Can modern food retailers improve diets and nutrition in urban Africa? Empirical evidence from Zambia

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Summary

In many developing countries, food environments are changing rapidly, with modern food retailers – such as supermarkets and convenience stores – increasingly replacing or complementing traditional food retailers. In comparison to traditional food markets and shops, modern retailers often sell a different range of products, at different prices and packaging sizes, and in different shopping atmospheres, thus affecting people's food environments and potentially also their food choices, diets, and nutrition. Understanding the dietary and nutrition effects of a modernizing retail sector is important, as many countries in Africa suffer from a double or even a triple burden of malnutrition – i.e., the coexistence of undernutrition, micronutrient deficiencies, and overweight or obesity within the same communities, households, and even individuals – with serious negative health consequences. Recent research suggests that access to and affordability of healthy diets remain formidable challenges in many developing countries. However, empirical studies analyzing the effects of modern retailers on consumer diets, dietary costs, and nutrition remain scant.

A few recent studies showed that the growth of modern retailers, especially supermarkets, in developing countries contributes to higher consumption of ultra-processed foods and rising rates of overweight and obesity among adults. For children, research on the links between modern retailers and child nutrition is still limited; the few existing studies found mixed results. In any case, the available evidence suggests that modern retailers may have different effects on dietary quality and nutrition among adults and children. One major drawback of existing studies is that they analyzed individual-level anthropometric data, yet without having individual-level dietary data to explain some of the underlying mechanisms. Therefore, none of the previous studies analyzed the effects of modern retailers – such as supermarkets – on dietary quality (i.e., nutrient intake) with individual-level dietary data to account for intra-household food distribution. Another drawback is that previous studies mostly focused on supermarkets, without accounting for the fact that other types of modern retailers – such as convenience stores and fast-food restaurants – are also gaining in importance as sources of food in urban Africa. Finally, the role of supermarkets and other modern retailers on the affordability of nutritious diets was not analyzed in any of the existing studies.

We make several contributions to the existing literature by addressing the highlighted research gaps in the three papers of this dissertation. In the first paper, we examine the relationships between consumers' socioeconomic status, use of different modern and traditional retailers, and dietary patterns. The analysis uses household survey data from urban Zambia. We

surveyed a total of 475 urban households in 2018. Results show that two-thirds of the households use modern and traditional retailers simultaneously, but that richer households are more likely than poorer ones to use supermarkets and hypermarkets. Use of modern retailers is positively associated with higher consumption of ultra-processed foods, after also controlling for income and other socioeconomic factors. However, the use of traditional stores and kiosks is also positively associated with the consumption of ultra-processed foods, suggesting that modern retailers are not the only drivers of dietary transitions.

In the second paper, we provide the first empirical study that analyzes effects of modern retailers on dietary quality and nutrition with individual-level food-intake/dietary and anthropometric data in a developing country. We collected data from 475 randomly selected households that use modern retailers at different intensities in Lusaka, Zambia. In these households, individual-level anthropometric and food-intake data were collected from 930 adults and 499 children. The data are analyzed with control function regression models to address potential endogeneity problems associated with food purchases made in modern retailers. We find that use of modern retailers is positively associated with overweight in adults, but not in children. For children, we find a positive effect on body height, also after controlling for income and other relevant factors. Use of modern retailers increases dietary diversity, calorie, protein, and micronutrient intakes among both adults and children. Effects on protein and micronutrient intakes are channeled primarily through higher consumption of meat and dairy products.

In the third paper, we analyze effects of using supermarkets on the affordability of recommended nutritious diets and dietary quality. We use individual-level food-intake data and food price data from our household survey conducted in Lusaka, Zambia, and control function regression models to account for the likely endogeneity of supermarket food purchases. We find that the cost of a recommended nutritious diet is US$1.22 per day, of which the largest share is the cost of starchy staples (68%), followed by fruits (11%), and meat, eggs, and fish (9%). However, this diet is not affordable to 41% of low-income group. Meat, fish, and dairy products are more expensive in supermarkets than in traditional retailers. Nevertheless, buying food in supermarkets increases dietary diversity and intake of nutritious diets, with varying effect sizes among demographic cohorts: men, women, boys, and girls. The positive effects of supermarkets on dietary quality largely come from animal source foods.

We draw several conclusions and policy implications from the three papers in this dissertation. The findings underline that the growth of modern food retailers in developing countries influences people's diets and nutrition; the effects can be both positive and negative. The positive effects on child nutrition and dietary quality of both children and adults imply that further modernization of food environments should be promoted. However, due to higher quality food products and safety standards, modern retailers – such as supermarkets – offer higher prices for meat, fish, and dairy products than traditional retailers. Thus, the results suggest a need to shift food policy from focusing on energy-dense foods to affordable nutritious foods. Modern retailers could be one of the platforms to make nutritious foods – i.e., meat, fish, eggs, milk, and other dairy products – more affordable especially among poor households. Lower prices could come from improvements in local production, higher efficiency in procurements, marketing and trade, and infrastructure developments especially cooling facilities and warehouses.

On the other hand, the increasing effect of modern retailers on the consumption of ultra-processed foods and adult overweight is undesirable and calls for certain policy regulations. Possible policy interventions include regulation of advertisement and promotional campaigns for unhealthy foods, regulation of health labels and portion/packaging sizes, taxes on ultra-processed foods and beverages with high contents of fats, added sugars and salts, among others. While the results cannot be generalized, effects may be similar also in other parts of Africa. Nevertheless, further research is needed to better understand the diet and nutrition effects of changing food environments in different geographical and socioeconomic contexts, and also focusing on long-run dynamics.

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1 General introduction

1.1. Background

Hunger and micronutrient malnutrition are global problems with serious negative health implications (Ruel et al., 2017; FAO et al., 2019; Swinburn et al., 2019). In many developing countries, undernutrition and micronutrient deficiencies typically coexist with rising rates of overweight and obesity within the same communities, households, and even individuals (Development Initiatives, 2018; FAO et al., 2019; Fongar et al., 2019; Harris et al., 2019; Hawkes et al., 2020; Popkin et al., 2020). Globally, it is estimated that 1.9 billion people are overweight or obese, and 600 million people have diabetes (IFPRI, 2017; Popkin, 2017). At least 2.8 million people die each year due to overweight or obesity (WHO, 2010). It is also estimated that over 800 million people are still chronically hungry, and at least 2 billion people suffer from micronutrient deficiencies worldwide (IFPRI, 2017). Approximately 45% of all child deaths are linked to undernutrition (Black et al., 2013). Food environments, defined as the physical, economic, and sociocultural context in which consumers acquire their food, can influence dietary choices, dietary quality, and nutrition (Popkin, 2014; Popkin, 2017; Qaim, 2017; Hawkes et al., 2020).

In many developing countries, food environments are changing rapidly, with modern food retailers – such as supermarkets and convenience stores – increasingly replacing or complementing traditional food retailers (Tschirley et al., 2015; Ziba and Phiri, 2017; Lu and Reardon, 2018). Unlike traditional food markets and shops, modern retailers often sell a different range of products, at different prices and packaging sizes, and in different shopping atmospheres (Asfaw, 2008; Hawkes, 2008; Reardon and Timmer, 2014; IFPRI, 2017). Due to higher efficiency and economies-of-scale, modern retailers may contribute to a larger variety of food products becoming available and affordable for many population segments (Hawkes, 2008; Tessier et al., 2008; Popkin, 2014; Qaim, 2017). For instance, most urban consumers can access both unhealthy foods – e.g., ultra-processed foods which are often rich in fat, sugar, and salt, but poor in micronutrients – and nutritious foods from supermarkets (Asfaw, 2008; Reardon and Timmer, 2014; Rischke et al., 2015; Rupa et al., 2019; Debela et al., 2020). Recent research suggests that healthy diets are not affordable to more than 1.58 billion people (21% of the world's population) worldwide, of which 72% are in South Asia and sub-Saharan Africa (Hirvonen et al., 2020). Changing food environments, especially in urban areas, may influence consumers' food choices, dietary costs, and nutrition. However, empirical studies analyzing the effects of modern retailers on food consumption, the affordability of recommended diets, and nutrition are relatively scant.

A few recent studies with data from Africa, Asia, and Latin America showed that the growth of modern retailers, especially supermarkets, contributes to higher consumption of highly processed foods and rising rates of overweight and obesity among adults. For instance, studies in Guatemala, Thailand, and Kenya showed that purchasing food in supermarkets leads to higher consumption of processed and highly-processed foods (Asfaw, 2008; Kelly et al., 2014; Rischke et al., 2015). In Guatemala and Kenya, supermarket food purchases were also shown to contribute to rising body mass index (BMI) and increased prevalence rates of overweight, obesity, and related chronic diseases among adults (Asfaw, 2008; Kimenju et al., 2015; Demmler et al., 2017; Demmler et al., 2018). For children, very few studies have analyzed effects of modern retailers on nutrition, and those that did found mixed results (Umberger et al., 2015; Debela et al., 2020).

1.2. Research gaps and objectives

While the existing research provides important evidence on the effects of modern retailers on diets and nutrition, several limitations exist. First, especially in Africa, relatively little is known about what type of consumers actually use modern supermarkets and to what extent. Another drawback is that most previous studies mostly focused on supermarkets, without accounting for the fact that other types of modern retailers – such as convenience stores and fast-food restaurants – are also gaining in importance as sources of food in urban Africa (Tschirley et al., 2015; Lu and Reardon, 2018). Moreover, focusing only on supermarkets may be misleading, as most consumers also obtain their food from various traditional retailers (Berger and van Helvoirt, 2018; Lu and Reardon, 2018; Vetter et al., 2019).

Second, one important shortcoming of all existing studies is that they did not collect individual-level food-intake/dietary data. Individual-level dietary data are important to analyze effects of modern retailers on dietary quality and better understand the mechanisms behind the nutrition impacts. Most existing studies (e.g., Asfaw, 2008; Rischke et al., 2015; Rupa et al., 2019; Debela et al., 2020) collected food consumption data at the household level, suggesting that purchasing food in supermarkets can lead to higher household dietary diversity in some situations. But household-level data neglect intra-household food distribution and are therefore not necessarily good proxies of individual-level dietary quality and micronutrient intakes. Hence, none of the available studies has analyzed effects of modern retailers on nutrition and dietary quality (i.e., nutrient intake) with individual-level anthropometric and food-intake data to account for intra-household food distribution in a developing country.

Third, none of the previous studies on retail modernization has analyzed effects of modern retailers on the affordability of recommended nutritious diets. Moreover, most previous studies analyzed the cost of nutritious diets only for particular target groups, such as women (e.g., Masters et al., 2018; Alemu et al., 2019; Hirvonen et al., 2020) or children (Headey et al., 2019). Yet, inequalities in dietary affordability could exist among various household members. More importantly, available studies analyzed the cost of nutritious diets using food price data from the World Bank's International Comparison Program, where only standardized food items are included (e.g., Alemu et al., 2019; Hirvonen et al., 2020). Hence, some of country-specific nutritious foods (e.g., local insects, fish, fruits, pulses and some dark green leafy vegetables) are omitted. Finally, none of the available studies on the cost of nutritious diets analyzed the role of modern retailers such as supermarkets.

This dissertation addresses the highlighted research gaps by analyzing effects of modern food retailers on consumer diets and nutrition in urban Africa. The specific objectives of the dissertation are:

1. To examine the relationships between consumers' socioeconomic status, use of different modern and traditional retailers, and dietary patterns.
2. To analyze effects of using modern food retailers on adult and child diets and nutrition.
3. To analyze effects of using supermarkets on the affordability of recommended nutritious diets and dietary quality among demographic cohorts.

1.3. Data and study context

The data used in this dissertation were collected through a household survey conducted by the author in Lusaka, the capital city of Zambia, between April and July 2018. Like many other countries in sub-Saharan Africa, Zambia is an ideal setting for this study for several reasons. First, it is one of the southern African countries with rapid growth in modern retailers (Tschirley et al., 2015; Ziba and Phiri, 2017). For instance, our own review of internet sources supplemented by key local informant interviews revealed that the number of large shopping malls in Lusaka City increased from one in 1995 to 25 in 2018 (Table 1.1). Moreover, a substantial share (43%) of the food consumed by urban households in Lusaka is purchased from modern retailers such as supermarkets and fast-food restaurants (Khonje and Qaim, 2019).

Table 1.1: List of main shopping malls with modern food retailers in Lusaka City

No.	Name of shopping mall	Location and surrounding compounds or sections	Modern food retailers: Hypermarkets, Supermarkets (Fast-food restaurants in parentheses)
1	Arcades	Roma, University of Zambia (UNZA)	Spurs
2	Cairo	Central Lusaka	Shoprite (Food Fayre, Hungry Lion, Machachos)
3	Chawama	Chawama, John Haward, Kuku	Spur
4	Chazanga Shoprite	Chazanga, SOS	Shoprite
5	Chilenje Shoprite	Chalala, Chilenje, Woodlands	Choppies, Shoprite (Debonairs Pizza, MM Chickens, Naaz)
6	Choppies Complex	Kabulonga, Sundel, Zamtel Flats	Choppies
7	Cosmopolitan	Chawama, John Howard, Jon-Lengi, Makeni, Misisi	Game Stores, Shoprite (Chicken Inn, Galito's, Hungry Lion, Mochachos, Pizza Hut)
8	Cross Roads	Cross Road, Kabulonga, Nyumba Yanga, Sundel	Spurs (Gigibonta, Major Meat)
9	Down Town	Chibolya, Jon-Lengi, Kabwata, Kamwala, Misisi	Spurs (Big Bite, Debonairs Pizza, Down Town Foods)
10	East Park	Childley, Kalingalinga, Kalundu, Ng'ombe, Roma, UNZA	Food Lover's, PicknPay (Fishaways, Gigibonta, GoatnChips, Hungry Lion, KEG, Pizza Hut)
11	Embassy	Chawama, Jon-Lengi, Makeni, Misisi	Embassy, Spurs (Papas, Piatto, Zorbas)
12	Garden City	Avondole, Chelston	Food Lover's, PicknPay (Bushman, Foodano)
13	Kabulonga and Melissa	Kabulonga	Melissa, PicknPay (Debonairs Pizza, KFC, Nando's, Subway)
14	Levy Junction	Central Lusaka, Chilulu, Evelyn Home College, Gardens, Nippa, North Mead, Roads Park, Thorn Park	Food Lover's, PicknPay (Chicken Inn, Hungry Lion, KFC, Pizza Inn, Wimpy)
15	Makeni	Chawama, Jon-Lengi, Makeni, Misisi	Food Lover's, PicknPay (Debonairs Pizza, KFC, Nando's)
16	Mama Betty Foxydale	Ngo'mbe, Roma	Spur (Debonairs Pizza, Gigibonta)
17	Manda Hill	Central Lusaka, Chilulu, Gardens, Longacres, Olympia, Roads Park	Shoprite, Game Stores (Bread Café, Debonairs Pizza, Galito's, Hungry Lion, Mugg and Bean, My Asia, Nando's, Pizza Inn, Steers, Subway, Vasila)
18	Matero	Matero	Shoprite (Hungry Lion)
19	Novara Great North	Chazanga, SOS	PicknPay (GoatnChips, Hungry Lion)
20	PHI	Kaunda Square, PHI, Mtendere	PicknPay (Debonairs Pizza, King-Pie)
21	SOS Spurs	Chazanga, SOS	Spur
22	Twin Palm	Avondole, Chelston, Ibex, Salama Park	Shoprite (Chicken Inn, Debonairs Pizza, Hungry Lion)
23	Waterfalls	Avondole, Chelston	Shoprite (Gigibonta, Hungry Lion)
24	Woodlands	Chilenje, Kabulonga, Woodlands	PicknPay (Creamy, Debonairs Pizza, Galito's, Nachies, O. Hagans, Pizza Inn)
25	Zappa	Chawama	(Debonairs Pizza)

Notes: The main shopping malls that were operating in 2018 are included. Very small shopping malls are not included. Likewise, malls that were still under construction in 2018 are not included. The list was compiled by the authors based on internet search, personal visits, and key informant interviews.

Second, Zambia is characterized by a high prevalence of micronutrient malnutrition (Harris et al., 2019; Kaliwile et al., 2019). For instance, among women and children; 98%, 34-55%, 26%, and 19% are deficient in vitamin B_{12}, zinc, vitamin A, and iron, respectively (Harris et al., 2019). Third, the share of adults who are overweight/obese has increased from 12% in 2002 to 32% in 2017 (Steyn and Mchiza, 2014; Harris et al., 2019). Finally, stunting rates in Zambia are high, ranging from 40% to 50% (Harris et al., 2019). Overall, different forms of malnutrition coexist with rising overweight and obesity in Zambia.

We surveyed a total of 475 households from several compounds/sections in Lusaka City using a two-stage random sampling procedure. At the first stage, we purposively selected 14 compounds/sections as primary sampling units based on population distributions, the locations of major shopping malls (Table 1.1), as well as information from the Lusaka City council on mean income levels in the different compounds/sections of the city. To ensure that the sample is fairly representative of households in the urban parts of Lusaka, we selected compounds/sections from high (Avondole, Chalala, Kabulonga, Woodlands), middle (Chelston, Chilenje, Kabwata, PHI), and low (Chawama, Chazanga, Gardens, Kalingalinga, Kaunda Square, Ng'ombe) mean income levels. A spatial distribution of the surveyed compounds/sections and households is shown in Figure 1.1.

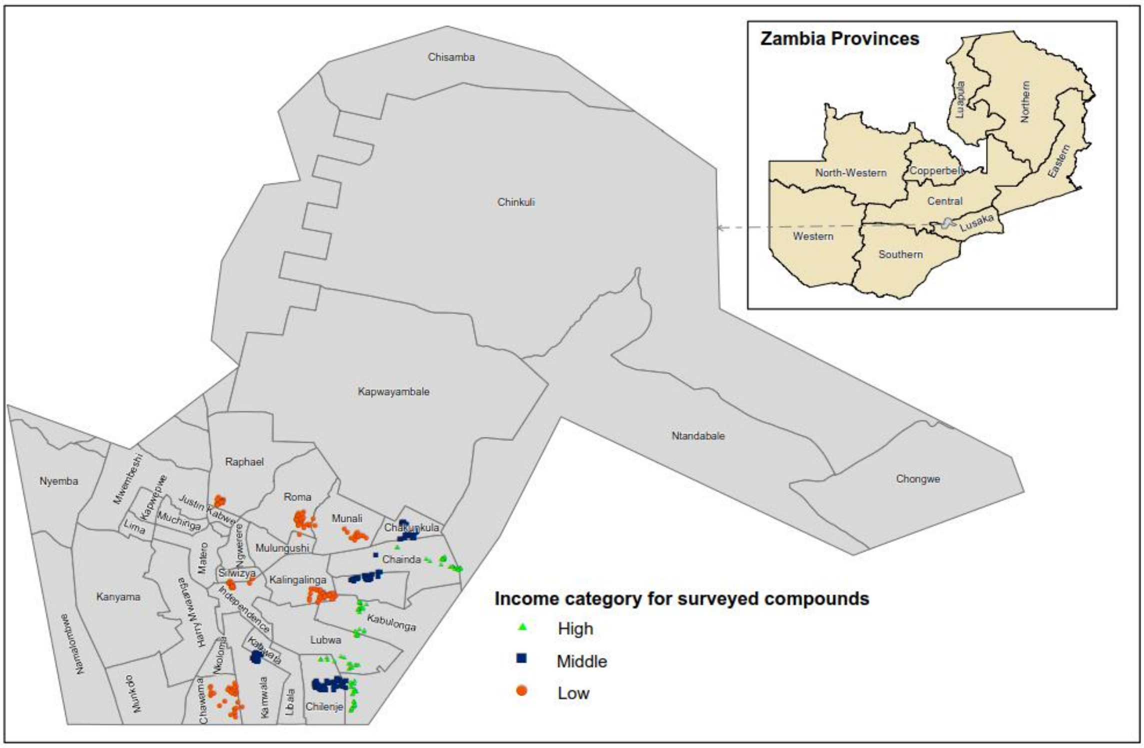


Figure 1.1: Map of Lusaka City with sampled compounds/sections and households

At the second stage, depending on the size of the compound/section, we randomly sampled about 35 households from each compound/section for study participation. In each of the sampled household, we interviewed the household head or another adult respondent responsible for most food purchase decisions and food preparation. We recruited local enumerators to conduct face-to-face interviews in local languages. The enumerators were trained and supervised by the researchers. Food-intake data were captured at the individual level for up to four randomly selected members of each household: two adults (≥18 years) and two children/adolescents (6 months – 18 years). Individual-level dietary data were collected through 24-hour dietary recalls; for small children the recall data were provided by the caregiver. Weight and height of all participating individuals were also measured. All participating adults provided written consent for themselves and for their children. The study was reviewed and approved by the Ethics Committee of the University of Goettingen.

In addition to the individual-level anthropometric and food-intake/dietary data, data on food consumption at the household level were collected through a seven-day recall using a list of 140 different food items typically consumed in the local setting, and capturing quantities and sources of each item. We also captured food price data for different food items at the household level through a seven-day recall. To account for individual and household level characteristics, our structured questionnaire also covered other sections including household demographic structure, economic activities, income, and consumption expenditures (see General Appendix).

1.4. Dissertation outline

The rest of this dissertation is organized as follows: Chapter 2 presents the first paper, analyzing the relationships between consumers' socioeconomic status, use of different modern and traditional retailers, and dietary patterns largely using the household level food consumption data from 475 households. The second paper is presented in Chapter 3, which analyzes effects of modern retailers on adult and child diets and nutrition. The second paper uses individual-level food-intake and anthropometric data from 930 adults and 499 children. The third paper, which analyzes effects of supermarkets on the affordability of recommended nutritious diets and dietary quality, is presented in Chapter 4. The third paper uses food price data and the individual-level food-intake/dietary data from 1,429 observations: 295 men, 594 women, 240 boys, and 300 girls. Chapter 5 draws general conclusions and policy implications, based on all three papers. Limitations of the study are also discussed. The questionnaire developed for the study is presented in the General Appendix.

2 Modernization of African food retailing and (un)healthy food consumption[1]

Abstract

Food environments in Africa are changing rapidly, with modern retailers – such as supermarkets, hypermarkets, and fast-food restaurants – gaining in importance. Changing food environments can influence consumers' food choices and dietary patterns. Recent research has suggested that the growth of supermarkets leads to more consumption of processed foods, less healthy diets, and rising obesity. However, relatively little is known about what type of consumers actually use modern supermarkets and to what extent. Moreover, focusing only on supermarkets may be misleading, as most consumers obtain their food from various modern and traditional retailers. We add to the literature by examining relationships between consumers' socioeconomic status, use of different modern and traditional retailers, and dietary patterns. The analysis uses household survey data from urban Zambia. Results show that two-thirds of the households use modern and traditional retailers simultaneously, but that richer households are more likely than poorer ones to use supermarkets and hypermarkets. Use of modern retailers is positively associated with higher consumption of ultra-processed foods, after also controlling for income and other socioeconomic factors. However, the use of traditional stores and kiosks is also positively associated with the consumption of ultra-processed foods, suggesting that modern retailers are not the only drivers of dietary transitions.

Keywords: Retail modernization; supermarkets; food consumption; diets; nutrition transition; Zambia.

[1] This paper has been co-authored with Matin Qaim (M.Q.). The research idea was jointly conceptualized and designed by I, Makaiko Gonapanyanja Khonje (M.G.K.) and M.Q.. M.G.K. collected, analyzed, and interpreted the data, and wrote the first draft of the manuscript. M.Q. commented on the paper at various stages and approved the final version – writing: review and editing. The paper is published in *Sustainability*, 11(16), 4306. DOI: https://doi.org/10.3390/su11164306.

2.1. Introduction

Food systems in developing countries have been evolving rapidly in the last few decades, with a growing role played by modern retailers such as supermarkets, hypermarkets, convenience stores, and fast-food restaurants (Gómez and Ricketts, 2013; Popkin 2014; Reardon and Timmer, 2014; Andersson et al., 2015). The modernization of food systems is largely driven by consumer preference changes resulting from urbanization, income growth, and globalization (Tschirley et al., 2015; Minten et al., 2017; Qaim, 2017; Lu and Reardon, 2018; Reardon et al., 2019). However, at the same time consumer preferences and demand may also be shaped by changing food environments (Popkin, 2017; Laska et al., 2018; Popkin and Reardon, 2018). For example, a shift from traditional markets to modern supermarkets and hypermarkets has effects on the types of food offered, as well as on food variety, food prices, and shopping atmosphere, all of which may influence consumer choices (Asfaw, 2008; Hawkes, 2008; Reardon and Timmer, 2014; Odunitan-Wayas et al., 2018). Understanding the links between changing food environments and food consumption patterns is important to promote food security and healthy diets. This is especially true in Africa, where poverty and undernutrition are still widespread, but where being overweight and obesity are also on the rise (Ruel et al., 2017; Harris et al., 2019; Kroll et al., 2019).

Available research suggests that the modernization of food retailing may make calories more affordable for urban consumers but – at the same time – may foster the nutrition transition towards more highly processed foods that are rich in fat, sugar, and salt, but contain low amounts of micronutrients and other ingredients for healthy nutrition (Asfaw, 2011; Gómez and Ricketts, 2013; Popkin and Reardon, 2018; Freire and Rudkin, 2019). Recent studies with data from different countries in Africa, Asia, and Latin America suggest that the growth of supermarkets may contribute to increased consumption of processed foods and a higher body mass index (BMI), after also controlling for household income (Asfaw, 2008; Kimenju et al., 2015; Rischke et al., 2015; Umberger et al., 2015; Demmler et al., 2018; Kroll et al., 2019). However, especially in Africa, relatively little is known about what type of consumers actually use modern supermarkets and to what extent. Moreover, focusing only on supermarkets may be misleading, as most consumers obtain their food from various modern and traditional retailers (Berger and van Helvoirt, 2018; Lu and Reardon, 2018; Zhong et al., 2018; Vetter et al., 2019).

Here, we add to the existing literature by analyzing more explicitly the associations between household socioeconomic status, the use of different types of retailers, and dietary patterns in urban Africa. In particular, we use household survey data from urban Zambia to analyze what type of socioeconomic characteristics are associated with the choice of modern and traditional food retailers, and to what extent the use of different retailers is associated with the consumption of processed and unprocessed foods, and products belonging to different healthy and unhealthy food groups. To our knowledge, this is the first study that looks into these issues with detailed data from Africa.

Zambia is an interesting empirical setting for this analysis, because it has recently experienced rapid growth of supermarkets, hypermarkets, and other modern retailers (Tschirley et al., 2015). Moreover, Zambia is experiencing a triple burden of malnutrition, where undernutrition and micronutrient malnutrition coexist with rising overweight and obesity (Steyn and Mchiza, 2014; Harris et al., 2019). Hence, our results may help to project how diets evolve with further changes in retail environments and what type of policy responses might be useful. We expect that the insights from Zambia can be useful also for other countries in Africa, where the modernization of the food retail sector is still in its earlier stages.

The rest of this paper is organized as follows. Section 2 provides an overview of the most important types of modern and traditional food retailers in Zambia. Section 3 explains materials and methods, including a description of the household survey, the measurement of key variables, and the econometric models used. Section 4 presents and discusses the results, while Section 5 provides the conclusions.

2.2. Modern and traditional food retailers in Zambia

Food retail environments in many African countries have been changing rapidly during the last 20 years, with a considerable growth of modern retailers such as supermarkets and hypermarkets (Tschirley et al., 2015; Ziba and Phiri, 2017). Zambia is one of the countries in the Southern African region with particularly high growth rates of modern retailers (PlanetRetail, 2017; Ziba and Phiri, 2017). For instance, our own review of internet sources supplemented by key informant interviews in the local context revealed that the number of large shopping malls in Lusaka City increased from one in 1995 to 25 in 2018 (Table 1.1). These shopping malls with a big variety of shops are also the main locations of supermarkets, hypermarkets, and fast-food restaurants.

Most of these modern retailers are almost homogenous in product offerings across countries in Africa. For instance, supermarket retail giant like Shoprite; Africa's largest food retailer is operating more than 2738 outlets in 15 African countries (Angola, Botswana, Democratic Republic of Congo, eSwatini, Ghana, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Nigeria, South Africa, Uganda and Zambia) (Shoprite Holdings, 2017). Smaller supermarkets and convenience stores are also found in other locations. In the following, we characterize the main types of modern food retailers that we also use in the empirical analysis below. We characterize the most important types of traditional food retailers as well. An overview of the key characteristics of each type of retailer is shown in Table 2.1. The classification builds on criteria similar to those used in previous studies (Rischke at al., 2015; Berger and Helvoirt, 2018; Demmler et al., 2018), partly adjusted to the local context based on key informant interviews.

The largest modern retailers are hypermarkets with a floor space of more than 200 m^2. The main hypermarket chains in Lusaka are Game Stores, Cheers, and Choppies. Supermarkets are similar to hypermarkets, but are smaller with 100–200 m^2 of floor space. Major supermarket chains in Lusaka include Shoprite and PicknPay, among others. Both hypermarkets and supermarkets are self-service stores with a wide range of fresh and processed products, including chilled and frozen foods. Convenience stores also belong to the category of modern retailers. They are also self-service in nature but are smaller (<100 m^2) and offer a more limited range of food products. Finally, we include fast-food restaurants – such as Hungry Lion, Debonairs Pizza, and KFC – in the group of modern retailers (Table 2.1).

Traditional food retailers include grocery stores, traditional markets, roadside markets, and neighborhood kiosks (Table 2.1). None of the traditional retailers have self-service options, all providing over-the-counter services. Traditional retailers are mostly owner-operated and do not belong to larger chains. Customers can negotiate prices to some extent and can usually also buy foods on credit. The range of products and brands offered by traditional retailers is smaller than that offered by modern retailers. Packaging sizes are also smaller. Sometimes traditional retailers repackage foods such as sugar, flour, or cooking oil, into very small packets, which are particularly demanded by poor customers. Traditional retailers rarely sell frozen and chilled foods, mostly due to lack of refrigeration facilities.

Table 2.1: Key characteristics of different food retailers in Lusaka City, Zambia

Characteristic	Modern retailers				Traditional retailers			
	Hypermarket	Supermarket	Convenience store	Fast-Food restaurant	Grocery store	Traditional market	Roadside market	Neighborhood kiosk
Typical location	Big shopping mall	Big shopping mall	Small shopping mall	Big shopping mall or gas station	Very small shopping mall	Traditional marketplace	Informal stall	Formal or informal stall
Floor space (m^2)	>200	100–200	<100	10–30	10–70	1–10	1–5	1–5
Modern cash tills	4–15	4–10	<4	<4	None	None	None	None
Service type	Self-service	Self-service	Self-service	Pressing order	Over the counter	Over the counter	Over the counter	Over the counter
Credit facility	No	No	No	No	Possible	Possible	Possible	Possible
Promotions via media	Often	Often	Often	Often	Very rare	No	No	No
Price discounts	Occasional (e.g., month ends)	Occasional (e.g., month ends)	Occasional (e.g., month ends)	Occasional (e.g., month ends)	Very rare	No	No	No
Price negotiation	No	No	No	No	No	Often	Often	Often
Product range	Large variety of food and non-food products	Large variety of food and non-food products	Limited variety of food and non-food products	Only fast food products and beverages	Limited variety of food products	Fairly large variety of legumes, cereals, vegetables	Fairly large variety of fruits and vegetables	Fairly large variety of legumes, cereals, vegetables
	Large variety of fruits and vegetables	Large variety of fruits and vegetables	Limited variety of fruits and vegetables	Limited variety of vegetables				
	Frozen, canned, and cooked food	Frozen, canned, and cooked food	Limited variety of frozen and canned food				Sometimes cooked food	
Packaging size	Small to very large	Small to very large	Small to very large	Small to very large	Small to large	Very small to small	Very small to small	Very small to small
Repacking	No	No	No	No	No	Often	Often	Often
Key actors (examples)	Game Stores, Cheers, Choppies	Shoprite, PicknPay, Food Lover's, Spurs	Numerous	Hungry Lion, Debonairs Pizza, KFC, KEG	Numerous	Soweto, Compound Markets	Numerous	Numerous

2.3. Materials and methods

2.3.1. Household survey

The data used in this study were collected through a household survey in Lusaka, the capital city of Zambia, between April and July 2018. We surveyed a total of 475 households using a two-stage random sampling procedure. At the first stage, we purposively selected 14 compounds or sections within Lusaka urban. These compounds were selected based on the locations of major shopping malls as well as information provided by the City Council on mean income levels in the different compounds or sections. Based on population distributions, we selected four compounds with high mean income levels (Avondole, Chalala, Kabulonga, Woodlands), four compounds with medium income levels (Chelston, Chilenje, Kabwata, PHI), and six compounds with low income levels (Chawama, Chazanga, Gardens, Kalingalinga, Kaunda Square, Ng'ombe). At the second stage, depending on compound size, we randomly sampled around 35 households from each compound for study participation. The spatial distribution of selected compounds and households is shown in Figure 1.1. The sample should be fairly representative of households in the urban parts of Lusaka.

In each of the sample households, we carried out a face-to-face interview with the household head or another adult responsible for food purchase decisions. The computer-aided structured interviews were conducted in the local language by a small team of interviewers that we recruited, trained, and supervised. The questionnaire that we had developed for this purpose captured general economic and socio-demographic information of the household and its members. Food consumption data were collected through a 7-day household-level recall, using a detailed list of food items typically consumed in the local setting. In addition to food quantities and expenditures, we also collected data on the processing level and the source of each food item, focusing particularly on the different modern and traditional retailers. These data were used to construct various key variables, as discussed below.

2.3.2. Measurement of key variables

We are interested in analyzing the relationship between socioeconomic characteristics and use of different retailers. Socioeconomic characteristics of interest include household income levels, education, gender, and age of the household head, household size and structure, ethnicity, religion, car ownership, among others. Previous research showed that these characteristics can influence the decision of which retailers to use (e.g., Asfaw, 2008; Rischke et al., 2015; Umberger et al., 2015; Demmler et al., 2018; Odunitan-Wayas et al., 2018; Rupa et al., 2019). The use of different retailers is measured through a set of dummy variables capturing whether or not the household purchased any food from a particular type of retailer during the 7-day recall period. In addition to the retailer dummies, we also examine the share of the total household food budget spent in different retail outlets.

We are also interested in analyzing associations between the use of different retailers and dietary patterns. One way of looking at dietary patterns is through classifying all food items consumed by their level of processing. We differentiate between unprocessed foods, primary processed foods, and ultra-processed foods (Demmler et al., 2018). For these three processing levels, we calculate household expenditures and food expenditure shares. Unprocessed foods include wholegrain cereals and pulses, fresh fruits and vegetables, eggs and fresh milk, among others. Primary processed foods include milled cereals and fresh meat and fish. Ultra-processed foods include bread, pasta, dairy products, sausages and meat products, soft drinks, sweets, and other ready-made dishes and snacks (Table A2.1 in the Supplementary material). Ultra-processed foods are generally considered less healthy than unprocessed foods, because they often have high sugar, fat, and salt contents, and low fiber and micronutrient contents. Research has shown that high consumption of ultra-processed foods is associated with obesity and increased risks of chronic diseases such as coronary heart diseases, stroke, and diabetes (Monteiro et al., 2010; Beatty et al., 2014; Steyn and Mchiza, 2014; Harris et al., 2019).

Separate indicators of dietary patterns that we use are the quantities of different food groups consumed by the households during the 7-day recall period. We use the following food groups: cereals and tubers, legumes, fruits, vegetables, meat and fish, dairy products, eggs, oils and fats, and sugar and sugar-sweetened beverages. While the last two food groups are considered as rather unhealthy, the others contain important nutrients and can therefore contribute to healthy nutrition.

2.3.3. Statistical analysis

We start the analysis by calculating descriptive statistics for the use of modern retailers and dietary patterns and comparing between households of different socioeconomic status. For this purpose, we subdivide the sample into three groups of almost equal size, namely the lower, middle, and upper income terciles. In addition, we use regression models to analyze the associations of interest more formally.

To analyze the socioeconomic factors that influence the use of different types of retailers, we estimate models of the following type:

$$\boldsymbol{FR}_i = \alpha + \beta' \boldsymbol{X}_i + \varepsilon_i \quad (2.1)$$

where $\boldsymbol{FR}_i$ is a vector of the types of food retailers that household i used during the 7-day recall period, $\boldsymbol{X}_i$ is a vector of socioeconomic variables, and ε_i is a random error term. $\boldsymbol{FR}_i$ is measured through a set of dummy variables, one for each of the modern and traditional retailers considered, so that we use a probit specification to estimate Equation (2.1). Households can use more than one type of retailer, and the decisions for different retailers are likely correlated. We use a multivariate probit model to account for possible error correlation between the equations for different retailers (Cappellari and Jenkins, 2003).

Next, we analyze how far the use of particular retailers is associated with more or less healthy dietary patterns by estimating regression models of the following type:

$$\boldsymbol{DP}_i = \gamma + \delta' \boldsymbol{FRS}_i + \rho' \boldsymbol{X}_i + u_i \quad (2.2)$$

where $\boldsymbol{DP}_i$ characterizes the observed dietary pattern of household i, and u_i is the random error term. $\boldsymbol{FRS}_i$ is a vector of variables representing the food expenditure shares of each of the retailers, and $\boldsymbol{X}_i$ is a vector of socioeconomic characteristics. In one set of regressions, $\boldsymbol{DP}_i$ will characterize expenditures for foods with different processing levels, while in another set of regressions $\boldsymbol{DP}_i$ will characterize the consumption of different healthy and unhealthy food groups.

For the processing level equations, we use an ordinary least squares (OLS) estimator. As error term correlation between the different equations is possible, we also use a seemingly unrelated regression (SUR) estimator to compare the results. Furthermore, in addition to estimates with the full sample, we estimate separate models for households below and above the poverty line, as the role of modern retailers may potentially differ by socioeconomic status. For the food group equations, we use a Tobit estimator, because the consumption quantities are left-censored at zero. To account for the heterogeneity among the sampled households, for all models, standard errors are clustered at the level of city compounds.

We start estimating the models in Equation (2.2) by only considering one food retailer in $\boldsymbol{FRS}_i$, namely supermarkets. This is similar to previous studies that have analyzed the effects of supermarkets on diets and nutrition (Asfaw, 2008; Rischke et al., 2015; Umberger et al., 2015; Demmler et al., 2018; Rupa et al., 2019). However, conclusions based on such models that only consider the use of supermarkets may be incomplete, as households typically use various types of retailers. To demonstrate this, we re-estimate the same models with all types of retailers included. We note that the use of food retailers (vector $\boldsymbol{FRS}_i$) is endogenous, so the estimated δ coefficients from Equation (2.2) should not be interpreted as causal effects. Using instruments to deal with possible endogeneity bias would be possible in principle, but is difficult in our case, with a total of eight endogenous variables. We were unable to identify eight valid instruments, which is why we interpret the estimated coefficients only in terms of associations.

2.4. Results and discussion

2.4.1. Household socioeconomic characteristics

Table 2.2 shows summary statistics for selected household socioeconomic variables (additional variables are shown in Table A2.2 in the Supplementary material). Average annual per capita incomes range from US$ 410 in the lowest tercile to more than US$5,000 in the highest tercile. Twenty-seven percent of the sample households fall below the international poverty line of US$1.90 per capita in purchasing power parity terms (World Bank, 2019). We observe large differences between the income terciles in terms of education, occupation, and car ownership. While only 3% of the households in the lowest tercile own a car, in the highest tercile the share is 60%.

The middle and lower parts of Table 2.2 show food consumption patterns. The average consumption of cereals, tubers, and legumes does not differ much between the three income terciles, whereas the consumption of most of the other food groups increases considerably with income, as one would expect. Noteworthy is the very low consumption of fruits in all three income terciles. Many of the households consume fruits only occasionally. In terms of processing levels, for the sample as a whole, 25% of the food expenditures are for unprocessed foods, 40% for primary processed foods, and 35% for ultra-processed foods.

Table 2.2: Socioeconomic characteristics and food consumption patterns

	Full sample	By income tercile		
		Lowest	Middle	Highest
Socioeconomic characteristics				
Household income (US$/year)	10691.40	1855.67	7548.14	22920.93
	(12163.16)	(1036.68)	(2134.58)	(14347.06)
Household size (members)	4.52	4.53	4.47	4.56
	(1.63)	(1.79)	(1.66)	(1.43)
Male household head (dummy)	0.53	0.46	0.49	0.65
	(0.50)	(0.50)	(0.50)	(0.48)
Education of household head (dummy)	12.03	9.48	11.88	14.77
	(3.93)	(3.62)	(3.46)	(2.71)
Office job (dummy, any household member)	0.45	0.10	0.51	0.74
	(0.50)	(0.30)	(0.50)	(0.44)
Car ownership (dummy)	0.28	0.03	0.21	0.60
	(0.45)	(0.16)	(0.41)	(0.49)
Food consumption				
Cereals and tubers (kg/week)	11.88	11.23	11.45	12.97
	(5.20)	(5.48)	(4.56)	(5.38)
Legumes (kg/week)	1.22	1.27	1.34	1.03
	(1.59)	(1.55)	(1.83)	(1.34)
Fruits (kg/week)	0.28	0.22	0.26	0.37
	(0.82)	(0.73)	(0.83)	(0.89)
Vegetables (kg/week)	4.22	4.36	4.57	3.70
	(3.74)	(3.78)	(3.87)	(3.52)
Meat and fish (kg/week)	4.81	3.38	4.85	6.24
	(3.45)	(2.86)	(3.24)	(3.64)
Dairy products (kg/week)	0.61	0.25	0.48	1.11
	(1.27)	(0.65)	(1.01)	(1.74)
Eggs (kg/week)	0.44	0.28	0.34	0.69
	(0.77)	(0.64)	(0.67)	(0.92)
Oils and fats (kg/week)	0.69	0.65	0.72	0.70
	(0.60)	(0.58)	(0.60)	(0.62)
Sugar, sweetened beverages (kg/week)	1.68	1.28	1.65	2.13
	(2.59)	(1.99)	(2.31)	(3.26)
Food expenditures				
Total weekly food expenditure (ZMW/capita)	112.46	96.32	115.61	125.69
	(62.98)	(65.99)	(59.37)	(60.18)
Unprocessed foods (%)	0.25	0.29	0.25	0.20
	(0.14)	(0.16)	(0.13)	(0.12)
Primary processed foods (%)	0.40	0.35	0.40	0.45
	(0.17)	(0.18)	(0.17)	(0.15)
Ultra-processed foods (%)	0.35	0.36	0.35	0.35
	(0.14)	(0.14)	(0.14)	(0.12)
Observations	475	159	160	156

Notes: Mean values are shown with standard deviations in parentheses. ZMW, Zambia Kwacha (local currency). The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. Descriptive statistics of additional variables are shown in Table A2.2 in the Supplementary material.

Strikingly, the expenditure share for ultra-processed foods does not increase with income, emphasizing that the purchase and consumption of these types of foods are very common for all types of households in Lusaka City.

2.4.2. Role of modern and traditional retailers

Table 2.3 shows the proportion of households using the different modern and traditional retailers. This refers to the sources of the foods consumed during the 7-day recall period used in the household survey. While the regular use of hypermarkets and fast-food restaurants is relatively low, the majority of all households (73%) used supermarkets. Even more (75%) used at least one of the modern food retailers. As expected, the use of modern retailers increases considerably from the lowest to the highest tercile. In the highest tercile, almost all

Table 2.3: Proportion of households using different modern and traditional retailers

	Full sample	By income tercile		
		Lowest	Middle	Highest
Modern retailers				
Hypermarkets	0.05	0.01	0.04	0.12
Supermarkets	0.73	0.48	0.78	0.92
Convenience store	0.12	0.12	0.09	0.16
Fast-food restaurant	0.02	0.01	0.01	0.04
Traditional retailers				
Grocery stores	0.45	0.64	0.43	0.28
Traditional market	0.73	0.70	0.74	0.74
Roadside market	0.36	0.54	0.33	0.20
Neighborhood kiosk	0.20	0.17	0.20	0.23
Observations	475	159	160	156

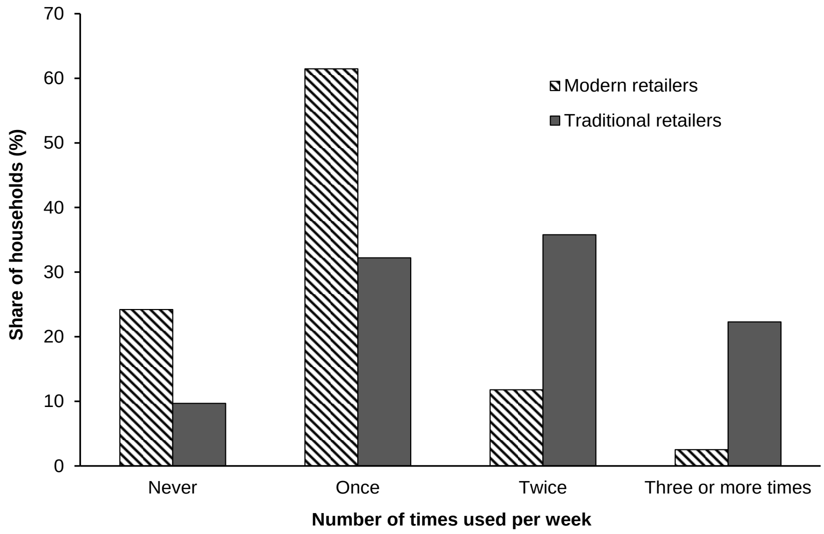


Figure 2.1: Frequency of use of modern and traditional retailers in Lusaka City

households used at least one of the modern retailers. Most households in all income terciles used more than one type of retailer during the 7-day recall period. Two-thirds used both modern and traditional retailers.

Figure 2.1 shows that the average frequency of traditional retailer use is higher than that of modern retailer use. Many households make one larger purchase in a supermarket or hypermarket once a week and then purchase additional foods from traditional retailers whenever needed during the week.

The finding that many consumers use both modern and traditional retailers is consistent with a recent study for Nairobi (Berger and van Helvoirt, 2018) and also with theoretical predictions for a setting with large socioeconomic heterogeneity (Lu and Reardon, 2018). The use of some traditional retailers decreases with rising household income, which is especially true for grocery stores and roadside markets. In contrast, the use of traditional markets and kiosks does not decrease with rising income (Table 2.3).

Figure 2.2 shows the distribution of household food expenditure shares by type of retailer. For the sample as a whole, 42% of the food expenditures are made for purchases from modern retailers. This is very high when compared to most other African countries, even when only looking at urban areas (Qaim, 2017). The rest of the household food budgets are spent (58%) in traditional retail outlets. Notable differences are observed between the three income terciles. While households in the highest tercile make 63% of their food expenditures in modern retailers, for households in the lowest tercile this share is only around 20%.

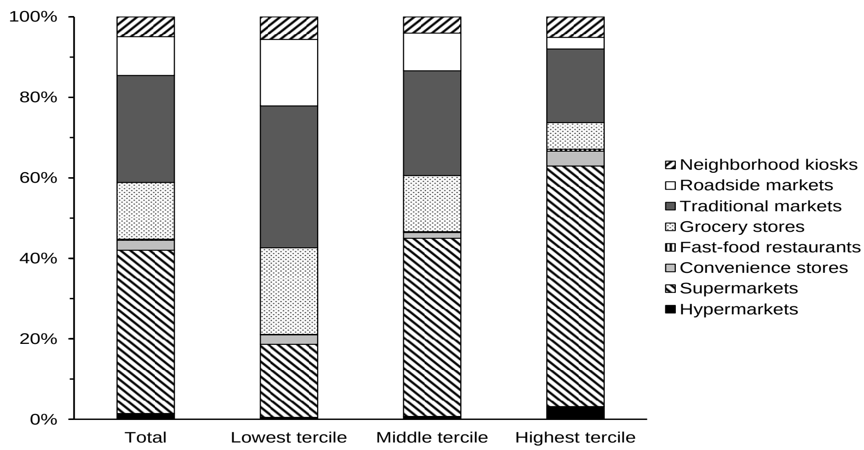


Figure 2.2: Household food expenditure shares spent in different retail outlets in Lusaka City

This is in line with Figuié and Moustier (2009), and Berger and van Helvoirt (2018) who found that poor households use modern retailers less extensively than rich households in Vietnam, and Kenya, respectively. Among the modern retailers, supermarkets account for the lion's share of food expenditures for all households in Lusaka.

2.4.3. Factors influencing the use of modern retailers

We now look at the estimation results from the multivariate probit model to analyze factors influencing the household decision regarding whether or not to use particular types of retailers (see Equation (2.1) above). Average estimated marginal effects are shown in Table 2.4. Household income has a positive effect on the likelihood of using modern supermarkets and hypermarkets and a negative effect on the likelihood of traditional grocery stores and roadside markets, also after controlling for a number of other household characteristics. As mentioned earlier, occasionally, many households make one larger purchase in a modern retailer and often buy smaller food quantities from a traditional retailer (e.g., see Figure 2.1). In contrast, and consistent with the descriptive statistics above, the likelihood of using traditional markets and kiosks does not decrease with rising income. The use of traditional kiosks even increases when household income rises.

Education also affects the use of modern supermarkets positively. Similarly, more education tends to increase the use of fast-food restaurants. This latter result may be surprising, because fast food dishes are typically not very healthy, and better-educated households are generally expected to know more about healthy nutrition. On the other hand, education may also be a proxy of more exposure to global influences and lifestyles, which may contribute to a certain preference for westernized diets. Furthermore, better-educated consumers are often more conscious about food safety issues. In many developing countries, modern retailers and restaurants are perceived to fulfill higher food safety standards than their traditional counterparts (Mergenthaler et al., 2009; Gorton et al., 2011; Schipmann and Qaim, 2011; Wertheim-Heck et al., 2015). This could also explain why households with more education are significantly less likely to use traditional grocery stores, roadside markets, and kiosks. For instance, each additional year of schooling reduces the likelihood of purchasing food from a roadside market by 2.8 percentage points.

Table 2.4: Factors influencing the use of different food retailers (Multivariate Probit Model)

	Modern retailers				Traditional retailers			
	Hypermarket	Supermarket	Convenience store	Fast-Food restaurant	Grocery store	Traditional market	Roadside market	Neighborhood kiosk
Income (log)	0.031**	0.063***	0.027	0.011	–0.045**	0.015	–0.043**	0.072***
	(0.015)	(0.017)	(0.018)	(0.009)	(0.022)	(0.022)	(0.021)	(0.022)
Household size	–0.004	–0.031**	0.019*	0.009*	0.054***	0.017	0.044***	–0.001
	(0.009)	(0.012)	(0.011)	(0.005)	(0.016)	(0.016)	(0.015)	(0.026)
Education (years)	–0.002	0.025***	–0.007	0.006**	–0.021***	0.000	–0.028***	–0.012*
	(0.005)	(0.006)	(0.005)	(0.003)	(0.007)	(0.007)	(0.007)	(0.006)
Age (years)	0.000	0.000	0.001	–0.001	–0.002	–0.001	–0.002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Male (dummy)	0.007	–0.088**	0.022	–0.008	0.105**	0.009	0.168***	0.091**
	(0.023)	(0.035)	(0.032)	(0.015)	(0.044)	(0.041)	(0.043)	(0.038)
Office job (dummy)	0.004	0.109**	–0.015	–0.033*	–0.072	0.123**	–0.125**	–0.100**
	(0.027)	(0.043)	(0.038)	(0.018)	(0.052)	(0.053)	(0.051)	(0.046)
Car ownership (dummy)	0.054**	0.157***	0.086**	0.010	–0.124**	–0.113**	0.008	–0.012
	(0.024)	(0.058)	(0.038)	(0.017)	(0.056)	(0.054)	(0.054)	(0.048)
Adolescents (dummy)	0.014	0.053	–0.003	0.010	–0.017	0.050	–0.060	0.043
	(0.022)	(0.037)	(0.034)	(0.015)	(0.046)	(0.045)	(0.045)	(0.040)
Children (dummy)	–0.002	–0.019	0.015	0.011	0.030	0.061	0.009	0.016
	(0.022)	(0.040)	(0.034)	(0.016)	(0.048)	(0.046)	(0.046)	(0.042)
Chewa (dummy)	–0.035	–0.011	–0.008	–0.176	0.107*	–0.024	–0.098	0.007
	(0.047)	(0.050)	(0.048)	(6.286)	(0.064)	(0.063)	(0.062)	(0.055)
Tonga (dummy)	0.058**	–0.118**	0.067	0.008	0.005	0.005	–0.057	–0.008
	(0.024)	(0.048)	(0.041)	(0.017)	(0.058)	(0.060)	(0.056)	(0.050)
Catholic (dummy)	0.039*	–0.089**	0.052	0.020	0.078	0.036	–0.041	0.067
	(0.023)	(0.039)	(0.033)	(0.016)	(0.049)	(0.047)	(0.047)	(0.041)
Seventh Day Adventist	–0.017	0.031	–0.059	0.001	0.010	0.083	–0.049	–0.007
(dummy)	(0.028)	(0.053)	(0.049)	(0.014)	(0.060)	(0.063)	(0.059)	(0.058)

Notes: Average marginal effects are shown with standard errors in parenthesis. Number of observations = 475. Log pseudo likelihood = −1460, and Wald χ^2 (104) = 364. Bemba and Protestant are used as a reference group for ethnicity – Chewa and Tonga, and religion status – Catholic and Seventh Day Adventist, respectively. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

The other results in Table 2.4 show that household size has a negative effect on using supermarkets and a positive effect on using traditional grocery stores and roadside markets. These results are probably related to shop opening hours and convenience. Supermarkets and hypermarkets have longer and more reliable opening hours than most traditional retailers. Furthermore, given the wide variety of products offered in supermarkets and hypermarkets, one-stop shopping is easily possible, which is much less the case for traditional retailers. These conditions make supermarkets particularly convenient for people with time constraints. In larger households, time constraints may be less severe, at least for some household members, so that the use of traditional retailers is more easily possible. Time constraints could also explain why people with an office job are more likely to use supermarkets and less likely to use roadside markets and kiosks. Also in line with this, is the fact that male-headed households are less likely to use supermarkets and more likely to use traditional retailers than female-headed households. Female household heads are typically the main income earners of the family and the main homemakers simultaneously, which means that only a small amount of time is available for shopping.

Other socioeconomic characteristics that seem to influence the choice of modern and traditional retailers include car ownership, ethnicity, and religion (Table 2.4). Car ownership increases the likelihood of using modern retailers and decreases the likelihood of using traditional retailers. This is unsurprising, given that most of the supermarkets and hypermarkets are located in larger shopping malls that typically also provide easy access by car and parking space. The patterns for ethnicity and religion are probably related to geographic clustering. On average, Tonga and Catholic households live more closely to shopping malls with a large hypermarket.

The error term correlation matrix for the multivariate probit model is shown in Table A2.3 in the Supplementary material. The null hypothesis of zero correlation between the equations for the different retailers is rejected, suggesting that the multivariate probit specification is preferred over separate single equation probit models. The correlation coefficients shown in Table A2.3 can also be interpreted economically. A positive correlation means that consumers use both retailers in a complementary way. This is observed, for instance, between hypermarkets and modern convenience stores. While the former are used for making large-quantity purchases, the latter are used for making complementary smaller purchases. A positive correlation is also observed between traditional grocery stores and neighborhood kiosks.

On the other hand, we also observe negative correlations, for instance between modern supermarkets and traditional grocery stores, indicating that these types of retailers are rather considered substitutes. Both offer a similar range of products, but the variety in modern supermarkets is larger. These results indicate that traditional grocery stores may suffer the most from a shrinking customer base with the continued expansion of modern supermarkets. Other traditional retailers – such as traditional markets and neighborhood kiosks – may also be affected negatively by further supermarket expansion, but to a lesser extent than grocery stores. These types of competitive relationships between modern and traditional retailers are in line with earlier observations in Asia, Europe, and the USA (Suryadarma et al., 2010; Schipmann and Qaim, 2011; Stewart and Dong, 2018; Zhong et al., 2018; Hovhannisyan et al., 2019).

2.4.4. Associations between retailers and food processing levels

We now estimate the associations between the use of different retailers and household dietary patterns (see Equation (2.2) above), starting with the disaggregation of the foods consumed by processing level. Results are summarized in Table 2.5 (full estimation results are shown in Table A2.4 in the Supplementary material).

The results in Table 2.5 are single-equation OLS estimates. We also used SUR as an alternative estimator to account for possible correlation between the error terms. SUR results are shown in Table A2.5 in the Supplementary material. They are very similar to the OLS estimates, only that the SUR estimator cannot easily be combined with the cluster correction of standard errors. The upper part of Table 2.5 (panel A) shows models where supermarkets are considered as the only retailer variable.

The higher the share of food expenditures made in supermarkets, the higher the consumption of ultra-processed and primary processed foods, and the lower the consumption of unprocessed foods (panel A, Table 2.5). These results are consistent with previous studies in Guatemala and Kenya showing that the use of supermarkets contributes to a shift from the consumption of unprocessed to highly processed foods (Asfaw, 2008; Kimenju et al., 2015; Rischke et al., 2015). As mentioned, the consumption of ultra-processed foods was shown to

Table 2.5: Associations between the use of different retailers and food processing levels

	Ultra-processed foods (Expenditure share, %)	Primary processed foods (Expenditure share, %)	Unprocessed foods (Expenditure share, %)
	Panel A: Only supermarkets considered		
Supermarket	0.051**	0.043*	–0.094***
	(0.022)	(0.021)	(0.027)
Other covariates	Yes	Yes	Yes
	Panel B: Multiple food retailers considered		
Hypermarket	0.146*	–0.018	–0.128
	(0.071)	(0.095)	(0.091)
Supermarket	0.196***	–0.053	–0.143*
	(0.052)	(0.075)	(0.075)
Convenience store	0.293***	–0.267**	–0.026
	(0.091)	(0.110)	(0.097)
Fast-food restaurant	0.611***	–0.671***	0.060
	(0.109)	(0.091)	(0.168)
Grocery store	0.217***	–0.043	–0.174**
	(0.055)	(0.070)	(0.066)
Traditional market	0.063	–0.122*	0.058
	(0.044)	(0.063)	(0.070)
Roadside market	0.041	–0.164**	0.122*
	(0.054)	(0.061)	(0.063)
Neighborhood kiosk	0.274***	–0.101	–0.173*
	(0.079)	(0.093)	(0.098)
Other covariates	Yes	Yes	Yes
Observations	475	475	475

Notes: Ordinary least squares estimates are shown with robust standard errors clustered at *compound* level in parentheses. All types of retailers are represented by the household expenditure share for this retailer. Socioeconomic control variables are included in all models, but are not shown here for brevity. Full estimation results are shown in Table A2.4 in the Supplementary material. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

be associated with increased risks of obesity and chronic diseases (Monteiro et al., 2010; Popkin, 2017).

The picture becomes more differentiated when also considering the other modern and traditional retailers, as shown in panel B of Table 2.5. The use of supermarkets (and hypermarkets) remains positively associated with the consumption of ultra-processed foods, and the size of the association is even larger than that evident in panel A. An increase in the expenditure share of supermarkets by 1 percentage point increases the expenditure share of ultra-processed foods by about 0.2 percentage points. Modern convenience stores and fast-food restaurants are also associated with higher consumption of ultra-processed foods. Interestingly, however, the same is true for some of the traditional retailers. For traditional grocery stores and neighborhood kiosks the size of the positive association is even somewhat larger than for modern supermarkets and hypermarkets. These results suggest that there is a general shift towards the consumption of ultra-processed foods that cannot be attributed to modern retailers alone.

As a robustness check, we re-estimated the models in Table 2.5 by using absolute food expenditures for the three processing levels as dependent variables instead of expenditure shares. These alternative results also show that modern retailers as well as traditional grocery stores and kiosks are associated with higher consumption of ultra-processed foods (Table A2.6 in the Supplementary material). Furthermore, we estimated the same models by splitting the sample into poor and non-poor households, using the international poverty line of US$1.90 a day (World Bank, 2019). Results in Table A2.7 of the Supplementary material suggest that the associations between the use of certain food retailers and the consumption of ultra-processed foods are more pronounced for non-poor than for poor households. This is plausible given that poor households' food choices are more constrained by income limitations. However, as was shown in Table 2.2, poor people also spend more than one-third of their food budget on ultra-processed foods.

2.4.5. Associations between retailers and food groups

Table 2.6 shows the associations between the use of different retailers and the consumption of various food groups. In these models, consumption is expressed in terms of the food quantities consumed by the household during the 7-day recall period. The upper part of Table 2.6 (panel A) includes supermarkets as the only retailer variable. The estimates suggest that the use of supermarkets is associated with higher consumption of meat, fish, and dairy products and lower consumption of sugar, sweets, and sweetened beverages.

However, the picture changes somewhat in the lower part of Table 2.6 (panel B), where the other retailers are also included as explanatory variables. The specifications in panel B show that the use of supermarkets and hypermarkets is associated with higher meat, fish, and dairy consumption, but also with higher consumption of sugar, sweets, and sweetened beverages. In addition, the use of modern convenience stores is associated with higher consumption of oils and fats. The higher consumption of animal-source products is likely related to better cooling facilities in modern retail outlets. This is generally positive from a dietary quality and nutrition perspective, as meat, fish, and dairy products are important sources of protein and micronutrients. Table 2.2 showed that the mean consumption of meat and fish in the sample households is not very low.

Table 2.6: Associations between the use of different retailers and the consumption of selected food groups

	Food quantity (kg/week)								
	Cereals and Tubers	Legumes	Fruits	Vegetables	Meat and Fish	Dairy Products	Eggs	Oils and Fats	Sugar, Beverages
	Panel A: Only supermarkets considered								
Supermarket	–0.003	–0.001	–0.005	–0.001	0.015***	0.014*	–0.002	–0.003	–0.010***
	(0.006)	(0.005)	(0.004)	(0.009)	(0.006)	(0.007)	(0.001)	(0.002)	(0.004)
Other covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Multiple food retailers considered								
Hypermarket	0.025	–0.009	–0.009	0.013	0.043*	0.053*	0.007	0.009	0.040***
	(0.031)	(0.019)	(0.018)	(0.020)	(0.023)	(0.029)	(0.006)	(0.005)	(0.008)
Supermarket	0.011	0.003	–0.031**	0.027	0.030*	0.055***	0.005	0.005	0.015*
	(0.018)	(0.012)	(0.015)	(0.021)	(0.016)	(0.020)	(0.003)	(0.004)	(0.008)
Convenience store	0.058**	–0.007	–0.039*	0.012	0.022	0.014	0.002	0.014**	0.020
	(0.025)	(0.011)	(0.023)	(0.019)	(0.015)	(0.050)	(0.005)	(0.006)	(0.013)
Fast-food restaurant	–0.100***				0.110*	0.132**			0.105**
	(0.037)				(0.062)	(0.055)			(0.049)
Grocery store	0.013	–0.003	–0.030*	0.016	0.026	0.063**	0.008**	0.005	0.028***
	(0.016)	(0.013)	(0.017)	(0.023)	(0.016)	(0.029)	(0.004)	(0.004)	(0.007)
Traditional market	0.011	0.016	–0.033**	0.058***	0.015	0.023	0.004	0.011***	0.024***
	(0.018)	(0.013)	(0.015)	(0.015)	(0.015)	(0.022)	(0.003)	(0.004)	(0.008)
Roadside market	0.010	0.012	–0.038**	0.038**	0.007	0.038**	0.006	0.005	0.010
	(0.019)	(0.013)	(0.018)	(0.016)	(0.016)	(0.015)	(0.004)	(0.004)	(0.007)
Neighborhood kiosk	0.030	–0.013	–0.014	–0.008	–0.010	0.057**	0.017***	0.007	0.027*
	(0.027)	(0.015)	(0.017)	(0.025)	(0.019)	(0.027)	(0.004)	(0.005)	(0.015)
Other covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	475	475	475	475	475	475	475	475	475

Notes: Tobit estimates are shown with robust standard errors clustered at compound level in parentheses. All types of retailers are represented by the household expenditure share for this retailer. Socioeconomic control variables are included in all models, but are not shown here, for purposes of brevity. Full estimation results are shown in Tables A2.8 and A2.9 in the Supplementary material. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Very high meat consumption levels can also be associated with negative health and environmental externalities (Godfray et al., 2018). However, more sugar, sweets, oils, and fats may contribute to people being overweight and increasing obesity, and therefore, worsen dietary quality and nutrition. In other words, modern retailers seem to be associated with both positive and negative dietary effects.

Strikingly, however, mixed dietary effects are also observed for traditional retailers. On the positive side, the estimates in Table 2.6 suggest that the use of traditional grocery stores and neighborhood kiosks is associated with higher consumption of dairy products and eggs. The use of traditional markets is associated with higher vegetable consumption. On the negative side, the use of grocery stores, traditional markets, and neighborhood kiosks is also associated with higher consumption of sugar, sweets, and sweetened beverages. The use of traditional markets is further associated with higher consumption of oils and fats. These patterns suggest that the retail format and the product ranges offered by different types of retailers do influence consumer food choices and diets, but that there is no clear division between modern and traditional retailers. This finding is in line with the analysis of links between food retailing and processing levels discussed above.

Another noteworthy observation from the estimates in Table 2.6 is that all retailers seem to be associated with lower consumption of fruits; several of these negative associations are statistically significant. This is surprising because consumers actually buy fresh fruits in several of the retail outlets, especially in supermarkets, traditional markets, and roadside markets. However, some of the fruits are also obtained from own production, and we do not include own production as an explanatory variable. Households with own fruit production consume more fruits than households that fully rely on purchases, which can explain the negative associations between all retailers and fruit consumption in Table 2.6. Overall, the consumption of fruits is very low among the sample households from Lusaka City.

In a robustness check of the estimates in Table 2.6 we ran the same models, but used consumption expressed in value terms instead of quantities as dependent variables. These alternative estimates are shown in Table A2.10 in the Supplementary material. The results support the same general conclusions only that the associations with consumption expenditures for sugar, sweets, and sweetened beverages are not statistically significant for any of the modern and traditional retailers.

2.5. Conclusions

Many countries in Africa are experiencing a rapid modernization of their food retail sector, with supermarkets, hypermarkets, modern convenience stores, and fast-food restaurants gaining in importance. These changing food environments, especially in urban areas, may influence consumers' food choices, dietary patterns, and nutrition. Previous research has suggested that the spread of modern retailers may contribute to less healthy diets, higher consumption of ultra-processed foods, and rising rates of overweight and obesity. However, previous studies did not pay much attention to the question as to which socioeconomic groups use what type of retailers. Furthermore, the existing research on diet and nutrition effects focused primarily on the role of supermarkets, without accounting for the fact that most consumers obtain their foods from various types of retailers. We have added to this research direction by more explicitly analyzing the associations between household socioeconomic status, the use of different types of modern and traditional retailers, and dietary patterns. We have collected and used data from households in Lusaka City in Zambia, one of the places in Southern Africa where food environments have changed dramatically in recent years.

Our results show that almost all households use different types of retailers on a regular basis. Two-thirds of the households use modern and traditional retailers simultaneously. Among the modern retailers, supermarkets account for the largest share of the food purchases, followed by modern convenience stores and hypermarkets. Overall, in Lusaka City, modern retailers account for 42% of the household food expenditures on average, although with notable differences between poor and rich households. Modern retailers account for 20% and 63% of total food expenditures in the lowest and highest income tercile, respectively. Income is also an important predictor of the use of modern retailers after controlling for other socioeconomic variables. Other variables that increase the likelihood of using modern retailers are education, car ownership, having an office job, and female household heads. Supermarkets and hypermarkets, in particular, offer a large variety of products, which consumers perceive as safe and of high quality. Supermarkets and hypermarkets also have longer and more reliable opening hours than most traditional retailers. All of these factors make supermarkets and hypermarkets attractive shopping places especially for better-off households with high opportunity costs of time.

The regression analysis also shows that using supermarkets is associated with a higher consumption of ultra-processed foods and a lower consumption of unprocessed foods, also after controlling for income and other socioeconomic variables. This is in line with earlier research on the dietary effects of supermarkets (Asfaw, 2011; Rischke et al., 2015; Kimenju et al., 2015; Demmler et al., 2018; Rupa et al., 2019). From a nutrition and health perspective, these dietary trends are undesirable, as high consumption of ultra-processed foods is associated with increased risks of obesity and chronic diseases (Monteiro et al., 2010; Beatty et al., 2014; Steyn and Mchiza, 2014; Popkin, 2017). However, unlike earlier studies, we also analyzed the role of other retailers and found that especially the use of traditional grocery stores and neighborhood kiosks is also associated with higher consumption of ultra-processed foods. These results suggest that there is a general shift towards the consumption of ultra-processed foods that cannot be attributed to modern retailers alone.

We also analyzed the consumption of different food groups and found that the use of modern retailers is associated with higher consumption of certain unhealthy food groups (sugar, sweets, oils, fats), but also with higher consumption of certain healthy food groups (meat, fish, dairy products). At the same time, the use of some of the traditional retailers – such as grocery stores, traditional markets, and kiosks – is also associated with higher consumption of unhealthy food groups.

Many countries in Africa are experiencing a nutrition transition with both positive and negative implications. On the positive side, the consumption of some nutritious foods is increasing. On the negative side, the consumption of sugar, fat, and salt is increasing as well. Changing food environments seem to influence and support these dietary trends and should, therefore, also be seen as potential entry points for public regulations and policies to support more healthy diets. Policy options to consider are regulations related to the advertisement and promotion of healthy and unhealthy foods and their strategic placement within shops. For instance, in studies referring to industrialized countries, Glanz et al. (2012) and Payne and Niculescu (2018) showed that changes in the placement of fruits and vegetables can positively influence consumer choices. Related regulations could also be relevant for countries in Africa. In urban Zambia, the consumption of fresh fruits is particularly low; policies to increase fruit consumption levels would be useful. Beyond advertisement, awareness campaigns, and nudges, taxes and subsidies could also be options to promote healthy diets. A detailed discussion of policy approaches is beyond the scope of this article. In any case, our results emphasize that modern retailers are not the only drivers of dietary transitions, so that a focus on regulating modern retailers alone would be insufficient to promote healthy eating.

In closing, three limitations of our research should briefly be discussed. First, we used processing level categories, which could not sufficiently classify the degree of healthfulness of a specific food. Moreover, the three categories (ultra-processed, primary processed and unprocessed foods) could not properly account for the overlap in nutritional attributes for some food products. Second, we used observational data and could not control for the endogeneity of households' decisions about which retailers to use. Therefore, our results are interpreted only in terms of associations, not as causal effects. Proper identification is difficult with observational data, but longer-term studies with panel data may possibly help. Third, results from Lusaka City in Zambia are not necessarily representative for other parts of Africa. Follow-up research in different geographical contexts would be interesting to further broaden the knowledge base.

Appendix A2

Table A2.1: Food processing levels by food groups and items

Processing level	Food group	Food items (Examples)
Unprocessed foods	Cereals and tubers	Maize (dry/green), cassava, Irish potato, sweet potato, yams
	Eggs and milk	Eggs, fresh whole milk
	Fruits	Apples, avocado, banana (ripe/boiled), guava, mango, pawpaw, pineapple, pumpkin, orange/tangerine, sugar plum, watermelon
	Legumes	Bean (fresh/dry), cowpea (fresh/dry), groundnut (fresh/dry), pigeonpea (fresh/dry), soybean, velvet bean
	Vegetables	Bean leaves, blackjack, cabbage, carrot, cassava leaves, cowpea leaves, cucumber, eggplant, garlic, greengram, lettuce, mushroom (cultivated/wild), okra, onion, pepper, pumpkin leaves, rape/mustard/chinese, tomato
Primary processed foods	Drinks and snacks	Bottled/clear beer, bottled water, roasted cashew/macadamia nuts
	Meat and fish	Beef, bush/game meat, chicken, duck, turkey, goat meat, sheep meat, pork, fish (fresh/frozen/dried)
	Cereals	Rice, millet, oats, sorghum
Ultra-processed foods	Bread and pasta	Bread, buns, pasta, instant noodles
	Cereals and tubers	Maize flour, cornflakes, porridge mix, wheat flour, cassava flour
	Dairy products	Cheese, milk, yoghurt
	Oils and fats	Butter/margarine, coconut oil, cooking oil/fat
	Meat and fish	Sausage (beef/chicken/pork), soya meat, canned meat and fish
	Miscellaneous	Canned foods, mandazi, mixed fruits/salads, pizza, samosa, ready-made foods/dishes
	Sugar, sweetened drinks and snacks	Soft drinks, sweetened fruit juices, wine, jam, tomato sauce, salt, sugar, biscuits/cookies, cake, chips, chocolate, crisps, puffed salted corn chips, popcorn, salted nuts

Note: The same classifications of foods were also used by Demmler et al. (2018).

Table A2.2: Additional descriptive statistics

	Full sample	By income tercile		
		Lowest	Middle	Highest
Socioeconomic characteristics				
Age of household head (years)	43.83	45.13	41.98	44.40
	(12.86)	(13.67)	(12.68)	(12.02)
Adolescent in household (dummy)	0.47	0.50	0.49	0.43
	(0.50)	(0.50)	(0.50)	(0.50)
Child in household (dummy)	0.59	0.71	0.53	0.54
	(0.49)	(0.45)	(0.50)	(0.50)
Bemba ethnicity (dummy)	0.29	0.28	0.24	0.36
	(0.45)	(0.45)	(0.43)	(0.48)
Tonga ethnicity (dummy)	0.19	0.15	0.21	0.21
	(0.39)	(0.36)	(0.41)	(0.41)
Protestant religion (dummy)	0.42	0.42	0.46	0.38
	(0.49)	(0.49)	(0.50)	(0.49)
Catholic religion (dummy)	0.26	0.31	0.19	0.29
	(0.44)	(0.47)	(0.39)	(0.45)
Food expenditures				
Cereals and tubers (ZMW/week)	106.41	87.37	108.25	123.94
	(57.02)	(49.60)	(55.01)	(60.40)
Legumes (ZMW/week)	30.15	30.84	32.36	27.16
	(43.99)	(43.52)	(49.17)	(38.63)
Fruits (ZMW/week)	7.88	7.23	6.75	9.70
	(20.64)	(20.94)	(17.37)	(23.25)
Vegetables (ZMW/week)	59.63	57.99	64.98	55.82
	(44.19)	(39.59)	(47.19)	(45.21)
Meat and fish (ZMW/week)	172.84	126.04	178.54	214.69
	(116.61)	(100.16)	(107.59)	(124.26)
Dairy products and eggs (ZMW/week)	23.53	14.45	18.54	37.90
	(33.24)	(18.70)	(25.32)	(45.25)
Oils and fats (ZMW/week)	9.82	9.14	10.28	10.05
	(9.47)	(8.65)	(9.09)	(10.61)
Sugar, sweetened beverages (ZMW/week)	33.86	27.55	32.23	41.96
	(50.67)	(42.59)	(43.95)	(62.54)
Observations	475	159	160	156

Notes: Mean values are shown with standard deviations in parentheses. ZMW, Zambia Kwacha (local currency). The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018.

Table A2.3: Correlation matrix from Multivariate Probit Model

	Modern retailer				Traditional retailer			
	HM	SM	CS	FF	GS	TM	RM	NK
Hypermarket (HM)	1.000							
Supermarket (SM)	0.161	1.000						
	(0.122)							
Convenience store (CS)	0.252**	0.149	1.000					
	(0.114)	(0.099)						
Fast-food restaurant (FF)	–0.088	–0.047	0.198	1.000				
	(0.236)	(0.220)	(0.205)					
Grocery store (GS)	–0.098	–0.304***	0.009	0.388***	1.000			
	(0.108)	(0.073)	(0.090)	(0.122)				
Traditional market (TM)	0.074	–0.164*	0.064	–0.046	0.022	1.000		
	(0.108)	(0.084)	(0.091)	(0.127)	(0.080)			
Roadside market (RM)	0.060	–0.040	0.163*	0.285**	0.249***	–0.282***	1.000	
	(0.105)	(0.086)	(0.091)	(0.124)	(0.076)	(0.081)		
Neighborhood kiosk (NK)	–0.003	–0.145*	–0.086	0.137	0.222***	–0.124	–0.026	1.000
	(0.117)	(0.086)	(0.096)	(0.114)	(0.081)	(0.086)	(0.083)	

Notes: Correlation coefficients are shown with standard errors in parentheses. The likelihood ratio test of zero correlation between the error terms is rejected at the 1% level; χ^2 (28) = 85. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A2.4: Associations between the use of retailers and food processing levels (full model results for Table 2.5)

	Only supermarkets considered: Panel A			Multiple food retailers considered: Panel B		
	Ultra-processed foods	Primary processed foods	Unprocessed foods	Ultra-processed foods	Primary processed foods	Unprocessed foods
	(1)	(2)	(3)	(1)	(2)	(3)
Hypermarket				0.146*	–0.018	–0.128
				(0.071)	(0.095)	(0.091)
Supermarket	0.051**	0.043*	–0.094***	0.196***	–0.053	–0.143*
	(0.022)	(0.021)	(0.027)	(0.052)	(0.075)	(0.075)
Convenience store				0.293***	–0.267**	–0.026
				(0.091)	(0.110)	(0.097)
Fast-food restaurant				0.611***	–0.671***	0.060
				(0.109)	(0.091)	(0.168)
Grocery store				0.217***	–0.043	–0.174**
				(0.055)	(0.070)	(0.066)
Traditional market				0.063	–0.122*	0.058
				(0.044)	(0.063)	(0.070)
Roadside market				0.041	–0.164**	0.122*
				(0.054)	(0.061)	(0.063)
Neighborhood kiosk				0.274***	–0.101	–0.173*
				(0.079)	(0.093)	(0.098)
Male	–0.174	–0.374	0.548	–0.648	–0.313	0.961
	(1.404)	(1.996)	(1.911)	(1.221)	(1.939)	(1.646)
Age	0.001	–0.057	0.056	0.015	–0.071	0.056*
	(0.050)	(0.039)	(0.050)	(0.039)	(0.043)	(0.027)
Household size	0.707*	–1.254***	0.547	0.875**	–1.063**	0.188
	(0.363)	(0.404)	(0.445)	(0.333)	(0.433)	(0.304)
Education	–0.550***	0.700***	–0.150	–0.601***	0.673***	–0.072
	(0.122)	(0.214)	(0.168)	(0.126)	(0.198)	(0.182)
Income (log)	0.159	1.389*	–1.548**	–0.440	1.297*	–0.857
	(0.423)	(0.714)	(0.621)	(0.458)	(0.712)	(0.599)
Chewa	0.089	2.757	–2.846	–0.241	2.327	–2.086
	(1.643)	(2.022)	(2.565)	(1.589)	(2.188)	(2.212)
Tonga	0.544	1.406	–1.950	–0.001	1.319	–1.318
	(1.608)	(2.057)	(1.553)	(1.698)	(2.208)	(1.581)
Catholic	–0.977	–0.171	1.148	–1.150	–0.697	1.847**
	(2.111)	(1.847)	(0.963)	(2.064)	(1.968)	(0.713)
Seventh Day Adventist	–2.916	0.252	2.664*	–2.075	0.570	1.505
	(1.719)	(1.770)	(1.441)	(1.566)	(1.985)	(1.413)
Constant	35.601***	22.579***	41.820***	29.124***	33.773***	37.103***
	(5.417)	(5.688)	(5.499)	(7.932)	(8.944)	(9.491)
R-squared	0.035	0.122	0.146	0.116	0.149	0.256
Observations	475	475	475	475	475	475

Notes: Ordinary least squares estimates are shown with robust standard errors clustered at *compound* level in parentheses. All types of retailers are represented by the household expenditure share for this retailer. Bemba and Protestant are used as a reference group for ethnicity – Chewa and Tonga, and religion status – Catholic and Seventh Day Adventist, respectively. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A2.5: Associations between supermarket use and food processing levels (Seemingly unrelated regressions)

	Ultra-processed foods (Expenditure share)	Primary processed foods (Expenditure share)	Unprocessed foods (Expenditure share)
Supermarket	0.051**	0.043	–0.094***
	(0.023)	(0.028)	(0.023)
Male	–0.174	–0.374	0.548
	(1.318)	(1.593)	(1.299)
Age	0.001	–0.057	0.056
	(0.051)	(0.061)	(0.050)
Household size	0.707*	–1.254**	0.547
	(0.412)	(0.497)	(0.406)
Education	–0.550**	0.700***	–0.150
	(0.219)	(0.264)	(0.216)
Income (log)	0.159	1.389*	–1.548**
	(0.645)	(0.780)	(0.636)
Chewa	0.089	2.757	–2.846
	(1.932)	(2.335)	(1.905)
Tonga	0.544	1.406	–1.950
	(1.756)	(2.122)	(1.731)
Catholic	–0.977	–0.171	1.148
	(1.474)	(1.781)	(1.453)
Seventh Day Adventist	–2.916	0.252	2.664
	(1.865)	(2.254)	(1.839)
Constant	35.601***	22.579***	41.820***
	(6.492)	(7.845)	(6.401)
Observations	475	475	475

Notes: Seemingly unrelated regression estimates are shown with standard errors in parentheses. Supermarkets are represented by the household expenditure share for this retailer. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A2.6: Associations between the use of different retailers and food processing levels (absolute expenditures)

	Ultra-processed foods (Expenditures, log)	Primary processed foods (Expenditures, log)	Unprocessed foods (Expenditures, log)
	Panel A: Supermarkets only		
Supermarket	0.002	0.002	–0.004*
	(0.001)	(0.001)	(0.002)
Other covariates	Yes	Yes	Yes
	Panel B: Multiple food retailers considered		
Hypermarket	0.012***	0.007*	0.006
	(0.004)	(0.004)	(0.006)
Supermarket	0.009**	0.003	0.0005
	(0.003)	(0.003)	(0.006)
Convenience store	0.014***	–0.003	0.009
	(0.005)	(0.003)	(0.006)
Fast-food restaurant	0.041***	0.0005	0.029***
	(0.006)	(0.012)	(0.006)
Grocery store	0.009**	0.001	–0.002
	(0.003)	(0.003)	(0.006)
Traditional market	0.006*	0.002	0.011**
	(0.003)	(0.003)	(0.005)
Roadside market	0.003	–0.002	0.010**
	(0.003)	(0.003)	(0.004)
Neighborhood kiosk	0.010**	0.0002	–0.004
	(0.004)	(0.003)	(0.006)
Other covariates	Yes	Yes	Yes
Observations	475	469	471

Notes: Ordinary least squares estimates are shown with robust standard errors clustered at *compound* level in parentheses. All types of retailers are represented by the household expenditure share for this retailer. The same socioeconomic control variables are included as in Table A2.4. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A2.7: Associations between the use of different retailers and food processing levels (by poverty status)

	Poor households		Non-poor households	
	Ultra-processed (Exp. share, %)	Unprocessed (Exp. share, %)	Ultra-Processed (Exp. share, %)	Unprocessed (Exp. share, %)
	Panel A: Only supermarkets considered			
Supermarket only	0.031	–0.058	0.057**	–0.111***
	(0.050)	(0.087)	(0.026)	(0.025)
Other covariates	Yes	Yes	Yes	Yes
	Panel B: Multiple food retailers considered			
Hypermarket			0.165**	–0.118
			(0.060)	(0.087)
Supermarket	0.035	–0.165	0.231***	–0.144
	(0.128)	(0.205)	(0.047)	(0.095)
Convenience store	0.274*	0.114	0.329**	–0.076
	(0.130)	(0.187)	(0.111)	(0.125)
Fast-food restaurant	–0.627	–1.055	0.679***	0.071
	(0.853)	(1.003)	(0.081)	(0.219)
Grocery store	0.009	–0.165	0.269***	–0.225*
	(0.118)	(0.163)	(0.052)	(0.106)
Traditional market	–0.029	–0.022	0.064	0.106
	(0.098)	(0.151)	(0.048)	(0.084)
Roadside market	–0.073	0.020	0.056	0.158*
	(0.075)	(0.147)	(0.067)	(0.084)
Neighborhood kiosk	0.040	–0.375**	0.358***	–0.067
	(0.147)	(0.165)	(0.053)	(0.123)
Other covariates	Yes	Yes	Yes	Yes
Observations	126	126	349	349

Notes: Ordinary least squares estimates are shown with robust standard errors clustered at *compound* level in parentheses. Poor households are those with less than US$1.90 per capita and day in purchasing power parity terms (World Bank, 2019). All types of retailers are represented by the household expenditure share for this retailer. For poor households, hypermarkets were dropped due to perfect collinearity. The same socioeconomic control variables are included as in Table A2.4. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A2.8: Associations between the use of different retailers and the consumption of food groups (full model results for Table 2.6, supermarkets only)

	Household food consumption (kg/week)								
	Cereals and Tubers	Legumes	Fruits	Vegetables	Meat and Fish	Dairy Products	Eggs	Oils and Fats	Sugar, Beverages
Supermarket	–0.003	–0.001	–0.005	–0.001	0.015***	0.014*	–0.002	–0.003	–0.010***
	(0.006)	(0.005)	(0.004)	(0.009)	(0.006)	(0.007)	(0.001)	(0.002)	(0.004)
Male	0.281	0.646***	–0.031	0.627	0.361	–0.072	0.122	0.397***	0.150
	(0.471)	(0.160)	(0.338)	(0.483)	(0.245)	(0.552)	(0.083)	(0.085)	(0.167)
Age	0.026	0.006	0.006	–0.007	–0.003	0.011	0.002	0.008***	0.019***
	(0.021)	(0.007)	(0.012)	(0.014)	(0.008)	(0.019)	(0.004)	(0.003)	(0.006)
Household size	0.907***	0.233***	–0.074	0.384***	0.145**	0.278	–0.017	0.052*	0.121
	(0.137)	(0.078)	(0.072)	(0.112)	(0.072)	(0.211)	(0.020)	(0.029)	(0.098)
Education	0.042	0.032	0.067*	–0.038	0.150***	0.121	0.050**	–0.017*	0.103***
	(0.048)	(0.031)	(0.037)	(0.065)	(0.043)	(0.097)	(0.020)	(0.010)	(0.022)
Income (log)	0.441**	–0.203	0.142	–0.205	0.445**	0.844***	0.121***	0.083**	0.217
	(0.203)	(0.139)	(0.133)	(0.210)	(0.174)	(0.286)	(0.044)	(0.038)	(0.134)
Chewa	0.933*	0.589	0.128	–0.422	0.790**	–0.619	0.065	0.468***	0.517
	(0.555)	(0.361)	(0.328)	(0.719)	(0.309)	(0.707)	(0.126)	(0.098)	(0.360)
Tonga	0.269	0.438**	–0.402	1.042**	0.581*	0.344	0.037	0.249***	–0.095
	(0.518)	(0.197)	(0.296)	(0.497)	(0.327)	(0.513)	(0.159)	(0.067)	(0.219)
Catholic	0.107	0.172	0.309	0.545	–0.327	–0.288	0.121	–0.030	0.007
	(0.386)	(0.252)	(0.305)	(0.554)	(0.345)	(0.344)	(0.087)	(0.086)	(0.205)
Seventh Day Adventist	0.964**	0.367	0.632***	0.704	–0.465	0.363	–0.114	0.165**	–0.295
	(0.393)	(0.272)	(0.232)	(0.588)	(0.444)	(0.512)	(0.132)	(0.077)	(0.218)
Constant	–0.035	0.813	–3.536*	4.512**	–3.650**	–15.110***	–1.964***	–1.043**	–3.487**
	(2.355)	(1.145)	(2.017)	(2.238)	(1.496)	(4.112)	(0.558)	(0.428)	(1.494)
Pseudo-R-squared	0.060	0.027	0.014	0.011	0.073	0.081	0.053	0.068	0.024
Observations	475	475	475	475	475	475	475	475	475

Notes: Tobit estimates are shown with robust standard errors clustered at *compound* level in parentheses. All types of retailers are represented by the household expenditure share for this retailer. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A2.9: Associations between the use of different retailers and the consumption of food groups (full model results for Table 2.6, all retailers)

	Household food consumption (kg/week)								
	Cereals and Tubers	Legumes	Fruits	Vegetables	Meat and Fish	Dairy Products	Eggs	Oils and Fats	Sugar, Beverages
Hypermarket	0.025	–0.009	–0.009	0.013	0.043*	0.053*	0.007	0.009	0.040***
	(0.031)	(0.019)	(0.018)	(0.020)	(0.023)	(0.029)	(0.006)	(0.005)	(0.008)
Supermarket	0.011	0.003	–0.031**	0.027	0.030*	0.055***	0.005	0.005	0.015*
	(0.018)	(0.012)	(0.015)	(0.021)	(0.016)	(0.020)	(0.003)	(0.004)	(0.008)
Convenience store	0.058**	–0.007	–0.039*	0.012	0.022	0.014	0.002	0.014**	0.020
	(0.025)	(0.011)	(0.023)	(0.019)	(0.015)	(0.050)	(0.005)	(0.006)	(0.013)
Fast-food restaurant	–0.100***				0.110*	0.132**			0.105**
	(0.037)				(0.062)	(0.055)			(0.049)
Grocery store	0.013	–0.003	–0.030*	0.016	0.026	0.063**	0.008**	0.005	0.028***
	(0.016)	(0.013)	(0.017)	(0.023)	(0.016)	(0.029)	(0.004)	(0.004)	(0.007)
Traditional market	0.011	0.016	–0.033**	0.058***	0.015	0.023	0.004	0.011***	0.024***
	(0.018)	(0.013)	(0.015)	(0.015)	(0.015)	(0.022)	(0.003)	(0.004)	(0.008)
Roadside market	0.010	0.012	–0.038**	0.038**	0.007	0.038**	0.006	0.005	0.010
	(0.019)	(0.013)	(0.018)	(0.016)	(0.016)	(0.015)	(0.004)	(0.004)	(0.007)
Neighborhood kiosk	0.030	–0.013	–0.014	–0.008	–0.010	0.057**	0.017***	0.007	0.027*
	(0.027)	(0.015)	(0.017)	(0.025)	(0.019)	(0.027)	(0.004)	(0.005)	(0.015)
Male	0.217	0.687***	–0.020	0.765	0.471*	–0.148	0.053	0.421***	0.173
	(0.478)	(0.141)	(0.308)	(0.469)	(0.249)	(0.531)	(0.085)	(0.092)	(0.193)
Age	0.025	0.007	–0.002	–0.003	–0.0003	0.015	0.003	0.009***	0.021***
	(0.021)	(0.008)	(0.011)	(0.014)	(0.007)	(0.018)	(0.004)	(0.003)	(0.006)
Household size	0.955***	0.208***	–0.034	0.342***	0.128*	0.281	–0.004	0.056**	0.139
	(0.123)	(0.073)	(0.072)	(0.088)	(0.076)	(0.208)	(0.020)	(0.028)	(0.101)
Education	0.049	0.034	0.064*	–0.045	0.121***	0.118	0.057***	–0.022*	0.086***
	(0.049)	(0.032)	(0.036)	(0.065)	(0.035)	(0.099)	(0.020)	(0.012)	(0.023)
Income (log)	0.374*	–0.098	0.016	0.032	0.462***	0.864***	0.106**	0.089*	0.195
	(0.193)	(0.127)	(0.114)	(0.197)	(0.171)	(0.263)	(0.043)	(0.047)	(0.148)
Chewa	0.953*	0.646**	0.086	–0.287	0.725**	–0.750	0.078	0.500***	0.546
	(0.537)	(0.301)	(0.389)	(0.718)	(0.292)	(0.728)	(0.109)	(0.103)	(0.332)
Tonga	0.290	0.473**	–0.409	1.040**	0.429	0.312	0.045	0.234***	–0.207
	(0.526)	(0.204)	(0.282)	(0.426)	(0.310)	(0.505)	(0.149)	(0.073)	(0.218)
Catholic	0.100	0.265	0.239	0.764	–0.297	–0.275	0.121	–0.003	0.039
	(0.424)	(0.242)	(0.304)	(0.466)	(0.340)	(0.335)	(0.094)	(0.084)	(0.167)
Seventh Day Adventist	1.025***	0.224	0.720***	0.366	–0.462	0.452	–0.078	0.129*	–0.312
	(0.384)	(0.265)	(0.219)	(0.574)	(0.434)	(0.510)	(0.119)	(0.071)	(0.211)
Constant	–0.852	–0.848	0.741	–1.149	–5.015*	–19.214***	–2.542***	–1.830***	–5.442***
	(3.222)	(1.862)	(1.744)	(2.243)	(2.774)	(5.136)	(0.711)	(0.563)	(1.490)
Pseudo-R-squared	0.065	0.045	0.044	0.028	0.086	0.101	0.074	0.085	0.034
Observations	475	475	475	475	475	475	475	475	475

Notes: Tobit estimates are shown with robust standard errors clustered at *compound* level in parentheses. All types of retailers are represented by the household expenditure share for this retailer. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A2.10: Associations between the use of different retailers and the consumption of food groups (in value terms)

	Food expenditure (ZMW/week)							
	Cereals and Tubers	Legumes	Fruits	Vegetables	Meat and Fish	Dairy and Eggs	Oils and Fats	Sugar, Beverages
				Panel A:Only supermarkets considered				
Supermarket	0.095	–0.015	–0.315**	–0.258***	0.445***	–0.059	–0.017	–0.086
	(0.069)	(0.134)	(0.140)	(0.081)	(0.167)	(0.053)	(0.032)	(0.054)
Other covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
				Panel B: Multiple retailers considered				
Hypermarket	0.863**	0.025	0.248	–0.300	1.115*	0.895**	0.237***	0.109
	(0.358)	(0.422)	(0.813)	(0.267)	(0.664)	(0.366)	(0.066)	(0.133)
Supermarket	0.233	0.197	–0.866***	–0.066	1.093***	0.284*	0.159**	–0.011
	(0.177)	(0.258)	(0.330)	(0.244)	(0.381)	(0.152)	(0.069)	(0.149)
Convenience store	0.952**	0.521*	–1.084*	0.446	0.436	0.384**	0.255***	0.024
	(0.409)	(0.284)	(0.564)	(0.410)	(0.356)	(0.173)	(0.077)	(0.220)
Fast-food restaurant	0.866				4.527**	1.518		0.355
	(1.317)				(1.789)	(1.231)		(0.369)
Grocery store	0.189	–0.035	–0.740**	–0.021	0.879**	0.348*	0.140**	0.074
	(0.180)	(0.242)	(0.342)	(0.268)	(0.400)	(0.209)	(0.065)	(0.123)
Traditional market	0.008	0.546**	–0.711**	0.418**	0.722*	0.203	0.220***	0.054
	(0.141)	(0.254)	(0.294)	(0.196)	(0.379)	(0.150)	(0.062)	(0.130)
Roadside market	–0.143	0.417*	–0.878***	0.593***	0.508	0.329**	0.110*	–0.111
	(0.168)	(0.225)	(0.301)	(0.173)	(0.383)	(0.164)	(0.063)	(0.129)
Neighborhood kiosk	0.229	–0.239	–0.108	0.017	0.146	0.670***	0.219**	0.282
	(0.221)	(0.279)	(0.445)	(0.310)	(0.477)	(0.177)	(0.091)	(0.262)
Other covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	475	475	475	475	475	475	475	475

Notes: Tobit estimates are shown with robust standard errors clustered at *compound* level in parentheses. All types of retailers are represented by the household expenditure share for this retailer. Socioeconomic control variables are included in all models, but are not shown here for brevity. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% levels.

3 Effects of modern food retailers on adult and child diets and nutrition[2]

Abstract

In many developing countries, food environments are changing rapidly, with modern retailers – such as supermarkets and convenience stores – increasingly replacing traditional markets and shops. Previous studies suggested that the rise of modern retailers contributes to overweight and obesity. Effects on dietary quality were not analyzed before due to the unavailability of individual-level dietary data. Here, we analyze effects of modern retailers on dietary quality and nutrition in Lusaka, Zambia. We collected data from randomly selected households that use modern retailers at different intensities. Individual-level anthropometric and food-intake data from 930 adults and 499 children are analyzed with control function regression models to estimate effects of modern retailers on body weight, height, dietary diversity, and nutrient intakes. Use of modern retailers is positively associated with overweight in adults, but not in children. For children, we find a positive effect on body height. Use of modern retailers increases dietary diversity, as well as calorie, protein, and micronutrient intakes among both adults and children. Effects on protein and micronutrient intakes are channeled primarily through higher consumption of meat and dairy products. The findings underline that the growth of modern retailers influences people's diets and nutrition; the effects can be both positive and negative. The positive effects on child nutrition imply that further modernization of food environments should be promoted. But the increasing effect on adult overweight is undesirable and calls for certain policy regulations. While the results cannot be generalized, effects may be similar also in other parts of Africa.

Keywords: Child undernutrition; overweight; obesity; food environments; supermarkets; Africa.

[2] This paper has been co-authored with Olivier Ecker (O.E.) and Matin Qaim (M.Q.). The research idea was jointly conceptualized and designed by I, Makaiko Gonapanyanja Khonje (M.G.K.) and M.Q.. O.E. contributed to the design. M.G.K. collected the data and did the data analysis in consultation with O.E., and M.Q.. M.G.K., and M.Q. wrote the manuscript. All authors read and approved the final version of the manuscript.

3.1. Introduction

Malnutrition is a global problem with serious negative health implications (FAO et al., 2019; Swinburn et al., 2019). Especially in developing countries, different types of malnutrition typically coexist within the same communities, households, and even individuals (Development Initiatives, 2018; Fongar et al., 2019; Hawkes et al., 2020; Popkin et al., 2020). While undernutrition and micronutrient deficiencies remain widespread, overweight and obesity are rapidly on the rise (Development Initiatives, 2018; FAO et al., 2019; Fongar et al., 2019; Swinburn et al., 2019; Hawkes et al., 2020; Popkin et al., 2020). Food environments, defined as the physical, economic, and sociocultural context in which consumers acquire their food, can influence dietary choices and nutrition (HLPE, 2017; Popkin, 2017; Hawkes et al., 2020). And food environments are changing rapidly.

In many developing countries, modern retailers – including supermarkets, hypermarkets, convenience stores, and fast-food restaurants – are gaining in importance at the expense of traditional food markets and shops (Popkin, 2014; Reardon and Timmer, 2014; Qaim, 2017). Due to higher efficiency and economies-of-scale, modern retailers may improve consumers' access to affordable foods (Hawkes, 2008; Tessier et al., 2008; Popkin, 2014; Qaim, 2017). On the other hand, modern retailers tend to sell more processed foods than traditional markets (Popkin, 2017; Khonje and Qaim, 2019; Swinburn et al., 2019). Highly processed foods are often rich in fat, sugar, and salt, but poor in micronutrients. Hence, the growth of modern retailers in developing countries may increase calorie consumption without necessarily improving dietary quality. Possibly, modern retailers may even worsen dietary quality through promoting the consumption of unhealthy snacks, beverages, and convenience foods (Popkin, 2017; Popkin and Reardon, 2018; Hawkes et al., 2020).

A few recent studies analyzed the effects of modern retailers on diets and nutrition in developing countries. Most of these studies focused on the role of supermarkets. Studies in Guatemala, Indonesia, Kenya, and Thailand showed that purchasing food in supermarkets leads to more consumption of processed and highly-processed foods (Asfaw, 2008; Kelly et al., 2014; Rischke et al., 2015; Umberger et al., 2015). In Guatemala and Kenya, supermarket food purchases were also shown to contribute to rising body mass index (BMI) and increased prevalence rates of overweight, obesity, and related chronic diseases among adults (Asfaw, 2008; Kimenju et al., 2015; Demmler et al., 2017; Demmler et al., 2018).

Effects of modern retailers on child nutrition were rarely analyzed. One recent study with data from Kenya showed that supermarkets do not contribute to childhood obesity but have a positive effect on child linear growth and height (Debela et al., 2020). Positive effects on child height are surprising, as linear growth is known to be closely related to dietary quality and balanced nutrient intakes (Ruel and Alderman, 2013; Development Initiatives, 2018). Do supermarkets and other modern retailers really contribute to improved nutrient intakes? This is an important question, which none of the previous studies was able to answer. Previous studies collected food consumption data at the household level, suggesting that purchasing food in supermarkets can lead to higher dietary diversity in some situations (Rischke et al., 2015; Rupa et al., 2019; Debela et al., 2020). But household-level data neglect intra-household food distribution and are therefore not necessarily good proxies of individual-level dietary quality and micronutrient intakes.

We provide the first study that analyzes effects of modern retailers on diets and nutrition with individual-level food-intake and anthropometric data from adults and children in a developing country. We use cross-section observational data collected in urban Zambia. Like many other countries in sub-Saharan Africa, Zambia is characterized by a high prevalence of different forms of malnutrition and a rapid modernization of food environments (Harris et al., 2019; Khonje and Qaim, 2019).

3.2. Methods

3.2.1. Survey of households and individuals

Data for this study were collected through a survey of households and individuals in Lusaka, the Capital City of Zambia. The survey was implemented between April and July 2018. As many other large cities in sub-Saharan Africa, Lusaka has recently experienced a rapid growth of modern retailers. The number of large shopping malls in Lusaka increased from one in 1995 to 25 in 2018 (Table 1.1). Shopping malls often include hypermarkets, supermarkets, and fast-food restaurants. In addition, the number of supermarkets and convenience stores outside of large shopping malls has also grown substantially.

We surveyed a total of 475 households from several compounds/sections in Lusaka City using a two-stage sampling procedure. At the first stage, we purposively selected 14 compounds/sections as primary sampling units based on population distributions and information from the Lusaka City

Council on mean income levels in the different compounds or sections. To ensure that the sample is representative and covers a wide variation of socioeconomic situations, we selected four compounds/sections (Avondole, Chalala, Kabulonga, and Woodlands) with high mean income levels, four compounds/sections (Chelston, Chilenje, Kabwata, and PHI) with middle mean income levels, and six compounds/sections (Chawama, Chazanga, Gardens, Kalingalinga, Kaunda Square, and Ng'ombe) with low mean income levels (Figure 1.1).

At the second stage, depending on the size of the compound/section, we randomly sampled about 35 households from each compound/section for study participation. In each sampled household, we interviewed the household head or the adult responsible for food purchase decisions and food preparation. We recruited local enumerators to conduct face-to-face interviews in local languages. The enumerators were trained and supervised by the researchers. The structured questionnaire covered sections on the household demographic structure, economic activities, income, and consumption expenditures. Data on food consumption at the household level were collected through a seven-day recall using a list of 140 different food items and capturing quantities, prices, and sources of each item.

Food-intake and nutrition data were captured at the individual level for up to four randomly selected members of each household: two adults (≥18 years) and two children/adolescents (6 months – 18 years). In this article, we use the term "children" for all individuals <18 years. Individual-level food-intake data were collected through 24-hour dietary recalls; for small children the recall questions were answered by the caregiver. Weight and height of all participating individuals were also measured. We have complete individual-level data for 930 adults (623 female and 307 male adults) and 499 children (Table A3.1 in the Appendix). All participating adults provided written informed consent for themselves and for their children. The study was reviewed and approved by the Ethics Committee of the University of Goettingen.

3.2.2. Measuring nutrition and dietary quality

Nutritional status of adults and children is evaluated with body height and weight measures. For adults, we calculate the body mass index (BMI), whereby BMI>25.0 kg/m² is defined as overweight or obese. For children, we calculate BMI-for-age Z-scores (BAZ) and height-for-age Z-scores (HAZ) (WHO, 2006). Child overweight/obesity is defined as BAZ>2 standard deviations (SD), child stunting as HAZ<-2 SD.

Dietary quality is evaluated with individual-level food-intake data. Simple dietary quality indicators are the food variety score (FVS), dietary diversity score (DDS), and healthy eating index (HEI) (Steyn et al., 2006; Demmler et al., 2018). FVS is as a simple count of the different food items eaten by the individual during the 24-hour recall period. DDS is a count of the number of different food groups eaten, considering a total of nine healthy food groups (Table A3.2 in the Appendix). FVS and DDS do not take into account the quantities of foods consumed. In contrast, HEI takes into account the quantities of 13 food components consumed, using a scoring method for the calculation (Table A3.2). HEI ranges from zero to 100, with higher values indicating better dietary quality (USDA, 2019). To our knowledge, HEI has been used as an indicator of dietary quality in the United States and other developed countries, but not yet in developing countries.

Other indicators of nutritional quality that we use are individual-level intakes of calories, protein, and several micronutrients, namely iron, zinc, and vitamin A. While the human body needs a large number of micronutrients for healthy nutrition, deficiencies in these three micronutrients are particularly common in developing countries and responsible for large health problems among children and adults (Development Initiatives, 2018). Calorie and nutrient intakes are calculated based on the quantities of the different food items consumed and local food composition tables (Nyirenda et al., 2009; FAO and Government of Kenya, 2018).

We also calculate micronutrient adequacy ratios for iron, zinc, and vitamin A, taking into account estimated average requirements for individual age and sex groups (Table A3.3 in the Appendix). Mean adequacy ratios are calculated by summing the adequacy ratios (truncated at 100%) for the three micronutrients and dividing by three (Steyn et al., 2006)

3.2.3. Statistical analysis

We analyze the effect of purchasing food in modern retailers on individual-level diets and nutrition with regression models of the following type:

(3.1) $$N_i = \alpha + \beta MR_{hi} + \gamma X_i + \delta X_{hi} + \varepsilon_i$$

where N_i is the nutrition status or dietary quality indicator of individual i, and MR_{hi} is the main explanatory variable of interest measuring the use of modern retailers for food purchases in household h that individual i belongs to. Modern retailers include hypermarkets, supermarkets, convenience stores, and fast-food restaurants. We define MR_{hi} as the share of total household food expenditures made in modern retailers expressed in percent and referring to the seven-day food consumption recall at the household level. In some of the models, we alternatively define MR_{hi} as a dummy variable that takes a value of one if the household purchased any of the food items consumed in a modern retailer, and zero if all of the foods were obtained from traditional sources (traditional markets, groceries, mom-and-pop-shops, kiosks, own production etc.). The estimation coefficient β indicates whether food purchases in modern retailers influence individual diets and nutrition.

Diets and nutrition can also be influenced by several other factors that we control for in the regression models. We control for individual characteristics (X_i), such as age, education, ethnicity, and religion, and also for relevant household characteristics (X_{hi}), such as household size and income (Asfaw, 2008; Demmler et al., 2018; Debela et al., 2020). ε_i is a random error term. We estimate all models separately for adults and children. For outcome variables that are measured with count data (FVS, DDS, HEI) we use Poisson models for estimation. Overweight/obese is a dummy variable, for which we use a probit specification. Several other outcomes are censored variables (calorie and nutrient intakes) for which we use Tobit specifications. For dependent variables that are continuous and normally distributed (BMI, HAZ), we use linear regression models. We use and report bootstrapped standard errors clustered at the compound level. All data analyses are performed with the software package Stata/SE 15.1.

3.2.4. Control function approach

In the regression models in equation (3.1), the main explanatory variable of interest ("treatment" variable) is food purchases in modern retailers (MR_{hi}), which is likely endogenous. What type of retailers to use for food purchases is a household-level decision that may depend on various factors not all of which we can observe and control for. If unobserved factors are jointly correlated with MR_{hi} and with the dietary and nutrition outcome variables, the coefficient estimate β may be biased.

We use a control function (CF) approach with instrumental variables (IV) to test and correct for such endogeneity bias (Wooldridge, 2010; 2015). In comparison to standard IV regressions, the CF estimator is more efficient and can also be used to control for unobserved heterogeneity in non-linear models, such as probit and Poisson models (Wooldridge, 2015). The CF is estimated as a two-stage model, whereby the first-stage regression is represented as:

$$MR_{hi} = \theta_0 + \theta_1 X_i + \theta_2 X_{hi} + \theta_3 Z_{hi} + \mu_i \quad (3.2)$$

where Z_{hi} is a vector of instrumental variables, and μ_i is a random error term. The other variables are defined as above. The second-stage model is the regression shown in equation (3.1) with the individual diet and nutrition outcomes as dependent variable but including the residuals from the first-stage model as an additional regressor. If the residual term is statistically insignificant in the second-stage regression, the null hypothesis of no endogeneity bias cannot be rejected, so that the CF approach is not required; in that case, regular one-stage models lead to unbiased and more efficient estimates. However, if the residual term turns out statistically significant, the CF approach is preferred and controls for endogeneity bias.

We use three instrumental variables for the CF models. First, distance from each household to the closest shopping mall, which is calculated using global positioning system (GPS) data collected during the survey. GPS-based data to measure distance to modern retailers were also used as instruments in several other studies (Kimenju et al., 2015; Rischke et al., 2015; Umberger et al., 2015; Debela et al., 2020). Second, whether or not the household feels that modern retailers sell food of higher quality than traditional retailers, which was also used by Umberger et al. (2015). Third, the number of visits to a shopping mall of the household's closest neighbor in the sample. Beyond distance and accessibility, the neighbor's behavior may capture influence through local social networks (Rupa et al., 2019). Tests for instrument validity are discussed below.

All three instruments are significantly correlated with the household's own use of modern retailers, MR_{hi} (Table A3.4 in the Appendix). As expected, distance to the closest shopping mall is negatively correlated, while the other two instruments are positively correlated with the food expenditure share spent in modern retailers. Moreover, the Wald test for the joint significance of the three instruments is statistically significant at the 1% level for both adults and children (Table A3.4). This underlines that the instruments are relevant. A second important criterion for validity is that the instruments do not affect the dietary and nutrition outcome variables directly, other than through own use of modern retailers. We perform a simple falsification test following Di Falco et al. (2011). Results show that the three instruments are jointly insignificant in all models with dietary and nutrition outcomes as dependent variables (Table A3.5 in the Appendix). Hence, we conclude that the instruments are valid.

3.3. Results

3.3.1. Descriptive comparisons

Three-quarters of all households in the sample used modern retailers during the seven days prior to the survey, at least for some of their food purchases. The rest obtained all of the foods consumed from traditional sources. Users of modern retailers spend 59% of their total food expenditures in modern retailers on average. Table 3.1 shows individual-level food intakes of adults and children. Differentiation is made between individuals from households with and without the use of modern retailers. Table 3.1 show that users of modern retailers consume lower quantities of vegetables and pulses and higher quantities of meat, dairy, sugar, and beverages than non-users. This comparison points at notable dietary differences between the two groups.

Table 3.1: Per capita food intake of adults and children using and not using modern retailers

Food intake (g/day)	Adults (≥18 years)		Children (<18 years)	
	Modern retailers		Modern retailers	
	Users (N = 713)	Non-users (N = 217)	Users (N = 358)	Non-users (N = 141)
Cereals and tubers	569.18	576.57	427.77	396.39
	(288.83)	(298.11)	(232.81)	(225.30)
Pulses	12.36***	24.07	9.18**	22.77
	(39.41)	(89.14)	(25.95)	(100.90)
Vegetables	47.33***	78.05	31.82***	58.28
	(71.80)	(123.14)	(63.30)	(89.26)
Fruits	3.30	3.04	1.19***	4.09
	(18.94)	(21.75)	(5.47)	(17.41)
Meat	36.66***	22.64	26.82***	14.95
	(43.80)	(47.43)	(31.40)	(46.14)
Dairy products	19.76**	7.85	22.22*	12.41
	(76.96)	(47.41)	(59.43)	(58.94)
Eggs	7.69	10.63	5.59*	10.80
	(24.07)	(46.93)	(19.85)	(42.16)
Fish	19.33	23.29	11.79	14.40
	(55.96)	(63.53)	(38.55)	(47.60)
Sugar, beverages	171.80***	124.83	140.79**	101.25
	(196.37)	(173.95)	(171.75)	(130.71)
Oils and fats	0.65	0.59	0.56	0.59
	(2.28)	(1.14)	(2.95)	(1.08)

Mean values are shown with standard deviations in parentheses. t-tests were carried out to test for mean differences between users and non-users of modern retailers. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. N, number of observations.

Table 3.2 shows individual diet and nutrition outcomes with and without modern retailer use. Overweight/obesity is fairly widespread, affecting 40-50% of the adults with no significant differences between the two groups. For children, overweight/obesity rates are much lower at 5-6%. Children are more affected by undernutrition; the prevalence of child stunting is lower among modern retail users than among non-users, even though the difference is not statistically significant. For the dietary indicators, several significant differences are observed. Adults and

Table 3.2: Nutrition and dietary indicators for adults and children using and not using modern retailers

Variables	Units	Adults (≥18 years) Modern retailers		Children (<18 years) Modern retailers	
		Users (N = 713)	**Non-users** (N = 217)	**Users** (N = 358)	**Non-users** (N = 141)
Body mass index (BMI)	kg/m^2 or BMI-for-age Z score	25.86	25.51	0.05	–0.18
		(4.88)	(5.65)	(1.45)	(1.72)
Overweight or obese	1 if BMI≥25 or BAZ>2 SD	0.50	0.44	0.05	0.06
		(0.50)	(0.50)	(0.22)	(0.24)
Height-for-age Z score (HAZ)	Z score	NA	NA	–0.51	–0.72
				(1.51)	(1.59)
Stunting	1 if HAZ <–2 SD	NA	NA	0.15	0.21
				(0.36)	(0.41)
Food variety score (FVS)	Score; range (0–18)	6.64**	6.26	6.69**	6.28
		(1.85)	(2.11)	(1.94)	(1.49)
Dietary diversity score (DDS)	Score; range (0–9)	3.23	3.12	3.02	3.08
		(1.02)	(1.00)	(1.00)	(1.00)
Healthy eating index (HEI)	Score; range (0–100)	32.58***	29.77	31.59***	28.41
		(10.12)	(10.94)	(10.88)	(10.73)
Calorie intake	kcal/day	2653.11**	2457.08	2006.76	1964.00
		(1161.83)	(985.42)	(936.00)	(969.40)
Protein intake	g/day	81.28	80.96	60.44	60.62
		(35.49)	(39.30)	(33.10)	(34.37)
Iron intake	mg/day	23.88	24.61	17.05	18.41
		(11.71)	(12.84)	(9.50)	(12.19)
Zinc intake	mg/day	7.59	7.64	5.36	5.47
		(5.45)	(6.19)	(3.10)	(5.44)
Vitamin A intake	µg retinol/day	525.83***	409.33	473.48**	380.22
		(499.93)	(454.70)	(487.48)	(428.93)

Mean values are shown with standard deviations in parentheses. t-tests were carried out to test for mean differences between users and non-users of modern retailers. ** $p < 0.05$, *** $p < 0.01$. N, number of observations; NA, not applicable. SD, standard deviation. Additional variables are shown in Table A3.6 in the Appendix.

children in households using modern retailers have higher food variety scores (FVS), a higher healthy eating index (HEI), and higher vitamin A intakes than their counterparts in households that obtain all of their foods from traditional sources. Nevertheless, mean micronutrient adequacy ratios are below 100% for all subsamples (Table A3.6 in the Appendix).

The differences in dietary and nutrition outcomes between users and non-users of modern retailers observed in Tables 3.1 and 3.2 cannot be interpreted as effects of modern retailers, because the groups also differ in terms of various other characteristics. For instance, users of modern retailers have significantly higher incomes and education levels than non-users (Table A3.6). As explained above, we use regression models with a control function approach to control for such heterogeneity and be able to make causal inference.

3.3.2. Effects of modern retailers on nutrition status

Table 3.3 shows estimated net effects of using modern retailers on nutrition status. We start by interpreting the results for adults. After controlling for household income and other relevant factors, a one percentage point increase in the food expenditure share spent in modern retailers increases adult BMI by 0.012 kg/m^2. Equivalently, a 10 percentage point increase in the modern

Table 3.3: Effects of using modern retailers on nutrition status

	Adults (≥18 years)		**Children (<18 years)**		
	BMI (kg/m^2)	**Overweight/Obese** (1,0)	**BAZ** (Z-score)	**Overweight/Obese** (1,0)	**HAZ** (Z-score)
	(1)	(2)	(3)	(4)	(5)
Modern retail use	0.012**	0.004***	–0.011	–0.016**	0.026***
(expenditure share, %)	(0.005)	(0.002)	(0.008)	(0.007)	(0.008)
Control variables	Yes	Yes	Yes	Yes	Yes
Joint F-statistic/Wald χ^2	761***	862***	66***	35***	117***
N	863	863	458	458	472

Marginal effects are shown with robust, bootstrapped standard errors clustered at compound level in parentheses. Full model results with all control variables are shown in Table A3.7 in the Appendix. For the adult sample, the null hypothesis of modern retailer use being exogenous could not be rejected, so that standard ordinary least squares and probit estimates are shown. For the child sample, the null hypothesis of exogeneity was rejected, so that control function estimates are shown. ** $p < 0.05$, *** $p < 0.01$. BAZ, BMI-for-age Z-score; BMI, body mass index; HAZ, height-for-age Z-score; N, number of observations.

retailer share is associated with a 0.12 increase in adult BMI (the mean expenditure share among modern retail users is 59%, implying a total effect on BMI of 0.7 kg/m^2). As mentioned, a considerable proportion of the adults are already overweight or obese. The risk of adult overweight/obesity further rises through the use of modern retailers: a 10 percentage point increase in the modern retailer expenditure share raises the likelihood of overweight/obesity by 4 percentage points (Table 3.3).

For children, the results are different. Using modern retailers has no significant effect on child BMI-for-age Z-scores (column 3 of Table 3.3), and the effect on child overweight/obesity is even negative (column 4). At the same time, we observe a statistically significant positive effect on child height (column 5). A 10 percentage point increase in the modern retail expenditure share raises child-for-age Z-scores (HAZ) by 0.26. This points at clearly positive effects of modern retailers on child nutrition

3.3.3. Effects of modern retailers on dietary quality

Figure 3.1 shows effects of modern retailers on adult and child dietary diversity. After controlling for income and other relevant factors, use of modern retailers increases adult FVS and dietary diversity score (DDS) by 10-12%. For children, the point estimates for FVS and DDS are positive

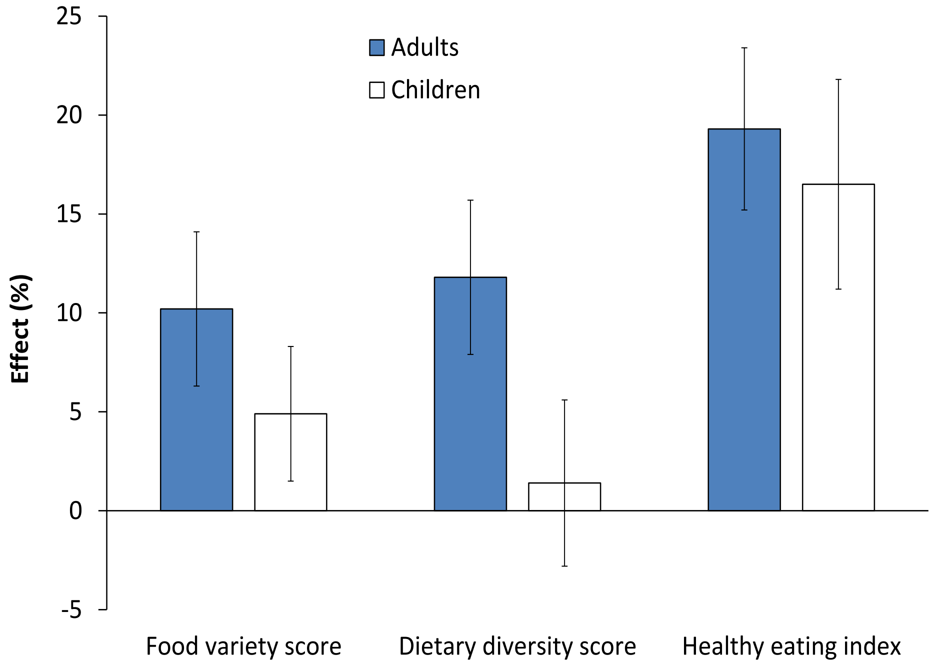


Figure 3.1: Effects of using modern retailers on dietary diversity

Percentage effects are shown with standard error bars. Use of modern retailers expressed as a dummy variable that takes a value of one if any of the food consumed was purchased in a modern retailer and zero if all of the foods consumed were obtained from traditional sources. Effects were estimated with control function models, controlling for income, education, age, and other relevant factors. Models for adults were estimated with 930 individual observations. Models for children were estimated with 499 individual observations. Full model results are shown in Tables A3.8 and A3.9 in the Appendix.

but not statistically significant. However, FVS and DDS only count the number of food items and food groups consumed without considering quantities. When considering intake quantities of different food components through the HEI, the effects are larger and statistically significant. Use of modern retailers increases HEI by 19% and 17% for adults and children, respectively (Figure 3.1).

Figure 3.2 shows effects of modern retailers on calorie and nutrient intakes. All effects are positive and statistically significant. After controlling for other factors, a 10 percentage point increase in the modern retail expenditure share raises calorie intakes by 133 and 97 kcal/day for adults and children, respectively. For adults, the additional calorie intake probably also explains the increase in BMI through using modern retailers, as shown above.

Modern retailers also have positive effects on nutrient intakes (Figure 3.2). A 10 percentage point increase in the modern retail expenditure share augments adult and child protein, iron, and zinc intakes by 5-7%; for vitamin A the increase is about 3% for both adults and children. These are sizeable effects, especially when considering that users of modern retailers spend 59% of their total food expenditures in modern retail outlets. Effects on mean micronutrient adequacy ratios are also positive and significant (Tables A3.12 and A3.13 in the Appendix). These findings underline that modern retailers improve adult and child micronutrient nutrition.

Most previous studies on the effects of modern retailers had focused on supermarkets only, not considering hypermarkets, convenience stores, and fast-food restaurants. In order to test whether our results change when only considering supermarkets, we reran the calorie and nutrient intake models with a modified modern retailer variable that only captures the supermarket food expenditure share. These alternative estimates are similar to those shown in Figure 3.2, only that the effect sizes are somewhat smaller (Table A3.14 in the Appendix), as one would expect. We infer that the different types of modern retailers have similar effects.

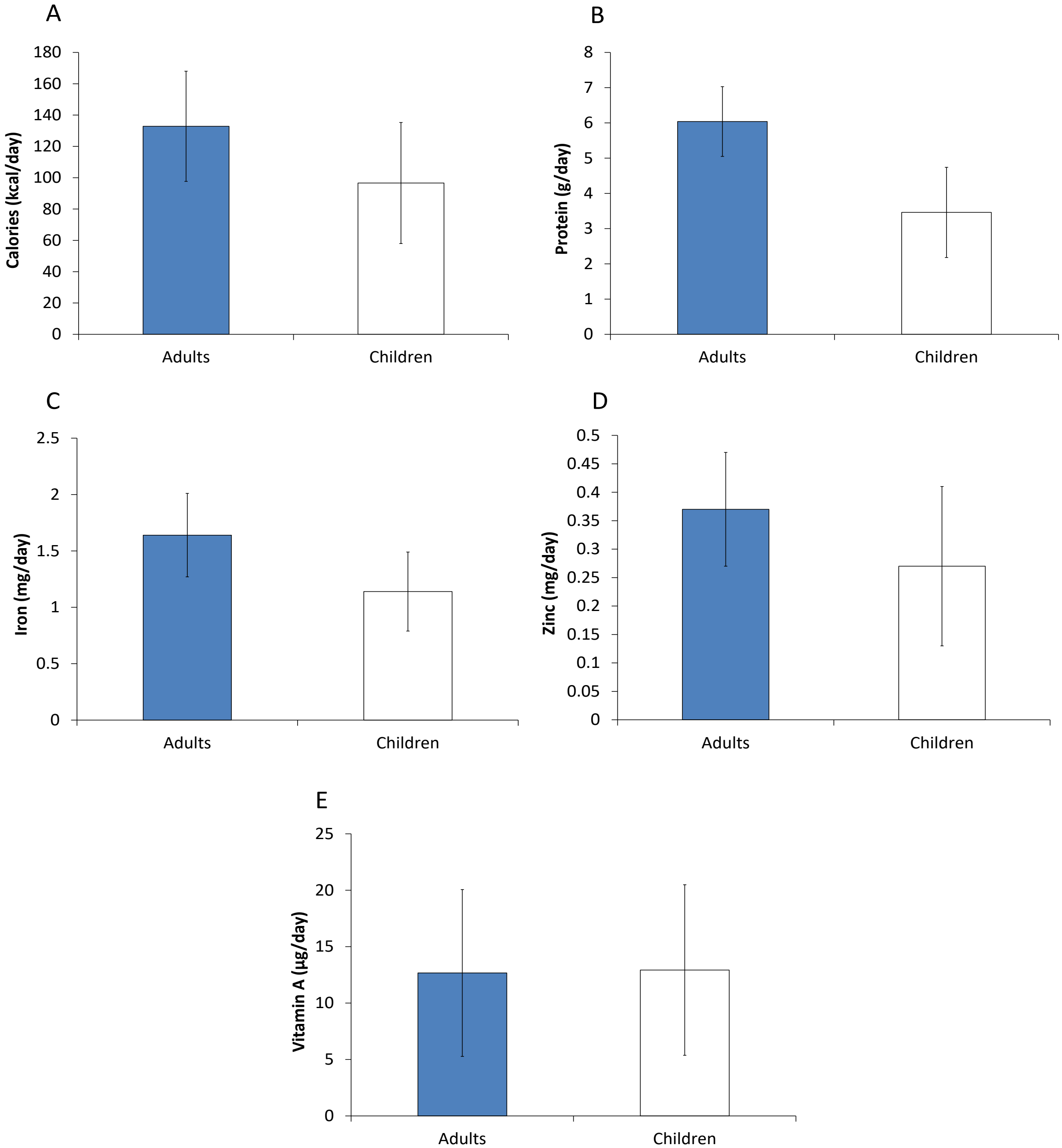


Figure 3.2: Effects of using modern retailers on calorie and nutrient intakes

Effects of a 10 percentage point increase in the household food expenditure share spent in modern retailers are shown with standard errors bars. Effects were estimated with control function models, controlling for income, education, age, and other relevant factors. Models for adults were estimated with 930 individual observations. Models for children were estimated with 499 individual observations. Full model results are shown in Tables A3.10 and A3.11 in the Appendix. (A) Effects on calorie intake in kcal/day. (B) Effects on protein intake in g/day. (C) Effects on iron intake in mg/day. (D) Effects on zinc intakes in mg/day. (E) Effects on vitamin A intakes in µg of retinol equivalents per day.

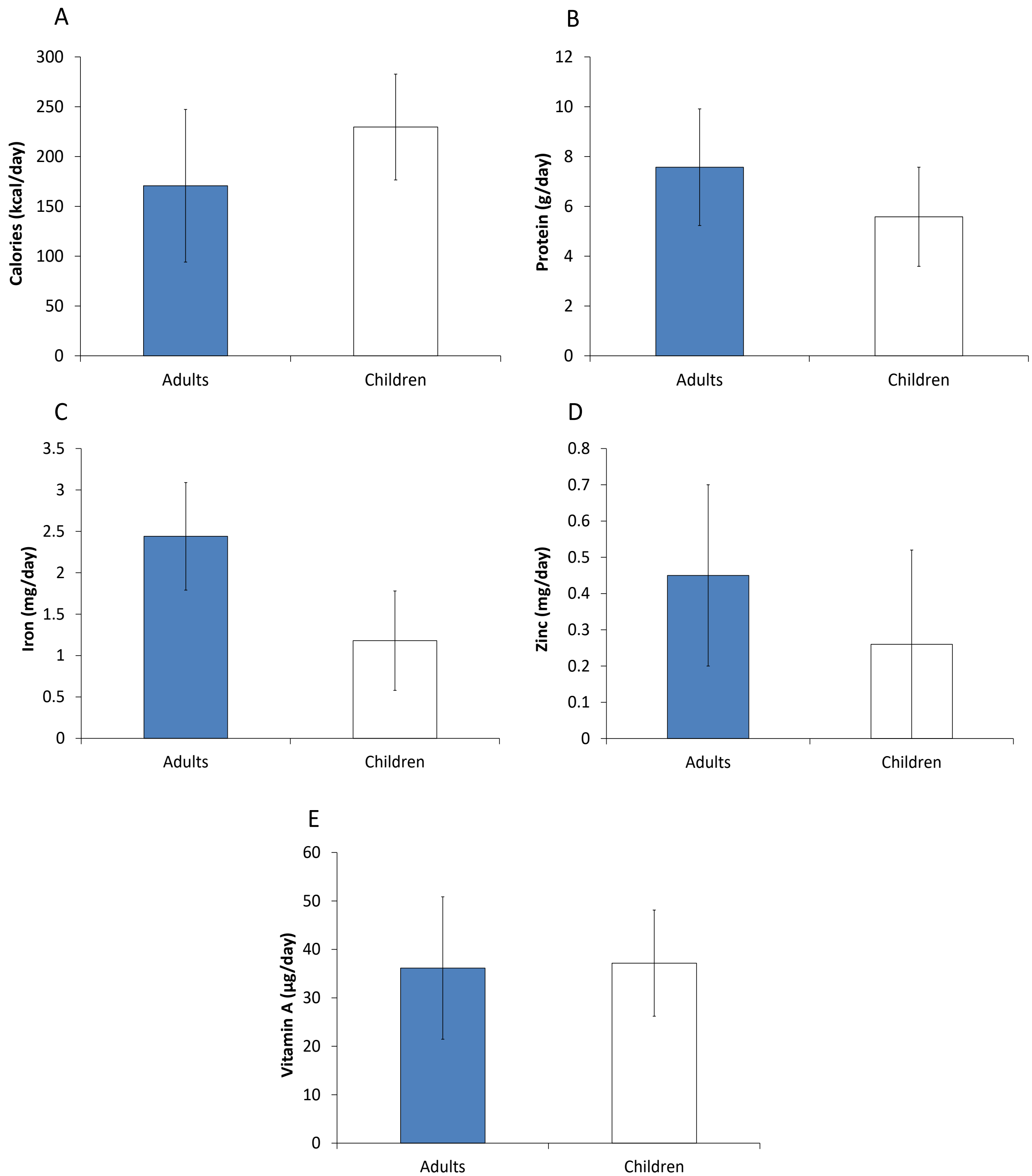


Figure 3.3: Effects of using modern retailers on calorie and nutrient intakes among poor households

Effects of a 10 percentage point increase in the household food expenditure share spent in modern retailers are shown with standard errors bars. Effects were estimated with control function models, controlling for income, education, age, and other relevant factors. Models for adults were estimated with 930 individual observations. Models for children were estimated with 499 individual observations. Detailed model results are shown in Table A3.15 in the Appendix. (A) Effects on calorie intake in kcal/day. (B) Effects on protein intake in g/day. (C) Effects on iron intake in mg/day. (D) Effects on zinc intakes in mg/day. (E) Effects on vitamin A intakes in µg of retinol equivalents per day.

In additional analyses, we looked specifically at effects on individuals living below the international poverty line of 1.90 US dollars per day. About 24% of the adults and 35% of the children in the sample are poor according to this definition. Interestingly, most of the effects of modern retailers on calorie and nutrient intakes are larger for poor individuals (Figure 3.3) than for the full adult and child samples (Figure 3.2). For vitamin A, the positive intake effects on poor individuals are almost three times larger. This is a welcome finding implying that poor people benefit over-proportionally from access to modern retailers. Finally, we disaggregated the adult and child samples by sex. While the estimates are generally less efficient, positive calorie and nutrient intake effects are observed for male and female adults and children (Table A3.16 in the Appendix). The estimated effects of modern retailers on micronutrient intakes are somewhat larger for girls than for boys.

3.4. Discussion and conclusion

In Zambia and many other developing countries, food environments are changing rapidly with modern retailers gaining in importance. Most households use both modern and traditional retailers for their food purchases, but the share of the food budget spent in modern retail outlets is rising. According to our data, the average household in Lusaka spends about 42% of its food budget for purchases in modern retail outlets. Excluding those that only use traditional sources, the modern retail share increases to 59%. Changing food environments can influence people's dietary choices and nutrition. Modern retailers tend to sell more processed foods than traditional markets. Moreover, there are differences in terms of food variety, prices, packaging sizes, and shopping atmosphere. Previous studies suggested that modern retailers increase the consumption of calories from processed foods and therefore contribute to overweight, obesity, and related chronic diseases (Asfaw, 2008; Kimenju et al., 2015; Demmler et al., 2017; Demmler et al., 2018). These studies mostly looked at adult populations. Very few studies analyzed effects of modern retailers on child nutrition, and those that did found mixed results (Umberger et al., 2015; Debela et al., 2020). One shortcoming of all existing studies is that they did not collect individual-level food-intake data. Individual-level data are important to analyze effects of modern retailers on dietary quality and better understand the mechanisms behind the nutrition impacts.

In this article, we have evaluated dietary and nutrition effects of modern retailers in Lusaka using individual-level food-intake and anthropometric data. The use of modern retailers is positively associated with BMI and the likelihood of being overweight and obese among adults. This is consistent with earlier results for adult populations in Guatemala (Asfaw, 2008) and Kenya (Kimenju et al., 2015; Demmler et al., 2018). For children, we did not find a significant relationship between the use of modern retailers and BMI-for-age Z-scores. Instead, we found that the use of modern retailers increases child height. This is consistent with recent results for children in urban Kenya (Debela et al., 2020). Gains in child height point at likely improvements in dietary quality, even though – due to data limitations – this could not be analyzed in previous studies.

Analysis of our individual-level dietary data confirms that the use of modern retailers improves dietary quality for both adults and children. First, modern retailers contribute to higher calorie intakes, resulting primarily from more consumption of sugar, meat, and dairy products. Second, especially the increase in the consumption of animal source foods also contributes to higher intakes of protein and micronutrients, such as iron, zinc, and vitamin A. These dietary effects are observed for both adults and children. For adults, this implies negative and positive nutrition effects at the same time: the growth of modern retailers is associated with a rise in overweight/obesity and a reduction in micronutrient deficiencies among adults. For children that have not yet reached their final body height, the mechanisms are different. Increases in calorie, protein, and micronutrient intakes contribute to linear growth, especially in situations where child stunting is still commonplace. Recent research with data from a large number of developing countries showed that consumption of animal source foods in particular is positively associated with child linear growth (Headey et al., 2018). This is especially true in situations where regular access to sufficient quantities of plant-based proteins and micronutrients is difficult.

Beyond nutrient intakes, our data from Lusaka show that the use of modern retailers is associated with higher consumption of processed foods (Khonje and Qaim, 2019). This is consistent with findings from other developing countries (Asfaw, 2008; Kelly et al., 2014; Kimenju et al., 2015; Demmler et al., 2018). Processed foods are often considered less healthy than unprocessed foods. However, differentiation is important. Ultra-processed foods with high sugar, fat, and salt, and low micronutrient contents are unhealthy (Popkin 2017; Swinburn et al., 2019; Popkin et al., 2020), whereas the same is not necessarily true for all processed foods. Processing can increase the hygiene and shelf-life of foods and therefore make nutritious, perishable products more accessible to consumers. Meat and dairy are good examples. Many poor households rarely buy fresh meat and milk, as these are expensive and highly perishable. Hence, access to processed versions with a longer shelf-life can increase the consumption of nutritious foods. This also explains why the effects of modern retailers on micronutrient intakes of individuals from poor households are particularly large.

A few policy implications emerge from these results. The growth of modern retailers influences people's diets and nutrition, and the effects can be positive and negative. The positive effects on child nutrition and dietary quality of both children and adults are not yet widely appreciated and speak in favor of supporting further modernization of food retail environments. On the other hand, the effect of increasing adult overweight and obesity is undesirable. Regulatory policies that can help to make food environments healthier would be useful. Possible policy interventions include regulation of advertisement and promotional campaigns for unhealthy foods, regulation of health labels and portion/packaging sizes, taxes on ultra-processed foods and beverages with high contents of added sugars, and incentives to offer more healthy foods, among others (Development Initiatives, 2018; Swinburn et al., 2019; Hawkes et al., 2020).

Our results are specific for Lusaka in Zambia and should not be generalized. It is likely that the diet and nutrition effects of modern retailers will be similar in situations where households are relatively poor, child stunting is widespread, and people only have limited or irregular access to healthy foods from traditional markets. This is probably the case in many parts of Africa, as recent research with data from Kenya also suggests (Kimenju et al., 2015; Rischke et al., 2015; Demmler et al., 2018; Debela et al., 2020). However, the effects of modern retailers may be different in situations where consumers are richer, micronutrient deficiencies are not a big problem, and child undernutrition rates are low. One study with data from Indonesia suggested that the use of modern retailers contributes to child overweight in high-income households (Umberger et al., 2015). More research is needed to better understand the diet and nutrition effects of changing food environments in different geographical and socioeconomic contexts.

Appendix A3

Table A3.1: Distribution of sampled individuals in Lusaka City

Name of the surveyed compounds/sections	Income level	By sex and age cohort			All
		Adult females (≥18 years)	**Adult males** (≥18 years)	**Children/Adolescents** (<18 years)	
Four: Avondole, Chalala, Kabulonga, and Woodlands	High	121	76	85	282
Four: Chelston, Chilenje, Kabwata, and PHI	Middle	250	122	187	559
Six: Chawama, Chazanga, Gardens, Kalingalinga, Kaunda Square, and Ng'ombe	Low	252	109	227	588
All		623	307	499	1429

Table A3.2: Food groups and components used for construction of dietary quality indicators

Dietary diversity score			
Group	**Food groups**	**Food items (examples)**	**Weight**
1	Cereals and tubers	Maize, rice, sorghum, millet, bread, cassava, potatoes, plantains	1
2	Pulses	Beans, cowpea, groundnuts, pigeonpea, soybean, velvet beans	1
3	Meat	Beef, chicken, ducks, goat meat, sheep meat, and pork	1
4	Fish	Fish (fresh/frozen/dried/tinned)	1
5	Eggs	Eggs	1
6	Vitamin A rich vegetables	Cassava leaves, sweet potato leaves	1
7	Other vegetables	Tomatoes, cabbage etc.	1
8	Fruits	Fruits	1
9	Dairy	Milk, yoghurt, and other dairy products	1
Healthy eating index (HEI)			
Component	**Standard for maximum score**	**Standard for minimum score (zero)**	**Maximum points**
Adequacy			
Total fruits	≥0·8 cup equivalent per 1000 kcal	No fruit	5
Whole fruits	≥0·4 cup equivalent per 1000 kcal	No whole fruit	5
Total vegetables	≥1·1 cup equivalent per 1000 kcal	No vegetables	5
Greens and beans	≥0·2 cup equivalent per 1000 kcal	No dark-green vegetables or pulses	5
Whole grains	≥1·5 ounce equivalent per 1000 kcal	No whole grains	10
Dairy	≥1·3 cup equivalent per 1000 kcal	No dairy	10
Total protein foods	≥2·5 ounce equivalent per 1000 kcal	No protein foods	5
Seafood and plant proteins	≥0·8 ounce equivalent per 1000 kcal	No seafood or plant proteins	5
Fatty acids [a]	(PUFAs+MUFAs)/SFAs≥2·5	(PUFAs+MUFAs)/SFAs≤1·2	10
Moderation			
Refined grains	≤1·8 ounce equivalent per 1000 kcal	≥4·3 ounce equivalent per 1000 kcal	10
Sodium	≤1·1 grams per 1000 kcal	≥2·0 grams per 1000 kcal	10
Added sugars	≤6·5% of energy	≥26% of energy	10
Saturated fats	≤8% of energy	≥16% of energy	10

[a] Ratio of poly-and mono-unsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs). HEI components and weights based on USDA (2019).

Table A3.3: Estimated average requirements of calories and nutrients by sex and age cohort

Sex	Age (years)	Calorie and nutrients [a]				
		Calorie [b]	Protein [d]	Iron	Zinc [e]	Vitamin A
		(kcal/day)	(g/day)	(mg/day)	(mg/day)	(µg retinol/day)
Child	1–3	531 [c]	10·0	5·8	2·0	200
	4–6	595 [c]	14·8	6·3	3·0	200
	7–9	680 [c]	21·0	8·9	5·0	250
	10–18	2200	36·4	8·0	8·6	330
Males	19–65	2400	55·5	11·0	10·0	300
	≥66	2200	54·6	8·0	10·0	300
	10–18	1600	38·6	8·0	7·0	330
Females	19–65 non-lactating	2000	54·9	18·0	6·0	270
	≥66	1800	57·1	8·0	6·0	300

[a] Estimated average requirements for nutrients are based on FAO (2001), WHO and FAO (2004), and IOM (2006). [b] Estimated average energy (calories) requirements for adults are based on IOM (2002), assuming a moderate active individual. [c] Daily energy requirements obtained by averaging values for respective age groups from Table 3·2 in FAO (2001). [d] Anthropometric data (weight in kg) and the reference body weight of 0·8 g/kg/day (IOM, 2002) used as conversion factor to calculate daily protein requirements for individuals. [e] Zinc requirements are based in International Zinc Nutrition Consultative Group (IZiNCG) for mixed or refined vegetarian diets (IZiNCG et al., 2004).

Table A3.4: First-stage estimation results on food purchases in modern retailers

	Modern retail use (expenditure share, %)	
	Adults	**Children**
	(1)	(2)
Male (dummy)	–4·493**	3·666
	(1·958)	(2·465)
Age of respondent (years)	–0·430	2·284**
	(0·312)	(1·161)
Age-squared (years)	0·005	–0·095
	(0·004)	(0·065)
Education of respondent (years)	2·611***	–0·435
	(0·304)	(0·941)
Household size (individuals)	–1·870***	–0·953
	(0·561)	(0·840)
Income (log)	10·992***	12·821***
	(0·835)	(1·100)
Chewa (dummy)	1·347	–5·753
	(2·682)	(3·646)
Tonga (dummy)	–4·961**	–0·331
	(2·268)	(3·459)
Catholic (dummy)	–3·751*	–5·233*
	(2·046)	(2·936)
Instruments		
High quality food products (dummy)	14·463***	16·610***
	(2·370)	(3·571)
Neighbor's shopping mall usage (visits/week)	2·397***	2·146***
	(0·328)	(0·447)
Distance to a shopping mall (km)	–1·132***	–1·622***
	(0·360)	(0·493)
Constant	–75·621***	–88·611***
	(10·594)	(12·721)
Joint significance of instruments: $\chi^2(3)$	120***	64***
N	930	499

Generalized linear models. Standard errors are reported in parentheses. * p < 0·10, ** p < 0·05, *** p < 0·01.

Table A3.5: Falsification test for instrument validity (Tobit estimates)

	BMI (kg/m²/Z-score)	HAZ (Z-score)	Calorie (kcal/day)	Protein (g/day)	Iron (mg/day)	Zinc (mg/day)	Vitamin A (µg retinol/day)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Adults		NA					
High quality food products (dummy)	–0·079		47·512	–0·018	–0·427	–0·073	0·674
	(0·358)		(96·791)	(0·302)	(1·307)	(0·376)	(0·696)
Neighbor's shopping mall usage (visits/week)	–0·004		24·340	0·040	0·250	0·036	–0·057
	(0·051)		(18·738)	(0·053)	(0·205)	(0·058)	(0·090)
Household distance to a shopping mall (km)	0·023		3·231	–0·011	0·032	–0·012	0·012
	(0·052)		(17·223)	(0·049)	(0·240)	(0·040)	(0·065)
Other controls	Yes		Yes	Yes	Yes	Yes	Yes
Joint significance of instruments: F (3, 853/919)	0·10		1·02	0·47	1·02	0·36	0·35
Joint significance of instruments: p-value	0·958		0·385	0·704	0·382	0·785	0·792
Joint F-statistic	355***		16***	3***	16***	15***	15***
Pseudo-R^2	0·038		0·012	0·044	0·027	0·051	0·070
N	864		930	930	930	930	930
Children							
High quality food products (dummy)	–0·275	0·145	–38·936	–0·009	1·068	–2·286	0·456
	(0·441)	(0·529)	(157·455)	(0·302)	(1·508)	(2·022)	(0·692)
Neighbor's shopping mall usage (visits/week)	–0·124**	0·159*	31·934	0·080*	0·126	0·343*	0.036
	(0·062)	(0·083)	(21·533)	(0·045)	(0·143)	(0·191)	(0·076)
Household distance to a shopping mall (km)	–0·080	–0·038	–6.909	–0·025	–0·067	0·091	–0·034
	(0·054)	(0·067)	(15·427)	(0·033)	(0·131)	(0·179)	(0·054)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Joint significance of instruments: F (3, 449/461/488)	1·66	1·23	0·99	1·53	0·46	1·73	0·47
Joint significance of instruments: p-value	0·18	0·298	0·398	0·205	0·712	0·159	0·704
Joint F-statistic	355***		145***	202***	48***	3***	39***
Pseudo-R^2	0·038	0·165	0·050	0·172	0·139	0·044	0·061
N	460	472	499	499	499	499	499

NA, not applicable. Protein and vitamin A intakes were transformed using an inverse hyperbolic sine transformation: $\ln[\{y + (y^2 + 1)^{0\cdot5}\}]$, in order to retain zero-valued observations. Coefficient estimates are shown with robust standard errors clustered at compound level in parentheses. Other controls: age, age-squared, education, household size, log of income, a dummy (1, 0) variable for male, ethnic groups – Chewa, and Tonga, and religion status – Catholic. * p < 0·10, *** p < 0·01.

Table A3.6: Additional descriptive statistics for users and non-users of modern retailers

Variables	Units	Adults (≥18 years)		Children (<18 years)	
		Modern retailers		Modern retailers	
		Users	Non-users	Users	Non-users
		(N = 713)	(N = 217)	(N = 358)	(N = 141)
Dependent variables					
Mean adequacy ratio	Percent, %	91·51***	86·99	93·44	92·22
		(17·68)	(21·51)	(16·03)	(17·92)
Iron	Percent, %	171·96	175·87	227·98	245·23
		(103·61)	(101·25)	(122·89)	(157·20)
Zinc	Percent, %	108·69	108·93	116·23	119·10
		(85·02)	(84·95)	(77·49)	(136·35)
Vitamin A	Percent, %	185·79***	146·75	185·80*	150·76
		(176·86)	(165·23)	(202·58)	(176·71)
Treatment variable					
Modern retailer use	Expenditure share,%	59·30***	0·00	51·59***	0·00
		(31·13)	(0·00)	(30·49)	(0·00)
Independent variables					
Household income	US$/capita/year	3265·18***	1041·53	2575·76***	866·82
		(3306·72)	(1212·42)	(3454·14)	(1141·88)
Male	1= Yes, 0 otherwise	0·33	0·33	0·46	0·45
		(0·47)	(0·47)	(0·50)	(0·50)
Age of household respondent	Years	34·84	36·56	8·98	8·59
		(13·97)	(15·08)	(4·87)	(4·73)
Education of respondent	Schooling years	12·27***	9·32	4·07**	3·29
		(3·18)	(3·39)	(3·93)	(3·39)
Household size	Number of members	4·47***	4·89	4·93	5·16
		(1·60)	(1·89)	(1·45)	(1·60)
Bemba as ethnicity	1= Yes, 0 otherwise	0·29**	0·20	0·34*	0·26
		(0·45)	(0·40)	(0·47)	(0·44)
Chewa as ethnicity	1= Yes, 0 otherwise	0·12**	0·18	0·12**	0·18
		(0·33)	(0·38)	(0·32)	(0·39)
Tonga as ethnicity	1= Yes, 0 otherwise	0·21	0·20	0·15	0·17
		(0·41)	(0·40)	(0·35)	(0·38)
Protestant as a religion	1= Yes, 0 otherwise	0·44	0·41	0·49	0·45
		(0·50)	(0·49)	(0·50)	(0·50)
Catholic as a religion	1= Yes, 0 otherwise	0·25**	0·32	0·18***	0·33
		(0·43)	(0·47)	(0·39)	(0·47)
Physical activity ratio	Ratio; range (0·03–15·95)	2·74	2·76	3·52	3·58
		(1·45)	(1·71)	(2·26)	(2·35)
Piped or tap drinking water	1= Yes, 0 otherwise	0·94**	0·88	0·92*	0·87
		(0·24)	(0·32)	(0·27)	(0·34)
Non-chronic infections	1= Yes, 0 otherwise	0·27	0·26	0·27*	0·19
		(0·44)	(0·44)	(0·45)	(0·39)
Distance to the nearest hospital	km; range (0·01–30)	2·38***	1·90	2·32	2.07
		(2·06)	(1·81)	(2·01)	(3·00)
High quality food products	1= Yes, 0 otherwise	0·23***	0·01	0·18***	0·04
		(0·42)	(0·12)	(0·38)	(0·19)
Neighbor's shopping mall usage	Number of visits per week	2·88***	1·68	3·00***	1·48
		(2·91)	(2·25)	(3·04)	(2·31)
Household distance to a shopping mall	GPS-measured distance in km	2·57***	3·59	2·53***	3·88
		(2·57)	(2·26)	(2·50)	(2·49)

Mean values are shown with standard deviations in parentheses. The average exchange rate was ZMW 9·87 = US$ 1 in mid-2018. t-tests were used to test for mean differences between users and non-users of modern retailers. * p < 0·10, ** p < 0·05, *** p < 0·01.

Table A3.7: Effects of modern retailers on nutritional status (full model results for Table 3.3)

	Adults (≥18 years)		Children (<18 years)			Adults (≥18 years)		Children (<18 years)		
	BMI	**Overweight /Obese**	**BAZ**	**Overweight /Obese**	**HAZ**	**BMI**	**Overweight /Obese**	**BAZ**	**Overweight /Obese**	**HAZ**
	OLS	Probit	OLS	Probit	OLS	CF	CF	CF	CF	CF
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Modern retail use	0·012**	0·004***	0·001	–0·002	0·006**	0·004	0·003	–0·011	–0·016**	0·026***
(expenditure share, %)	(0·005)	–0.002	(0·002)	(0·004)	(0·003)	(0·014)	(0·005)	(0·008)	(0·007)	(0·008)
Male (dummy)	–0·900**	–0·284***	0·558**	0·410*	–0.083	–0·930***	–0·290**	0·566***	0·440**	–0·097
	(0·349)	(0·104)	(0·217)	(0·228)	(0·186)	(0·341)	(0·117)	(0·190)	(0·179)	(0·206)
Age (years)	0·374***	0·101***	–0·154**	–0·144	0·273***	0·371***	0·101***	–0·132*	–0·116	0·236***
	(0·062)	(0·022)	(0·067)	(0·094)	(0·063)	(0·054)	(0·016)	(0·074)	(0·076)	(0·077)
Age-squared (years)	–0·003***	–0·001***	0·003	0·003	–0·022***	–0·003***	–0·001***	0·002	0·002	–0·020***
	(0·001)	(0·0002)	(0·003)	(0·004)	(0·002)	(0·001)	(0·000)	(0·004)	(0·004)	(0·004)
Education (years)	–0·099	–0·0003	0·127**	0·111**	0·114**	–0·077	0·004	0·130***	0·113*	0·109**
	(0·080)	(0·017)	(0·045)	(0·050)	(0·053)	(0·070)	(0·023)	(0·040)	(0·060)	(0·049)
Household size (individuals)	0.086	0·020	–0·022	–0·036	0·005	0·071	0·017	–0·038	–0·058	0·029
	(0·073)	(0·030)	(0·041)	(0·049)	(0·047)	(0·104)	(0·029)	(0·047)	(0·052)	(0·047)
Income (log)	0·079	0·039	0·025	0·064	–0·055	0·172	0·056	0·205	0·283**	–0·365***
	(0·206)	(0·056)	(0·112)	(0·094)	(0·066)	(0·247)	(0·077)	(0·146)	(0·127)	(0·140)
Chewa (dummy)	0·061	0·278	–0·220	–0·315*	–0·085	0·061	0·278**	–0·263	–0·396	–0·006
	(0·555)	(0·183)	(0·182)	(0·165)	(0·136)	(0·412)	(0·134)	(0·214)	(0·250)	(0·148)
Tonga (dummy)	0·373	0·145	0·088	–0·151	0·014	0·334	0·137	0·092	–0·152	0·015
	(0·449)	(0·106)	(0·193)	(0·211)	(0·236)	(0·404)	(0·119)	(0·217)	(0·203)	(0·249)
Catholic (dummy)	0·387	0·025	0·018	0·018	–0·105	0·367	0·022	–0·061	–0·068	0·036
	(0·275)	(0·113)	(0·174)	(0·200)	(0·170)	(0·301)	(0·110)	(0·158)	(0·197)	(0·146)
Physical activity ratio	–0·843***	–0·215***	–0·140***	–0·111**	–0·086*	–0·840***	–0·215***	–0·132***	–0·107**	–0·098**
	(0·120)	(0·031)	(0·038)	(0·052)	(0·048)	(0·116)	(0·039)	(0·036)	(0·043)	(0·041)
Piped drinking water (dummy)					0·263					0·214
					(0·335)					(0·222)
Non-chronic infections (dummy)					–0·239					–0·182
					(0·139)					(0·149)
Distance to the nearest hospital (km)					–0·039*					–0·038*
					(0·021)					(0·022)
Constant	19·016***	–2·420***	0·628	–0·549	–0·631	18·353***	–2·548***	–0·613	–2·049**	1·527
	(2·341)	(0·595)	(1·068)	(1·096)	(0·807)	(2·360)	(0·756)	(1·223)	(0·997)	(1·062)
First-stage residual						0·008	0·002	0·013*	0·016**	–0·023***
						(0·015)	(0·005)	(0·007)	(0·007)	(0·008)
Joint F-statistic/Wald χ^2	761***	862***	37***	192***		327***	162***	66***	35***	117***
R^2/Pseudo-R^2	0·220	0·146	0·057	0·046	0·133	0·220	0·147	0·063	0·055	0·151
N	863	863	458	458	472	863	863	458	458	472

Coefficient estimates are shown with robust, bootstrapped standard errors clustered at compound level in parentheses. OLS, ordinary least-squares estimator. Bemba and Protestant are used as reference group for ethnicity – Chewa and Tonga, and religion status – Catholic, respectively. * p < 0·10, ** p < 0·05, *** p < 0·01.

Table A3.8: Effects of modern retailers on adult dietary diversity (full model results for Figure 3.1)

	HEI Score (0–100) Poisson	FVS Score (0–18) Poisson	DDS Score (0–9) Poisson	HEI Score (0–100) CF	FVS Score (0–18) CF	DDS Score (0–9) CF
	(1)	(2)	(3)	(4)	(5)	(6)
Modern retail use	1·109***	1·038	1·040	1·193***	1·102**	1·118**
(dummy)	(0·039)	(0·026)	(0·041)	(0·041)	(0·039)	(0·039)
Male	–0·994	–0·995	1·019	1·001	1·001	1·025
	(0·027)	(0·021)	(0·027)	(0·022)	(0·020)	(0·024)
Age	–0·999	1·001	–0·999	–0·999	1·001	–0·999
	(0·004)	(0·003)	(0·003)	(0.004)	(0·003)	(0·004)
Age-squared	1·000	–1.000	1·000	–1·000	–1·000	1·000
	(0·00005)	(0·003)	(0·00004)	(0·00004)	(0·00003)	(0·00004)
Education	–0·990*	–0·999	–0·999	–0·988**	–0·997	–0·997
	(0·005)	(0·004)	(0·005)	(0·005)	(0·003)	(0·003)
Household size	–0·994	1·004	1·008	–0·993	1·003	1·007
	(0·008)	(0·008)	(0·006)	(0·008)	(0·007)	(0·007)
Income	1·012	1·023*	1·007	1·003	1·016	–0·998
	(0·016)	(0·013)	(0·013)	(0·011)	(0·010)	(0·012)
Chewa	1·027	1·049	1·057	1·029	1·050	1·059
	(0·036)	(0·031)	(0·039)	(0·033)	(0·034)	(0·038)
Tonga	1·078**	1·049	1·024	1·084***	1·054**	1·030
	(0·037)	(0·033)	(0·036)	(0·026)	(0·023)	(0·024)
Catholic	1·053	1·027	1·067**	1·056**	1·030	1·070***
	(0·034)	(0·026)	(0·021)	(0·028)	(0·026)	(0·024)
Constant	30·469***	4·845***	2·777***	32·133***	5·061***	2·931***
	(0·034)	(0·699)	(0·354)	(4·518)	(0·543)	(0·391)
First-stage residual				–0·998***	–0·998***	–0·998***
				(0·0004)	(0·0004)	(0·001)
Wald χ^2	123***	130***	56***	56***	41***	43***
Pseudo-R^2	0·013	0·003	0·002	0·021	0·005	0·004
N	930	930	930	930	930	930

Incidence rate ratios are shown with bootstrapped standard errors clustered at compound level in parentheses. For Figure 3.1, incidence ratios and standard errors were converted for percentage interpretation. CF, control function approach; HEI, healthy eating index; FVS, food variety score; DDS, dietary diversity score. Bemba and Protestant are used as a reference group for ethnicity – Chewa and Tonga, and religion status – Catholic, respectively. * p < 0·10, ** p < 0·05, *** p < 0·01.

Table A3.9: Effects of modern retailers on child dietary diversity (full model results for Figure 3.1)

	HEI Score (0–100) Poisson	FVS Score (0–18) Poisson	DDS Score (0–9) Poisson	HEI Score (0–100) CF	FVS Score (0–18) CF	DDS Score (0–9) CF
	(1)	(2)	(3)	(4)	(5)	(6)
Modern retail use	1·109***	1·049	–0·974	1·165***	1·049	1·014
(dummy)	(0·033)	(0·036)	(0·039)	(0·053)	(0·034)	(0·042)
Male	1·075***	–0·998	1·054*	1·075**	–0·998	1·054
	(0·025)	(0·019)	(0·031)	(0·033)	(0·025)	(0·034)
Age	1·061***	1·025**	1·032**	1·061***	1·025*	1·031
	(0·021)	(0·010)	(0·014)	(0·018)	(0·015)	(0·017)
Age-squared	–0·998*	–0·999	–0·999	–0·998**	–0·999	–0·999
	(0·001)	(0·001)	(0·001)	(0·001)	(0·001)	(0·001)
Education	–0·997	–0·983	–0·980	–0·996	–0·983	–0·979*
	(0·018)	(0·015)	(0·014)	(0·012)	(0·014)	(0·011)
Household size	–0·999	1·021***	1·020**	–0·999	1·021**	1·020**
	(0·010)	(0·007)	(0·009)	(0·012)	(0·009)	(0·010)
Income	1·017	1·040**	1·030	1·010	1·040***	1·023**
	(0·020)	(0·018)	(0·021)	(0·013)	(0·011)	(0·012)
Chewa	1·118**	1·097*	1·162***	1·122**	1·097***	1·165***
	(0·060)	(0·052)	(0·062)	(0·051)	(0·034)	(0·054)
Tonga	1·086	1·095***	1·068**	1·092*	1·095***	1·072*
	(0·065)	(0·034)	(0·031)	(0·049)	(0·037)	(0·043)
Catholic	1·055**	1·053**	1·019	1·063*	1·053**	1·025
	(0·027)	(0·026)	(0·032)	(0·035)	(0·025)	(0·031)
Constant	17·303***	3·495***	1·745***	17·861***	3·493***	1·794***
	(3·180)	(0·510)	(0·339)	(2·673)	(0·440)	(0·241)
First-stage residual				–0·999**	1·000	–0·999*
				(0·001)	(0·001)	(0·001)
Wald χ^2	216***	47***	259***	53***	57***	42***
Pseudo-R^2	0·040	0·009	0·007	0·043	0·009	0·008
N	499	499	499	499	499	499

Incidence rate ratios are shown with bootstrapped standard errors clustered at compound level in parentheses. For Figure 3.1, incidence ratios and standard errors were converted for percentage interpretation. CF, control function approach; HEI, healthy eating index; FVS, food variety score; DDS, dietary diversity score. Bemba and Protestant are used as a reference group for ethnicity – Chewa and Tonga, and religion status – Catholic, respectively. * $p < 0·10$, ** $p < 0·05$, *** $p < 0·01$.

Table A3.10: Effects of modern retailers on adult calorie and nutrient intakes (full model results for Figure 3.2)

	Calorie (kcal/day) Tobit	Protein (g/day) Tobit	Iron (mg/day) Tobit	Zinc (mg/day) Tobit	Vitamin A (µg/day) Tobit	Calorie (kcal/day) CF	Protein (g/day) CF	Iron (mg/day) CF	Zinc (mg/day) CF	Vitamin A (µg/day) CF
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Modern retail use	3·556***	0·096**	0·028**	0·008**	0·697*	13·286***	0·604***	0·164***	0·037***	1·267*
(expenditure share, %)	(0·916)	(0.046)	(0·013)	(0·004)	(0·409)	(3·517)	(0·099)	(0·037)	(0·010)	(0·739)
Male	269·499***	6·759***	1·466***	0·666***	–14·677	306·203***	8·705***	2·073***	0·773***	9·006
	(71·397)	(1·470)	(0·331)	(0·224)	(26·302)	(77·809)	(2·183)	(0·674)	(0·223)	(13·645)
Age	21·424*	0·639	0·029	0·085**	–0·275	25·303***	0.848**	0·088	0·096***	1·795
	(12·323)	(0·409)	(0·091)	(0·034)	(3·036)	(9·497)	(0·382)	(0·092)	(0·032)	(2·243)
Age-squared	–0·305**	–0·008*	–0·001	–0·001***	–0·009	–0·347***	–0·010**	–0·001	–0·001***	–0·024
	(0·132)	(0·005)	(0·001)	(0·0004)	(0·036)	(0·106)	(0·005)	(0·001)	(0·0004)	(0·027)
Education	–22·152***	–0·755***	–0·087	–0·059*	4·750	–50·816***	–2·256***	–0·480***	–0·144***	–0·308
	(8·361)	(0·244)	(0·074)	(0·033)	(2·966)	(17·861)	(0·547)	(0·154)	(0·053)	(3·107)
Household size	–40·738	–3·180**	–0·388	–0·253**	–14·600**	–19·778	–2·080***	–0·100	–0·192***	–7·428*
	(36·400)	(1·305)	(0·250)	(0·117)	(5·918)	(22·973)	(0·739)	(0·202)	(0·072)	(3·896)
Income	45·815	1·182	0·205	0·040	22·066	–76·970	–5·222***	–1·514***	–0·322**	1·923
	(37·039)	(1·035)	(0·356)	(0·106)	(13·680)	(52·564)	(1·522)	(0·542)	(0·158)	(10·781)
Chewa	–178·209*	0·603	0·044	–0·364	–7·026	–180·927*	0·425	–0·063	–0·370	9·029
	(95·287)	(4·727)	(1·063)	(0·434)	(21·073)	(100·034)	(3·692)	(1·029)	(0·339)	(20·210)
Tonga	162·359**	10·934***	2·943***	0·540**	4·938	212·855**	13·568***	3·739***	0·688**	23·457
	(81·023)	(2·299)	(0·773)	(0·269)	(26·619)	(96·257)	(2·922)	(0·938)	(0·325)	(17·390)
Catholic	109·489	7·143**	1·091	0·593**	72·108*	134·599*	8·469***	1·466**	0·667**	41·942***
	(71·476)	(2·925)	(0·751)	(0·246)	(37·249)	(81·645)	(2·691)	(0·747)	(0·263)	(14·340)
Constant	1990·091***	70·085***	17·915***	6·350***	164·583	2854·905***	115·080***	29·946***	8·902***	190·720**
	(602·489)	(16·065)	(3·279)	(1·622)	(149·339)	(501·210)	(15·024)	(4·638)	(1·639)	(94·957)
First-stage residual						–11·004***	–0·574***	–0·150***	–0·033***	–0·637
						(3·836)	(0·108)	(0·039)	(0·011)	(0·787)
Joint F-statistic	11***	202***	43***	8***	12***					
Wald χ^2						103***	199***	78***	98***	88***
Pseudo-R^2	0·004	0·010	0·024	0·011	0·006	0·004	0·013	0·033	0·012	0·009
N	930	930	930	930	930	930	930	930	930	930

Coefficient estimates are shown with bootstrapped standard errors clustered at compound level in parentheses. Estimates for modern retail use can be interpreted as marginal effects of a 1 percentage point increase in the modern retail expenditure share. For Figure 3.2, coefficients and standard errors were multiplied by 10, to show effects of a 10 percentage point increase in the modern retail expenditure share. CF, control function approach. Bemba and Protestant are used as reference group for ethnicity – Chewa and Tonga, and religion status – Catholic, respectively. * $p < 0·10$, ** $p < 0·05$, *** $p < 0·01$.

Table A3.11: Effects of modern retailers on child calorie and nutrient intakes (full model results for Figure 3.2)

	Calorie (kcal/day) Tobit	Protein (g/day) Tobit	Iron (mg/day) Tobit	Zinc (mg/day) Tobit	Vitamin A (µg/day) Tobit	Calorie (kcal/day) CF	Protein (g/day) CF	Iron (mg/day) CF	Zinc (mg/day) CF	Vitamin A (µg/day) CF
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Modern retail use	2·455*	0·018	0·021**	0·010**	0·405	9·662**	0·346***	0·114***	0·027**	1·293*
(expenditure share, %)	(1.413)	(0·061)	(0·009)	(0·004)	(0·653)	(3·865)	(0·128)	(0·035)	(0·014)	(0·756)
Male	139·026**	5·023	1.032**	0·315	12·135	107·787	4·059	1·445**	0·270	–0·908
	(69·052)	(3·727)	(0·485)	(0·317)	(20·830)	(67·943)	(2·474)	(0·628)	(0·224)	(16·540)
Age	197·369***	6·622***	2·087***	0·660***	–10·283	166·034***	5·965***	1·756***	0·626***	–10·561
	(23·568)	(1·047)	(0·414)	(0·130)	(9·907)	(36·470)	(1·233)	(0·332)	(0·131)	(8·765)
Age-squared	–7·327***	–0·198***	–0·082***	–0·019**	0·413	–5·845***	–0·162***	–0·057***	–0·017**	0·370
	(1·236)	(0·064)	(0·015)	(0·007)	(0·516)	(2·030)	(0·063)	(0·019)	(0·007)	(0·445)
Education	8·979	–0·336	–0·239	–0·049	6·473	4·290	–0·423	–0·100	–0·052	6·454
	(34·658)	(0·779)	(0·372)	(0·044)	(10·394)	(33·179)	(0·936)	(0·276)	(0·084)	(5·801)
Household size	3·084	–0·783	–0·080	–0·138	–26·300***	13·519	–0·358	–0·141	–0·117	–11·612**
	(27·250)	(1·087)	(0·248)	(0·124)	(7·226)	(24·648)	(0·701)	(0·222)	(0·073)	(4·932)
Income	38·802	0·856	0·035	0·083	59·428***	–76·856	–4·171**	–1·348**	–0·180	16·124
	(62·287)	(0·965)	(0·411)	(0·096)	(13·054)	(65·738)	(2·078)	(0·557)	(0·245)	(14·000)
Chewa	86·984	8·839	–1·169	0·313	41·493	111·387	10·019**	1·307	0·368	41·133
	(223·630)	(5·999)	(1·227)	(0·427)	(50·216)	(112·804)	(4·131)	(1·020)	(0·413)	(26·894)
Tonga	–52·352	6·526	0·006	0·243	1·015	–37·812	6·698*	0·974	0·245	23·155
	(113·153)	(5·805)	(0·530)	(0·386)	(44·334)	(106·656)	(3·495)	(0·922)	(0·370)	(17·906)
Catholic	95·974	3·274	0·657	0·445	42·909	124·233	5.349*	2·245**	0·554*	29·816
	(126·386)	(3·647)	(0·966)	(0·393)	(36·907)	(98·235)	(3·084)	(0·945)	(0·323)	(21·011)
Constant	272·873	12·095	2·892	0·454	–84·023	1124·865**	46·557***	13·317***	2.259	135·035
	(518·702)	(8·614)	(3·629)	(1·081)	(117·647)	(522·421)	(16·289)	(4·423)	(2.057)	(117·268)
First-stage residual						–8·618**	–0·371***	–0·113***	–0·019	–1·105
						(4·191)	(0·130)	(0·037)	(0·014)	(0·866)
Joint F-statistic	37***	108***	29***	64***	10***					
Wald χ^2						130***	203***	163***	194***	89***
Pseudo-R^2	0·044	0·030	0·134	0·057	0·011	0·041	0·031	0·081	0·058	0·013
N	499	499	499	499	499	499	499	499	499	499

Coefficient estimates are shown with bootstrapped standard errors clustered at compound level in parentheses. Estimates for modern retail use can be interpreted as marginal effects of a 1 percentage point increase in the modern retail expenditure share. For Figure 3.2, coefficients and standard errors were multiplied by 10, to show effects of a 10 percentage point increase in the modern retail expenditure share. CF, control function approach. Bemba and Protestant are used as reference group for ethnicity – Chewa and Tonga, and religion status – Catholic, respectively. * $p < 0·10$, ** $p < 0·05$, *** $p < 0·01$.

Table A3.12: Effects of modern retailers on adult micronutrient adequacy ratios

		Micronutrient adequacy ratio		
	Mean adequacy ratio	Iron	Zinc	Vitamin A
	(1)	(2)	(3)	(4)
Modern retail use	0·245***	1·073***	0·386*	–0·033
(expenditure share, %)	(0·046)	(0·283)	(0·230)	(0·660)
Male	3·739***	91·887***	–40·047***	–23·791*
	(1·117)	(7·163)	(5·657)	(12·423)
Age	–0·344**	–4·543***	1·120	1·057
	(0·171)	(1·150)	(0·789)	(1·988)
Age-squared	0·003*	0·060***	–0·016*	–0·020
	(0·002)	(0·014)	(0·008)	(0·023)
Education	–0·563*	–3·450**	–1·553	3·983
	(0·288)	(1·431)	(1·199)	(2·642)
Household size	–0·545	–3·071*	–4·171***	–6·718*
	(0·465)	(1·752)	(1·339)	(3·503)
Income	–0·688	–10·273***	–5·625*	15·838
	(0·859)	(3·761)	(3·340)	(10·274)
Chewa	–0·827	–3·285	–5·520	–27·278*
	(2·194)	(8·198)	(7·358)	(14·103)
Tonga	3·019**	32·493***	7·424	–2·784
	(1·237)	(8·499)	(8·037)	(16·177)
Catholic	2·190	16·228***	11·188*	34·900***
	(1·389)	(5·854)	(5·967)	(12·633)
Constant	99·622***	309·095***	175·356***	4·742
	(8·760)	(38·222)	(34·081)	(90·443)
First-stage residual	–0·210***	–0·997***	–0·321	0·210
	(0·050)	(0·289)	(0·246)	(0·718)
Wald χ^2 (11)	142***	296***	121***	73***
R^2	0·093	0·233	0·070	0·053
N	930	930	930	930

Coefficient estimates from control function models are shown with bootstrapped standard errors clustered at compound level in parentheses.
* p < 0·10, ** p < 0·05, *** p < 0·01.

Table A3.13: Effects of modern retailers on child micronutrient adequacy ratios

		Micronutrient adequacy ratio		
	Mean adequacy ratio	Iron	Zinc	Vitamin A
	(1)	(2)	(3)	(4)
Modern retail use	0·179***	1·380**	0·849**	0·072
(expenditure share, %)	(0·069)	(0·659)	(0·428)	(0·945)
Male	2·823**	25·477**	0·283	11·346
	(1·408)	(12·476)	(7·283)	(17·115)
Age	0·800	10·011*	–11·086***	–17·490*
	(0·997)	(5·237)	(3·748)	(9·156)
Age-squared	–0·028	–0·113	0·473***	0·606
	(0·043)	(0·283)	(0·168)	(0·460)
Education	–0·082	–1·419	–4·091*	–1·268
	(0·482)	(3·613)	(2·323)	(4·630)
Household size	–0·383	–5·487*	–2·659	–11·848**
	(0·555)	(3·190)	(2·119)	(5·390)
Income	–0·476	–21·234**	–10·676	41·194**
	(1·316)	(10·194)	(8·768)	(16·821)
Chewa	–0·145	31·016	10·337	39·890
	(2·119)	(20·533)	(11·368)	(30·429)
Tonga	1·032	43·547**	20·892	–8·811
	(1·669)	(18·522)	(18·827)	(16·828)
Catholic	2·497	36·843***	13·791	5·847
	(1·837)	(14·034)	(9·011)	(20·482)
Constant	86·888***	303·276***	255·781***	–61·510
	(11·732)	(79·592)	(76·754)	(137·665)
First-stage residual	–0·165**	–1·411**	–0·676	0·420
	(0·075)	(0·682)	(0·482)	(1·019)
Wald χ^2 (11)	38***	92***	69***	78***
R^2	0·067	0·117	0·097	0·132
N	499	499	499	499

Coefficient estimates from control function models are shown with bootstrapped standard errors clustered at compound level in parentheses.
* p < 0·10, ** p < 0·05, *** p < 0·01.

Table A3.14: Effects of supermarkets on child and adult calorie and nutrient intakes

	Calorie (kcal/day)	Protein (g/day)	Iron (mg/day)	Zinc (mg/day)	Vitamin A (µg retinol/day)
	(1)	(2)	(3)	(4)	(5)
Adults					
Supermarket use	10·430***	0·497***	0·139***	0·029***	1·029**
(expenditure share, %)	(2·882)	(0·094)	(0·031)	(0·009)	(0·488)
Controls	Yes	Yes	Yes	Yes	Yes
First-stage residual	–7·724**	–0·440***	–0·118***	–0·024**	–0·424
	(3·237)	(0·103)	(0·034)	(0·009)	(0·525)
Wald χ^2 (11)	76***	133***	53***	72***	66***
Pseudo-R^2	0·004	0·013	0·034	0·012	0·009
N	930	930	930	930	930
Children					
Supermarket use	8·276**	0·295**	0·102***	0·022*	1·106
(expenditure share, %)	(3·595)	(0·119)	(0·029)	(0·013)	(0·722)
Controls	Yes	Yes	Yes	Yes	Yes
First-stage residual	–8·810**	–0·324***	–0·104***	–0·015	–0·843
	(3·700)	(0·123)	(0·033)	(0·013)	(0·781)
Wald χ^2 (11)	127***	220***	188***	217***	88***
Pseudo-R^2	0·041	0·031	0·081	0·057	0·013
N	499	499	499	499	499

Coefficient estimates from control function models are shown with bootstrapped standard errors clustered at compound level in parentheses. The same control variables as those shown in Tables A3.10 and A3.11 were included in estimation. * $p < 0{\cdot}10$, ** $p < 0{\cdot}05$, *** $p < 0{\cdot}01$.

Table A3.15: Effects of modern retailers on calorie and nutrient intakes of individuals from poor households (model results for Figure 3.3)

	Calorie (kcal/day)	Protein (g/day)	Iron (mg/day)	Zinc (mg/day)	Vitamin A (µg retinol/day)
	(1)	(2)	(3)	(4)	(5)
Adults					
Modern retail use	17·070**	0·757***	0·244***	0·045*	3·615**
(expenditure share, %)	(7·656)	(0·234)	(0·065)	(0·025)	(1·470)
Controls	Yes	Yes	Yes	Yes	Yes
First-stage residual	–18·272**	–0·760***	–0·260***	–0·059*	–2·541
	(8·971)	(0·277)	(0·073)	(0·034)	(1·668)
Wald χ^2 (11)	14	32***	24**	17***	51***
Pseudo-R^2	0·003	0·012	0·026	0·010	0·012
N	226	226	226	226	226
Children					
Modern retail use	22·962***	0·558***	0·118**	0·026	3·716***
(expenditure share, %)	(5·310)	(0·199)	(0·060)	(0·026)	(1·096)
Controls	Yes	Yes	Yes	Yes	Yes
First-stage residual	–22·306***	–0·653***	–0·147**	–0·032	–3·064**
	(5·857)	(0·207)	(0·065)	(0·030)	(1·250)
Wald χ^2 (11)	61***	164***	62***	76***	35***
Pseudo-R^2	0·058	0·039	0·103	0·057	0·016
N	175	175	175	175	175

Poor households are defined as those with incomes less than $1·90 per capita and day. Coefficient estimates from control function models are shown with bootstrapped standard errors clustered at compound level in parentheses. The same control variables as those shown in Tables A3.10 and A3.11 were included in estimation. For Figure 3.3, coefficients and standard errors were multiplied by 10, to show effects of a 10 percentage point increase in the modern retail expenditure share. * p < 0·10, ** p < 0·05, *** p < 0·01.

Table A3.16: Effects of modern retailers on calorie and nutrient intakes disaggregated by sex

	Calorie (kcal/day)	**Protein** (g/day)	**Iron** (mg/day)	**Zinc** (mg/day)	**Vitamin A** (µg/day)
	(1)	(2)	(3)	(4)	(5)
Effects on adult males	11·802*	0·550***	0·221**	0·035*	1·556
	(6·963)	(0·201)	(0·106)	(0·019)	(0·972)
N	307	307	307	307	307
Effects on adult females	13·464***	0·628***	0·140***	0·036***	1·056
	(4·498)	(0·136)	(0·037)	(0·012)	(0·816)
N	623	623	623	623	623
Effects on boys	13·375**	0·238	0·103**	0·018	0·571
	(6·359)	(0·163)	(0·051)	(0·019)	(1·336)
N	228	228	228	228	228
Effects on girls	7·399	0·448**	0·138***	0·040*	1·964
	(6·419)	(0·218)	(0·052)	(0·023)	(1·278)
N	271	271	271	271	271

Coefficient estimates from control function models are shown with bootstrapped standard errors clustered at compound level in parentheses. The treatment variable in all models is the share of total food expenditures (in %) made in modern retailers. The same control variables as those shown in Tables A3.10 and A3.11 were included in estimation. * p < 0·10, ** p < 0·05, *** p < 0·01.

4 Supermarkets and affordability of nutritious diets: Evidence from urban Zambia[3]

Abstract

Access and affordability of nutritious diets remain formidable challenges in many developing countries, where hunger and micronutrient malnutrition coexist with overweight and obesity. With rapid growth in modern supermarkets replacing/complementing traditional retailers, supermarkets can influence consumer diets and nutrition. Previous research suggests that supermarkets may improve dietary quality. However, none of the available studies analyzed the role of supermarkets on affordability of nutritious diets; largely due to data limitations. Here, we analyze effects of supermarkets on dietary quality and affordability. We use individual-level food-intake data and food price data from Lusaka, Zambia, and control function regression models to account for the likely endogeneity of supermarket food purchases. We find that the cost of a recommended nutritious diet is US$1.22 per day, of which the largest share is the cost of starchy staples (68%), followed by fruits (11%), and meat, eggs, and fish (9%). However, this diet is not affordable to 41% of low-income group. Meat, fish, and dairy products are more expensive in supermarkets than in traditional retailers. Nevertheless, buying food in supermarkets increases dietary diversity and intake of nutritious diets, with varying effect sizes among demographic cohorts: men, women, boys, and girls. The positive effects of supermarkets on dietary quality largely come from animal source foods.

Keywords: Supermarkets, dietary affordability, dietary diversity, intra-household allocation, Zambia.

JEL classification: O12, Q11, Q12, Q18.

[3] This paper has been sole-authored by the doctoral student (Makaiko Gonapanyanja Khonje). However, the paper substaintially benefited from useful comments made by Prof. Dr. Matin Qaim and Prof. Stephan Klasen at various stages of the manuscript.

4.1. Introduction

Hunger – measured by the prevalence of undernourishment – and micronutrient malnutrition remain widespread public health problems in many developing countries (Ruel et al., 2017; FAO et al., 2019). The rapid growth of modern food retailers, in particular supermarkets and fast-food restaurants, in many developing countries (Reardon et al., 2003; Tschirley et al., 2015; Lu and Reardon, 2018) may affect consumer diets and nutrition. For instance, most urban consumers can access both unhealthy foods and nutritious foods from supermarkets (Asfaw, 2008; Reardon and Timmer, 2014; Rischke et al., 2015; Rupa et al., 2019; Debela et al., 2020). However, recent research suggests that healthy diets – the EAT-*Lancet* diets – are not affordable to more than 1.58 billion people (21% of the world's population) worldwide, of which 72% are in South Asia and sub-Saharan Africa (Hirvonen et al., 2020).

Typical for many developing countries, urban consumers in Zambia tend to spend more of their income on food from modern retailers compared to traditional food retailers (Khonje and Qaim, 2019). Hence, with a rapid growth of supermarkets, changes in dietary affordability may significantly affect dietary intake among consumers. Moreover, unaffordability of recommended nutritious foods – such as fruits, vegetables, meat, fish, and dairy products – in many developing countries, may affect nutritional outcomes especially among poor consumers (Colen et al., 2018; Headey et al., 2018; Dizon et al., 2019; Headey et al., 2019; Hirvonen et al., 2020). We therefore seek to address three research questions in this study: First, to what extent are recommended nutritious diets affordable among the urban poor in Africa? Second, do supermarkets contribute to affordability of recommended nutritious diets in low-income countries? And third, what are the effects of supermarkets on dietary quality among demographic cohorts: men, women, boys, and girls in urban Africa?

Empirical studies analyzing the effects of supermarkets on dietary quality and affordability are scarce. Using household-level food consumption data, a few existing studies suggests that supermarket food purchases improve diet quality in developing countries such as Tunisia (Tessier et al., 2008), Vietnam (Rupa et al., 2019), and Kenya (Debela et al., 2020). On cost of nutritious diets, Masters et al. (2018) proposes price indexes that measure the cost of diet diversity and nutrient adequacy in Ghana. They found that the cost of diet diversity index fluctuated seasonally and fruits drove up the cost of nutrient adequacy. Though at global level, other similar studies (e.g., Headey et al., 2018; Headey and Alderman, 2019; Hirvonen et al., 2020) found that healthy diets are not affordable to most people in low-income countries. In Ethiopia, Headey et al. (2019) observed that children in proximity to rural markets that sell more non-staple foods have more diverse diets.

While the existing research provides important evidence on the effects of modern retailers – such as supermarkets – on dietary quality, and the cost of nutritious diets; several limitations exist. First, none of the previous studies on retail modernization has analyzed effects of supermarkets on the affordability of recommended nutritious diets. Moreover, most previous studies analyzed the cost of nutritious diets only for particular target groups, such as women (e.g., Masters et al., 2018; Alemu et al., 2019; Hirvonen et al., 2020) or children (Headey et al., 2019). Yet, inequalities in dietary affordability could exist among various household members. More importantly, available studies analyzed the cost of nutritious diets using food price data from the World Bank's International Comparison Program, where only standardized food items are included (e.g., Alemu et al., 2019; Hirvonen et al., 2020). Hence, some of country-specific nutritious foods (e.g., local insects, fish, fruits, pulses and some dark green leafy vegetables) are omitted. Finally, none of the available studies on the cost of nutritious diets analyzed the role of modern retailers such as supermarkets.

Using unique data – i.e., recent (2018) food price data and individual-level dietary data – collected in urban Zambia, we add to the existing literature in several ways. First, we provide the first empirical study that analyzes effects of using supermarkets on the affordability of recommended nutritious diets in Africa. Second, we also extend the existing literature (e.g., Masters et al., 2018; Hirvonen et al., 2020) on the cost of a nutritious diet in Africa, where it is not yet conclusive and relatively very thin. Third, we expand on limited evidence analyzing effects of supermarkets on dietary quality in Africa, where intra-household food distributions were hardly analyzed. Overall, a better understanding on these issues remains vital in designing cohort-specific policy interventions aimed at tackling micronutrient malnutrition in most developing countries, especially among the urban poor households.

The rest of the article is organized as follows. The next section provides a description on study context, data, and estimation strategy. In the following section, we present and discuss empirical results and the last section concludes.

4.2. Data

4.2.1. Survey of households and individuals

The data used in this study were collected through a household survey in Lusaka, the capital city of Zambia, between April and July 2018. Zambia is an ideal setting for this study for two reasons. First, it is one of the southern African countries with rapid growth in modern supermarkets (Tschirley et al., 2015; Ziba and Phiri, 2017). For instance, our own review of internet sources supplemented by key local informant interviews revealed that the number of large shopping malls with supermarkets in Lusaka City increased from one in 1995 to 25 in 2018 (Table 1.1). Moreover, other existing studies (e.g., Khonje and Qaim, 2019) have found that a substantial share (43%) of the food consumed by urban households in Lusaka is purchased from modern retailers such as hypermarkets, supermarkets, and fast-food restaurants. Finally, like many other countries in sub-Saharan Africa, Zambia is characterized by a high prevalence of micronutrient malnutrition (Harris et al., 2019; Kaliwile et al., 2019). For instance, among women and children; 98%, 34-55%, 26%, and 19% are deficient in vitamin B_{12}, zinc, vitamin A, and iron, respectively (Harris et al., 2019).

We surveyed a total of 475 households from several compounds/sections in Lusaka City using a two-stage random sampling procedure. At the first stage, we purposively selected 14 compounds/sections as primary sampling units based on population distributions, the locations of major shopping malls (see Table 1.1 and Table A4.1 in the Appendix), as well as information from the Lusaka City council on mean income levels in the different compounds. To ensure that the sample is fairly representative of households in the urban parts of Lusaka, we selected compounds with different mean income levels: high, middle, and low. Figure 1.1 shows a spatial distribution of the surveyed compounds/sections and households.

At the second stage, depending on the size of the compound/section, we randomly sampled about 35 households from each compound for study participation. In each sampled household, we interviewed the household head or the adult responsible for food purchase decisions and food preparation. We recruited local enumerators to conduct face-to-face interviews in local languages. The enumerators were trained and supervised by the researchers. The structured questionnaire covered sections on the household demographic structure, economic activities, and income. Food consumption data were collected through a seven-day recall using a list of 140 different food items and capturing quantities, food prices, and sources of each item. Food-intake data were captured at the individual level for up to four randomly selected members of each household: two adults (>18 years) and two children/adolescents (6 months – 18 years).

Individual-level food-intake/dietary data were collected through 24-hour dietary recalls; for small children the recall data were provided by the caregiver. We have complete individual-level data for 1,429 observations: 295 men, 594 women, 240 boys, and 300 girls (Table A4.1 in the Appendix).

4.2.2. Measuring dietary affordability and quality

To measure dietary affordability, we use food price data from food consumption data to calculate the cost of recommended nutritious diets (CoRD). We estimate the CoRD using food price data for 57 food items (Table A4.2 in the Appendix) and the recommended dietary serving rates adapted from the EAT-*Lancet* (flexitarian) diet (Willett et al., 2019). The serving rates for each food group or item are shown in Table 4.1. We included ten healthy food groups (see Table 4.1) only to calculate the CoRD, following classification by FAO and FHI 360 (2016), Cost of Nutritious Diets Consortium (2018), and Masters et al. (2018).

Table 4.1: Serving rates for a nutritious diet, by food group

FG No.	Food group (FG)	Food items (examples only)	Serving rate (grams/day)
1	Grains, white roots and tubers	Maize flour, Rice, Bread, Buns, Samosa, Pasta	232
		Cassava, Sweet potatoes, Irish potatoes	50
2	Pulses	Common beans, Green beans/Peas/Pods	50
		Soybean	25
3	Nuts and seeds	Groundnut dry/flour	25
4	Dairy	Milk, Cheese, Yoghurt	250
5	Meat, poultry, and fish	Beef, Goat meat, Pork, Sheep meat	7
		Chicken, Ducks	29
		Fish	28
6	Eggs	Eggs	13
7	Dark green leafy vegetables	Bean leaves, Green/Red pepper, Pumpkin leaves, Rape/Mustard/Chinese	100
8	Vitamin A rich vegetables	Cassava leaves, Carrots, Sweet potato leaves,	100
9	Other vegetables	Cabbage, Cucumber, Egg plants, Frozen vegetables, Lettuce, Okra, Onions, Tomatoes	100
10	All fruits	Apples, Avocadoes, Bananas, Pineapples, Oranges/Tangerines, Water melons, Mixed fruits	200

Note: The dietary serving rates are adapted from the EAT-*Lancet* reference diet (Willett et al., 2019). Full list of food items based on the individual-level food-intake data is shown in Table A4.2 in the Appendix.

In calculating the CoRD, the recommended quantities (Table 4.1) are the same for a specific food group but price (Table A4.2 in the Appendix) varies with each food item in a food group.

Due to unavailability of local food-based dietary guidelines, we use dietary serving rates from the EAT-*Lancet* diet, which is a global reference diet for a more plant-based healthy diet. Moreover, other existing studies (e.g., Springmann et al., 2018; Hirvonen et al., 2020) have used the EAT-*Lancet* diet in low-income countries including Zambia. However, the EAT-*Lancet* diet ignores difference among regions, age groups, and gender (Sanchez, 2020).

Using the individual-level food-intake/dietary data, we calculated two indicators on dietary quality. First, following classification by Masters et al. (2018), dietary diversity score 1 (DDS1) is calculated by summing the number of healthy food groups consumed in the last 24 hours from the ten food groups: (1) grains, white roots and tubers, (2) pulses, (3) nuts and seeds, (4) dairy, (5) meat, poultry, and fish, (6) eggs, (7) dark green leafy vegetables, (8) vitamin A-rich vegetables, (9) other vegetables, and (10) fruits. DDS1 focuses on intake of nutritious foods shown in Table 4.1. We therefore excluded nutrient-poor foods such as sugary products and beverages in calculating the DDS1. Specific food items in each food group are shown in Table A4.2 in the Appendix. The selected food groups have been linked to nutrient adequacy in several low-income countries (Torheim et al., 2004; Steyn et al., 2006; Arimond et al., 2010).

Finally, to account for other food groups excluded in the DDS1, we also calculated another indicator for dietary quality: the dietary diversity score 2 (DDS2). DDS2 is calculated as a count of the different food groups (out of twelve possible groups) consumed by household members in the last 24 hours (Steyn et al., 2006; Kennedy et al., 2011; FAO and FHI 360, 2016). The twelve food groups and their respective food items used in our scoring are shown in Table A4.2 in the Appendix. Food items are categorized into groups based on their nutritional value. Dietary diversity has been widely used as an indicator of individual-level dietary quality in several developing countries (e.g., Torheim et al., 2004; Steyn et al., 2006; Villa et al., 2011; Headey et al., 2019). Moreover, dietary diversity indicators can be measured quickly using a food list-based method, whereas the quantity of food consumed and its nutrient composition are much more difficult to measure and analyze (Masters et al., 2018). Thus, dietary diversity indicators are unlikely to suffer from some of the measurement errors especially in estimation of nutrient intake (Villa et al., 2011).

4.3. Empirical strategy

4.3.1. Regression models

We hypothesize that buying food in supermarkets may influence dietary quality. To test this hypothesis, we estimate regression models of the following form:

$$D_{ijk} = \beta_0 + \beta_1 SM_{ijk} + \rho' X_{ijk} + u_{ijk} \quad (4.1)$$

where D_{ijk} is the outcome of interest – e.g., DDS1, DDS2, and dietary intake (grams/day) of nutritious foods – for an individual i from household j in compound/section k. SM_{ijk} is our treatment binary variable equal to one if any of the food consumed by household members come from a modern supermarket, and zero otherwise – if all of the foods were obtained from traditional sources (e.g., traditional/wet markets, roadside vendors, grocery stores, neighborhood kiosks or shops, own production). X_{ijk} is a vector of control variables that represents individual and household level characteristics – such as age, education, income, ethnicity (Bemba and Chewa), and religion status. u_{ijk} represents the random error term.

We use Poisson and Tobit estimators for the outcomes that are count and continuous with censored data, respectively. In all models, a positive and significant coefficient for parameter (β_1), would show that buying food in supermarkets increases dietary quality: dietary diversity and intake among demographic cohorts. To our knowledge, this hypothesis has not been adequately tested before; largely due to the unavailability of individual-level dietary data.

4.3.2. Control function approach

Equation (4.1) can be estimated using standard Poisson/Tobit regression models. However, parameter estimates for supermarket (SM_{ijk}) may be biased and inconsistent due to several sources of endogeneity. For instance, it is possible that unobservable factors – such as personal taste and preferences for special food products, seasonal discounts, and food safety – are omitted in equation (4.1). Further, improved dietary quality could also make individuals more productive in work places, and ultimately this could increase supermarket purchases.

Here, we test and correct for potential endogeneity by using a control function (CF) approach with instrumental variables (Wooldridge, 2010; 2015). In comparison to standard instrumental variable (IV) regressions, the CF estimator is more efficient and can also be used to control for unobserved heterogeneity in non-linear models, such as Poisson models (Wooldridge, 2010; Rupa et al., 2019). Moreover, the CF approach allows studying the nature of self-selection and estimation of treatment effects for a subpopulation (Wooldridge, 2015).

The CF approach is estimated as a two-stage regression model procedure. Thus, the first stage regression is estimated using all exogenous variables including IVs, and it is specified as:

$$SM_{ijk} = \gamma_0 + \gamma_1 X_{ijk} + \gamma_2 Z_{ijk} + \varepsilon_{ijk} \tag{4.2}$$

where Z_{ijk} is a vector of instrumental variables identifying outcome equation of interest (i.e., equation (4.1)). SM_{ijk} and X_{ijk} represents supermarket food purchases; expressed as expenditure share, and household living standards as defined in equation (4.1), respectively. γ are vectors of the parameters to be estimated, and ε_{ijk} is an error term.

In the second stage, we rerun equation (4.1) using the residuals from the first stage regression (equation (4.2)), as an additional regressor. Thus, the second-stage model is specified as:

$$D_{ijk} = \beta_0 + \beta_1 SM_{ijk} + \rho' X_{ijk} + \rho v_{ijk} + \epsilon_{ijk} \tag{4.3}$$

where D_{ijk}, SM_{ijk} and X_{ijk} represents key dependent variables, treatment variable and relevant control variables, respectively, as previous defined in equation (4.1). v_{ijk} is the residual from equation (4.2), and the significance of ρ – i.e., testing $H_0\colon \rho = 0$ – is key in testing the exogeneity of the endogenous explanatory variable. If the residual term (v_{ijk}) is statistically insignificant in equation (4.3), the null hypothesis of no endogeneity bias cannot be rejected, so that the CF approach is not required; in that case, the standard one-stage regression model (equation (4.1)) lead to unbiased and more efficient estimates. However, if the residual term turns out statistically significant, the CF approach is preferred and controls for endogeneity bias. ϵ_{ijk} is the random error term. Overall, to account for the heterogeneity among the sampled individuals and the two-stage CF estimation procedure, the standard errors are clustered at city compound or household levels and bootstrapped, respectively.

To meet the exclusion restriction in equation (4.3), we use two instrumental variables. First, we use distance from each household to the nearest supermarket; which is calculated using global positioning system (GPS) data collected during our household survey. A few related studies (e.g., Kimenju et al., 2015; Rischke et al., 2015; Courtemanche et al., 2019; Debela et al., 2020) have used GPS-based distance estimate as an identifying instrument. Second, the number of visits to a shopping mall of the household's closest neighbor in the sample is also used as an identifying instrument. Beyond distance and accessibility, we expect that the neighbor's behavior may capture influence through local social networks (Rupa et al., 2019).

To further test the validity of the two instruments, we perform a simple falsification test following Di Falco et al. (2011). A valid instrument should be significantly correlated with treatment variable; supermarket food purchases (i.e., equation (4.2)), but it should not be correlated with the dependent variable (e.g., DDS1 and DDS2) of interest. Regression results are shown in Tables A4.3 and A4.4 in the Appendix. As expected, distance to the closest shopping mall with a supermarket is negatively correlated with supermarket food purchases (Table A4.3). On the other hand, number of visits by the household's closest neighbor to a shopping mall is positively correlated with supermarket food purchases. Moreover, the results suggest that both instruments are relevant and valid as they jointly affect supermarket food purchases (Table A4.3), but not DDS1 and DDS2 directly – i.e., coefficient estimates for the instruments in these models are jointly insignificant (Table A4.4).

4.4. Results and discussion

4.4.1. Cost of recommended nutritious diets

Table 4.2 present the mean daily cost for recommended nutritious diets; adapted from the EAT-*Lancet* diet, differentiated by supermarket users, demographic cohorts, and income terciles. We find that on average, the cost of a recommended nutritious diet (CoRD) is estimated to be US$1.22 per day. As expected, the estimated cost is high for supermarket users (US$1.24) than non-users (US$1.18). Interestingly, income terciles comparison show that the average cost is highest (US$1.25) for low-income consumers than high-income consumers (US$1.19). The food group whose prices and food quantities contributed the largest share of the total cost is starchy staples[4] (68%), followed by fruits (11%), and meat, eggs, and fish (9%) (Table 4.2).

Overall, these findings suggest that starchy staples, fruits and animal source foods (ASFs) are relatively expensive in comparison to other nutritious foods such as pulses and nuts in Zambia. This is in line with descriptive results shown in Table A4.2 in the Appendix. Similarly, at global level, Hirvonen et al. (2020) found that ASFs, fruits and vegetables

[4] The main starchy staple in Zambia is maize flour, which is sold in most supermarkets as a fortified product. Hence, it is rich in micronutrients such as iron and vitamin A. However, the price of maize flour had increased significantly in 2018 because most parts of Zambia experienced extreme droughts when crops were at critical (e.g., flowering) stage in 2015/2016 and 2017/2018 growing seasons.

Table 4.2: Cost of recommended nutritious diets by supermarket users, demographic cohorts and income terciles

	Total	Starchy staples	Meat, eggs and fish	Dairy	Pulses and nuts	Vegetables	Fruits	Unaffordability of nutritious diets
	(US$/day)	(US$/day)	(US$/day)	(US$/day)	(US$/day)	(US$/day)	(US$/day)	(%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall (N=1,429)	1.22 (1.28)	0.83 (1.06)	0.11 (0.16)	0.06 (0.17)	0.02 (0.07)	0.07 (0.07)	0.13 (0.66)	15.40 (0.36)
	100.00%	68.03%	9.02%	4.92%	1.64%	5.74%	10.66%	
By supermarket users								
Users (N=938)	1.24 (1.30)	0.86 (1.12)	0.11 (0.15)	0.07 (0.18)	0.02 (0.05)	0.07 (0.07)	0.12 (0.61)	8.53 (0.28)
Non-users (N=491)	1.18 (1.23)	0.78 (0.94)	0.10 (0.18)	0.03 (0.15)	0.03 (0.09)	0.07 (0.07)	0.16 (0.75)	28.51 (0.45)
By demographic groups								
Men (N=295)	1.23 (1.52)	0.87 (1.39)	0.12 (0.21)	0.05 (0.15)	0.02 (0.05)	0.07 (0.07)	0.10 (0.59)	10.51 (0.31)
Women (N=594)	1.17 (1.21)	0.79 (0.92)	0.10 (0.14)	0.04 (0.13)	0.02 (0.06)	0.07 (0.07)	0.15 (0.73)	14.65 (0.35)
Boys (N=240)	1.17 (1.05)	0.76 (0.77)	0.09 (0.12)	0.08 (0.21)	0.02 (0.06)	0.07 (0.07)	0.15 (0.67)	18.75 (0.39)
Girls (N=300)	1.33 (1.32)	0.93 (1.14)	0.12 (0.19)	0.08 (0.21)	0.02 (0.08)	0.06 (0.06)	0.12 (0.57)	19.00 (0.39)
By income tercile								
Lowest (N=506)	1.25 (1.49)	0.82 (1.21)	0.11 (0.22)	0.03 (0.14)	0.03 (0.09)	0.07 (0.07)	0.19 (0.82)	41.11 (0.49)
Middle (N=472)	1.20 (1.05)	0.82 (0.85)	0.12 (0.15)	0.06 (0.17)	0.01 (0.05)	0.08 (0.07)	0.11 (0.59)	2.54 (0.16)
Highest (N=451)	1.19 (1.24)	0.85 (1.09)	0.09 (0.09)	0.08 (0.19)	0.01 (0.05)	0.05 (0.06)	0.10 (0.50)	

Note: The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. Cost of recommended nutritious diets in column (1) of Table 4.2 = summation of columns (2) to (7) in Table 4.2. Mean values are shown with standard deviations in parentheses. A diet is considered unaffordable if the mean daily per capita household income is below the cost of a recommended nutritious diet (Dizon et al., 2019; Hirvonen et al., 2020). N = number of observations.

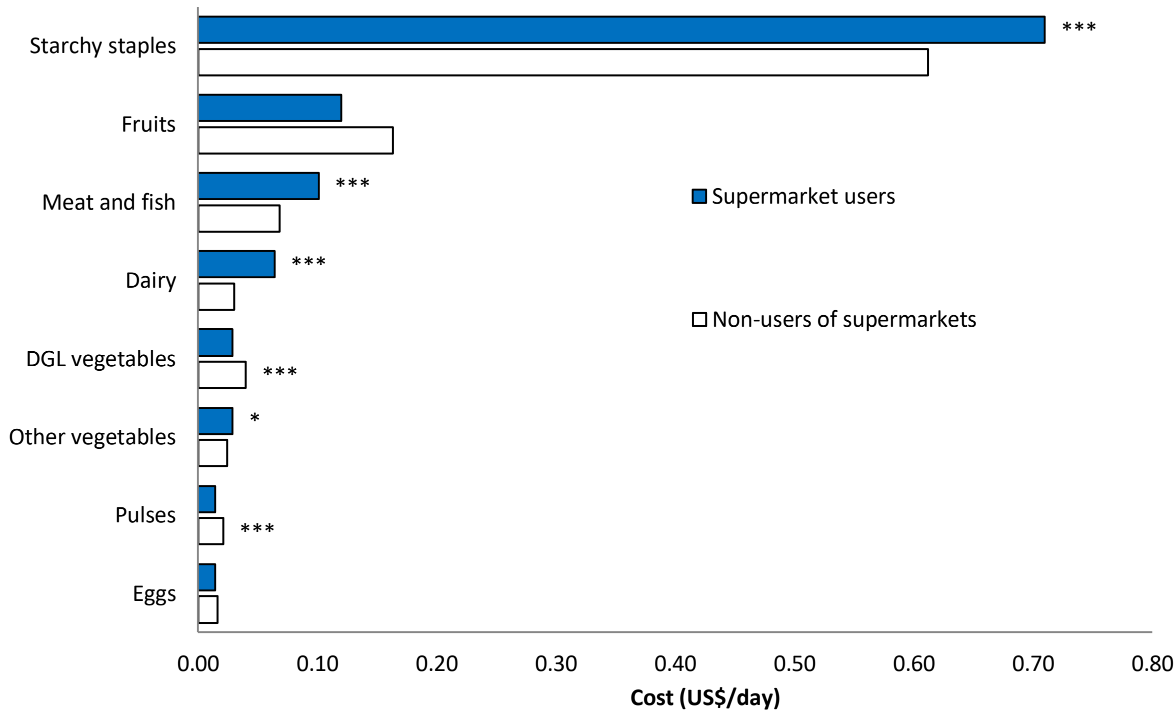
contributed the largest share to the overall cost of the EAT-*Lancet* diet. This is also consistent with Dizon et al. (2019), where they found that most households overspend on staples and protein foods than vegetables in south Asia: Sri Lanka, Pakistan, Afghanistan, and Bangladesh. Generally, these results are also consistent with other existing studies (e.g., Colen et al., 2018; Headey et al., 2018; Headey and Alderman, 2019; Headey et al., 2019) in low-income countries.

To further address the first research question, we also report unaffordability of nutritious diets in column (8) of Table 4.2. A diet is considered to be unaffordable if the average CoRD exceeds the mean daily per capita household income (Dizon et al., 2019; Hirvonen et al., 2020). We find that the CoRD is not affordable to 15% of the sample. However, the prevalence of individuals with total household income per person below the estimated cost of a recommended nutritious diet is highest (41%) in low-income tercile (Table 4.2). This suggests that some of the nutrient-dense foods – such as meat, eggs, and fish, and fruits – can be relatively expensive to some of the consumers with low income. Hence, it is important for poor consumers to know where to source affordable nutritious foods. This could help to improve poor-quality diets and meet nutrient adequacy among the urban poor in Africa.

4.4.2. Role of supermarkets on affordability of nutritious diets

To analyze the role of supermarkets on affordability of nutritious diets (second research question), we re-calculated the CoRD using the recommended dietary serving rates and average food price data shown in Table 4.1 and Table A4.5 in the Appendix, respectively. The results are shown in Figure 4.1. In a simple cost comparison, the results suggest that supermarkets are associated with both positive and negative effects on dietary affordability.

On a positive note, we find that pulses and dark green leafy vegetables are relatively cheaper in supermarkets than in traditional retailers (Figure 4.1). A similar pattern is observed for fruits and eggs, even though the mean differences are statistically insignificant. Minten et al. (2010) observed similar findings in India for vegetables and fruits. This suggests that some nutritious foods are relatively cheaper in supermarkets than in traditional retailers. Therefore, could this be associated with rapid growth of modern retailers such as supermarkets, where a large variety of foods are sold at a lower price? For instance, when asked why a household prefer buying food in supermarkets, almost half (47%) of them responded that they did so be-



Note: The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. DGL = Dark green leafy vegetables. Detailed summary statistics are shown in Table A4.6 in the Appendix. Asterisk (*) show significance t-test for the mean differences between users and non-users of supermarkets. * $p < 0.1$; *** $p < 0.01$.

Figure 4.1: Cost of recommended nutritious diets, by users and non-users of supermarkets

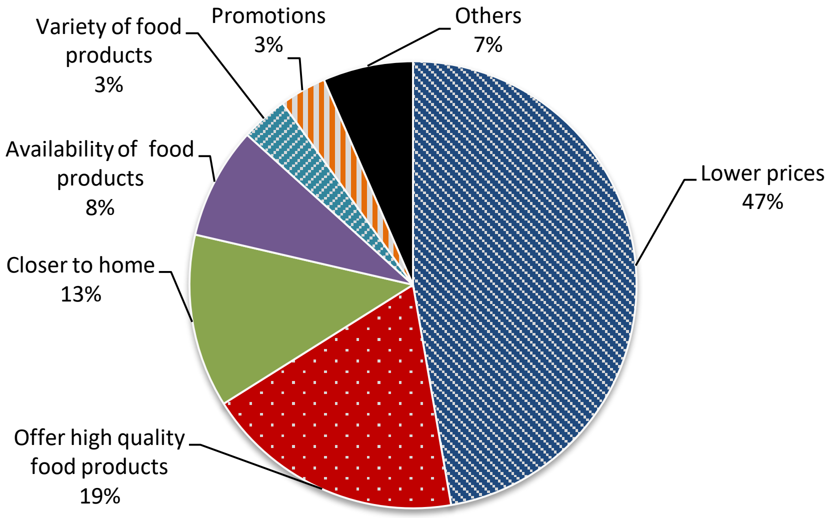


Figure 4.2: Reasons for buying food in modern supermarkets

-cause of lower prices (Figure 4.2). This is also observed with observational data from urban Kenya (Rischke et al., 2015; Berger and van Helvoirt, 2018).

Moreover, due to higher efficiency and economies-of-scale, modern retailers such as supermarkets may buy farm produce or food products in bulky and sell them at lower prices (Hawkes, 2008; Minten and Reardon, 2008; Lu and Reardon, 2018). Ultimately, traditional shop owners (who have limited resources) may take advantage of lower prices offered by supermarkets especially during promotions or discounts. Hence, traditional shop owners may buy farm produce or food products in bulky for reselling in traditional retail outlets.

On the other hand, we find that starchy staples, animal source foods (ASFs) such as meat, poultry, fish, and dairy products, as well as other vegetables – e.g., cabbage, onions, and tomatoes; full list is shown in Table 4.1 – are more expensive in supermarkets than in traditional retailers (Figure 4.1). This is consistent with findings from other developing countries such as Madagascar (Minten and Reardon, 2008) and Thailand (Schipmann and Qaim, 2011), even though these studies did not analyze dietary costs especially for ASFs. Supermarkets are likely to offer higher quality food products (Schipmann and Qaim, 2011) – which are more expensive especially ASFs – than traditional retailers due to better cooling facilities/warehouses (Lu and Reardon, 2018; Khonje and Qaim, 2019). This is also perceived by 19% of the respondents, who reported high quality food products as an important reason for buying food in supermarkets (Figure 4.2). Moreover, beyond food quality and higher prices, in many developing countries, supermarkets are perceived to fulfill higher food safety standards than traditional retailers (Umberger et al., 2015; Wertheim-Heck et al., 2015).

Nevertheless, the simple cost comparisons in Figure 4.1 does not control for the confounding factors such as income and education. To account for such factors, we run equation (4.3) using costs of nutritious diets as dependent variables. Food-specific regression results are shown in Table A4.7 in the Appendix. Interestingly, we still find that starchy staples, ASFs, and other vegetables are more expensive in supermarkets than in traditional retailers. On the other hand, pulses are relatively cheaper in supermarkets. In summary, these findings suggest that supermarkets have both positive and negative effects on the affordability of nutritious diets.

4.4.3. Socioeconomic characteristics

Table 4.3 present descriptive statistics for key variables used in the regression analyses, differentiated by users and non-users of supermarkets. We generally find that supermarket users have a higher dietary diversity score 2 (DDS2) than non-users. We also find that users of supermarkets have a higher dietary diversity score 1 (DDS1) – measured as count of healthy foods groups consumed in the last 24 hours – than non-users, even though the mean difference is not significant. Further, the results show that men have higher mean values for DDS1 than women and boys (Table A4.8 in the Appendix).

Table 4.3: Summary statistics, by users and non-users of supermarkets

	Units	Overall	Supermarket		Mean difference
			Users	Non-users	
		(1)	(2)	(3)	(4) = (2) – (3)
Dependent variables					
Dietary diversity score 1	Count of healthy food groups consumed	2.93 (0.93)	2.95 (0.92)	2.90 (0.95)	0.05
Dietary diversity score 2	Count of all food groups consumed	6.57 (1.91)	6.74 (1.91)	6.24 (1.86)	0.49***
Selected independent variables					
Income	US$/capita/year	2504.86 (3221.92)	3192.38 (3645.29)	1191.45 (1486.26)	2000.93***
Household size	Number of members	4.72 (1.63)	4.51 (1.49)	5.12 (1.81)	–0.61***
Age of the respondent	Years	26.03 (17.27)	25.96 (16.38)	26.16 (18.87)	–0.20
Education of the respondent	Schooling years	8.88 (5.14)	9.76 (5.20)	7.20 (4.58)	2.56***
Bemba as ethnicity	1= Yes, 0 otherwise	0.28 (0.45)	0.32 (0.47)	0.22 (0.42)	0.10***
Protestant as a religion	1= Yes, 0 otherwise	0.45 (0.50)	0.46 (0.50)	0.43 (0.50)	0.04
Neighbor’s shopping mall usage	Number of visits per week	2.59 (2.86)	3.10 (3.04)	1.61 (2.15)	1.49***
Household distance to a supermarket	GPS-measured distance in km	2.84 (2.55)	2.45 (2.49)	3.60 (2.49)	–1.16***
Observations		1,429	938	491	1,429

Note: The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. Mean values are shown with standard deviations in parentheses. Summary statistics, by age and sex cohorts are shown in Table A4.8 in the Appendix. *** $p < 0.01$.

Furthermore, Table 4.3 results also suggest that several socioeconomic characteristics are different with and without supermarket food purchases. For instance, we find that household income is higher for supermarket users than non-users. We observe a similar pattern for education. We also observe that supermarket users have a smaller household size than non-users. Across demographic cohorts, as expected, men have more education and income than women, boys, and girls (Table A4.8 in the Appendix). Generally, without controlling household living standards such as income and education, the results in Table 4.3 cannot be interpreted as perfect correlations or causal effects.

4.4.4. Effects of supermarkets on dietary quality

Table 4.4, column (1) shows Poisson regression (i.e., equation (4.3)) results on the effects of supermarkets on dietary quality: measured as number of healthy food groups consumed in the last 24 hours (third research question). Unlike a previous study in Vietnam (Rupa et al., 2019), after controlling for confounding factors including household income and education, we find that buying food in supermarkets increases intake of nutritious diets by roughly 11% (panel A of Table 4.4, column (1))[5]. Interestingly, the results in panel B of Table 4.4 further

Table 4.4: Effects of using supermarkets on dietary diversity

	Number of healthy food groups consumed (in last 24 hours)	Number of all food groups consumed (in last 24 hours)
	(1)	(2)
	Panel A: Overall results	
Overall (N=1,429)		
Supermarket purchase (1,0)	1.105*** (0.017)	1.141*** (0.017)
	Panel B: Heterogeneous effects, by demographic cohorts	
Men (N=295)		
Supermarket purchase (1,0)	1.054*** (0.014)	1.090*** (0.014)
Women (N=594)		
Supermarket purchase (1,0)	1.137*** (0.014)	1.152*** (0.016)
Boys (N=240)		
Supermarket purchase (1,0)	1.111*** (0.021)	1.192*** (0.014)
Girls (N=300)		
Supermarket purchase (1,0)	1.096*** (0.024)	1.132*** (0.020)
Controls	Yes	Yes

Note: Coefficient estimates from control function (CF) approach through Poisson estimator are shown, with bootstrap standard errors clustered at household level in parentheses. Coefficients estimates are reported as incidence-rate ratios. Full model results with all control variables are shown in Tables A4.9 and A4.10 in the Appendix. *** $p < 0.01$.

[5] Note that coefficient estimates for supermarket in Tables 4.4 and A4.9-A4.11 are calculated as 100 × [incidence-rate ratio (coefficient) - 1].

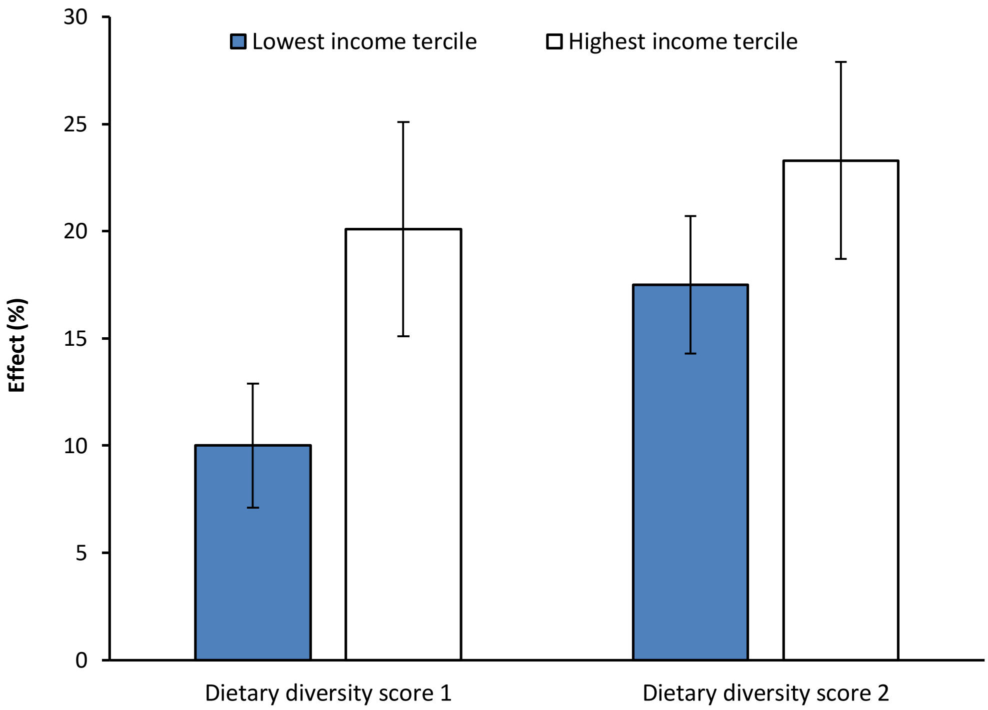
show that women (14%) have more diversified diets from supermarket food purchases compared with boys (11%), girls (10%), and men (5%). Overall, these findings imply that buying food in supermarkets is associated with increased intake of nutritious diets among adults and children.

While previous studies (e.g., Asfaw 2008; Rischke et al., 2015; Demmler et al., 2018) have found that supermarkets are associated higher consumption of unhealthy diets (negative effects), it is interesting to note that supermarkets may also be associated with higher intake of nutritious diets (positive effects). Nevertheless, results in column (1) of Table 4.4 accounts for intake of nutritious foods only, but not both healthy and less healthy foods.

To analyze the effects of supermarkets on dietary intake of both healthy and less healthy foods, we rerun equation (4.3), focusing on all food groups consumed in the last 24 hours. Thus, we included less healthy foods – such as sugar, salt, and fat-rich foods – in calculating the dietary diversity score 2 (DDS2). Further, DDS2 also includes some of the country-specific nutritious foods (e.g., local insects – such as caterpillars/ants – and wild mushrooms). Regression results are shown in column (2) of Table 4.4. After controlling for confounding factors, we find that buying food in supermarkets increases dietary diversity by roughly 14% (panel A of Table 4.4, column (2)). We also find that buying food in supermarkets increases dietary diversity, ranging from 9% to 19%, for men and boys, respectively (panel B of Table 4.4). This is in line with a recent study in urban Kenya (Debela et al., 2020); even though – due to the unavailability of individual-level dietary data – intra-household food distribution could not be analyzed.

As a robustness check, we also rerun equation (4.3) in order to understand the heterogeneous effects of using supermarkets on dietary diversity, by income terciles. About 35% of the individuals in the sample come from low-income households. Results are shown in Figure 4.3.

Interestingly, the results show that buying food in supermarkets increases dietary diversity even among low-income consumers by approximately 10-18% (Figure 4.3). This implies that poor consumers are significantly benefiting from the growth of modern retailers (supermarkets) in urban Zambia. The effect sizes are slightly larger (20-23%) among high-income consumers as expected (Figure 4.3). These findings suggest that supermarkets have a positive effect on dietary quality even among poor consumers in urban Africa.



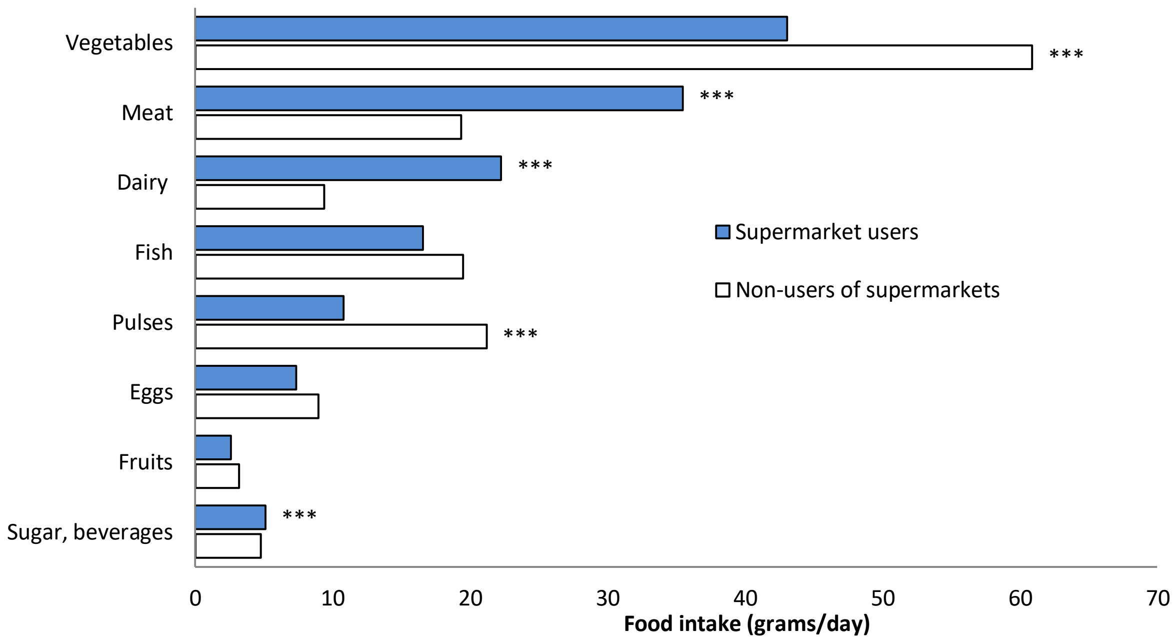
Note: Percentage effects are shown with standard error bars. Use of supermarkets expressed as a dummy variable that takes a value of one if any of the food consumed was purchased in a supermarket and zero if all of the foods consumed were obtained from traditional sources. Effects were estimated with control function models, controlling for income, education, age, and other relevant factors. Full model results are shown in Table A4.11 in the Appendix.

Figure 4.3: Heterogeneous effects of using supermarkets on dietary diversity, by income terciles

4.4.5. Dietary mechanisms

To provide some insights on dietary mechanisms, as mentioned before, we conceptualize that buying food in supermarkets may influence dietary quality through higher intake of both healthy and less healthy foods. Figure 4.4 provides a simple comparison on dietary intake with and without supermarket food purchases. The results show that supermarkets have both positive and negative effects on dietary intake. For instance, we find that supermarkets increase the intake of nutrient-dense foods such as meat and dairy products (positive effects).

On the other hand, buying food in supermarkets also increases intake of calorie-dense and nutrient-poor (unhealthy) foods such as sugar and beverages (Figure 4.4). This implies that supermarkets are also likely to be the main source of unhealthy diets. This hypothesis has been confirmed by several studies (e.g., Asfaw 2008; Rischke et al., 2015; Demmler et al., 2018; Khonje and Qaim, 2019) in some developing countries. Nevertheless, Figure 4.4 results are only simple correlations and they do not account for household living standards.



Note: Asterisk (*) show significance t-test for the mean differences between users and non-users of supermarkets. Sugar and beverage values are expressed in natural logarithm. Summary statistics, by age and sex cohorts are shown in Table A4.12 in the Appendix. *** $p < 0.01$.

Figure 4.4: Per capita food intake, by users and non-users of supermarkets

To control for household living standards, we ran control function (Tobit) regression models (i.e., equation (4.3)) using food intake (grams/day) for different food groups as dependent variables. Food-specific regression results on effects of supermarkets on intensity of dietary intake are shown in Table 4.5. After controlling for confounding factors – such as household

Table 4.5: Effects of using supermarkets on dietary intake

	Food intake (grams/day)						
	Meat	Dairy	Eggs	Fish	Pulses	Vegetables	Fruits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Supermarket purchase (1,0)	1.141***	2.395***	0.834*	1.785***	–1.528***	0.395**	0.799
	(0.158)	(0.840)	(0.498)	(0.286)	(0.394)	(0.156)	(0.933)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald χ^2	1021***	156***	74***	178***	313***	308***	33***
Pseudo-R^2	0.028	0.026	0.015	0.007	0.013	0.015	0.012
N	1,429	1,429	1,429	1,429	1,429	1,429	1,429

Note: We transformed food intake using an inverse hyperbola sine: $\ln[\{y + (y^2 + 1)^{0.5}\}]$, in order to retain zero-valued observations. Coefficient estimates from CF approach through Tobit estimator is shown, with bootstrap standard errors clustered at household level in parentheses. Full model results with all control variables are shown in Table A4.13 in the Appendix. * $p < 0.1$; *** $p < 0.01$.

income and education, we find that buying food in supermarkets significantly increases intake of meat, fish, eggs and dairy products, as well as vegetables.

We also find similar results if the share of total household food expenditures made in supermarkets is used (see Table A4.14 in the Appendix). For instance, we observe that a 10% increase in the share of supermarket food purchases increases intake of meat, fish, and dairy products by about 4 g/day, 10 g/day, and 22 g/day, respectively (Table A4.14). However, we now observe that coefficient estimates for eggs and vegetables are statistically insignificant. Overall, these findings are in line with a recent study in urban Kenya (Debela et al., 2020), where it was also observed that supermarkets are associated with higher consumption of healthy food groups.

In summary, these results confirm the hypothesis that supermarkets have a positive effect on intake of nutritious diets, which largely come from animal source foods (ASFs). The higher dietary intake of ASFs is likely related to better cooling facilities and warehouses in supermarkets compared to traditional retailers (Lu and Reardon, 2018; Khonje and Qaim, 2019). These facilities can improve access to both fresh/perishables and processed versions of ASFs. Conversely, consistent with Figure 4.4 results and an earlier study by Asfaw (2008) in Guatemala, we also find that buying food in supermarkets is negatively associated with lower intake of pulses. This suggests that pulses are largely sourced from traditional food retailers.

The positive effect of supermarkets on dietary intake of ASFs is a welcome finding because ASFs are important source of proteins and micronutrients in many developing countries (Headey et al., 2018; Rupa et al., 2019; Debela et al., 2020; GAIN, 2020). Hence, our results suggest a need to shift food policy from focusing on energy-dense foods to affordable nutritious foods. Modern supermarkets could be one of the platforms to make nutritious foods – i.e., meat, fish, eggs, milk and other dairy products – more affordable especially among low-income consumers and ultimately reduce health problems related to micronutrient malnutrition. Nevertheless, our findings also suggest that supermarkets lead to higher intake of unhealthy foods such as sugar, salt, and fat-rich foods (Table A4.13 in the Appendix), which might contribute to overweight or obesity especially among adult population. A few existing studies (e.g., Asfaw 2008; Rischke et al., 2015; Demmler et al., 2018; Khonje and Qaim, 2019) found similar results in selected developing countries.

4.5. Conclusion

Access and affordability of nutritious diets remain formidable challenges in many developing countries, where hunger and micronutrient malnutrition coexist with overweight and obesity. Available research suggests that healthy diets are not affordable to most people in sub-Saharan Africa (Hirvonen et al., 2020). In many developing countries, modern retailers such as supermarkets are spreading rapidly, replacing or complementing traditional food markets and shops as well as grocery stores. This transformation may influence consumer diets and nutrition, through higher consumption of healthy foods as well as less healthy foods. Previous research suggests that supermarkets may improve diet quality (Tessier et al., 2008; Rupa et al., 2019; Debela et al., 2020). However, most existing research analyzed the effects of supermarkets on dietary quality using food consumption data captured at household-level; which hardly accounts for intra-household food distribution. Moreover, the role of supermarkets and other modern retailers on the affordability of nutritious diets was not analyzed in any of the existing studies.

Using food price data and individual-level dietary data from Lusaka, Zambia, and control function regression models to account for the likely endogeneity of supermarket food purchases, we have analyzed the effects of using supermarkets on the affordability of recommended nutritious diet and dietary quality. Our results show that the cost of a recommended nutritious diet is US$1.22 per day, of which the largest share is the cost of starchy staples (68%), followed by fruits (11%), and meat, eggs, and fish (9%). This is consistent with other existing studies in low-income countries (Headey et al., 2018; Dizon et al., 2019; Headey et al., 2019; Hirvonen et al., 2020). However, on average, this diet is not affordable to 41% of low-income group. Furthermore, we find that nutrient-dense foods such as meat, fish, and dairy products are more expensive in supermarkets than in traditional retailers; largely due to higher quality food products and safety standards.

Nevertheless, we also find that dietary diversity is higher for consumers using supermarkets than non-users. After controlling for confounding factors such as income and education, we find that buying food in supermarkets increases dietary diversity and intake of nutritious diets, with varying effect sizes among demographic cohorts. The positive effect of supermarkets on dietary quality is channeled through higher intake of animal source foods such as meat, eggs, fish, and dairy products. This is a welcome finding as it may help to reduce micronutrient malnutrition. Animal source foods are important source of proteins and micronutrients in many developing countries (Headey et al., 2018; Rupa et al., 2019; Debela et al., 2020).

Our results suggest a need to shift food policy from focusing on energy-dense foods to affordable nutritious foods. Modern retailers – such as supermarkets – could be one of the platforms to make nutritious foods – i.e., meat, fish, eggs, milk, and other dairy products – more affordable especially among poor households. Lower prices could come from improvements in local production, higher efficiency in procurements, marketing and trade, and infrastructure developments especially cooling facilities and warehouses. This would ultimately help individuals to access sufficient quantities of nutritious foods; consequently reducing health problems related to micronutrient malnutrition. Nevertheless, our findings also suggest that supermarkets lead to higher intake of less healthy foods, which is in line with a few existing studies (e.g., Asfaw 2008; Rischke et al., 2015; Demmler et al., 2018; Khonje and Qaim, 2019) in some developing countries. Hence, regulatory policies such as regulation of advertisement and promotional campaigns for unhealthy foods and taxes on highly-processed foods and beverages with high contents of fats, added sugars and salts (Hawkes et al., 2020) among others, would be ideal policy interventions.

This study has some limitations that could be addressed in future studies. First, we captured individual-level food-intake/dietary data only at one point in time. Hence, we may have systematically missed certain food items that are not consumed on a daily basis. Though more costly, conducting multiple 24-hour dietary recalls could account for the missed food items. Second, our results are specific for Lusaka in Zambia and should not be generalized. The changing food environment may have different effects on dietary quality and affordability in different geographical and socioeconomic contexts. However, it is more likely that supermarkets will have similar effects on dietary quality and affordability in other parts of Africa; which are characterized by a rapid modernization of food environment and a high prevalence of different forms of malnutrition concurrently (Lu and Reardon, 2018; FAO et al., 2019). Finally, we used cross-sectional data in this study, which limits the strength of the identification strategy and the options to analyze dynamic effects.

Appendix A4

Table A4.1: The distribution of the sampled individuals in Lusaka City, Zambia

Name of the surveyed compounds/sections	Income level	By demographic cohort				All
		Men (>18 years)	Women (>18 years)	Boys (≤18 years)	Girls (≤18 years)	
Four: Avondole, Chalala, Kabulonga, and Woodlands	High	75	114	40	53	282
Four: Chelston, Chilenje, Kabwata, and PHI	Middle	114	239	101	105	559
Six: Chawama, Chazanga, Gardens, Kalingalinga, Kaunda Square, and Ng'ombe	Low	106	241	99	142	588
All		295	594	240	300	1,429

Table A4.2: Descriptive statistics for food prices per gram in Lusaka City, Zambia (mid-2018)

FG No.	Food group (FG)	No.	Food item	Food price (ZMW/gram)			
				Mean	SD	Min	Max
1	Grains, white roots and tubers	1	Maize flour (Mgaiwa)	0.011	0.000	0.011	0.011
		2	Maize flour (Ufa oyera)	0.004	0.002	0.001	0.011
		3	Maize green	0.167	0.037	0.100	0.250
		4	Rice	0.015	0.005	0.003	0.050
		5	Cassava	0.003	0.000	0.003	0.003
		6	Pumpkins	0.033	0.007	0.010	0.050
		7	Irish potatoes	0.008	0.002	0.003	0.009
		8	Sweet potatoes (SP)	0.008	0.002	0.000	0.009
		9	Orange fleshed (SP)	0.009	0.000	0.009	0.009
		10	Porridge	0.013	0.002	0.010	0.025
		11	Samosa	0.025	0.000	0.025	0.025
		12	Instant noodles	0.021	0.009	0.005	0.054
		13	Bread (White)	0.015	0.002	0.008	0.024
		14	Bread (Brown)	0.015	0.001	0.010	0.020
		15	Pasta (Spaghetti)	0.122	0.088	0.007	0.300
		16	Buns	0.045	0.044	0.000	0.400
		17	Cerelac	0.025	0.012	0.001	0.046
2	Pulses	18	Common beans	0.015	0.003	0.004	0.016
		19	Soybean	0.039	0.037	0.000	0.090
3	Nuts and seeds	20	Groundnut dry/flour	0.030	0.003	0.024	0.040
		21	Green beans/Peas/Pods	0.008	0.000	0.008	0.008
4	Dairy	22	Milk	0.016	0.005	0.006	0.064
		23	Cheese	0.018	.	0.018	0.018
		24	Yoghurt	0.018	0.001	0.014	0.018
5	Meat, poultry, and fish	25	Beef	0.064	0.107	0.028	0.840
		26	Chicken	0.034	0.008	0.000	0.040
		27	Ducks	0.059	0.002	0.055	0.060
		28	Sausage-Beef	0.076	0.180	0.016	1.000
		29	Sausage-Chicken	0.070	0.069	0.025	0.250
		30	Sausage-Pork	0.042	0.004	0.036	0.050
		31	Goat meat	0.027	0.002	0.025	0.030
		32	Pig meat	0.033	0.009	0.020	0.045
		33	Sheep meat	0.050	0.000	0.050	0.050
		34	Fish	0.048	0.079	0.000	0.750
6	Eggs	35	Eggs	0.077	0.015	0.008	0.080
7	Dark green leafy vegetables	36	Bean leaves	0.006	0.000	0.006	0.006
		37	Green/Red pepper	0.007	0.000	0.007	0.007
		38	Pumpkin leaves	0.006	0.000	0.006	0.006
		39	Rape/Mustard/Chinese	0.007	0.001	0.001	0.007
8	Vitamin A rich vegetables	40	Cassava leaves	0.007	0.000	0.007	0.007
		41	Carrots	0.007	0.000	0.007	0.007
		42	Sweet potato leaves	0.006	0.000	0.006	0.006
9	Other vegetables	43	Cabbage	0.010	0.002	0.003	0.011
		44	Cucumber	0.004	0.002	0.003	0.007
		45	Egg plants	0.008	0.004	0.003	0.033
		46	Frozen vegetables	0.047	.	0.047	0.047
		47	Lettuce	0.011	0.000	0.011	0.011
		48	Okra	0.008	0.001	0.004	0.008
		49	Onions	0.006	0.001	0.001	0.006
		50	Tomatoes	0.008	0.001	0.001	0.008
10	Fruits	51	Apples	0.047	0.064	0.010	0.200
		52	Avocadoes	0.162	0.075	0.000	0.200
		53	Bananas (Ripe)	0.072	0.011	0.020	0.075

		54	Pineapples	0.009	0.000	0.009	0.009
		55	Oranges/Tangerines	0.047	0.000	0.047	0.047
		56	Water melons	0.047	.	0.047	0.047
		57	Mixed fruits	0.020	.	0.020	0.020
11	Sugar, salt and fat-rich foods	58	Cooking oil/fats	0.014	0.001	0.008	0.014
		59	Sandwich/Burger	0.080	0.000	0.080	0.080
		60	Mandazi/Scones	0.014	0.000	0.014	0.014
		61	Margarine/Butter	0.032	0.006	0.025	0.045
		62	Jam	0.030	0.000	0.030	0.030
		63	Pizza (Fresh/Frozen)	0.134	0.021	0.030	0.138
		64	Tea/Coffee	0.011	0.001	0.000	0.011
		65	Sugar	0.017	0.005	0.005	0.027
		66	Biscuits/Cookies	0.090	0.000	0.090	0.090
		67	Chocolate	0.250	0.212	0.100	0.400
		68	Ice cream	0.100	0.000	0.100	0.100
		69	Soft drinks (Coca-cola,..etc)	0.016	0.000	0.016	0.017
		70	Juice	0.020	0.009	0.008	0.064
12	Miscellaneous/ Traditional foods	71	Mushroom	0.020	.	0.020	0.020
		72	Caterpillars/Ants	0.097	0.099	0.042	0.300

Note: The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. SD = standard deviation. Food prices were collected through our household survey: food consumption data through a seven-day recall. We also validated food prices through our own random price survey during the study supplemented by review of internet sources.

Table A4.3: First stage regression results on supermarket food purchases (GLM estimates)

	Share of supermarket purchases (%)				
	Overall	Men	Women	Boys	Girls
	(1)	(2)	(3)	(4)	(5)
Male (dummy)	1.750				
	(1.546)				
Age of respondent (years)	–0.909***	0.108	–0.323	1.195	–0.657
	(0.200)	(0.655)	(0.391)	(1.733)	(1.345)
Age-squared (years)	0.009***	–0.001	0.003	–0.099	0.022
	(0.003)	(0.008)	(0.004)	(0.091)	(0.069)
Education of respondent (years)	1.959***	2.672***	2.605***	1.469	0.756
	(0.235)	(0.642)	(0.352)	(1.379)	(1.220)
Household size (individuals)	–3.043***	–1.742	–2.915***	–2.490**	–3.198***
	(0.466)	(1.068)	(0.684)	(1.264)	(1.045)
Income (log)	6.759***	10.350***	8.275***	5.514***	5.088***
	(0.519)	(1.651)	(0.998)	(0.957)	(0.908)
Chewa (dummy)	0.086	5.953	6.087*	–2.578	–8.003*
	(2.185)	(4.741)	(3.499)	(5.313)	(4.722)
Tonga (dummy)	–3.086	–2.183	–6.157**	3.695	–3.691
	(1.927)	(4.410)	(2.740)	(5.183)	(4.437)
Catholic (dummy)	–4.551***	–0.611	–3.986	–11.387**	–5.039
	(1.704)	(3.806)	(2.496)	(4.575)	(3.837)
Instruments					
Neighbor's shopping mall usage (visits/week)	2.965***	3.169***	2.784***	2.947***	3.011***
	(0.266)	(0.594)	(0.410)	(0.701)	(0.545)
Distance to a supermarket (km)	–1.635***	–1.373*	–1.228***	–2.140***	–1.974***
	(0.295)	(0.740)	(0.420)	(0.765)	(0.639)
Joint significance of instruments: $\chi^2(2)$	186***	38***	62***	33***	52***
Constant	–21.160***	–98.451***	–55.893***	–10.037	–2.969
	(6.332)	(21.502)	(13.530)	(13.603)	(11.837)
N	1,429	295	594	240	300

Note: GLM = generalized linear model. N = observations. Standard errors are reported in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4.4: Falsification test for instrument validity (Poisson estimates)

	Number of healthy food groups consumed (DDS1)	Number of all food groups consumed (DDS2)
	Poisson	*Poisson*
	(1)	(2)
Male (dummy)	0.024	0.002
	(0.224)	(0.877)
Age of respondent (years)	0.003	0.000
	(0.379)	(0.877)
Age-squared (years)	–0.000	–0.000
	(0.505)	(0.861)
Education of respondent (years)	0.003	–0.001
	(0.475)	(0.745)
Household size (individuals)	0.016***	0.009*
	(0.002)	(0.080)
Income (log)	0.001	0.019***
	(0.956)	(0.006)
Chewa (dummy)	0.070***	0.065**
	(0.001)	(0.016)
Tonga (dummy)	0.015	0.057**
	(0.600)	(0.017)
Catholic (dummy)	0.042*	0.033
	(0.078)	(0.152)
Instruments		
Neighbor's shopping mall usage (visits/week)	0.001	0.004
	(0.819)	(0.428)
Distance to a supermarket (km)	–0.001	–0.010
	(0.926)	(0.102)
Joint significance of instruments: $\chi^2(2)$	0.110	4.570
	(0.947)	(0.102)
Constant	0.894***	1.630***
	(0.000)	(0.000)
Wald χ^2	145***	68***
N	1,429	1,423

Note: We excluded individuals who consumed more than 16 food groups in column (2). Distance to a supermarket and the number of visits by the household's closest neighbour to a shopping mall are used as identifying instruments for supermarket food purchases. Standard errors are clustered at compound/section level, and *p*-values are shown in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4.5: Descriptive statistics for food prices (ZMW/gram), by food groups, users and non-users of supermarkets

FG No.	Food group (FG)	Overall	Supermarket	
			Users	Non-users
		(1)	(2)	(3)
1	Grains, white roots and tubers (N=1419)	0.015	0.015	0.014
		(0.017)	(0.018)	(0.016)
2	Pulses (N=242)	0.019	0.018	0.020
		(0.018)	(0.015)	(0.021)
3	Nuts and seeds (N=22)	0.023	0.026	0.020
		(0.011)	(0.010)	(0.012)
4	Dairy (N=176)	0.016	0.016	0.016
		(0.004)	(0.004)	(0.003)
5	Meat, poultry, and fish (N=1034)	0.050	0.051	0.047
		(0.091)	(0.101)	(0.055)
6	Eggs (N=208)	0.077	0.076	0.077
		(0.015)	(0.016)	(0.014)
7	Dark green leafy vegetables (N=701)	0.006	0.006	0.007
		(0.001)	(0.001)	(0.000)
8	Vitamin A rich vegetables (N=32)	0.006	0.006	0.006
		(0.000)	(0.000)	(0.000)
9	Other vegetables (N=417)	0.008	0.008	0.007
		(0.003)	(0.003)	(0.002)
10	All fruits (N=85)	0.107	0.099	0.120
		(0.074)	(0.071)	(0.078)

Note: The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. N = number of observations. Mean values are shown with standard deviations in parentheses.

Table A4.6: Summary statistics on cost of recommended nutritious diets, by users and non-users of supermarkets

Cost (US$/day)	Overall	Supermarkets		Mean difference
		Users	Non-users	
	(1)	(2)	(3)	(4) = (2) – (3)
Total cost	1.046	1.082	0.977	0.11***
	(0.618)	(0.578)	(0.683)	
Starchy staples	0.676	0.710	0.612	0.10***
	(0.224)	(0.221)	(0.215)	
Pulses	0.016	0.014	0.021	–0.01***
	(0.036)	(0.033)	(0.041)	
Nuts and seeds	0.001	0.001	0.001	0.00
	(0.007)	(0.008)	(0.006)	
Dairy	0.052	0.064	0.030	0.03***
	(0.144)	(0.157)	(0.109)	
Meat, poultry and fish	0.090	0.101	0.068	0.03***
	(0.080)	(0.081)	(0.075)	
Eggs	0.015	0.014	0.016	–0.00
	(0.035)	(0.035)	(0.037)	
Dark green leafy vegetables	0.033	0.029	0.040	–0.01***
	(0.034)	(0.032)	(0.037)	
Vitamin A rich vegetables	0.001	0.001	0.002	–0.00
	(0.009)	(0.008)	(0.010)	
Other vegetables	0.027	0.029	0.024	0.00*
	(0.047)	(0.049)	(0.041)	
All fruits	0.135	0.120	0.163	–0.04
	(0.549)	(0.502)	(0.629)	
N	1,429	938	491	1,429

Note: The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. N = number of observations. Mean values are shown with standard deviations in parentheses. * $p < 0.1$; *** $p < 0.01$.

Table A4.7: Effects of using supermarkets on cost of nutritious diets

	Cost of recommended nutritious diets (ZMW/day)								
	Starchy staples	Meat, poultry and fish	Dairy	Eggs	Legumes	Dark green leafy vegetables	Vitamin A rich vegetables	Other vegetables	Fruits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Supermarket purchase (1,0)	0.176***	0.457***	1.000***	0.167	–0.327***	0.011	–0.150	0.200***	0.623
	(0.022)	(0.033)	(0.337)	(0.103)	(0.066)	(0.025)	(0.182)	(0.044)	(0.833)
Gender	–0.010	0.031	–0.130	–0.313***	0.017	0.050	–0.012	0.200***	0.039
	(0.018)	(0.032)	(0.245)	(0.093)	(0.076)	(0.031)	(0.177)	(0.056)	(0.787)
Age	–0.002	0.009*	–0.073*	–0.015	–0.011	0.014***	–0.020	0.017**	0.015
	(0.002)	(0.005)	(0.038)	(0.015)	(0.011)	(0.004)	(0.026)	(0.008)	(0.079)
Age-squared	0.000	–0.000*	0.001	0.000	0.000	–0.000***	0.000	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Education	–0.004	–0.004	–0.017	0.023	0.016	–0.009**	0.060**	–0.010	–0.180*
	(0.003)	(0.006)	(0.042)	(0.017)	(0.011)	(0.004)	(0.027)	(0.009)	(0.101)
Household size	–0.001	0.004	–0.089	0.078***	0.005	0.040***	0.040*	–0.004	0.198
	(0.006)	(0.006)	(0.070)	(0.020)	(0.011)	(0.005)	(0.022)	(0.010)	(0.161)
Income	0.019***	0.030***	0.372***	0.033	–0.107***	–0.029***	0.005	–0.041***	0.292
	(0.004)	(0.007)	(0.088)	(0.023)	(0.015)	(0.006)	(0.039)	(0.012)	(0.351)
Chewa	–0.022	–0.033	–0.626*	0.371***	0.240***	0.021	–0.304	0.437***	0.205
	(0.026)	(0.041)	(0.337)	(0.117)	(0.074)	(0.035)	(1.276)	(0.055)	(0.967)
Tonga	0.027	0.112***	0.144	0.215**	0.004	–0.046	–0.814	0.346***	–1.374
	(0.020)	(0.031)	(0.300)	(0.103)	(0.074)	(0.032)	(5.099)	(0.047)	(0.995)
Catholic	0.007	0.063**	0.338*	0.291***	–0.187***	0.038*	–0.182	0.195***	1.005
	(0.019)	(0.027)	(0.192)	(0.084)	(0.043)	(0.021)	(0.179)	(0.037)	(0.626)
First-stage residual	–0.001	–0.003***	0.005	–0.007***	0.003***	–0.003***	–0.007**	–0.001*	–0.019
	(0.000)	(0.000)	(0.004)	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)	(0.013)
Constant	2.291***	–0.185**	–6.751***	–2.211***	0.169	0.024	–2.902***	–0.658***	–15.588***
	(0.060)	(0.075)	(1.088)	(0.270)	(0.168)	(0.064)	(0.398)	(0.142)	(3.599)
Wald χ^2	188***	573***	147***	76***	315***	228***	61***	173***	35***
Pseudo-R^2	0.047	0.034	0.031	0.024	0.020	0.032	0.048	0.023	0.012
N	1,429	1,429	1,429	1,429	1,429	1,429	1,429	1,429	1,429

Note: We transformed costs of recommended nutritious diets using an inverse hyperbola sine: $\ln[\{y + (y^2 + 1)^{0.5}\}]$, in order to retain zero-valued observations. Coefficient estimates from control function (CF) approach through Tobit estimator is shown, with robust/bootstrap standard errors clustered at household level in parentheses. Bemba and Protestant are the reference groups for Chewa and Tonga, and Catholic, respectively. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4.8: Summary statistics, by age and sex cohorts

	Overall	Adults (>18 years)		Children (≤18 years)	
		Men	Women	Boys	Girls
	(1)	(2)	(3)	(4)	(5)
Dependent variables					
DDS1	2.93	3.00	2.96	2.92	2.81
	(0.93)	(0.88)	(0.92)	(0.93)	(0.98)
DDS2	6.57	6.57	6.52	6.56	6.65
	(1.91)	(2.01)	(1.91)	(1.71)	(1.95)
Selected independent variables					
Income	2504.86	3292.56	2524.09	2227.02	1914.50
	(3221.92)	(3957.26)	(2913.16)	(3458.60)	(2600.50)
Household size	4.72	4.28	4.68	4.96	5.05
	(1.63)	(1.68)	(1.68)	(1.50)	(1.50)
Age of the respondent	26.03	34.79	36.65	8.75	10.21
	(17.27)	(14.34)	(13.91)	(4.94)	(5.39)
Education of the respondent	8.88	12.83	10.97	3.75	4.96
	(5.14)	(3.00)	(3.61)	(3.96)	(4.29)
Bemba as ethnicity	0.28	0.27	0.28	0.31	0.30
	(0.45)	(0.44)	(0.45)	(0.46)	(0.46)
Protestant as a religion	0.45	0.45	0.42	0.47	0.49
	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)
Neighbor's shopping mall usage	2.59	2.78	2.53	2.47	2.62
	(2.86)	(2.97)	(2.75)	(2.85)	(2.96)
Household distance to a	2.84	2.57	2.95	2.95	2.81
Shopping mall	(2.55)	(2.37)	(2.64)	(2.49)	(2.56)
N	1,429	295	594	240	300

Note: The average exchange rate was ZMW 9.87 = US$ 1 in mid-2018. Mean values are shown with standard deviations in parentheses.

Table A4.9: Effects of using supermarkets on dietary diversity (full model results for panel A in Table 4.4)

	Number of healthy food groups consumed (in last 24 hours)		Number of all food groups consumed (in last 24 hours)	
	Poisson	*CF*	*Poisson*	*CF*
	(1)	(2)	(3)	(4)
Supermarket purchase (1,0)	1.030	1.105***	1.080***	1.141***
	(0.029)	(0.017)	(0.027)	(0.017)
Gender	1.025	1.025*	–0.998	–0.998
	(0.019)	(0.015)	(0.017)	(0.011)
Age	1.003	1.004*	1.001	1.002
	(0.002)	(0.002)	(0.002)	(0.002)
Age-squared	–1.000	–1.000	–1.000	–1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Education	1.002	–1.000	–0.997	–0.996**
	(0.003)	(0.002)	(0.003)	(0.002)
Household size	1.017**	1.019***	1.010	1.012***
	(0.007)	(0.003)	(0.007)	(0.003)
Income	–0.999	–0.993	1.018**	1.014***
	(0.008)	(0.005)	(0.007)	(0.003)
Chewa	1.074**	1.080***	1.064**	1.068***
	(0.036)	(0.021)	(0.030)	(0.015)
Tonga	1.017	1.023**	1.068**	1.073***
	(0.030)	(0.012)	(0.027)	(0.014)
Catholic	1.046*	1.055***	1.040	1.047***
	(0.028)	(0.010)	(0.028)	(0.011)
First-stage residual	N/A	–0.998***	N/A	–0.999***
		(0.0002)		(0.000)
Constant	2.440***	2.439***	4.868***	4.857***
	(0.230)	(0.130)	(0.410)	(0.169)
Wald χ^2	22**	166***	29**	223***
Pseudo-R^2		0.004		0.006
N	1,429	1,429	1,429	1,429

Note: N/A = not applicable. Coefficient estimates from Poisson and control function (CF) approach are shown, with robust/bootstrap standard errors clustered at household level in parentheses. Coefficient etsimates are reported as incidence-rate ratios. Bemba and Protestant are the reference groups for Chewa and Tonga, and Catholic, respectively. We excluded gender in the estimation for cohort-specific results in Table A4.10. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4.10: Effects of using supermarkets on dietary diversity (full model results for panel B in Table 4.4)

	Number of healthy food groups consumed (in last 24 hours)				Number of all food groups consumed (in last 24 hours)			
	Men	Women	Boys	Girls	Men	Women	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Supermarket purchase (1,0)	1.054***	1.137***	1.111***	1.096***	1.090***	1.152***	1.192***	1.132***
	(0.014)	(0.014)	(0.021)	(0.024)	(0.014)	(0.016)	(0.014)	(0.020)
Age	–0.996	1.000	1.025**	1.041***	–1.000	1.004	1.030***	1.007
	(0.003)	(0.003)	(0.008)	(0.009)	(0.002)	(0.003)	(0.004)	(0.007)
Age-squared	1.000	1.000	–0.999	–0.999*	1.000	–1.000	–0.999*	1.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	1.000	–0.998	–0.988	–0.979***	1.000	–0.994**	–0.989	–0.973***
	(0.004)	(0.002)	(0.008)	(0.005)	(0.002)	(0.002)	(0.010)	(0.005)
Household size	–1.000	1.018***	1.008**	1.041***	–0.990**	1.010***	1.015***	1.029***
	(0.004)	(0.003)	(0.002)	(0.005)	(0.003)	(0.002)	(0.001)	(0.004)
Income	–0.983*	–0.992	–0.991	–0.998	1.011**	1.015***	1.015***	1.010**
	(0.007)	(0.005)	(0.009)	(0.004)	(0.003)	(0.004)	(0.001)	(0.003)
Chewa	1.027	1.018	1.210***	1.103***	1.060***	1.035*	1.085***	1.090***
	(0.026)	(0.018)	(0.015)	(0.024)	(0.018)	(0.017)	(0.009)	(0.018)
Tonga	–0.991	1.004	–0.925***	1.212***	1.073***	1.053***	1.037***	1.157***
	(0.013)	(0.012)	(0.013)	(0.020)	(0.010)	(0.014)	(0.008)	(0.014)
Catholic	1.057***	1.055***	1.035*	1.077***	1.026**	1.054***	1.051***	1.078***
	(0.014)	(0.011)	(0.014)	(0.017)	(0.009)	(0.010)	(0.010)	(0.014)
First-stage residual	–0.998***	–0.998***	–0.998***	–0.999*	–0.998***	–0.998***	–0.998***	1.001**
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Constant	3.684***	2.686***	2.489***	1.731***	4.456***	4.610***	4.115***	4.351***
	(0.384)	(0.223)	(0.275)	(0.114)	(0.254)	(0.286)	(0.074)	(0.217)
Wald χ^2	133***	312***	1225***	296***	727***	357***	1207***	623***
Pseudo-R^2	0.002	0.003	0.009	0.011	0.005	0.006	0.012	0.018
N	295	594	240	300	295	594	240	300

Note: Coefficient estimates from control function (CF) approach through Poisson estimator are shown, with bootstrap standard errors clustered at household level in parentheses. Coefficient etsimates are reported as incidence-rate ratios. Bemba and Protestant are the reference groups for Chewa and Tonga, and Catholic, respectively. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4.11: Heterogeneous effects of using supermarkets on dietary diversity, by income terciles (full model results in Figure 4.3)

	Lowest income tercile		Highest income tercile	
	DDS1	DDS2	DDS1	DDS2
	(1)	(2)	(3)	(4)
Supermarket purchase (1,0)	1.100***	1.175***	1.201***	1.233***
	(0.029)	(0.032)	(0.050)	(0.046)
Gender	1.063**	–0.994	1.006	1.009
	(0.025)	(0.023)	(0.027)	(0.024)
Age	1.004	1.002	1.007	1.006
	(0.003)	(0.003)	(0.004)	(0.004)
Age-squared	–1.000	–1.000	–1.000	–1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Education	1.002	–0.998	–0.997	–0.989**
	(0.004)	(0.004)	(0.004)	(0.004)
Household size	1.027***	1.012**	1.018*	1.013
	(0.005)	(0.005)	(0.009)	(0.007)
Income	1.007	1.012	–0.922***	–0.933***
	(0.008)	(0.007)	(0.020)	(0.014)
Chewa	1.090**	1.083***	1.118*	1.052
	(0.029)	(0.026)	(0.050)	(0.029)
Tonga	1.036	1.110***	1.055*	1.103***
	(0.027)	(0.032)	(0.025)	(0.022)
Catholic	1.082***	1.092***	1.027	1.044*
	(0.019)	(0.022)	(0.024)	(0.019)
First-stage residual	–0.999	–0.998*	–0.997***	–0.998***
	(0.001)	(0.001)	(0.000)	(0.000)
Constant	2.009***	4.656***	5.090***	11.397***
	(0.158)	(0.239)	(1.349)	(2.121)
Wald χ^2	105***	161***	106***	175***
Pseudo-R^2	0.007	0.011	0.007	0.010
N	506	506	451	451

Note: Coefficient estimates from control function (CF) approach through Poisson estimator are shown, with bootstrap standard errors clustered at household level in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4.12: Per capita food intake, by age and sex cohorts

Food intake (g/day)	Adults (>18 years)		Children (≤18 years)	
	Men	Women	Boys	Girls
	(1)	(2)	(3)	(4)
Meat	36.26	32.03	26.12	26.12
	(47.80)	(44.43)	(31.63)	(31.63)
Dairy products	19.07	15.69	19.76	19.76
	(76.85)	(67.83)	(55.96)	(55.96)
Eggs	9.52	7.98	3.98	3.98
	(38.91)	(27.16)	(14.25)	(14.25)
Fish	16.09	23.12	14.78	14.78
	(35.51)	(67.53)	(49.46)	(49.46)
Pulses	16.15	14.88	12.03	12.03
	(65.73)	(50.99)	(38.12)	(38.12)
Vegetables	50.81	57.27	46.37	46.37
	(63.52)	(98.29)	(76.51)	(76.51)
Fruits	2.50	3.66	2.52	2.52
	(15.37)	(21.91)	(13.25)	(13.25)
Sugar, beverages	168.55	157.76	115.83	115.83
	(196.14)	(191.50)	(144.02)	(144.02)
N	295	594	240	300

Table A4.13: Effects of using supermarkets on dietary intake (full model results in Table 4.5)

	Food intake (grams/day)							
	Meat	Dairy	Eggs	Fish	Pulses	Vegetables	Fruits	Sugar, Beverages
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Supermarket purchase (1,0)	1.141***	2.395***	0.834*	1.785***	–1.528***	0.395**	0.799	0.914***
	(0.158)	(0.840)	(0.498)	(0.286)	(0.394)	(0.156)	(0.933)	(0.151)
Gender	0.148	–0.304	–1.499***	0.290	0.223	0.478***	0.145	–0.268*
	(0.169)	(0.608)	(0.468)	(0.345)	(0.441)	(0.174)	(0.880)	(0.140)
Age	0.002	–0.191**	–0.057	0.082	–0.027	0.096***	0.032	0.030
	(0.027)	(0.092)	(0.074)	(0.052)	(0.062)	(0.021)	(0.090)	(0.020)
Age-squared	0.000	0.002*	0.000	–0.001	0.000	–0.001***	0.001	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)
Education	0.076***	–0.026	0.105	–0.094	0.057	–0.048**	–0.225*	–0.001
	(0.028)	(0.102)	(0.084)	(0.062)	(0.062)	(0.023)	(0.115)	(0.021)
Household size	0.147***	–0.243	0.340***	–0.270***	–0.016	0.213***	0.198	0.001
	(0.034)	(0.171)	(0.101)	(0.056)	(0.058)	(0.025)	(0.184)	(0.033)
Income	0.543***	0.925***	0.200*	–0.364***	–0.650***	–0.226***	0.382	0.230***
	(0.038)	(0.223)	(0.119)	(0.060)	(0.083)	(0.040)	(0.407)	(0.041)
Chewa	–0.370**	–1.679**	1.694***	0.452	1.578***	0.501***	0.349	0.579***
	(0.185)	(0.832)	(0.572)	(0.407)	(0.414)	(0.185)	(1.091)	(0.138)
Tonga	0.085	0.374	1.025**	0.837**	0.166	0.162	–1.529	0.376***
	(0.138)	(0.744)	(0.507)	(0.354)	(0.436)	(0.154)	(1.109)	(0.130)
Catholic	0.094	0.814*	1.522***	0.916***	–0.887***	0.687***	0.897	0.446***
	(0.119)	(0.473)	(0.412)	(0.253)	(0.244)	(0.115)	(0.704)	(0.117)
First-stage residual	0.007***	0.013	–0.032***	–0.030***	0.018***	–0.018***	–0.020	–0.006**
	(0.002)	(0.010)	(0.009)	(0.005)	(0.006)	(0.003)	(0.015)	(0.002)
Constant	–6.393***	–16.568***	–11.355***	–1.768***	0.890	1.568***	–18.151***	0.569
	(0.429)	(2.758)	(1.406)	(0.652)	(0.935)	(0.396)	(4.255)	(0.441)
Wald χ^2	1021***	156***	74***	178***	313***	308***	33***	244***
Pseudo-R^2	0.028	0.026	0.015	0.007	0.013	0.015	0.012	0.014
N	1,429	1,429	1,429	1,429	1,429	1,429	1,429	1,429

Note: We transformed food intake using an inverse hyperbola sine: $\ln[\{y + (y^2 + 1)^{0.5}\}]$, in order to retain zero-valued observations. Coefficient estimates from CF approach through Tobit estimator is shown, with robust/bootstrap standard errors clustered at household level in parentheses. Bemba and Protestant are the reference groups for Chewa and Tonga, and Catholic, respectively. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A4.14: Effects of using supermarkets on dietary intake: Robustness check

	Food intake (grams/day)							
	Meat	Dairy	Eggs	Fish	Pulses	Vegetables	Fruits	Sugar, Beverages
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Share of supermarket purchases (%)	0.377***	2.197***	0.282	1.010***	0.437	–0.208	–1.623***	1.945***
	(0.101)	(0.729)	(0.329)	(0.184)	(0.284)	(0.182)	(0.548)	(0.408)
Gender	3.475	–13.388	–21.157***	–2.156	3.216	9.839**	3.590	–20.101*
	(3.216)	(22.368)	(7.544)	(7.719)	(12.536)	(4.887)	(10.804)	(11.072)
Age	0.451	–5.399*	0.116	2.881**	1.159	2.490***	–0.627	3.707***
	(0.534)	(3.065)	(1.347)	(1.261)	(1.443)	(0.964)	(1.236)	(1.376)
Age-squared	–0.006	0.054	–0.008	–0.028*	–0.007	–0.026**	0.017	–0.047***
	(0.007)	(0.037)	(0.017)	(0.016)	(0.018)	(0.012)	(0.016)	(0.017)
Education	1.373**	–2.084	0.727	–3.363**	–1.589	–0.330	0.081	–0.806
	(0.580)	(3.884)	(1.688)	(1.345)	(1.770)	(1.019)	(1.683)	(1.843)
Household size	2.595***	–3.634	4.922***	–7.819***	0.355	2.472**	–4.661	4.901*
	(0.651)	(6.100)	(1.869)	(1.361)	(1.903)	(1.195)	(2.877)	(2.659)
Income	6.360***	17.021	3.269	–14.329***	–24.004***	–6.412***	19.781**	9.317**
	(1.058)	(11.157)	(3.373)	(1.960)	(3.095)	(1.802)	(8.044)	(4.594)
Chewa	–3.154	–56.362**	26.666***	7.956	58.433***	23.394***	2.167	33.414***
	(3.988)	(28.276)	(8.741)	(8.837)	(10.049)	(6.301)	(14.918)	(12.681)
Tonga	5.308*	14.488	17.262*	19.909***	8.453	10.486**	–30.990**	19.187*
	(2.998)	(26.435)	(9.943)	(7.100)	(9.787)	(4.392)	(13.837)	(11.313)
Catholic	2.067	25.262	26.336***	22.412***	–1.617	31.168***	1.166	21.264**
	(3.044)	(22.589)	(6.625)	(6.146)	(9.736)	(3.224)	(9.106)	(8.764)
First-stage residual	–0.041	–1.085	–0.674*	–1.392***	–0.485*	–0.208	1.479***	–1.612***
	(0.098)	(0.817)	(0.364)	(0.190)	(0.269)	(0.191)	(0.558)	(0.421)
Constant	–105.054***	–478.391***	–197.901***	7.438	32.439	26.364**	–297.588***	–113.513***
	(10.308)	(107.117)	(30.998)	(13.596)	(28.230)	(11.067)	(75.808)	(36.165)
Wald χ^2	987***	108***	53***	279***	127***	286***	34***	280***
Pseudo-R^2	0.015	0.014	0.009	0.006	0.009	0.007	0.014	0.006
N	1,429	1,429	1,429	1,429	1,429	1,429	1,429	1,429

Note: Coefficient estimates from CF approach through Tobit estimator is shown, with robust/bootstrap standard errors clustered at household level in parentheses. Bemba and Protestant are the reference groups for Chewa and Tonga, and Catholic, respectively. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

5 General conclusion and policy implications

5.1. Main findings

In many developing countries, food environments are changing rapidly, with modern food retailers – such as supermarkets and convenience stores – increasingly replacing or complementing traditional food retailers. Unlike traditional food markets and shops, modern retailers often sell a different range of products, at different prices and packaging sizes, and in different shopping atmospheres. Hence, these changing food environments, especially in urban areas, may influence consumers' food choices, dietary quality and affordability, and nutrition. Access and affordability of nutritious diets remain formidable challenges in many developing countries, where hunger and micronutrient malnutrition coexist with overweight and obesity.

Previous research suggested that the growth of modern retailers may contribute to less healthy diets, higher consumption of ultra-processed foods, and rising rates of overweight and obesity among adults. However, previous studies did not pay much attention to the question as to which socioeconomic groups use what type of retailers. Furthermore, the existing research on diet and nutrition effects focused primarily on the role of supermarkets, without accounting for the fact that most consumers obtain their foods from various types of retailers. Furthermore, very few studies analyzed effects of modern retailers on child nutrition, and those that did found mixed results (Umberger et al., 2015; Debela et al., 2020). One shortcoming of all existing studies is that they did not collect individual-level food-intake data. Individual-level dietary data are important to analyze effects of modern retailers on dietary quality (i.e., nutrient intake) and better understand the mechanisms behind the nutrition impacts. Finally, the role of supermarkets on the affordability of recommended nutritious diets was not analyzed in any of the existing studies.

We have addressed the highlighted research gaps by more explicitly analyzing the associations between household socioeconomic status, the use of different types of modern and traditional retailers, and dietary patterns. Using data collected in Lusaka, Zambia, we found that two-thirds of the households use modern and traditional retailers simultaneously. Among the modern retailers, supermarkets account for the largest share of the food purchases. On average, modern retailers account for 42% of the household food expenditures with notable differences between poor and rich households. Income is an important predictor of the use of modern retailers after controlling for other socioeconomic variables. The regression analysis has also shown that using modern retailers is associated with a higher consumption of ultra-processed foods and a lower consumption of unprocessed foods, also after controlling for income and other socioeconomic variables. This is in line with earlier research on the dietary effects of supermarkets (Asfaw, 2008; Rischke et al., 2015). However, unlike earlier studies, we also analyzed the role of other retailers and found that especially the use of traditional grocery stores and neighborhood kiosks is also associated with higher consumption of ultra-processed foods with high content of oils and fats, sugar, and salt. These results suggest that there is a general shift towards the consumption of ultra-processed foods that cannot be attributed to modern retailers alone.

We have also provided the first study that analyzes effects of modern retailers on diets and nutrition with individual-level food-intake and anthropometric data in a developing country. We had collected data from randomly selected households that use modern retailers at different intensities. Individual-level anthropometric and food-intake data were analyzed with control function regression models to estimate effects of modern retailers on body weight, height, dietary diversity, and nutrient intakes. We found that use of modern retailers is positively associated with overweight in adults, but not in children. This is consistent with earlier results for adult populations in Guatemala (Asfaw, 2008) and Kenya (Kimenju et al., 2015; Demmler et al., 2018). For children, we found a positive effect on body height. This is consistent with recent results for children in urban Kenya (Debela et al., 2020). Gains in child height point at likely improvements in dietary quality, even though – due to data limitations – this could not be analyzed in previous studies. Furthermore, use of modern retailers increases dietary diversity, as well as calorie, protein, and micronutrient intakes among both adults and children. Effects on protein and micronutrient intakes are channeled primarily through higher consumption of meat and dairy products.

Finally, using food price data and individual-level dietary data from Lusaka, Zambia and control function regression models to account for the likely endogeneity of supermarket purchases, we have analyzed the effects of using supermarkets on the affordability of nutritious diets and dietary quality. We found that on average, the cost of a recommended nutritious diet is US$1.22 per day, of which the largest share is the cost of starchy staples (68%), followed by fruits (11%), and meat, eggs, and fish (9%). This is consistent with other existing studies in low-income countries (Headey et al., 2019; Hirvonen et al., 2020).

However, on average, this diet is not affordable to 41% of low-income group. Furthermore, we found that nutrient-dense foods such as meat, fish, and dairy products are more expensive in supermarkets than in traditional food retailers; largely due to higher quality food products and safety standards. Nevertheless, after controlling for confounding factors such as income and education, we found that buying food in supermarkets increases dietary diversity and intake of nutritious diets, with varying effect sizes among demographic groups. The positive effect of supermarkets on dietary quality is channeled through higher intake of animal source foods such as meat, eggs, fish, and dairy products. This is a welcome finding as it may help to reduce micronutrient malnutrition.

5.2. Policy implications

Generally, we find that the growth of modern food retailers influences people's diets and nutrition, and the effects can be positive and negative. These results have a few important policy implications. The positive effects on child nutrition and dietary quality of both children and adults imply that further modernization of food environments should be promoted. However, due to higher quality food products and safety standards, modern retailers – such as supermarkets and convenience stores – offer higher prices for meat, fish, and dairy products than traditional retailers. Therefore, these results suggest a need to shift food policy from focusing on energy-dense foods to affordable healthy diets. Modern retailers could be one of the platforms to make nutritious foods more affordable especially among poor households. Lower prices could come from improvements in local production, higher efficiency in procurements, marketing and trade, and infrastructure developments especially cooling facilities and warehouses. This could help poor consumers to access sufficient quantities of nutritious foods especially animal source foods. Eventually, this could reduce health problems related to micronutrient malnutrition in many developing countries.

Other incentives to offer more healthy foods from modern retailers would be useful policy interventions. For instance, other policy options to consider are regulations related to the advertisement and promotion of healthy foods and their strategic placement within shops. In urban Zambia, the consumption of fresh fruits is particularly low; policies to increase fruit consumption levels would be useful. For instance, a few existing studies (e.g., Glanz et al., 2012; Payne and Niculescu, 2018) have showed that changes in the placement of fruits and vegetables can positively influence consumer choices in developed countries. Related regulations could also be relevant for countries in Africa.

On the negative side, the effect of increasing adult overweight and obesity associated with modern retailers is undesirable. This is largely due to higher consumption of ultra-processed foods with high contents of fats, added sugars and salts, but poor in micronutrients. Hence, regulatory policies that can help to make food environments healthier would be useful. Possible policy interventions include regulation of advertisement and promotional campaigns for unhealthy foods, regulation of health labels and portion/packaging sizes would be relevant in Zambia and other parts of Africa. Moreover, the results also suggest that modern retailers lead to higher intake of less healthy foods such as sugar, salt, and fat-rich foods in Zambia. Therefore, policy options including taxes on ultra-processed foods and beverages, and incentives to offer more healthy foods, among others (Development Initiative, 2018; Swinburn et al., 2019; Hawkes et al., 2020), would be useful to address different forms of malnutrition in many developing countries.

5.3. Limitation of the study

This study has some limitations that should be briefly discussed. First, in the first paper (chapter 2), we used processing level categories, which could not sufficiently classify the degree of healthfulness of a specific food. Second, in the second (chapter 3) and third (chapter 4) papers, we captured individual-level food-intake/dietary data only at one point in time. Hence, we may have systematically missed certain food items that are not consumed on a daily basis. Though more costly, conducting multiple 24-hour dietary recalls could account for the missed food items. Moreover, we could not capture possible seasonal effects of food consumption and nutrition. While seasonality in consumption is expected to be lower in urban than rural areas, it will likely still exist to some extent.

Third, our results are specific for Lusaka in Zambia and should not be generalized. However, it is likely that the diet and nutrition effects of modern retailers may be similar also in other parts of Africa; which are characterized by a rapid modernization of food environment and a high prevalence of different forms of malnutrition concurrently (Lu and Reardon, 2018; FAO et al., 2019). Nevertheless, further research is needed to better understand the diet and nutrition effects of changing food environments in different geographical and socioeconomic contexts. Finally, we used cross-sectional data in all three papers, which limits the strength of the identification strategy and the options to analyze dynamic effects.

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General appendix: Survey questionnaire

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

GlobalFood

CAN MODERN FOOD RETAILERS IMPROVE DIETS AND NUTRITION IN URBAN AFRICA? EMPIRICAL EVIDENCE FROM ZAMBIA

Household Consumption and Expenditure Survey for Urban Zambia 2018

The National Food and Nutrition Commission of Zambia and University of Goettingen in Germany are carrying out a research on modernization of the food retail environment and nutrition transition. We are currently doing a survey which aims to analyze whether the modernization of the food retail environment in urban Africa, with its growth of supermarkets and other modern food outlets, is influencing consumer food choices, dietary quality, and nutrition. Your participation in answering these questions is very much appreciated. Your responses will be COMPLETELY CONFIDENTIAL and will only be used for purpose of this study.

CONTENTS

PART 0: QUESTIONNAIRE IDENTIFIERS AND INTERVIEW BACKGROUND

01	**Household Identification Number (xxx)**:				
02	Respondent's name (**First Name, Last Name**):				
03	Mobile phone number:	+2	6	0	
04	Interviewer Identification Number (**Codes A**):				
05	Compound/section of the city (**Codes B**):				
06	Physical address of the homestead (**Plot/House Number**):				
07	Classification of the compound by income level (**Codes C**):				
08	Date of interview (**Day/Month/Year**):				
09.a	Time of interview (**Hours/Minutes**):	Start (**hh/mm**)			
09.b		End (**hh/mm**)			
10.a	GPS readings of homestead (**Decimal Degrees**):	Latitude			
10.b		Longitude			

Codes A
1. Brian Mpande
2. Eric Chikwalila
3. Eugine Kaango
4. Kelvin Sinyinza
5. Samba Manjolo
6. Mully Phiri

Codes B
1. Avodale
2. Chalala
3. Chelston
4. Chilenje
5. Gardens
6. Kawata
7. Kaunda square
8. Kalingalinga
9. Mtendere
10. Ngombe
11. North Mead
12. PHI
13. Woodlands

Codes C
1. High
2. Middle
3. Low

DECLARATION OF CONSENT FORM

We are researchers from the National Food and Nutrition Commission of Zambia and University of Goettingen in Germany. We are currently doing a survey which aims to analyze whether the modernization of the food retail environment in urban Africa, with its growth of supermarkets and other modern food outlets, is influencing consumer food choices, dietary quality, and nutrition. The knowledge can help to better understand the wider implications of the observed transformation of food systems and to guide policies aimed at reducing malnutrition. The survey includes questions about the household generally – economic, social, and demographic data (employment, income, food consumption, education, age etc.), and questions specific to some individuals i.e., food consumption within your household. We will also take body size measurements – height, weight, and waist circumference – of adults and children. Your participation in answering these questions is very much appreciated. Your responses will be **COMPLETELY CONFIDENTIAL** and will only be used for purpose of this study.

Do you have any questions about the survey or what I have said? Do you agree to participate in the survey, including the interviews and the anthropometric measurements of adults and children? If yes, let the potential respondent sign this form, even on behalf of other members of household especially children. May we begin the interview then?

I hereby confirm that I have adequately received information about the study and I understood the purpose of the study and procedure of measurements that will be taken in the survey: "**Can modern food retailers improve diets and nutrition in urban Africa? Empirical evidence from Zambia**".

Yes ☐ No ☐

I had enough opportunity to ask questions about the study and all my questions have been answered in a satisfactory way.

Yes ☐ No ☐

I agree that my body size – height, weight, and waist circumference – will be measured and that all my personal data will be treated confidentially. The data will be used for the purpose of this research study only. I agree that my personal data are stored and handled in accordance with the Lower Saxony and Federal German data privacy act.

Yes ☐ No ☐

I feel completely informed and agree to the participation in the study "**Can modern food retailers improve diets and nutrition in urban Africa? Empirical evidence from Zambia**".

Compound/Section of the city:……………..........................…… **Date**:…........…/…........…/2018

(1)	____________________ Name of the participant	____________________ Signature of participant	______________ Family Member_ID
(2)	.... Name of the interviewer	.... Signature of interviewer	.... Interviewer_ID

PART 1: HOUSEHOLD COMPOSITION AND CHARACTERISTICS

Notes: Total household size is the filter in this section

Household size (= **No. of individuals in column 3**)	**FAMILY MEMBER ID (FM_ID)**	Name (**First Name, Last Name**) of household member (**start with head of the household/respondent**)	Gender (**Codes A**)	Relation to household head (**Codes B**)	Age * (**Years, months**)	Education (**schooling years**)	Marital status (**Codes C**)	Religion (**Codes D**)	Ethnicity (**Codes E**)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	01								
	02								
	03								
	04								
	05								
	06								
	07								
	08								
	09								
	10								
	11								
	12								
	13								
	14								
	15								

Notes: * For the under 5 year olds, ask month, day and year born and then compute the age yourself (in one decimal places).

Codes A	Codes B	Codes C	Codes D	Codes E	Codes E
0. Female 1. Male	1. Household head 2. Spouse/Partner 3. Son/Daughter 4. Brother/Sister 5. Brother/Sister in-law 6. Parent (Mother/Father) 7. Grand children 8. Grand parents 9. Step children 10. House maid/Garden boy 11. Other relative 12. Non-relative	1. Married living with Spouse/Husband 2. Married but Spouse/Husband away 3. Divorced/Separated 4. Widow/Widower 5. Single 6. Too young to be married	1. Protestant 2. Catholic 3. SDA 4. Muslim 5. Jewish 6. Traditionalist 7. Others 8. No religion	1. Bemba 2. Chewa 3. Goba 4. Kaonde 5. Lala 6. Lozi 7. Lunda 8. Luvale 9. Mbunda 10. Ngoni 11. Nsenga	12. Tonga 13. Tumbuka 14. Others

PART 2: HOUSEHOLD FOOD CONSUMPTION (7 DAYS RECALL) (1/5)

Here, wife and/or the person involved in purchases should be the principal respondent/s
Notes: Please include all foods consumed by all household members.

FOOD ITEM_ID	**FOOD ITEM**	During the **past 7-days**, did your household consume this food item? **(1=Yes, 0= No)** **(if No skip to next food item)**	**Food consumption expenditure in the past 7-days** How much in total was consumed by the HH during last 7 days? **(Qty)**	Units **(Codes A)**	Average price per unit **(ZMK)**	Total cost of food item **(ZMK)**	Where exactly did your household purchase or source this food item? **(Codes B)**	Which month is this food item cheapest/ plenty? **(Codes C)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	**Cereals**							
01	Maize (Dry)							
02	Maize (Flour)							
03	Maize (Green)							
04	Rice (White)							
05	Rice (Brown)							
06	Wheat (Flour)							
07	Sorghum							
08	Millet							
09	Porridge mix							
10	Cornflakes							
11	Oats							
12	Bread (White)							
13	Bread (Brown)							
14	Wheat buns (White)							
15	Wheat buns (Brown)							
16	Pasta (Spaghetti)							
17	Other cereals							
B	**Roots and Tubers**							
18	Irish potatoes							
19	Sweet potatoes							
20	Cassava (Tuber)							
21	Cassava (Flour)							
22	Banana/Plantains (Boiled)							
23	Pumpkins							
24	Yams							
25	Other roots and tubers (Specify)							
C	**Legumes (1/2)**							
26	Beans dry							
27	Beans fresh							
28	Groundnut dry							
29	Groundnut fresh							

Codes A
1. Teaspoon
2. Tablespoon
3. Slice of bread
4. Piece
5. Coffee/Tea cup
6. Cup (Standard)
7. Milliliter
8. Liter
9. Gram

Codes A
10. Kilogram
11. Number
12. Lump of Nshima
13. Regular (Small) Chips
14. Pizza box (Small)
15. Cone (Ice cream)
16. Loaf of Bread
17. Packet (Sugar..etc)
18. Heap
19. Bunch
20. Meda
21. Bp
22. Bottle/can
23. Crate

Codes B
1. Superstore/Hyper store
2. Supermarket
3. Convenience store
4. Grocery store
5. Wet (Soweto) market
6. Traditional/Compound market
7. Neighborhood kiosks
8. Roadside market
9. Weekly market
10. Fast food restaurant
11. Casual/Ordinary restaurant
12. Own production
13. Gift/Free food
14. Others, specify……

Codes C
0. Almost the same in a year
1. January
2. February
3. March
4. April
5. May
6. June
7. July
8. August
9. September
10. October
11. November
12. December
13. Not applicable

PART 2: HOUSEHOLD FOOD CONSUMPTION (7 DAYS RECALL) (2/5)

Here, wife and/or the person involved in purchases should be the principal respondent/s
Notes: Please include all foods consumed by all household members.

FOOD ITEM_ID	FOOD ITEM	During the past 7-days, did your household consume this food item? (1=Yes, 0= No) (if No skip to next food item)	Food consumption expenditure in the past 7-days					
			How much in total was consumed by the HH during last 7 days? (Qty)	Units (Codes A)	Average price per unit (ZMK)	Total cost of food item (ZMK)	Where exactly did your household purchase or source this food item? (Codes B)	Which month is this food item cheapest/ plenty? (Codes C)
1	2	3	4	5	6	7	8	9
C	**Legumes (2/2)**							
30	Cowpea dry grain							
31	Cowpea fresh grain							
32	Greengram (*Mphodza)*							
33	Pigeonpea dry							
34	Pigeonpea fresh							
35	Soybean							
36	Velvet beans (Nzama)							
37	Other legumes (Specify)							
D	**Meat and Fish**							
38	Beef							
39	Sausage-(Beef)							
40	Chicken							
41	Sausage-(Chicken)							
42	Goat meat							
43	Pig meat							
44	Sausage-(Pork)							
45	Soymeat							
46	Sheep meat							
47	Turkey							
48	Ducks							
49	Bush/game meat							
50	Fish dried (Utaka)							
51	Fish (Fresh)							
52	Fish (Frozen)							
53	Tinned fish							
E	**Dairy products and Eggs**							
54	Eggs							
55	Milk							
56	Butter							
57	Cheese							
58	Yoghurt							
59	Other dairy products							

Codes A	Codes A	Codes B	Codes C
1. Teaspoon 2. Tablespoon 3. Slice of bread 4. Piece 5. Coffee/Tea cup 6. Cup (Standard) 7. Milliliter 8. Liter 9. Gram	10. Kilogram 11. Number 12. Lump of Nshima 13. Regular (Small) Chips 14. Pizza box (Small) 15. Cone (Ice cream) 16. Loaf of Bread 17. Packet (Sugar,...etc) 18. Heap 19. Bunch 20. Meda 21. Bp 22. Bottle/can 23. Crate	1. Superstore/Hyper store 2. Supermarket 3. Convenience store 4. Grocery store 5. Wet (Soweto) market 6. Traditional/Compound market 7. Neighborhood kiosks 8. Roadside market 9. Weekly market 10. Fast food restaurant 11. Casual/Ordinary restaurant 12. Own production 13. Gift/Free food 14. Others, specify……	0. Almost the same in a year 1. January 2. February 3. March 4. April 5. May 6. June 7. July 8. August 9. September 10. October 11. November 12. December 13. Not applicable

PART 2: HOUSEHOLD FOOD CONSUMPTION (7 DAYS RECALL) (3/5)

Here, wife and/or the person involved in purchases should be the principal respondent/s
Notes: Please include all foods consumed by all household members.

FOOD ITEM_ID	**FOOD ITEM**	During the **past 7-days**, did your household consume this food item? **(1=Yes, 0= No) (if No skip to next food item)**	**Food consumption expenditure in the past 7-days**					
			How much in total was consumed by the HH during last 7 days? **(Qty)**	Units **(Codes A)**	Average price per unit **(ZMK)**	Total cost of food item **(ZMK)**	Where exactly did your household purchase or source this food item? **(Codes B)**	Which month is this food item cheapest/ plenty? **(Codes C)**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
F	**Vegetables and Mushroom**							
60	Frozen vegetables							
61	Tinned vegetables							
62	Tomatoes							
63	Tomatoes source							
64	Onions							
65	Rape/Mustard/Chinese							
66	Cabbage							
67	Lettuce							
68	Bean leaves							
69	Cassava leaves							
70	Cowpea leaves							
71	Pumpkin leaves							
72	Blackjack							
73	Okra							
74	Carrot							
75	Pepper							
76	Garlic							
77	Egg plant							
78	Cucumber							
79	Mixed salad							
80	Other vegetables (Specify)							
81	Mushroom (Cultivated)							
82	Mushroom (Wild)							
G	**Fruits (1/2)**							
83	Mixed fruits							
84	Tinned fruits							
85	Frozen fruits							
86	Apples							
87	Avocadoes							
88	Banana (Ripe)							
89	Guavas							

Codes A	**Codes A**	**Codes B**	**Codes C**
1. Teaspoon	10. Kilogram	1. Superstore/Hyper store	0. Almost the same in a year
2. Tablespoon	11. Number	2. Supermarket	1. January
3. Slice of bread	12. Lump of Nshima	3. Convenience store	2. February
4. Piece	13. Regular (Small) Chips	4. Grocery store	3. March
5. Coffee/Tea cup	14. Pizza box (Small)	5. Wet (Soweto) market	4. April
6. Cup (Standard)	15. Cone (Ice cream)	6. Traditional/Compound market	5. May
7. Milliliter	16. Loaf of Bread	7. Neighborhood kiosks	6. June
8. Liter	17. Packet (Sugar,…etc)	8. Roadside market	7. July
9. Gram	18. Heap	9. Weekly market	8. August
	19. Bunch	10. Fast food restaurant	9. September
	20. Meda	11. Casual/Ordinary restaurant	10. October
	21. Bp	12. Own production	11. November
	22. Bottle/can	13. Gift/Free food	12. December
	23. Crate	14. Others, specify……	13. Not applicable

PART 2: HOUSEHOLD FOOD CONSUMPTION (7 DAYS RECALL) (4/5)

Here, wife and/or the person involved in purchases should be the principal respondent/s

Notes: Please include all foods consumed by all household members.

FOOD ITEM_ID	FOOD ITEM	During the past 7-days, did your household consume this food item? (1=Yes, 0= No) (if No skip to next food item)	Food consumption expenditure in the past 7-days					
			How much in total was consumed by the HH during last 7 days? (Qty)	Units (Codes A)	Average price per unit (ZMK)	Total cost of food item (ZMK)	Where exactly did your household purchase or source this food item? (Codes B)	Which month is this food item cheapest/ plenty? (Codes C)
1	2	3	4	5	6	7	8	9
G	**Fruits (2/2)**							
90	Oranges/Tangerines							
91	Pawpaws							
92	Pineapples							
93	Mangoes							
94	Watermelons							
95	Other fruits (Specify)							
H	**Food away from home (take/eat aways etc)**							
96	Chips							
97	Nshima							
98	Rice							
99	Prepared meat							
100	Prepared fish							
101	Prepared vegetables							
102	Mandazi							
103	Samosa							
104	Prepared pasta							
105	Prepared sausage							
106	Pizza (Fresh/Frozen)							
I	**Partially prepared or ready food (PPF)**							
107	Crips							
108	Puffed salted corn chips							
109	Salted nuts							
110	Popcorn							
111	Other ready meals							
112	Instant noodles							
113	Other PPF (Specify)							
J	**Indigenous food (IF)**							
114	Caterpillars/ants							
115	Masuku							
116	Masau							
117	Other IFs (Specify)							

Codes A	Codes A	Codes B	Codes C
1. Teaspoon	10. Kilogram	1. Superstore/Hyper store	0. Almost the same in a year
2. Tablespoon	11. Number	2. Supermarket	1. January
3. Slice of bread	12. Lump of Nshima	3. Convenience store	2. February
4. Piece	13. Regular (Small) Chips	4. Grocery store	3. March
5. Coffee/Tea cup	14. Pizza box (Small)	5. Wet (Soweto) market	4. April
6. Cup (Standard)	15. Cone (Ice cream)	6. Traditional/Compound market	5. May
7. Milliliter	16. Loaf of Bread	7. Neighborhood kiosks	6. June
8. Liter	17. Packet (Sugar,...etc)	8. Roadside market	7. July
9. Gram	18. Heap	9. Weekly market	8. August
	19. Bunch	10. Fast food restaurant	9. September
	20. Meda	11. Casual/Ordinary restaurant	10. October
	21. Bp	12. Own production	11. November
	22. Bottle/can	13. Gift/Free food	12. December
	23. Crate	14. Others, specify……	13. Not applicable

PART 2: HOUSEHOLD FOOD CONSUMPTION (7 DAYS RECALL) (5/5)

Here, wife and/or the person involved in purchases should be the principal respondent/s
Notes: Please include all foods consumed by all household members.

FOOD ITEM_ID	FOOD ITEM	During the past 7-days, did your household consume this food item? (1=Yes, 0= No) (if No skip to next food item)	Food consumption expenditure in the past 7-days					
			How much in total was consumed by the HH during last 7 days? (Qty)	Units (Codes A)	Average price per unit (ZMK)	Total cost of food item (ZMK)	Where exactly did your household purchase or source this food item? (Codes B)	Which month is this food item cheapest/ plenty? (Codes C)
1	2	3	4	5	6	7	8	9
K	**Fats, Oils, Sweeteners, Snacks and Others**							
118	Cooking oil/fat							
119	Groundnut (Flour)							
120	Coconut oil							
121	Margarine/Butter							
122	Jam							
123	Salt							
124	Sugar							
125	Biscuits/Cookies							
126	Cake							
127	Chocolate							
128	Curry							
129	Ginger							
130	Cashew nuts							
131	Macadamia nuts							
132	Popcorn							
133	Sugarcane							
L	**Beverages and Drinks**							
134	Tea (Leaves)							
135	Coffee (Powder)							
136	Ricoffy (Powder)							
137	Soft drinks (Cococola, Fanta,….etc)							
138	Juices (Apple, Orange,…..etc)							
139	Bottled/Clear beer							
140	Opaque beer (*Chibuku*)							
141	Local beer							
142	Wine							
143	Drinking water							

Codes A	Codes A	Codes B	Codes C
1. Teaspoon	10. Kilogram	1. Superstore/Hyper store	0. Almost the same in a year
2. Tablespoon	11. Number	2. Supermarket	1. January
3. Slice of bread	12. Lump of Nshima	3. Convenience store	2. February
4. Piece	13. Regular (Small) Chips	4. Grocery store	3. March
5. Coffee/Tea cup	14. Pizza box (Small)	5. Wet (Soweto) market	4. April
6. Cup (Standard)	15. Cone (Ice cream)	6. Traditional/Compound market	5. May
7. Milliliter	16. Loaf of Bread	7. Neighborhood kiosks	6. June
8. Liter	17. Packet (Sugar,…etc)	8. Roadside market	7. July
9. Gram	18. Heap	9. Weekly market	8. August
	19. Bunch	10. Fast food restaurant	9. September
	20. Meda	11. Casual/Ordinary restaurant	10. October
	21. Bp	12. Own production	11. November
	22. Bottle/can	13. Gift/Free food	12. December
	23. Crate	14. Others, specify……	13. Not applicable

PART 3: ACCESS TO FOOD OUTLETS, HEALTH FACILTIES AND SHOPPING BEHAVIOUR

FACILITY_ID	**FACILITY** Did you use this facility during the last 30 days? **(1=Yes, 0= No)** **(if No skip to next facility)**	Distance (km)	What is the **common** mode of transport you use to the facility? **(Codes A)**	Travelling time to this facility (one way) **(min)**	Travelling cost to this facility (one way) **(ZMK)**	Is the most food bought on the way to home from work? **(1=Yes, 0=No)**	How many times did you buy food from this outlet during the last 30 days?	What are the most important reasons you prefer shopping/eating at this outlet? **(Codes B)**	How do you learn about new/ promotion on food products? **(Codes C)**	Which food products would you consider are **cheapest** from this food outlet? **(Codes D)**	For how long have you been using this facility? **(Years)**	Number of facilities in or closer to the compound
1	2	3	4	5	6	7	8	9	10	11	12	13
A	**Food Outlet**											
301	Superstore/Hyper store											
302	Supermarket											
303	Convenience store											
304	Grocery store											
305	Wet (Soweto) market											
306	Traditional/Compound market											
307	Neighborhood kiosks											
308	Roadside market											
309	Weekly market											
310	Fast food restaurant											
311	Casual/ordinary restaurant											
B	**Health Facility**											
312	Nearest clinic											
313	Health center/Central hospital											

3.14. What kind of information on food labels influences you to buy food products (**Codes E**)? **3.15**. Which shopping mall do you frequently use (**Codes F**)? **3.16**. How often have you used this shopping mall in the last 30 days?

Codes A
1. Foot
2. Bicycle
3. Private car
4. Public transport
5. Motorcycle
6. Others, specify

Codes B
1. Lower prices
2. Variety of food products
3. Availability of food products
4. Offer high quality food products
5. Specialty of food products
6. Closer to home
7. Promotions/discounts
8. Foods products under one roof
9. Shopping atmosphere
10. Social status
11. Different packaging sizes
12. Variety of non-food products
13. Time saving
14. Higher perceived food safety
15. Self service
16. Long opening hours
17. Customer service
18. Others, specify

Codes C
1. TV adverts
2. Radio adverts
3. Newspaper
4. Neighbors
5. Friends
6. Food retailer adverts
7. Medical adviser
8. Monthly promotions
9. Special offers

Codes D
1. Cereals
2. Roots & tubers
3. Legumes
4. Meat & Eggs
5. Milk products
6. Fruits
7. Vegetables
8. Bakery products
9. Oil products

Codes E
1. Expiry date
2. Serving size
3. Calories/Energy
4. Total fat
5. Saturated fat
6. Carbohydrates
7. Added sugar
8. Fiber
9. Protein
10. Vitamins
11. Calcium
12. Iron
13. ZABS label
14. Brand name
15. List of ingredients
16. Date of manufacture

Codes F
1. Arcades
2. Cairo
3. Kabulonga
4. Chawama
5. Choppies complex
6. Cosmopolitan
7. Cross roads
8. Down Town
9. East Park
10. Embassy
11. Garden city
12. Levy junction
13. Makeni
14. Mama Betty
15. Manda Hill
16. Matero
17. PHI
18. Changoz
19. Chilenje
20. SOS
21. Twin Palm
22. Waterfalls
23. Woodlands

PART 4: NON-FOOD EXPENDITURE (12 MONTHS RECALL)

Here, wife and/or the person involved in purchases should be the principal respondent/s

Notes: Please include all non-food expenditure of the whole household (all members) and not only respondent.

ITEM_ID	EXPENSE ITEM OR SERVICE	During the **past 12-months** **(Apr 17-Apr 18)**, did your household spend on this item or service? **(1=Yes, 0= No)** **(if No skip to next item)**	How much did your household spend on this item or service during the **last 12- months** (**Apr 17-Apr 18**) **(ZMK)**
1	**2**	**3**	**4**
401	Soap/Washing products		
402	Personal care (Toothpaste, Nail,………etc)		
403	House rent		
404	Electricity bills		
405	Candles		
406	Match boxes		
407	Fuel wood		
408	Charcoal		
409	Water bills		
410	Grain milling		
411	School fees		
412	School books and supplies		
413	School uniforms		
414	Newspapers, magazines, books,….etc		
415	Fuel and engine oils for cars		
416	Car/Motorcycle insurance		
417	Public transport		
418	Other transport and travel expenses		
419	Air time (Mobile Phones, Landlines)		
420	DSTV/Gotv subscription		
421	Clothing		
422	Shoes		
423	Blankets		
424	Bed sheets		
425	Mosquito net		
426	Health care (Medical Care, Treatment, Insurance)		
427	Funeral payments (Costs, Policy, Life Insurance,….etc)		
428	Church contributions		
429	Dowry		
430	Contributions to associations/Cooperatives/Club		
431	Ceremony and other social activities		
432	Guard/security		
433	Kitchen utensils		
434	Furniture (Tables, Chairs, Beds,… etc)		
435	Remittances paid		
436	Debt payments		
437	Home maintenance		
438	Payment for city rent in cash		
439	Purchase of agricultural inputs (Fertilizer, Seed,……etc)		
440	Purchase of bicycle, motorcycle,……etc		
441	Purchase of cars		
442	House building/construction		
443	Other, specify..............		

PART 5: INCOME SOURCES, TRANSFERS AND HOUSEHOLD INCOME

Notes: Please include all income sources including remittance for all members of the household if applicable and not only respondent.

FAMILY MEMBER ID (FM_ID)	Name (**First Name, Last Name**) of household member (**start with head of the household/respondent**)	Main occupation (**Codes A**)	How many months has member working in the last **12-months** (**Apr 17-Apr 18**) (**No/12**)	Average monthly income (**ZMK/Month**)	Annual income (**ZMK**)
1	**2**	**3**	**4**	**5**	**6=4x5**
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					

Codes A		
0. None	4. Farming (Crop + Livestock)	8. Non-school child
1. White- collar worker (Office job)	5. Renting out houses	9. Household chores.
2. Blue-collar worker (Manual labor)	6. Casual laborer	10. Pension fund.
3. Self-employed	7. School/College child	11. Others, specify……..

5.7 Did your household receive money from relatives in the past six months (**since October, 2017**)? (**1=Yes, 0= No**)

5.8 If yes in 5.7, how many months did your household receive the money in past six months (**since October, 2017**)? (**No/6**) ☐

5.9 On average, how much did your household receive per month? ______________ (**ZMK/month**)

5.10 What was the annual income from transfers or cash in kind? _____________ (**ZMK**)

PART 6: HOUSEHOLD ASSETS

Notes: Respondents should exclude permanently broken items

ASSET_ID	ASSET	Does your household own this asset? **(1=Yes, 0= No (if No skip to next item))**	What is the condition of this asset? **(Codes A)**	Number of assets (if applicable)	If you would sell [….] how much would you receive from the sale? (**ZMK**) (if more than one item reported in column 4 **take average price**)	Value of the asset **(ZMK)**
1	**2**	**3**	**4**	**5**	**6**	**7=5x6**
601	TV (Plasma, LED,…. etc)					
602	Decoder, DVD/VCR player					
603	Home theater					
604	Satellite dish					
605	Ordinary radio					
606	Mobile phone					
607	Laptop/Computer/Tablet					
608	Iron					
609	Cooker					
610	Electric/Gas stove					
611	Charcoal stove					
612	Microwave					
613	Electronic kettle					
614	Refrigerator					
615	Washing machine					
616	Fan					
617	Air conditioner					
618	Bed					
619	Mattress					
620	Chair					
621	Sofa set					
622	Bicycle					
623	Motorcycle					
624	Car, Truck					
625	Working desk					
626	Wall clock					
627	Solar panel					
628	Battery					
629	Generator					
630	Solar lump					
631	Maize mill					
632	Water pump					
633	Water storage tank					
634	Axe					
635	Hoe					
636	Sprayer					
637	Shovel					
638	Wheelbarrow					
639	Tractor					
640	Modern house (Tile, Cement, Iron Sheet)					
641	Standard house					
642						

Codes A
1. New
2. Used
3. Heavily used
4. Partially broken
5. Completely broken

PART 7: INDIVIDUAL FOOD CONSUMPTION (24-HOUR DIETARY RECALL) (1/3)

Notes: Interview at least <u>FOUR</u> individuals from the household including at least <u>one child</u> (<10 years), <u>one adolescent</u> (10-18 years), and <u>two adults</u> (Male and Female) (>18 years) if applicable. For children ask their caretakers or parent (i.e., mothers).

USE HARD COPY ON LISTING OF FAMILY MEMBER IDs AND FOOD DIARY BEFORE INTERVIEW IN THIS SECTION

Probe for all food items consumed in the last 24 hours including food away from home, free food and food prepared at home. If the respondent had mixed dishes ask for ingredients that were used to prepare the food.

Family Member ID **(from <u>PART 1, Column 2</u>):** ☐ **Filter: How many (count form the hard copy) food items were consumed by this individual?** ☐

FOOD ITEM_ID	During the **<u>past 24-hours</u>**, did you consume this **<u>FOOD ITEM</u>**? **(1=Yes, 0= No (if No skip to next food item))**	Occasion **(Codes A)**	Where was the food consumed? **(Codes B)**	Ingredients	**Food consumed in the last 24 hours**				
					Quantity of ingredients used if applicable		Amount of food consumed		Food preparation method **(Codes D)**
					(Qty)	Units **(Codes C)**	**(Qty)**	Units **(Codes C)**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	**Beverages, Sweeteners, Snacks**								
701	Tea/Coffee								
702	Sugar								
703	Biscuits/Cookies								
704	Chocolate								
705	Ice cream								
706	Soft drinks (Cocacola,...etc)								
707	Juice (Apple, Orange,…etc)								
B	**Dairy products**								
708	Milk								
709	Cheese								
710	Yoghurt								
C	**Cereal products**								
711	Bread (White)								
712	Bread (Brown)								
713	Pasta (Spaghetti)								
714	Wheat buns								
D	**Mixed foods/Ingredients**								
715	Cerelac								
716	Chips/Crips								
717	Cooking oil/fats								
718	Sandwich/Burger								
719	Mandazi/Scones								
720	Margarine/Butter								

Codes A	**Codes B**	**Codes C**	**Codes C**	**Codes D**
1. Breakfast	1. Home-made	0. Not applicable	12. Lump (Nsima)	0. Raw
2. Brunch	2. Fast food restaurant	1. Teaspoon	13. Small chips	1. Boiled
3. Lunch	3. Ordinary restaurant	2. Tablespoon	14. Pizza box	2. Boiled with groundnut
4. Supper	4. Superstore	3. Slice (Bread)	15. Cone (Ice cream)	3. Boiled and fried
5. Late supper	5. Supermarket	4. Piece	16. Loaf	4. Shallow fried
6. Snack	6. Ordinary food store	5. Coffee/Tea cup	17. Packet	5. Dip fried
	7. Neighborhood kiosks	6. Cup (Standard)	18. Heap	6. Roasted
	8. Daycare/School	7. Milliliter	19. Bunch	7. Dried
	9. Friend/Relative	8. Liter	20. Meda	8. Steamed
	10. Party/Social event	9. Gram	21. Bp	9. Others, specify
	11. Others	10. Kilogram	22. Bottle/Can	
		11. Number		

PART 7: INDIVIDUAL FOOD CONSUMPTION (24-HOUR DIETARY RECALL) (2/3)

FOOD ITEM_ID	During the **past 24-hours**, did you consume this **FOOD ITEM**? **(1=Yes, 0= No (if No skip to next food item))**	Occasion **(Codes A)**	Where was the food consumed? **(Codes B)**	Ingredients	**Food consumed in the last 24 hours**				
					Quantity of ingredients used if applicable		Amount of food consumed		Food preparation method **(Codes D)**
					(Qty)	Units **(Codes C)**	**(Qty)**	Units **(Codes C)**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
721	Jam								
722	Pizza (Fresh/Frozen)								
723	Porridge								
724	Samosa								
725	Instant noodles								
E	**Roots and Tubers**								
726	Cassava								
727	Pumpkins								
728	Irish potatoes								
729	Sweet potatoes (SP)								
730	Orange fleshed (SP)								
731	Yams								
F	**Cereal(s) products**								
732	Maize green								
733	Nshima (Maize Mgaiwa)								
734	Nshima (Maize Ufa Oyera)								
735	Nshima (Cassava Flour)								
736	Rice								
737	Sorghum								
G	**Legumes**								
738	Common beans								
739	Cowpeas dry grain								
740	Groundnut dry/flour								
741	Pigeon peas dry grain								
742	Soybean								
743	Velvet beans (Nzama)								
H	**Meat and Fish**								
744	Beef								
745	Chicken								
746	Ducks								
747	Sausage-Beef								
748	Sausage-Chicken								
749	Sausage-Pork								
750	Eggs								
751	Fish								
752	Goat meat								
753	Pig meat								
754	Sheep meat								

Codes A	**Codes B**	**Codes C**	**Codes C**	**Codes D**
1. Breakfast	1. Home-made	0. Not applicable	12. Lump (Nsima)	0. Raw
2. Brunch	2. Fast food restaurant	1. Teaspoon	13. Small chips	1. Boiled
3. Lunch	3. Ordinary restaurant	2. Tablespoon	14. Pizza box	2. Boiled with groundnut
4. Supper	4. Superstore	3. Slice (Bread)	15. Cone (Ice cream)	3. Boiled and fried
5. Late supper	5. Supermarket	4. Piece	16. Loaf	4. Shallow fried
6. Snack	6. Ordinary food store	5. Coffee/Tea cup	17. Packet	5. Dip fried
	7. Neighborhood kiosks	6. Cup (Standard)	18. Heap	6. Roasted
	8. Daycare/School	7. Milliliter	19. Bunch	7. Dried
	9. Friend/Relative	8. Liter	20. Meda	8. Steamed
	10. Party/Social event	9. Gram	21. Bp	9. Others, specify
	11. Others	10. Kilogram	22. Bottle/Can	
		11. Number		

PART 7: INDIVIDUAL FOOD CONSUMPTION (24-HOUR DIETARY RECALL) (3/3)

FOOD ITEM_ID	During the **past 24-hours**, did you consume this **FOOD ITEM**? **(1=Yes, 0= No (if No skip to next food item))**	Occasion **(Codes A)**	Where was the food consumed? **(Codes B)**	Ingredients	**Food consumed in the last 24 hours**				
					Quantity of ingredients used if applicable		Amount of food consumed		Food preparation method **(Codes D)**
					(Qty)	Units **(Codes C)**	**(Qty)**	Units **(Codes C)**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
I	**Fruits**								
755	Mixed fruits								
756	Tinned fruits								
757	Frozen fruits								
758	Apples								
759	Avocadoes								
760	Bananas (Ripe)								
761	Mangoes								
762	Pawpaws								
763	Pineapples								
764	Oranges/Tangerines								
765	Water melons								
J	**Vegetables and Mushroom**								
766	Mixed salad								
767	Tinned vegetables								
768	Frozen vegetables								
769	Baobab leaves								
770	Bean leaves								
771	Black jack leaves								
772	Cabbage								
773	Cassava leaves								
774	Cowpeas leaves								
775	Lettuce								
776	Moringa leaves								
777	Pumpkin leaves								
778	Rape/Mustard								
779	Sweet potato leaves								
780	Okra								
781	Tomatoes								
782	Onions								
783	Carrots								
784	Cucumber								
785	Green pepper								
786	Green beans/Peas								
787	Mushroom								
K	**Others**								
788	Caterpillars/Ants								

Codes A	**Codes B**	**Codes C**	**Codes C**	**Codes D**
1. Breakfast	1. Home-made	0. Not applicable	12. Lump (Nsima)	0. Raw
2. Brunch	2. Fast food restaurant	1. Teaspoon	13. Small chips	1. Boiled
3. Lunch	3. Ordinary restaurant	2. Tablespoon	14. Pizza box	2. Boiled with groundnut
4. Supper	4. Superstore	3. Slice (Bread)	15. Cone (Ice cream)	3. Boiled and fried
5. Late supper	5. Supermarket	4. Piece	16. Loaf	4. Shallow fried
6. Snack	6. Ordinary food store	5. Coffee/Tea cup	17. Packet	5. Dip fried
	7. Neighborhood kiosks	6. Cup (Standard)	18. Heap	6. Roasted
	8. Daycare/School	7. Milliliter	19. Bunch	7. Dried
	9. Friend/Relative	8. Liter	20. Meda	8. Steamed
	10. Party/Social event	9. Gram	21. Bp	9. Others, specify
	11. Others	10. Kilogram	22. Bottle/Can	
		11. Number		

PART 8: HEALTH, HEALTH KNOWLEDGE AND HOUSEHOLD SHOCKS

Here, wife and/or the person involved in purchases should be the principal respondent/s

Notes: Interview at least FOUR individuals SELECTED FOR PART 7.

FAMILY CODE (FM_ID) FROM PART 1, COLUMN 2	Name of household member	Source of drinking water (Codes A)	Distance to water source (mins)	Type of toilet used (Codes B)	Do you smoke? (1=Yes, 0= No)	Has anyone suffered from chronic illnesses? (Codes C)	Has anyone suffered from non-chronic illnesses in the last six months (since Oct 17)? (Codes D)	Annual average treatment cost for (ZMK)		Has your HH experience any major household shock in last 12-months (Apr 17-Apr 18)?		How would you rate the overall healthiness of the diets consumed last 30 days? (Codes F)	How would you rate the your knowledge about nutrition and health? (Codes F)	Are you on special diets due to illness or other reasons? (Codes G)
								Chronic	Non- chronic	Type of shock (Codes E)	Average economic loss to the household (ZMK)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
01														
02														
03														
04														
05														
06														
07														

Codes A
1. Piped/Tap
2. Bottled water
3. Deep well protected
4. Deep well uncovered
5. Stream
6. Borehole
7. Others, specify

Codes B
1. Flash toilet private
2. Flash toilet shared
3. Pit latrine private
4. Pit latrine shared
5. Other, specify…….

Codes C
0. No
1. Diabetes
2. Hypertension
3. Heart disease
4. Kwashiorkor
5. Cancel
6. Ananemia
7. Goiter
8. Bad teeth
9. Blindness
10. Ricketts
11. Others, specify

Codes D
0. No
1. Fever, Malaria
2. Diarrhea
3. Stomach ache
4. Vomiting
5. Flu/Cold
6. Headache
7. Skin problems
8. Eye problem
9. Bad teeth (Ache)
10.Tuberculosis
11. HIV/AIDS
12. Pneumonia
13. Typhoid
14. Intestinal worms
15. Others, specify…

Codes E
0. No
1. Death of family member
2. Death of close relative
3. Theft
4. Job loss
5. Acute illness
6. Fire
7. Natural calamities
8. House damage
9. Conflict

Codes F
1. Very good
2. Good
3. Normal
4. A little poor
5. Very poor
6. Not sure

Codes G
0. No
1. Food with less sugar or salt
2. Food with less oil and fats
3. Food rich in Vitamin A
4. Food rich in Iron
5. A lot of fruits and vegetables
6. Child diet
7. Others, specify…….

PART 9: ANTHROPOMETRIC MEASUREMENTS, PHYSICAL AND LEISURE ACTIVITIES

Here, caretakers and/or parent (i.e. mother) should be the respondent/s on behalf of children

Notes: Interview at least FOUR individuals SELECTED IN PART 7. Take measurements for all individuals in Column 3 if applicable.

Sample selected for anthropometric measurements (**Note: Do not take measurements for pregnant women**)	**FAMILY CODE (FM_ID) FROM PART 1, COLUMN 2**	Name of household member	How do you mostly get to work/school? **(Codes A)**	What are the top 3 preferred leisure activities? **(Codes B)**			During the past **7-days**, how many minutes did you do physical activities during leisure time? **(min/week)**	How would rate your physical activities during work time? **(Codes C)**	What could be the reasons you often do physical activities if applicable? **(Codes D)**	What could be the reasons you rarely do physical activities if applicable? **(Codes E)**	Anthropometric measurements (**All members in column 3 without heavy clothing and shoes if applicable**)		
				1st	2nd	3rd					Weight **(kg)**	Height **(cm)**	Waist **(cm)**
1	**2**	**3**	**4**	**5a**	**5b**	**5c**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Male adult (>18 years)													
Female adult (>18 years)													
Adolescent (10-18 years)													
Children (6-9 years)													
Children (< 6 years)													

Codes A
1. Public Bus/Minibus
2. Private car
3. Cycling
4. Walking

Codes B
1. Watching TV/Movies/Football
2. Surfing internet
3. Computer games
4. Household chores
5. Gardening
6. Walking for exercise
7. Basic walking
8. Biking for exercise
9. Basic biking
10. Jogging/Running
11. Aerobatics
12. Weight lifting
13. Football/Netball
14. Volleyball
15. Basket ball
16. Tennis
17. Drinking at home
18. Drinking at public place
19. Reading (Newspaper, Books)
20. Meeting friends/Social events

Codes C
1. Hardly
2. A bit
3. Medium
4. Strong
5. Very strong

Codes D
1. Health advice by doctor/expert
2. Beauty reasons (lose weight)
3. Sport program for social event
4. Weather reasons
5. Others, specify

Codes E
1. Lack of time
2. Laziness
3. Illness/Injury
4. Bad weather
5. Gym is too costly
6. Physical disability
7. There is no need
8. Others, specify

APPENDIX

Information for Study Participants

Dear participant:

We would like to ask for your consent to participate in a research study to analyze possible effects of the modernization of food retailing on consumer food choices, diets, and nutrition in Zambia. The study is led by the University of Göttingen, Germany. The research depends on data to be collected from 475 households in Lusaka that are randomly selected for this purpose. Your household is one of these randomly selected households. The researchers involved in this study are Prof. Dr. Matin Qaim (Germany), Mr. Makaiko Khonje (Germany), and Ms. Patricia Sakala from the National Food and Nutrition Commission of Zambia.

Your participation in this research is voluntary. If you do not want to participate or would like to withdraw later on, there will be no negative consequences for you. You can drop out of the study at any time based on your preference. Please do not hesitate to ask additional questions if you need further details after reading (or listening to) the following information.

Why are we doing this study?

In Zambia, there is a change in the way people eat, drink and live their lives. In many cases, traditional diets are replaced by so called western-style diets with high intakes of highly processed food products and sugar, e.g., fast food, soft drinks, or other snacks. Concurrently, there is substantial growth in modern food retailers in Zambia, such as supermarkets, hypermarkets, and fast-food restaurants. Hence, we want to examine if people who buy or eat food from these modern food outlets make different food choices or have different diets and nutrition outcomes than people who primarily obtain their food from traditional markets. This research can help towards better understanding on how to improve nutrition and health in the context of modernizing food systems.

What will be your part in our study?

We want to explore how people eat and drink, and how their food choices and nutrition are possibly influenced by where they buy their food and other socioeconomic factors. Therefore, we will ask you and other family members questions about your food consumption habits and other aspects of your life and living conditions, including employment, education, and levels of physical activity. Furthermore, we need to measure your body height, body weight, and waist circumference. For these body measurements, you will have to stand on a height board and on a weighing scale without heavy clothing and shoes. We would like to collect such data from one male adult, one female adult, and one child or adolescent living in your household. The data collection does not involve any risk for you or your family members.

What will be done with your data and measurements?

All personal data collected will be seen only by the interviewers and the researchers directly involved in this study. Only these people will have access to the personal data. The data will be analyzed anonymously and the names of study participants will not be published or released to anyone not directly involved in the research study. We will treat the data with utmost confidentiality.

What are advantages for you to participate in the study?

If you participate in this study you will get to know your body size measurements. You will see if you are too thin or too thick for your height and age. The research team will advise you accordingly if you are overweight or obese. Further, at the end of the interview, we have a small gift as an appreciation for your participation in our study.

What are your rights?

You can withdraw from the study at any time. There are no negative consequences that you or your family will face if you decide not to participate or if you decide to drop out at any time. It is your free choice to participate in the measurements. If you withdraw, your data and information will be destroyed. Makaiko Khonje and his assistants will answer any questions you have regarding the study.

What do you need to do if you decide to participate in the study?

To participate in the study, you need to sign the “Declaration of Consent” form with your name and date. Parents and/or caretakers sign for children under the age of 18 years. If you have any questions, we will be happy to answer them.

Food Measurement Conversion Table

Notes: To be used for PART 2 AND 7.

MEASUREMENT_ID	Measurement	Metric conversion
1	**2**	**3**
01	1 Teaspoon	5 ml
02	1 Tablespoon	15 ml
03	1 Slice of bread	25 g
04	1 Piece (Tablespoon)	20 g
05	1 Coffee/Tea cup	150 ml
06	1 Standard cup	240 ml
07	1 Milliliter	1 ml
08	1 Liter	1000 ml
09	1 Gram	1 g
10	1 Kilogram	1000 g
11	Number	
12	1 Lump of Nshima	200 g
13	1 Regular (Small) Chips	120 g
14	1 Pizza box (Small)	300 g
15	1 Cone (Ice Cream)	42 g
16	1 Loaf of bread	500 g
17	1 Packet of Sugar/Salt	1000 g
18	1 Heap	250 ml
19	1 Bunch	
20	1 Meda	5000 g
21	1 Bp	
22	1 Bottle/Can	330 ml
23	½ Crate	10 bottles

No.	Ingredient	Density (g/ml)
1	**2**	**3**
01	Water	1.00
02	Milk	1.03
03	Cooking oil	0.92
04	Salt	1.20
05	Sugar	0.80
06	Flour	0.70

Food Diary Template for PART 7

Household Identification Number (xxx): ☐☐☐ **Family Member Identification Number (FM_ID) (xx)** ☐☐

Time/Meal	**Food Item/Ingredients**	**Amount**
1	**2**	**3**
Break fast		
Snack		
Lunch		
Snack		
Supper		
Total		