GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

GRK 2654
Sustainable Food Systems

RTG 2654 Sustainable Food Systems

University of Goettingen

SustainableFood Discussion Papers

No. 5

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March 2024

RTG 2654 Sustainable Food Systems · Heinrich Düker Weg 12 · 37073 Göttingen · Germany
www.uni-goettingen.de/sustainablefood

ISSN (2750-1671)

Suggested Citation

Purushotham, A., L. Steinhübel (2024). Livelihood diversification and nutrition in the Indian rural-urban interface. SustainableFood Discussion Paper 5, University of Goettingen.

Imprint

SustainableFood Discussion Paper Series (ISSN 2750-1671)

Publisher and distributor:
RTG 2654 Sustainable Food Systems (SustainableFood) – Georg-August University of Göttingen
Heinrich Düker Weg 12, 37073 Göttingen, Germany

An electronic version of the paper may be downloaded from the RTG website:

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Livelihood diversification and nutrition in the Indian rural-urban interface

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Abstract

With growing cities and improving infrastructure all over the world, smallholder farms not only gain better access to agricultural markets but also off-farm labor markets. As a result, the opportunity cost of farm labor increases, and households' livelihood portfolios often become more complex, i.e., a share of the household labor is allocated towards off-farm activities. While such diversification is often beneficial for household incomes, the consequences for household nutrition are less clear. Especially, empirical evidence considering the interaction of different employment choices and pathways through which livelihood diversification affects nutrition is still scarce. To address this gap, we first develop a conceptual framework that considers subsistence agricultural production, commercialized agricultural operations, off-farm employment, and the role of market access in explaining household nutrition. Then, we use panel data from the rural-urban interface (RUI) of Bangalore in South India and apply a fixed-effects regression framework to analyze how employment choices affect household consumption of calories, protein, fat, saturated fat, carbohydrates, total sugar, and sodium. We also explore whether the observed effect patterns are driven by income or lifestyle changes associated with livelihood diversification. Our analysis shows that households in the RUI of Bangalore on average consume excess quantities of nutrients considered, indicating the onset of dietary transition that accompanies urbanization. Commercialized agriculture and/or off-farm employment lead to a reduction in the excess consumption of nutrients. This effect is however linked to lifestyle changes, while potential income gains further increase excess consumption. Our analysis also shows that the observed reductions in nutrient consumption through lifestyle changes vary depending on a household's location in the RUI, with households located close to Bangalore displaying stronger improvements. All in all, livelihood diversification is associated with an improvement in the household nutrient consumption status mediated by lifestyle rather than income factors associated with improved market access.

Keywords: livelihood strategies, dietary transition, fixed-effects regression, rural-urban interface, India.

JEL codes: D12, D13, I3, Q12, Q18

Acknowledgements: We are grateful to Prof. Dr. Stephan von Cramon-Taubadel and Prof. Dr. Liesbeth Colen for helpful discussions and comments on the draft. We acknowledge the support from Dr. Nitya Mittal in the design and implementation of the round 2 socioeconomic survey. This research was funded by the German National Science Foundation, DFG, through grant number CR 95/8-2, and by the Indian Department of Biotechnology, DBT, as part of the Research Unit 2432/1 and 2. This project has also received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101025600 and from the Innovative Methods and Metrics for Agriculture and Nutrition Action (IMMANA) programme, led by the London School of Hygiene & Tropical Medicine (LSHTM). IMMANA is co-funded with UK Aid from the UK government and by the Bill & Melinda Gates Foundation INV-002962 / OPP1211308.

1 Introduction

Rural livelihoods are changing in many low- and middle-income countries (LMICs) around the world. Urbanization, improved infrastructure, and access to new technologies are some of the factors changing the way smallholder households earn a living and shape their lives (Schneider & Masters, 2019; Vandercasteelen, Beyene, Minten, & Swinnen, 2018). Literature shows that once provided with better market access, smallholder households are likely to diversify their livelihood strategies and that there are trade-offs in household decision-making regarding the allocation of labor into the farm and/or off-farm sectors (Diao, Magalhaes, & Silver, 2019; Steinhübel & von Cramon-Taubadel, 2020). This can mean a shift from labor-intensive subsistence agriculture to commercialized agricultural operations (Damania et al., 2016; Pingali, 2007a; Vandercasteelen et al., 2018) and/or an increased share of household labor allocated into off-farm employment (Deichmann, Shilpi, & Vakis, 2009; Fafchamps & Shilpi, 2003; Haggblade, Hazell, & Reardon, 2010).

Several studies have analyzed the effects of commercialized agriculture and off-farm employment on household income and living standards, generally finding a positive association (Haggblade et al., 2010; Imai, Gaiha, & Thapa, 2015; Ogutu & Qaim, 2019; Pfeiffer, López-Feldman, & Taylor, 2009). However, patterns often become complex when it comes to their effect on household food security and nutrition. This holds, particularly when smallholder households earn income from a diversified set of activities (including off-farm employment) and are experiencing dietary and nutrition transition as in an urbanization context.[1]

Studies on the link between smallholder employment and nutrition generally either investigate the role of agricultural operations in nutrition or are concerned with the effects of off-farm employment. Regarding agricultural operations, studies emphasize increased on-farm production diversity as a means to increase dietary diversity (Ecker, 2018; Jones, Shrinivas, & Bezner-Kerr, 2014). However, this link mainly applies to subsistence farmers and becomes weaker when households shift to commercialized agricultural operations (Muthini, Nzuma, & Qaim, 2020; Pingali & Sunder, 2017;

[1] Many LMICs are undergoing rapid transitions in dietary patterns towards excess intake of energy-dense, fatty, salty, and sugary foods and beverages. Such dietary transitions are associated with nutrition transition where the increased prevalence of overweight/obesity and NCDs is observed in otherwise nutrition-insecure populations. We discuss these phenomena in detail in Section 2.2.

Sibhatu, Krishna, & Qaim, 2015; Sibhatu & Qaim, 2018). While some studies show that agricultural commercialization improves household nutrition (Cazzuffi, McKay, & Perge, 2020; Ntakyo & van den Berg, 2019), others suggest a weaker relationship (Carletto, Corral, & Guelfi, 2017; Radchenko & Corral, 2017). As for the effect of off-farm employment, studies generally imply a positive effect as households' expenditure on diversified diet and nutrient consumption increase (Babatunde & Qaim, 2010; D'Souza, Mishra, & Hirsch, 2019; Owusu, Abdulai, & Abdul-Rahman, 2011; Rahman & Mishra, 2019).

Now, the question is what happens to household nutrition, when its members are involved in several of these different employment types? We argue that solely focusing on the effects of agricultural operations or off-farm employment—as typically done in the literature—might not be sufficient to understand how different employment types and accompanying changes in income, preferences, and habits are linked to nutrition. Particularly when households engage in multiple employment dimensions at the same time, the net effect of interacting changes in production, income generation, and consumption patterns can be highly complex. That is, when households display complex and diversified income activities, estimating the effect of one employment dimension (e.g. agricultural operations) on nutrition without accounting for the effects brought about by the other (e.g. off-farm employment) likely leads to a biased understanding of the relationship (Carletto et al., 2017; Cazzuffi et al., 2020; Ecker, 2018; Rahman & Mishra, 2019; Sibhatu et al., 2015).

In addition, a common feature of most of the existing studies is that they analyze nutrition in the context of food insecurity and undernutrition in often rural and/or remote areas. Thus, the question is if found patterns also hold for regions undergoing rapid economic transformations such as South Asia (Pingali, 2007a; Pingali, Aiyar, Abraham, & Rahman, 2019; Pingali & Sunder, 2017; Reardon & Minten, 2011; Timmer, 2009). The forces of urbanization, globalization, easy access to modern food outlets, and changing food preferences have increased the intake of energy-dense, salty, fatty, and sweetened foods and beverages in the region (Cockx, Colen, & Weerdt, 2018; Pingali, 2007b; Pingali & Khwaja, 2004; Popkin, 1999). Furthermore, with improved opportunities to work outside the home in the off-farm sector, the opportunity cost of food preparation has increased (Kennedy & Reardon, 1994; Reardon et al., 2021; Regmi & Dyck, 2001; Sauer et al., 2021). As a consequence, many consumers might prefer convenience over the nutritional quality of their food, leading to increased consumption of processed and packaged food items and eating-out practices (Deaton & Dreze, 2008; Purushotham, Aiyar, & von Cramon-Taubadel, 2023). The resulting increase in the intake of energy-dense foods together with changes in work effort due to the shift in occupation patterns has led to increased prevalence of overweight/obesity and non-communicable diseases (NCDs) in many LMICs (Gupta & Bansal, 2020; Meenakshi, 2016; Popkin, Corvalan, & Grummer-Strawn, 2020; Purushotham et al., 2023).

Thus, by analyzing the effect of smallholder livelihood diversification on household nutrition in the rural-urban interface (RUI) of the South Indian megacity of Bangalore, we contribute to the literature in two important ways. First, we explicitly consider the effects of interactions between smallholders' agricultural operations and off-farm employment choices on their nutrition consumption status. We also investigate whether these effects are driven by income gains or lifestyle changes. Second, our analysis is set in a region known to be in the middle of dietary and nutrition transition (Mittal & Vollmer, 2020; Purushotham et al., 2023, 2022). Hence, we provide new important empirical evidence to extend the understanding of the relationship between employment choices and nutrition, particularly in the context of multiple burdens of malnutrition.

We start our analysis with a conceptual framework illustrating the pathways between smallholder employment and dietary choices in an urbanization setting. We then use primary socio-economic panel survey data from 1,241 households in the RUI of Bangalore to empirically investigate the interlinkages illustrated in the framework. The Bangalore region shows exactly the development characteristic representative of many parts of India and other LMICs: a relative decline of the importance of income from the agricultural sector (Chand, Srivastava, & Singh, 2017; Chatterjee, Murgai, & Rama, 2015; Pingali, 2007a) and a growing casual labor and off-farm sector (Chandrasekhar & Mehrotra, 2016; Jatav & Sen, 2013). By using household consumption/availability of calories, protein, fat, saturated fat, carbohydrates, total sugar, and sodium, we investigate the households' nutrition from the perspective of dietary transition.

Our results show that the composite effect of agricultural operations and off-farm employment is important in explaining household nutrition. Of particular importance is the combination of commercialized agricultural operations and off-farm employment. Households with such a mix of employment choices display a reduction in the excess consumption of nutrients compared to subsistence agricultural households. Upon disentangling the income effects, we find that the lifestyle component that accompanies livelihood diversification is associated with the observed reduction in the excess consumption of nutrients, whereas the income component further increases in excess consumption. Our results also suggest that the effect of the lifestyle component of livelihood diversification differs across space. Thus, making the households engaged in the same combination of employment choices vulnerable to excess nutrient consumption if they are located further away from Bangalore city. This suggests that participation in more than one employment activity, accompanying lifestyle changes, and proximity to urban markets decrease the burden of overconsumption in the RUI of Bangalore.

The remainder of the paper is structured as follows. In the next section (2), we present our conceptual framework and some background information on dietary and nutrition transition in India. Afterward (section 3), we describe our data, the key variables of our analysis, and our empirical strategy. In section 4, we present and discuss our results and finish with some concluding remarks in section 5.

2 Background

2.1 A conceptual framework of market access, labor allocation, and nutrition

Literature shows that market access significantly influences household livelihood choices (Diao et al., 2019; Steinhübel & von Cramon-Taubadel, 2020) and dietary patterns (Pingali & Khwaja, 2004; Purushotham et al., 2023; Timmer, 2009). Muthini et al. (2020) develop a conceptual framework where they illustrate the interdependencies between market access, farm production diversity, and nutrition. We build on their approach by adding an off-farm employment dimension. That means we assume that not only decision-making regarding the share of labor attributed to agricultural operations (subsistence or commercialized) depends on market access but also on off-farm employment. Vandercasteelen et al. (2018) and Damania et al. (2016) argue that with proximity to agricultural markets net input prices decrease and net output prices increase, leading to higher rates of modern technology adoption and commercialized agriculture closer to markets and cities. The same concept holds for the off-farm sector, i.e., access costs to off-farm labor markets generally decrease with urban proximity, and the opportunity for farm labor increases. This is supported by Deichmann et al. (2009) and Fafchamps and Shilpi (2003) who show that once access to (urban) labor markets increases, smallholder households are likely to remove some labor from their agricultural operations and engage in off-farm employment. Households often face trade-offs when assigning labor between agricultural operations and/or off-farm employment resulting in potentially complex patterns of employment choices based on market access and their location in peri-urban areas (Steinhübel & von Cramon-Taubadel, 2020). Therefore, we visualize households' employment choices as a continuum between agricultural operations and off-farm employment in Fig. 1 assuming that most smallholder households are located somewhere between the two extremes. The exact position on the continuum is determined by households' access to labor and agricultural markets (gray box - *Labor and agricultural markets*).

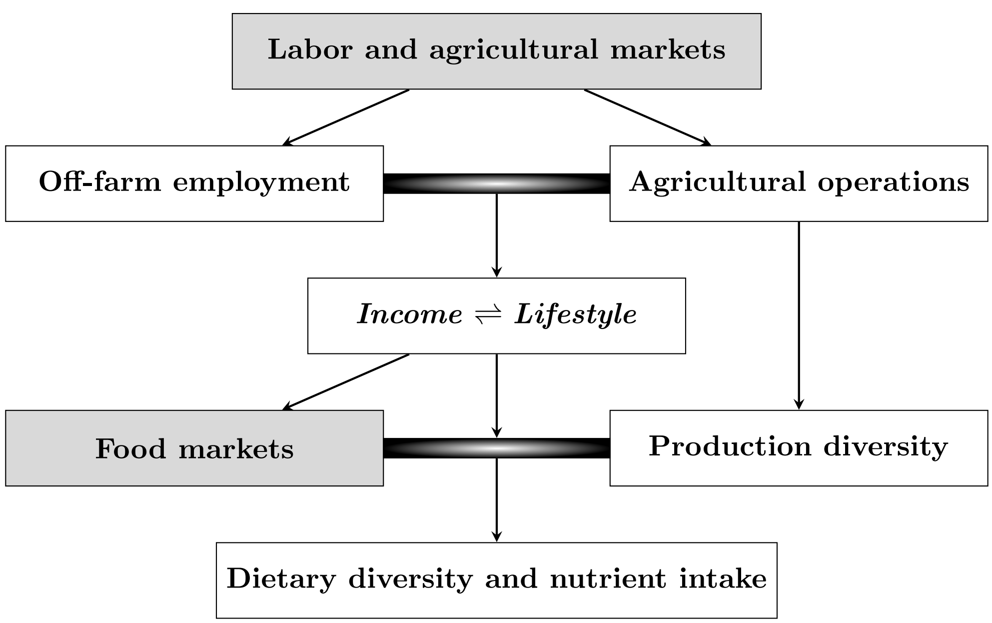

Figure 1: Household employment choices, nutrition, and access to markets

Employment choices are linked to household nutrition mainly through three pathways. The first is the subsistence pathway, where households consume food crops produced on their farm. The second pathway is income, where households use income generated through agricultural commercialization and off-farm employment to purchase food items from the market. The third pathway is a change in consumption behavior due to lifestyle changes resulting from new work environments (e.g., off-farm place of work). The respective share of either type of economic activity—on-farm production and off-farm activities—will determine how much of households' diet relies on food markets. Furthermore, off-farm employment is likely connected to lifestyle changes such as food preference, nutritional knowledge, the opportunity cost of cooking, etc. Hence, if a higher disposable income increases nutrient consumption through the income pathway of livelihood diversification, the accompanying lifestyle effect influences whether this increased nutrient consumption is desirable for the overall nutritional status of the household. Thus, next to pure access to food markets (gray box - *Food markets*), the income pathway to nutrition also relies on the choice made in the market (i.e. which food items are purchased). Ultimately, households' dietary patterns and nutrient consumption are, therefore, determined by the (subsistence) production diversity as well as the assortment of food markets and outlets available to a household.

2.2 Dietary and nutrition transition in India

Much like the other emerging economies in South Asia, India is undergoing a rapid dietary transition leading to a shift in dietary patterns dominated by staple grains, roots, legumes, and vegetables towards excess intake of processed foods and beverages (Deaton & Dreze, 2008; d'Amour et al., 2020; Pingali, 2007a; Tak, Law, Green, & Shankar, 2022). Urbanization, changing food environment, demographic composition, increased disposable income, and changing tastes and preferences are widely attributed factors for the observed dietary transitions in India (Deaton & Dreze, 2008; d'Amour et al., 2020; Meenakshi, 2016; Pingali & Abraham, 2022). These transitions have led to excess intake of nutrients such as calories, saturated fat, carbohydrates, sugar, and sodium leading to increased prevalence of overweight/obesity among different demographics in India (Aiyar, Rahman, & Pingali, 2021; Meenakshi, 2016; Purushotham et al., 2023, 2022). While a large share of the population is facing the increasing burden of overweight/obesity, significant undernutrition prevails in the form of stunting and anemia (NFHS-5, 2019-21). Thus posing a major food security challenge for India through the coexistence of undernutrition and overnutrition among different demographic groups (Mittal & Vollmer, 2020; Purushotham et al., 2022; Young, Nguyen, Tran, & Avula, 2020). At the micro-level, knowledge of how different employment choices influence nutrient consumption patterns helps in designing potential solutions to address the undesirable implications of dietary and nutrition transition in India.

3 Materials and methods

3.1 Study area and survey design

According to the last census statistics (DCO, 2011), Bangalore had a population of 9.6 million and is currently estimated to be the home of 13 million people (Bharadwaj, 2017). It is the fifth most urban agglomeration in India and is expanding continuously (Sudhira, Ramachandra, & Subrahmanya, 2007). Bangalore and several satellite towns, located within a 40-kilometer distance, provide many opportunities for employment in the formal and/or informal off-farm sector. Several highways connecting the urban centers lead to a rise in urbanization patterns in the entire region (DCO, 2011). Nevertheless, agriculture still prevails as a major livelihood strategy for people living in the peripheries and small towns around Bangalore (DCO, 2011). Improved infrastructure and agricultural market access help farmers intensify their production systems (cultivating crops and rearing dairy cows) beyond just subsistence.

While undernutrition persists, overweight/obesity and anemia are rising health concerns in both the Bangalore urban and rural districts (Mittal & Vollmer, 2020; NITI-Aayog, 2016; Purushotham et al., 2022). Changing dietary patterns is attributed to be one of the main factors for the increasing prevalence of overweight/obesity in the region (Purushotham et al., 2023). As per Pingali and Khwaja (2004), economic growth and urbanization patterns around Bangalore display the exact characteristics of a region experiencing the second stage of the nutrition transition.

In this setting, two rounds of a socio-economic panel survey of 1275 households conducted in the years 2016-17 and 2022 (hereafter round 1 and round 2) provide the basis for our empirical analysis. Our study area comprises two research transects that cut through the RUI of Bangalore

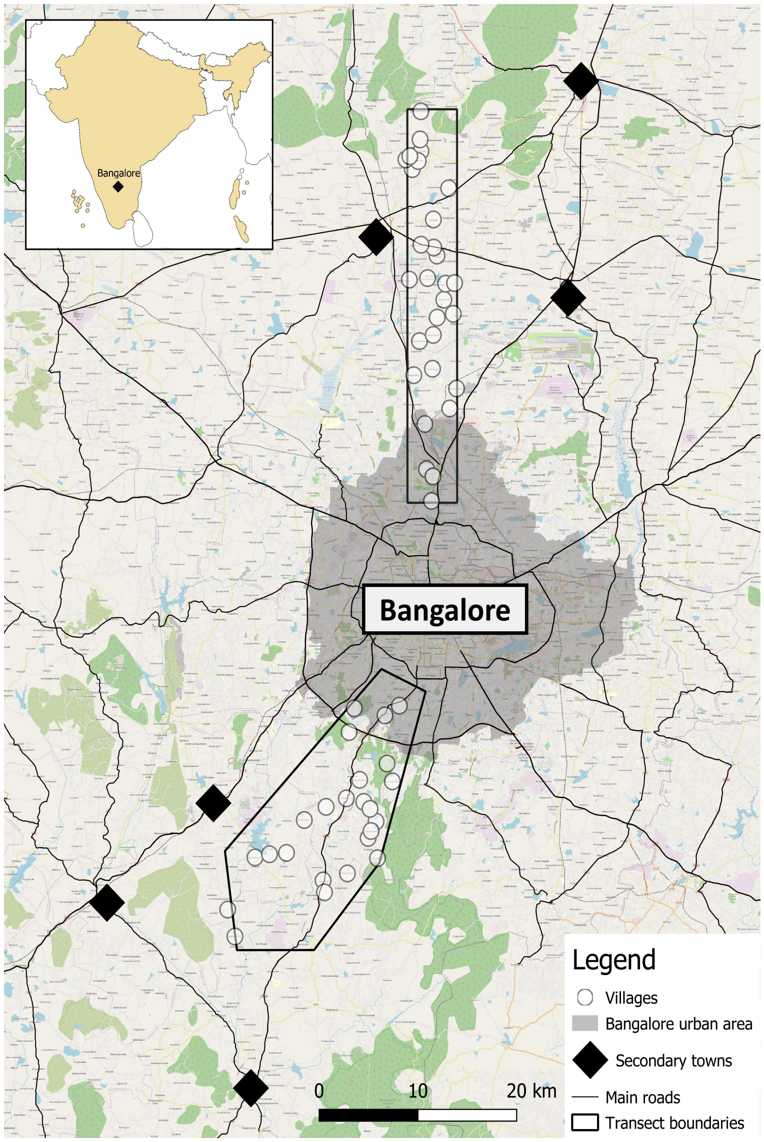

Figure 2: Study area, research transects, and sample villages

city, as shown in Fig. 2. The first transect extends towards the northern part of Bangalore and the second transect extends towards the southwest part of Bangalore. By applying a two-stage stratified random sampling technique, we ensured that the selected households provided a good representation of urbanization patterns in the region. In the first stage, all villages in each transect were divided into three strata (urban, peri-urban, and rural) using the "Survey Stratification Index (SSI)" constructed by Hoffmann, Jose, Nölke, and Möckel (2017). Then, 10 villages were randomly selected from each stratum, yielding 61 villages in total. In the second stage, the households were randomly selected in each sample village again proportional to their size using a village household list maintained by the publicly run village kindergartens. All sampled households were interviewed using a comprehensive questionnaire covering socio-demographic, economic, and agricultural information. The respective caregiver of the family was also interviewed to collect food consumption data for the past 14 days of the interview.

Though the survey comprises 1275 households, we were not able to incorporate both socioeconomic and food consumption survey tools in 151 households. Thus, data on livelihood strategies and food consumption is only available for 1126 households for the round 1 survey. Of these, we were able to able to track 882 households again during the round 2 survey. The majority of the remaining 224 (21 percent of the sample) households that we could not track were located in the urban stratum. Hence, we randomly selected an additional 112 households in the sample villages from the urban stratum. Of the total, total 994 (stayers and replacements) households interviewed in 2022, complete data on household livelihood strategies and food consumption is available for 861 households. Furthermore, after dropping the observable outliers of nutrition variables and missing observations of covariates, a sub-sample of 1118 and 845 households from the round 1 and 2 surveys, respectively is considered for empirical analysis.

Dropping all these observations at different stages of surveys leaves us with an unbalanced panel data set with a potentially high rate of attrition bias. To test this, we compare the characteristics between stayers and replacement households, and also between replacement households and the remaining sample. Appendix Tables A1 and A2 show that the differences are significant for some household characteristics. Hence, we estimated an attrition probit model, with attrition status as the dependent variable (see Appendix Table A3). An inverse mills ratio calculated based on these estimates was used as an additional covariate in the outcome models summarized in Section 3.6. The results presented in Appendix Table A4 show that the inverse mills ratio has no statistically significant association with the outcome variables. This indicates that attrition bias is not a problem in our empirical analysis.

3.2 Measurement of nutrition

We measure nutrient consumption in terms of adult male equivalents (AME), one of the widely used metrics of household nutrition in the development literature (Babatunde & Qaim, 2010; Berti, 2012; Ntakyo & van den Berg, 2019). This holds especially when individual food intake data is unavailable like in our case. We calculate AME consumption measures for seven nutrients, namely calories, protein, fat, saturated fat, carbohydrates, total sugar, and sodium. These nutrients have been identified as good proxies for consumption patterns in regions in the middle of the dietary transition such as the RUI of Bangalore (Ameye, 2023; Purushotham et al., 2023). All AME calculations are based on a 14-day recall household food consumption data.

Following Coates, Rogers, Blau, Lauer, and Roba (2017), we estimate the energy-AME-based nutrient consumption at the household level in four steps. In the first step, demographic information such as age, gender, and physiological status of each household member is used to estimate their energy requirement in a day. In the second step, the individual AME for energy requirement is calculated relative to the energy requirement of the adult male member.[2] Third, individual AME for energy are added together to get the AME at the household level. Lastly, household-level AME is multiplied by the respective nutrient consumed at the household level to get the AME-based nutrient consumption availability at the household level. For a detailed summary of nutrient intake measurement using the AME method, please refer to Coates et al. (2017).

Despite its wide usage in development literature, the AME method has limitations in accounting for potential intra-household inequities in consumption that arise due to factors such as power imbalance within the household and the inability of the caregiver to account for the consumption of food away from home (FAFH) by other household members, etc. (Sununtnasuk & Fiedler, 2017; Weisell & Dop, 2012). In the case of the former, intra-household allocation of nutrients is found to be equitable for other LMICs contexts when measured using the AME method for most of the nutrients we consider in our study (Berti, 2012; Coates et al., 2018; Jariseta, Dary, Fiedler, & Franklin, 2012). To address the measurement issue, following Fiedler and Yadav (2017) we collect detailed information on the FAFH by household members and calculate the respective nutrient consumption

[2] While estimating the energy requirement, moderate physical activity levels are assumed for adult sample demographics (Coates et al., 2017).

allocated to this FAFH. Hence, we are confident that AME nutrient metrics calculated using the detailed household food consumption data are good estimates of nutrient consumption/availability at the household level given the data limitations. Nevertheless, we interpolate these metrics as nutrition consumption/availability at the household level and not as nutrient intake by individual household members.

Table 1 presents the average consumption levels for the nutrients considered (the distributions are all somewhat skewed with flatter tails to the right). Since the quantity of a particular nutrient supposed to be consumed by an individual depends on his/her age, gender, and physical activity level, we do not have a fixed value for a particular nutrient measured in AME units against which we can compare the nutrient consumption values of our sample households. However, by looking at the average nutrient consumption values in Table 1, we can still argue that on average our sample households consume higher quantities of nutrients. Particularly for fat, carbohydrates, total sugar, and sodium, the households on average consume more than two to three times the recommended quantities of the respective nutrients supposed to be consumed by an adult man engaged in heavy work in a day. For calories, protein, and saturated fat households on average consume little more than the recommended quantities of their respective nutrients to be consumed by an adult male engaged in physically intense work. These nutrient consumption levels again confirm our discussion that RUI of Bangalore is undergoing a rapid dietary transition (Pingali, 2007b; Pingali & Khwaja, 2004).

When comparing the nutrient consumption values between the two rounds of the survey, we observe that there is slightly lower consumption in round 2. One reason for the lower consumption in the round 2 survey could be attributed to the implications of the COVID-19 pandemic. Even though this difference is statistically significant in most cases, the absolute difference is relatively small, and overall consumption in round two still points toward excess consumption.

To bring further perspective on this excess nutrient consumption among our sample households, we calculate how much of calories are coming from different food groups. We categorize all the food items consumed in our sample households into seven broad categories such as cereals, fruits & vegetables, legumes & nuts, animal source foods (ASF), oils & fats, sugars & sweets, and processed

Table 1: Nutrients consumption at household-level

	2017 1,118 (57.0%)	2022 845 (43.0%)	Total 1,963 (100.0%)	Test
Calories (Kcal)	3491.71 (1577.10)	3201.95 (1554.18)	3366.72 (1573.41)	<0.001
Protein (gm)	86.66 (41.73)	83.23 (44.48)	85.18 (42.96)	0.080
Fat (gm)	84.75 (52.74)	79.03 (50.85)	82.29 (52.00)	0.016
Saturated fat (gm)	28.93 (24.43)	23.99 (20.30)	26.80 (22.87)	<0.001
Carbohydrates (gm)	568.63 (263.91)	498.55 (236.05)	538.40 (254.59)	<0.001
Total sugar (gm)	92.62 (59.30)	80.41 (56.00)	87.36 (58.20)	<0.001
Sodium (gm)	7164.03 (4769.99)	7581.71 (5285.06)	7343.98 (5001.38)	0.067

Notes: Mean (Standard deviation), p-value from a pooled t-test. Nutrients are measured in adult male equivalent (AME) units per day.

foods. Appendix Table A5 lists the different food items in each of these seven food groups considered. We calculate the quantities of calories coming from each of the aforementioned seven food groups per capita per day. We can see from Table 2 that 53 percent (1623 kcal/per capita/day) of the calories are consumed from cereals in our sample households on average. Nutrient-dense food groups such as fruits & vegetables, legumes & nuts, and ASF constitute around 24 percent of total calories consumed. Potentially unhealthy food groups such as oils & fats, sugars & sweets, and processed foods contribute to the remaining 23 percent of the calories consumed. This indicates that even though the households on average consume higher quantities of nutrients, a large and significant share of this excess nutrient consumption accrues to staple cereals (53%) and food groups that are energy-dense (23%), respectively. According to Smith and Subandoro (2007), 53 percent of calories from cereals are considered to be medium diet quality at the household level. Furthermore, we do not see large changes in these consumption patterns between the two rounds of the survey, the only exception being the calories consumed by the cereals and fruits & vegetables food groups. These dietary patterns further strengthen our observation before the dietary transition is underway in the RUI of Bangalore.

Table 2: Calories consumed from different food groups

	2017 1118.0 (57.0%)	2022 845.0 (43.0%)	Total 1963.0 (100.0%)	Test
Cereals	1725.15 (880.41)	1489.74 (755.52)	1623.88 (836.95)	<0.001
Frutis & vegetables	327.73 (280.63)	249.76 (249.04)	294.19 (270.20)	<0.001
Legumes & nuts	204.28 (166.00)	190.75 (163.55)	198.46 (165.04)	0.073
Animal source food	229.53 (216.85)	263.89 (219.49)	244.31 (218.59)	<0.001
Oils & fats	269.10 (233.02)	267.92 (223.83)	268.59 (229.05)	0.910
Sugars & sweets	163.94 (137.59)	160.85 (146.00)	162.61 (141.24)	0.632
Processed foods	209.80 (189.19)	285.94 (381.99)	242.55 (290.75)	<0.001

Notes: Mean (Standard deviation), p-value from a pooled t-test. Calories from different food groups are measured as Kcal per day per person.

3.3 Measurement of livelihood diversification and household income

Following our conceptual framework in section 2, the employment choices of the households should play an important role in determining what they eat and, thus, their nutritional consumption. Common classifications in previous studies on employment choices are — formal vs. informal, casual vs. full-time off-farm employment (D'Souza et al., 2019; Rahman & Mishra, 2019), or commercialized vs. non-commercialized agriculture (Babatunde & Qaim, 2010; Carletto et al., 2017). Likewise, agricultural operations relevant to our study area are subsistence agriculture and commercialized agriculture (defined as at least one crop sold in 2016 and 2021 for survey rounds 1 and 2, respectively). Due to data limitations on the nature of off-farm employment taken up by the households in our sample, we cannot distinguish between different types of off-farm employment taken up by the households. Hence, relevant off-farm operations in our study area are households with and without off-farm employment. Based on these major types of agricultural operations and off-farm employment, we categorize our sample households into six types. They are households engaged in (i) subsistence agriculture (**SA**), (ii) commercialized agriculture (**CA**), (iii) subsistence agriculture and off-farm employment (**SA & Off**), (iv) commercialized agriculture and off-farm employment (**CA & Off**), (v) off-farm employment (**Off**), and (vi) no employment activity (**No-emp**). Note that these categories are exclusively based on crop management systems. Dairy production is common in our study area, with 48 percent of our households owning dairy cows (Table 4). We consider this aspect with a separate dummy variable in the subsequent regression analysis.

Table 3: Employment dimensions of sample households

	2017	2022	Total	Test
	1118.0 (57.0%)	845.0 (43.0%)	1963.0 (100.0%)	
SA	0.30 (0.46)	0.02 (0.14)	0.18 (0.38)	<0.001
CA	0.17 (0.37)	0.20 (0.40)	0.18 (0.38)	0.049
SA & Off	0.08 (0.27)	0.26 (0.44)	0.16 (0.36)	<0.001
CA & Off	0.03 (0.16)	0.42 (0.49)	0.19 (0.39)	<0.001
Off	0.40 (0.49)	0.10 (0.30)	0.27 (0.44)	<0.001
No-emp	0.03 (0.18)	0.01 (0.09)	0.02 (0.15)	<0.001

Notes: Mean (Standard deviation), p-value from a pooled t-test. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity.

Table 3 summarizes the different employment choices taken up by our sample households in the RUI of Bangalore. On average, 18 percent of households are engaged in both pure subsistence and commercialized agriculture. 16 and 19 percent are engaged in a composite of subsistence agriculture and off-farm employment and commercialized agriculture and off-farm employment, respectively. Pure off-farm employment constitutes the largest share (27 percent) of employment choice taken up by our sample households. In addition, around 2 percent of households do not engage in any employment activity.[3] An important point to note from Table 3 is that there is a substantial difference in the employment choices adopted by our sample households between the round 1 and 2 surveys. While we see a large share of households engaged in pure subsistence, commercialized agriculture, and off-farm employment in the round 1 survey, a composite of agricultural and off-farm employment is the popular employment choice taken up by households in round 2. There are two potential explanations for this observed occupation transition. First, due to the COVID-19 pandemic, a significant share of labor from off-farm employment has been shifted back to agriculture in India (Preusse, Silva, Steinhübel, & Wollni, 2024). Second, a fair share of households that we could not track during the round 2 survey lived in urban villages/wards and were engaged in off-farm employment, hence the reduced share of pure off-farm employment activity in 2022. Overall, we observe that households in the RUI of Bangalore engage in a diverse set of employment choices.

[3] The households with no employment activity depend either on remittances or other forms of income such as rent.

In addition, we can also observe a pattern where more and more households have at least one member engaged in off-farm employment. This confirms our argument of simultaneous engagement of households in more than one employment activity described in Section 2.1.

In addition, as discussed in Section 2.1, livelihood diversification affects nutrition through income and lifestyle pathways. To disentangle these pathways we control for the log of per capita monthly expenditure as a proxy for household income. This helps to separate the income effect from the lifestyle effect that accompanies livelihood diversification.

3.4 Measurement of market access

To measure the effects of market access on household nutrition, we calculate household travel times to the center of Bangalore. For that purpose, we source 2016 and 2022 road network data for the Bangalore area from *Open Street Map (OSM)* via the *Overpass API* to fit the two panels of our survey data.[4] We then apply the *ONEAT3* plugin in *QGIS* to find the fastest way between households' coordinates and the Bangalore city center in 2016 and 2022 based on the OSM road network data. Since OSM does not provide travel speeds for all road segments in the data set, we build averages based on non-zero values for every road type and use them in our calculations. On average, households take 67 and 73 minutes to reach the Bangalore city center in round 1 and 2 surveys, respectively.

3.5 Control variables

We control for socioeconomic characteristics such as the number of household members, average age and education of household members, and the number of durable assets owned by the household. Furthermore, we include variables directly related to food consumption such as the household member typically purchasing food items and the household's main food source. The person buying groceries in the market likely influences the household nutritional consumption; a female household member might prioritize the nutritional quality of food items over their price and convenience more than a male household member (Wardle et al., 2004; Wardle, Parmenter, & Waller, 2000). Almost

[4] To keep the dataset concise and comparable between the two rounds, we limit the road data used for the calculation to primary, secondary, tertiary, and unclassified highways as per OSM definition.

62 percent of the sampled households report that an adult male is primarily responsible for grocery shopping; whereas in 25 percent of households, it is a female and in 13 percent of households any member is responsible for grocery shopping. The source of food is also associated with the nutritional status of the households with increased access to modern food retail stores having both positive and negative effects on nutrition consumption (Debela, Demmler, Klasen, & Qaim, 2020; Demmler, Klasen, Nzuma, & Qaim, 2017). In our sample, the majority of the households buy food from the Kirana (mom & pop) stores (59 percent) followed by supermarkets (15 percent) and wholesale markets (15 percent).

Table 4: Socio-economic characteristics of sample households

	2017 1,118 (57.0%)	2022 845 (43.0%)	Total 1,963 (100.0%)	Test
Travel time to Bangalore (min)	67.59 (16.18)	73.58 (14.60)	70.17 (15.80)	$<$0.001
Cow	0.49 (0.50)	0.47 (0.50)	0.48 (0.50)	0.598
Household size	4.64 (2.16)	4.53 (2.21)	4.59 (2.18)	0.285
Asset index	5.69 (1.70)	6.95 (1.60)	6.23 (1.77)	$<$0.001
Female shopper	0.25 (0.43)	0.24 (0.43)	0.25 (0.43)	0.512
Male shopper	0.57 (0.49)	0.68 (0.47)	0.62 (0.49)	$<$0.001
Other shopper	0.17 (0.38)	0.08 (0.27)	0.13 (0.34)	$<$0.001
Open market	0.08 (0.27)	0.04 (0.19)	0.06 (0.24)	$<$0.001
Kirana store	0.46 (0.50)	0.77 (0.42)	0.59 (0.49)	$<$0.001
Wholesale market	0.19 (0.39)	0.10 (0.30)	0.15 (0.36)	$<$0.001
Supermarket	0.22 (0.42)	0.06 (0.24)	0.15 (0.36)	$<$0.001
Other food sources	0.05 (0.21)	0.03 (0.17)	0.04 (0.20)	0.045
Average age	33.65 (10.88)	37.03 (11.23)	35.11 (11.16)	$<$0.001
Average education	6.42 (2.99)	7.00 (3.07)	6.67 (3.04)	$<$0.001
Household income	8.19 (0.63)	9.91 (0.78)	8.93 (1.10)	$<$0.001

Notes: Mean (Standard deviation), p-value from a pooled t-test.

3.6 Statistical analysis

To estimate the relationship between household livelihood diversification and nutrition, we define the following regression model:

$$\ln Y_{ijt} = \alpha + \gamma_1 E_{ijt} + \gamma_2 M_{ijt} + \gamma_3 (E_{ijt} \times M_{ijt}) + \beta X_{ijt} + v_{ijt} + \varepsilon_{ijt} \quad (1)$$

Where $\ln Y_{ijt}$ refers to the log-transformed indicator of the consumption of nutrient i in household (measured in AME) j in year t. The parameter γ_1 estimates the effect of our main variable of interest—household employment choice—represented by the vector E that consists of the six different types of employment as discussed in section 3.3. Market access is considered to play an important in household nutrition (section 2.1). Hence, parameter γ_2 quantifies the effect of market access (measured as household travel time to the city center of Bangalore) represented by vector M_{ijt}. γ_3 quantifies the interaction effect between household employment choice and market access on nutrition (vector $E_{ijt} \times M_{ijt}$). Parameter β represents the effect of vector X_{ijt} which includes the control variables presented in section 3.5. In addition, the model includes the time-fixed effects (v_{ijt}) and an error term ε_{ijt}.

According to our conceptual framework (section 2.1), income-generating employment activities of the household affect nutrition through income and lifestyle pathways. To disentangle these two effects, in model (2) in addition to the employment choice of the households we also include the log of per capita household consumption expenditure in vector I_{ijt}. Thereby, the parameter γ_4 quantifies the income effect, and parameters γ_1 and γ_3 quantify the lifestyle effect accompanied by the household employment choice.

$$\ln Y_{ijt} = \alpha + \gamma_1 E_{ijt} + \gamma_2 M_{ijt} + \gamma_3 (E_{ijt} \times M_{ijt}) + \gamma_4 I_{ijt} + \beta X_{ijt} + v_{ijt} + \varepsilon_{ijt} \tag{2}$$

The regression models (1) and (2) include a time dimension, so the use of the ordinary least squares (OLS) method would lead to biased estimates. In principle, the panel data estimation method such as a random-effects (RE) estimator leads to efficient estimates as it accounts for the variations within and between the data points. However, RE estimates may be biased if there is a likely correlation between explanatory variables and the error term. The error term in our model likely carries unobserved heterogeneity such as the innate ability of household members, family background, etc. that affect the employment choice of the households. When we estimate the effect of the employment choice of a household on its nutrition consumption, the unobserved heterogeneity in the error term is likely correlated with our main explanatory variable. In this scenario, the fixed-effects (FE) estimator is unbiased as it relies only on the data variation within households and over time, in which any unobserved factors that do not vary over time cancel out (Wooldridge, 2010). In addition, we find significant variation in the employment choice variable between the two survey rounds (section 3.3), which further suggests that the FE estimator performs better than the RE estimator. Finally, also a Hausman test supports the application of a FE model.

4 Results and discussion

4.1 Descriptive statistics

In Table 5, we present the means of all six log-transformed nutrient consumption values grouped by different employment choices of the household. Tests for overall mean differences among different employment groups give a first idea of interactions between employment choice and nutrient consumption at the household level. In Table 5, we can see that households engaged in subsistence agriculture on average consume higher quantities of nutrients than those engaged in other forms of employment activities.[5] We can also see that the consumption levels for some nutrients steadily decrease as the households move from subsistence agriculture to other income-generating farm and off-farm activities. This is contrary to what is typically observed for subsistence agriculture households in other regions, where subsistence agriculture households are considered to be poor and thus exhibit lower consumption levels (Barrett, 2008; Sibhatu & Qaim, 2017). To further understand these contradicting patterns in consumption, we present the means of all nutrients by the household income level (measured as the quartiles of per capita consumption expenditure) in Table 6. As per the common evidence (Colen et al., 2018; Jumrani, 2023), the nutrient consumption increases with the increase in the household income level.

Furthermore, nutrient consumption by the intersection of employment choice and income level is shown in Appendix Tables A6 - A9. It appears that at lower income levels, households engaged in subsistence agriculture consume fewer nutrients than others, whereas at middle- and higher-income

[5]Note that households with no employment have a slightly higher consumption of nutrients. These households as discussed in section 3.3 depend on remittances or other forms of income and are likely well-off than the rest of the sample. However, we call for caution while interpreting the estimates for this employment category as they are also based on a few observations.

Table 5: Nutrients consumption by employment choice of the household

	SA	CA	SA & Off	CA & Off	Off	No-emp
Calories	8.11	8.10	7.92	8.03	7.96	8.17***
	(0.44)	(0.43)	(0.43)	(0.42)	(0.45)	(0.49)
Protein	4.41	4.42	4.25	4.36	4.27	4.47***
	(0.45)	(0.44)	(0.46)	(0.44)	(0.47)	(0.52)
Fat	4.31	4.31	4.17	4.29	4.21	4.44***
	(0.56)	(0.57)	(0.52)	(0.54)	(0.55)	(0.67)
Saturated fat	3.15	3.11	2.91	3.06	2.98	3.20***
	(0.73)	(0.72)	(0.65)	(0.63)	(0.72)	(0.88)
Carbohydrates	6.30	6.28	6.07	6.16	6.13	6.33***
	(0.46)	(0.43)	(0.44)	(0.41)	(0.48)	(0.49)
Total sugar	4.39	4.40	4.11	4.30	4.19	4.38***
	(0.64)	(0.64)	(0.60)	(0.61)	(0.68)	(0.59)
Sodium	8.70	8.78	8.66	8.77	8.56	8.79***
	(0.73)	(0.69)	(0.73)	(0.65)	(0.81)	(0.68)

Notes: Standard deviations in parentheses. Results from F-test of joint significance - * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Nutrients are measured in adult male equivalent (AME) units per day and are log-transformed.

levels, subsistence agricultural households consume higher quantities of all nutrients compared to other employment choices. This suggests that higher nutrient consumption levels in subsistence households are driven by relatively well-off households. At low-income levels, we observe the expected pattern of increased nutrient consumption with livelihood diversification (Carletto et al., 2017; D'Souza et al., 2019; Rahman & Mishra, 2019). Whereas, at middle- and higher-income levels, we observe a contrasting pattern where subsistence agricultural households are at the risk of overconsumption and livelihood diversification seems to bring improved dietary and consumption patterns. This further highlights the importance of disentangling the pathways presented in our conceptual framework—the subsistence pathway, and the income and lifestyle—pathway of livelihood diversification on nutrition.

4.2 Regression results

We present the FE regression results for the relationships among employment choice, market access, and nutrients in Table 7. Two important aspects of our conceptual framework (section 2.1)—the full

Table 6: Nutrients consumption by income level of the household

	Income quartile 1	Income quartile 2	Income quartile 3	Income quartile 4
Calories	7.78	7.97	8.11	8.24***
	(0.45)	(0.35)	(0.37)	(0.44)
Proteins	4.07	4.28	4.43	4.57***
	(0.46)	(0.36)	(0.38)	(0.47)
Fat	3.94	4.20	4.36	4.53***
	(0.57)	(0.46)	(0.45)	(0.54)
Saturated fat	2.70	2.98	3.16	3.33***
	(0.72)	(0.64)	(0.61)	(0.68)
Carbohydrates	5.97	6.14	6.27	6.37***
	(0.48)	(0.37)	(0.39)	(0.46)
Total sugar	3.92	4.19	4.42	4.57***
	(0.69)	(0.55)	(0.56)	(0.59)
Sodium	8.43	8.67	8.78	8.86***
	(0.89)	(0.64)	(0.65)	(0.66)

Notes: Standard deviations in parentheses. Results from F-test of joint significance - * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Nutrients are measured in adult male equivalent (AME) units per day and are log-transformed.

composite effect of employment choices and market access on nutrient consumption—are presented in these tables. In addition, the income and lifestyle effect of livelihood diversification is compared between models 1 and 2 as summarized in Table 7. Because the dependent variables are log-transformed, the coefficients are given in percentage changes. The reference group for estimated effects of employment choices is the subsistence agricultural activity. Hence, the estimated effects have to be understood relative to the mean consumption of respective nutrients in this reference group. We chose subsistence agriculture as the reference group because we consider this to be the traditional livelihood strategy of smallholder households and livelihood diversification always occurs out of subsistence agriculture to other income-generating farm and off-farm activities (Ellis, 1998; Loison, 2015).

Compared with households engaged in subsistence agriculture, households with commercialized agriculture consume lower quantities of calories, fat, saturated fat, and total sugar by 40, 79, 100, and 75 percent, respectively. Considering that the reference group—subsistence agricultural households—consumes excess nutrients (Table 5), it appears that the households that generate income through agricultural commercialization display a reduction in this excess consumption. This reduction in excess consumption is desirable as excess consumption of calories, fat, saturated fat, and total sugar is associated with overnutrition and diet-related NCDs (Popkin et al., 2020; Purushotham et al., 2023). This improvement in the nutrient consumption status might be associated with an initially positive income effect, which exhibits a shift away from the consumption of energy-dense staples to a diversified diet (Cazzuffi et al., 2020; Ntakyo & van den Berg, 2019; Pingali & Khwaja, 2004). However, if the same households are engaged in commercialized agriculture but are located further away from Bangalore city, the excess consumption of the same nutrients increases by 6-13 percent. It might be that these households in the hinterland are stuck in traditional dietary patterns consisting of staple foods rather than the ones that are closer to Bangalore and, thus, display excess consumption of nutrients (likely similar to households engaged in subsistence agriculture).

For the households engaged in a composite of commercialized agricultural and off-farm employment, we find that the consumption of calories, protein, fat, carbohydrates, and total sugar (Table 7) decreases by 41-85 percent in comparison to the subsistence agriculture households. These associations also indicate a reduction in the excess consumption of nutrients, which is a desirable outcome as it indicates an improvement in the nutrient consumption status. Similar to the case of commercialized agriculture above, if the households engaged in a composite of commercialized agriculture and off-farm employment are located further away from Bangalore city, we observe an increase in the excess consumption of nutrients by 7-13 percent. This again indicates that the sociocultural norms of food consumption and food environment might differ among households located away from Bangalore from their counterparts closer to the city. Hence, despite the livelihood diversification, excess nutrient consumption among these households increases.

When we compare the estimates between models 1 and 2, we observe positive coefficients for household income level. It indicates (as also observed in Table 6) that nutrient consumption increases with increased income. However, an important point to note is that even after controlling for household income level, the effect of household employment choice on nutrition remains more or less unchanged. In terms of pathways illustrated in Section 2.1, this indicates that the income effect of livelihood diversification increases the excess nutrient consumption (as observed by the positive coefficients for household income) and the effect brought about by households' engagement in commercial agriculture and off-farm employment activities reduce the excess nutrient consumption. This suggests that the relationship between livelihood diversification into the income-generating farm and off-farm employment and nutrition is mediated by a distinct factor—which we attribute as the lifestyle effect—in addition to the income factor. Thus, livelihood diversification for nutrition is important not just for the implications it brings on nutrition through income effect but also through lifestyle changes and nutritional knowledge.

Among the households that do not engage in any form of employment activity, we observe an increase in the consumption of calories, protein, and carbohydrates (Table 7) when compared to subsistence agricultural households. As discussed in section 4.1, the households with no employment activity who depend on remittances and other forms of income are likely well-off. Hence they exhibit higher consumption quantities of nutrients compared to the subsistence agricultural households. Furthermore, if these households with no employment activity are located further away from Bangalore city, they tend to consume less of the excess nutrients. This means that the nutrient consumption status in households with no employment activity is relatively worse than the subsistence agriculture households. On the contrary, if the same is located further away from Bangalore city, they display an improvement in their nutrient consumption.

In addition to the associations of different employment choices, we find that households' engagement in rearing cows for milk production is also associated with the reduction in the excess consumption of nutrients. Milk production is one of the stable sources of income for smallholder households in India and found to be positively correlated with milk consumption (Narayanan, Negi, & Gupta, 2023). Milk production in our sample households might not only increase the consumption of milk from their production but also improve the dietary patterns through market participation in selling the milk.

4.3 Calories consumed from different food groups

To bring more perspective to the results above, we estimate the effect of livelihood diversification on the calories consumed from different food groups at the household level in Table 8. Households engaged in a composite of commercialized agriculture and off-farm employment consume fewer quantities of calories from food groups such as cereals, fruits & vegetables, legumes & nuts, and oils & fats. This indicates an overall reduction in the calories consumed as a result of livelihood diversification. However, when we control for household income, we also observe significant reductions in the excess calories consumed from food groups such as oils & fats, sugars & sweets, and processed foods. This indicates that if some household members work outside the farm, they might bring changes in lifestyle and food preferences even after controlling for their income level. Though some forms of lifestyle changes are mostly discussed from the context of their undesirable effects on nutrition and health, they are beneficial if they lead to healthy eating practices (Popkin, 1999). In the case of Bangalore, the lifestyle effect of livelihood diversification particularly contributes to the reduced consumption of potentially unhealthy food groups such as oils & fats, sugars & sweets, and processed foods. This shows that considering the full composite effect of different income-generating employment choices (in this case commercialized agriculture and off-farm employment) is important for household nutrition. Previous studies that considered only either the agricultural operations or off-farm employment dimension might, thus, provide partial evidence on the relationship between livelihood strategies and nutrition (Carletto et al., 2017; Rahman & Mishra, 2019; Sibhatu et al., 2015). However, the lifestyle changes and food preferences effects of livelihood diversification do not seem to reach the same households that are located further away from Bangalore city. We can see that the consumption of calories from food groups such as cereals, legumes, ASF, oils & fat, sugars & sweets, and processed foods is higher among the households engaged in the aforementioned combination of employment choices and are located further away from Bangalore. This also highlights that the lifestyle effect accompanied by livelihood diversification penetrates households differently depending on their market access.

Table 7: Livelihood diversification, market access, and nutrients consumption at household-level—fixed-effects regression model

	Calories		Protein		Fat		Saturated fat		Carbohydrates		Total sugar		Sodium	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
SA (ref)														
CA	-0.408*	-0.350	-0.340	-0.277	-0.792**	-0.728**	-1.004**	-0.946**	-0.294	-0.244	-0.752**	-0.679*	-0.579	-0.534
	(0.197)	(0.184)	(0.206)	(0.192)	(0.258)	(0.247)	(0.340)	(0.333)	(0.201)	(0.192)	(0.289)	(0.275)	(0.366)	(0.362)
SA & Off	-0.139	-0.242	-0.166	-0.278	-0.389	-0.505	-0.559	-0.665	0.022	-0.067	0.096	-0.039	-0.326	-0.407
	(0.240)	(0.224)	(0.251)	(0.233)	(0.314)	(0.300)	(0.414)	(0.405)	(0.245)	(0.234)	(0.352)	(0.335)	(0.445)	(0.440)
CA & Off	-0.477**	-0.565**	-0.437*	-0.534**	-0.696**	-0.794***	-0.856**	-0.945**	-0.411*	-0.488**	-0.817**	-0.931***	-0.652	-0.720*
	(0.184)	(0.172)	(0.193)	(0.179)	(0.242)	(0.231)	(0.318)	(0.311)	(0.188)	(0.180)	(0.270)	(0.257)	(0.342)	(0.339)
Off	-0.123	-0.141	-0.177	-0.197	-0.097	-0.119	0.120	0.100	-0.067	-0.083	0.315	0.282	-0.122	-0.138
	(0.226)	(0.211)	(0.237)	(0.220)	(0.296)	(0.282)	(0.389)	(0.381)	(0.231)	(0.221)	(0.334)	(0.318)	(0.418)	(0.414)
No-emp	1.309*	1.239*	1.267*	1.190*	1.031	0.953	1.274	1.202	1.417*	1.357*	1.421	1.329	0.973	0.918
	(0.575)	(0.538)	(0.603)	(0.560)	(0.755)	(0.721)	(0.994)	(0.973)	(0.589)	(0.562)	(0.845)	(0.804)	(1.068)	(1.057)
Travel time to Bangalore	-0.003	-0.002	-0.003	-0.002	-0.004	-0.003	-0.006	-0.004	-0.003	-0.002	-0.005	-0.004	0.003	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)
SA # Bangalore (ref)														
CA # Bangalore	0.006*	0.005*	0.005	0.004	0.011**	0.010**	0.013**	0.012**	0.005	0.004	0.010**	0.009*	0.008	0.008
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
SA & Off # Bangalore	0.002	0.003	0.002	0.003	0.005	0.006	0.008	0.008	0.000	0.001	-0.001	-0.000	0.007	0.007
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.006)	(0.005)	(0.003)	(0.003)	(0.005)	(0.004)	(0.006)	(0.006)
CA & Off # Bangalore	0.008**	0.008***	0.007**	0.007**	0.010**	0.011***	0.013**	0.013**	0.007**	0.007**	0.012***	0.013***	0.011*	0.011*
	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)	(0.004)
Off # Bangalore	0.001	0.001	0.002	0.002	-0.001	-0.001	-0.004	-0.004	0.000	0.000	-0.006	-0.005	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)	(0.003)	(0.003)	(0.005)	(0.005)	(0.006)	(0.006)
No-emp # Bangalore	-0.019*	-0.019*	-0.019*	-0.019*	-0.015	-0.015	-0.019	-0.019	-0.021*	-0.021**	-0.020	-0.020	-0.015	-0.014
	(0.008)	(0.007)	(0.008)	(0.008)	(0.010)	(0.010)	(0.014)	(0.013)	(0.008)	(0.008)	(0.012)	(0.011)	(0.015)	(0.015)
Household income		0.193***		0.212***		0.215***		0.197***		0.168***		0.248***		0.151***
		(0.019)		(0.020)		(0.026)		(0.035)		(0.020)		(0.029)		(0.038)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1959	1959	1959	1959	1960	1960	1961	1961	1959	1959	1958	1958	1959	1959

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Model 1 estimates Eq. 1—the effect of employment choice and market access on nutrition. Model 2 estimates Eq. 2—disentangling the effect brought about by changes in income and lifestyle. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Controls: cow, household size, asset index, the person responsible for buying groceries, food source, the average age of household members, average education of household members, and time-fixed effects.

Table 8: Livelihood diversification, market access, and consumption of calories from different food groups at household-level—fixed-effects regression model

	Cereals		Fruits & vegetables		Legumes & nuts		Animal source foods		Oils & fats		Sugars & sweets		Processed foods	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
SA (ref)														
CA	-0.206	-0.165	-1.009*	-0.957*	-0.302	-0.211	-0.469	-0.375	-0.664	-0.572	-0.436	-0.367	-0.538	-0.424
	(0.220)	(0.214)	(0.405)	(0.400)	(0.373)	(0.362)	(0.381)	(0.368)	(0.348)	(0.338)	(0.389)	(0.380)	(0.513)	(0.493)
SA & Off	0.139	0.060	-0.391	-0.497	0.092	-0.043	-0.140	-0.293	-0.385	-0.514	0.357	0.204	-0.526	-0.752
	(0.268)	(0.261)	(0.494)	(0.488)	(0.450)	(0.437)	(0.465)	(0.449)	(0.419)	(0.407)	(0.474)	(0.463)	(0.626)	(0.601)
CA & Off	-0.423*	-0.490*	-0.903*	-0.994**	-0.769*	-0.881**	-0.575	-0.687*	-0.670*	-0.773*	-0.607	-0.727*	-0.819	-1.012*
	(0.206)	(0.201)	(0.380)	(0.375)	(0.346)	(0.336)	(0.355)	(0.343)	(0.322)	(0.313)	(0.364)	(0.355)	(0.481)	(0.462)
Off	-0.304	-0.321	0.219	0.193	-0.220	-0.248	-0.130	-0.158	-0.564	-0.588	0.433	0.355	-0.015	-0.067
	(0.252)	(0.246)	(0.465)	(0.459)	(0.424)	(0.412)	(0.439)	(0.424)	(0.395)	(0.383)	(0.457)	(0.446)	(0.591)	(0.567)
No-emp	1.526*	1.474*	1.861	1.787	2.065	1.974	1.975	1.871	-0.533	-0.624	2.610*	2.658*	2.400	2.249
	(0.642)	(0.625)	(1.184)	(1.169)	(1.077)	(1.047)	(1.103)	(1.065)	(1.001)	(0.972)	(1.184)	(1.155)	(1.499)	(1.439)
Travel time to Bangalore	-0.002	-0.002	-0.007	-0.006	-0.004	-0.003	0.001	0.002	-0.004	-0.002	-0.002	-0.001	-0.006	-0.003
	(0.003)	(0.003)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.006)	(0.006)
SA # Bangalore (ref)														
CA # Bangalore	0.004	0.003	0.013*	0.012*	0.005	0.003	0.006	0.005	0.009*	0.008	0.007	0.006	0.006	0.004
	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.007)	(0.006)
SA& Off # Bangalore	-0.002	-0.001	0.005	0.006	-0.002	-0.001	0.003	0.005	0.005	0.006	-0.004	-0.003	0.008	0.010
	(0.004)	(0.003)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.008)	(0.008)
CA & Off # Bangalore	0.007*	0.007**	0.013*	0.013**	0.011*	0.011*	0.009*	0.010*	0.010*	0.010*	0.011*	0.011*	0.013*	0.014*
	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
Off # Bangalore	0.004	0.004	-0.004	-0.004	0.003	0.003	0.001	0.001	0.007	0.007	-0.005	-0.004	-0.005	-0.004
	(0.004)	(0.003)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.007)	(0.006)	(0.008)	(0.008)
No-emp # Bangalore	-0.022*	-0.022*	-0.029	-0.028	-0.030*	-0.029*	-0.027	-0.027	0.009	0.009	-0.033*	-0.034*	-0.036	-0.036
	(0.009)	(0.009)	(0.016)	(0.016)	(0.015)	(0.014)	(0.015)	(0.015)	(0.014)	(0.013)	(0.016)	(0.016)	(0.021)	(0.020)
Household income		0.141***		0.186***		0.246***		0.278***		0.231***		0.239***		0.400***
		(0.023)		(0.043)		(0.038)		(0.039)		(0.036)		(0.041)		(0.052)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1952	1952	1952	1952	1944	1944	1928	1928	1937	1937	1896	1896	1950	1950

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Model 1 estimates Eq. 1—the effect of employment choice and market access on nutrition. Model 2 estimates Eq. 2—disentangling the effect brought about by changes in income and lifestyle. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Controls: cow, household size, asset index, the person responsible for buying groceries, food source, the average age of household members, average education of household members, and time-fixed effects.

5 Conclusion

We analyze how different employment choices of smallholder households affect their nutrient consumption. We are particularly interested in how the different combinations between household agricultural operations and off-farm employment are associated with nutrition in the face of dietary transition. Especially, when urbanization and improved market access enable households to engage in more than one form of employment, it is not just different types of employment chosen but also their combinations that affect their nutrition. Therefore, we present a conceptual framework describing the pathways between household employment choice and nutrition while accounting for the composite effect of different agricultural operations and off-farm employment, and the market access on the production and consumption side. In our empirical analysis, we use the consumption of calories, protein, fat, saturated fat, carbohydrates, total sugar, and sodium at the household level to explore the interactions between employment choices, market access, and household nutrition in the RUI of Bangalore. We find that on average households consume excess quantities of nutrients considered. Such high consumption shows the onset of dietary transition among our sample households and suggests the existence of multiple forms of malnutrition.

There are three main findings of our empirical analysis. First, a mix of income-generating agricultural operations and off-farm employment in households' livelihood portfolios is associated with changes in nutrient consumption. Relative to subsistence agriculture, households with commercialized agriculture display an improvement in their nutrient consumption status by consuming less excess nutrients. In addition, households engaged in a composite of commercialized agriculture and off-farm employment also exhibit a reduction in the excess consumption of nutrients when compared to households engaged in subsistence agriculture. Such reductions in the excess consumption of calories, protein, fat, saturated fat, carbohydrates, total sugar, and sodium indicate an improvement in the nutritional consumption status as their excess consumption is associated with overnutrition and diet-related NCDs (Popkin et al., 2020; Purushotham et al., 2023).

We find a distinct difference between nutrient consumption patterns among different employment choices. Factors driving these differences are probably the share of income generated from agricultural commercialization and off-farm employment relative to subsistence agricultural production, and access to food outlets but also lifestyle changes due to urban proximity and off-farm employment opportunities. This is highlighted by our second finding that upon disentangling the income effect, livelihood diversification to income-generating farm and off-farm employment reduces the excess consumption of nutrients through the lifestyle pathway. This reduction in excess consumption is achieved through the lower consumption of potentially unhealthy food groups such as oils & fats, sugars & sweets, and processed foods. This suggests that livelihood diversification leads to households' exposure to lifestyle changes that improve dietary patterns and food preferences and thus mediate the reduction in excess consumption of nutrients.

Third, we find that the lifestyle effects brought about by the employment choices in reducing excess nutrient consumption penetrate households differently depending on their location in the rural-urban gradient. That is, households located further away from Bangalore, despite the livelihood diversification, are vulnerable to excess nutrient consumption unlike their counterparts located close to Bangalore city. Proximity to an urban center improves market access on both the production and consumption side, which might bring behavioral and lifestyle changes that lead to a shift away from energy-dense staples to a nutrient-dense diet leading to a reduction in excess nutrient consumption (Pingali, 2007b; Pingali & Sunder, 2017).

These results not only fill an important gap in the literature but are also relevant for policymakers. We show that a combination of income-generating agricultural operations and off-farm employment is associated with a reduction in the excess consumption of nutrients. Thus, initiatives targeting the food systems to prevent emerging health issues such as overweight and/or diet-related NCDs should consider the full livelihood portfolio of a household and focus on the pathways through which livelihood diversification affects nutrition. Especially, households active in commercialized agriculture and with members engaged in off-farm employment that are located in the hinterlands are vulnerable to overconsumption of nutrients in our study context. Strengthening market integration for nutrient-dense foods such as fruits, vegetables, and ASF in rural areas is one of the commonly advocated policy measures to improve nutrition in smallholder households. Such policies should complement behavioral change communication (BCC) strategies on nutritional knowledge highlighting the benefits of shifting away from the excess consumption of traditional energy-dense staples and other unhealthy foods towards to intake of nutrient-rich food items, especially, in those areas facing multiple burdens of malnutrition.

The framework we propose in the study can be further applied in regions experiencing malnutrition as well as urbanization and rural transformation. One possible extension would be to differentiate between skilled and unskilled laborers to further explore the relevance of lifestyle changes associated with off-farm employment and reduction in excess consumption of nutrients. Furthermore, it is also worth exploring the role of dairy farming (for own consumption and selling in the market) in household nutrition. Since our nutrition indicators are estimated at the household level, we cannot conclude on the intra-household distribution of nutrients, especially the nutrient intake by vulnerable household members such as children and women. Therefore, another extension would be to use individual intake data to apply this conceptual framework.

References

Aiyar, A., Rahman, A., & Pingali, P. (2021, feb). India's rural transformation and rising obesity burden. *World Development*, *138*, 105258. Retrieved from https://doi.org/10.1016%2Fj.worlddev.2020.105258 doi: DOI: 10.1016/j.worlddev.2020.105258

Ameye, H. (2023). Dietary quality in rural areas, secondary towns, and cities: Insights from tanzania. *Food Security*. doi: DOI: 10.1007/s12571-023-01399-9

Babatunde, R. O., & Qaim, M. (2010, aug). Impact of off-farm income on food security and nutrition in nigeria. *Food Policy*, *35*(4), 303–311. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2010.01.006 doi: DOI: 10.1016/j.foodpol.2010.01.006

Barrett, C. B. (2008). Food systems and the escape from poverty and ill-health traps in sub-saharan africa. *SSRN Electronic Journal*. doi: DOI: 10.2139/ssrn.1141840

Berti, P. R. (2012). Intrahousehold distribution of food: A review of the literature and discussion of the implications for food fortification programs. *Food and Nutrition Bulletin*. doi: DOI: 10.1177/15648265120333s204

Bharadwaj, K. A. (2017). *Bengaluru's population to shoot up to 20.3 million by 2031 - the hindu.* Retrieved 2024-01-14, from https://www.thehindu.com/news/cities/bangalore/bengalurus-population-to-shoot-up-to-203-million-by-2031/article20941568.ece

Carletto, C., Corral, P., & Guelfi, A. (2017, feb). Agricultural commercialization and nutrition revisited: Empirical evidence from three african countries. *Food Policy*, *67*, 106–118. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2016.09.020 doi: DOI: 10.1016/j.foodpol.2016.09.020

Cazzuffi, C., McKay, A., & Perge, E. (2020, jul). The impact of agricultural commercialisation on household welfare in rural vietnam. *Food Policy*, *94*, 101811. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2019.101811 doi: DOI: 10.1016/j.foodpol.2019.101811

Chand, R., Srivastava, S. K., & Singh, J. (2017). *Changing structure of rural economy of* *india: Implications for employment and growth* (Tech. Rep.). NITI Aayog.

Chandrasekhar, S., & Mehrotra, N. (2016, April). Doubling farmers' incomes by 2022: What would it take? *Economics and Political Weekly*, *51*(18), 10–13. Retrieved from https://www.jstor.org/stable/44004225

Chatterjee, U., Murgai, R., & Rama, M. (2015, June). Employment outcomes along the rural-urban gradation. *Economics and Political Weekly*, *50*(26/27), 5–10. Retrieved from https://www.jstor.org/stable/24482080

Coates, J., Patenaude, B. N., Rogers, B. L., Roba, A. C., Woldetensay, Y. K., Tilahun, A. F., & Spielman, K. L. (2018). Intra-household nutrient inequity in rural ethiopia. *Food Policy*. doi: DOI: 10.1016/j.foodpol.2018.10.006

Coates, J., Rogers, B. L., Blau, A., Lauer, J., & Roba, A. (2017, oct). Filling a dietary data gap? validation of the adult male equivalent method of estimating individual nutrient intakes from household-level data in ethiopia and bangladesh. *Food Policy*, *72*, 27–42. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2017.08.010 doi: DOI: 10.1016/j.foodpol.2017.08.010

Cockx, L., Colen, L., & Weerdt, J. D. (2018, oct). From corn to popcorn? urbanization and dietary change: Evidence from rural-urban migrants in tanzania. *World Development*, *110*, 140–159. Retrieved from https://doi.org/10.1016%2Fj.worlddev.2018.04.018 doi: DOI: 10.1016/j.worlddev.2018.04.018

Colen, L., Melo, P., Abdul-Salam, Y., Roberts, D., Mary, S., & Paloma, S. G. Y. (2018). Income elasticities for food, calories and nutrients across africa: A meta-analysis. *Food Policy*. doi: DOI: 10.1016/j.foodpol.2018.04.002

Damania, R., Berg, C., Russ, J., Barra, A. F., Nash, J., & Ali, R. (2016, mar). Agricultural technology choice and transport. *American Journal of Agricultural Economics*, *99*(1), 265–284. Retrieved from https://doi.org/10.1093%2Fajae%2Faav073 doi: DOI: 10.1093/ajae/aav073

DCO. (2011). *Census of india 2011: Karnataka, district cesus handbook, bangalore* (Tech.

Rep.). Directorate of Census Operations Karnataka.

Deaton, A. S., & Dreze, J. (2008). Nutrition in india: Facts and interpretations. *SSRN Electronic Journal*. doi: DOI: 10.2139/ssrn.1135253

Debela, B. L., Demmler, K. M., Klasen, S., & Qaim, M. (2020). Supermarket food purchases and child nutrition in kenya. *Global Food Security*. doi: DOI: 10.1016/j.gfs.2019.100341

Deichmann, U., Shilpi, F., & Vakis, R. (2009, mar). Urban proximity, agricultural potential and rural non-farm employment: Evidence from bangladesh. *World Development*, *37*(3), 645–660. Retrieved from https://doi.org/10.1016%2Fj.worlddev.2008.08.008 doi: DOI: 10.1016/j.worlddev.2008.08.008

Demmler, K. M., Klasen, S., Nzuma, J. M., & Qaim, M. (2017). Supermarket purchase contributes to nutrition-related non-communicable diseases in urban kenya. *PLOS ONE*. doi: DOI: 10.1371/journal.pone.0185148

Diao, X., Magalhaes, E., & Silver, J. (2019, sep). Cities and rural transformation: A spatial analysis of rural livelihoods in ghana. *World Development*, *121*, 141–157. Retrieved from https://doi.org/10.1016%2Fj.worlddev.2019.05.001 doi: DOI: 10.1016/j.worlddev.2019.05.001

D'Souza, A., Mishra, A. K., & Hirsch, S. (2019, dec). Enhancing food security through diet quality: The role of nonfarm work in rural india. *Agricultural Economics*, *51*(1), 95–110. Retrieved from https://doi.org/10.1111%2Fagec.12543 doi: DOI: 10.1111/agec.12543

d'Amour, C. B., Pandey, B., Reba, M., Ahmad, S., Creutzig, F., & Seto, K. (2020). Urbanization, processed foods, and eating out in india. *Global Food Security*. doi: DOI: 10.1016/j.gfs.2020.100361

Ecker, O. (2018, aug). Agricultural transformation and food and nutrition security in ghana: Does farm production diversity (still) matter for household dietary diversity? *Food Policy*, *79*, 271–282. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2018

.08.002 doi: DOI: 10.1016/j.foodpol.2018.08.002

Ellis, F. (1998). Household strategies and rural livelihood diversification. *Journal of Development Studies*. doi: DOI: 10.1080/00220389808422553

Fafchamps, M., & Shilpi, F. (2003, aug). The spatial division of labour in nepal. *Journal of Development Studies*, *39*(6), 23–66. Retrieved from https://doi.org/10.1080%2F00220380312331293577 doi: DOI: 10.1080/00220380312331293577

Fiedler, J. L., & Yadav, S. (2017). How can we better capture food away from home? lessons from india's linking person-level meal and household-level food data. *Food Policy*. doi: DOI: 10.1016/j.foodpol.2017.08.015

Gupta, S., & Bansal, S. (2020). Effect of urbanization, sedentary lifestyle and consumption pattern on obesity: An evidence from india. *SSRN Electronic Journal*. Retrieved from http://dx.doi.org/10.2139/ssrn.3741382 doi: DOI: 10.2139/ssrn.3741382

Haggblade, S., Hazell, P., & Reardon, T. (2010, oct). The rural non-farm economy: Prospects for growth and poverty reduction. *World Development*, *38*(10), 1429–1441. Retrieved from https://doi.org/10.1016%2Fj.worlddev.2009.06.008 doi: DOI: 10.1016/j.worlddev.2009.06.008

Hoffmann, E., Jose, M., Nölke, N., & Möckel, T. (2017, nov). Construction and use of a simple index of urbanisation in the rural–urban interface of bangalore, india. *Sustainability*, *9*(11), 2146. Retrieved from https://doi.org/10.3390%2Fsu9112146 doi: DOI: 10.3390/su9112146

Imai, K. S., Gaiha, R., & Thapa, G. (2015, feb). Does non-farm sector employment reduce rural poverty and vulnerability? evidence from vietnam and india. *Journal of Asian Economics*, *36*, 47–61. Retrieved from https://doi.org/10.1016%2Fj.asieco.2015.01.001 doi: DOI: 10.1016/j.asieco.2015.01.001

Jariseta, Z. R., Dary, O., Fiedler, J. L., & Franklin, N. (2012). Comparison of estimates of the nutrient density of the diet of women and children in uganda by household consumption and expenditures surveys (hces) and 24-hour recall. *Food and Nutrition*

Bulletin. doi: DOI: 10.1177/15648265120333s208

Jatav, M., & Sen, S. (2013, June). Drivers of non-farm employment in rural india: Evidence from the 2009-10 nsso round. *Economics and Political Weekly*, *48*(26/27), 14-21. Retrieved from https://www.jstor.org/stable/23527236

Jones, A. D., Shrinivas, A., & Bezner-Kerr, R. (2014, jun). Farm production diversity is associated with greater household dietary diversity in malawi: Findings from nationally representative data. *Food Policy*, *46*, 1–12. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2014.02.001 doi: DOI: 10.1016/j.foodpol.2014.02.001

Jumrani, J. (2023). How responsive are nutrients in india. *Food Policy*, *114*(102379). doi: DOI: 10.1016/j.foodpol.2022.102379

Kennedy, E., & Reardon, T. (1994, feb). Shift to non-traditional grains in the diets of east and west africa: role of women's opportunity cost of time. *Food Policy*, *19*(1), 45–56. Retrieved from https://doi.org/10.1016%2F0306-9192%2894%2990007-8 doi: DOI: 10.1016/0306-9192(94)90007-8

Loison, S. A. (2015). Rural livelihood diversification in sub-saharan africa: A literature review. *The Journal of Development Studies*. doi: DOI: 10.1080/00220388.2015.1046445

Meenakshi, J. V. (2016, nov). Trends and patterns in the triple burden of malnutrition in india. *Agricultural Economics*, *47*(S1), 115–134. Retrieved from https://doi.org/10.1111%2Fagec.12304 doi: DOI: 10.1111/agec.12304

Mittal, N., & Vollmer, S. (2020). The double burden of malnutrition in bangalore, india. In *World review of nutrition and dietetics* (pp. 138–148). S. Karger AG. Retrieved from https://doi.org/10.1159%2F000507521 doi: DOI: 10.1159/000507521

Muthini, D., Nzuma, J., & Qaim, M. (2020, dec). Subsistence production, markets, and dietary diversity in the kenyan small farm sector. *Food Policy*, *97*, 101956. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2020.101956 doi: DOI: 10.1016/j.foodpol.2020.101956

Narayanan, S., Negi, D. S., & Gupta, T. (2023). Separability, spillovers, and segmented markets : Evidence from dairy in india. *Agricultural Economics*. doi: DOI: 10.1111/agec.12786

NFHS-5. (2019-21). *National family health survey 5 - state fact sheet, karnataka* (Tech. Rep.). Indian Institue of Population Science, New Delhi.

NITI-Aayog. (2016). *Evaluation study on role of public distribution system in shaping household and nutritional security in india, demo report* (Tech. Rep.). NITI Aayog.

Ntakyo, P. R., & van den Berg, M. (2019, aug). Effect of market production on rural household food consumption: evidence from uganda. *Food Security*, *11*(5), 1051–1070. Retrieved from https://doi.org/10.1007%2Fs12571-019-00959-2 doi: DOI: 10.1007/s12571-019-00959-2

Ogutu, S. O., & Qaim, M. (2019, feb). Commercialization of the small farm sector and multidimensional poverty. *World Development*, *114*, 281–293. Retrieved from https://doi.org/10.1016%2Fj.worlddev.2018.10.012 doi: DOI: 10.1016/j.worlddev.2018.10.012

Owusu, V., Abdulai, A., & Abdul-Rahman, S. (2011, apr). Non-farm work and food security among farm households in northern ghana. *Food Policy*, *36*(2), 108–118. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2010.09.002 doi: DOI: 10.1016/j.foodpol.2010.09.002

Pfeiffer, L., López-Feldman, A., & Taylor, J. E. (2009, feb). Is off-farm income reforming the farm? evidence from mexico. *Agricultural Economics*, *40*(2), 125–138. Retrieved from https://doi.org/10.1111%2Fj.1574-0862.2009.00365.x doi: DOI: 10.1111/j.1574-0862.2009.00365.x

Pingali, P. (2007a, dec). Agricultural growth and economic development: a view through the globalization lens. *Agricultural Economics*, *37*(s1), 1–12. Retrieved from https://doi.org/10.1111%2Fj.1574-0862.2007.00231.x doi: DOI: 10.1111/j.1574-0862.2007.00231.x

Pingali, P. (2007b, jun). Westernization of asian diets and the transformation of food systems: Implications for research and policy. *Food Policy*, *32*(3), 281–298. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2006.08.001 doi: DOI: 10.1016/j.foodpol.2006.08.001

Pingali, P., & Abraham, M. (2022, JUL). Food systems transformation in asia – a brief economic history. *Agricultural Economics*, *53*, 895–910. Retrieved from https://dx.doi.org/10.1111/agec.12734 doi: DOI: 10.1111/agec.12734

Pingali, P., Aiyar, A., Abraham, M., & Rahman, A. (2019). *Transforming food systems for a rising india*. Palgrave Macmillan.

Pingali, P., & Khwaja, Y. (2004). *Globalization of indian diets and the transformation of food supply systems* (Tech. Rep.). ESA Working Paper.

Pingali, P., & Sunder, N. (2017, oct). Transitioning toward nutrition-sensitive food systems in developing countries. *Annual Review of Resource Economics*, *9*(1), 439–459. Retrieved from https://doi.org/10.1146%2Fannurev-resource-100516-053552 doi: DOI: 10.1146/annurev-resource-100516-053552

Popkin, B. M. (1999, nov). Urbanization, lifestyle changes and the nutrition transition. *World Development*, *27*(11), 1905–1916. Retrieved from https://doi.org/10.1016%2Fs0305-750x%2899%2900094-7 doi: DOI: 10.1016/s0305-750x(99)00094-7

Popkin, B. M., Corvalan, C., & Grummer-Strawn, L. M. (2020, jan). Dynamics of the double burden of malnutrition and the changing nutrition reality. *The Lancet*, *395*(10217), 65–74. Retrieved from https://doi.org/10.1016%2Fs0140-6736%2819%2932497-3 doi: DOI: 10.1016/s0140-6736(19)32497-3

Preusse, V., Silva, M. S., Steinhübel, L., & Wollni, M. (2024, JAN). Covid-19 and agricultural labor supply: Evidence from the rural–urban interface of an indian mega-city. *Agribusiness*, *Not available*, Not available. Retrieved from https://dx.doi.org/10.1002/agr.21893 doi: DOI: 10.1002/agr.21893

Purushotham, A., Aiyar, A., & von Cramon-Taubadel, S. (2023). Processed foods, socio-economic status, and peri-urban obesity in india. *Food Policy*. doi:

DOI: 10.1016/j.foodpol.2023.102450

Purushotham, A., Mittal, N., Ashwini, B., Umesh, K., von Cramon-Taubadel, S., & Vollmer, S. (2022). A quantile regression analysis of dietary diversity and anthropometric outcomes among children and women in the rural–urban interface of bangalore, india. *Food Policy*. doi: DOI: 10.1016/j.foodpol.2021.102216

Radchenko, N., & Corral, P. (2017, feb). Agricultural commercialisation and food security in rural economies: Malawian experience. *The Journal of Development Studies*, *54*(2), 256–270. Retrieved from https://doi.org/10.1080%2F00220388.2017.1283014 doi: DOI: 10.1080/00220388.2017.1283014

Rahman, A., & Mishra, S. (2019, jul). Does non-farm income affect food security? evidence from india. *The Journal of Development Studies*, *56*(6), 1190–1209. Retrieved from https://doi.org/10.1080%2F00220388.2019.1640871 doi: DOI: 10.1080/00220388.2019.1640871

Reardon, T., & Minten, B. (2011, oct). Surprised by supermarkets: diffusion of modern food retail in india. *Journal of Agribusiness in Developing and Emerging Economies*, *1*(2), 134–161. Retrieved from http://dx.doi.org/10.1108/20440831111167155 doi: DOI: 10.1108/20440831111167155

Reardon, T., Tschirley, D., Liverpool-Tasie, Fanzo, J., Minten, B., Vos, . . . Popkin, B. M. (2021, mar). The processed food revolution in african food systems and the double burden of malnutrition. *Global Food Security*, *28*, 100466. Retrieved from http://dx.doi.org/10.1016/j.gfs.2020.100466 doi: DOI: 10.1016/j.gfs.2020.100466

Regmi, A., & Dyck, J. (2001). *Effects of urbanization on global demand* (A. Regmi, Ed.). DIANE Publishing.

Sauer, C. M., Reardon, T., Tschirley, D., Liverpool-Tasie, S., Awokuse, T., Alphonce, R., . . . Waized, B. (2021, JUL). Consumption of processed food amp; food away from home in big cities, small towns, and rural areas of tanzania. *Agricultural Economics*, *52*, 749–770. Retrieved from https://dx.doi.org/10.1111/agec.12652 doi: DOI: 10.1111/agec.12652

Schneider, K., & Masters, W. (2019, jun). Nutrient adequacy at the household level and the cost of nutritious diets in malawi (p10-055-19). *Current Developments in Nutrition*, *3*, nzz034.P10–055–19. Retrieved from https://doi.org/10.1093%2Fcdn%2Fnzz034.p10-055-19 doi: DOI: 10.1093/cdn/nzz034.p10-055-19

Sibhatu, K. T., Krishna, V. V., & Qaim, M. (2015, aug). Production diversity and dietary diversity in smallholder farm households. *Proceedings of the National Academy of Sciences*, *112*(34), 10657–10662. Retrieved from https://doi.org/10.1073%2Fpnas.1510982112 doi: DOI: 10.1073/pnas.1510982112

Sibhatu, K. T., & Qaim, M. (2017). Rural food security, subsistence agriculture, and seasonality. *PLOS ONE*. doi: DOI: 10.1371/journal.pone.0186406

Sibhatu, K. T., & Qaim, M. (2018, may). Review: Meta-analysis of the association between production diversity, diets, and nutrition in smallholder farm households. *Food Policy*, *77*, 1–18. Retrieved from https://doi.org/10.1016%2Fj.foodpol.2018.04.013 doi: DOI: 10.1016/j.foodpol.2018.04.013

Smith, L. C., & Subandoro, A. (2007). Measuring food security using household expenditure surveys. *Food security in practice technical guide series 3*. doi: DOI: 10.2499/0896297675

Steinhübel, L., & von Cramon-Taubadel, S. (2020, sep). Somewhere in between towns, markets and jobs – agricultural intensification in the rural–urban interface. *The Journal of Development Studies*, *57*(4), 669–694. Retrieved from https://doi.org/10.1080%2F00220388.2020.1806244 doi: DOI: 10.1080/00220388.2020.1806244

Sudhira, H., Ramachandra, T., & Subrahmanya, M. B. (2007). Bangalore. *Cities*. doi: DOI: 10.1016/j.cities.2007.04.003

Sununtnasuk, C., & Fiedler, J. L. (2017, oct). Can household-based food consumption surveys be used to make inferences about nutrient intakes and inadequacies? a bangladesh case study. *Food Policy*, *72*, 121–131. Retrieved from https://doi.org/

10.1016%2Fj.foodpol.2017.08.018 doi: DOI: 10.1016/j.foodpol.2017.08.018

Tak, M., Law, C., Green, R., & Shankar. (2022, oct). Processed foods purchase profiles in urban india in 2013 and 2016: a cluster and multivariate analysis. *BMJ Open*, *12*(10), e062254. Retrieved from http://dx.doi.org/10.1136/bmjopen-2022-062254 doi: DOI: 10.1136/bmjopen-2022-062254

Timmer, C. P. (2009, November). Do supermarkets change the food policy agenda? *World Development*, *37*(11), 1812–1819. Retrieved from http://dx.doi.org/10.1016/j.worlddev.2008.08.022 doi: DOI: 10.1016/j.worlddev.2008.08.022

Vandercasteelen, J., Beyene, S. T., Minten, B., & Swinnen, J. (2018, jun). Big cities, small towns, and poor farmers: Evidence from ethiopia. *World Development*, *106*, 393–406. Retrieved from https://doi.org/10.1016%2Fj.worlddev.2018.03.006 doi: DOI: 10.1016/j.worlddev.2018.03.006

Wardle, J., Haase, A. M., Steptoe, A., Nillapun, M., Jonwutiwes, K., & Bellisie, F. (2004). Gender differences in food choice: The contribution of health beliefs and dieting. *Annals of Behavioral Medicine*. doi: DOI: 10.1207/s15324796abm2702$_5$

Wardle, J., Parmenter, K., & Waller, J. (2000). Nutrition knowledge and food intake. *Appetite*. doi: DOI: 10.1006/appe.1999.0311

Weisell, R., & Dop, M. C. (2012, sep). The adult male equivalent concept and its application to household consumption and expenditures surveys (HCES). *Food and Nutrition Bulletin*, *33*(3_suppl2), S157–S162. Retrieved from https://doi.org/10.1177%2F15648265120333s203 doi: DOI: 10.1177/15648265120333s203

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data, second edition.* MIT Press.

Young, M. F., Nguyen, P., Tran, L. M., & Avula. (2020, feb). A double edged sword? improvements in economic conditions over a decade in indialed to declines in undernutrition as well as increases in overweight among adolescents and women. *The Journal of Nutrition*, *150*(2), 364–372. Retrieved from http://dx.doi.org/10.1093/jn/nxz251

doi: DOI: 10.1093/jn/nxz251

A Appendix

Table A1: Comparision of household characteristics by attrition status: replacements vs. stayers

	Replacements 90 (10.7%)	Stayers 755 (89.3%)	Total 845 (100.0%)	Test
Travel time to Bangalore	57.41 (9.57)	75.51 (13.89)	73.58 (14.60)	<0.001
Cow	0.10 (0.30)	0.52 (0.50)	0.47 (0.50)	<0.001
Household size	4.43 (1.49)	4.54 (2.28)	4.53 (2.21)	0.657
Asset index	7.08 (1.92)	6.93 (1.56)	6.95 (1.60)	0.417
Female shopper	0.29 (0.46)	0.23 (0.42)	0.24 (0.43)	0.254
Male shopper	0.67 (0.47)	0.68 (0.47)	0.68 (0.47)	0.767
Other shopper	0.04 (0.21)	0.08 (0.28)	0.08 (0.27)	0.196
Open market	0.00 (0.00)	0.04 (0.20)	0.04 (0.19)	0.054
Kirana store	0.87 (0.34)	0.76 (0.43)	0.77 (0.42)	0.025
Wholesale market	0.02 (0.15)	0.11 (0.31)	0.10 (0.30)	0.010
Supermarket	0.11 (0.32)	0.06 (0.23)	0.06 (0.24)	0.045
Other food sources	0.00 (0.00)	0.03 (0.18)	0.03 (0.17)	0.080
Average age	30.89 (10.18)	37.76 (11.13)	37.03 (11.23)	<0.001
Average education	7.93 (3.08)	6.89 (3.05)	7.00 (3.07)	0.002
Household income	9.82 (0.69)	9.92 (0.79)	9.91 (0.78)	0.265

Mean (Standard deviation), p-value from a pooled t-test.

Table A2: Comparision of household characteristics by attrition status: replacements vs. rest of the sample

	Replacements 90 (4.6%)	Rest of the sample 1,873 (95.4%)	Total 1,963 (100.0%)	Test
Travel time to Bangalore	57.41 (9.57)	70.78 (15.78)	70.17 (15.80)	<0.001
Cow	0.10 (0.30)	0.50 (0.50)	0.48 (0.50)	<0.001
Household size	4.43 (1.49)	4.60 (2.21)	4.59 (2.18)	0.480
Asset index	7.08 (1.92)	6.19 (1.76)	6.23 (1.77)	<0.001
Female shopper	0.29 (0.46)	0.25 (0.43)	0.25 (0.43)	0.353
Male shopper	0.67 (0.47)	0.62 (0.49)	0.62 (0.49)	0.340
Other shopper	0.04 (0.21)	0.14 (0.34)	0.13 (0.34)	0.011
Open market	0.00 (0.00)	0.06 (0.24)	0.06 (0.24)	0.013
Kirana store	0.87 (0.34)	0.58 (0.49)	0.59 (0.49)	<0.001
Wholesale market	0.02 (0.15)	0.16 (0.36)	0.15 (0.36)	<0.001
Super market	0.11 (0.32)	0.16 (0.36)	0.15 (0.36)	0.245
Other food sources	0.00 (0.00)	0.04 (0.20)	0.04 (0.20)	0.048
Average age	30.89 (10.18)	35.31 (11.16)	35.11 (11.16)	<0.001
Average education	7.93 (3.08)	6.61 (3.02)	6.67 (3.04)	<0.001
Household income	9.82 (0.69)	8.89 (1.10)	8.93 (1.10)	<0.001

Mean (Standard deviation), p-value from a pooled t-test.

Table A3: Attrition probit model

	(Attrition)	
Cow	-0.948***	(0.265)
Household size	-0.092	(0.065)
Asset index	-0.383***	(0.084)
Female shopper (ref)		
Male shopper	-0.779*	(0.303)
Other shopper	-0.226	(0.416)
Open market (ref)		
Kirana store	-0.259	(0.504)
Wholesale market	-0.271	(0.567)
Supermarket	0.346	(0.565)
Other food source	-0.249	(0.788)
Average age	-0.048***	(0.013)
Average education	-0.034	(0.048)
Constant	1.346	(0.930)
lnsig2u	4.141***	(0.123)
Observations	1962	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A4: Fixed effects model after controlling for potential attrition bias

	Calories	Protein	Fat	Saturated fat	Carbohydrates	Total sugar	Sodium
SA (ref)							
CA	-0.350	-0.277	-0.729**	-0.946**	-0.244	-0.680*	-0.534
	(0.184)	(0.192)	(0.247)	(0.333)	(0.192)	(0.275)	(0.362)
SA & Off	-0.241	-0.274	-0.496	-0.662	-0.068	-0.028	-0.397
	(0.225)	(0.234)	(0.301)	(0.406)	(0.235)	(0.335)	(0.441)
CA & Off	-0.564**	-0.531**	-0.787***	-0.943**	-0.489**	-0.923***	-0.713*
	(0.173)	(0.180)	(0.231)	(0.312)	(0.180)	(0.258)	(0.339)
Off	-0.141	-0.196	-0.119	0.100	-0.083	0.281	-0.137
	(0.211)	(0.220)	(0.282)	(0.381)	(0.221)	(0.318)	(0.414)
No-emp	1.244*	1.219*	1.012	1.221	1.351*	1.401	0.983
	(0.541)	(0.563)	(0.725)	(0.979)	(0.565)	(0.808)	(1.064)
Travel time to Banagalore	-0.002	-0.002	-0.003	-0.004	-0.002	-0.004	0.004
	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)
SA # Bangalore							
CA # Bangalore	0.005*	0.004	0.010**	0.012**	0.004	0.009*	0.008
	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.005)
SA & Off # Bangalore	0.003	0.003	0.006	0.008	0.001	-0.000	0.007
	(0.003)	(0.003)	(0.004)	(0.005)	(0.003)	(0.004)	(0.006)
CA & Off # Bangalore	0.008***	0.007**	0.011***	0.013**	0.007**	0.013***	0.011*
	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)
Off # Bangalore	0.001	0.002	-0.001	-0.004	0.000	-0.005	0.000
	(0.003)	(0.003)	(0.004)	(0.005)	(0.003)	(0.005)	(0.006)
No-emp # Bangalore	-0.019*	-0.019*	-0.015	-0.019	-0.021**	-0.021	-0.015
	(0.007)	(0.008)	(0.010)	(0.014)	(0.008)	(0.011)	(0.015)
Household income	0.193***	0.213***	0.216***	0.197***	0.168***	0.250***	0.152***
	(0.019)	(0.020)	(0.026)	(0.035)	(0.020)	(0.029)	(0.038)
Inverse mills ratio	-0.079	-0.488	-1.013	-0.333	0.104	-1.244	-1.109
	(0.958)	(0.997)	(1.283)	(1.732)	(1.001)	(1.432)	(1.883)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1959	1959	1960	1961	1959	1958	1959

Notes: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Model 1 estimates Eq. 1—the effect of employment choice and market access on nutrition. Model 2 estimates Eq. 2—disentangling the effect brought about by changes in income and lifestyle. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Controls: cow, household size, asset index, the person responsible for buying groceries, food source, the average age of household members, average education of household members, and time-fixed effects.

Table A5: Description of food items in calories from different food groups

Food groups	Food items
Cereals	Barley, Flattened rice, Finger millet, Jowar, Maize, Puffed rice, Refined wheat flour, Rice, Small millets, Vermicelli, Wheat, Wheat flour
Fruits & vegetables	Apple, Banana, Berries, Dates, Grapes, Guava, Jack fruit, Muskmelon, Kiwi, Leechi, Lemon, Mango, Orange, Pears, Pineapple, Raisin, Water chestnut, and Watermelon, Arum, Beetroot, Bitter gourd, Brinjal, Cabbage, Capsicum, Carrot, Cauliflower, Chillies, Coconut, Cucumber, Curry leaves, French beans, Garlic, Ginger, Gourd, Green Jack fruit, Green papaya, Green plantain, Ridge gourd, Okra, Onion, Pointed gourd, Potato, Pumpkin, Radish, Salad, Snake gourd, Spinach, Sweet potato, Tomato, Turnip
Legumes & nuts	Tur lentil, Chickpea lentil, Horse gram, Green gram, Black gram, Peas, Soybean, Cashew nuts, Ground nuts, Walnuts
Animal source foods	Beef, Chicken, Curd, Eggs, Fish, Mutton, Milk, Milk powder, Pork
Oils & fats	Butter, Edible oil, Ghee, Groundnut oil, Mustard oil, Oil seeds, Margarine
Sugars & sweets	Sugar, Jaggery
Processed foods	Biscuits, Bread, Burger, Cake and pastry, Candy, Chicken nuggets, Cola, Purchased meals, French fries, Purchased fruit juice and shakes, Ice cream, Maggie noodles, Mazaa, Packaged paratha, Packaged roti, Pickles, Pizza, Purchased sweets, Rolls, Salted refreshments, Sauce

Table A6: Nutrients consumption by employment choice of the household among households in income quartile 1

	SA	CA	SA & Off	CA & Off	Off	No-emp
Calories	7.79	7.97	7.71	7.85	7.67	7.91***
	(0.42)	(0.47)	(0.39)	(0.40)	(0.47)	(0.43)
Protein	4.09	4.26	4.01	4.17	3.95	4.17***
	(0.41)	(0.49)	(0.42)	(0.43)	(0.49)	(0.43)
Fat	3.94	4.06	3.95	4.00	3.85	4.06
	(0.51)	(0.67)	(0.51)	(0.49)	(0.59)	(0.74)
Saturated fat	2.76	2.85	2.66	2.73	2.59	2.79
	(0.69)	(0.79)	(0.61)	(0.60)	(0.77)	(0.79)
Carbohydrates	5.99	6.18	5.87	6.04	5.86	6.12***
	(0.45)	(0.46)	(0.39)	(0.41)	(0.53)	(0.38)
Total sugar	3.95	4.18	3.84	4.00	3.78	4.06***
	(0.67)	(0.77)	(0.55)	(0.58)	(0.74)	(0.59)
Sodium	8.41	8.64	8.49	8.63	8.21	8.38***
	(0.82)	(0.72)	(0.71)	(0.73)	(1.09)	(0.72)

Notes: Standard deviations in parentheses. Results from F-test of joint significance - * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Nutrients are measured in adult male equivalent (AME) units per day and are log-transformed.

Table A7: Nutrients consumption by employment choice of the household among households in income quartile 2

	SA	CA	SA & Off	CA & Off	Off	No-emp
Calories	8.08	8.01	7.88	7.95	7.94	7.93***
	(0.32)	(0.38)	(0.32)	(0.38)	(0.33)	(0.28)
Protein	4.38	4.33	4.19	4.26	4.25	4.20**
	(0.34)	(0.37)	(0.35)	(0.39)	(0.35)	(0.31)
Fat	4.30	4.21	4.10	4.20	4.20	4.23
	(0.45)	(0.49)	(0.47)	(0.47)	(0.41)	(0.64)
Saturated fat	3.16	3.00	2.74	2.98	2.97	3.02***
	(0.66)	(0.64)	(0.61)	(0.59)	(0.64)	(0.90)
Carbohydrates	6.25	6.19	6.05	6.10	6.10	6.05***
	(0.35)	(0.38)	(0.33)	(0.39)	(0.38)	(0.33)
Total sugar	4.30	4.31	4.02	4.19	4.13	4.05***
	(0.46)	(0.54)	(0.55)	(0.60)	(0.56)	(0.41)
Sodium	8.60	8.72	8.67	8.81	8.56	8.67*
	(0.63)	(0.65)	(0.76)	(0.61)	(0.59)	(0.35)

Notes: Standard deviations in parentheses. Results from F-test of joint significance - * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Nutrients are measured in adult male equivalent (AME) units per day and are log-transformed.

Table A8: Nutrients consumption by employment choice of the household among households in income quartile 3

	SA	CA	SA & Off	CA & Off	Off	No-emp
Calories	8.27	8.17	8.00	8.09	8.05	8.25***
	(0.30)	(0.39)	(0.40)	(0.35)	(0.34)	(0.35)
Protein	4.57	4.47	4.35	4.42	4.36	4.57***
	(0.32)	(0.40)	(0.44)	(0.37)	(0.34)	(0.40)
Fat	4.47	4.40	4.27	4.34	4.33	4.48***
	(0.42)	(0.47)	(0.42)	(0.49)	(0.44)	(0.40)
Saturated fat	3.34	3.23	3.03	3.12	3.12	3.13**
	(0.59)	(0.69)	(0.54)	(0.58)	(0.62)	(0.65)
Carbohydrates	6.46	6.34	6.14	6.23	6.20	6.42***
	(0.35)	(0.41)	(0.43)	(0.36)	(0.36)	(0.38)
Total sugar	4.64	4.55	4.17	4.41	4.31	4.54***
	(0.39)	(0.60)	(0.55)	(0.57)	(0.55)	(0.48)
Sodium	8.93	8.86	8.73	8.77	8.66	8.88**
	(0.54)	(0.69)	(0.67)	(0.63)	(0.64)	(0.83)

Notes: Standard deviations in parentheses. Results from F-test of joint significance - * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Nutrients are measured in adult male equivalent (AME) units per day and are log-transformed.

Table A9: Nutrients consumption by employment choice of the household among households in income quartile 4

	SA	CA	SA & Off	CA & Off	Off	No-emp
Calories	8.41	8.26	8.09	8.14	8.30	8.45***
	(0.42)	(0.40)	(0.48)	(0.46)	(0.37)	(0.58)
Protein	4.71	4.59	4.43	4.49	4.62	4.78***
	(0.45)	(0.41)	(0.50)	(0.49)	(0.40)	(0.62)
Fat	4.63	4.54	4.38	4.47	4.59	4.81**
	(0.61)	(0.52)	(0.55)	(0.58)	(0.40)	(0.70)
Saturated fat	3.46	3.34	3.19	3.26	3.38	3.69*
	(0.78)	(0.69)	(0.69)	(0.63)	(0.58)	(0.97)
Carbohydrates	6.59	6.38	6.23	6.22	6.44	6.58***
	(0.42)	(0.42)	(0.51)	(0.45)	(0.41)	(0.62)
Total sugar	4.80	4.54	4.38	4.47	4.66	4.70***
	(0.60)	(0.60)	(0.61)	(0.58)	(0.51)	(0.60)
Sodium	8.94	8.89	8.74	8.81	8.90	9.10
	(0.75)	(0.67)	(0.76)	(0.63)	(0.53)	(0.54)

Notes: Standard deviations in parentheses. Results from F-test of joint significance - * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. SA—subsistence agriculture, CA—commercialized agriculture, SA & Off—subsistence agriculture and off-farm employment, CA & Off—commercialized agriculture and off-farm employment, Off—off-farm employment, and No-emp—no employment activity. Nutrients are measured in adult male equivalent (AME) units per day and are log-transformed.