Original Research Article

Local Food Environment and Household Food Security Status: Case Study of Pulilan, Bulacan, Philippines

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Abstract

The persistent problem of food insecurity has been a major global concern. Understanding the relationship between the food environment and how it affects food security is crucial for improving the overall health and well-being of the population. This study utilized secondary cross-sectional data from the 2016 Local Level Food Health and Nutrition Survey (LFHNS) conducted by the Department of Science and Technology- Food and Nutrition Research Institute (DOST-FNRI) in the Municipality of Pulilan, Bulacan. Logistic regression was used to determine the association between the density of food stores, perceived nutrition environment, and food security status. The study's results showed no association between the density of food stores, perceived nutrition environment, and food security; however, a positive association was found with the number of food stores. Findings showed that for every unit increase in the number of food stores, an increase of 1.9 food-secure households (p=<0.05, 95% C.I. 1.3-2.7) was noted. The "sari-sari store" was the most common type of food store and the most accessible among the poor and poorest households. Further studies should include other food environment factors affecting food security, such as typology, proximity, and other food retail outlets available in the community, including traditional restaurants or carinderia and fast-food chains.

Keywords— food access, food store, food environment, perceived food environment, food security

1 Introduction

The persistent hunger and food insecurity of households and individuals have been a major global concern. Over the years, efforts have been made to enhance the nutritional outcomes of the expanding global population by improving food systems. This is to facilitate healthier food options, improve food security status, and enhance the quality of the food environment [1]. The United Nations' 2030 Agenda on Sustainable Development has established 17 global goals aimed at addressing and improving the challenges faced by the world. One of these goals is Zero Hunger (SDG2), which seeks to eradicate all forms of hunger, ensure food security, promote sustainable agriculture, and improve nutrition [2].

According to Turner et al. [3], "The food environment is the interface that mediates people's food acquisition and consumption within the wider food system. It encompasses external dimensions such as the availability, prices, vendor, and product properties, and promotional information; and personal dimensions such as the accessibility, affordability, convenience, and desirability of food sources and products". The food environment serves as the connection between the individual's food acquisition and consumption to the broader food systems. Improving accessibility and availability in the local food environment can create many opportunities to enhance food security and promote better nutrition for society.

Kent and Thompson [4] have highlighted the significance of having access to nutritious food choices that impact health behaviors, especially in relation to chronic illnesses. Moreover, having access to supermarkets and grocery stores, as well as small grocery/convenience stores, can help mitigate the likelihood of adults experiencing food insecurity [5].

The food environment is where consumers interact with the food system to acquire and eat food. It determines what food consumers can access at any given time, at what price, and with what degree of convenience [3]. The food environment may greatly influence people's food choices and consumption patterns. It can either promote or hinder their healthy food consumption, significantly impacting their health and overall well-being. In the Philippines, there are about 33,215 establishments engaged in accommodation and food service in 2021, based on the Annual Survey of Business and Industry [6]. However, smaller food stores and establishments such as household-level variety stores (sari-sari stores) and street vendors are not accounted for and often offer mostly packaged and ready-to-eat unhealthy foods that can be easily purchased within the local community. Given that food environments are associated with dietary intake [7, 8, 9], neighborhood food environments may exacerbate poor dietary intake associated with food insecurity among households through less availability and accessibility of low-energy, nutritious foods and excess availability of cheaper energy-dense foods. There is available data on the food and nutrition situation in the country; however, limited local literature is available to better understand the relationship between the food environment and the food security situation of households and individuals. The decline in the consumption of fruits and vegetables in recent years further amplifies the need to have a holistic approach in the conduct of research to provide sustainable, accessible, and healthier food options to the public, particularly in areas with a high prevalence of food insecurity and malnutrition.

The two key components of the food environment are availability, which refers to the range of food options and outlets, and accessibility, which involves the proximity of food sources and the ability to obtain food [3]. These factors may be linked to the food security status of an individual or at the household level [5, 10]. Food security is defined as when all people, at all times, have physical, economic, and social access to sufficient, safe, and nutritious food for a healthy and active life [11].

Using the Household Food Insecurity Access Scale (HFIAS), the proportion of food-secure households in the Philippines has steadily increased, from 34.1% in 2013 to 33.9% in 2015 and peaking at 44.0% in 2018-2019. Although food insecurity in the country remains more than half of the population, it has decreased from 65.9% in 2013 to 56.0% in 2018-2019, with the largest difference

between 2015 and 2018-2019 [12]. A study [13] conducted in Cambodia, Myanmar, and the Philippines discussed the importance of various factors affecting the achievement of food security in these countries. Factors such as the impact of climate change on the local food system, land ownership, distribution and transport, economic status, access to basic needs, and the food environment were deemed as important concerns that need to be addressed [13].

In this study, we explored how different types of food stores relate to the food security of households among adults in a peri-urban municipality, particularly in Pulilan, Bulacan, where most livelihoods are focused on agriculture such as farming, fishing, swine, and poultry raising but also the presence of manufacturing and retail industry [14]. This study aimed to identify the association between the density of food stores and the food security status of households. The study also determined the number of food stores present in the municipality. Furthermore, the perceived nutrition environment of households, in terms of the type, location, and accessibility of food stores in the community, and the association between the perceived nutrition environment and food security were explored.

The density of food stores, particularly sari-sari stores at the barangay level, was determined to understand whether these constrain or facilitate food security and healthier eating among the residents in the area. This information can provide insights and empirical evidence on the nexus of food availability, accessibility, and nutrition at the micro level that may be important to program managers, policymakers, and the public in terms of zoning and environmental planning for health and nutrition promotion. The results of this study may contribute to the body of knowledge and help address research gaps in the food environment, which remains an understudied component of the food system in Low- and Middle-Income Countries (LMICs).

To our knowledge, this is the first study done in the local context in the Philippines that looks into the association of the types and density of food stores with the food security status of households in the community.

2 Materials and Methods

2.1 Data Source and Sampling Method

This study utilized secondary, cross-sectional data from the 2016 Local-level Food, Health, and Nutrition Survey (LFHNS) particularly on the Food Environment Survey (FES), conducted by the Food and Nutrition Research Institute (DOST-FNRI) to examine the association of household food security, perceived nutrition environment, and identification of the different types of food outlets available in the area where people buy food to prepare at home. The LFHNS aimed to determine the food, health, and nutrition situation at the household and the food establishments within selected local government units (LGUs) to produce estimates on various food, health, and nutrition indicators at the provincial and selected municipal levels.

The selection of target sample households was done through the use of the Community-Based Monitoring System (CBMS) 2014 listings as a sampling frame. The total sample size was determined using Simple Random Sampling (SRS), while sample households in each barangay were allocated proportionally to the distribution of households by barangay in Pulilan. The LFHNS targeted 1,200 households with a 3% level of absolute precision within the 95% CI and selected the highest proportion of 50%. Sample allocation across barangays followed the Probability Proportional to Size (PPS) method, where the number of households selected in each barangay was proportional to its share of the total household population in Pulilan, Bulacan.

The Food Environment Survey (FES) component gathered data on food stores and food establishments where households purchased food for consumption, as well as the safety and nutritional value of food consumed outside the home. This was done to determine the characteristics and availability of food in the survey area. However, this study focused only on the food stores that were

present during the time of data collection and excluded food establishments that sold only cooked foods in the area. A total enumeration was conducted for all food stores and food establishments available in the community during the data collection period.

Food stores were categorized based on the number of cash registers and the number of people manning the store. These were then grouped into Mobile Stores, Sari-sari stores, Convenience stores, Grocery stores, Talipapa, Public Markets, Weekend Market, Supermarket/Hypermarket, Food Kiosks/Stall, Night Market, and Single Food Item stores. These were located and mapped using the Geographical Information System (GIS) within the barangay. Consent to participate in the survey was obtained from the owner of the food stores as survey participants, and an informed consent form was signed as proof of voluntary participation.

Meanwhile, at the household level, the HFIAS was used to determine the household's food security status. This consisted of nine questions about experiences within the past 30 days and probed for how frequently these conditions were experienced by the household. This was conducted through a face-to-face interview using an in-house developed electronic data collection system (e-DCS).

To evaluate the perceived nutrition environment, a validated questionnaire was administered during the same face-to-face interviews, also facilitated by the e-DCS. Perceived nutrition environment refers to an individual's subjective assessment of their food environment, including the availability, accessibility, quality, and affordability of healthy food options within their community.

Availability and variety were assessed by asking meal planners whether fruits, vegetables, fish, meat, and poultry/chicken were available for purchase within a 20 to 30-minute walk from their home, and how frequently they observed these food items in their local stores or food retail outlets. Food quality was measured by asking whether the foods available were perceived to be fresh and of good quality. Response options included "no", "yes, sometimes", "yes, always", and "not applicable." Perceived food cost was evaluated by asking meal planners to rate food prices of the available food items they mentioned, using a seven-point scale ranging from "very expensive" to "very inexpensive."

Additional questions explored the usual food shopping practices of household meal planners, including where they typically purchase food for household consumption. A one-time checklist was also completed to assess the availability and quality of foods sold in various food stores. This included checking food labels and identifying fortified food items.

2.2 Operational Definitions

The operational definitions of food store types and perceived nutrition environment characteristics were developed as guides for data collection and analysis. Table 1 presents the classification of different types of food stores, while Table 2 defines key characteristics of the nutrition environment.

2.3 Inclusion Criteria and Exclusion Criteria

All households with complete data on socio-economic and demographic profile, food security, perceived nutrition environment, and all food stores, including mobile vendors, present in the study area were all included in the analysis of this study.

All households with incomplete data on socio-economic and demographic profiles, food security, and perceived nutrition environment were excluded from the study. Food establishments present in the study area were not included in this study.

2.4 Socio-demographic Characteristics of Households

A total of 752 households and 1,967 food stores in Pulilan were included in the study. Nearly half (46.2%) of the meal planners were between the ages of 40 to 59 years old, and most were females

Table 1. Operational definition of the different types of food stores in Pulilan, Bulacan, 2016

Food Store Type	Definition
Convenience Store	A food store that operates for longer hours, like 15 hours up to 24 hours a day (e.g. 6 am-10 pm operating hours) for the convenience of customers and has 1-2 cash registers, like the grocery store (e.g., Ministop, 7-11, Family Mart, etc.)
Food Kiosk/Stall	A stand, booth, or compartment from which food products and other goods are sold. Some kiosks/stalls are in open markets, but usually located in large covered areas such as malls.
Grocery Store	Stores that often offer non-perishable food that is packaged in cans, bottles, and boxes, with some also having fresh produce, butchers, delis, and bakeries. To differentiate it from sari-sari stores and supermarkets, the food store will be classified as a grocery if there are 1-2 cash registers.
Mobile Store	When food items are sold by vendors pushing carts or riding a pedicab, tricycle or any vehicle as a means to sell food items in the neighborhood.
Public Market	A place, building, or structure of any kind owned or operated by a city or municipality designated as such by the city or municipality, dedicated to the service of the general public, where basic food items and other commodities are displayed and offered for sale [15].
Sari-sari store	A small one-stop shop offering almost anything from candies to alcohol and many non-food and household food items. It does not maintain a cash register.
Single Item Store	A store that sells only one type of food item (e.g., rice retailer, fruit stand, meat shop, etc.)
Supermarket/ Hypermarket	A store that sells both food and household merchandise, organized in aisles. It has more than 3 cash registers.
Talipapa	A small version of a wet market in a village or barangay.
Tiangge	Sells both food and non-food items. It may be indoors, as in a warehouse or school gymnasium, or outdoors, as in a field, parking lot under a tent. Its market can be held annually or semi-annually. Others may be conducted monthly, on weekends, or daily. (e.g., bazaar, tabuan, expo, etc.)
Weekend Market	A more focused kind of farmers' market, such as organically produced food items applicable to affluent foodie communities in Metro Manila and suburban.

*Pharmacy, food establishment/ carinderia, and bakery that sell other food items will be classified as sari-sari or grocery stores depending on the availability of cash registers.

Table 2. Operational definitions on perceived nutrition environment, Pulilan, Bulacan, 2016

Characteristics	Definition
Affordability	The ability of meal planners to buy food items within their budget.
Availability	Food items are available for purchase within a 20 to 30-minute walk from their home.
Fresh Food	Food items that are not preserved and processed such as fresh meat, poultry, eggs, fruits, and vegetables.
Good Quality	Characterized by perceived freshness, cleanliness, properly packed and stored, free from insect infestation, discoloration, offensive odor, deterioration, any deformities, and other foreign matter.
Healthy Food	Food items that are nutrient-dense such as whole grains, fruits and vegetables, legumes and nuts, unprocessed meat, poultry and eggs.
Variety	Refers to the number and diversity of food selections available in the area, indicated by the presence of at least three or more kinds of fruits and vegetables, or at least three different sellers or meat producers.

(86.8%). Half of the meal planners did not have a job or business (51.7%) and were high school graduates (46.2%). Disaggregated by wealth, the data showed a relatively balanced distribution across the different wealth status categories. However, a considerable proportion of the households fall into the poorest (19.7%) and poor (20.7%) wealth categories, and 61.1% of the households were food insecure (Supplementary Table S1).

2.5 Statistical Analysis

Descriptive statistics were used to present frequency, percentages, standard errors, and a 95% confidence interval using STATA 16.1. The density of food stores was computed per 1,000 population per barangay to estimate the food store density. Bivariate analysis was used to explore the association of food security with the various study variables.

Logistic regression was applied to analyze the association between household food security and other indicators. Both crude and adjusted odds ratios were calculated for each predictor and were considered significant with a probability value of $p<0.05$. A simple linear regression analysis was employed to examine the relationship between the density of food stores and the number of food stores present in the community, and the food security status of households.

2.6 Ethical Clearance

The 2016 Local-level Food, Health, and Nutrition Survey proposal was submitted to the FNRI Institutional Review Committee (FIERC) for ethical clearance and was approved on May 19, 2016, with protocol code FIERC-2016-005.

3 Results

3.1 Food Security Status

The result of the study revealed that households with meal planners aged <40 years old (70.3%) and 40-59 years old (59.3%) were food insecure, with no significant difference for the food security status of households with meal planners 60 years old and above. Additionally, there were more food-insecure households among female (62.2%) meal planners compared to male (54.1%). Furthermore, meal planners who reached college level (54.4%) have a higher proportion of food-secure households, while the highest proportion of food-insecure was among those who reached only the elementary level (66.1%). Food security is directly proportional to wealth status, with more food security among the richest households (72.3%) and higher food insecurity among the poorest

(83.9%) (Supplementary Table S2).

Results showed that Brgy. Longos and Brgy. Penabatan had the highest proportion of food-insecure households, with 59.5% and 57.1%, respectively. Furthermore, the proportion of food-secure households was highest in Brgy. Tibag (76.0%) and Brgy. Cutcot (74.1%) (Supplementary Table S3).

3.2 Number and Types of Food Stores

Figure 1 summarizes the different types and the number of food stores present in Pulilan, Bulacan. A total of 1,967 food stores were recorded, with 1,683 of them being sari-sari stores, and the highest number was in Brgy. Poblacion. Sari-sari store was the common type of food store found in all barangays. A sari-sari store is a local Filipino retail store that offers mostly processed and packaged food products, ready-to-drink sugar-sweetened beverages, condiments, and ready-to-eat calorie-dense foods sold in small amounts (popularly known as tingi tingi in Filipino culture) and minimum price [16]. These serve as the primary source of daily necessities, mostly family-owned, usually operated by mothers or female adults of the households, and can be found in all corners of the neighborhood. Furthermore, households with financial constraints can also purchase food on credit, which will help ensure that food is available. Moreover, 111 tiangges and 64 public market stalls were also present in the area, all of which were located in Brgy. Cutcot. Notably, Brgy. Cutcot has the highest number of food stores in the area, with a total of 293.

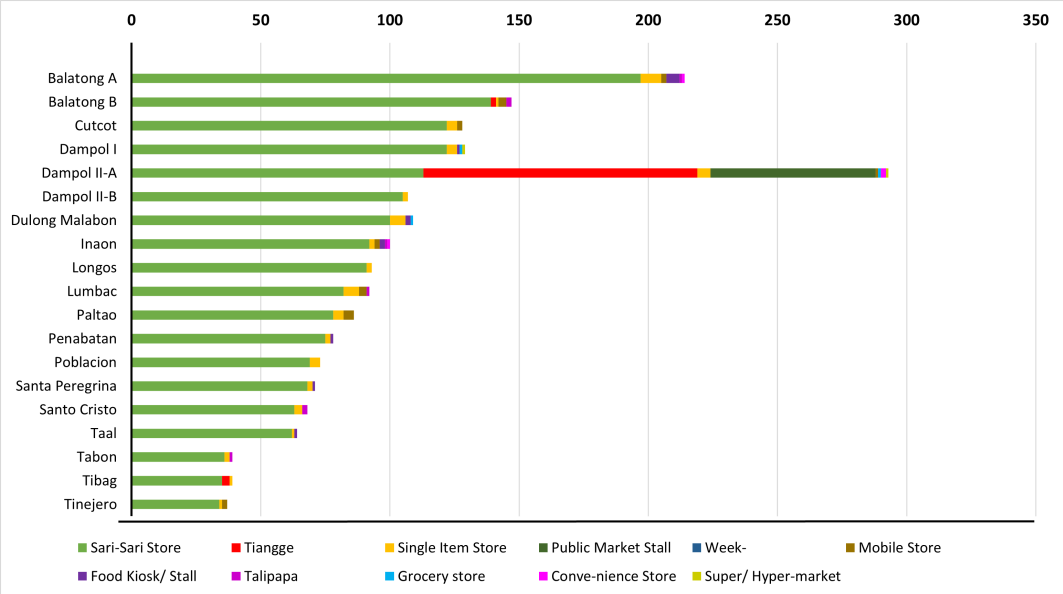

Figure 1.
Number of Food Stores per Barangay in Pulilan, Bulacan, 2016

The result revealed that the highest density of food stores was found in Brgy. Cutcot with a total of 60 stores per 1,000 population. Meanwhile, Barangay Dulong Malabon and Dampol I have the lowest food store density, with 16 and 17 stores, respectively, shown in Figure 2.

Perceived Nutrition Environment

This study defines healthy food options as food items that are nutrient-dense such as whole grains, fruits and vegetables, legumes and nuts, unprocessed meat, poultry and eggs. Among the household meal planners, almost 80.0% reported that there were available options for healthy food. Healthy food options such as fruits (39.0%), vegetables (42.9%), fish and seafood (43.6%), meat (43.4%), and poultry (43.3%) were reportedly available 6-7 days a week (Supplementary Table S4).

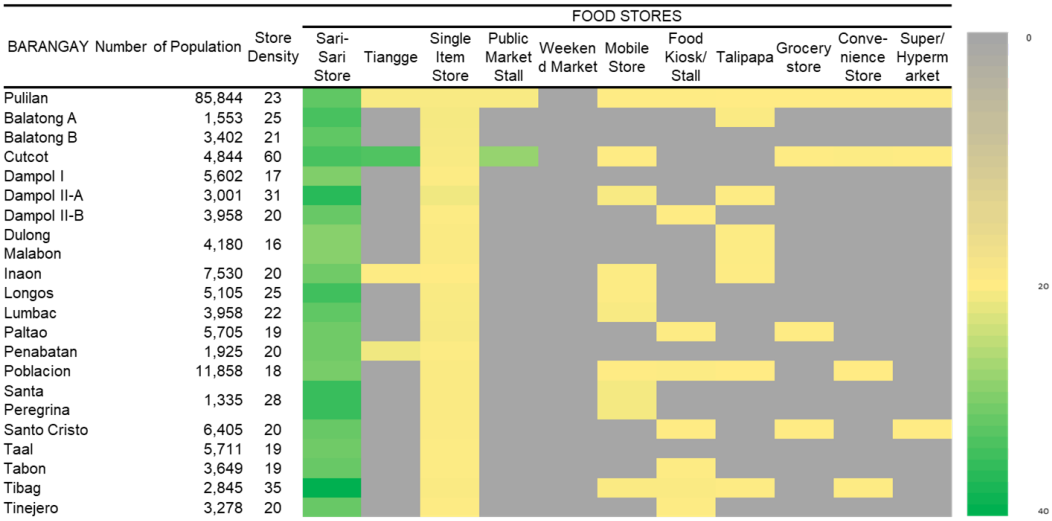

Figure 2.
Food Store Density by Barangay in Pulilan, Bulacan, 2016
Note: Food Store Density is calculated as the number of stores per 1,000 population

Moreover, nearly half of the meal planners perceived that food items within the community were always fresh and of good quality, as shown in (Supplementary Table S5). Among the food items, vegetables (43.6%) and fish and seafood (43.6%) had the highest percentage of meal planners who perceived these items as fresh and of good quality.

Meal planners also reported a wide range of healthy food selections in the area. Fruits (33.2%) and vegetables (40.7%) were noted to always have three or more selections. Moreover, fish and seafood (39.7%), meat (37.8%), and poultry (38.5%) were always retailed by three or more sellers/producers within the community (Supplementary Table S6).

Meal planners perceived that the price rate of healthy food options, particularly protein-rich foods such as meat (35.8%), poultry/chicken (35.2%), fish and seafood (33.1%), and fruits (30.8%) and vegetables (29.4%) was expensive. Notably, fruits (1.8%) had the highest percentage of meal planners who considered them very expensive (Supplementary Table S7).

Table 3. Univariate logistic regression of food security by availability of healthy foods: Pulilan, Bulacan, 2016

Food Security	Crude ratio	SE	t	p-value	95% CI	
					lower	upper
Fruits	0.97	0.17	-0.19	0.852	0.69	1.36
Vegetables	0.81	0.15	-1.14	0.254	0.56	1.16
Fish	0.75	0.14	-1.54	0.125	0.52	1.08
Meat	0.73	0.13	-1.73	0.084	0.51	1.04
Poultry	0.75	0.14	-1.56	0.119	0.52	1.08

Table 3 examined the crude association between food security status and the perceived availability of healthy food items in public markets in Pulilan, Bulacan. The crude odds ratios ranged from 0.73 to 0.97, but none of the associations were statistically significant. Table 4 extends the analysis through univariate logistic regression, examining the relationship between food security status and the perceived frequency of availability of healthy food options. This also showed that no statistically significant associations were observed.

Table 4. Univariate logistic regression of food security by availability of healthy foods within the community: Pulilan, Bulacan, 2016

Food Security	Crude ratio	SE	t	p-value	95% CI	
					lower	upper
Fruits						
Rarely	0.94	0.20	-0.29	0.774	0.62	1.42
Sometimes	0.98	0.24	-0.08	0.939	0.61	1.58
Often	0.88	0.37	-0.31	0.757	0.39	1.99
Always	*Reference*					
Vegetables						
Rarely	0.80	0.17	-1.09	0.277	0.53	1.20
Sometimes	0.75	0.18	-1.18	0.24	0.46	1.21
Often	0.73	0.27	-0.83	0.405	0.35	1.52
Always	*Reference*					
Fish						
Rarely	0.84	0.18	-0.84	0.404	0.55	1.27
Sometimes	0.71	0.17	-1.41	0.16	0.43	1.15
Often	0.64	0.24	-1.19	0.235	0.30	1.34
Always	*Reference*					
Meat						
Rarely	0.83	0.17	-0.9	0.368	0.55	1.25
Sometimes	0.75	0.19	-1.14	0.255	0.45	1.23
Often	0.79	0.28	-0.66	0.508	0.39	1.60
Always	*Reference*					
Poultry/Chicken						
Rarely	0.78	0.16	-1.19	0.235	0.51	1.18
Sometimes	0.76	0.19	-1.07	0.284	0.46	1.25
Often	0.68	0.24	-1.07	0.287	0.34	1.38
Always	*Reference*					

3.3 Food Purchase

Most meal planners in Pulilan purchased fresh produce such as fruits (63.9%), vegetables (54.9%), fresh meat (53.6%), fish and seafoods (53.0%), chicken and poultry (52.4%), mostly at a public market. Meanwhile, other food items such as eggs (54.2%), milk and milk products (43.0%), canned goods (50.3%), oil (50.35%), condiments (52.1%), and beverages (55.5%) were usually bought at a sari-sari store (Supplementary Table S8).

By frequency of visit to a type of food store in a week, the sari-sari store was the most frequently visited, almost every day for 6-7 days by 55.8% of meal planners, followed by the mobile store (27.8%) and talipapa (24.6%), as shown in (Supplementary Table S9).

Table 5. Adjusted predictions using the probability margin of food security by purchasing in sari-sari stores and by wealth status

Purchase food in a sari-sari store based on wealth status	Margin	Delta-method Std. Error	t	P>t	95% CI	
					lower	upper
NO						
Poorest	0.05	0.03	1.44	0.149	-0.02	0.12
Poor	0.13	0.06	2.14	**0.033***	0.01	0.25
Middle	0.35	0.07	4.88	**0.000****	0.21	0.49
Rich	0.55	0.06	8.63	**0.000****	0.43	0.68
Richest	0.74	0.05	14.08	**0.000****	0.63	0.84
YES						
Poorest	0.20	0.04	5.18	**0.000****	0.12	0.28
Poor	0.28	0.04	6.9	**0.000****	0.20	0.36
Middle	0.32	0.05	7.12	**0.000****	0.23	0.41
Rich	0.45	0.05	8.43	**0.000****	0.35	0.56
Richest	0.71	0.06	12.87	**0.000****	0.60	0.82

Note: **significant at p-value<.05*

Purchases in Sari-sari Store

Table 5 shows the effect of buying food in a sari-sari store. When foods are not purchased in a sari-sari store, among the poorest households, there is a predicted probability of food security at 0.05. However, the difference is not statistically significant (p=0.149). Meanwhile, when foods are purchased in a sari-sari store, the probability of being food secure is higher than when food is not bought in a sari-sari store. Among the poorest households, the probability of being food secure significantly increases to 0.20 (p <0.01). The effect of wealth status is more visible when food is bought in a sari-sari store, with a significant increase in the predicted probability of food security across all wealth categories. This also indicates that as wealth status increases, the probability of being food secure also increases.

3.4 Number of Food Stores and Food Security

A significant positive relationship was noted between food security and the number of food stores. The result showed that in every unit increase in the number of food stores, there is an increase of 1.9 food-secure households (p= <0.05 95% C.I 1.3-2.7). The findings imply that the greater availability of food stores contributes to improved food security, likely by enhancing access to food sources within the community. The results highlight the importance of the availability of food stores as a key factor influencing the status of food security. (Table 6).

Table 6. Regression analysis of Food Security and Number of Food Store, Pulilan, Bulacan, 2016

Food secure	Coefficient	Std. Error	t	P-value	95% CI	
					Lower	Upper
No. of food stores	1.9	0.2	3.91	**0.001****	1.3	2.7
Intercept	1.2	0.7	0.25	0.803	0.3	5.8
Food Store Density	-0.4	0.2	-2.04	**0.058**	-0.7	0.0
Intercept	23.9	4.5	5.34	0.000	14.5	33.4

Note: **significant at p-value<.05*
***significant at p-value<.01*

3.5 Food Store Density and Food Security

Examining the relationship between store density and food security, the results showed that a one-unit increase in food store density corresponds to a 0.04-unit decrease in the number of food-secure households (Table 6). This indicates a weak negative relationship with food security; however, the result is not statistically significant. In summary, the findings suggest that while food store density may have an inverse association with food security, the evidence remains inconclusive, suggesting that other socioeconomic factors may better explain variations in food security.

4 Discussion

This study determined whether an association existed between the types of food stores, the density of food stores, and the food security status of households in Pulilan, Bulacan. Results showed no association between the density of food stores and food security, but had a positive association with the number of food stores. This means that the ratio of stores to population is not significant, but the absolute number of stores in an area, regardless of the population, is associated with food security.

There is also a possibility that households from other barangays may purchase food from other food stores that provide a variety of food selections, located nearby or outside their barangay, which is why the density of stores is not associated with food security compared to the number of stores present in the municipality. This extends to Garasky et al. [17] findings, wherein scarcity of food stores in the area is positively associated with food insecurity. The density of food stores

may not reflect whether there are enough resources to address food insecurity in the community. Additionally, the computation for the density was assumed to be evenly distributed across a given population. This result agrees with the study of Buscemi et al. [18], wherein they found no clear relationship between the density of food stores and food security because the food-insecure study participants were living in the lowest-income area.

In contrast, examining the association between the number of food stores and food security, the study found that for every unit increase in food stores, there is an estimated increase of 1.9 food-secure households. This finding suggests that a greater number of food stores may enhance physical access and availability of food within communities, contributing to improved food security status of a household [19].

Positively, the majority of meal planners perceived that healthy food items were readily available in the area, with good quality food products, with a wide range of healthy selections, but mostly found it expensive. This may be related to the livelihoods and sources of income in Pulilan, Bulacan, which were mostly on agriculture, such as farming, fishing, swine, and poultry raising, that might have influenced their perception.

Despite these perceptions, results showed no significant relationship between the perceived availability of healthy food options and food security. This may be due to the high cost of healthy options, which remains a barrier even when such foods are readily accessible and available. As shown in Tables 3 and 4, univariate logistic regression showed no statistically significant associations between the availability or frequency of healthy food items and food security. However, Table 8 showed that after adjusting for wealth status, significant differences in the probability of being food secure become evident depending on where households buy food. For instance, among the poorest households, those who bought food from sari-sari stores had significantly higher food security margins (0.20) than those who did not (0.05), though the overall levels were still low. This suggests that store type and socioeconomic context interact in shaping food security, and that availability alone may be insufficient without economic access and contextual factors being considered.

While sari-sari stores primarily offer processed and packaged food items, they serve as the most accessible and immediate food source for many low-income households. These stores are often located within walking distance, allow small quantity purchases, and sometimes offer food on credit. For the poorest households, these factors can reduce short-term food insecurity, as they ensure consistent food availability, even if the nutritional value is limited. This may explain the statistically significant increase in food security probability when purchasing from sari-sari stores. It highlights the difference between food security and nutrition security, where access and affordability may take precedence over dietary quality in vulnerable settings.

Previous research suggests various factors may influence the food security of a household. For instance, a study conducted in Lima, Peru by Chapparo [20] found that food-secure and insecure households have similar physical access to fresh food outlets. Still, food-insecure households reported a negative perception of their food environment. Similarly, findings from the study of Mayer [21] show that food-insecure individuals reported easy access to good-quality grocery stores, but food insecurity persists in Southeastern Pennsylvania. These suggest that perception alone may not always coincide with physical access, and other contributing factors may also be considered in addressing this issue.

The study also explored the various food stores available where meal planners typically purchase food. Results showed that the sari-sari store was the most visited type of food store, and purchasing from this was associated with a relatively higher probability of food security among poor and poorest households compared to those who did not buy from these stores. Both wealth status and buying from sari-sari stores are significant predictors of food security, though the probability margin of being food secure remained low. For instance, it only increased from 0.05 to 0.20 among the poorest households when food was purchased from a sari-sari store. This suggests that sari-sari

stores may serve as an accessible and flexible food source, especially for households with limited income, but they do not fully address underlying food insecurity. The findings agree with the study conducted by Pedraza [22] among Mexican households' purchases of taxed and untaxed food products and beverages, which revealed that low-socioeconomic status households mostly purchase food at traditional retailers, and purchases of taxed foods and beverages decreased among low-socioeconomic status households. A similar study conducted by Reimold [23] revealed that low-income households prefer convenient and affordable food products, found in nearby food stores; however, these stores mostly sell products with low nutritional value. Furthermore, Hackbarth [24] deemed the informal food sector as a potential channel for improving food and nutrition security where food is available, accessible, and affordable to all.

Since most of the poor and poorest households often purchase food products in sari-sari stores, which are linked to better food security status, interventions must focus on this type of store. This could include the provision of equipment or incentives to offer healthier, more affordable fresh food options aside from packaged foods. Additionally, since a higher number of food stores is positively associated with improved food security, increasing the number of Kadiwa stores or other food hubs that offer fresh products from smallholder producers with subsidies should be encouraged and promoted in the communities.

Limitations of the Study

The study identifies several limitations. First, the exclusion of the possible contributions of quick-serve restaurants, carinderia, specialty food stores, and other food establishments that sell only cooked food, which may have influenced food security outcomes. This was because the study focused solely on food stores present during the time of data collection.

In addition, food purchases outside the study area were excluded, potentially limiting the comprehensiveness of the data. Lastly, the exclusive use of quantitative methods such as surveys and questionnaires restricted the exploration of qualitative findings into the dynamics of available food stores, perceived nutrition environment, and household food security. Nonetheless, the findings contribute to understanding the local food environment, highlighting the potential of sari-sari stores to improve food security, especially if they were able to offer fresher, healthier, and more affordable food items to poor households.

5 Conclusion & Recommendation

This study found that the number of food stores, but not food store density, was positively associated with food security. Sari-sari store was the most frequently visited type of food store in Pulilan. Further, meal planners perceived that healthy foods were available but expensive in the area. These provide insights on crafting strategies that would make sustainable, accessible, and healthier food options available to the public, particularly in areas with a high prevalence of food-insecure households.

Further studies are recommended to incorporate other food establishments and foods purchased outside the home in analyzing their association with food security. Moreover, the inclusion of nutritional status to check whether the number of food stores affects the nutritional outcomes of the target population can also be explored. Analyzing the different food items in the sari-sari store and their association with the nutritional status and food security of the residents is another point for investigation. Lastly, future studies are encouraged to adopt a combination of qualitative and quantitative approaches for a robust and comprehensive understanding of this field.

6 Policy Implications and Recommendations

Food security is a vital issue that needs to be addressed at the individual, household levels, and particularly among the underserved communities. Access to affordable, safe, and nutritious food can be limited by factors such as the number of food stores, the availability and the price of healthy food options, and socioeconomic and demographic characteristics. To address this concern, the following policy recommendations aim to create a more equitable and sustainable food environment to foster healthier communities.

1. Improve Supply Chain and Distribution
   Farm-to-store program: Develop programs that directly connect retail stores with local farmers to streamline the supply chain of fresh produce and provide healthier and cheaper options in the community. This will ensure a consistent supply of fresh fruits and vegetables, thus reducing the consumption of processed foods.
2. Healthy Retail Stores
   A "Healthy Stores" certification may be awarded to a retail store that offers a wide variety of healthy food options and meets the specific criteria for offering nutritious foods. This will provide a tangible way for consumers to easily identify stores that give priority to healthy eating and promote healthier food choices.
3. Sustainable Farming Practices
   Provide financial and technical support for small-scale farmers who prioritize the production of fruits and vegetables to ensure the continuous supply of fresh produce that will be readily available and accessible in the community.
4. Community Seminars and Training
   Implement a nutrition education program aimed at increasing consumer awareness and knowledge of the benefits of fruits and vegetables, thus improving their eating habits and daily consumption.
5. Community Zoning
   Develop a community zoning plan to identify those households who experience extreme food insecurity and those who reside in a food desert area. Opening of grocery stores or farmers' markets, and Kadiwa stores will be a priority of the LGUs in these areas. This will help to increase access to nutritious, safe, and affordable food products.

Supplementary Materials

Supplementary Tables

Statements and Declarations

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Competing Interest

The authors declare no known conflict of interest.

Ethical Considerations

The 2016 Local-level Food, Health, and Nutrition Survey proposal was submitted to the FNRI Institutional Review Committee (FIERC) for ethical clearance and was approved on May 19, 2016, with protocol code FIERC-2016-005.

Data Availability

The data are available upon request from the authors.

Author Contributions

C.A.J. & **M.O.G.**: project component leaders for food security and food environment, respectively, were responsible for the study's conceptualization, study design, and drafting of the manuscript; **R.P.B.L.**: assisted in the drafting of the study proposal, dummy tables, analysis of results, and preparing and writing the manuscript. **M.C.D.S.**: conducted data cleaning and processing, validation, analysis of results, and review of the manuscript. All authors revised and commented on the draft manuscript and agreed on the final version of the published manuscript.

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