desired outcomes (optimal nutrient intakes) for individuals living in the household. Also included are conventional controls for individual characteristics (X_{ijk}) and household characteristics (H_{jk}), along with unobservables (u_{ijk}).

3.2.1 Hypotheses

Economic food access or affordability is jointly measured by food prices and household disposable income. Although food prices are generally found to affect energy intake, the direction of price effects is not clear since households can substitute between quality and

quantity (Ecker & Qaim 2011; Gibson & Kim 2013). Consumers can choose higher quality products within the same food group or can diversify their diet towards more expensive foods, which could be less nutritious (Gibson & Kim 2013; Skoufias et al. 2009). It was found that households in Vietnam maintained their energy intake during the 2008 food crisis by downgrading the quality of rice consumed (Gibson & Kim 2013). Moreover, You et al. (2016) suggest that increasing the prices of animal-source foods can reduce the protein consumption of urban households in China, but higher prices for cereal have little effect on carbohydrate consumption. In Malawi, household protein consumption is much more price elastic for maize than for meat, fish, and dairy products given the important role of maize in the local diet (Ecker & Qaim 2011).

Income can affect the demand for both calories and macronutrients (Salois et al. 2012). Recent studies have shown that the relationship between income and total energy or calorie consumption is not linear (Gibson & Rozelle 2002; Salois et al. 2012; Trinh et al. 2018b). At a low level of income, consumers tend to increase calorie consumption as their income grows, but the marginal growth rate tends to decline when their calorie intake reaches a saturation point (Salois et al. 2012; Skoufias et al. 2011; Zhou & Yu 2014). This is because higher-income households may consider other food attributes such as taste, quality, and food safety rather than energy intake when they purchase foods (Jensen & Miller 2010; Skoufias et al. 2011; Variyam et al. 1998). Using a cross-sectional sample of 171 countries, Salois et al. (2012) found that as income per capita increased, the share of carbohydrates decreased with a small rise in protein share but a much larger rise in fat share. Trinh et al. (2018a) also found that from 2004 – 2014, the share of fat increased significantly with increasing household food expenditure for households in Vietnam, whilst the carbohydrate share tended to decrease. Our study therefore aims to formally test the following hypotheses:

Hypothesis 1a: As household income increases, an individual's caloric intake will increase accordingly, but the marginal increase will decline when it approaches a high level of subsistence. With respect to changes in the share of macronutrients, a higher income is expected to increase the proportion of calories from fat and protein, but to decrease the share of carbohydrates.

Hypothesis 1b: An increase in the price of food that is intensive in a macronutrient will reduce the calorie share from that macronutrient, but it will have no significant effect on the total caloric intake due to a substitution effect.

There is not only a monetary cost of obtaining food, but also a time cost. As individuals spend more time working outside of the home, they are likely to have less time for shopping, preparing, and cooking foods at home. A longer distance to food markets increases the travel cost, and this may also reduce access to certain types of foods for time-poor consumers. For example, Wrigley et al. (2003) explored how increased access to supermarkets in the UK influences food consumption in a natural experimental setting by comparing fruit and vegetable intakes pre- and post- having a new supermarket in the neighbourhood. The authors found that a shorter distance to a new food outlet (less than 500 meters) was significantly associated with increased fruit and vegetable consumption. However, recent studies on "food deserts" have shown mixed findings with regard to the impacts of food deserts on dietary outcomes (Caspi et al. 2012; Walker et al. 2010; Zeng et al. 2019). This is not surprising as the food desert literature has generally failed to take into consideration other aspects of food access involving individual behaviour.

The literature from developing countries has also explored the relationships between changes in urban food environments (e.g. proliferation and penetration of supermarkets) and the household diet quality (Demmler et al. 2018; Rupa et al. 2019; Umberger et al. 2015; Wertheim-Heck & Raneri 2019). Empirical studies found that improved access to supermarkets

was associated with a significant increase in the body mass index (BMI) of consumers from urban households in Kenya (Demmler et al. 2018), and of children in high-income households in Indonesia (Umberger et al. 2015). Other studies have examined the relationship between food retail transformation and measures of diet quality in urban Vietnam, but found no significant association (Rupa et al. 2019; Wertheim-Heck & Raneri 2019). The current study aims to formally test the following hypothesis regarding geographical food access, particularly the relationship with access to supermarkets, and calorie intake and macronutrient shares:

Hypothesis 2: An increasing distance to supermarkets and to wet markets (decrease in geographical access) will increase individuals' total caloric intake as consumers have less time to prepare meals and may consume more highly processed foods and the relationship with macronutrient shares is likely to be heterogenous for different income levels.

Given the behavioural nature of food consumption, levels of nutrition concern can also have a direct impact on an individual's nutrient intakes. For example, when consumers had a positive attitude about calcium in dairy products, their demand for milk and calcium increased significantly (Jensen et al. 1992). In contrast, Frazao and Cleveland (1994) found that consumers with a better diet-related awareness were not more likely than others to meet dietary recommendations for total fat, saturated fat, and cholesterol. Our study aims to test the following hypothesis:

Hypothesis 3: Increasing concern about nutrition will have a negative relationship with total caloric intake and share of calories from fat (relative to shares of protein and carbohydrates).

3.2.2 Empirical methods

The baseline regression equation is specified as

$$Calorie_{ijk} = \alpha + \beta_1 E_{jk} + \beta_2 G_{jk} + \beta_3 S_{jk} + \gamma X_{ijk} + \delta H_{jk} + w_k + u_{ijk} \qquad (2)$$

where $Calorie_{ijk}$ is the individual caloric intake for individual (i) within household (j) living in ward (k). Economic food access (E_{jk}) includes vectors of income and food prices. Per capita

monthly household expenditure is used as a proxy for household income (in millions of Vietnamese Dong). The squared term of expenditure is also introduced to capture the nonlinear relationship between household income and individual caloric intake. The prices of two of the most commonly consumed food products (pork and rice) in Vietnam are averaged at the ward level to account for the possible heterogenous impacts of their price levels on an individual's caloric intake. Pork and rice make up more than one-half of the calories consumed by the average Vietnamese adult (Hoang 2018; Vu 2009). Geographical food access (G_{jk}) measures the distance to the nearest market (both wet market and super-market).

Principal component factor analysis is used to create an attitudinal variable to capture the nutrition concern of the household respondent (S_{jk}) (Bartholomew et al. 2008). The variable is based on the household respondent's answers to three related questions where they were asked to indicate how strongly they agreed or disagreed (1=strongly disagree and 5=strongly agree) with the following statement: "I avoid purchasing food and drinks with high amounts of sugar"; "I avoid purchasing food containing high amounts of salt"; "I avoid purchasing food containing high amounts of fat or cholesterol".

X_{ijk} and H_{jk} are vectors of individual and household characteristics, respectively, that previous studies have found to be associated with caloric and macronutrient intakes. Individual characteristics such as age and gender can explain some differences in the dietary energy intake (Nayga 1994; Variyam et al. 2002). For example, older female adults might consume less calories, as compared to younger, male adults. Household variables including family age structure and the characteristics of the female head are found to have impacts on the nutrient intakes of individuals in the household (Abdulai & Aubert 2004; Gibson & Rozelle 2002). Given the female head of household's significant role in food shopping and preparation in Vietnamese culture (Yarr 1996), it is expected that the female head's characteristics (e.g. work status, education level) may affect the individual's nutrient intake. For example, Rupa et al.

(2019) found that the female head's education was positively associated with the measures of diet quality (vitamin A, heme iron, and protein).

The term w_k represents ward dummies to capture possible unobserved characteristics at this geographical level. α is a constant and u_{ijk} is the error term.

Ordinary Least Squares (OLS) regression analysis is used to identify variables that are significant in explaining the average daily caloric intake of individual household members. Going beyond the caloric intake model, a system of equations is then estimated to explain individual macronutrient shares:

$$\begin{cases} Carb_{ijk} = \alpha_C + \beta_{1C}E_{jk} + \beta_{2C}G_{jk} + \beta_{3C}S_{jk} + \gamma_C X_{ijk} + \delta_C H_{jk} + w_k + u_{ijk} \\ Fat_{ijk} = \alpha_F + \beta_{1F}E_{jk} + \beta_{2F}G_{jk} + \beta_{3F}S_{jk} + \gamma_F X_{ijk} + \delta_F H_{jk} + w_k + u_{ijk} \\ Protein_{ijk} = \alpha_P + \beta_{1P}E_{jk} + \beta_{2P}G_{jk} + \beta_{3P}S_{jk} + \gamma_P X_{ijk} + \delta_P H_{jk} + w_k + u_{ijk} \end{cases} \quad (3)$$

where $Carb_{ijk}$, Fat_{ijk} and $Protein_{ijk}$ represent, for individual i, the average daily share of total calories from consumption of carbohydrates, fat and protein, respectively. The key variables of interest E_{jk}, G_{jk}, S_{jk} represent the three dimensions of food access as explained in Equation (2). Again, X_{ijk} measures individual-level factors and H_{jk} is a vector of household-level factors, which are similar to those mentioned in the baseline regression. We also include a constant (α) and ward dummies (w_k) in each equation. Finally, u_{ijk} represents the vector of error terms assumed to be independent and identically distributed in the model.

Multivariate regression is appropriate to estimate the system of equations above because the components of the outcome variables (proportions of total calories) are correlated with each other (Izenman 2008). Multivariate regression allows estimations of the between-equation co-variances, so one can test coefficients across equations. Results from multivariate regression analysis are identical to those produced by Seemingly Unrelated Regression (SUR) when the same list of independent variables is repeated in each equation of the system, which is the situation in this study. The Breusch-Pagan test was also used to test for heteroscedasticity in our model.

3.3 Data

Our analyses are based on data collected via a comprehensive study of 1,590 households in the two largest cities of Vietnam, Hanoi and Ho Chi Minh City during 2016 and 2017. Households were selected using a proportional sampling strategy considering ward-level populations in these two cities. The resulting income distribution of our sample is similar the large-scale Nielsen database of households (Nielsen 2013), which was the most recent third-party information available at the time of our study (Appendix Table 3.A1).

Data collection methods included: 1) a household survey, which covered information on both household and individual socio-demographic characteristics, food preferences and purchasing behaviours, food expenditures, and different dimensions of food access (including food prices, physical access to markets, and the household respondent's nutrition concerns); and 2) a 24-hour food diary, where households kept detailed records (diaries) of the food and beverages consumed by each household member over a 24-hour period. Household surveys were conducted by trained and experienced enumerators, through face-to-face interviews with the household member who was responsible for household food purchasing and preparation / cooking activities.

The 24-hour food diary was designed to collect detailed food and beverage intake data for each individual living in the household. Information was collected on both food consumed at home and food consumed away from home. The dietary intake data were collected on four different days throughout the year to account for seasonal variations in food consumption pattern. For each individual, dietary intake was averaged for the four days to reduce the measurement error from day-to-day and seasonal fluctuations in food intake.

In this study, four dependent variables are used to measure nutrition outcomes at an individual-level: total caloric intake (in kilocalories) and share of total calories from each macronutrient (carbohydrates, protein, and fat). Macronutrient shares provide an understanding

of the overall balance of the individual's diet, as consuming disproportionately lower or higher amounts of energy from a given macronutrient may be a sign of an unbalanced diet (Moltedo et al. 2014). Additionally, understanding the relative shares can also provide insight on potential changes in diet quality due each dimension of food access and other socio-economic variables (e.g. income). The World Health Organisation suggests that a balanced adult diet should have 10-15% of total energy from protein and 15-30% of energy from fats (Moltedo et al. 2014)

To calculate each of the dependent variables, quantities of each food item reported in the 24-hour food diaries were converted into gram equivalence using the FAO INFOODS databases (Charrondiere et al. 2012). The daily intake for each food item was calculated using the weighted averaging method. For example, if an individual i consumed m (grams) of rice in n days ($n \leq 4$), then his/her daily intake for rice was m/n (grams). After calculating the weight equivalents, all food items were converted into grams of macronutrients using the 2007 Vietnamese Food Composition Table (VFCT), and the updated online version of the 2017 VFCT (National Institute of Nutrition 2017). The nutrient contents of mixed dishes not included in the VFCT database were calculated by identifying the average component ingredients from Vietnamese recipes (Gibson & Ferguson 2008). The total grams of each macronutrient were added together, and the caloric value of each food item calculated using the Atwater coefficients[10] as following:

$$Calories\ (Kcal) = Protein(g) \times 4 + Fats(g) \times 9 + Carbohydrates(g) \times 4.$$

The average daily (four-day average) caloric intake is computed by summing the caloric contribution of all food items. Finally, the proportion from each macronutrient is calculated by dividing the calories for each macronutrient by the total calories consumed and multiplying by

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[10] The Atwater coefficients (kcal/g) associated with the macronutrients, 16.7 kilojoules (kJ) (4kcal)/g for carbohydrates and protein, and 37.6 kJ (9kcal)/g for fat, are used to convert the gram equivalent of each macronutrient to calories (MacLean et al. 2003).

100 to determine the share. Descriptive statistics of the relevant variables are presented in Table 3.1. On average, adults in our sample consume 2,262 calories per day and 18.5% of their calories are from protein, 23.6% are from fat, and 58.0% are from carbohydrates (Table 3.1).

Table 3.1 Descriptive statistics of variables included in the estimated models

Variable	Description	Mean	SD	Min	Max
Dependent variables					
Calories	Individual's daily average total caloric intake	2262.12	410.41	1052.67	4469.15
Protein	Individual's daily average share of total calories from protein	18.45	2.96	9.45	37.17
Fat	Individual's daily average share of total calories from fat	23.56	4.45	8.41	47.25
Carb	Individual's daily average share of total calories from carbohydrates	57.99	6.04	34.58	79.17
Explanatory variables					
Expenditure	Monthly household expenditure per capita (millions VND/month)	2.51	1.41	0.43	29.65
$Expenditure^2$	Monthly household expenditure per capita squared	8.30	27.41	0.18	878.90
PriceRice	Price of rice at ward level ('000 VND/kg)	13.83	2.15	9.20	18.69
PricePork	Price of pork at ward level ('000 VND/kg)	70.94	8.55	54.68	87.29
NutConcern	Nutrition concern score	0.01	1.00	-3.18	1.35
DistanceSM	Distance to the nearest supermarket (km)	2.29	2.29	0.01	30.00
DistanceWM	Distance to the nearest wet market (km)	1.23	1.17	0.00	14.00
Other covariates					
Male	Individual's gender (1= male)	0.45	0.50	0.00	1.00
Age	Individual's age (years)	41.19	14.09	19.00	95.00
FemaleWork	(= 1 if female head of the household works outside of the home)	0.47	0.50	0	1
EduFemale	(= 1 if female head of the household completed high-school)	0.49	0.50	0	1
Child_under5	(=1 if at least 1 child aged under 5 years is living in the household)	0.31	0.46	0	1
Child_6to18	(=1 if at least 1 child aged from 6 to 18 years is living in the household)	0.46	0.50	0	1
Number of individuals		4,103			
Number of households		1,590			

Note: Authors' calculation. SD represents standard deviation and Min and Max represent minimum and maximum values of the sample statistics

3.4 Results and Discussion

3.4.1 Full sample results

Table 3.2 shows the results of the estimations using the full sample where all models are appropriately identified. Income is nonlinearly associated with caloric intake. While individual caloric intake increases with income on average, it does so at a decreasing rate (Table 3.2). These results support Hypothesis 1a that caloric intake first increases with income growth and then becomes less sensitive when it reaches a subsistence level. In addition, as income goes up, the share of calories from protein and fat increase, whilst the share of carbohydrates decreases significantly, which suggests that consumers may substitute carbohydrates for protein and fat as reflected in the 'nutrition transition' literature (Harris et al. 2019; Harris et al. 2020; Kelly 2016; Popkin 2003; Popkin et al. 2012; Zhai et al. 2009).

An increasing food price does not necessarily reduce the overall caloric intake, in fact, a higher rice price is associated with increasing caloric intake, possibly because of an increase in the relative share of calories from fat (rice price was not significantly associated with the share of calories from protein or carbohydrates). An increase is the price of pork is associated with a significant decrease in the share of calories from protein and a significant increase in the share of calories from fat. These are concerning results as increases in the price of both staple foods seem to be associated with diets relatively less healthy, i.e. higher in fat and lower in protein and carbohydrates (Cuong et al. 2007; Nguyen & Hoang 2018). These results support the macronutrient substitution effect outlined in Hypothesis 1b however, total caloric intake may be affected depending on the calorie-macronutrient substitution effect.

Table 3.2 Regression results for estimation of caloric intake and macronutrient shares for whole sample

Variables	Calories	Macronutrient share (%)		
		Protein	**Fat**	**Carb**
Expenditure	28.921***	0.358***	0.211**	-0.569***
	(8.001)	(0.064)	(0.093)	(0.126)
Expenditure^2	-1.280***	-0.008**	-0.004	0.012**
	(0.381)	(0.003)	(0.004)	(0.006)
PriceRice	45.303***	-0.758	2.528***	-1.770
	(11.306)	(0.596)	(0.870)	(1.173)
PricePork	12.919	-0.333***	0.478**	-0.145
	(26.505)	(0.128)	(0.187)	(0.253)
DistanceSM	-3.128	-0.058*	-0.031	0.089
	(3.739)	(0.030)	(0.044)	(0.059)
DistanceWM	13.054*	-0.048	0.067	-0.019
	(7.478)	(0.060)	(0.087)	(0.118)
NutConcern	-33.601***	-0.018	-0.201**	0.219*
	(7.518)	(0.060)	(0.088)	(0.118)
Male	3.530	0.720***	0.436***	-1.156***
	(10.857)	(0.087)	(0.127)	(0.171)
Age	-3.129***	0.007**	-0.005	-0.002
	(0.401)	(0.003)	(0.005)	(0.006)
FemaleWork	23.327*	0.395***	0.237	-0.633***
	(13.269)	(0.106)	(0.155)	(0.209)
EduFemale	-10.291	-0.045	-0.317	0.362
	(17.973)	(0.144)	(0.210)	(0.283)
Child_under5	3.338	0.379***	-0.064	-0.316
	(12.886)	(0.103)	(0.150)	(0.203)
Child_6to18	-16.493	-0.029	-0.155	0.184
	(11.443)	(0.091)	(0.134)	(0.180)
Constant	452.693	51.879***	-46.655*	94.775***
	(2,235.864)	(17.132)	(25.015)	(33.730)
Ward-dummy	Yes	Yes	Yes	Yes
Observations	4,103	4,103	4,103	4,103
R-squared	0.319	0.160	0.209	0.221

Note: Standard errors in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)

Regarding geographical food access, the results provide little support for our second hypothesis, except with respect to access to nearest wet market. An increase in distance to the nearest wet market is associated with a higher daily caloric intake, however, distance to the nearest supermarket is only significantly associated with a share of calories from protein (lower). Perhaps these results are not surprising considering the mixed results found in other studies in the literature exploring the impact of food environment in similar contexts (Caspi et al. 2012; Stifel & Minten 2017; Walker et al. 2010). However, previous studies have found

heterogenous effects among various income groups, generally suggesting that lower income individuals are especially vulnerable to being far away from food outlets. To address this concern, subsample heterogeneity between income groups will be investigated in the following section.

The results of the nutrition concern variable are outlined in hypothesis 3. For individuals, both total caloric intake and the relative share of calories from fat decrease significantly if the household respondent (main food purchaser for the household) is more concerned about nutritional content. This suggests that improving nutrition knowledge can help reduce the proportion of calories from unhealthy fat intake. Hence, improving individuals' nutrition knowledge is meaningful in urban Vietnam where, like in many other developing economies, the double and triple burden of nutrition is emerging (Ha et al. 2011; Harris et al. 2020; Nguyen & Hoang 2018).

Among the covariates, the female head characteristics (e.g. working status and education level) are not significantly associated with the total caloric intake of individuals in the household, but these variables are significant in models estimated to explain the variation of certain macronutrient shares. For example, adults living in a household where the female head is employed outside of the household tend to consume a relatively higher share of protein and relatively lower share carbohydrates. Family composition does not appear to affect total caloric intake, with one exception: adults living in households with children less than five years of age consume a higher share of protein.

With respect to individual characteristics, male adults tend to consume relatively more protein and fat and less carbohydrates than female adults. Also, older individuals consume fewer total calories, but a relatively higher share of their calories are from protein compared to younger adults. Most of these results are consistent with the literature (Nayga 1994; Variyam

et al. 2002). To further test the potential heterogeneous income effects of food access on macronutrient shares, we continue with subsample analysis below.

3.4.2 Subsample analysis by income levels

Table 3.3 reports the relationship between food access dimensions and caloric and nutrient intake for Vietnamese urban adults by income tercile. The Breusch-Pagan χ^2 is sufficiently large to reject the null hypothesis of homoscedasticity of the error terms from Equation (3), thus confirming that the estimated variance of the residuals is dependent on the values of the independent variables.

Regarding economic access to food (affordability), it is found that increasing household income only has a significant and positive impact on the total caloric intake for individuals from high-income households. For individuals from low- and middle-income households, although an increase in household income is not significantly associated with a higher level of caloric intake, it is positively associated with a significantly higher share of calories from protein. This means that urban Vietnamese consumers may shift towards a diet containing more protein-rich foods as their household disposable income increases. This finding is similar to other Vietnamese studies. For example, Nguyen and Hoang (2018) found that per capita daily consumption of meat, fish, eggs, and dairy almost doubled in Vietnam from 2000-2010 as GDP increased; and (Harris et al. 2020) reported that from 2002 to 2014, poor (bottom quintile) households in Vietnam increased the share of their food expenditures on meat from 18% to 27%, while the wealthiest (top quintile) households expenditure shares on meat remained consistent at about 34%.

Increasing the price of rice is significantly associated with a lower total caloric intake for high-income consumers, but interestingly rice price has no significant association with either caloric intake or macronutrient shares for individuals from low- and middle-income households. The significant negative effect for high-income households but not low- and

middle-income households is puzzling, one possible explanation is that individuals from high-income households have economic access to more alternatives; thus, they can substitute rice for other food products more easily as compared to low-income consumers, and in the substitution process calories somehow go down as they substitute rice for relatively lower calorie food products (e.g. other starchy staples, vegetables or inexpensive protein such as eggs). Rice accounts for a significantly higher share of both household food expenditures and calories for individuals from low-income and middle-income households compared to individuals from high-income households (see Table 3.4).

Table 3.3 Regression results for estimation of caloric intake and macronutrient shares, by income sub-samples

Variables	Low-income				Middle-income				High-income			
	Calories	Protein	Fat	Carb	Calories	Protein	Fat	Carb	Calories	Protein	Fat	Carb
Expenditure	49.98	3.81**	1.68	-5.49	-1054.94	20.65**	1.32	-21.97	32.89**	0.08	0.08	-0.16
	(209.60)	(1.61)	(2.50)	(3.43)	(1,188.63)	(8.94)	(12.69)	(17.09)	(14.25)	(0.13)	(0.18)	(0.24)
Expenditure²	14.15	-1.35**	-0.77	2.13*	239.85	-4.42**	-0.25	4.67	-1.45***	0.001	-0.001	0.000
	(77.49)	(0.59)	(0.92)	(1.26)	(254.21)	(1.91)	(2.71)	(3.65)	(0.53)	(0.005)	(0.007)	(0.009)
PriceRice	-10.69	-0.13	0.18	-0.05	-22.24	-1.46*	1.83	-0.36	-81.29**	-0.87	1.87*	-0.99
	(43.24)	(0.22)	(0.35)	(0.48)	(48.30)	(0.79)	(1.12)	(1.51)	(38.73)	(0.67)	(0.97)	(1.30)
PricePork	9.78	-0.26***	0.23	0.03	23.12**	-0.39**	0.49*	-0.10	44.58*	-0.27*	0.49**	-0.21
	(12.36)	(0.09)	(0.15)	(0.20)	(11.20)	(0.18)	(0.26)	(0.35)	(23.04)	(0.14)	(0.20)	(0.27)
DistanceSM	11.72**	-0.09**	-0.22***	0.31***	-7.81	0.007	0.12*	-0.13	-18.85**	-0.22***	0.011	0.21
	(5.93)	(0.04)	(0.07)	(0.09)	(6.33)	(0.05)	(0.06)	(0.09)	(8.95)	(0.08)	(0.12)	(0.15)
DistanceWM	7.69	0.37***	0.50**	-0.87***	15.08	-0.18*	0.29**	-0.11	19.24	0.09	-0.15	0.05
	(17.17)	(0.13)	(0.20)	(0.28)	(12.94)	(0.09)	(0.14)	(0.18)	(13.23)	(0.12)	(0.17)	(0.23)
NutConcern	-26.58*	0.32***	0.17	-0.49**	-45.21***	-0.24**	-0.48***	0.72***	-24.60*	0.04	-0.16	0.12
	(14.48)	(0.11)	(0.17)	(0.24)	(15.47)	(0.116)	(0.16)	(0.22)	(13.71)	(0.12)	(0.18)	(0.24)
Male	24.51	0.67***	0.64***	-1.30***	-13.09	0.75***	0.21	-0.95***	-14.40	0.72***	0.51**	-1.23***
	(17.69)	(0.14)	(0.21)	(0.29)	(19.75)	(0.15)	(0.211)	(0.284)	(17.70)	(0.16)	(0.23)	(0.31)
Age	-4.00***	0.00	-0.00	-0.00	-3.20***	0.00	-0.01	0.01	-2.42***	0.014**	-0.004	-0.01
	(0.62)	(0.00)	(0.00)	(0.01)	(0.76)	(0.00)	(0.00)	(0.01)	(0.71)	(0.006)	(0.01)	(0.01)
FemaleWork	3.92	0.37**	0.56*	-0.92**	45.33*	0.74***	0.48*	-1.21***	-12.81	0.02	-0.02	-0.00
	(24.40)	(0.19)	(0.29)	(0.39)	(26.22)	(0.20)	(0.28)	(0.37)	(23.22)	(0.208)	(0.299)	(0.40)
EduFemale	38.94	0.68**	-0.43	-0.25	50.65	-0.41	-0.16	0.57	-72.18***	0.60**	-0.18	-0.42
	(43.70)	(0.34)	(0.52)	(0.71)	(34.58)	(0.26)	(0.37)	(0.50)	(27.54)	(0.24)	(0.35)	(0.48)
Child_under5	-3.82	0.70***	0.05	-0.75**	4.55	0.36*	-0.39	0.03	33.52	-0.18	0.27	-0.15
	(23.42)	(0.18)	(0.28)	(0.38)	(25.06)	(0.18)	(0.27)	(0.36)	(22.15)	(0.20)	(0.28)	(0.38)
Child_6to18	-39.50**	0.43***	0.23	-0.66**	11.60	-0.06	-0.20	0.27	-8.37	-0.09	0.03	0.06
	(19.89)	(0.15)	(0.23)	(0.32)	(23.40)	(0.17)	(0.25)	(0.33)	(20.02)	(0.17)	(0.25)	(0.34)
Constant	1,879.7**	36.58***	-2.16	65.58***	2,238.43	41.56*	-38.17	96.60**	67.32	51.15***	-38.65	87.50**
	(798.18)	(9.49)	(14.78)	(20.22)	(1,537.15)	(24.87)	(35.32)	(47.57)	(2,073.27)	(18.44)	(26.53)	(35.61)
Ward-dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,365	1,365	1,365	1,365
R-squared	0.444	0.253	0.281	0.280	0.325	0.238	0.286	0.279	0.373	0.231	0.278	0.293

Note: Standard errors in parentheses (*** p < 0.01, ** p < 0.05, * p < 0.1)

An increase in the price of pork is significantly associated with a decrease in the share of calories from protein for individuals in all income sub-samples. Increasing pork prices appear to have varying implications for different income sub-samples. It appears that individuals from middle- and high-income households, substitute pork protein with foods higher in fat when pork becomes more expensive, this may contribute to the significant and positive relationship observed between pork prices and total caloric intake for individuals from middle- and high-income households. However, our results further imply that an increasing pork price can have negative impacts on consumers' health, regardless of income levels as they consume a lower share of nutrient rich protein. Consuming a relatively lower share of total calories from protein and a higher share from fat may increase an individual's risk of being overweight or obese, particularly for middle- and higher-income consumers.

Table 3.4 Share of total monthly household food expenditure shares and individual calorie shares for different types of food (4,103 individuals from 1,590 urban households in Hanoi and Ho Chi Minh City, Vietnam)

Food product	Food expenditure shares			Calorie shares		
	Low income	Middle income	High income	Low income	Middle income	High income
Rice	8.66[a]	6.74[b]	5.38[c]	38.90[a]	38.00[a,b]	37.66[b]
Other staples[2]	1.27[a]	1.50[b]	1.43[b]	2.53[a]	2.42[a]	2.26[a]
Pulses, nuts, and beans	1.94[a]	1.83[a,b]	1.77[b]	1.31[a]	1.62[b]	1.50[a]
Pork	16.56[a]	13.50[b]	11.79[c]	12.18[a]	11.67[a]	11.51[a]
Beef	5.50[a]	5.05[b]	5.12[b]	4.07[a]	4.08[a]	5.01[b]
Eggs	2.05[a]	1.54[b]	1.44[b]	1.07[a]	1.01[a]	1.09[a]
Dairy products	5.23[a]	6.73[b]	7.34[c]	0.64[a]	0.71[a]	0.75[a]
Other meat	7.36[a]	8.33[b]	7.96[b]	6.89[a]	7.02[a]	6.78[a]
Fish and seafood	9.64[a]	9.43[a]	10.26[b]	7.56[a]	8.24[b]	8.28[b]
Fruit & Vegetables	7.95[a]	9.05[b]	9.00[b]	11.29[a]	11.07[a]	11.05[a]
Processed foods[3]	22.25[a]	19.28[b]	19.31[b]	8.70[a]	8.65[a]	8.77[a]
Beverages	4.05[a]	6.06[b]	7.26[c]	2.82[a]	2.83[a]	2.51[a]
Others	7.53[a]	10.95[b]	11.96[c]	2.02[a]	2.69[b]	2.83[b]

Note: Significant differences test among three income groups using Bonferroni method in STATA, the same letter means there is no significant difference; [2]Other staples include maize, other grains, and tubers; [3]Processed foods include instant noodles, bread, pasta, breakfast cereals, cakes, biscuits, chocolate bars, ready-to-eat meals, quick prepare meals, potato crisps and snack food.

Regarding geographical food access, a greater distance to a supermarket is positively associated with total caloric intake for lower income consumers, but there is a negative relationship for higher-income consumers. Although supermarket distance reduces share of calories from protein in both cases, the share of carbohydrates increases significantly to help lower income consumers recover the loss of energy from forgone protein and fat shares. For higher-income consumers, the pure loss of energy and protein's share associated with longer distance to supermarket can be explained by their more significant consumption of western foods associated with increasing supermarket expansion in urban Vietnam (Rupa et al. 2019) and their higher total caloric intake (See Appendix Table 3.A2). Thus, a longer distance to nearest supermarket could mean a net reduction in total caloric intake. This is not necessarily a negative nutrition outcome if individuals are consuming more than the recommended daily intake of calories (energy).

Distance to a wet market is only significantly associated with macronutrient shares for individuals from low- and middle-income households. Interestingly, for individuals from households in these lower two terciles of income, a more distant wet market is associated with a higher share of calories from fat. Individuals in low-income households further from wet markets also consume a higher share of their calories from protein, and a lower share from carbohydrates. Conversely, individuals from middle-income households consume proportionally less protein. This indicates that the wet market is an important source of carbohydrates for low-income individuals and protein-rich food for middle-income households. Reducing low-income and middle-income households' geographical access to these important food markets can result in negative nutrition outcomes for individuals in these households. This is supported by previous literature which has shown that in Vietnam, low-income and middle-income urban households spend a relatively higher share of their food

expenditure at wet markets, and provide an important source of nutrient rich fresh foods (particularly fresh fruits and vegetables) (Harris et al. 2020; Mergenthaler et al. 2009).

Increasing concern about the nutritional content of foods has heterogenous effects on caloric intake and macronutrient shares across income levels. Individuals from low-income households, where the main food purchaser has higher concerns about nutrition content, tend to substitute protein for carbohydrates, which has a weakly significant and negative relationship with total caloric intake. For middle-income households increasing concern about nutrition is associated with a significant reduction in total calorie intake, which is likely due to consumption of a lower proportion of calories from fat and protein, and a higher proportion from carbohydrates. While lower income households appear to be more concerned about food with high sugar or salt, middle-income households might be more worried about excessive amounts of fat and cholesterol in food. For higher-income households, nutrition concern is only marginally significant and negative in the model explaining total calorie intake, but does it is not significant in the estimations of macronutrient shares.

Apart from food access factors, certain characteristics of the female household head are also significant in explaining the share of macronutrients and these effects are different for income sub-samples. For low- and middle-income groups, household members substitute carbohydrates for increasing shares of protein and fat if the female head is employed. There is also evidence that a higher level of education of the female head is associated with an increased share of protein for household members, such effects being significant for individuals from both low- and high-income households, but not middle-income households. This is in line with literature findings suggesting the important role of female head's education in improving the nutrient intake (Abdulai & Aubert 2004; Rupa et al. 2019).

The results show that family composition only has a significant effect on shares of macronutrients for lower income consumers. The presence of children in the family is

associated with an increase in the adults' share of protein but a reduction in their share of carbohydrates. This could be because individuals from low-income households in our sample are still able to purchase or access less expensive types of animal-source foods rich in protein (e.g. eggs, fish or seafood) for their children and these may end up being shared with adult family members.

3.5 Conclusions and policy implications

This study attempts to disentangle the possible effects of various dimensions of food access on individual energy intake as well as the proportion of calories from macronutrients. We construct measures which allow us to consider three dimensions of food access: 1) affordability or economic access (income and food prices); 2) accessibility or geographical access (distance to supermarket and wet market); and 3) acceptability (nutrition concern). Our empirical work is based on intra-household data from a comprehensive study which includes 4,103 adults from 1,590 households in Hanoi and Ho Chi Minh City, Vietnam. We first use ordinary least squares to estimate a total caloric intake model. A system of equations is then estimated using multivariate regression analysis allowing possible correlations among carbohydrate, protein and fat macronutrient shares to be formally addressed. We then perform subsample analyses to test for the heterogeneous impacts of food access dimensions across different income groups.

In general, food access (particularly affordability and acceptability), is significantly associated with individual caloric intake. Food access dimensions affect macronutrient shares in different ways. On average, increasing disposable income (increased affordability or economic access) is associated with increases in individual adults' total caloric intake; this appears to be due to substitution of calories high in carbohydrates with calories relatively higher in protein and fat. We expect these macronutrient substitutions to lead to some improvements in diet quality of low- and middle-income households by increasing the share of

energy from protein, however, this effect will only be a net positive on nutrition if the protein is lean and less processed.

Food prices, especially the pork price, seem to have significant negative effects on individuals' diet. For example, a higher price leads to some reduced share of calories from protein for all individuals, regardless of their household income levels, these impacts appear to have the most significant implications for individuals from middle- and high-income households as their total caloric intake increases – likely because they consume a higher share of calories from fat. These results imply that although the positive economic growth in Vietnam over the recent times can improve diet quality for most urban consumers, increasing prices of staples such as pork may continue to negatively impact the welfare of consumers. This will be particularly true if the price of nutritious staples increases relative to less healthy highly processed food.

Geographical food access in terms of distance to market does not show any consistent significant impact in the full sample analysis. However, in the subsample analysis we find that that lower income consumers are impacted more than higher-income consumers if they have to travel longer distance to markets, especially wet markets. Regarding nutrition concern, our analysis reveals that this is negatively associated with total caloric intake and the share of fat. These impacts again are found to be heterogenous amongst different income groups, possibly reflecting differences in consumers' perceptions or concerns about different nutrients in food. Increasing concerns about nutrition may increase the share of protein at the expense of a carbohydrates for low-income consumers; but may reduce the share of fat for middle-income consumers.

Our findings suggest that policy instruments or programs, which aim to improve overall public health through increasing diet quality and nutrition, may work differently for subgroups of the Vietnamese urban population.

In particular, policy makers need to approach nutrition issues from multifaceted aspects. Policies aimed at food price stabilization to address food security by ensuring adequate calories, should also consider the overall nutrition implications. In Vietnam, income growth has shifted the diet towards more protein and fat consumption. Our findings suggest that individuals' calorie intakes and macronutrient shares, particularly those in low-income households, are less responsive to changes in the price of rice. On the contrary, large increases in the price of pork have a more negative impact on calorie and nutrition outcomes, as consumers substitute between protein and fat. Providing good market access, especially wet markets, is also necessary to maintain an adequately balanced diet in terms of macronutrients. This means that instead of reducing the presence of wet markets through food market modernization policies (Wertheim-Heck et al. 2015), policies should aim to provide good physical access to affordable, safe and healthy food for poor consumers by ensuring a mix both wet markets and supermarkets. Lastly, nutrition education programs can be used to increase consumer's awareness and knowledge of the nutritional value of foods, hence contributing to an improvement in individual diet quality for all income levels.

While this study contributes to the literature on food access and nutrition in several ways, it also has several limitations which provide opportunities for future research. First, our data does not distinguish between different types of fat or carbohydrates. For example, fat is necessary for a healthy diet and unsaturated fats found in some foods are of less concern than saturated and trans fats. While fresh fruit is relatively high in sugar (carbohydrates) it is also high in important micronutrients and dietary fibre. Thus, additional analysis of the types of foods which contribute to macronutrient shares and the nutritional content of these foods can provide deeper insight into diet quality and the potential for negative diet-related health outcomes (e.g. overweight and obesity, type II diabetes and cardiovascular disease).

Second, our study has only focused on caloric intake and macronutrient shares of adults, further research could explore the relationships between food access dimensions and these measures for children. Finally, our data only covers the two largest cities in Vietnam, Hanoi and Ho Chi Minh City, and therefore may not be fully representative of all Vietnamese adults, particularly less developed urban, peri-urban and rural areas of Vietnam, as well as other developing countries.

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Appendices

Table 3.A1 Percentage of surveyed household income, by income groups and comparison with Nielsen 2013 report

Gross family income per month[a]	Sample (%)	Nielsen 2013[b] (%)
Less than 4.99 million VND (*Less than 201.88 USD*)	7	9
Between 4.5 and 7.49 million VND (*201.89 to 336.46 USD*)	31	34
Between 7.5 and 14.99 million VND (*336.47 to 672.92 USD*)	41	38
15 million VND and above (*672.93 USD and above*)	21	19

Note: (a) Exchange rate 1 USD = 22,291 VND on 1 December 2016; (b) Nielsen 2013 data for urban areas of Hanoi and Ho Chi Minh City only

Table 3.A2 Individual's daily average caloric intake for tercile income groups

	Low income	Middle income	High income
Individual's caloric	2170.96[a]	2291.96[b]	2323.62[b]
intake	(411.77)	(418.41)	(384.55)

Note: Standard deviation in parenthesis; Significant differences test among three income groups using Bonferroni method in STATA, the same letter means there is no significant difference.

Chapter 4: Statement of Authorship

Title of Paper	Understanding Vietnamese urban consumers' nutrition label use, health concerns and consumption of food and beverages with added sugars
Publication Status	Published
Publication Details	Nguyen-Anh, D., Umberger, W.J. and Zeng, D., 2020. Understanding Vietnamese Urban Consumers' Nutrition Label Use, Health Concerns, and Consumption of Food and Beverages with Added Sugars. *Nutrients*, *12*(11), p.3335.

Principal Author

Name of Principal Author (Candidate)	Anh Duc Nguyen		
Contribution to the Paper	Contributed to primary survey, data collection, calorie conversion from 24-hour food diaries, data analysis and interpretation, wrote manuscript		
Overall percentage (%)	65		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	14/10/2020

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

vii. the candidate's stated contribution to the publication is accurate (as detailed above);

viii. permission is granted for the candidate in include the publication in the thesis; and

ix. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Professor Wendy J Umberger		
Contribution to the Paper	Project leader responsible for conception and design of the Vietnam Urban Food Consumption and Expenditure Study and the manuscript, acquisition of funding for data collection, led design the household questionnaire, guided the development of the manuscript and data analysis, and critically edited the manuscript.		
Signature		Date	14/10/2020

Name of Co-Author	Dr Di Zeng		
Contribution to the Paper	Supervised data collection in the field, guided the development of the manuscript and data analysis, and critically edited the manuscript.		
Signature		Date	14/10/2020

Chapter 4: Understanding Vietnamese urban consumers' nutrition label use, health concerns and consumption of food and beverages with added sugars

Abstract

Vietnam is experiencing a diet and nutrition transition. Increasing consumption of food and beverages with added sugars is a significant public health concern. Policies and interventions, such as mandatory nutrition labelling, are being considered to improve consumers' awareness and understanding of diet and health implications of added sugars in food and beverages. The effectiveness of various policy approaches relies on an improved understanding of the interrelationships between urban Vietnamese consumers' health concerns, nutrition label use, and intake of sugars. We empirically disentangle these relationships for urban Vietnamese households using novel intra-household data covering 4,047 adults and 737 adolescents from 1,590 households in Hanoi and Ho Chi Minh City. The data are from comprehensive household surveys and 24-hour food diaries. Simultaneous equation regression models are estimated using three-stage least squares (3SLS) to account for possible endogeneity. Nutrition label use is significantly associated with a lower share of calories from foods and beverages with added sugars. These findings suggest that nutrition labelling programs may be an effective policy mechanism to reduce the negative health implications of increasing availability and consumption of food and beverages with added sugars in urban Vietnam.

Key words: nutrition label; health concern; added sugars; consumption; urban; food diary; dietary transition; Vietnam.

4.1 Introduction

Changing food systems, diet transition resulting in increasing consumption of highly processed non-traditional foods, and more sedentary lifestyles are all contributing to the growing prevalence of non-communicable diseases (NCDs), such as cardiovascular disease, obesity, type 2 diabetes and some types of cancer, in emerging and developing economies across the Southeast Asia region (Afshin et al. 2019; Gaziano et al. 2010; Harris et al. 2020; Mozaffarian 2016; Popkin et al. 2020).

One particular concern resulting from the diet transition in many countries is increasing consumption of non-traditional foods and beverages with added sugars (Aurino et al. 2017; Drewnowski et al. 2019; Kelly 2016; Umberger et al. 2015). Added sugars are defined as all sugars and syrups (monosaccharides and disaccharides) eaten separately or used as ingredients in processed or prepared foods (Sigman-Grant & Morita 2003). Higher consumption of foods and beverages with added sugars (Sigman-Grant & Morita 2003) has been shown to be associated with excess energy intake and poorer diet quality (Bailey et al. 2018; Vartanian et al. 2007), resulting in a heightened risk of NCDs, particularly overweight and obesity, and type II diabetes (Khan & Sievenpiper 2016; Rippe & Angelopoulos 2016).

Increasing consumption of foods and beverages with added sugars is now a significant public health concern in Vietnam (Luong & Vu 2020; Nguyen & Hoang 2018). In fact, per capita availability of sugar and sweets in Vietnam increased 176% from 1961 to 2013 (Harris et al. 2020). Total sugar consumption per capita in Vietnam (estimated at 46.5g per person per day) is nearly twice the maximum level (25g per person per day) recommended by the World Health Organisation (WHO) (The Department of Preventive Medicine Vietnam 2017; World Health Organisation 2015).

The prevalence of overweight and obesity in urban Vietnam has increased rapidly among all age groups. An estimated 23% and 17% of Vietnamese adult females and males,

respectively were estimated to be overweight or obese in 2016, up from 13% and 8%, respectively in 2000 (2020 Global Nutrition Report 2020; Harris et al. 2020). The same report estimated that although only about 2% of Vietnamese children and adolescents (aged five to 19) were overweight or obese in 2000, by the year 2016, the prevalence of overweight and obesity had increased dramatically; with the prevalence for boys (15%) being much higher than for girls (9%) (2020 Global Nutrition Report 2020). This increased prevalence of overweight and obesity in Vietnamese children and adolescents is especially concerning because of the associated increased risk of other diet-related NCDs is subsequently higher in later life stages (Beal et al. 2020; Nguyen et al. 2013; Nguyen & Hoang 2018). Furthermore, the incidence of diabetes is growing at alarming rates and has almost doubled from 3.7% in 2004 to 6% in 2016 (Miyakawa et al. 2017; World Health Organisation 2016). In 2017, the annual average cost per patient for diabetes was estimated to be US$246, or an estimated 12% of the GDP per capita (Le et al. 2017).

The growing prevalence of overweight and obesity and diabetes in urban Vietnam, combined with rising per capita consumption of food and beverages with added sugars (e.g. highly processed breads, cakes, sugar-sweetened dairy and fruit drinks and carbonated beverages), suggest that government interventions may be needed to avoid longer-run negative impacts on human health and productivity as Vietnam continues to develop and urbanize.

Some policy options that have been considered include imposing an excise tax on sugar-sweetened beverages, raising consumer awareness about the harmful effects of food with high amounts of added sugars, and mandatory nutrition labels on food products (Allcott et al. 2019; Kessler 2014; Luong & Vu 2020). In Vietnam, nutrition labelling regulations state that food companies must provide information about the amount of added sugars in foods in currently not required; and generally, it is not available for consumers at the point-of-purchase (USDA FAS 2017). Understanding the potential effectiveness of these current regulations and other

policy options relies on an improved knowledge of the interrelationships between consumers' use of nutrition labels, health concerns, and consumption of added sugars.

Food labels that include nutritional information (e.g., nutrition panels) have been shown to assist consumers in making healthier food choices (Anastasiou et al. 2019; Cowburn & Stockley 2005; Ikonen et al. 2020). Several studies have found that individuals who use nutrition labels tend to have healthier diets as measured by Healthy Eating Index (HEI) scores (Kim et al. 2001; Miller et al. 2015; Pérez-Escamilla & Haldeman 2002). A number of studies in high-income countries have also suggested a significant correlation between nutrition label use and individuals' dietary intake (Anastasiou et al. 2019; Drichoutis et al. 2006). For example, label use was associated with higher fiber and iron intakes (Variyam 2008), lower energy intakes from fat, carbohydrates, and sodium (Kim et al. 2016; Kreuter et al. 1997; Neuhouser et al. 1999; Ollberding et al. 2010), and a significant reduction in the share of energy intake from added sugar (Weaver & Finke 2003).

Most previous studies have not explicitly considered the role of health concerns, a latent factor that could affect both the use of nutrition labels and dietary intake of certain nutrients such as added sugars (Barreiro-Hurlé et al. 2010; Drichoutis et al. 2006; Grimes et al. 2009; Hoefkens et al. 2011; Weaver & Finke 2003). Yet, consumers' health concerns may have an indirect relationship with dietary intake of food and nutrients through food label use (Barreiro-Hurlé et al. 2010; Grimes et al. 2009). Consumers who are more concerned about nutrition and health have been found to be more likely to use nutrition labels (Drichoutis et al. 2006). Consumers may search for nutrition information because they want to avoid potential negative effects of consuming high amounts of certain nutrients such as saturated fat, salt, and added sugars (Grimes et al. 2009; Hoefkens et al. 2011). This could also explain why consumers who looked for specific nutrient information when purchasing food tended to reduce their energy

intakes by minimizing consumption of foods high in some of these nutrients (e.g., fat and sugar) (Kim et al. 2000; Weaver & Finke 2003).

In addition to food label use and nutrition and health concerns, previous studies have found several sociodemographic factors (e.g. age, education, gender, income) to be associated with intake of food and beverages with added sugars (Fisberg et al. 2018; Weaver & Finke 2003). For example, a study of over 9000 adults from eight Latin American countries (Fisberg et al. 2018) found that females and younger individuals had a higher share of energy intake from foods with added sugars as compared to males and older age groups. Other studies in Southeast Asia showed that households with older respondents had a lower share of healthy food (Toiba et al. 2015), or a lower intake of vitamin A and protein (Rupa et al. 2019). Household income was found to have a nonlinear relationship with individuals' daily caloric intake from macronutrients (Salois et al. 2012; Trinh, TH et al. 2018)

While previous research has examined the impact of label use on individuals' dietary intake, little is currently known about how consumers' health concerns may influence their dietary intake. A few studies exploring this hypothesized relationship exist, but these studies are based on a sample of adolescents and university students in other countries, and are not likely to represent the Vietnamese population (Jezewska-Zychowicz et al. 2017; Sun 2008). Moreover, these previous studies did not account for possible linkages between consumers' health concerns and label use with respect to dietary intake of sugar.

Therefore, this study aims to understand the relationship between Vietnamese urban consumers' health concerns related to added sugar, their use of nutrition labels, and individual household members' energy intake from foods and beverages with added sugars. Our main objectives are to: (1) Understand the relationship between household-level use of nutrition labels and the share of daily calories from foods with added sugars for adults and adolescents living in the household (Barreiro-Hurlé et al. 2010; Grimes et al. 2009; Hoefkens et al. 2011;

Kim et al. 2000; Weaver & Finke 2003); (2) understand the association between household-level concerns about sugar content in food and the share of daily calories from food with added sugars (Barreiro-Hurlé et al. 2010; Grimes et al. 2009); and (3) understand the relationship between household-level concerns about added sugar in food and use of nutrition labels (Drichoutis et al. 2006).

Two main hypotheses are investigated: (1) household-level use of nutrition labels and concerns about added sugar in foods jointly affect the share of calories from foods with added sugars for adults and adolescents living in the household (Barreiro-Hurlé et al. 2010; Drichoutis et al. 2006; Grimes et al. 2009; Hoefkens et al. 2011; Kim et al. 2000; Weaver & Finke 2003); (2) households' concerns about added sugar directly affect households' use of nutritional labels (Drichoutis et al. 2006).

The contributions of this study are threefold. First, we not only consider the relationship of nutrition label use on individuals' dietary intake of sugars, but we also analyse how concerns about intake of added sugar, affect use of nutrition labels and dietary intake of added sugars. This understanding allows us to provide a broader insight on the mechanisms affecting individuals' consumption behaviour with respect to intake of sugary foods and beverages. Second, while similar studies have focused on high-income countries such as the United States or Europe, this is the first study to investigate the impact of nutrition label use on dietary intake in Vietnam, where such knowledge is urgently needed since the country is at the intermediate stage of the diet transition (Aurino et al. 2017) and is considering potential policy interventions to improve diet quality. Third, a subsample analysis is conducted for different gender and age groups to capture the possible heterogenous effects of nutrition label use and concerns related to sugar on individuals' nutrition outcomes, thereby providing information useful for developing policies to target segments of the population most at-risk of developing obesity or diabetes.

The remainder of this paper is structured as follows. Section 4.2 describes the data and explains the empirical methods of the following analysis. Section 4.3 discusses the empirical results. Section 4.4 concludes with policy implications that arise from our findings.

4.2 Material and methods

4.2.1 Survey of household and individuals

The data used in this study were derived from a comprehensive study covering 1,590 households in Hanoi and Ho Chi Minh City, Vietnam. In the study (conducted by the authors), individual food consumption information for 4,047 adults and 737 adolescents (aged between 10 to 19 years of age) was collected using 24-hour food diaries.

The household survey was implemented between December 2016 and March 2017 (with a four-week break to avoid food consumption fluctuations around Tet, the Vietnamese lunar New Year). Households were selected using a proportional random sampling strategy, where the probability of selecting each ward (the primary sampling unit within each city) is proportional to its population. The survey was conducted by trained enumerators through face-to-face interviews with the individual in the household who was responsible for household food purchasing and cooking activities (referred to hereafter as the "household respondent"). Data were collected on Android tablets with a customised data application developed by CommCare, a major mobile data collection platform that prevented missing entries of key information and included the GPS coordinates of households.

The household questionnaire was adapted from an instrument used for a similar study conducted in Indonesia (Umberger et al. 2015). The questionnaire was used to collect the following information at the household-level: food expenditures for 92 different food and beverage products; the type of food outlet where food products are typically purchased; access to various types of food outlets (physical distance and travel time to the nearest outlet); non-food expenditures; use of food ingredient and nutrition labels when shopping for food, and if

labels are used, what type of label information they consider. A set of questions was also included to understand household nutrition attitudes and concerns about the content of sugar, fat, cholesterol, and salt in food. Sociodemographic information was collected for each individual living in the household (including their role in the household).

The 24-hour food diaries were used to collect detailed food and beverage intake data for each individual living in the households for four different days throughout 2017. Data were collected on multiple days throughout the year to account for seasonal variation in individuals' food consumption behaviour. Food and nutrient intake data for a total of 786 food items was computed for each individual in the household (Umberger et al. 2020).

Quantities of each food item reported for an individual (i) were converted into gram equivalence for all food items using the FAO INFOODS databases (Charrondiere et al. 2012). The daily intake for each food item was calculated using a weighted average method. For example, if an individual i consumed m (grams) of rice in n days (n≤4), then his/her daily intake for rice was m/n (grams). After calculating the weight equivalents, single food items were converted into macronutrients (in grams) using the 2007 Vietnamese Food Composition Table (VFCT), and the updated online version of the 2017 VFCT (National Institute of Nutrition 2017). The nutrient contents of mixed dishes that were not included in the VFCT database were calculated by identifying the average component ingredients from Vietnamese recipes (Gibson & Ferguson 2008). The total grams of each macronutrient were summed, and the Atwater coefficients (kcal/g) were used to convert the gram equivalent of each macronutrient to calories (i.e., 4kcal/g for carbohydrates and protein, and 9kcal/g for fat) (MacLean et al. 2003). The mean daily caloric intake was computed by summing the calorie contributions of all food items. We exclude food diary data for children less than 10 years of age because school-age children in urban Vietnam usually eat lunch at school during the week (Huynh et al. 2008).

4.2.2 Measuring added sugar intake

The dependent variable in the estimated model, $SugarCalorie_{ihc}$ represents, for individual i, living in household h, located in city c, the share of daily caloric intake from food and beverages with added sugars. Based on similar studies in Asia (Amarra et al. 2016; Ha et al. 2016), and after consulting with nutrition scientists at the National Institute of Health in Vietnam, a list of food and beverages with added sugars was created. The full list is provided in Appendix Table 4.A1.

$SugarCalorie_{ihc}$ was constructed by dividing individual i's mean daily caloric intake from food and beverage products with added sugars by their mean total daily caloric intake (Table 4.1). This measure has been used by a number of studies conducted across the US, Europe, and Malaysia (Amarra et al. 2016; Azaïs-Braesco et al. 2017; Bailey et al. 2018). It allows us to compare individuals with different caloric needs and to understand which individuals consume a relatively larger proportion of their daily caloric intake from food and beverages with added sugars (Weaver & Finke 2003).

4.2.3 Variables explaining sugary food and beverage consumption

4.2.3.1 Main explanatory variables

Two key explanatory variables are considered in the analyses: 1) $LabelSugar_{hc}$ and 2) $AvoidSugar_{hc}$. Both of these variables were captured at the household level (h). Information was provided by the household respondent who was the person primarily responsible for making household food purchase decisions. In most cases, the respondent was also responsible for preparing meals for the household.

In the survey, household respondents were first asked to indicate how often (1=always, 2=often, 3=sometimes and 4=never) they used food ingredient and nutrition labels when shopping for food. If a respondent indicated that they used food labels at least 'sometimes' then they were asked a follow-up question: "What type of nutritional information do you use

or look for?" They were provided with a list of nine possible options which included sugar, calories, salt/sodium, fat and an 'other' option. $LabelSugar_{hc}$ is a binary variable equal to 1 if the respondent for household h indicated they searched for information on sugar content when shopping for food (Table 4.1).

The variable $AvoidSugar_{hc}$ is a proxy for concerns about added sugar in food and beverages. The variable is based the household respondents' answers to a question where they were asked to indicate how strongly they agreed or disagree (1=strongly disagree and 5=strongly agree) with the following statement: "I avoid purchasing food and drinks with a high amount of sugar". As we wanted to identify those household respondents that consciously avoided purchasing food and drinks with high amounts of sugar, we dichotomized the original five-point scale so that $AvoidSugar$ equals 1 if the household respondent indicated they "somewhat agree/ strongly agree" and equals 0 if they indicated they were "unsure/ somewhat disagree/ strongly disagree" (Table 4.1). Only a few (n = 21) respondents indicated that they were "unsure" when answering this question. Alternative grouping of the 21 "unsure" respondents into the opposite category yielded almost identical regression results (given their limited number).

4.2.3.2. Other individual and household covariates

Characteristics of both the household respondent and the individual (i) may influence our main outcome variable, $SugarCalorie_{ihc}$. Following the literature (Fisberg et al. 2018; Rupa et al. 2019; Toiba et al. 2015; Weaver & Finke 2003), two categorical variables are incorporated to indicate individual's age (Age) and the household respondent's age ($RespAge$) (Kim et al. 2016; Lin & Yen 2008). Additionally, the binary variable Female (equal to 1 if the individual was female) is included to indicate gender (Huynh et al. 2008). We also include the respondent's education level ($RespEduc$) measured in the number of years of school completed (Table 4.1).

Other household characteristics have been shown to have significant impacts on individuals' dietary intake (Kim et al. 2000; Salois et al. 2012; Trinh et al. 2018; Umberger et al. 2015; Umberger et al. 2020) (Table 4.1). Thus, we include both $Income$ and $Income^2$ to capture the possible non-linear relationship between household income and the share of total calories from added sugars (Azaïs-Braesco et al. 2017; Lin & Yen 2008). Three dummy variables were used to capture the effect of having at least one child in the family aged from under five years ($Child\_under5$), five to nine years ($Child\_5to9$), and 10 to 19 years ($Child\_10to19$) (Umberger et al. 2015). A dummy variable ($Smoker$) representing the presence of any cigarette smoker in the family was also included in the model to capture possible effect of an unhealthy lifestyle on the diet quality as suggested from the literature (Kim et al. 2000; Schroeter et al. 2012). Finally, a city dummy variable ($Hanoi$) was included to control for unobservable city-level effects (e.g. social norms, cultural traditions, dietary patterns and levels of economic development) that may differ between cities and affect the outcome variable (Umberger et al. 2015).

4.2.4 Statistical analysis

We hypothesize that the intake of food and beverage products with added sugars is associated with both respondents' use of nutrition labels ($LabelSugar$) and their attempts to avoid added sugars in food and beverages ($AvoidSugar$). We also hypothesize that the variables $AvoidSugar$ and $LabelSugar$ are interrelated. To examine the potential interrelationship among these variables, we estimate a simultaneous equation model specified as follows:

$$\begin{cases} AvoidSugar_{hc} = \alpha_0 + \alpha_1 LabelSugar_{hc} + \alpha_2 X_{ihc} + \alpha_3 Z_{1hc} + e_{1ihc} \\ LabelSugar_{hc} = \beta_0 + \beta_1 AvoidSugar_{hc} + \beta_2 X_{ihc} + \beta_3 Z_{2hc} + e_{2ihc} \\ SugarCalorie_{ihc} = \gamma_0 + \gamma_1 LabelSugar_{hc} + \gamma_2 AvoidSugar_{hc} + \gamma_3 X_{ihc} + e_{3ihc} \end{cases} \quad (1)$$

In the above system of equations ((Equation (1)), $AvoidSugar_{hc}$ indicates that the respondent for household h agreed or strongly agreed with the statement that they avoid purchasing food

and drinks with a high amount of sugar. $LabelSugar_{hc}$ indicates that the respondent uses nutrition labels (when available) to obtain information about sugar content in food products. $SugarCalorie_{ihc}$ measures individual i's share of daily caloric intake from food and beverages with added sugars. X_{ihc} is a vector of the individual and household characteristics explained earlier. Z_{1hc} and Z_{2hc} are two vectors of instrumental variables, and e_{1ihc} to e_{3ihc} are random error terms which are assumed to be independent and identically distributed in the model.

Equation (1) represents a non-recursive system of equations where the reciprocal effect exists in the first two lines of the system equations, for $AvoidSugar_{hc}$ and $LabelSugar_{hc}$, thus, they cannot be estimated with stepwise ordinary least squares. Previous studies have suggested that label use and health concern are likely to be determined by some of the factors that also affect the intake of sugars (Kim et al. 2000; Lin & Yen 2008). Therefore, in our system of equations, the variables $AvoidSugar_{hc}$ and $LabelSugar_{hc}$ are used on both the left and right sides of the equations; and the error term, e_{3ihc}, is potentially correlated with these variables. In this case, three-stage least squares method (3SLS) is an appropriate estimation method to use since it obtains instrumental variable estimates considering the covariances across equation disturbances (Zellner & Theil 1992). This method can produce consistent estimates and generalized least squares is used to account for the correlation structure in the disturbances across the equations.

We use $InfoSourceDoctor_{hc}$ and $HealthProblem_{hc}$ as instruments (Z_{1hc}) for the endogenous variable $AvoidSugar_{hc}$. The binary variable $InfoSourceDoctor_{hc}$, indicates whether or not the household respondent received nutrition information or advice from medical professionals (i.e. doctor, nurse, and nutritionist). The second instrument, $HealthProblem_{hc}$ reflects whether any household member had been previously diagnosed as having a chronic health problem related to high sugar consumption (e.g. overweight or obesity, diabetes, high blood pressure, or heart disease). We expect these instruments to have a high correlation with

$AvoidSugar_{hc}$. Medical doctors are seen as the most important source of nutrition information and may be able to encourage individuals to follow certain dietary recommendations (Van Dillen et al. 2003). Their health advice may increase the respondent's concern about high sugar consumption, but the respondent's concern may not be directly linked with an individual's intake of added sugars ($SugarCalorie_{ihc}$). Similarly, having a household member with chronic health problems related to sugar consumption may be associated with the individual's intake of added sugar through increasing household respondent's concerns about sugar.

$DistanceWetMarket_{hc}$ is used as an instrument (Z_{2hc}) for the endogenous variable, $LabelSugar_{hc}$. This instrument measures the distance from the individual's home to the nearest wet market (traditional formal Vietnamese food market) (Wertheim-Heck et al. 2015). We expect that the instrument is negatively associated with label use as a shorter distance to a wet market may encourage consumers to buy more fresh foods which are more available at wet markets. Further, point-of-purchase nutrition information is not usually accessible at wet markets (Wertheim-Heck et al. 2015). The instrument is not expected to be directly linked with the main outcome variable as it is unlikely to directly influence an individual's consumption of foods with added sugar. To ensure that all instruments are not correlated with the share of calories from added sugars ($SugarCalorie_{ihc}$), we conducted a Pearson correlation coefficient test. We found very low correlations between the dependent variable, $SugarCalorie_{ihc}$ and the instrumental variables ($DistanceWetMarket_{hc}$= 0.014; $InfoSourceDoctor_{hc}$ = 0.019; and $HealthProblem_{hc}$ = -0.029).

The summary statistics for all variables used in the model are provided in Table 4.1. It is worth noting that all three variables of primary interest exhibit relatively large variations from the mean. For example, the standard deviation of $LabelSugar_{hc}$ (0.48) is larger than its mean (0.38), suggesting the existence of large variance across households, which is beneficial to our analyses.

Table 4.1 Descriptive statistics of variables included in the estimations

Variables	Definition	Mean	SD	Min	Max
	Dependent variables				
SugarCalorie	Individual's share of daily calorie intake from food and drinks with added sugar	6.88	6.86	0	44.76
	Key explanatory variables				
LabelSugar	1 = Respondent uses nutrition labels to obtain information about sugar content in food products; 0 = otherwise	0.38	0.48	0	1.00
AvoidSugar	1= Respondent avoids purchasing food and drinks with a high amount of sugar; 0 = Otherwise	0.73	0.44	0	1
	Control variables				
Age					
10-19 years	1= Individual's age is between 10 and 19 years	0.15	0.36	0	1
20-29 years	1= Individual's age is between 20 and 29 years	0.19	0.39	0	1
30-39 years	1= Individual's age is between 30 and 39 years	0.23	0.42	0	1
40-49 years	1= Individual's age is between 40 and 49 years	0.20	0.40	0	1
50-59 years	1= Individual's age is between 50 and 59 years	0.14	0.35	0	1
60+ years	1= Individual's age is 60+ years	0.09	0.29	0	1
Female	Gender of the individual (1=Female; 0=Male)	0.54	0.50	0	1
RespAge					
20-29 years	1= Respondent's age is between 20 and 29 years	0.14	0.35	0	1
30-39 years	1= Respondent's age is between 30 and 39 years	0.28	0.45	0	1
40-49 years	1= Respondent's age is between 40 and 49 years	0.32	0.47	0	1
50-59 years	1= Respondent's age is between 50 and 59 years	0.20	0.40	0	1
60+ years	1= Respondent's age is 60+ years	0.06	0.24	0	1
RespEduc	Highest years of education completed by household respondent (years)	10.86	3.16	1	19
Income	Monthly household expenditure per capita (million VND per month)	2.51	1.36	0.43	29.65
Income²	Monthly household expenditure per capita (million VND per month), squared	8.16	25.53	0.18	878.9
Child_under5	Presence of at least 1 child aged below 5 years in the family (1=Yes)	0.30	0.46	0	1
Child_5to9	Presence of at least 1 child aged 5 to 9 years in the family (1=Yes)	0.26	0.44	0	1
Child_10to19	Presence of at least 1 child aged 10 to 19 years in the family (1=Yes)	0.46	0.50	0	1
Smoker	If any household member regularly smoked cigarettes (1= Yes)	0.54	0.50	0	1
Hanoi	Hanoi city dummy (1= Yes)	0.41	0.49	0	1
	Instrumental variables				
DistanceWetMarket	Distance to the nearest wet market (km)	1.18	1.08	0.01	14
InfoSourceDoctor	1= If the source of nutrition information was from medical professionals; 0= No	0.68	0.47	0	1
HealthProblem	1= If any household member has any diet-related health problems; 0= No	0.14	0.35	0	1

VND/month represents Vietnamese dong per month. 1 USD = 22318 VND on 30 December 2016. *Source:* Authors' estimation from Vietnam Urban Food Consumption and Expenditure Study. Sd = standard deviation.

4.3 Results and Discussion

4.3.1 Full sample analysis

Table 4.2 reports the 3SLS estimation results. Before interpreting individual coefficients, a non-recursive structural equation model (SEM) was first employed to test the covariance between the dependent variable and the two potentially endogenous variables. This method is similar to the Hausman endogeneity test (Antonakis et al. 2010). The chi-squared test statistic of 40.99 (significant at the 1% level) provides evidence to suggest that the variables are indeed endogenous. As shown in Table 4.2, the coefficients on the instrumental variables: $DistanceWetMarket$ (-0.021), $InfoSourceDoctor$ (0.07), and $HealthProblem$ (0.154) are statistically significant at the 5% level. Thus, they appear to satisfy the relevance condition. The first-stage F-statistics (36.44 and 37.21) are both significant at the 1% level and have values greater than 10, suggesting that the instruments are likely to be valid (Staiger & Stock 1997). These results give credence to the overall set of instruments used in the 3SLS estimation.

Table 4.2 3SLS estimates for full sample. (n = 4,784)

Variables	SugarCalorie	LabelSugar	AvoidSugar
AvoidSugar	0.565	0.169	
	(1.812)	(0.130)	
LabelSugar	-5.406***		-0.919**
	(1.880)		(0.416)
AgeGroup (Ref: 10-19 years)			
20-29 years	-2.448***	-0.007	-0.048
	(0.397)	(0.028)	(0.035)
30-39 years	-3.830***	-0.007	-0.044
	(0.383)	(0.027)	(0.034)
40-49 years	-4.719***	0.003	0.008
	(0.343)	(0.024)	(0.031)
50-59 years	-4.545***	-0.000	-0.018
	(0.410)	(0.029)	(0.037)
$\geq$ 60 years	-4.600***	-0.062**	-0.087*
	(0.461)	(0.031)	(0.053)
Female	3.047***	0.009	0.006
	(0.193)	(0.014)	(0.018)
RespAge (Ref: 21-29 years)			
30-39 years	0.263	-0.008	-0.012
	(0.374)	(0.026)	(0.034)
40-49 years	0.880**	0.012	-0.042
	(0.388)	(0.027)	(0.034)
50-59 years	0.753*	0.001	-0.048
	(0.400)	(0.028)	(0.037)
$\geq$ 60 years	-0.572	0.000	-0.154***
	(0.575)	(0.041)	(0.050)
RespEduc	0.171***	0.021***	0.024**
	(0.056)	(0.003)	(0.010)
Expenditure	-0.126	-0.025**	-0.085***
	(0.165)	(0.011)	(0.019)
Expenditure^2	-0.003	0.000	0.003***
	(0.007)	(0.001)	(0.001)
Child_under5	-0.526**	-0.016	-0.057**
	(0.253)	(0.018)	(0.024)
Child_5to9	0.352	0.021	0.022
	(0.242)	(0.017)	(0.023)
Child_10to19	0.255	0.034*	0.006
	(0.257)	(0.018)	(0.026)
Smoker	0.781***	0.035**	0.015
	(0.207)	(0.014)	(0.021)
Hanoi	0.831**	0.175***	0.130*
	(0.406)	(0.016)	(0.075)
DistanceWetMarket		-0.021***	
		(0.006)	
InfoSourceDoctor			0.070**
			(0.030)
HealthProblem			0.154***
			(0.052)
Constant	7.390***	0.003	0.948***
	(1.750)	(0.124)	(0.091)

Note: Standard errors in parentheses (*** p < 0.01, ** p < 0.05, * p < 0.1). *n*, number of observations

The coefficients from the estimation of Equations 1-3 for the full sample of adults and adolescents are shown in Table 4.2. The empirical results show that nutrition label use ($LabelSugar$) is negatively associated with individuals' share of calories from food and beverages with added sugars ($SugarCalorie$). This suggests that if the household respondent (the person in the household responsible for food purchases and preparation) generally uses food labels to access sugar content information, then individual members of the household are more likely to have a lower share of their calories from added sugars. This result is in line with other literature which suggests that nutrition label use can have significant and positive impacts on the diet quality of the household members (Kim et al. 2000; Variyam 2008; Weaver & Finke 2003). The coefficient on $AvoidSugar$, suggests that respondent's attempts to avoid sugar, are not statistically significant in explaining higher consumption of added sugar ($SugarCalorie$). One possible explanation is that although many respondents (73%) indicated that they tried to avoid food and beverages with added sugar, they might be not be aware of the main sources of added sugar, and would have no way of knowing the sugar content if relevant nutrition information is not accessible (Grimes et al. 2009).

Nutrition label use is negatively associated with the variable which indicates household respondents try to avoid sugar, yet the converse relationship does not hold (Column 2-3, Table 4.2). These results seem to suggest that respondents who indicate that they try to avoid sugar are not using nutrition labels, however, this could be because of limited access to nutrition labels, i.e. a large share of the food and beverage products available at markets, particularly traditional markets, do not have nutrition labelling. Thus, policies which encourage more food retailers and food processors to provide nutrition labels on products and/or point of purchase nutrition information may help consumers who are trying to avoid food and beverages with added sugars, ultimately to reduce the consumption of added sugars.

Simple statistical analysis of our data shows that on average, compared to other groups, younger individuals and females tend to have a higher share of their caloric intake from food and beverages with added sugars (Table 4.3). Thus, it is not surprising that the coefficients on the $AgeGroup$ variables in Table 4.2 are negative and significant, indicating that adults, as compared to adolescents, consume relatively less food and beverages with added sugars. This is consistent with other literature which highlights the risk of high intake of added sugars among adolescents (Aurino et al. 2017; Bailey et al. 2018; Fisberg et al. 2018). The coefficient on $Female$ is significant and positive, thus indicating that, on average, Vietnamese females tend to consume a higher share of calories from added sugars as compared to men, which also echoes the results of other studies (Fisberg et al. 2018; Weaver & Finke 2003). These results suggest that there are potential heterogenous effects which differ by gender and across adults and adolescents, this potential heterogeneity is further explored through the subsample analyses discussed in Section 4.3.2.

Table 4.3 Share of caloric intake from food and beverages with added sugars, by gender and age groups

Age groups	Male		Female	
	N	Mean (Sd.)	N	Mean (Sd.)
10 – 19 years	377	9.91 (7.45)	360	10.56 (7.36)
20 – 29 years	383	5.70 (5.89)	508	9.21 (7.52)
30 – 39 years	508	3.96 (5.11)	592	8.07 (6.94)
40 – 49 years	455	3.86 (4.99)	481	7.30 (6.42)
50 – 59 years	317	4.05 (5.36)	372	7.23 (7.19)
≥ 60 years	174	4.85 (6.38)	257	6.39 (6.35)

N, number of observations and Sd., standard deviation

In the analyses of the full sample, we also find significant relationships between the household respondent's age ($RespAge$) and education ($RespEduc$) and the individual's share

of calories from added sugars. Results indicate that individuals tend to have a relatively higher share of calories from added sugars if the age of household respondent is between 40 and 50 years as compared to the reference group of under 30 years. Moreover, the household respondent's education is positively associated with the share of food energy from added sugar consumed by individuals in the household. Yet, respondent's education level is positively associated with their use of nutrition labels and avoidance of food and beverages with added sugars. A possible explanation is households with more educated respondents (usually the female household head) may have a stronger preference for western food, and this may be indicative of the lifestyle changes that happen with economic development and increasing availability of ultra-processed foods due to westernisation of food markets. For example, there is evidence that education might increase demand for western food products purchased from modern markets (Mergenthaler et al. 2009), and frequent shopping at these markets is associated with higher consumption of ultra-processed foods for Vietnamese urban consumers (Wertheim-Heck et al. 2019).

Other household characteristics significantly associated with the share of food energy from added sugars include having children in the household that are less than five years of age, the presence of a cigarette smoker in the household, and city of residence ($Hanoi$). Individuals from households with children less than five years of age are more likely to consume a relatively lower share of their calories from added sugars. This supports findings from other studies in developing countries which show that household members' diet quality tends improve when there are young children present (Rupa et al. 2019; Toiba et al. 2015). In contrast, individuals who live with any cigarette smoker in the household tend to have a higher share of calories from added sugars. Past studies have also found that households with smokers were more likely to have poorer diet quality, as smoking created an altered pattern of demand for some specific foods including high sugary food and beverages (Dallongeville et al. 1998;

Margetts & Jackson 1993). Lastly, individuals living in Hanoi are more likely to obtain a higher share of their calories from foods and beverages with added sugars as compared to those residing in Ho Chi Minh City. This could be due to some significant differences in eating habits, lifestyle, culture and food availability found between the two cities (Van Dinh et al. 2013).

4.3.2 Sub sample analysis

To explore the possible heterogeneous relationships between nutrition label use, concerns about sugar and the share of calories from added sugars, subsample analyses were conducted to compare males versus females for both adults and adolescents. The results are reported in Table 4.4 (for adults) and Table 4.5 (for adolescents). Overall, the empirical results show significant differences across gender for both the adult and adolescent analyses.

4.3.2.1 Adults

As shown in Table 4.4, nutrition label use is shown to be negatively and significantly associated with the share of calories from added sugars for adult males only. Similar to the full sample analyses, the *AvoidSugar* variable is not statistically significant in explaining calorie share from added sugars for either male or female adults. Relative to younger adults (reference age group 19-29 years), older adults (both males and females) are more likely to consume less calories from foods with added sugars. This is possibly because they become more concerned about the healthfulness of their diet as they get older, as shown in other studies (Schroeter et al. 2012; Toiba et al. 2015), and it may also suggest changing preferences for sugary foods (i.e. diet and nutrition transition) over time.

Similar to the full sample analysis reported in Table 4.2, the respondent's education is positively associated with share of calories from foods with added sugars, however, the variable is only significant for male adults. These results suggest that adult males' food intake is likely to be influenced by the decisions of the main food shopper/food preparer for the household (the respondent), which in most cases was also the female head of the household.

Table 4.4 3SLS estimates for adults

Variables	Male adults (≥ 20 years) (n = 1,837)			Female adults (≥ 20 years) (n = 2,210)		
	SugarCalorie	LabelSugar	AvoidSugar	SugarCalorie	LabelSugar	AvoidSugar
AvoidSugar	-0.984	0.452*		1.671	0.160	
	(2.887)	(0.258)		(2.563)	(0.172)	
LabelSugar	-5.630**		-0.706	-2.207		-0.805
	(2.437)		(0.495)	(3.073)		(0.567)
AgeGroup (Ref: 20-29 years)						
30-39 years	-1.501***	-0.005	-0.031	-0.881	-0.004	0.025
	(0.439)	(0.038)	(0.045)	(0.650)	(0.043)	(0.053)
40-49 years	-1.901***	0.011	0.054	-2.700***	0.001	0.033
	(0.452)	(0.039)	(0.045)	(0.595)	(0.040)	(0.048)
50-59 years	-1.966***	-0.004	0.012	-2.394***	0.013	0.043
	(0.440)	(0.038)	(0.044)	(0.582)	(0.039)	(0.047)
More than 60 years	-0.665	-0.037	-0.029	-2.856***	-0.087**	-0.045
	(0.545)	(0.047)	(0.061)	(0.679)	(0.042)	(0.078)
RespAge (Ref: 21 – 29 years)						
30-39 years	-0.044	-0.012	-0.015	-0.079	-0.003	-0.020
	(0.466)	(0.040)	(0.047)	(0.692)	(0.046)	(0.056)
40-49 years	0.766	-0.001	-0.074	1.174*	0.010	-0.027
	(0.526)	(0.046)	(0.052)	(0.649)	(0.043)	(0.053)
50-59 years	0.689	-0.016	-0.094	0.983	0.010	-0.025
	(0.535)	(0.046)	(0.058)	(0.638)	(0.043)	(0.052)
≥ 60 years	-0.966	-0.002	-0.142*	-0.517	0.042	-0.153**
	(0.721)	(0.063)	(0.075)	(0.938)	(0.062)	(0.067)
RespEduc	0.175**	0.017***	0.018	0.092	0.021***	0.023*
	(0.070)	(0.005)	(0.011)	(0.090)	(0.004)	(0.014)
Expenditure	-0.328	-0.013	-0.076***	0.160	-0.027*	-0.092***
	(0.224)	(0.019)	(0.026)	(0.260)	(0.016)	(0.028)
Expenditure^2	0.008	-0.000	0.003***	-0.013	0.001	0.003***
	(0.011)	(0.001)	(0.001)	(0.011)	(0.001)	(0.001)
Child_under5	-0.328	-0.023	-0.069*	-0.607	-0.010	-0.043
	(0.357)	(0.030)	(0.040)	(0.378)	(0.025)	(0.031)
Child_5to9	0.361	0.034	0.041	0.472	0.023	0.027
	(0.344)	(0.029)	(0.039)	(0.379)	(0.025)	(0.033)
Child_10to19	0.431	0.028	0.000	-0.044	0.047*	0.008
	(0.332)	(0.028)	(0.035)	(0.385)	(0.024)	(0.039)
Smoker	0.827***	0.026	0.006	0.781**	0.034*	0.010
	(0.277)	(0.023)	(0.029)	(0.322)	(0.020)	(0.029)
Hanoi	1.341**	0.195***	0.105	-0.065	0.158***	0.080
	(0.575)	(0.026)	(0.099)	(0.614)	(0.024)	(0.093)
Constant	5.848**	-0.179	0.943***	6.930***	0.015	0.878***
	(2.539)	(0.227)	(0.134)	(2.331)	(0.156)	(0.113)

*Note*s: Standard errors in parentheses (*** p < 0.01, ** p < 0.05, * p < 0.1). *n*, number of observations.

4.3.2.2 Adolescents

Table 4.5 reports the empirical results for adolescents. Interestingly, the two variables indicating that the main food shopper/ food preparer for the household (the respondent) uses nutrition labels (*LabelSugar*) and avoids purchasing food and beverages high in sugar (*AvoidSugar*), both have negative, significant, and relatively large coefficients in the estimation of female adolescents' share of calories from added sugars (*SugarCalorie*). The variable *LabelSugar* is also significant and large in the model for *SugarCalorie*. Other household characteristics show limited effects on the share of food energy from added sugars. Again, the education of respondent and the city dummy variable (*Hanoi*) are shown to be positively correlated with the calorie share, but only for female adolescents.

Given that the highest share of calories from added sugars is observed among female (10.6% of calories) and male (9.9% of calories) adolescents (Table 4.3), these results are useful to inform policymakers about the importance of providing access to nutrition information at the point of purchase and raising consumer awareness of the impacts of high consumption of added sugars. Use of nutrition labelling by the main food shopper for the household appears to significantly reduce intake of added sugars for adolescents.

Table 4.5 3SLS estimates for adolescents

Variables	Male adolescents (10 – 19 years) (n = 377)			Female adolescents (10 – 19 years) (n = 360)		
	SugarCalorie	*LabelSugar*	*AvoidSugar*	*SugarCalorie*	*LabelSugar*	*AvoidSugar*
AvoidSugar	27.474	0.594		-18.951**	-0.451	
	(17.167)	(0.752)		(7.639)	(0.304)	
LabelSugar	-20.698*		0.516	-28.394***		-0.928
	(10.834)		(1.163)	(8.095)		(0.698)
RespAge (Ref: 21 – 29 years)						
30-39 years	1.822	0.005	-0.025	-1.741	-0.042	-0.065
	(3.061)	(0.143)	(0.161)	(3.312)	(0.149)	(0.152)
40-49 years	4.910	0.086	-0.117	-1.253	0.025	-0.005
	(3.446)	(0.154)	(0.159)	(3.200)	(0.145)	(0.150)
50-59 years	4.809	0.125	-0.163	-3.192	-0.022	-0.035
	(4.151)	(0.182)	(0.184)	(3.668)	(0.166)	(0.171)
≥ 60 years	5.890	-0.076	-0.166	-2.119	-0.067	-0.074
	(5.863)	(0.282)	(0.390)	(4.753)	(0.214)	(0.239)
RespEduc	0.588*	0.022*	-0.011	0.691**	0.026**	0.020
	(0.345)	(0.012)	(0.031)	(0.347)	(0.013)	(0.023)
Expenditure	2.665	0.008	-0.040	-0.340	-0.049	-0.127
	(1.680)	(0.081)	(0.078)	(2.682)	(0.120)	(0.114)
Expenditure^2	-0.192	0.002	0.001	-0.298	0.001	0.014
	(0.191)	(0.009)	(0.010)	(0.435)	(0.020)	(0.020)
Child_under5	0.796	0.010	-0.031	-2.206	-0.019	-0.052
	(1.764)	(0.083)	(0.089)	(1.684)	(0.076)	(0.075)
Child_5to9	2.360	-0.023	-0.030	-2.574*	-0.019	-0.035
	(1.751)	(0.084)	(0.102)	(1.432)	(0.064)	(0.065)
Smoker	4.598*	0.169**	-0.142	1.046	0.006	0.010
	(2.507)	(0.075)	(0.152)	(1.199)	(0.054)	(0.055)
Hanoi	3.305	0.181***	-0.110	7.509***	0.243***	0.263
	(2.389)	(0.067)	(0.188)	(2.537)	(0.071)	(0.176)
Constant	-21.250	-0.530	0.949***	30.405***	0.494	0.968***
	(17.033)	(0.756)	(0.267)	(9.377)	(0.386)	(0.251)

Notes: Standard errors in parentheses (*** p < 0.01, ** p < 0.05, * p < 0.1). *n,* number of observations.

4.4 Conclusion

This study explores the interrelationship between nutrition label use, health concerns related to sugar consumption, and the share of caloric intake from food and beverages with added sugars among adults and adolescents in urban Vietnam. The empirical work is based on intra-household data from a comprehensive survey covering 4,047 adults and 737 adolescents. We perform subsample analyses to test for the heterogenous associations of the explanatory variables on the share of calories from added sugars for adults and adolescents. The analysis for adolescents is especially interesting, given that adolescents may be at higher risk of overconsumption of added sugars than adults.

The empirical results consistently show that the use of sugar labels by the household's main food shopper (respondent) is associated with a lower share of caloric intake from added sugars. The magnitude of this association is relatively larger for adolescents as compared to adults. We also find that the level of education attained by household's main food shopper is positively associated with calorie share from added sugars for individuals living in the households.

Another important finding of this study is that main food shoppers' reported attempts to avoid purchasing food and beverages with high amounts of added sugars are not significantly associated with the share of caloric intake from added sugars for adults. However, we find some evidence that attempts to avoid sugar by the household's main food shopper can reduce female adolescents sugar consumption. This result is quite meaningful given that female adolescents are at greater risk of consuming a higher share of calories from added sugars, as compared to adults and male adolescents.

Considering these results, the Vietnamese government may want to be proactive and develop initiatives to tackle the impacts of increasing consumption of sugary foods and beverages. The government may want to prioritise increasing consumers' awareness about the negative health consequences of consuming high amounts of added sugars and increase consumers access to information on nutrition profiles of food through food labelling or other point-of-purchase mechanisms. Early initiatives could include public health programs targeting female adolescents and the household food shoppers and food preparers (usually the mother). These programs could focus on increasing their nutrition and health knowledge and improving awareness about the potential negative impacts of consuming food and beverages with added sugars and increasing the use of nutrition labels on food and beverage products. Moreover, to achieve a large-scale reduction in added sugar consumption, food labels should include

detailed, highly visible and easily understood information about added sugar (Weaver & Finke 2003).

Our research contributes to the growing body of literature which explores the impact of nutrition label use on the dietary intake and quality. There are several limitations which future research might address. The cross-sectional nature of our data allows us to only examine associations between covariates and outcome variables, therefore we cannot make strong causal inferences. Additionally, our data covers only the two largest cities in Vietnam, Hanoi and Ho Chi Minh City, and therefore may not be fully representative of all Vietnamese urban households. Additional research on this topic should consider focusing on less developed urban, peri-urban and rural areas of Vietnam, as well as in other developing countries.

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Appendix

Table 4.A1 List of food and beverages with added sugars

English Name	Vietnamese Name
Sweet sticky rice (with bean, peanut, Momordica)	Xôi (đỗ, lạc, đậu phộng, xôi ngô)
Sweet soup with sticky rice	Xôi chè
Vietnamese hollow doughnuts	Bánh tiêu
Sweet Popcorn	Bỏng ngô có đường/mật
Floating cake (dessert wading in water)	Bánh trôi nước
Sticky rice cake (sweet)	Bánh nếp (ngọt)
Sponge cake	Bánh bò (bột gạo nếp)
Sweet puffed rice	Bỏng gạo có đường
Glutinous rice cake	Bánh gai
Banh Cam	Bánh cam (bánh rán)
Corn sweet soup	Chè ngô
Young rice cake	Bánh cốm
Chè mixed beans (many types of bean)	Chè thập cẩm
Tau Pho (tofu syrup)	Tào phớ (đậu hủ nước đường)
Green bean sweet soup	Chè đỗ xanh
Peanut candy	Kẹo lạc
Black bean sweet soup	Chè đỗ đen
Black seasame milk	Sữa mè đen
Green bean cake	Bánh đậu xanh
Black bean milk	Sữa đậu đen (có đường)
Dried jackfruit chips	Mít sấy
Fried banana cake	Chuối chiên
Banana ice cream	Kem chuối
Sweet fruit mixture	Trái cây dầm
Drinking yogurt	Sữa chua uống
Soya milk	Sữa đậu nành có đường
Pasteurized milk	Sữa tiệt trùng
Yogurt (sweet)	Sữa chua có đường
Sweetened condensed milk	Sữa đặc có đường
Cream	Kem
Glutinous Rice Yogurt	Sữa chua nếp cẩm
Fresh fruit juice (orange, pomelo, tangerine juice)	Nước ép từ trái cây tươi
Carbonated soft drink (Coca cola, Pepsi…)	Nước ngọt có ga (Cocacola, Pepsi…)
Instant coffee	Cà phê hòa tan
Bottled green tea	Trà xanh đóng chai
Energy drink (Sting, Red bull)	Nước tăng lực (Sting, Red Bull….)
Milk tea	Trà sữa
Tea bag (Lipton…)	Trà túi lọc (Lipton)
Smoothie (avocado, strawberry…)	Sinh tố (sinh tố bơ, dâu….)
Sugarcane juice	Nước mía

Table 4.A1 Continued

English Name	Vietnamese Name
Lotus seed sweet soup	Chè hạt sen
Fruit mix sweet soup (mango, pomelo…)	Chè trái cây (chè xoài, chè bưởi, chè Thái…)
Banana sweet soup	Chè chuối
Bottled herbal tea (Dr Thanh, Ô long…)	Trà thảo mộc đóng chai (Dr Thanh, Ô long…)
Fruit milk (corn milk)	Sữa trái cây (Sữa ngô)
Bird nest drink	Nước yến (Yến sào_
Lemon tea	Trà chanh
Lotus seed milk	Sữa hạt sen
Hot Cocoa (liquid, with added sugar)	Đồ uống ca cao thêm đường
Cake in general	Bánh ngọt không nêu rõ
Chewing gum	Kẹo cao su
Choco pie cake	Bánh Chocopie
Lollipop / candy	Kẹo mút / Kẹo
Chicken thighs cake	Bánh đùi gà
Egg cake (Custas,..)	Bánh ngọt nhân trứng (Custas , ...)
Banana cake	Bánh chuối
Biscuits	Bánh qui
Rice cake (sweet)	Bánh gạo ngọt
Donuts	Bánh rán
AFC cake	Bánh AFC
Brithday cake/Cheesecake	Bánh kem
Sweet Jelly	Thạch rau câu ngọt
Cream Puffs	Bánh su kem
Caramel / Flan	Caramen / Bánh Flan
Chocolate	Kẹo Sô-cô-la
Pig skin cakes	Bánh da lợn
Chè lam cake	Bánh chè lam
Coconut jams	Mứt dừa
Theochew pastry	Bánh pía
Fried sweet potato cake	Bánh khoai
Cassava sweet soup	Chè sắn
Taro sweet soup	Chè khoai môn

Chapter 5: Summary, policy implications, limitations and recommendations for future research

5.1 Summary of key findings

This thesis aims to understand the potential implications of ongoing changes in the Vietnamese food environment on urban food purchasing and consumption behaviours, attitudes and concerns about food safety and nutrition, and nutrition outcomes. The analyses in the main empirical chapters of the thesis (Chapters 2-4) use a novel primary dataset from the Vietnamese Urban Food Consumption and Expenditure Study (VUFCES), which includes household-level and individual-level information from 1,700 urban households in the two largest cities of Vietnam: Hanoi and Ho Chi Min City. The VUFCES was conducted in 2016 and 2017 by a team of researchers from the Centre for Global Food and Resources, at the University of Adelaide, including the author of this thesis.

Data collection methods for the VUFCES included: 1) a household survey, which covered information on both individual socio-demographic characteristics and household shopping behaviours, food and non-food expenditures, and attitudes regarding food safety and nutrition; and 2) multiple rounds of 24-hour food diary recording, where households kept detailed records of the food and beverages consumed by each household member over a 24-hour period. The following paragraphs summarize the key findings from the three analytical chapters.

In **Chapter 2**, we address the following research questions: Do Vietnamese urban households differentiate their food retail outlet format choices based on travel time to the market and their food quality and safety concerns? Are retail outlet choices heterogenous across household income levels?

Data from the household survey conducted in Hanoi and Ho Chi Minh City, are used in the empirical analysis to investigate these research questions. We use a reduced form

regression function with shares of household food expenditure made at each type of food retail as dependent variables. We further account for heterogeneity through estimation of the regression function for different income and city cohorts.

No direct association is found between household respondents' food safety concerns and higher food expenditure shares at modern retail outlets. However, we find that concerns about food prices and freshness are significantly associated with a lower share of food expenditures at modern outlets. These results are consistent across different household income levels. Another important finding of Chapter 2 is that for lower income households, the relative difference in travel time to market are not significantly associated with differences in household food expenditure shares at modern and traditional retail outlets. However, we find some evidence that wealthier households tend to substitute modern markets with traditional markets based on the relative difference in travel time to market.

The following research question is addressed in **Chapter 3**: Do food access and nutrition concerns affect the caloric (energy) intake and relative proportions of macronutrient (protein, carbohydrates, and fat) consumed by urban Vietnamese consumers?

By combining the household data with further individual-level food consumption data from multiple rounds of 24-hour food diaries, we explore the relationships between three dimensions of food access, individual energy (calorie) intake, and macronutrient (protein, fat, and carbohydrate) shares. Three measures of food access for urban Vietnam are constructed: 1) economic access (income and food prices); 2) geographical access (distances to different types of markets); and 3) nutrition concerns. The dependent variables in this study are individuals' total energy intake (in kilocalories) and macronutrient shares, defined as the proportion of calories from each macronutrient: protein, fat, and carbohydrates. Ordinary least squares and multivariate regression methods are applied to empirically estimate the model. Subsample analyses are also performed to test for the heterogeneous relationships between

food access measures and the individual calorie intake and macronutrient shares across different income groups.

Empirical results show that income growth can result in overall increase the total calorie intake through a substitution of calories from macronutrients (i.e. substituting carbohydrates with more protein and fat). This may improve the diet quality of lower- and middle- income groups by increasing the share of protein, however, it is likely to have negative nutrition outcomes for wealthier households. Moreover, a higher pork price is associated with lower shares of protein for all individuals, and increased shares of fat for middle- and higher- income consumers. On average, geographical food access in terms of distance to market does not appear to be significantly associated with changes in caloric intake or macronutrient shares. A further distance to wet market is associated with a higher share of calories from fat for individuals from low- and middle-income households. Increased household nutrition concern is associated with lower individual caloric intake and a lower share of calories from fat.

Finally, in **Chapter 4**, we address the following research question: To what extent are nutrition label use and health concerns associated with share of daily caloric (energy) intake from food and beverages with added sugars among urban Vietnamese consumers?

This study applied a 3SLS estimation procedure to a simultaneous equation model, to account for the likely endogeneity of two explanatory variables, namely nutrition label use and health concerns related to sugar consumption, and possible correlations of error terms among covariances. The empirical work is facilitated by intra-household data from both the household survey and 24-hour food recalls. The dependent variable is an individual's share of average daily (four-day) caloric intake obtained from food and beverages with added sugars. Subsample analyses are performed to test for the heterogenous associations of the explanatory variables on the share of calories from added sugars for both adults and adolescents.

The empirical results consistently show that the use of nutrition labels with information about sugar by the household's main food shopper (respondent) is associated with a significantly lower share of caloric intake from added sugars for individual members of the household. We also find that attempts to avoid sugar by the household's main food shopper are significantly associated with a lower share of caloric intake from added sugars for female adolescents. Additionally, the level of education attained by household's main food shopper is shown to be positively associated with calorie share from added sugars for both adults and adolescents.

5.2 Discussion and policy implications

In urban Vietnam, food safety concerns are influencing food retailing policies that exclusively favour modern food outlets in urban areas of Vietnam, based on the government expectation that the modernisation of food retail outlets can improve food safety and efficiency of supply chains (Wertheim-Heck et al. 2019; Wertheim-Heck et al. 2015). However, findings from **Chapter 2** indicate that the assumptions underpinning these policies might not hold. Specifically, whilst most consumers appear to care about food safety, there is no apparent linkage between households' food safety concerns and their choice of retail format for food purchases.

These results imply that policies which seek to stimulate the development of modern markets in the Vietnam urban environment at the expense of traditional markets are potentially harmful to the overall nutrition of poor households, and the policies are only moderately beneficial to relatively wealthy households. For example, rather than encouraging food market modernisation, the Vietnamese Government should focus on ensuring that safe, fresh, and healthy food is accessible for all households by improving the market conditions of traditional outlets and increasing their competitive position relative to modern retail outlets. Providing good market access, especially access to wet markets, is also necessary to maintain an

adequately balanced diet in terms of macronutrients. Public resources could focus on increasing competition amongst modern retailers which would lead to a reduction in prices matching those of traditional markets.

Findings from **Chapter 3** further suggest that potential interventions in improving public health nutrition are complicated as a single policy may work differently for subgroups of the Vietnamese urban population. In particular, policy makers could approach nutrition issues from several aspects. Policies aimed at food price stabilization should fully consider the ongoing 'nutrition transition' as income growth has shifted the diet towards more protein and fat consumption. For example, maintaining a low grain price may not be necessary and can waste policy resources since consumers are less responsive to changes in the price of rice relative to the price of pork. On the contrary, a high level of fluctuation in the price of pork could be relatively more harmful than rice price volatility, as consumers substitute between protein and fat intakes and in the face of pork price increases the substitution is usually towards the latter. Providing good market access, especially wet markets, is also necessary to maintain the individual's diet balance in terms of macronutrients. This means that instead of reducing the presence of wet markets through supermarketization, policies should aim to provide good access to affordable, safe and healthy foods for poor consumers by ensuring the coexistence of and competition among wet markets and supermarkets. Lastly, nutrition education programs can help increase the consumers awareness and knowledge of the nutritive value of healthy foods, hence contributing to an improvement in individual diet quality.

The empirical results from **Chapter 4** imply that nutrition labeling can be an effective measure to reduce the health impacts of added sugars in urban Vietnam. Considering these results, the Vietnamese government may want to be proactive and develop initiatives to tackle the impacts of increasing consumption of sugary food and beverages. The government may want to prioritise increasing consumer awareness about the negative health consequences of

consuming high amounts of added sugars and increase consumers' access to information on nutrition profiles of food through food labeling or other point-of-purchase mechanisms. Early initiatives could include public health programs targeting female adolescents and the household food shoppers and food preparers (usually the mother). Moreover, to effectively reduce added sugar consumption, nutrition labels should include detailed, highly visible and easily understood information about added sugar. These measures need to be further tested to understand the costs versus the benefits as mandatory nutrition labelling programs tend be costly and can have perverse effects on small food businesses.

5.3 Limitations and recommendations for future research

While this study contributes to the literature on understanding the impact of ongoing changes in the food environment on Vietnamese urban consumers' food purchasing and consumption and their diet quality, it also has some limitations which provide opportunities for future research.

First, the cross-sectional nature of the household survey data used in this thesis allows us to identify potential associations between covariates and outcome variables but not strong causal inferences. For example, given suitable panel data, the empirical findings from **Chapter 2** could further improve our understanding about the dynamic changes in food consumption patterns among Vietnamese urban consumers.

Second, the data used in **Chapter 3** does not distinguish between different types of fat or carbohydrates, which can provide deeper insight into diet quality and the potential for negative diet-related health outcomes (e.g. overweight, obesity, type II diabetes, and cardiovascular disease). Future research in this direction should consider estimating the macronutrient shares from different types of healthy versus unhealthy food groups, for example for carbohydrates, the nutritional quality of fresh fruit is much better than highly processed

sweets and beverages, to improve our understanding on the relationship between food access and individual diet quality.

Finally, the focus on the more developed urban areas of Vietnam, whilst representative of key urban populations in Hanoi and Ho Chi Minh City, is likely to not represent populations from smaller urban centres or rural households. Further research in this direction may be implemented towards less developed urban and peri-urban areas of Vietnam, and other developing countries.

5.4 References

Wertheim-Heck, S. C. O., Raneri, J. E. & Oosterveer, P. 2019, 'Food safety and nutrition for low-income urbanites: exploring a social justice dilemma in consumption policy', *Environment and Urbanization*, vol. 31, no. 2, pp. 397-420.

Wertheim-Heck, S. C. O., Vellema, S. & Spaargaren, G. 2015, 'Food safety and urban food markets in Vietnam: The need for flexible and customized retail modernization policies', *Food Policy*, vol. 54, pp. 95-106.

Appendix 1: Training manual prepared for the Vietnamese Urban Food Consumption and Expenditure Study

INTRODUCTION

This manual is designed to help the enumerators and their supervisor to carry out the Vietnamese Urban Food Consumption and Expenditure Study (VUFCES). It provides definitions and instructions for completing the questionnaire.

INTERVIEW

Starting the interview

To begin the interview, introduce yourself and explain the purpose of the survey. There is a suggested paragraph on the cover page, but you may wish to expand or modify this based on your experience. If the respondent is hesitant about responding to the interview or asks what the data will be used for, explain that the information you collect will remain confidential, no individual names will be used for any purpose, and all information will be collated to write a report.

It is important to establish a good relationship with the respondent since we are asking for about 90 minutes of their time. In addition, a respondent that is treated well might trust the enumerator more and is more likely to give accurate responses.

Next ask who in the household would be most knowledgeable about food purchases and preparation. Normally, this will be the wife/mother or may be grandmother in the household, but not always. If the most knowledgeable person is not present, it may be possible to interview someone else who is well informed or it may be necessary to return to the household later.

THE ENUMERATOR SHOULD ALSO KINDLY ASK THE RESPONDENT IF HE OR SHE WOULD BE WILLING TO FILL THE 24 HOUR FOOD CONSUMPTION DIARY FOR

ALL THE HOUSEHOLD MEMBERS SOME TIME LATER OF THE DAY WHEN THEY HAVE AN AVAILABLE TIME.

An Example:

Hello, my name is _____. I work for a research institute in Hanoi called Indochina Research Ltd and we are carrying out a survey on food shopping habits. The survey is intended to improve our understanding of how food shopping patterns are changing and how to help farmers adapt to those changes. The survey will be conducted for two rounds. The first round is in December 2016 and the second round will be conducted in May 2017. You are one of 2000 households in Hanoi, HCM and North West Vietnam selected to participate. The individual results are confidential - only summary results will be included in the report. I would like to have some of your time to ask you some questions. I would also like to seek your kind consent to let me get all family member's (including a new born) weight and Height, Waist, Hip and Mid-Upper Arm Circumference (MUAC).

Whenever possible, the interview should be carried out privately, without neighbours, company representatives, or government officials.

General Information:

- Only use **CommCare application in the tablet for full Household Socioeconomic survey** and **leave 24-hour food diary modules (Module M1 to Module M3), to the interviewee to be filled in later**. Then ask the interviewee kindly what is the most convenient day and time for picking the form later.

- **Steps to use the tablets:**

The device that has been provided for surveys would need to have latest version of the application 'CommCare'. Always update and synchronize the version so that you do not miss

any updated information. Below is an example of how to update and synchronize the application:
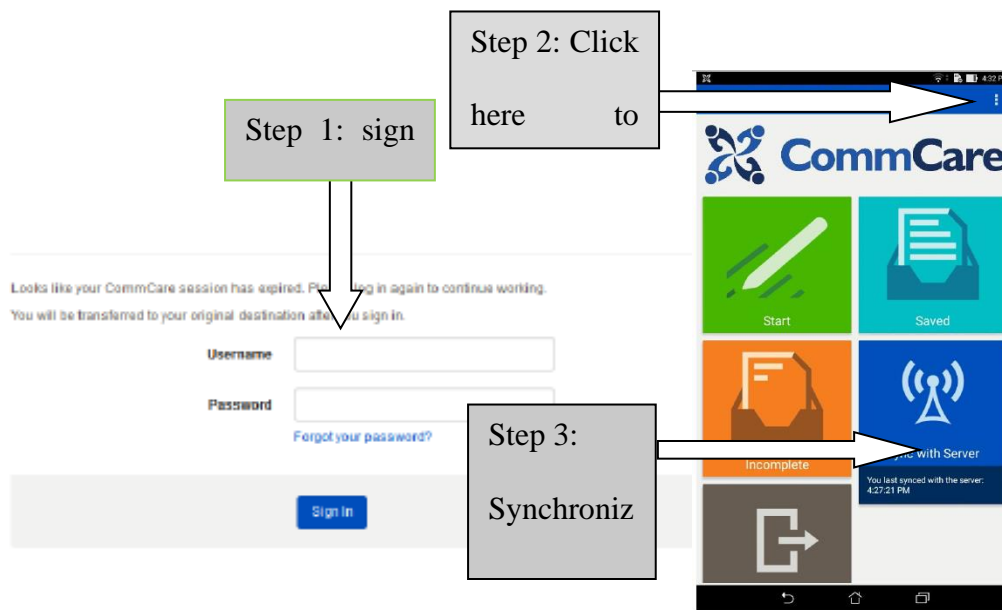
Figure: 1 Steps to access the CommCare application

Step 1: You would need a user name and a password to access the application. These credentials must be used to log into the application and access the projects assigned for survey.

Step 2: Always update the app before you use it.

Step 3: Always synchronize the app before you start the survey.

Also, check that the device has adequate battery power to sustain the survey through the day. Furthermore, following steps must be taken to improve performance of the device on field:

1. Do not use this device for purposes other than survey;

2. Do not install any other application than 'CommCare';

3. Power off the device if not in use for prolonged periods in the day;

4. Turn off Bluetooth and Wi-Fi when not in use;

5. Turn off GPS location service, whenever not on field;

6. Also turn off synchronisation to save power;

7. Do not leave apps running in the background;

8. Use power saver mode on the device, and turn off 'vibrate alert

Filling in the questionnaire using CommCare Application

Below are some general guidelines for filling in the questionnaire:

- Ask the questions in order, skipping to questions when instructed to.

- There should be just *one number in each box*. For example, if the respondent says "10 to 20 kilograms", ask him to estimate the average or use 15. If the respondent gives two reasons, but there is only one box, ask him to select the most important reason.

COVER PAGE

The cover page records information to identify the respondent and to monitor the process of data collection and quality control. For example, the cover page includes the explanation and the objective of the usage of the data, Name of the wards by districts and by cities. It also includes the information about household name, Household identification number, name of the respondent, household address or location and information about the interviewer. The cover page also includes the name of the household head and his/her ID. In the CommCare app, the enumerator should write down the member ID number to identify the household head.

What is a household?

For this survey, a household is defined as a group of people who normally live and eat their meals together. To be a member, a person must live in the household for at least 6 months of the year or for at least 4 days per week. Make sure the respondent includes him or herself. To ensure that you get everyone who lives in the household, probe by asking if there are any employees or non-family-members living at the house. If so, ask more questions to see if they meet the criteria for household members. It is not necessary to record information about people who normally live elsewhere, such as someone who works in his/her rural origin most of the year.

IMPORTANT:

A household includes:

•   Infants born within the family and living with the family within the past year.

•   Servants, lodgers, farm-workers, and other individuals who have lived and eaten with the household over most of the last 12 months, even if they have no blood relation to the household head.

•   Anyone who has lived and eaten with the household for most of the last 12 months.

•   New members of the household (such as a son-in-law) who has lived in the household at least one month.

A household does not include:

•   People who live in the same dwelling, but do not share food expenses and make economic decisions separately. For example, if two brothers, each having his own family, live in the same house but maintain separate food budgets and cooking facilities, and make their economic decisions separately, they would be two separate households.

- People who normally live away from the household for more than six months of the year, even if they are family members and are considered members of the household by the household itself. For example, if the mother of the family lives and works in the rural origin of the family and only lives for 4 months of the year in the city she is not considered a member of the household (under our definition). Similarly, a son who comes home only on weekends is not a household member.

Children of the household who have lived and eaten elsewhere most of the past 12 months, such as students who live at a boarding school and children who live with relatives.

> Housemaid: what if the housemaid makes the decision of food purchasing and she is gone after 2 months. Then who will be person to take the decision? The decision for food purchasing for the family members must come from a permanent member of the family. For example, the wife or the grandmother of the family who are living permanently in the household. The housemaid may prepare food or go to the shopping market to purchase food but they do not take the economic decision of food purchasing for the members. In this case, the respondent who is responsible for the household food purchase in May (the second round) will be the respondent for the second round. Wendy: we should never interview the house maid. But the respondent should always be from the permanent household member. The household maid can help her to answer questions.

Who is a head of household? **The head of household is defined as the household member who makes most of the decisions for the members of the household**.

IMPORTANT:

- The head is not necessarily the oldest male.

- Also, because the head of household must be a member of the household, it cannot be someone who lives elsewhere for most of the year. For example, if the husband lives in another place and sends money or visits the household regularly, then the wife makes the day-to-day decisions and she is considered the household head (this would be referred to as a female headed-household).

- If the decisions for the members of the household is taken jointly, the enumerators should write the name and the ID of the both members. For example, if the husband and the wife make most of the decisions jointly, then the enumerator should write the names and the ID of the husband and the wife both.

  Enumerators may accept the judgment of the household members regarding who is the head of household, provided the person is a member according to our definition.

Household Registration:

1. Information for household ID number

This section provides the codes that will be used to construct the household identification (ID) number. Choose the codes for the city, district, ward and the household ID that are provided in the app. The codes for city, district, and ward are provided on the back of the cover page of the hard copy of survey questionnaire. The codes for each enumerator will be provided by the supervisors which is also shown on the back of the cover page.

2. Information on the household: The name, address, and phone number of the respondents should also be filled in. There are no codes for this information. This information is important for identifying the household in case there is a mistake in the household ID. This information is also important in case we have a question about the information provided and we need to contact the respondent.

3. Questionnaire Interview: The interviewer should record the start date of the data entry and the finish date of the data entry here. The supervisor will check the questionnaire in the field. Any random checks by the supervisor will be recorded in the appropriate row. The office check will be carried out in the headquarters.

SECTION A: HOUSEHOLD MEMBER CHARACTERISTICS

The purpose of this section is to collect basic information on each member of the household.

Order of questions in module A:

Tell the respondent that you would like to make a list of all members of the household starting with the head of household and the spouse. Try to organize the roster so that, after the head of household and spouse, the household members are listed by age, from eldest to youngest. This will make it easier to complete and check the questions that only apply to members 7 years and older and the questions that only apply to members 17 years and older.

A1 and A2 Household ID NO:

In CommCare app, the household ID number will appear in this section followed by member ID in A2

A3: NAME OF THE MEMBERS IN THE HOUSEHOLD (Confidential and will be kept by Indochina for their record and quality control)

As described above, list the name of the household members in the following order: 1) head of the household, 2) the spouse(s), and 3) others in order of age from oldest to youngest. Putting them in order of age will help ensure than the schooling question is asked of everyone who is six years or older. It will also help ensure that A6-A8 are only asked about members 17 years or older.

Do not write a number here. You need to write the name of the respondent. See the example below:

A1. Name of member no.1
jesmin
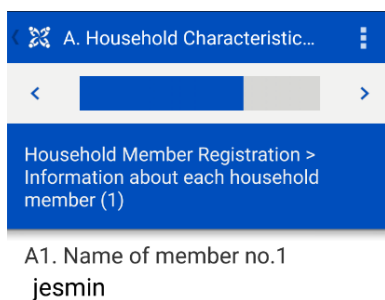
A4 SEX

Write the code for the sex of the household member (1=Male, 2=Female).

A5 RELATIONSHIP

Record the member's relationship to the head of the household.

"Other related" refers to people with a blood or marriage connection to the head of household, including cousins and grandparents.

"Other unrelated" refers to people in the household but not related by blood or marriage to the head of household, including domestic employees, boarders (who eat with the family), or long-term visitors.

"Domestic employee" refers to the people who perform a variety of **household** services for an individual or a family, from providing care for children and elderly dependents to housekeeping, including cleaning and **household** maintenance, eating and living with the households in the past 12 months or more.

A6 AGE

Record the age of the member in the app, expressed in day, months and years needs to be completed (i.e. age at the last birthday). If the oldest members do not remember their exact date of birth, then request him/her to remember the year. If they do not remember the year, then politely ask what they think their age would be. Then the enumerators should find out in which year they were born.

A7   EDUCATION

For all the members 6 years and older, record the number of years of schooling starting from grade 1 in primary school that the child has had. For example, if the member never completed any schooling, write "0". If the respondent completed 3rd grade, write "3". If s/he completed 7th grade and started 8th grade. Write "7".

A8   MARITAL STATUS

For members who are 17 or older, ask about his or her marital status. Marital status refers to whether the household member is or has ever been married. "Single" means never married. "Married" means the member is currently wedded to someone, usually but not necessarily another member of the household. "Divorced/separated" means that the member was married but has legally or informally separated from his/her spouse. "Widowed" means the member was married but the spouse died. If the ex-spouse of a household member dies, the member is considered "Divorced/separated", not "Widowed."

A9   MAIN ACTIVITY

For members who are 17 years old or older, ask about his or her primary activity. The primary activity is defined according to the time it takes, rather than the money it generates. For example, a woman who spends 5 hours per day doing housework and 3 hours as a vegetable trader would have "Housework" as the main activity, even though trading generates more income. The activity codes are given on the back of Section A. The two main categories of occupations are "self-employed" and "employee".

- The "self-employed" category refers to people who own their own business and are paid by the product or by the tasks (not by the time-period). They often have business expenses such as raw materials, rent, and labour. They typically sell to various customers.

- The "employee" category refers to people who is paid by the day, month, or year. They generally do not have business expenses.

The table below provides brief descriptions of each occupation/activity code:

11.	**"Farmer/fisherman"** includes people involved in crop production, livestock raising, aquaculture, and fishing. It includes independent farmers, farmers renting farmland, and sharecroppers. It does not include agricultural laborers working for a daily wage (these are "Employees – labourer").
12.	**"Self-employed commerce"** refers people who have their own business buying and reselling products without processing or transforming them. The activities may include storage and transportation. This includes assemblers, wholesalers, and shopkeepers who own their businesses. It does not include people who work as employees in a store or trading company (they are "Employees semi-skilled active").
13.	**"Self-employed service"** refers to people who have their own business and are paid by the task. They have different customers who pay them, rather than always working for one person or company. Examples include barbers, repairmen, electricians, plumbers, and drivers with own vehicle.
14.	**"Self-employed manufacturing"** includes activities in which the household member is self-employed and is paid by the product. Examples include bakers, butchers, metal-workers, furniture makers, and brick-makers.
21.	**"Employee professional active"** refers to an employee with relatively high education and skills who typically spends most of the day on his/her feet. Examples include teachers, doctors, and nurses.

22.	**"Employee professional less active"** refers to an employee with relatively high education and skills who typically spends most of the day seated. Examples include executives, administrators, and managers.
23.	**"Employee semi-skilled active"** refers to an employee with some skills and education who typically spends most of the day standing. Examples include policemen, salespeople, and bank tellers.
24.	**"Employee semi-skilled less active"** refers to an employee with some skills and education who usually spends most of the day seated, such as secretaries, receptionists, clerks, and drivers.
25.	**"Employee labourer"** refers to an employee with less education, such as a construction worker, a factory worker, a cleaner, a security guard, and an agricultural labourer.
26.	**"Domestic employee"** refers to someone hired by a family to help with household tasks. Examples include a housekeeper, a cook, a nanny, and a gardener.
31.	**"Housework"** refers to an unpaid member of the family who cleans, cooks, and takes care of the children. It is often the wife/mother or an older child but does not have to be. If the person does housework as a paid job, this should be recorded as "Domestic employee."
32.	**"Student"** includes school students, university student, and those in training.
33.	**"Retired"** includes those who have stopped working because of age.
34.	**"Not working"** refers to people who are not working, either because they cannot find work or because they choose not to.
35.	**"Others (Specify)"** includes anyone who does not fit in the other categories. If you use this code, please describe the activity/occupation. The enumerators

	should specify what other activity the household member mentioned as employment.

A10   HOURS WORKED

For members 17 and older who have a paid occupation (codes 11-35), ask about the number of hours per week that they spend on the primary activity.

In the app, if the household have chosen the option "other", please specify what other activities he/she is doing.

See an example below:
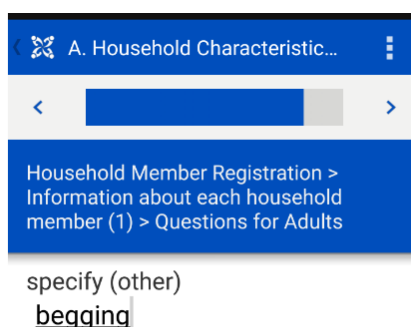
In the form (in case the app is not working), If the member has an unpaid primary activity (codes 31-35), then fill in the box with "99" since it would be difficult to estimate the time involved and not very useful for analysis.

A11 RELIGION

Record the religion of the household using the codes provided.

A12   ETHNICITY OF HEAD

Record the ethnicity of the head of household from the given codes.

A13 ETHNICITY OF SPOUSE

Record the ethnicity of the spouse of the head of household.

A14. On average, how many hours per day does each member (aged 2 years and above) in your household spend watching TV, videos, or on the internet?

CHILDREN and ADULTS (aged 2 years or more): TV, VIDEOS, and OR OTHER ENTERTAINMENT

- For Adults only, response should be in HOURS per day.
- We just want the average for the household per DAY.
- We just want an estimate per day, it does not have to be exact.
- If the amount is less than an hour then code to the nearest quarter of an hour. For example, 30 minutes = 0.5 hours.

A15. On average, how many hours per week does each member (aged 2 years and above) in your household do exercise (e.g. sports, physical education at school, bike riding, playing outside)? Note: If no children code as 999.

CHILDREN and ADULTS (aged 2 years or more): EXERCISE

- For adults only, response should be in HOURS per WEEK.
- We just want the average for the each household member per WEEK.
- For example if the 3 adults in the household, Jesmin and Wahida exercise for different amounts of time each week (e.g. Jesmin never exercises, Wahida usually exercises for 6 hours per week, then the answer should be for Wahida 6 hours per week and for Jesmin 0.
- We just want an estimate per WEEK, it does not have to be exact.
- If the amount is less than an hour then code to the nearest quarter of an hour. For example 30 minutes = 0.5 hours, 45 minutes = 0.45 hours.

Enumerators should try to make an estimation from the respondent if the respondent cannot tell exactly how many hours/does not know. No "999" is allowed.

A16. Who in the household smokes cigarette?

Write down the member ID who smokes cigarette.

A17   PREGNANCY AND LACTATION

Who in the household pregnant or lactating?" Write down the member ID. If no one is pregnant or lactating, then put code 999 in case you are using hard copy. In the app, you only need to select the option as below:

A. Household Characteristic...

Household Member Registration >
Information about each household
member (1) > Questions for Adults

A9.Is jr pregnant or breastfeeding?

○ no

○ yes, pregnant

○ yes, breastfeeding

○ yes, both

SECTION B.   HOUSING AND ASSETS

The objective of this section is to obtain general information on housing characteristics and ownership of assets.

B1   WATER SOURCE

Pick the first response that describes the main source of water for household. If there are

multiple sources, ask which the source of most of the water is.

B2   TOILET

Pick the response that best describes the type of toilet used by the household most of the time.

B3   LIGHTING

This question asks about the type of lighting used by the household in the evening. If they use

more than one type, pick the first one listed.

B4   FUEL

This question focuses on the fuel used for cooking. If more than one fuel is used, pick the most

important one.

B5   DISTANCE TO TRANSPORTATION

The distance to the nearest transportation should be measured in meters from the edge of the household's property. If the public transport is immediately in front of the house, you can enter "0".

B5a. The type of the nearest transport

In the app, also select the type of the nearest transport from the option in the app, they are: 1) Bus, 2) Xe Om, 3) Taxi, 4) Cycle, 5) other, please write down the "other" type of vehicle that is used by the respondent. Do not select a number for the option "Other".

B6   ASSET OWNERSHIP

The respondent will choose from the asset options which of the assets do they own currently.

This question records   each type of consumer good owned and used by members of household.

B7   YEAR OF FIRST OWNERSHIP

Which of these assets did your households own five years ago in 2011?

SECTION C. COOKING AND SHOPPING ATTITUDES AND BEHAVIOR

C1-C2   ROLE OF DOMESTIC EMPLOYEE(S)

First ask if the household has a domestic employee such as a cook or a housekeeper. If not, you can continue to C3. If they do have a domestic employee, ask questions C1 and C2. In the app, you only need to select the option as below:

C3-C6   DIVISION OF RESPONSIBILITY

These questions ask who in the household has responsibility for deciding what to buy, for

shopping, for deciding what to cook, and for cooking. If responsibility is shared, pick

the person with more responsibility. See the picture below:

C7   SHOPPING LIST

Asks if the household usually makes a *written* shopping list before going food shopping.

C7A. In the app, you will also ask the name of the person who writes the shopping list.

See the example below:

C8   EATING MEALS TOGETHER

Asks In an average MONTH, how often is the main food for the evening meal is eaten by the

most of the members together. The answer should be between 0 and 7.

C9-C11 EATING OUT

 Asks about the frequency that the household makes use of food prepared outside the house,

including take-out, delivered food, eating in restaurants, and eating at street vendors.

SECTION D. RETAIL OUTLETS

D1. TYPE OF SHOPPING OUTLET

Hypermarket and Supermarkets include Metro, Big C, Fivi Mart, Unimart, AC Mart

Minimart/Convenience store includes seven eleven, Vinmart, Shop & Go, Circle K

Specialty shops are small sized shops with clear external billboards signaling the offer of certified safe (rau an toàn), clean (rau sạch) or organic (rau hữu cơ) vegetables. Examples of this would include stores selling "Safe Vegetables" or "Organic Vegetables". Examples Include "Big Tom" Big Green and Klever Fruit.

Formal wet market is a market formally established by the authorities

Traditional family shop: A traditional family shop is a small food shop run by the households that sell only processed foods and beverages but no fresh foods or vegetables.

A **semi-permanent stand** sells from a table, stand, cart, or stall that can be moved, but generally stays in one place during the day.

Peddlers/mobile street vendors operate on foot, on bicycle, or pick-ups that sell both food and non-food items

Informal street Markets sell to the public without having method for a permanent built-up structure format to sell.

In the app, question D2 –D8 will appear for each of the shopping outlet starting with hyper/supermarket, minimart and then Specialty shop and so on. Example is shown as below:
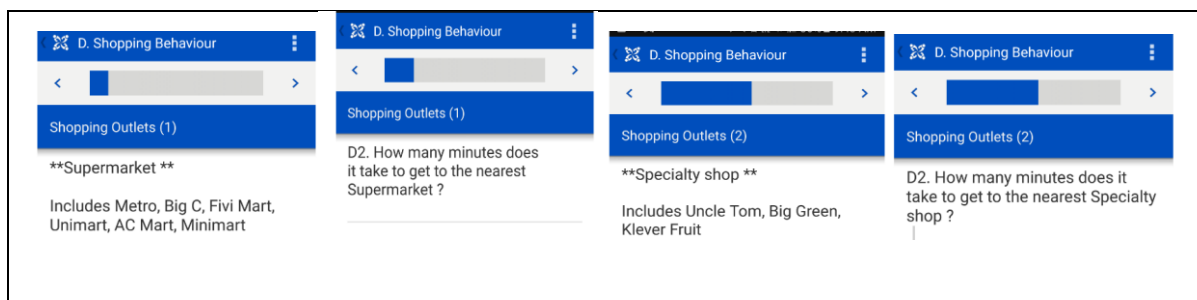
D2. TIME to OUTLET

- THIS SHOULD NEVER BE BLANK- They should fill it out how many minutes does it take to get to the nearest shopping outlet.

D3. DISTANCE to OUTLET

- THIS SHOULD NEVER BE BLANK- They should fill the distance in kilometres to the nearest shopping outlets.

- If they do not know distance then the enumerator should try to ask someone else in the household. If this is impossible to know then you should indicate -999.

- If the enumerator thinks or know that the distance reported by the respondent is incorrect then the enumerator should write his estimated distance.

D4. THE FREQUENCY OF HOUSEHOLD SHOPPING FOR NON-FOOD ITEM

Asks the question about how frequently does the household shop for NON-FOOD items at a shopping outlet.

D5. THE FREQUENCY OF HOUSEHOLD SHOPPING FOR FOOD ITEM

Asks the question about how frequently does the household shop for FOOD items at a shopping outlet. Food does not include tobacco and betel nut.

D6. TRANSPORTATION METHOD TO OUTLET

For this question, it is the transportation method they use MOST frequently. If they use "Other", tell them to specify the type of the transportation method, e.g. it could be "Xe Om" then code as Xe Om as "Other".

D7 MAIN REASONS TO SHOP AT OUTLET

- Enumerator should show the options for the reasons they use outlets and ask respondent to select the main reason first.

SECTION E1, E2 and E3.   FOOD CONSUMPTION EXPENDITURE FOR FOOD PREPERATION AND FOOD CONSUMPTION AT HOME

The goal of this section is to collect information about food consumption expenditure, food patterns and where households buy different types of food products which are used to prepare food at home. Section E1 asks the information about staples and animal products, E2 asks the information about fruits and vegetables and Section E3 asks the questions about the processed food and beverages. Although there are about 90 food categories in total, most households will not consume food from all of these categories.

Questions E2 to E9 are repeated on the three sections E1, E2 and E3.

FRESH VS. PROCESSED

PLEASE NOTE: In several cases enumerator needs to distinguish between Fresh/Frozen and processed food products. It is important that the enumerator specifies that they want information on Fresh versus Processed. Here are the cases:

In Section E1 (Staples and animal products)

- Codes **510 to 520** refer to products that may be fresh, chilled, or frozen, but are **not** breaded, seasoned, salted, canned, dried, smoked, or semi-prepared.

- Codes **521 and 522** refer to products that are breaded, seasoned, salted, canned, dried, smoked, or semi-prepared in other ways.

In Section E2 (fruits and vegetable products)

- Codes **611 to 633** refer to Fresh vegetables or frozen vegetables – they can be cut for soups. They can be frozen if there is nothing (including salt) added to them.

- Code **635** is for "processed vegetables (e.g. canned or dried vegetables or vegetables in sauce (NOT fried or crisps).

- Codes **711-723** refer to FRESH fruits, **NOT** processed (Not frozen, not sweetened, not dried, not juiced, and not canned).

- Code **724** is for any non-fresh processed fruit (including frozen, sweetened, juiced, dried and canned)

In Section E3 (Processed food and beverages)

- Codes **811 to 900** refer to any processed food and beverages including cooking oil, chocolates and ready to eat meals.

Question E2   FOOD CONSUMPTION OVER LAST 12 MONTHS

On each section E1, E2 and E3, complete question E2 before moving to E3. Consumption includes purchased food as well as food from their own gardens or farms and food received as a transfer. Record "1" for yes and "2" for no. In the app, you need to select the option if the respondent says YES or No.

Question E3   FOOD CONSUMPTION OVER LAST 30 DAYS

On each section E1, E2 and E3, complete question E2 before moving to E3. Consumption includes purchased food as well as food from their own gardens or farms and food received as a transfer. Record "1" for yes and "2" for no. In the app, you need to select the option if the respondent says YES or No.

Question E4   CHANGES IN CONSUMPTION OVER LAST 5 YEARS

E4 asks whether per capita consumption of this food item has increased or decreased over the past five years. We want the **per capita** comparison because we do not want it to be affected by changes in the number of household members. If they didn't consume it 5 years ago and they do consume it now, select for larger quantities in the app. If they consumed it 5 years ago and do not consume it now, select for smaller quantities in the app.

Question E5   NUMBER OF TIMES FOOD PURCHASED IN THE PAST MONTH

This question will only appear in the app if the respondent answered "Yes" in question E2 and E3.

Question E6   VALUE OF AVERAGE PURCHASE

E6 asks about the average amount spent in Vietnamese Dong on the food item per unit (e.g. per kilograms, grams, litters or number) of each time it is purchased. Note that it is the value per purchase, not per week or per month. We will estimate monthly expenditure by multiplying E5 and E9.

AN EXAMPLE:

Example: I buy 24 eggs weekly.   The price that I usually pay (average price) is 28,000 VND for 12 eggs. So because I buy eggs weekly, for E5 I would put 4 times; For E6 the respondent should report 56,000;

Question E9   OUTLET WHERE FOOD IS PURCHASED

E9 asks where most of this food item is purchased, meaning what type of food store. If the food item is bought at more than one type of store, ask at which store their spending on this food is greater.

Extra questions E3a and E3b in Section E1:

In **Section E1 [FOOD CONSUMPTION EXPENDITURE FOR FOOD PREPARATION AT HOME (staples and animal products)]**, there are two extra questions (questions E3a and E3b) to know which pork meat cuts and beef meat cuts have the household consumed in the past 30 days. This question will only be asked if the households responded that they have eaten pork and/or beef in the past 30 days. Therefore, in the app, q**uestion E3a and E3b will only appear if the household responds that they have eaten pork and/or beef in the past 30 days.**

The different meat cuts for pork meat and beef meat are as follows:

Question E3a: Which pork cuts did you consume over the past 30 days?	**Question E3b: Which beef cuts did you consume over the past 30 days?**
Boston Butt (Pork Shoulder)	**Brisket**
Belly	**Rib eye roll**
Pork Rib	**Shin/shank**
Loin	**Striploin**
Fatback	**Tenderloin**
Rump	**Other, Please specify (…)**
Leg	
Other, Please specify (…)	

Extra questions E2a and E2b in Section E2:

In **Section E2 (Fruits and vegetables)**, there are two extra questions (from questions E2a and E2b) for four fruits that will be asked by the enumerators. **Question E2a and E2b will only appear in the app if the household responds that they have eaten any of these four temperate fruits, i.e. plum, persimmon, pear and peach in the last 12 months.** For the rest of the fruits and vegetable products in section E2, question E2a and E2b will NOT be asked. Below is an example picture from the app:
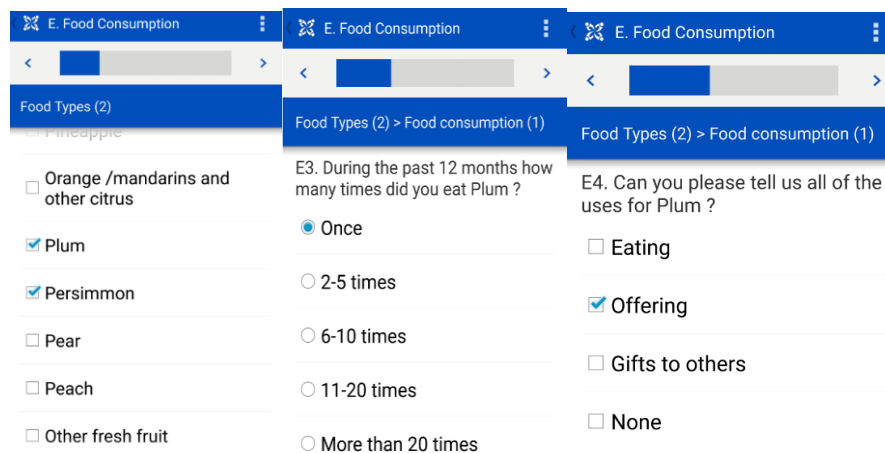
F. NON-FOOD EXPENDITURE

The goal of this section is to estimate non-food consumption expenditure, which will be combined with food consumption expenditure to calculate per capita consumption expenditure, a measure of the standard of living of the household. This is an important variable because many variables such as food consumption and shopping patterns are expected to differ between low-income and high-income households.

The question is "How much does your household spend on [item] in a typical week, month, or year?" For each non-food item, we code the responses with two variables.
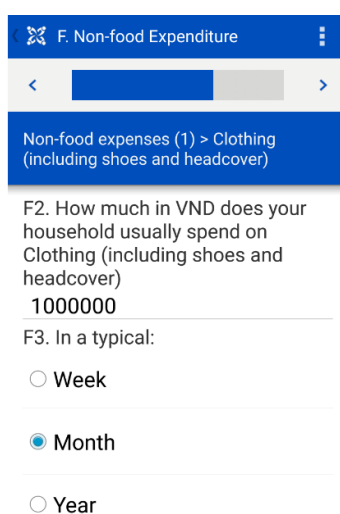
F2   VALUE (NON-FOOD EXPENDITURE)

Record the value (in Vietnamese Dollar) of the expenditure on each non-food category in F2.

F3   TIME PERIOD

Record the time period in F3, with "1" meaning weekly, "2" meaning monthly, and "3" meaning yearly. This does NOT refer to the frequency of purchases. It is only to give flexibility to the respondent in the response.

- In the app, if, for example, the respondent says that the household spends VND 100, 0000 per month on clothing, write "1000000"in F2 and select the time period in F3. See the picture below:

- Again, the time period does NOT refer to the frequency of purchases. It is for the convenience of the respondent. Sometimes it is easier to estimate the amount on a weekly basis (such as soap and toiletries), other items may be easier to estimate on a monthly basis (such as water and electricity bills), while others may be easier to estimate on an annual basis (such as school fees). Let the respondent decide which time unit is easiest to estimate.

Do not include spending on the following categories:

- Food or beverages: Food expenditure is covered in Section E. We do count expenditure on city water delivered to the house in this Section, a portion of which is used for drinking. Bottled water, Aqua, and water refills are counted in Section E.

- Durable goods. Durable goods are large items that last for at least two years such as furniture, motorbikes, cars, and home improvements.   Because the use (or

"consumption) of these goods lasts for several years, it does not make sense to count their expenditure in one year as "consumption.""

- Taxes. Taxes paid to central or local authorities are not directly linked to consumption, so we exclude these expenditures. We are not trying to estimate "income"; rather we are trying to estimate the value of consumption expenditure.

- Business expenses. We do not want to include business expenses because the items purchased do not directly contribute to the "consumption" and standard of living of the household. In other words, if a household owns a shop, we do not want to include the value of expenditures to restock the shop. Likewise, we do not want to count the cost of wood bought by a carpenter to make and sell furniture. These activities contribute to the household indirectly by providing income, but we count the value of consumer goods and services bought with those profits.

F4 OWNERSHIP STATUS

Ask the respondent whether the house is 1. Owned by the household 2. Rented/borrowed from the Government 3. Rented/ borrowed from the private landlord 4. Collectively owned 5. Owned by religious establishment 6. Collectively financed by both state and people

F5. What is the total area in square meter that you own? Ask this question if F4=1

F5 RENTAL/MORTGAGED EQUIVALENT: How much rented/mortgaged amount does your household pay per year?

Ask the respondent to estimate what it would cost to rent/mortgage a house like this in a neighbourhood like this for one year.

- If this is difficult, ask how much they could get in rent if they rented out their entire house. What we want is the "rental equivalent".

- Another way to phrase the question is how much household pay for similar houses in this neighbourhood do.

- We do NOT want the value of the house if they sold it or the cost if they had to buy the house. The rental equivalent is an important part of non-food consumption expenditure, so it is important to get an estimate of this value.

G. RETAIL OUTLET USE

The following are explanations for the food product categories:

1. Fresh meat poultry and offal: Any fresh meat product that is not fish or seafood and has

   not been processed (not nuggets, not breaded, not salted, not smoked)

2. Fresh fish and seafood: Any fresh fish or seafood product (not processed, breaded,

   not nuggets, not salted, not smoked)

3. Fresh Fruits: Any fresh fruit product that is not frozen or processed (not

   dried, canned etc.)

4. Fresh Vegetables: Any fresh vegetable product that is not frozen or processed

   (not dried, canned etc.)

5. Fresh Milk and Yogurt Only fresh cow milk or fresh yogurt, (NOT UHT, canned,

   long-life, dried or cheese, soymilk, cheese)

6. Processed food items Frozen foods, cakes, candies, biscuits, boxed food

7. Rice Only Rice

In the App, question G1-G6 will appear for each of the food categories. See the picture below:
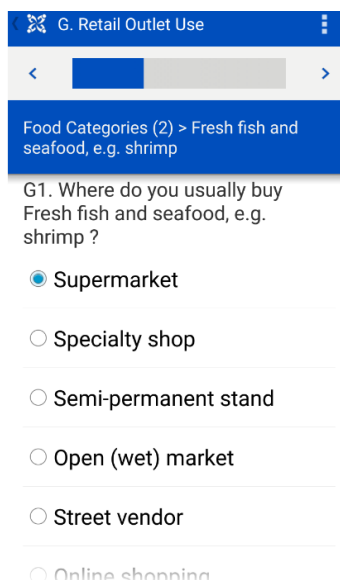
G1. WHERE DO YOU USUALLY BUY [Food Product...]

- NO cell in column G1 can be blank.

- They may purchase as multiple locations, but only one answer is allowed in the app. So emphasize to the respondent that we want to know the outlet that they purchase product at MOST frequently only.

G2. PRIMARY REASON THEY BUY [Food Product...] AT SPECIFIC OUTLET

- PROMT ANSWER: Enumerator should ask respondent to explain the reasons they choose outlet for food product and if the answer matches with the options in the app, just select the option.

- If respondent struggles to think of reason then enumerator can prompt them by showing them the lists from the app and let them pick one (See codes provided on bottom of Section G (1-22) in the form).

- Use only 1 option for each food product category- if respondent indicates more than one reason then ask them to specify the MOST important.

H. FACTORS IN FOOD CHOICE

H1-H2: **FOR FOOD:** Please ask this question UNPROMPTED (without showing them the code).

H1. In choosing the food products in general you purchase, what are the 3 most important factors influencing your decision?

- An example of how to ask: "*In choosing the food products you purchase, what are the 3 most important factors influencing your decision?" Or "what comes in your mind as the most important factor that influence your decision?"* We are referring to food in general, Cabbage, Tomatoes, Broccoli Water spinach, Su su leaves, Cai meo, Mango, Plum, Pear, Peach, Shrimp, Chicken, Beef and Pork. We are not interested in processed products (e.g. dried, salted, canned, seasoned, juiced etc.)

- If the respondents cannot think about the most important factor, enumerators should read the options for H1 then ask what is overall the <u>most important in choosing the food in general</u>. Enumerator should let <u>the respondent explain what is most important </u>and then use Codes (1-22). You can only have one code (one answer) for H1.

- **H1 should never be left blank**. There should be at least one answer here.

- In the app, the option "Never purchase", should NEVER be used for FOOD as all people purchase some type of food.

	Codes for H1 - H3	
1	Price	Vietnamese Dong per unit
2	Nutritional content	Food is a good source of nutrition, energy, protein, vitamins, minerals
3	Food safety	food that will not harm my health
4	Quality	Overall food product is good
5	Taste	Product will have a good taste and texture when I eat it
6	Freshness	Product is fresh, not old, rotten or frozen
7	Easy to prepare	Can prepare it quickly with minimal preparation time
8	Production method (e.g. organic)	Care about how product is produced – issues such as organic, pesticide-free, GMO free, chemical free.

9	Brand	Manufacturing company or food processor (e.g. Vinamik, Unilever, Masan, Vina Acecook, Nestle etc.)
10	Origin (country or region)	(Vietnam, USA, China, Thailand, Malaysia)
11	Grade or class	Food grading *involves the inspection, assessment and sorting of various* foods *regarding quality, freshness, legal conformity and market value.*
12	Diversity	Many different types of food products (apples, and seafood, and milk NOT certain varieties (e.g. varieties of apples or varieties of mangoes)
13	Smell	How the product smells
14	Color	That the color is right according to beliefs about what is good
15	Appearance	Appearance overall- not just color, for example if the product has blemishes, bruises, looks slimy or has flies on it.
16	Firmness/texture	Is product soft or firm?
17	Variety	Variety means type of a specific food product (varieties of apples)
18	Package size	Whether the package size is too big or too little- pre-packaged versus loose
19	Expiry date	Expiration date information (Use-by-Date)
20	Other labelling info	Any other labelling information
21	Never purchase this item	I never purchase this food item

22	Other, please Specify	If the respondent chooses any other option, please ask them to specify.

H3. In choosing each of the following types of products, where does the best quality of these products come from and where would you prefer to not purchase products from?

Here we are interested in the origin or places from where the best quality of these abovementioned products in H1 and in H2 come from.

> The respondent can provide up to 3 best origins of their preference and 3 worst origins of these food products that they do not prefer.

H4. How often do you use food ingredients and nutrition labels when shopping for food?

Codes are provided for this question as: 1= Always, 2=Often, 3= Sometimes and 4= Never.

H5. [If H4 is 1-3] What type of nutritional information do you use or look for?

- This question should only be answered if H4 =1-3.

- Enumerator should prompt and ask about each specific nutrient in H5-H13.

- Response is 1 = Yes, look for information, 2 = No, do not look for information

H6. What are the first and second most important sources of nutrition information for your household?

For H6,

- ask about their most important source of information regarding nutrition and health information. See codes provided to right (1-7)

- ask them who second most important source of information is. See codes provided to right (1-7)

- If code is "other", then please specify what "other" means.

I. NUTRITION ATTITUDES AND FOOD CONCERNS

I1-I10: Before starting these questions, the enumerator should read the following statement (on top of page) to the respondent:

"*For the next set of questions I1-I10, I am going to read you several statements. After I read you each statement then I would like you to point at the scale and tell me how strongly you agree or disagree with what I have said. 1 = STRONGLY DISAGREE and 5 = STRONGLY AGREE. There is no right or wrong response – I am really just interested in getting your OPINIONS and BELIEFS.*"

- **SHOW RESPONDENT GREEN "AGREEMENT" SCALE PROVIDED ON CARD. RESPONDENT SHOULD POINT TO LEVEL OF AGREEMENT**

- Place 1-5 in the blanks for I1-I10.

- NO QUESTION SHOULD BE BLANK- ALL QUESTIONS SHOULD BE CODED 1, 2, 3, 4, or 5.

LEVEL OF AGREEMENT				
STRONGLY DISAGREE	SOMEWHAT DISAGREE	INDIFFERENT/ UNSURE	SOMEWHAT AGREE	STRONGLY AGREE
1	2	3	4	5
---				+++

J1. CERTIFICATION AWARENESS, PURCHASES, PERCEPTIONS

SECTION J1. AWARENESS OF CLAIMS

Question J1

- For each claim listed the enumerator should ask "Have you ever seen or heard of fruits and vegetable products that are sold ….

  Example for organic: "Have you ever seen or heard of fruits and vegetable products that are sold *Organic or Certified Organic?*"

Question J2

Have you ever PURCHASED fruits and vegetables that are sold as …

  Example for organic: "Have you ever PURCHASED fruits and vegetables that are sold as *Organic or Certified Organic?*"

- Note: AWARE means whether or not they have ever seen or heard of the claim.

- Code as 1 = Yes, they have heard or seen such products; 2 = No they have never heard of or seen such products.

  o If the respondent "does not know" then code as "2 = No"

- No space should be left blank, must be coded as 1 or 2.

J3 – J6. Questions about different labels/standards of fruits and vegetables.

- This section/table is to assess respondents' perceptions of what FOOD products labelled with the 5 claims: Advertised quality by seller, Safe" Vegetables, VietGap certified, Organic and Organic certified by PGS.

Definition:
Advertised Quality by seller: Traceability information covers place of origin of the product but no further information on the product label.
Safe Vegetables: Product is produced by safe vegetables protocol by a group of farmers and certification is only on production condition.

Vietgap fruits and Vegetables: Vietnamese Good Agricultural Practices (VietGap) is certified by Government which prevents or minimizes the potential hazards of chemical, biology and physics that could occur during production, harvesting and post-harvest handling of fruit and vegetables. Safe and clean fruits and vegetables are sold in safe vegetable stores. Traceability information covers farming
Organic Vegetables: Produced by a group of farmers. It has a certificate which shows that no chemicals or pesticide have been used in the production.
Participatory Guarantee Systems (PGS) certified organic vegetables: Organic certification is certified by NGOs organizations which adopted international PGS organic standards. Organic certified vegetables are sold in the fresh market. Traceability information covers farming, distribution and processing, circulation and marketing.
Moc Chau: Grow in Moc Chau
Bac Ha: Grow in Bac Ha

- Please do this one column at a time.

- **Question J3:**

    Begin question J3 by first asking: "When purchasing fruits and vegetables, how important it is for you that the product is labelled or certified as….?" This question is asked to understand if the respondent is aware of the meaning of certified labels how much of importance they are giving in choosing between conventional fruits and vegetables and organic, safe or pesticide free fruits and vegetables.

- Show the respondent the 'Importance Scale" on the app window. Respondent should point to level of importance.

- Place 1-5 for question J3.

- NO QUESTION SHOULD BE BLANK- ALL QUESTIONS SHOULD BE CODED 1, 2, 3, 4, or 5.

- **Question J4:**

Have you ever bought/use fruits or vegetables labelled as […]? Show the respondent the food product labels with the 5 claims: Advertised quality by seller, Safe" Vegetables, VietGap certified, Organic and Organic certified by PGS.

• If their response in row 1 is "yes", then proceed to ask the questions in rows 2-10.

• No space should be left blank, must be coded as yes = 1 or no = 2.If the consumer doesn't know any standards for fruits and vegetables, the answer should be "No", then go to the next module.

- **Question J5: Place(s) you have bought them**

This question asked to know the place from where they have bought the fruits and vegetables labelled as […].

- **J6. Agreement**

- Do you agree with the following statements? [Complete each column in this section ONLY if the answer in row 1 above = yes. Otherwise leave column blank]

- Asks the question about the reason of buying the fruits and vegetables labelled as […]. We have 9 agreement statements which are answered by choosing the option "Yes" or "No"

- No space should be left blank, must be coded as 1 – 10 in the hard copy of the questionnaire.

- If they do not want someone to certify then use "10 = no difference".

SECTION J2: TRUSTS AND CERTIFICATION

- J7-J9 ask the questions about TRUST TO CERTIFY [...] For Fruits and Vegetables, Shrimp, Chicken and Beef.

• For each certification in the row, we want to know who they think would be best to certify that attribute for FRESH Fruits and Vegetables, Shrimp, and Beef.

• There is no right answer – it is the respondent's opinion of who they think is best for each different type of certification and food product.

Safety certification: Agency is inspecting the production processes to ensure that producers and processors are following "best practices" to prevent food borne pathogens or residues that might harm human health. The following are claims that might be used: "Clean", "Safe", "Organic", Expiry Date, and No Additives.

Quality certification: Agency inspects the product to guarantee that the product meets specific grades or standards or levels of quality.

Production information certification: Agency inspects and verifies that claims such as organic, pesticide free, natural etc. are actually used.

Nutrition information certification = Agency is inspecting food manufacturer to make sure any nutritional claims such as fat free, low fat, low calorie, low sugar, high energy etc. are true.

The following table provides some examples for codes for J8

Codes for J7-J9	
1 The Vietnamese Government (Federal)	(e.g. Central Government, Ministry of Health)
2 State or local government	(e.g. Provincial or District government)
3 Foreign Government	(e.g. E.U., USA, China, Japanese government)
4 Farmers & farmer organizations	Individual farmer or Vietnamese farmers org. HKTI
5 Food company (brand)	Vinamik, Unilever, Masan, Vina Acecook, Nestle
6 Retailer/Supermarket	Metro, Big C, Fivi Mart, Unimart, AC Mart, Minimart.
7 Independent 3rd party (not for profit)	Not for profit organization, WHO, consumer group,
8 Religions organization	The Charity Commission of the Buddhist Church of Vietnam
9 Other (Specify)	
10 No opinion	This should be used only if they suggest another option, this is not suitable for "do not know"

J11. DOES YOUR HOUSEHOLD EVER PURCHASE PRODUCT (SHOWN IN J10)?

- All cells in J11 must be filled in with either 1 = Yes or 2 = No

- If J12 = 2 then do not need to answer J13-J15 for the product and can skip to next product (row)

J12-J14: Only Ask for product if J12 = 1, otherwise skip to next product (row)

J12. NORMAL PRICE PAID

- Ask respondent to estimate the average price per unit (VND per kilogram) that they pay for each product. It is their best estimate.
  - If they purchase different varieties (e.g. different varieties of mangos), then just ask for an average price per kilogram.
- Only blank if J11 = 2

J13. CHOICE: between buying conventional [product] and [product] that is labeled "Certified […]" Ask respondent "*If you have a choice between buying conventional [product] and [product] that is labeled "Certified Organic", which one would you buy*?"

- Must be a code (1-3) if respondents buy product (J11 = 1).
- Only blank if J11 = 2

J14. MAXIMUM AMOUNT WILLING-to-PAY: What is the maximum amount that you would be willing to pay for [product] that is labelled as "[Certified …]"

- Only ask to respondents if J12 = 2 or J12 = 3.
- Ask respondent "What is the maximum amount extra that you would be willing to pay for [product] that is labelled as "Certified "?
- Note for the enumerators:
- For J14, create that comes up with a series of prices that are calculated off of the value the respondent indicates for J13. So, we would have 5 boxes each in 20% premium increments. If the respondent said that they would pay $2/kg for tomatoes normally then we'd have 5 boxes that had a formula in them that calculates the % based on what they put in J13. The boxes that would pop-up in the app would be as shown below in

$ values appropriate. Then enumerator would code in what they punched 1-5 where 1=0% premium, 2=25% premium, 3 = 50% premium; 4= 75% premium; 5= 100% premium.

Considering the value that the household normally pay for (product listed (J10) for question J11), what is the most that you would be willing to pay for a certified .... (NOTE- this would be 1) "Certified-Safe" and then 2) "Certified Bac Ha Grown"

| Formula embedded | = J13 | =1.25*J13 | =1.50*J13 | =1.75*J13 | =1*J13 |
| Values REspondent Sees on Screen and can point to and select | $2.00/kg | $2.50/kg | $3.00/kg | $3.50/kg | $4.00/kg |

K. DIET RELATED HEALTH AND MANAGEMENT

K2. LEVEL of CONCERN:

- We want to know whether or not they are concerned about these health and diet related diseases – we are NOT asking about whether they have the disease, but whether they are concerned.

- You might suggest explaining that OBESITY means "very fat" and UNDERWEIGHT means very thin

- Please try to get them to answer 1-5 (Show them the options in the app)

  o 1 = NOT at all Concerned. This means that they are not worried at all about whether or not they have or will get this disease.

  o 5 = EXTREMELY OR VERY CONCERNED- they are worried about getting this disease and possibly do things such as buying different food products or changing what they eat or the amount of exercise they get to try and prevent or manage the disease.

K3. DIAGNOSED

- This question is to know if a **<u>licensed medical practitioner (e.g. doctor, nurse, dietician, government health official)</u>** has diagnosed ANYONE (adult or child) with the diseases.

    o Diagnosis by a non-medical professional (e.g. natural health practitioner) is <u>not</u> suitable for "Yes"

- If the answer is "Yes" then they also need to answer K4 and following questions in the row.

- If the answer "No" then they do not need to answer K4-K9 for that row, they can skip to the next row.

K4. Which Household Member?

- Select the name of the household member from the options in the app

K5. YEAR FIRST DIAGNOSED

- If K3 = 2 ("no") for row then please leave blank.

- We just want to know the year of diagnosis for the first person who had the disease in the household.

    o **<u>Example:</u>** A household has 3 members that have obesity, their names are Jesmin, Dung and Ina, Jesmin was diagnosed with obesity in 1998, Dung was diagnosed with obesity in 2002 and Ina was diagnosed in 2008.

- o The response in K5 (Obesity) would be "1998" because this was the year the disease was FIRST diagnosed in the household.

K6. WERE CHANGES MADE TO MANAGE OR PREVENT DISEASE

- This is "yes" or "no". Ask if they have done anything to try and manage their disease, in other words, if they have diabetes, what are they doing to keep it from getting worse or harming their ability to lead a normal life. If they have obesity, are they doing things to keep from gaining more weight or to lose weight?

- If Yes then go to K7

- If No then No need to ask questions for K7, K8 and K9 and these questions will not appear in the app.

K7-K9. WHAT IS DONE TO CONTROL PROBLEM?

- Please ask this question "Unprompted". In other words, if their answer to K6 was "YES" then you would ask the respondent "*What have you done to control [problem]?*" You should code their responses using the codes provided in the lower right-hand side of page. (Codes for K7-K9 are 1-15).

- If respondent cannot think of specific ways they manage disease, THEN show respondent the codes and they can indicate yes or no. We do not want more than 3 for each row/disease.

- If they only do 1 or 2 things to manage disease then no need to ask questions K8 to K10

- If no code matches their explanation then please code using "15" and explain in the space provided.
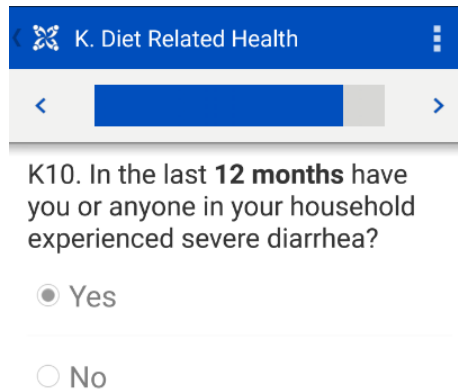
NOTE: FOR K1 "Underweight or malnourished" K6-K9 should not be filled in.

K10. EXPERIENCED DIARRHEA

- We want to know if ANYONE (ADULTS AND CHILDREN) in the household has experienced diarrhea in the past year. The answer should be either Yes or No. If they

answer Yes, then you should ask the name of the family member that appears in the app as below:

- This does not have to be diagnosed by medical professional- just if they think they have had diarrhea.

- NOTE: Code is provided above question.

K11. EXPERIENCED ILLNESS RELATED TO FOOD POISONING

- We want to know if ANYONE (ADULTS AND CHILDREN) in the household has experienced any illness that they think they obtained from bad food. For example, if they got diarrhea, vomiting, and/or stomach-ache that they think is related to the food they ate then the response should be 1 or 2.

- This does not have to be diagnosed by medical professional- just if they think they got sick because of something they ate.

K12. ADULT SAW A MEDICAL PROFESSIONAL

- We want to know if any ADULTS saw a doctor or health care provider in the past 12 months- this should be a licensed doctor, nurse or government health care worker – NOT traditional or alternative medicine provider.

K13. CHILD SAW A MEDICAL PROFESSIONAL

- We want to know if any of the CHILDREN saw a doctor or health care provider in the past 12 months- this should be a licensed doctor, nurse or government health care

worker – NOT traditional or alternative medicine provider. The answer should be either Yes or No.

L. OTHER

L1. CHANGE IN HOUSEHOLD SIZE

- L1 has a code (1-3)

- Today compared to 5 years ago (2011 vs. 2016)

- 1 = increased could be because of birth, marriage, in-laws moving in etc.

- 2 = No change or household is the same size as it was 5 years ago

- 3 = household size decreased could be because of a death, divorce/separation, child moving out, household member working away from home etc.

L2. CHANGE IN HEALTH STATUS

- L2 must have a code (1-4)

- On average are people in the household more or less healthy than 5 years ago? (2011 vs. 2016)

- This is the respondent's opinion or perception.

- 1 = improved, 2 = no change (same as 5 years ago), 3 = deterioration (worse than 5 years ago), 4 = do not know (only use if respondent doesn't understand or really has no understanding)

L3. SPECIFY CHANGE IN HEALTH STATUS

- Only answer if L2 = 1 (improved) or 3 (deterioration)

- Use codes 1- 6 provided

- Specify the reason in word, if the respondent chose the option "Other".

In the app L3 will only appear if the respondent answers Improved or deterioration in question L7.

L4. APPROXIMATE INCOME per MONTH

- L4 has a code (1-10)

- Income of the household per MONTH, this should include any income coming into the household from all household members EXCEPT domestic employees. For self-employed members income is business revenue minus business expenses.

- Use the code (1- 10) provided that gives the best estimate of total household income

L5. CHANGE IN STANDARD OF LIVING

- L10 must have a code (1-5)

- Standard of living today compared to 5 years ago? (2011 vs. 2016)

- This is the respondent's opinion or perception.

L6. REASON FOR CHANGE IN STANDARD OF LIVING

- If L5 = 3 then skip question L6. Otherwise L6 must have a code (1-9) and only one response should be coded. If respondent says change is related to more than one reason then enumerator must ask them to specify the most important reason for the change.

- This is the respondent's opinion or perception.

M. ECONOMIC SHOCKS

The Recall period for economic shocks is 5 years (2011-2016).

- Note to enumerator: Households sometimes have good and bad surprises. First ask about any bad surprises or things that hurt the household financially.

- Section M has Shock codes from (1-32) for a variety of economic loss that affected the household member financially. If the household responds that there was some other reason (NOT included in the codes), then select the option "Other" (code 99) and specify the reason.

M1. WHICH SHOCKS

- Asks the respondent "Which shocks did you experience in the last 5 years (2011-2016)?" The respondent may either select the options from the app or may specify other option.

- Please note that the household can select multiple option considering the possibility of facing multiple shocks faced by the household members.

M2. NUMBER OF OCCURANCEs

- Asks the following question: "If yes, how many times did it occur in your household in the last 5 years (2011-2016)?" The household may have faced the same shock more than one time during the past 5 years.

M3 – M4. WHEN DID IT HAPPEN

- Select **the month and the year** of the first occurrence of a shock. You do not need a specified date if the household does not know which day it has happened.

M5. CURRENT CONDITION AFTER THE SHOCK

Asks the current condition of the household after the shock/shocks.

M6 HOW MUCH ECONOMIC IMPACT HAVE YOU FACED AFTER THE SHOCK?

0= no impact, 1=small impact, 2 = moderate impact, 3= Large/significant impact

M7 COPING STRATEGY

These questions ask about the coping strategies taken by the household in response to any shocks. M7 will ask about the first coping strategy

M8 IMPACT OF THE SHOCK (How Long?)

- This question asks the respondent how long did the impact of the event or shock last. The answer should be given as the number of days that were affected by the event/shock.

  In the app, M2 to M10 will appear for each type of the shocks selected by the respondent.

M9 RANK THE WORST 3 SHOCKS

- Ask the respondent to rank the worst 3 shocks if they have responded more than two shocks in the past five years. Show them the options from the app to rank the worst 3 shocks.

Module N HOUSEHOLD FOOD CONSUMPTION SCORE NUTRITIONAL QUALITY ANALYSIS

- The enumerator should read the following to the respondent: "Now, I am going to ask you how many days over the last 7 days, did members of your household eat the following food items, prepared and/or consumed at home, and what was their source? I am going to read you several statements. Please tell me either yes or no, and if yes, how often does it happen."

- Question N1-N9 are the questions about the food items that were prepared and/or consumed by the household at home and where was their source. There are 16 food groups in **SECTION N** which are as follows:

FOOD ITEMS IN SECTION N
Cereals, grains, roots and tubers: Rice, pasta, bread, sorghum, millet, maize, potato, yam, cassava, white sweet potato
Legumes / Nuts: beans, cowpeas, lentils, nut, soy, pigeon pea and / or other nuts
Milk and other dairy products: fresh milk / sour, yogurt, cheese, other dairy products (Exclude margarine / butter or small amount of milk for tea / coffee
Meat, fish and eggs: goat, beef, chicken, pork, blood fish including canned tuna, escargot, and / or other seafood, eggs (meat and fish consumed in large quantities and not as a condiment)
Flesh meat: beef, pork, lamb, goat, rabbit, chicken, duck, other birds, insects
Organ meat: liver, kidney, heart and / or another organ meat

Fish/shellfish: fish including canned tuna, escargot, and / or other seafood, eggs (fish in large quantities and not as a condiment)
Eggs
Vegetables and leaves: spinach, onion, tomatoes, carrots, peppers, green beans, lettuce, etc.
Orange vegetables (vegetable rich in Vitamin A): carrot, red pepper, pumpkin, orange sweet potatoes
Green leafy vegetables: spinach, broccoli, amaranth and / or other dark green leaves, cassava leaves
Fruits: banana, apple, lemon, mango, papaya, apricot, peach, etc.
Orange Fruits (Fruits rich in Vitamin A): mango, papaya, apricot, peach
Oil / fat / butter: vegetable oil, palm oil, shear butter, margarine, other fats / oil
Sugar, or sweet: Sugar, honey, jam, candy cookies, pastries, cakes and other sweet (sugary drinks)
Condiments / Spices: tea, coffee / cocoa, salt, garlic, spices, yeast / baking powder, tomato / sauce, meat or fish as a condiment, condiments including small amount of milk / tea coffee

- For each of these 16 food items, the respondent must answer the "Number of days eaten in previous 7 days"

- For each of these 16 food items, the respondent must answer the "main source of this food in the last 7 days"

- An example in the app is shown below:

- Codes for the question: "What was the main source of this food in the last 7 days?" are as follows:

  1. From Own production (e.g. own garden or farm)

  2. Purchased by the family member

3. Borrowed from friends/relatives

4. Gifts from friends/relatives

5. Food assistance (e.g. from government organizations or NGOs)
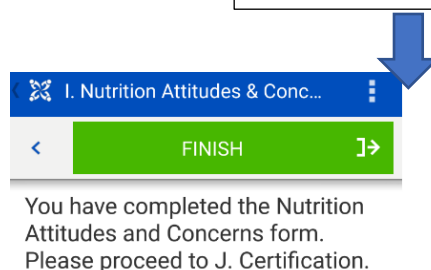
FINAL QUESTION:

1. **TAKE THE ANTHROPOMETRIC MEASUREMENTS: Follow the instruction provided in the anthropometric manual**

2. **LEAVE THE 24-HOUR FOOD RECALL FORM TO THE HOUSEHOLD AND PICK THEM LATER**

   - **THE ENUMERATOR SHOULD LEAVE THE 24 HOUR FOOD DIARY FORM TO THE RESPONDENT TO BE FILLED IN LATER. ALSO ASK HIM/HER THE MOST CONVINIENT TIME TO PICK THE FORM LATER OR SOME OTHER DAY.**

IMPORTANT NOTE FOR THE ENUMER

Always click this arrow after

You have completed the Nutrition
Attitudes and Concerns form.
Please proceed to J. Certification.

ENDING THE INTERVIEW

After completing the questions thank the respondent for his or her time. As a matter of courtesy, it may be appropriate to ask the respondent if he or she has any questions about the survey or the study.

Appendix 2: 24-hour food dairy questionnaires and instructions for the interviewee to complete the 24-hour food diaries

This module solicits detailed information about everything the respondent and all household members had to eat and drink from midnight to midnight the previous day or over the past 24-hour period, and the usual food they prepare during special occasions. This module is divided into 4 parts: cover page, 24-hour food recall, recipes of home-cooked food items, usual food prepared during special occasions.

The cover page contains several household identifiers, the data day, market days and actual market visits of the household to buy food items. Again, before starting the interview for this module, read the instruction to the respondent. The target respondent in this module is <u>the person who normally prepares food in the family</u>. Other household members present may also be invited to participate so they could answer the portion sizes they consumed in each meal by themselves. Emphasize to the respondent the need to get detailed information for <u>all</u> food and drinks (including drinking water and baby food, if applicable) consumed in the previous day, as well as the portion sizes of each household member, including infants and children.

> *Instruction: This part of the interview is to ask you [THE MAIN PERSON WHO PREPARES FOOD] what your entire household members ate or drink yesterday. If the other household members are available, we would like to invite them as well so they can answer the amount of food they consumed. Please recall and tell us all food items including drinks (water, vegetable soup, tea, soft drinks, other beverages and alcohol) and any type of condiment (fish sauce, vinegar, pepper, salt, ketchup, chili or any other spices). Also include the food intake by infants and young children - milk and other milk substitutes and any other soft food taken. Try to be as detailed as you can.*

The cover page of the consumption module includes the following information:

M1	Please tick which day the information for the 24-hour food recall refers to	• This is the data day for which the 24-hour food recall module was based on. Based on the results of the Observational Study done in December 2016-January 2017, it was decided that the printed copy of 24-hour food diary will be dropped off on the same weekday to interviewee and picked up later. Then two (2) 24-h food recall surveys (one weekday and one non-consecutive weekend) will be dropped to interviewee and picked up later)
	HH ID no	
	Date of interview (dd/mm/yyyy)	
M2	Name of head family	
M3	Name of respondent	
M4	Address/location	
M5	Name of village	
M6	Name of commune	
M7	Name of district	
M8	City	
M9	Phone/Mobile number	
M10	When is the main market day(s) in your location? [Tick all that applies]	This is the main market day in the village (or in the commune or district if there is no village market). The type of market we are referring here pertains to supermarket, wet market or

		traditional market where people gather to buy food. It does not include small stores located near the household. Multiple response is allowed.
M11	Tick what day(s) you normally go to market* to buy food. Place 88888 if NA.	Multiple response is allowed. If the household does not visit any market and buys only at a small store near their house, write "88888" to mean "not applicable".

The second part is the 24-hour food recall which solicits detailed information about everything the respondent and all household members had to eat and drink from midnight to midnight the previous day or over the past 24-hour period. The 24-hour recall segment is from columns M12 – M27 and is divided into three parts:

- Module M1 (24-hour food recall diary when dining out): Total amount of food servings prior to consumption (M12– M14). This refers to the total serving size of all recipes/mixed dishes when eaten away from home and acquired (bought or given by others) individual food items before most (if not all) household members ate or drank them. Information sought are the cooking method for each food item, quantity of total servings and the household members who shared the meal. Normally, the mother or the father would bring out serving dishes of rice or mixed dishes in large containers before all household members get their individual portions. This is what is required in these columns, e.g. 5 cups of hot steamed white rice served on a big bowl, or boiled cabbage served on a big bowl, or 1.5 litres of soft drink.

- Module M2 (24-hour food recall diary of Intra-Household food consumption): Portion sizes (edible portions only) eaten by each household member (M15-M24). This refers to the edible portions eaten by each household member, including infants and children. Similar with the total amount of servings, information sought pertains to the portion size eaten by each household member, as well as some validation questions on whether the meal is considered a usual meal by the household member or otherwise, and if the household member is on special diet. Take note that the portion sizes indicated here for all household members who shared the meal must not exceed the total amount of food servings.

- Module M3 (Recipes of food cooked at home over the last 24 hour) (M24-M25). The list of recipes only includes those that were prepared and cooked at home. Then, the list of ingredients need to be listed based on the quantity used per recipe. Aside from this information, where the food item came from, who bought it, quantity of raw ingredient used, price per unit and total cost of raw ingredient are also included.

Let us begin with the first two parts: **(M1) Total amount of food servings prior to consumption and (M2) the Portion sizes (edible portions only) eaten by each household member.**

(M1) Total amount of food servings

M12: During the last 24 hours, did your family have any member eat-away-from-home for this meal _____? 1. YES, please fill in the following table   2. NO

If the respondent says YES, then they will fill-up the following table:

Start time (6:30am) [Begin from the earliest time they ate to the latest]	This is the time the respondent and other household members start eating the particular meal or food.
End time (e.g. 8:30am)	This is the time the respondent and other household members finished eating the particular meal or food.
Occasion	Ask the respondent what s/he calls this occasion. Then, find the nearest match in the codes provided at the end of this section in the questionnaire. If none in the codes matches with what the respondent said, select "99" and write it down.
Write complete recipe names. For individual items (e.g. mango, cake, etc.). For commercial products, include brand name (e.g. Nestea iced-tea lemon flavour).	Write the name of the recipe or individual item in each row. In this part, you need to write down the complete name of the recipe or dish eaten by the household. For instance, "boiled cabbage with pork meat and tomato." Please, write down all individual food items in the paper questionnaire. Commercial products should be written down as is, including the brand name if possible.
Where was the food prepared?	This is to know if the recipes and/or individual food items listed were prepared at home, bought outside or given by a neighbour.

Cooking method	How the recipes/mixed dishes and individual food items were prepared: ready-made ingredient like those commercial products bought at the store; eaten as raw like some fresh fruit and vegetables; steamed; and others. Refer to the codes in the questionnaire.
Quantity/volume of total serving [before eating or drinking]	This is the number of serving dishes brought to the dining table or bought by individual household member(s) prior to eating or drinking.
	For dishes prepared and cooked at home, this refers to the number of serving dishes taken out to the dining table. For instance, if the mother brought one (1) big bowl of rice and two (2) big plate of fried fish, you will write in this column these numbers to refer to the quantity of total serving.
	Another example is a commercial product bought in a shop. For instance, the son bought 2 cakes and 1 bottle of Pepsi soft drink from a nearby store. Under this column, you will write these numbers to refer to the quantity of total serving.
Unit of measure	This is the unit of measure for the quantities of total servings. The categories here are the household measures used as serving dishes or the containers of commercial products prior to cooking or consumption. Weight of total serving [before eating] (in g or mL)
Place where eaten	For example, the respondent has eaten at the office cafeteria

Write all HH members who shared this food.	Write down all household members who shared this meal together in the space provided. Use the Household Member code in A1.

M13. Who paid the meal?

The meal could be family self- paid, employer paid, paid by friends or relatives or could be some other option. Please specify the other options if paid by other.

M14. Did you have any left over from the meal?

Answer as either Yes or No.

(M2) Portion sizes (edible portions only) eaten by each household members

M15. Who is the respondent giving this information? (If the person providing this information for the other household members is not the main respondent who prepares the food for all household members, please write down the name below)

M16-24: Name of the respondent who is giving the information of portion sizes (household no 1-9 or more)

Place eaten	Location of where the food was consumed: home, office or school cafeteria, etc. Refer to the codes in the questionnaire.

Portion size	This is the number of portion servings eaten by the household member using the local household measures (e.g. bowl, plate, glass, cup/mug) and utensils (e.g. tablespoon).
	For instance, if the mother ate 1 small bowl of rice and half a small bowl of boiled cabbage, under this column, you write these numbers to refer to the number of portions serving eaten.
Unit of measure	This refers to the local household measures (e.g. bowl, plate, glass, cup/mug) and utensils (e.g. tablespoon) used by the household member when eating. Refer to the codes in the questionnaire.
	Using the above example, you write under this column "7" to refer to "small bowl" for both rice and boiled cabbage under the mother's entry.
	Then, write under the Notes section the different diameters of the local household measures to help the field supervisor and survey coordinator derive the conversion factors for the correct household containers.

Note: *For any food item that contains inedible portion (e.g. banana skin, mango stone, chicken or fish bones), only weigh the edible portion only. * (in g or mL)

The suggested line of questioning in these two parts is by occasion.

- o **IMPORTANT**: For all local household items used for serving food (serving bowl, serving plate, pitcher for water or any drinks, cookware if used as serving dishes) or for eating (Vietnamese households commonly use a small bowl to eat food) mentioned in the 24-h food recall, take a picture of these local household containers and utensils using a ruler as scale. This will help the field supervisor and survey coordinator in deriving its conversion factor (gram-mL-equivalents) for mixed dishes served or eaten on local household items.

M3: Recipes of food cooked at home (M25)

After getting information on the total servings and individual portion sizes consumed by the household members, we will now get the list of ingredients used by the respondent in preparing and cooking the mixed dishes/recipes identified in module M1.

M25. Did your family prepare any foods for this meal _____? 1. YES, please fill in the following table. Please record all materials used for the new cooked foods for this meal and the drinks consumed in this meal (does not include seasonings and leftover from previous meals) 2. No

To fill these portions, do it by recipe.

1. List all ingredients used for the first recipe (ingredient 1, ingredient 2, ingredient 3, etc.) and fill B33.

2. Then, for each ingredient, ask questions w

3. Go to the next recipe and do steps 1 and 2, until you reach the last home-cooked recipe

List down the home-cooked food indicated.	
List all ingredients** used per recipe in descending order of quantity per recipe. Indicate brand name if possible.	The list of all ingredients <u>per mixed dish</u> should be recorded in descending order of quantity used. Include the brand name and the net weight per container, if possible.
Where did you get this?	From where the ingredient was sourced: home, own garden/farm, market (specify), etc.
If purchased, who bought it?	This is to know who brought it to the house.
Quantity of raw ingredient in recipe	This is the amount of raw ingredient used in the recipe.
Unit of measure	This is the unit of measure used, e.g. sachet, gram, millilitre, etc. Refer to the codes in the questionnaire.

Price per g or mL	This is the price per gram or millilitre. The survey coordinator will calculate this.
	
	If, for instance,
	
	   a. The father bought 1 bottle of orange juice (=350 mL) for 10,000 VND, the price per g/mL = 10,000 VND/ 350mL = 28.51 VND/mL.
	
	   b. If the father bought 1 kg of tofu for 25,000 VND/kg, the price per gram is 25,000 VND/1,000g = 25 VND/gram.