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Determinants of household food and nutrition security status between peri-urban and rural areas in Mbale District, Eastern Uganda

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ABSTRACT

This study assessed household Food and Nutrition Security (FNS) status and its socio-economic and demographic predictors in rural and peri-urban Mbale District, Eastern Uganda. A cross-sectional study involved 221 households. Food security was assessed using the Household Food Insecurity Access Scale (HFIAS), while Water, Sanitation and Hygiene (WASH) conditions served as indicators of nutrition security. Descriptive statistics were used to summarize data, and binary logistic regression identified predictors of FNS. Food insecurity was high in rural (81.1%) and peri-urban households (85.5%), with no significant difference between settings ($p > 0.05$). Peri-urban households had better access to safe water (90.0% versus 67.6%), whereas rural households had better access to toilet facilities (95.5% versus 90.0%). Among rural households, secondary or tertiary education of the household head was associated with higher odds of food security (OR = 2.55, 95% CI: 1.08–6.02; $p = 0.032$). In peri-urban households, larger household size was associated with lower odds of food security (OR = 0.33, 95% CI: 0.13–0.82; $p = 0.015$). For rural WASH indicators, secondary or tertiary education (OR = 3.75, 95% CI: 1.29–10.90; $p = 0.015$) and larger household size (OR = 3.27, 95% CI: 1.19–9.03; $p = 0.022$) were associated with higher odds of accessing safe water. Purchasing food was associated with lower odds of safe water access (OR = 0.25, 95% CI: 0.08–0.74; $p = 0.012$) and higher odds of toilet sharing (OR = 3.11, 95% CI: 1.17–8.26; $p = 0.023$). No significant predictors of WASH outcomes were identified in peri-urban households. Food insecurity remains widespread, with differing socio-economic and WASH factors. The study recommends strengthening education and household food production in rural areas, improving livelihoods and access to affordable food in peri-urban areas, and expanding water, sanitation and hygiene services across both settings.

1. Introduction

Food and Nutrition Security (FNS) is a multidimensional concept that combines food security with the conditions necessary for individuals to achieve and maintain good nutritional well-being [1,2]. Food security exists when all people have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and preferences for an active and healthy life [3]. Its six pillars are availability, access, utilization, stability, agency and sustainability [4–7]. Nutrition security extends beyond access to food to include adequate care, healthcare and a healthy environment that support proper nutrient utilization [8,9]. Therefore, household food security depends not only on food availability and affordability but also on socio-economic circumstances and environmental conditions that influence health and nutritional well-being [1,2,8,9].

Despite global efforts to improve FNS, the challenge remains significant. In 2023, approximately 2.33 billion people experienced moderate or severe food insecurity, while about 733 million faced hunger [10]. Sub-Saharan Africa remains disproportionately affected, with an estimated 22.7% of its population undernourished, compared with a substantially lower global average [11]. In East Africa, the prevalence of undernourishment was estimated at 33.9% [12]. In Uganda, national assessments indicated that approximately 48% of the population experienced moderate food insecurity and 11% experienced severe food insecurity in mid-2022 [13]. Furthermore, about 846,000 people faced high levels of acute food insecurity between August 2023 and January

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2024 [14]. The challenge is also evident in the Bugisu Sub-region of Eastern Uganda, where the 2024 census reported that only 41% of households were food secure. The same source reported stunting and underweight among 36% and 15% of children under five years, respectively [15]. These figures highlight the need to understand the household-level factors associated with food security in the region.

Water, Sanitation and Hygiene (WASH) conditions are also important for nutritional well-being. Inadequate access to safe drinking water, poor sanitation and unhygienic practices can increase exposure to diarrhoeal and other infections, raise healthcare costs and compromise the body's ability to utilize nutrients effectively [16,17]. Inadequate WASH has been associated with a substantial global disease burden, including deaths among children under five years [18–21]. Poor WASH conditions have also been linked to child undernutrition [22,23]. In Uganda, access to safe water and sanitation remains a public health concern despite government initiatives, including community-led total sanitation and home improvement campaigns [24–26]. However, the relationship between household characteristics, WASH conditions and food security may vary across settlement contexts, warranting further investigation.

Food insecurity has traditionally been associated with rural households because of their dependence on agriculture and natural resources for livelihoods [27,28]. However, the expansion of urban and peri-urban settlements has introduced additional challenges to household food access [29–31]. Peri-urban households may benefit from better access to markets, employment and services, but urban expansion can also reduce agricultural land, increase dependence on purchased food and expose households to fluctuating food prices [27,30,32,33]. Informal and insecure employment may further limit purchasing power and dietary diversity, forcing some households to reduce meal sizes, skip meals or purchase cheaper, less nutritious foods [34–36]. Rural households may face different constraints, including limited market access and livelihood opportunities. Consequently, neither settlement type should automatically be assumed to have better food security; the situation may depend on household resources and local living conditions [27,30,37]. The food security framework and household livelihood perspective provide a basis for understanding these differences. They suggest that food security is shaped by the interaction between household resources, livelihood opportunities and access to food, while environmental conditions influence health and nutrient utilization [1–9,27]. Household size, education, occupation, income, number of income earners, expenditure and means of obtaining food may therefore be associated with household food security [27,38–40]. For example, larger households may experience greater pressure on available resources, whereas education and stable employment may improve income and access to diverse foods [39,40]. Similarly, household resources and settlement conditions may be associated with access to safe water, water-treatment practices, sanitation facilities and hygiene. However, the strength and direction of these relationships may differ between rural and peri-urban settings. In spite of existing studies on household food security, there is still a need to understand how food security and nutrition security, assessed through selected WASH conditions, differ between rural and peri-urban households in Mbale District. The two settings may differ in livelihood opportunities, access to markets, and dependence on purchased food, household resources and availability of basic services, which may influence FNS in different ways. However, the socio-economic and demographic factors associated with these outcomes in each setting require further investigation. Examining food-security status alongside WASH conditions can help provide a better understanding of household FNS and inform interventions suited to the needs of both rural and peri-urban households. Therefore, this study aimed to assess and compare household food-security status and nutrition security, using selected WASH conditions as indicators, between rural and peri-urban households in Mbale District, Eastern Uganda. Specifically, the study compared household food-security status between the two settings, assessed differences in WASH conditions, and examined the socio-economic and demographic factors associated with food-security status and WASH indicators in each setting. The findings are intended to inform context-specific interventions to improve household food and nutrition security across both rural and peri-urban contexts.

1.1. Conceptual framework

This study draws on the food and nutrition security framework and household livelihood perspective to explain how settlement context and household characteristics may influence food security and WASH conditions (Fig. 1). Rural and peri-urban households may differ in livelihood opportunities, market access, agricultural land, income, infrastructure and basic services. Household demographic and socio-economic characteristics, including age, sex, education, marital status, household size, occupation, income, access to credit, expenditure and means of obtaining food, may shape food security and access to WASH services. Peri-urbanization may offer improved access to markets, employment and services but may also increase vulnerability through dependence on purchased food, price fluctuations and insecure livelihoods. The framework guides comparisons between rural and peri-urban households and logistic regression analyses of food-security status and selected WASH indicators as distinct outcomes. Given the cross-sectional design, the framework represents hypothesized relationships rather than established causal effects.

2. Methodology

2.1. Study design

The study adopted a cross-sectional design to collect quantitative data from households in both rural and peri-urban areas. This design was considered appropriate because it provides a snapshot of household food security, nutrition security, and associated socio-economic factors at a specific point in time, allowing for the identification of patterns and associations without requiring longitudinal follow-up [41,42].

2.2. Study area

The study was conducted in the rural and peri-urban areas of Mbale District. Mbale District is located in the Bugisu sub-region of Eastern Uganda, with its headquarters in Mbale City. The district spans an area of approximately 534.4 square kilometer (km^2) and has an estimated population of 290,356 people [15]. Mbale District comprises a combination of rural and peri-urban settlements. Rural areas are predominantly engaged in subsistence farming, while peri-urban areas exhibit higher population density, diversified income sources, and better access to markets and social services. The district is bordered by several neighbouring districts, providing important geographical context. Sironko District lies to the north, Bududa District to the northeast, Manafwa District to the southeast, Tororo District to the south, Butaleja District to the southwest, Budaka District to the west, and Pallisa and Kumi Districts to the northwest (Fig. 2). The district's diverse socio-economic and environmental contexts provide a suitable setting for assessing how household characteristics influence food and nutrition security [15].

2.3. Study population

The target population comprised adult members of households in the selected rural and peri-urban areas of Mbale District. Eligible participants were defined as household heads or any adult member who had resided in the household for at least six months prior to the study and was willing to provide informed consent. Including individuals with a minimum six-month residency ensured that participants had adequate knowledge of the household's food and nutrition practices, socio-

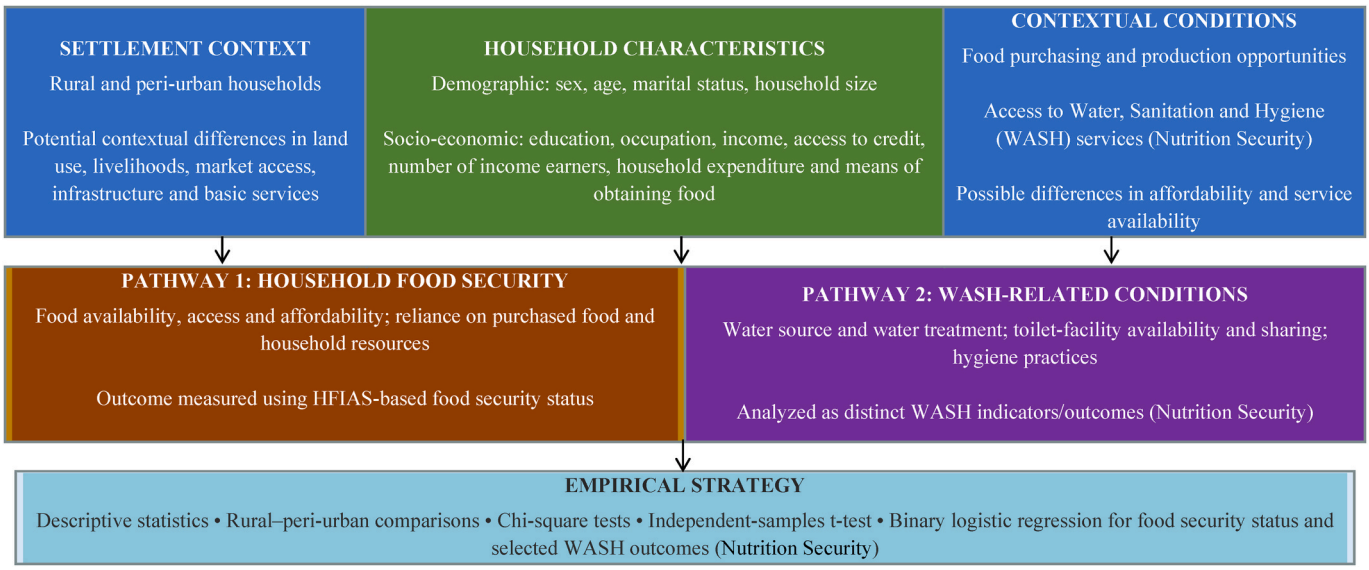

Fig. 1. Conceptual pathways linking settlement context and household characteristics to food security and WASH-related conditions among rural and peri-urban households in Mbale District, Eastern Uganda.

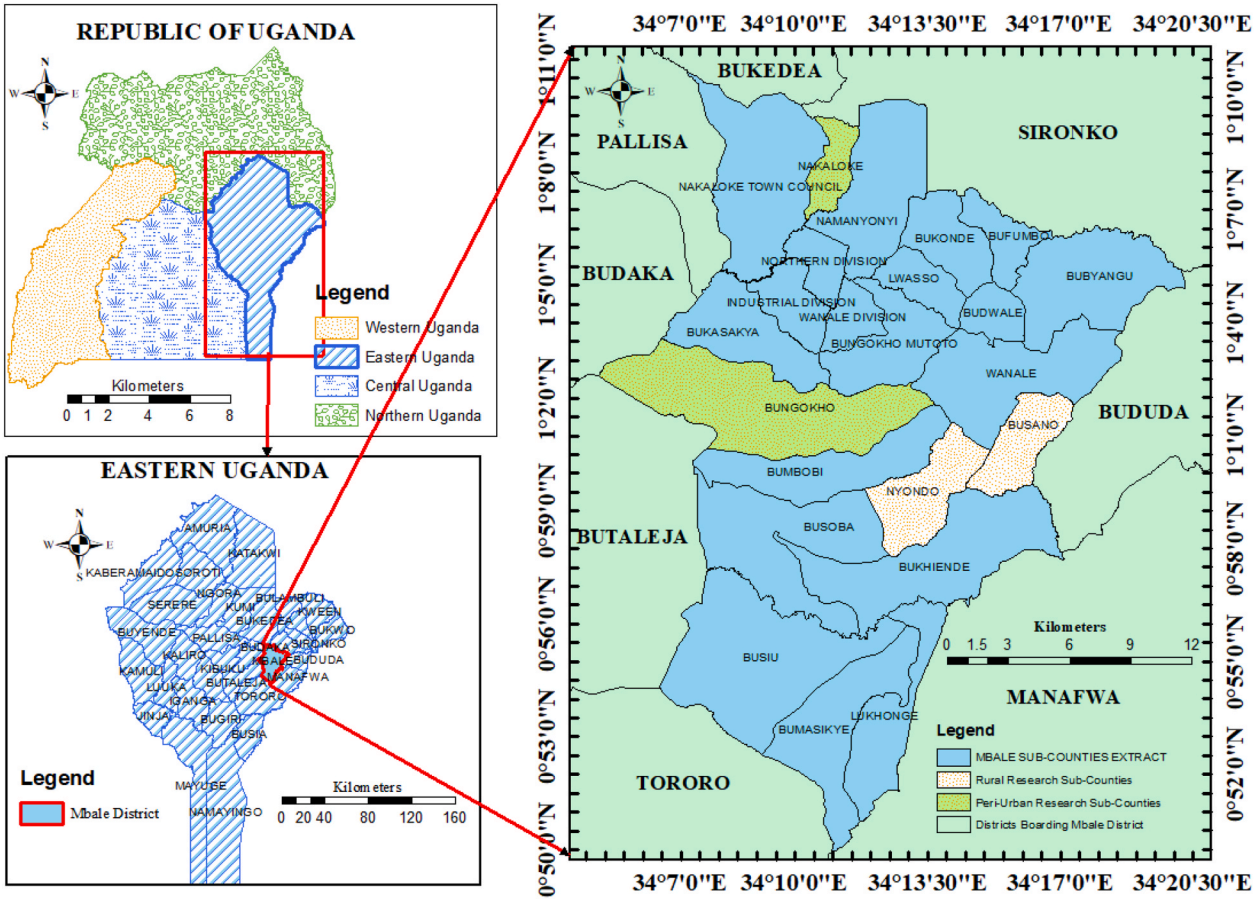

Fig. 2. Location of Mbale district (Sub-counties inclusive) and the bordering districts.

economic conditions, and resource management [43]. Both male and female adults were considered to capture diverse perspectives and experiences within households. This approach ensured that the study population was representative of households in the study area and provided reliable information on food security, nutrition security, and related socio-economic factors.

2.4. Sample size estimation

The required sample size (n) was determined using a standard formula [44].

Hence,

$$n = \frac{p(100-p)Z^2}{E^2} \quad (1)$$

Where n is the required sample size, Z is the standard normal value at 95% confidence level (1.96), p is the proportion of households consuming fewer than two meals per day in Mbale District, reported at 15.5% [45], and E is the margin of error set at 5%. After adding a 10% adjustment to account for non-response, the final sample comprised 221 households (rural = 111; peri-urban = 110).

2.5. Sampling procedure

A multi-stage sampling approach was employed to select study participants. In the first stage, two sub-counties within Mbale District were purposively identified to represent rural and peri-urban settings. Within each selected sub-county, parishes and villages were randomly selected using the ballot method to ensure that each unit had an equal chance of inclusion, thereby reducing selection bias. In the second stage, households within the selected villages were sampled using systematic random sampling. Household lists obtained from village registers served as the sampling frame. A sampling interval (k) was calculated by dividing the total number of households in a village by the required number of households to be surveyed. The first household was randomly selected, and subsequent households were chosen at every kth interval until the target sample size was reached [46]. This systematic approach ensured a representative sample of households in both rural and peri-urban areas while maintaining fairness and minimizing selection bias.

2.6. Data collection methods and instruments

Data were collected through face-to-face interviews by three trained enumerators over three days under the supervision of the principal investigator. Enumerators assisted in translating the questionnaire between English and the local language (Lumasaaba) as needed. Household food security was assessed using the Household Food Insecurity Access Scale (HFIAS) questionnaire [47], while nutrition security, socio-economic, and demographic data were collected using a semi-structured questionnaire.

2.7. Data analysis

Data were processed and analyzed using Microsoft Excel and SPSS version 20 [48]. Household food security, as assessed using HFIAS, was classified as food secure (0–1), mildly food insecure (2–7), moderately food insecure (8–11), and severely food insecure (>11) [49]. Descriptive statistics summarized household characteristics, food security, and WASH conditions operationalized as indicators of nutrition security. An independent-samples *t*-test compared mean HFIAS scores between rural and peri-urban households, while Pearson's chi-square test assessed associations between categorical variables. Binary logistic regression was used to identify predictors of household food security status and selected WASH indicators, considering 15 socio-economic, demographic and household variables (Table 1). Household food security status was coded as a binary dependent variable, where $Y_i = 1$ represented a food-secure household and $Y_i = 0$ represented a food-insecure household. Separate models were fitted for rural and peri-urban households using six predictors which included; sex (X_1), age (X_2) and education level of the household head (X_3), household size (X_4), average monthly food expenditure (X_5), and access to credit (X_6).

The relationship was modelled as follows:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum \beta_k X_{ki}, \text{where k} = 1, \ldots, 6 \quad (2)$$

Therefore:

Table 1
Independent variables, coding, and measurement for assessing household food security and nutrition security.

Variable	Definition/coding	Type
Sex of household head	Male = 1; Female = 0	Dummy
Age of household head	Age in completed years	Continuous
Education level of household head	Secondary/Tertiary = 1; Primary/None = 0	Dummy
Education level of spouse	Secondary/Tertiary = 1; Primary/None = 0	Dummy
Marital status of household head	Married = 1; Others = 0	Dummy
Occupation of household head	Salaried employment = 1; Others = 0	Dummy
Occupation of spouse	Salaried employment = 1; Others = 0	Dummy
Access to credit	Yes = 1; No = 0	Dummy
Average monthly household income	Higher income (160,000–200,000 & Above 200,000) = 1; Lower income (Below 50,000 & 50,000–150,000) = 0	Dummy
Number of income earners	Higher (3 or more) = 1; Lower (0–2) = 0	Dummy
Average monthly household expenditure	Higher expenditure (160,000–200,000 & Above 200,000) = 1; Lower expenditure (Below 50,000 & 50,000–150,000) = 0	Dummy
Average monthly food expenditure	Higher expenditure (60,000–100,000, 110,000–200,000, Above 200,000) = 1; Lower expenditure (Below 20,000 & 20,000–50,000) = 0	Dummy
Household size	6 or more persons = 1; 1–5 persons = 0	Dummy
Means of obtaining food	Purchase = 1; Own production/Gifts = 0	Dummy
Household location	Rural; Peri-urban	Categorical

Source: Authors' operational definitions

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} \quad (3)$$

Where p_i is the probability that household i is food secure; X_{1i} to X_{6i} represent the six predictor variables for household i; β_0 is the intercept; and β_1 to β_6 are the regression coefficients associated with the respective predictors.

Separate binary logistic regression models were estimated for four WASH outcomes as proxy of nutrition security status among rural and peri-urban households. These included; access to a safe water source (1 = safe; 0 = unsafe), drinking water treatment (1 = treated; 0 = untreated), toilet-facility availability (1 = available; 0 = unavailable), and toilet sharing (1 = shared; 0 = not shared).

The relationship was modelled as follows:

General model:

$$\ln\left(\frac{P_{ik}}{1-P_{ik}}\right) = \alpha_{0k} + \sum \alpha_k X_{ki}, \text{where, k} = 1, \ldots, 9 \quad (4)$$

Therefore:

$$\ln\left(\frac{P_{ik}}{1-P_{ik}}\right) = \alpha_{0k} + \alpha_{1k} X_{1i} + \alpha_{2k} X_{2i} + \alpha_{3k} X_{3i} + \alpha_{4k} X_{4i} + \alpha_{5k} X_{5i} + \alpha_{6k} X_{6i} + \alpha_{7k} X_{7i} + \alpha_{8k} X_{8i} + \alpha_{9k} X_{9i} \quad (5)$$

Where Y_{ik} denotes WASH outcome k for household i, and P_{ik} is the probability that the outcome was coded 1. The predictors X_{1i} to X_{9i} represent, respectively, sex (X_1), age (X_2), education level of household head (X_3), occupation of the household head (X_4), occupation of the spouse (X_5), household size (X_6), average monthly household income (X_7), average monthly household expenditure (X_8), and means of obtaining food (X_9). The intercept is α_{0k}, and α_{1k} to α_{9k} are the corresponding regression coefficients.

The above models were assessed for independence of observations,

appropriate binary outcomes, linearity of continuous predictors in the logit, and the absence of serious multicollinearity. Multicollinearity was assessed using the variance inflation factor (VIF), with values above 5 indicating potential concern and excluded from the models. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). ORs above 1 indicated higher odds of the outcome coded 1, while ORs below 1 indicated lower odds at statistical significance level of $p < 0.05$.

3. Results

This section presents the study findings on the socio-economic and demographic characteristics of respondents, household food security status, and selected WASH conditions relevant to nutrition security. It also examines the factors associated with household food security and selected WASH outcomes, comparing rural and peri-urban households in Mbale District.

3.1. Demographic and socio-economic characteristics of respondents

The results presented in Tables 2 and 3 show that the majority of household heads were males, constituting 90.1% in rural and 82.7% in peri-urban areas, with an average age of 42.5 ± 12.04 and 44.9 ± 11.27 years, respectively. Most household heads were married (86.5% in rural and 82.7% in peri-urban areas). In terms of education, more than half of the household heads in both locations had completed primary education (46.8% in rural and 51.8% in peri-urban areas), while a considerable proportion had attained secondary education (30.6% and 33.6%, respectively). However, tertiary education attainment was higher among rural household heads (17.1%) compared to peri-urban ones (7.3%). Farming was the main occupation among household heads, accounting for 61.3% in rural and 40% in peri-urban areas, followed by salaried employment (21.6% and 8.2%, respectively) and casual labour (7.2% and 36.4%, respectively). The same trend was observed among spouses, with farming being the dominant occupation (84.4% in rural and 64.4% in peri-urban areas). Household size ranged between 6 and 10 persons for 52.3% of rural and 48.1% of peri-urban households, suggesting relatively large family units across both locations. Most households (98.2% rural and 93.6% peri-urban) had one to two income earners. Regarding household income, 35.1% of rural and 40% of peri-urban households earned above UGX 200,000 per month, while a substantial proportion (31.5% rural and 37.3% peri-urban) earned between UGX 50,000–150,000. Average monthly household expenditure ranged between UGX 60,000–100,000 for 32.4% of rural and 29.1% of peri-urban households, while food expenditure in the same range was reported by 26.1% and 34.5%, respectively. Access to credit facilities was relatively similar in both settings, with 45% of rural and 44.5% of peri-urban households reporting access. In terms of food acquisition, 51.4% of rural households relied on their own food production, whereas a greater proportion of peri-urban households (67.3%) mainly purchased food from the market.

Table 2
Demographic characteristics of respondents.

Demographic characteristics	Category	Rural n (%)	Peri-urban n (%)
Sex of household head	Male	100 (90.1)	91 (82.7)
	Female	11 (9.9)	19 (17.3)
Education level of household head	No formal education	6 (5.4)	8 (7.3)
	Primary	52 (46.8)	57 (51.8)
	Secondary	34 (30.6)	37 (33.6)
	Tertiary	19 (17.1)	8 (7.3)
Education level of spouse	No formal education	12 (12.5)	9 (9.9)
	Primary	47 (49.0)	50 (54.9)
	Secondary	28 (29.2)	28 (30.8)
	Tertiary	9 (9.4)	4 (4.4)
Marital status of household head	Single	1 (0.9)	3 (2.7)
	Divorced	1 (0.9)	1 (0.9)
	Married	96 (86.5)	91 (82.7)
	Widower	1 (0.9)	1 (0.9)
	Widow	11 (9.9)	13 (11.8)
	Separated	1 (0.9)	1 (0.9)
Occupation of household head	Not employed	1 (0.9)	3 (2.7)
	Employed (salaried)	24 (21.6)	9 (8.2)
	Small-scale trading	8 (7.2)	12 (10.9)
	Casual labour	8 (7.2)	40 (36.4)
	Farming	68 (61.3)	44 (40.0)
	Retired/pension earner	2 (1.8)	2 (1.8)
Occupation of spouse	Not employed	1 (1.0)	5 (5.6)
	Employed (salaried)	10 (10.0)	4 (4.4)
	Small-scale trading	3 (3.1)	15 (16.7)
	Casual labour	1 (1.0)	8 (8.9)
	Farming	81 (84.4)	58 (64.4)
Household size	1–5 persons	45 (40.5)	41 (37.3)
	6–10 persons	58 (52.3)	53 (48.1)
	>10 persons	8 (7.2)	16 (14.6)
Age of household head	Mean (SD), years	42.5 (12.04)	44.9 (11.27)

n: number of households; n = 111 (Rural), n = 110 (Peri-urban), SD = Standard Deviation.

Table 3
Socio-economic characteristics of respondents.

Socio-economic characteristics	Category	Rural n (%)	Peri-urban n (%)
Number of income earners	None	0 (0.0)	1 (0.9)
	1–2	109 (98.2)	103 (93.6)
	3–5	1 (0.9)	5 (4.5)
	Above 5	1 (0.9)	1 (0.9)
Average monthly household income	Below 50,000 UGX	21 (18.9)	10 (9.1)
	50,000–150,000 UGX	35 (31.5)	41 (37.3)
	160,000–200,000 UGX	16 (14.4)	15 (13.3)
	Above 200,000 UGX	39 (35.1)	44 (40.0)
Average household monthly expenditure	Below 20,000 UGX	9 (8.1)	4 (3.6)
	20,000–50,000 UGX	19 (17.1)	20 (18.2)
	60,000–100,000 UGX	36 (32.4)	32 (29.1)
	110,000–200,000 UGX	27 (24.3)	28 (25.5)
	Above 200,000 UGX	20 (18.0)	26 (23.6)
Average household monthly food expenditure	Below 20,000 UGX	16 (14.4)	11 (10.0)
	20,000–50,000 UGX	36 (32.4)	31 (28.2)
	60,000–100,000 UGX	29 (26.1)	38 (34.5)
	110,000–200,000 UGX	20 (18.0)	17 (15.5)
	Above 200,000 UGX	10 (9.0)	13 (11.8)
Access to credit	Yes	50 (45.0)	49 (44.5)
	No	61 (55.0)	61 (55.5)
Means of obtaining food	Own production	57 (51.4)	36 (32.7)
	Purchase	52 (46.8)	74 (67.3)
	Gifts/donations	2 (1.8)	0 (0.0)

n: number of households; n = 111 (Rural), n = 110 (Peri-urban), UGX = Uganda Shillings.

3.2. Household food insecurity experience by domain among rural and peri-urban households

As shown in Table 4, affirmative responses to nine items grouped under three (3) domains (Table 4) indicated that rural (78.4%) and peri-

Table 4
Percent distribution of affirmative responses to domains and questions of HFIAS segregated between Rural and Peri-urban households.

Domain and Questions	% of the affirmative responses							
	Rural				Peri-urban			
	Yes	Rarely	Sometimes	Often	Yes	Rarely	Sometimes	Often
Domain: Anxiety and Uncertainty								
In the past four weeks, did you worry that your household would not have enough food?	**78.4**	**9.9**	**39.7**	**28.8**	**86.4**	**14.5**	**37.3**	**34.5**
Domain: Insufficient Quality								
In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of lack of resources?	76.5	15.3	47.7	13.5	81.7	13.6	43.6	24.5
In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of lack of resources?	77.4	13.5	46.8	17.1	82.7	11.8	38.2	32.7
In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	77.4	9.0	36.9	31.5	81.8	13.6	37.3	30.9
Average for insufficient quality	**77.1**	**12.6**	**43.8**	**20.7**	**82.1**	**13.0**	**39.7**	**29.4**
Domain: Insufficient Quantity								
In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	73.8	9.0	47.7	17.1	76.3	13.6	39.1	23.6
In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?	73.8	20.7	34.2	18.9	78.2	21.8	30.9	25.5
In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	38.7	12.6	14.4	11.7	46.4	16.4	17.3	12.7
In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	37.8	18.9	14.4	4.5	45.5	18.2	20.0	7.3
In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	9.9	0.9	6.3	2.7	20.9	7.3	10.0	3.6
Average for insufficient quantity	**46.8**	**12.4**	**23.4**	**10.9**	**53.5**	**15.5**	**23.5**	**14.5**

urban (84.4%) households had anxiety and uncertainty of having food in the previous four weeks. On average, 77.1% and 82.1% of rural and peri-urban households respectively, had insufficient quality food while 46.8% and 53.5% of households in rural and peri-urban areas, respectively reported insufficient quantity of food in the previous four weeks.

3.3. Prevalence of food security among rural and peri-urban households

As presented in Table 5, food insecurity was prevalent across both rural and peri-urban households with 81.1% of rural and 85.5% of peri-urban households classified as food insecure, while only 18.9% and 14.5%, respectively, were food secure. Among the food-insecure households, 5.4% in rural and 3.6% in peri-urban areas were classified as mildly food insecure, 15.3% and 16.4% as moderately food insecure, and 60.4% and 65.5% as severely food insecure. The mean Household Food Insecurity Access Scale (HFIAS) score was slightly higher among peri-urban households (12.65 ± 6.38) compared to rural households (11.17 ± 6.30). However, this difference was not statistically significant ($p>0.05$) between rural and peri-urban households.

Table 5
Proportion of food secure and food insecure households, and mean HFIAS score segregated by location.

HFIAS cut-offs	Categories	Household Location				p-value
		Rural		Peri-urban		
		n	%	n	%	
0 – 1	Food secure	21	18.9	16	14.5	0.276
2 – 7	Mildly food insecure	6	5.4	4	3.6	
8 – 11	Moderately food insecure	17	15.3	18	16.4	
12 – 27	Severely food insecure	67	60.4	72	65.5	
2 – 27	Food insecure combined	90	81.1	94	85.5	
Mean HFIAS score (SD)		11.17 ± 6.30		12.65 ± 6.38		

n: number of households; n = 111 (Rural), n = 110 (Peri-urban).
P-value significant at ≤ 0.05 level.

3.4. Household nutrition security status of rural and peri-urban households

The results in Table 6 show notable differences in WASH (Water, Sanitation, and Hygiene) conditions between rural and peri-urban households. A significantly higher proportion of peri-urban households (90.0%) accessed safe water sources compared to rural households (67.6%) ($p = 0.000$). Conversely, more rural households relied on unsafe water sources (32.4%) than peri-urban households (10.0%). Interestingly, a higher proportion of rural households (61.3%) reported treating their water compared to peri-urban households (43.6%) ($p = 0.009$). Among those treating water, boiling was more common in peri-urban households (43.8%) than in rural households (22.1%), whereas adding bleach or chlorine was more prevalent in rural households (76.5%) than peri-urban households (52.1%) ($p = 0.016$). Furthermore, toilet facility availability was high in both locations but slightly lower in peri-urban households (90.0%) compared to rural households (95.5%) ($p = 0.006$). Sharing of toilet facilities was similar across locations, with about one-third of households reporting shared facilities (33.3% rural, 32.7% peri-urban; $p = 0.924$). Among households that shared toilets, most shared with fewer than 10 households. Hand washing practices were generally good in both rural and peri-urban areas. The majority of households reported always washing hands before and after food preparation (93.7% rural, 96.4% peri-urban), before eating (98.2% rural, 99.1% peri-urban), and after visiting the toilet (96.4% rural, 98.2% peri-urban), with no significant differences between locations ($p > 0.05$).

3.5. Predictors of household food security in rural and peri-urban areas

Results in Table 7 present the socio-economic and demographic predictors of household food security in rural and peri-urban areas. Among rural households, those headed by individuals with secondary or tertiary education had higher odds of being food secure (OR = 2.55, 95% CI: 1.08–6.02, $p = 0.032$). In peri-urban areas, households with six or more members had lower odds of being food secure (OR = 0.33, 95% CI: 0.13–0.82, $p = 0.015$). However, sex and age of the household head, monthly food expenditure, and access to credit were not significantly

Table 6
Proportion of households indicating WASH status segregated by household location.

WASH Categories	Household Location				
	Rural		Peri-urban		p-value
	n	%	n	%	
Source of water					**0.000*****
Safe water sources	75	67.6	99	90.0	
Unsafe water sources	36	32.4	11	10.0	
Do you treat the water?					**0.009*****
Yes	68	61.3	48	43.6	
No	43	38.7	62	56.4	
Treatment given to water					**0.016*****
Boil	15	22.1	21	43.8	
Add bleach/Chlorine	52	76.5	25	52.1	
Use water filter	1	1.5	2	4.2	
Toilet facility availability					**0.006*****
Toilet facility available	106	95.5	99	90	
Toilet facility not available	5	4.5	11	10.0	
Is the toilet facility shared?					0.924
Yes	37	33.3	36	32.7	
No	74	66.7	74	67.3	
Number of Households that share the toilet facility					0.572
<10	30	81.1	28	75.7	
>10	7	18.9	9	24.3	
Washing hands before and after food preparation					0.602
Rarely	1	0.9	1	0.9	
Sometimes	6	5.4	3	2.7	
Always	104	93.7	106	96.4	
Washing hands before eating food					0.566
Sometimes	2	1.8	1	0.9	
Always	109	98.2	109	99.1	
Washing hands after visiting toilet					0.414
Sometimes	4	3.6	2	1.8	
Always	107	96.4	108	98.2	

n: number of households; n = 111 (Rural), n = 110 (Peri-urban); *** **indicates p-value significant at ≤ 0.05 level**; Safe water sources (Private piped water, Public piped water, Protected well/spring, Borehole); Unsafe water sources: (Unprotected well/spring, River/stream); Toilet facility available (Flush toilet, Ventilated Improved pit latrine (VIP), Covered pit latrine with no slab, Covered pit latrine with slab, Uncovered pit latrine with no slab, Uncovered pit latrine with slab).

Table 7
Socio-economic and demographic predictors of household food security status in rural and peri-urban areas.

Predictor	Rural OR (95% CI)	p-value	Peri-urban OR (95% CI)	p-value
Sex of household head	1.67 (0.26–10.80)	0.591	0.92 (0.20–4.13)	0.909
Age of household head	0.99 (0.94–1.03)	0.511	1.03 (0.98–1.08)	0.277
Education level of household head	**2.55 (1.08–6.02)**	**0.032**	2.48 (0.79–7.75)	0.119
Household size	0.59 (0.22–1.58)	0.291	**0.33 (0.13–0.82)**	**0.015**
Average monthly household food expenditure	0.64 (0.21–2.01)	0.447	1.11 (0.33–3.76)	0.862
Access to credit	1.13 (0.41–3.11)	0.808	1.75 (0.55–5.55)	0.344

*** **indicates p-value significant at ≤ 0.05 level**. The variables education level of the spouse, marital status of the respondent, occupation of the household head, occupation of the spouse, average monthly household income, number of income earners, average household monthly expenditure, and means of obtaining food were omitted from the model due to multicollinearity, as they exhibited high intercorrelations with other explanatory variables included in the analysis.

associated with food-security status in either setting ($p > 0.05$).

3.6. Predictors of household nutrition security in rural and peri-urban areas

The results presented in Table 8 show that, among rural households, three predictors were significantly associated with selected WASH outcomes. Education level of the household head (Secondary or tertiary education) was associated with higher odds of accessing a safe water source (OR = 3.75, 95% CI: 1.29–10.90, p = 0.015), while household size (six or more members) also had higher odds of accessing safe water (OR = 3.27, 95% CI: 1.19–9.03, p = 0.022). In contrast, households that purchased food had lower odds of accessing a safe water source (OR = 0.25, 95% CI: 0.08–0.74, p = 0.012), but higher odds of sharing a toilet facility (OR = 3.11, 95% CI: 1.17–8.26, p = 0.023). No statistically significant associations were observed between the other predictors and the WASH outcomes ($p > 0.05$).

The results in Table 9 show that, among peri-urban households, none of the socio-economic and demographic predictors was significantly associated with the selected WASH outcomes such as access to safe water, drinking water treatment, toilet availability, or toilet sharing ($p > 0.05$). However, households with six or more members had higher odds of accessing a safe water source (OR = 2.91, 95% CI: 0.68–12.48, p = 0.151), and households that purchased food had higher odds of sharing a toilet facility (OR = 1.84, 95% CI: 0.62–5.53, p = 0.275), although these associations were not statistically significant.

4. Discussion

4.1. Household food security status in rural and peri-urban areas

Household food security is an important determinant of health and well-being, reflecting a household's ability to access sufficient, safe and nutritious food to meet the dietary needs of all its members [1,2]. The Household Food Insecurity Access Scale (HFIAS) provides a useful measure of household experiences of food insecurity and allows comparisons across different socio-economic and geographical settings [50]. A high mean HFIAS score (>11) indicates household food insecurity [47]. In the present study, the mean HFIAS scores for both rural and peri-urban households were below the maximum possible score of 27, which represents the highest level of food insecurity when all nine frequency-of-occurrence questions are answered "often", with a response code of 3 [49]. An examination of individual HFIAS items (Table 4) showed that households more frequently experienced less severe forms of food insecurity, particularly having to eat a limited variety of foods because of insufficient resources, than more severe experiences such as going a whole day and night without eating. This suggests that the main challenge for many households was maintaining dietary variety rather than experiencing complete food deprivation. A similar pattern was reported by Farhadian et al. [51], who observed a progressive decline in affirmative responses from the first to the last HFIAS question. Although the mean HFIAS scores in the present study were lower than those reported by Moroda et al. [52], they were higher than those documented in other studies [49]. Such differences reflect the variation in household food-security experiences across geographical and socio-economic contexts. Within the study area, peri-urban households had significantly higher mean HFIAS scores than rural households (Table 5), indicating greater food insecurity. This finding agrees with studies reporting relatively better food-security conditions among rural households than peri-urban households [49,53]. Similarly, Chagomoka et al. [54] found that food insecurity was higher among peri-urban households (54%) than rural households (45%) in Burkina Faso. However, other studies have reported better food-security outcomes among peri-urban households [55], suggesting that the relationship between settlement location and food security is influenced by local livelihood conditions and households' ability to access food.

Table 8
Socio-economic and demographic predictors of selected WASH outcomes among rural households.

Predictor	Safe water OR (95% CI)	p-value	Water treatment OR (95% CI)	p-value	Toilet available OR (95% CI)	p-value	Shared toilet OR (95% CI)	p-value
Sex of the household head	0.47 (0.09–2.42)	0.366	0.96 (0.26–3.62)	0.955	1.09 (0.13–8.81)	0.938	0.68 (0.17–2.73)	0.583
Age of household head	1.02 (0.98–1.06)	0.411	1.00 (0.96–1.03)	0.900	0.96 (0.90–1.03)	0.260	1.00 (0.96–1.03)	0.774
Education level of household head	**3.75 (1.29–10.90)**	**0.015**	1.41 (0.58–3.45)	0.453	1.18 (0.20–6.86)	0.857	0.82 (0.31–2.18)	0.695
Occupation of the household head	0.72 (0.18–2.84)	0.636	0.62 (0.18–2.17)	0.454	0.80 (0.05–14.08)	0.877	2.27 (0.63–8.13)	0.208
Occupation of the spouse	10.43 (0.43–251.33)	0.149	3.25 (0.41–25.80)	0.266	0.43 (0.01–18.45)	0.661	1.17 (0.22–6.21)	0.852
Household size	**3.27 (1.19–9.03)**	**0.022**	1.27 (0.54–3.01)	0.590	1.64 (0.34–7.99)	0.538	0.69 (0.28–1.70)	0.422
Average household monthly income	1.83 (0.61–5.52)	0.285	1.41 (0.52–3.78)	0.497	5.75 (0.51–64.68)	0.157	0.80 (0.28–2.30)	0.677
Average household monthly expenses	1.12 (0.34–3.72)	0.850	1.22 (0.43–3.48)	0.712	0.55 (0.07–4.34)	0.569	0.39 (0.12–1.24)	0.109
Means of obtaining food	**0.25 (0.08–0.74)**	**0.012**	1.53 (0.62–3.75)	0.354	1.02 (0.18–5.79)	0.983	**3.11 (1.17–8.26)**	**0.023**

*** **indicates p-value significant at ≤ 0.05 level.** Variables including education level of spouse, marital status of the respondent, access to credit, number of income earners, average monthly food expenditure, and household location were excluded from the regression model due to multicollinearity, as diagnostic tests indicated strong correlations with other independent variables in the model.

Table 9
Socio-economic and demographic predictors of selected WASH outcomes among peri-urban households.

Predictor	Safe water OR (95% CI)	p-value	Water treatment OR (95% CI)	p-value	Toilet available OR (95% CI)	p-value	Shared toilet OR (95% CI)	p-value
Sex of the household head	0.93 (0.14–6.32)	0.937	1.82 (0.56–5.91)	0.320	0.78 (0.12–5.21)	0.801	0.52 (0.15–1.77)	0.295
Age of household head	1.01 (0.95–1.08)	0.707	1.00 (0.96–1.03)	0.813	1.05 (0.99–1.12)	0.260	0.96 (0.93–1.01)	0.086
Education level of household head	1.23 (0.27–5.66)	0.795	1.05 (0.45–2.47)	0.905	1.51 (0.40–5.74)	0.549	0.87 (0.35–2.19)	0.768
Occupation of the household head	1.20 (0.07–20.99)	0.901	2.39 (0.52–10.98)	0.264	2.07 (0.11–39.71)	0.629	0.58 (0.11–3.03)	0.519
Occupation of the spouse	0.62 (0.02–17.85)	0.781	0.98 (0.12–8.16)	0.988	0.81 (0.03–25.06)	0.901	0.74 (0.07–7.34)	0.795
Household size	2.91 (0.68–12.48)	0.151	0.80 (0.34–1.88)	0.608	0.93 (0.25–3.49)	0.913	1.11 (0.44–2.78)	0.830
Average household monthly income	1.38 (0.28–6.77)	0.691	1.16 (0.45–3.01)	0.757	1.89 (0.46–7.84)	0.381	1.21 (0.44–3.35)	0.711
Average household monthly expenses	1.53 (0.26–8.86)	0.638	1.18 (0.41–3.36)	0.762	0.90 (0.20–4.08)	0.895	1.10 (0.37–3.26)	0.865
Means of obtaining food	0.78 (0.13–4.73)	0.785	0.76 (0.28–2.09)	0.598	0.64 (0.13–3.14)	0.580	1.84 (0.62–5.53)	0.275

*** **indicates p-value significant at ≤ 0.05 level.** Variables including education level of spouse, marital status of the respondent, access to credit, number of income earners, average monthly food expenditure, and household location were excluded from the regression model due to multicollinearity, as diagnostic tests indicated strong correlations with other independent variables in the model.

In the present study, differences in how households obtained food offer one possible explanation for the greater food insecurity observed in peri-urban areas. More than half of rural households (51.4%) relied mainly on their own food production, whereas most peri-urban households (67.3%) depended on market purchases (Table 3). Producing food for household consumption can reduce dependence on markets and provide a degree of protection against food-price fluctuations, although this advantage depends on land availability, production levels, seasonality and exposure to agricultural risks [56]. By contrast, households that rely on purchased food must have sufficient and relatively stable income to meet their food needs. This may be particularly challenging for peri-urban households, where casual labour was common among household heads in the present study (Table 2). Although peri-urban areas may offer better proximity to markets and employment opportunities, these advantages do not necessarily translate into improved food access when households experience poverty, unemployment or limited access to productive land [30,49]. Consequently, the ability to purchase food, rather than its availability in local markets alone, becomes an important determinant of household food security. This observation is consistent with Farhadian et al. [51], who identified low socio-economic status, particularly income level, as an important factor influencing household food security. Similarly, asset ownership can influence the resources available to households for meeting food and other essential expenditures [57]. When income is inadequate or unstable, households may be forced to reduce the quality and quantity of food consumed or the number of meals taken each day [34].

These differences in food-acquisition patterns also need to be considered within the wider context of peri-urbanization. As settlements expand, agricultural land may be converted into housing, roads, commercial premises and other built-up areas [32,33]. Such changes can reduce opportunities for household food production and income generation from agricultural surpluses, potentially increasing reliance on purchased food [27,30]. Reviews of peri-urban development in sub-Saharan Africa have identified shrinking farmland, changing land-tenure arrangements and unequal livelihood opportunities as important pressures affecting smallholder farmers Alemu and Kombe [58]. Similarly, research in peri-urban Ethiopia has associated land-use changes and increasing market dependence with household food insecurity Agidew and Singh [59]. These observations provide a useful context for understanding the greater dependence on market purchases among peri-urban households in the present study.

In a nutshell, the findings of the present study suggest that peri-urbanization brings both opportunities and challenges for household food security. Although peri-urban areas may offer better access to markets and employment, greater dependence on purchased food makes households more vulnerable when income is limited or unstable. This highlights the importance of strengthening household livelihoods, supporting local food production and improving the affordability of food to enhance food security in rapidly urbanizing areas.

4.2. Household nutrition security status in rural and peri-urban areas

The current study used WASH conditions as indicators of nutrition security [60]. Access to clean and safe water for drinking, washing and cooking is essential for maintaining a healthy lifestyle [60,61]. Conversely, unsafe water increases exposure to waterborne diseases such as cholera, typhoid fever and dysentery, which can compromise nutrition security, particularly when water is not adequately treated before consumption [62]. In the present study, a significantly higher proportion of peri-urban households accessed water from safe sources compared with rural households (90% and 67.5%, respectively; $p < 0.05$) (Table 6). The proportion of peri-urban households accessing safe water was higher than that reported in a previous study [30], while the finding also aligns with earlier reports indicating that a high proportion of rural households accessed drinking water from safe sources [63].

However, access to safe water sources did not necessarily translate into greater household water treatment. For instance, a significantly higher proportion of rural households (61.3%) treated their water compared with peri-urban households (43.6%) ($p < 0.05$) (Table 6). This proportion was higher than that reported by Kuberan et al. [61] in India. Differences were also observed in the methods used, with significantly higher proportions of peri-urban households boiling and filtering their water ($p < 0.05$), while the use of bleach or chlorine was more common among rural households. The proportion of peri-urban households that boiled water was also higher than that reported in previous studies [64]. Household water treatment is important because it reduces exposure to disease-causing organisms associated with diarrhoeal illnesses, cholera, amoebiasis, shigellosis, salmonellosis and worm infestations such as roundworms [65]. Preventing these infections helps improve nutrient absorption and utilization, which are important aspects of nutrition security.

Beyond water safety, access to adequate sanitation also plays an important role in protecting household members from infections that can compromise nutrition security [66]. Household toilet facilities help reduce open defecation and limit the spread of diarrhoeal diseases and cholera, which can interfere with nutrient absorption and utilization [67,68]. In the present study, the overall proportion of households with toilet facilities was similar in rural and peri-urban areas. Nevertheless, a significantly higher proportion of peri-urban households (10%) lacked toilet facilities compared with rural households (4.5%) ($p < 0.05$) (Table 6). No significant differences ($p > 0.05$) were observed in toilet sharing, the number of households sharing toilets or hand washing practices between the two settings. The findings differ from those of Abera et al. [64], who reported that 88.6% of peri-urban households possessed latrines. The proportion of rural households without toilet facilities was slightly lower than that reported in previous studies in Uganda [69], although it contrasts with the Ministry of Water and Environment [63], which reported that 21% of rural households lacked basic sanitation facilities. The relatively better sanitation conditions observed in the study area may partly be attributed to community-led total sanitation and home improvement campaigns spearheaded by district health and water officials, with support from village health teams [26]. These initiatives have encouraged households to improve sanitation and hygiene, while water sources such as protected wells, springs and boreholes have been equipped with chlorine points (Aqua Safe or Water Guard) to promote safe water practices [63].

In spite of the above results, it is important to note that although peri-urban households had better access to safe water sources, rural households were more likely to treat their water, and fewer peri-urban households had access to toilet facilities. This points to potential trade-offs associated with peri-urbanization, whereby improved access to some basic services may coexist with gaps in sanitation and household hygiene. As settlements expand, increasing demand for water and sanitation services may place pressure on existing infrastructure, while unequal access may leave some households exposed to poor hygiene conditions. Thus, improvements in water infrastructure alone may not be sufficient to strengthen nutrition security without corresponding improvements in sanitation and household hygiene practices. Interventions should therefore prioritize appropriate household water treatment, expanded sanitation coverage and sustained hygiene promotion in both rural and peri-urban communities. Further research is also needed to understand the barriers to effective WASH practices and assess how improvements in these conditions contribute to nutritional outcomes across different settlement settings.

4.3. Predictors of household food security and nutrition security in rural and peri-urban areas

Different socio-economic and demographic factors were examined to identify those associated with household food security in the study area. As shown in Tables 7 and in rural households, household heads with secondary or tertiary education had higher odds of being food secure than those with primary or no formal education. This finding is consistent with Asiimwe et al. [70], who reported that secondary-level education was associated with improved household food security in Namutumba District, Uganda. Similarly, Mutisya et al. [71] found a significant relationship between educational attainment and household food security in two informal urban settlements in Kenya. Evidence from Ethiopia also supports this relationship, as Bogale et al. [72] reported higher odds of household food insecurity among households with lower educational attainment. Ikendi et al. [73] further highlighted the relevance of education through their examination of livelihood education programmes and household food security in rural Uganda. The relationship may be explained by the role of education in improving access to information, broadening livelihood opportunities and enhancing households' capacity to generate income to meet their food needs. These findings suggest that education can be an important factor in strengthening household food security, although its influence may vary depending on the livelihood opportunities available in a particular setting. In contrast, the sex and age of the household head, household size, average monthly food expenditure and access to credit were not statistically significantly associated with food-security status among rural households.

In peri-urban households, household size was significantly associated with food security, with households comprising six or more members having lower odds of being food secure than those with fewer than six members. This is not surprising, given that larger household sizes are often associated with higher prevalence of food insecurity, as evidenced by previous studies [74]. This finding is consistent with Asiimwe et al. [70], who reported an increase in severe food insecurity with increasing household size in Namutumba District, Uganda. Similarly, Semazzi and Kakungulu [75] found that larger households were less likely to be food secure in rural Central Uganda. Wagaba et al. [76] also reported a higher prevalence of food insecurity among households with seven to twelve members compared with those with one to six members in Ugandan refugee settlements. These findings suggest that larger households may face greater demands on available food and financial resources, particularly when household income and food supplies do not increase proportionately with the number of household members. This may make it more difficult for such households to meet their food needs consistently. The findings highlight the importance of considering household size when designing interventions to improve food security, particularly in peri-urban settings.

Regarding nutrition security, the results showed that household heads that attained secondary or tertiary education had higher odds of accessing a safe water source than households whose heads had primary or no formal education in rural but not in peri-urban households (Table 8). The findings are consistent with previous studies that reported educational level of the household head as a positive predictor of access to water from improved sources [77,78]. Education may increase awareness of the importance of safe water and improve the ability to

identify and use available water services [64]. Additionally, educated household heads may also have greater access to information, employment opportunities, and financial resources that can facilitate access to safe water [79,80]. Similarly, households with six or more members also had higher odds of accessing safe water in rural but not in peri-urban areas (Table 8). These findings align with Adams et al. [80], but deviate from Simelane et al. [81], who reported a negative association between household size and access to improved drinking water. One possible explanation is that larger households may have more members able to contribute labour or income, improving their capacity to obtain water from safer sources [77]. Secondly, larger households may differ in their resource-sharing arrangements and water needs and therefore, may prioritize access to a reliable source.

In contrast, households that purchased food had lower odds of accessing a safe water source in rural but not in peri-urban areas. This association may reflect differences in livelihood strategies, household resources, or the costs of meeting competing needs. For example, households that depend on market purchases may have to allocate limited resources between food and other essential requirements, while households that produce some of their own food may benefit from reduced dependence on market purchases. Furthermore, households that relied on purchased food had higher odds of sharing a toilet facility among rural but not in peri-urban households. These findings are not consistent with Yallew et al. [82], who reported that educational level significantly influenced household sanitation status. The possible explanation is that reliance on purchased food may coincide with limited access to land, lower livelihood security, or competing household expenditures that make it difficult to construct or maintain a private toilet. Shared facilities may provide an essential sanitation option where private facilities are unaffordable, but their implications depend on the number of users, maintenance, cleanliness, and accessibility.

For household water treatment, none of the examined predictors was statistically significant in the rural or peri-urban households (Tables 8 and 9). Previous studies have identified factors such as age, education, and income as predictors of household water treatment practices [79,82]. In addition, household responsibilities, including water collection, food preparation, and childcare, may influence how water is handled and treated [83]. These studies provide relevant context for understanding water treatment behaviour although the present study did not identify statistically significant independent predictors of this outcome. The findings therefore point to the need to consider household practices and access to treatment options cautiously without attributing the observed behaviour to a specific factor.

Regarding sanitation, the results showed that reliance on purchased food was associated with higher odds of sharing a toilet facility in rural but not in peri-urban households (Table 8). This may indicate that households dependent on purchased food also experience constraints in accessing private sanitation facilities or face competing demands on limited resources. Previous research has reported associations between household characteristics and access to sanitation facilities [84,85]. Shared sanitation may have adverse health implications when facilities are poorly maintained or overcrowded, potentially increasing exposure to pathogens and diseases such as diarrhoea and cholera that can compromise nutrient utilization and nutrition-related well-being [66,84]. These findings highlight the need for context-specific interventions to improve food and nutrition security. Further research should examine how household resources, livelihood strategies, access to water and sanitation services, and local infrastructure interact to shape FNS in rural and peri-urban communities.

4.4. Strength and limitations of this study

A key strength of this study was the use of the Household Food Insecurity Access Scale (HFIAS), a recognized measure of household food insecurity, alongside selected WASH indicators to assess nutrition security. The inclusion of both rural and peri-urban households also provided an opportunity to compare their FNS conditions and identify household-level factors associated with the observed differences. However, the cross-sectional design limits the ability to establish causal relationships, while reliance on self-reported information may have introduced recall and reporting bias. Furthermore, although WASH conditions were used as indicators of nutrition security, the study did not include detailed dietary assessments or direct measurements of nutritional status. These limitations should be considered when interpreting the findings.

5. Conclusion

This study found that household food insecurity was highly prevalent among both rural and peri-urban households, highlighting persistent challenges in achieving household FNS. Rural households relied more on own food production, while peri-urban households depended largely on market purchases. The regression results further showed that, education level of household heads was significantly associated with food security in rural areas, whereas larger household size was associated with lower odds of food security in peri-urban areas. In terms of nutrition security, assessed through WASH conditions, peri-urban households had better access to safe water sources, while rural households were more likely to treat their water. However, lack of household toilet facilities was more common among peri-urban households. Among rural households, household head education, household size and means of obtaining food were significantly associated with access to safe water, while means of obtaining food was also associated with toilet sharing. No significant predictors of the selected WASH outcomes were identified among peri-urban households. These findings highlight the differing food and nutrition security challenges faced by rural and peri-urban households.

In light of these findings, interventions should address the specific needs of rural and peri-urban households. These should include strengthening household food production and educational opportunities in rural areas, improving livelihoods and access to affordable food in peri-urban areas, and expanding access to safe water, sanitation and hygiene services in both settings. Protecting productive agricultural land should also be considered in local planning as settlements expand.

Building on the findings of the present study, future research should adopt longitudinal approaches and incorporate direct nutritional status measurements and dietary assessments to better understand the links between food security, WASH conditions and nutrition security. Further studies should also examine how urban expansion, land-use changes and livelihood patterns influence household food and nutrition security.

CRediT authorship contribution statement

Sunday Mark Oyet: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Robert Mbabazi Kaahwa:** Writing – review & editing, Validation, Software, Formal analysis, Conceptualization. **Christopher Muggaga:** Writing – review & editing, Visualization, Validation, Supervision, Software, Formal analysis, Data curation. **Duncan Ongeng:** Writing – review & editing, Visualization, Validation, Supervision, Software, Formal analysis.

Ethics approval and consent to participate

The study was conducted following the ethical principles set forth in the Declaration of Helsinki of 2024. Ethical clearance was granted by the Gulu University Research Ethics Committee (GUREC) under approval number GUREC-104-19. Permission to carry out the study was also obtained from the Chief Administrative Officer (CAO) of Mbale District, with additional authorization secured from Local Council (LC1) leaders at the village level.

At the household level, informed consent was obtained from all participants prior to data collection. This involved introducing the

research team to respondents and clearly explaining the objectives of the study as well as the anticipated benefits of participation. Only individuals who voluntarily agreed to participate provided their signature on the consent forms before inclusion in the study. Participants were assured of the confidentiality of their responses, with all data collected used solely for research purposes. Furthermore, data collection was arranged through prior appointments with households to minimize disruption to their daily routines and to ensure their comfort and cooperation throughout the process.

Consent for publication

Not applicable. This manuscript does not contain any identifiable personal information from participants, including images or videos, in any form.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available to ensure the confidentiality of participants but can be obtained from the corresponding author (sundaymarkoyet@gmail.com) upon reasonable request.

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Declaration of competing interest

The authors declare that they have no conflicts of interest.

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Data availability

Data will be made available on request.

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