Determinants of household food expenditure in Tanzania: implications on food security

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Abstract

Background Food expenditure in developing countries particularly those in sub-Saharan Africa constitutes about 65–70% of total household expenditure. Existing literature on the determinants of household food expenditure in developing countries have mixed results. Thus, this study aimed at examining the determinants of household food expenditure in Tanzania and their implications on food security using country representative data from the 2017/18 household budget survey. The Two-Stage least squares (2SLS) regression analysis was used as method of analysis.

Results Results show that, on average, monthly household food expenditure in Tanzania is about TZS 159,072.80($\approx$ US $ 69.2). Food expenditure exhibited a non-linear relationship with age of household head with income elasticity of 0.72%. Expenditure also increases with household size, household head sex, education, asset ownership, group membership and marital status while being located in rural areas is negatively associated with food expenditure.

Conclusions To increase household's food expenditure with dietary diversity for improved health, strategies aiming at improving household income, family planning, gender equity, education and social cohesion are important which will further increase household's food security.

Keywords Food security, Food expenditure, Households, Tanzania

Introduction

Food expenditure in developing countries particularly those in sub-Saharan Africa constitutes a largest share in the total expenditure of the household and the country's gross domestic product [37]. It constitutes about 65–70% of the gross domestic product (GDP), and 70% of total household expenditure with income elasticity averaging at 0.78 [28, 57]. It is also a crucial component of the economy considered in poverty reduction strategies,

food security and welfare of developing countries, including Tanzania [22].

In Tanzania, household total expenditure is dominated by food expenditure (59.9%) and there is a rural–urban divide in expenditure, where urban dwellers spend more (63.2%) than their rural counterpart (55.2%) [35]. Despite the importance of food expenditure in the total household expenditure, it is argued by scholars that food expenditure particularly in some food baskets including those rich in protein is still lower in developing countries than those spent in middle and high income countries [28, 38].

The extant literature put forward several factors that may lead to low or high expenditure on food by different segments of people in the community. These factors range from an increase in population (household size), education level, household income, marital status, age,

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Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 2 of 16

geographical location of the household, agricultural productivity and composition of household [27, 53, 55]. For example, the Engel law asserts that" there is an inverse relationship between an increase in income and the proportion of income spent on food. Initially, when income increases, expenditure on food increases, and expenditure on non-food items increases more and eventually leading to a decline in the proportion of income spent on food. Poor people spend most of their income share on food, while rich people spend most of their income share on non-food items [58]. Taking Tanzania as an example, low income households spend about 69.6% of their income on food and 30.4% on non-food items, while those with high income spend only about 33.9% of their income on food items [35].

However, the noted large share of food expenditure as a percentage of total household expenditure has not resulted into improved living standard. Other problems including malnutrition and food insecurity are still rampant particularly in the bread basket regions of the country. This is caused mainly by low uptake of protein rich foods [35]. Basic needs poverty has marginally reduced from 28.2% in 2012 to about 26.4% in 2018, while the food extreme insecurity was recorded at 9.7% and 4.4% in rural and urban areas, respectively [35]. In 2022, Tanzania was ranked 90th globally by the global food security index (GFSI) with a score of 49.1 up from a score of 48 in 2021 among 113 countries examined [19]. The GFSI measures three dimensions of food security qualitatively, including "food availability" which focuses mainly on food supply, "affordability" that focuses on the capacity to pay for food based on the costs of food, and finally is the quality and safety dimension all being at national level [15]. The observed rankings of Tanzania by the GFSI places the country among countries with relatively weak food security score. Figure 1 provides the trend of Tanzania GFSI score from 2012 to 2022. Figure 1 shows

that global food security index score for Tanzania has improved from 37.8 in 2012 to 49.1 in 2022. The score has improved by +11.3 during this period.

Food security is defined as a "situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preference for an active and healthy life" (FAO 2002). For the last three decades, scholars have shown a linkage between household food expenditure as a proxy of household income, factors affecting food expenditure and food security [26]. Food expenditure in Tanzania by households emanates mainly from own food production or from market purchases. Agricultural growth is thus considered a powerful tool in alleviating poverty and enhancing food security, since more than 65% of global rural people derived their livelihoods including as a source of food through the sector in the last decade (World Bank 2022). The sector is linked to increased food security of a household through two major pathways. First, it helps a household involved in agriculture to consume its own produced food which has been shown by previous studies to have stronger effect in reducing food insecurity and improving dietary diversity due to existence of imperfect markets in developing countries [5]. Second, through income generated from agriculture that can be used to purchase nutrient-dense foods (meat, milk, and fish) from the market to supplement the gaps in production [48].

Despite the existing literature establishing these relationships particularly on the factors affecting food expenditure, most studies were conducted in developed countries [25, 43, 55] which means that the factors identified may not be generalized to a developing country such as Tanzania due to heterogeneity in terms of income, household size, agricultural production, technology and cultural as well as geographical aspects.
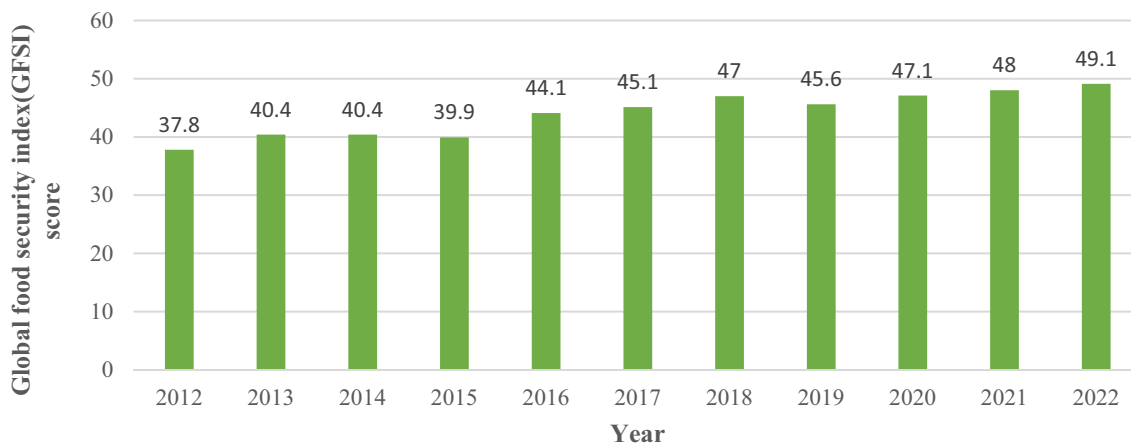

Fig. 1 Tanzania global food security index (GFSI) score 2012–2022. Source: Author computations from GFSI report 2022

Table 1 Mean monthly household food expenditure between rural and urban areas, 2017/18 Source: Author computation from NBS [35] data

Food basket	Rural	Urban	Total	% rural	% urban	% total
Bread and cereals	61,772.13	56,098.04	117,870.17	38.76	34.16	36.43
Meat	15,502.90	19,362.76	34,865.66	9.73	11.79	10.77
Fish	13,226.59	18,744.73	31,971.32	8.30	11.41	9.88
Milk, cheese and eggs	5,897.26	3,499.11	9,396.37	3.70	2.13	2.90
Oils and fats	7,559.06	10,287.67	17,846.73	4.74	6.26	5.52
Fruits	4,134.72	5,852.66	9,987.38	2.59	3.56	3.09
Vegetables	40,961.42	37,476.85	78,438.27	25.70	22.82	24.24
Sugar, jam, honey,	5,731.64	8,576.76	14,308.40	3.60	5.22	4.42
Food products n.e.c	1,559.67	1,571.46	3,131.13	0.98	0.96	0.97
Coffee, tea and cocoa	467.2	549.62	1016.82	0.29	0.33	0.31
Mineral waters, soft drinks, fruit and vegetable	2,549.31	2,207.87	4,757.18	1.60	1.34	1.47
Total food Expenditure	159,361.8	164,227.5	323,589.41	49.25	50.75	100.00

In addition, the existing literature provides mixed results on the determinants of household food expenditure employing mostly OLS regression model which is subjected to endogeneity problem.

Some studies [61] find a positive effect of education on household food expenditure attributed by the role of education in enhancing access to food information, awareness of consumers on food attributes, and stimulates the cognizance to adapt new innovations in the food industry [6]. Contrary to these studies, a study by Zani et al. [61] found a negative effect of education on food expenditure by making consumers spend less on food without affecting their nutritional requirements to increase their food expenditure efficiency. To our knowledge, there is only one study by Kh'ng et al. [26] in Malaysia that examined the implications of food and nutrition security on household food expenditure focusing on adults as their unit of analysis without focusing on other segments which may yield different results. Even the few studies existing in Tanzania focused on consumer food nutrition awareness [6], food diversity and consumption score [30], and patterns of food demand leaving the factors that affect food expenditure and the implications of food expenditure on household food security unexplored.

It is against this backdrop that this study aims at examining the determinants of household food expenditure in Tanzania. The study is worth undertaking, since information on the factors influencing household food expenditure will help nutritionists, development stakeholders and planning entities in making informed decisions by utilizing information from this study. The next sections are organized as follows: "Literature review" section presents literature on the patterns of food expenditure in Tanzania, debates and conceptual framework.

"Methodology" section describes the methodology, sources of data, description of variables, and an analytical framework. "Results" section presents the results, discussion and implications for food security, whereas conclusion and policy implications are presented in "Conclusion and policy implications" section.

Literature review
Patterns of food expenditure in Tanzania
The pattern of food expenditure in Tanzania can be expressed as a function of the type of food products receiving relatively largest share of total food expenditure, location of household, sex as well as household income. On the type of food product, a largest share of food expenditure in Tanzania goes to bread and cereals. This can be attributed by the reason that, cereals including millet, wheat, rice, sorghum and maize are the most produced and consumed food staple in Tanzania, since they can grow in most parts of the country [30]. As observed in Table 1, bread and cereals constitute about 36% of household total expenditure on food items. In addition, cereal expenditure is higher in rural areas (38.8%) than in urban areas (34.2%). This could be attributed by presence of variety of foods in urban areas coming from different rural areas which provides them with several choices unlike rural residents [58]. The next largest share of household food expenditure goes to vegetables which constitutes about 24.2% of the total household expenditure on food. This implies that, cereals and vegetables are the most consumed food in Tanzania and receive the largest share of household food expenditure totaling to 60.6% [35].

Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 4 of 16

As noted in other developing countries, the share of protein rich foods including meat, fish, milk, and eggs is low compared to that of cereals and vegetables. Meat share in the total food expenditure is about 10.8%, while that of milk, cheese and eggs is approximately 9.9%. This emanates from the reason that, these goods especially animal-produced meat is perceived by most Tanzanians to be luxurious and expensive in nature, since they are rarely found in all areas in the country relative to their demand [38].

In addition, total food expenditure varies between rural and urban areas. Urban areas spend more (50.25%) of the total food expenditure compared to their counterpart in rural areas (49.75%). Urban dwellers are likely to consume more, since they have access to varieties of foods from different parts of the country as well as having access to variety of income generating activities. Unlike in rural areas, where they depend mostly on agriculture as their source of income, and most of foods being used in rural areas are produced by within rural areas and hence lack of varieties [28, 58].

Hence, food expenditure pattern in Tanzania is given by the type of food products being consumed with its relative availability and transaction costs, nutrient content of the products and geographical location of the consumers.

Theoretical framework

From the consumption theory, the principal aim of a consumer is utility maximization. A consumer in this case a household chooses a combination of goods that yield maximum utility from the constrained resources available [61]. The utility maximization problem can be expressed as follows:

$$\text{Max } U_{\text{xy}} = u(x_1, y_1 \ldots x_n, y_n) \text{ Subject to } x_1 p_1 + x_2 p_2 = m \tag{1}$$

where U is the level of consumer utility on consuming bundles of goods x and y and constrained by income. Based on the Engel law, low income households spend largest share of their income on food items, where they derive maximum utility. However, the proportion of income spent on food stuffs tend to decrease when income increases. Given inelastic demand of most food items, a household who has attained a point of saturation will shift his/her consumption of food items to non-food items or save more [61]. Previous studies have also shown that household level of income exhibit a positive effect on farm production and marketing efficiency [10, 59]. It also affects household food sufficiency, prevents malnutrition and food expenditure pattern of households [4, 11, 24].

Expenditure is also linked to household size, where a household with more members is expected to have more expenditure on food which also affects the level of income [18]. Other factors affecting household food expenditure includes education level of household head which can have negative or positive effect, location of household which could have bearing on availability of resources and cultural differences [27]. In addition, age of household head, marital status, sex of household head and transfers/remittances influence household food expenditure [53]. The next section presents a brief review of empirical studies on the determinants of household food expenditure.

Empirical review of the determinants of household food expenditure

The reviewed literature suggest the importance of household income as a determinant of household food expenditure. Income influences food expenditure, since it represents the purchasing power of the household on particular food items [3]. A study by Tingum and Kuponiyi [51] in Lesotho using ordinary least square (OLS) and an instrumental variable (IV) found positive effects of off-farm income on household food expenditure. However, the results were different from those estimated with OLS compared with those estimated by IV attributed by endogeneity problem in the OLS estimations. The study findings from the IV models revealed that a 1% rise in household off-farm income led to 22.7% increase in household food consumption expenditure.

Empirical literature also show mixed results on the level of food expenditure across different education levels. Some studies [2, 61] found a negative impact of education on household food expenditure. This is implies that, consumers with higher education are likely to allocate less budget on food consumption, since they are more interested on the quality of diets, nutritional contents leading the increased income to be spent on none-food items, including education and health. However, the results are contrary to those found by Umar et al. [53] that presented a positive relationship between education and household food expenditure. Higher education stimulates consumption of more diversified foods to bring about a healthier household leading to an increase in the budget allocated for food expenditure unlike those with low education. This study also hypothesize that education may have positive or negative impacts on household food expenditure.

In addition, literature also presumes occurrence of differences between male headed and female headed

households in food expenditure. In making informed decisions on suitable food baskets, males are argued to be less knowledgeable which in turn cause them to have more expenditure on food items as well as on per capita non-food products relative to females [6]. Sex also signifies difference in access to resources among males and females, where males have more access to resources than their counterpart due to traditions and culture. Furthermore, there are variations in food expenditure with reference to household size. A relatively larger household is expected to have more food expenditure than households with fewer members, since additional members lead to resource constraint given scarcity of resources [51]. Family composition also positively affects food expenditure particularly when most of the household members are dependent [25, 61].

Similarly, the existing literature shows that there is heterogeneity on the effects of marital status to food expenditure. It is argued that, married consumers tend to spend less than unmarried consumers when individual factors such as household size are controlled for. However, when the size of household has been considered, there is higher expenditure among married couples than unmarried, since more mouths need more food [8, 30].

There is also heterogeneity across age groups with regard to food expenditure. Aged people are likely to spend more on food than younger ones, since they are expected to support other people, including their families and relatives [28]. This assertion is supported by previous studies conducted by Venn et al. [55], and Sekhampu [46]. Despite these reviewed literature, there is still a gap in the determinant of household food expenditure in Tanzania. The current study by Kilima [28] focused on the factors that influence allocation of household's food budget in Tanzania using the 2010/2011 national panel data with a sample size of 3768. The current study differs from this study by utilizing current household budget survey data (2017/18) with a relatively larger sample size of 9463 which is more representative and may yield different results due to effect size.

Methodology
Study area
This study covered the twenty six (26) regions of Tanzania mainland. The study area is located in the East African Coast between Latitude 1^0 South and 12^0 South and between Longitudes 29^0 East and 41^0 East of Prime meridian. It extends from Lake Tanganyika in the West to Indian Ocean in the East. It also extends from Lake Victoria to the North and Lake Nyasa to the South. Tanzania mainland being part of the United Republic of Tanzania (URT) covers an area of 939,702 square kilometers (99.4%) out of 945,087 square kilometers of the United

Republic of Tanzania of which the rest is covered by the Zanzibar archipelago [54]. The study area's economy is dependent on the agricultural sector which contributes about 28.2% of the Tanzania gross domestic product. According to the population and housing census 2022, the country has a total population of 61.7 million people of which 8% are food poor [35]. The area was selected based on data availability, where the data covered only Tanzania mainland.

Data source and design
This study used secondary data extracted from the Tanzania national household budget survey collected by the Tanzania national bureau of statistics over the 12 consecutive months from December 2017 to November 2018. These are national representative data covering a total of 26 regions in Tanzania mainland. Data were collected throughout the year to cover seasonal variability in household seasonal consumption expenditure. The households were spread throughout the year to secure a sufficient sample in all seasons at aggregate level. It involved cross-sectional research design, where data from households were collected at a single point in time, since the design is time and cost-effective [56].

Sample size and sampling procedures
A two stage cluster sample design was employed during data collection, where at first stage, enumeration areas (primary sampling units—PSUs) from the 2012 population and housing census were selected. In this stage, a total of 796 PSUs of which 69 were from Dar es Salaam (the largest city in Tanzania), 167 from other urban areas, while 560 PSUs were selected from rural areas. At the second stage, a systematic sampling was used to select a sample of 12 households from the updated list of PSUs forming a total of 9465 households [35]. However, due to some missing values, a sample was reduced to 7335 households which were taken for further econometric analysis. The description and descriptive statistics of the variables used in this study are shown in Table 2.

Measurement of key variables
In this study, key variables included household food expenditure and food security. Food expenditure was measured as the total amount of income in Tanzania shillings spent on food items by a household per month. Food security was measured by the household food insecurity access scale (HFIAS) developed by the food and nutrition technical assistance project (FANTA) in 2007 [9]. Though there are several measures of food security used by different agencies globally, including the global food security index, global hunger index, household consumption and expenditure surveys, such as the

Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 6 of 16

Table 2 Definition of variables and their descriptive statistics Source: Authors' computations

Variable	Description	Mean	Std. Dev
Food expenditure	Household monthly food expenditure in TZS (2017/18)	159,072.77	141,660.99
Household income	Annual household income in TZS	946,893.39	2,343,842.6
Age	Age of the head of household in years	47.106	15.737
Household size	Number of members in a household	4.866	2.908
Sex	1 if household head is male, 0 = female	0.727	0.445
Marital status	1 = married, 0 = not married	0.678	0.467
Education level	1 = no formal education, 0 = formal education	0.502	0.5
Location	1 = rural, 0 = urban	0.7065	0.647
Employment status	1 = employed, 0 = not employed	0.112	0.315
Land ownership	1 = yes, 0 = no	0.625	0.484
Assets	1 = if household owns a mobile phone, 0 = not own	0.768	0.422
Regional dummy	1 = Tanzania food basket region, 0 = otherwise	0.202	0.402
Own produced	Expenditure on own household produced food (TZS)	42,673.01	75,678.98
Purchased food	Household expenditure on purchased food (TZS)	96,429.53	99,864.36

household dietary diversity and food consumption score, and coping strategies index among others, the household food insecurity access scale has been validly used as a cross-sectional measure for assessing food insecurity at household level in different developing countries [12, 34, 41]. It was also used in this study given data availability. The HFIAS is a continuous measure of degree of household's access to food, food preferences, and expression of concern about food shortage in terms of quality and quantity in the last 4 weeks (30 days). It consists of nine questions that cover the three sub-domains of food insecurity in order of extremities. These includes uncertainty and anxiety, inadequacy of food in terms of quality and quantity [9], Otekunrin et al. 2021).

For each question, the respondent is asked on the frequency of occurrence of a certain food insecurity condition resulting in a score of zero or 1 (never/rarely) to 3(often) making a scale showing a continuum of responses from 0 to 27 as a summated scale. The higher the score, the higher the vulnerability to food insecurity and the lower the score the less the incidence of food insecurity at the household level. The questions included in the HFIAS showing occurrences of food insecurity condition with their descriptive statistics are presented in Table 3, while the repetitive question asking on the frequency of occurrence is shown in Table 4.

Since the HFIAS score provides only the food insecurity score (0–27) but does not provide the category by which the household falls within the food insecurity continuum, this study also employed the household food insecurity access prevalence (HFIAP) that shows the status of households food insecurity distinctively [9]. In this

measure, four categories of household's food insecurity status are identified as a household being food secure, mildly food insecure, moderately food insecure and severely food insecure.

Households are grouped progressively as they respond to a more severe food insecurity condition from question one to question 9. Table 5 indicates how the categories were obtained. A household is said to be food secure given that it did not encounter any of the food insecurity situations in Table 5, or it only rarely worried about not having enough food (Q1a = 0 or Q1a = 1). A household is categorized as mildly food insecure if it worries about not having enough food sometimes or often (Q1a = 2 or Q1a = 2), and/or not able to eat preferred foods ((Q2a = 1 or Q2a = 2 or Q2a = 3), and eating few kinds of food (Q3a = 1) and eating food that a household do not real want on rare cases (Q4a = 1).

Table 3 Incidence of food insecurity conditions Source: Author computations from HBS 2017/18

Qn	Occurrence question (*n* = 9374)	No (%)	Yes (%)
1	Worried about not having enough food?	46.28	53.72
2	Not able to eat preferred foods?	44.16	55.84
3	Eat just a few kinds of foods?	42.34	57.66
4	Eat foods they really do not want eat?	45.21	54.79
5	Eat a smaller meal?	44.53	55.47
6	Eat fewer meals in a day?	52.8	47.2
7	No food of any kind in the household?	63.78	36.22
8	Go to sleep hungry?	74.41	25.59
9	Go a whole day and night without eating?	97.6	2.4

Table 4 Frequency of occurrence of food insecurity conditions Source: Author (s) computations from HBS 2017/18 data

Qn	Frequency of occurrence question (*n* = 9374)	Frequency of food insecurity condition (%)		
		Rarely	Sometimes	Often
1a	Worry about not having enough food?	24.27	50.94	20.79
2a	Not able to eat preferred foods?	17.45	47.14	34.41
3a	Eat just a few kinds of foods?	19.82	51.55	28.63
4a	Eat foods they really do not want eat?	21.71	53.46	24.83
5a	Eat a smaller meal?	21.75	55.03	23.22
6a	Eat fewer meals in a day?	25.29	56.62	18.08
7a	No food of any kind in the household?	32.05	49.84	18.11
8a	Go to sleep hungry?	36.44	47	16.56
9a	Go a whole day and night without eating?	85.9	2	2.1

Table 5 Household food insecurity prevalence levels Source: Adapted from Coates et al. [9]

	Frequency of occurrence		
Qn	Rarely (1)	Sometimes (2)	Often (3)
1a	Food secure	Mildly food insecure	Mildly food insecure
2a	Mildly food insecure	Mildly food insecure	Mildly food insecure
3a	Mildly food insecure	Moderately food insecure	Moderately food insecure
4a	Mildly food insecure	Moderately food insecure	Moderately food insecure
5a	Moderately food insecure	Moderately food insecure	Severely food insecure
6a	Moderately food insecure	Moderately food insecure	Severely food insecure
7a	Severely food insecure	Severely food insecure	Severely food insecure
8a	Severely food insecure	Severely food insecure	Severely food insecure
9a	Severely food insecure	Severely food insecure	Severely food insecure

Legend:
- Food secure (green)
- Mildly food insecure (light green)
- Moderately food insecure (orange)
- Severely food insecure (red)

In addition, a household is said to be moderately food insecure if a household sometimes or often eats few kinds of food and food it does not want ((Q3a = 2, Q3a = 3 or Q4a = 2, Q4a = 3), and eat a smaller amount of meals rarely or sometimes (Q5a = 1, Q5a = 2), and rarely or sometimes reduce the number of meals per day (Q6a = 1, Q6a = 2) but did not encounter a situation, where a household had no any kind of food, went to sleep hungry or going a whole day or night without eating (Q7a–Q9a). Finally, a household is categorized a severely food insecure if it has started eating small amount of meals and reducing the number of meals per day often times (Q5a = 3, Q6a = 3), and experiencing the three most food insecurity extreme conditions (Q7a–Q9a) on either rare, sometimes or often basis. Using Table 5, this study examined the proportions of households falling under each of the four categories of food insecurity presented in Fig. 2.

Other variables (independent variables) included household income in Tanzania shillings, age of household head in years, and household size expressed as number of members all of which were continuous variables, as described in Table 2. The rest of the variables were dummy variables, including sex of household head, location, marital status, land ownership, employment status, and asset ownership (Table 2). Mobile phone ownership was used as a proxy for asset, since more than three-quarters of the sampled respondents had mobile phones unlike other forms of assets which were owned by less than half of the respondents. Owning a mobile phone as an asset helps in increasing efficiency in allocation of resources, including savings, labor, reducing risk and improve education, health, and agricultural yield through communication, access to information and financial resources [32, 45, 50].
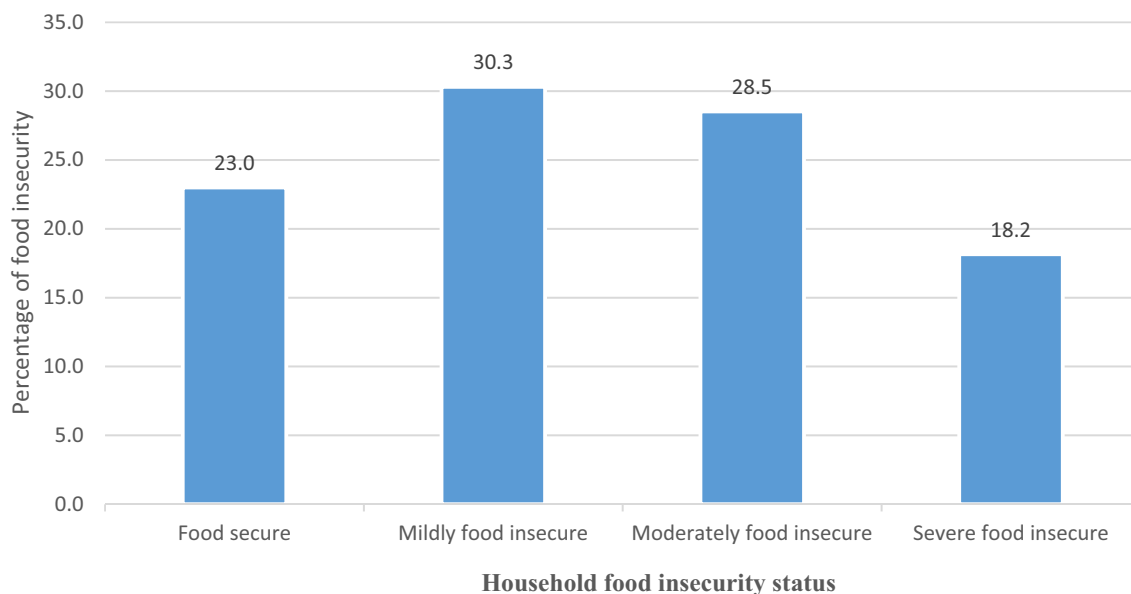
Fig. 2 Household food insecurity categories. Source: Author computations from HBS 2017/18 data

Data analysis

To examine the determinants of household food expenditure, previous studies [8, 22, 51, 61], used of ordinary least square (OLS) regression models. However, using OLS regression model is subjected to various limitations, including failing to take into account the endogeneity problem emanating from reverse causality [17, 29]. In this study, among the variables that were hypothesized to influence household food expenditure, household income level was found to be endogenously determined as supported with previous studies [7, 21, 29]. This implies that, estimating the determinants of household's food expenditure without taking into account the endogeneity of some explanatory variables, including income may lead to inconsistent and biased results [29].

In this stance, to take into account the endogeneity problem emanating from the effect of household income as one of the determinants of household's food expenditure that was not addressed by most of the previous studies identified above closely to this topic, this study employed a two-stage least square (2SLS) technique as a model of analysis. The technique is suitable in dealing with the endogeneity problem particularly when the dependent variable is continuous [7, 17]. Since it is a two-stage approach, the first stage was estimated as shown hereunder:

$$I_i = \theta_i + \varphi_i X_i + \delta_i M_i + \varepsilon_i \tag{2}$$

where I_i is household income assumed to be endogenously determined and expressed in natural logarithm, X_i represents a vector of independent variables, including (household size, age, sex of household head, education, marital status, location of household whether rural or urban, food basket region dummy). ε_i is the disturbance term, while φ_i and δ_i are parameters to be computed. The variable M_i represents a vector of instrumental variables that are hypothesized to influence household income but with no direct influence on household expenditure, their effect on expenditure is only through income. Income is hypothesized to be endogenous, since it may affect food expenditure but can also be affected by household food expenditure particularly when the household size is relatively large which needs more food and thereby reducing household's income that could be allocated to other activities [17]. It can also be endogenous due to errors of measurement which may result from under or overestimation [35]. At the second stage, the effects of household income with other explanatory variables on food expenditure was estimated in the following equation:

$$\text{Food}^E = \alpha_i + \beta_i I_i + \omega_i X_i + \eta_i \tag{3}$$

where Food^E is equal to household monthly food expenditure expressed in Tanzania shillings (TZS), X_i is household characteristics, I_i is the household income which is endogenously determined, β_i and ω_i are parameters to be estimated in this study. The variable η_i represents the disturbance term which includes unobservable variables not included in the model but which influences household

Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 9 of 16

Table 6 Pairwise correlation between the variables

	LNfoodx	Hhhage	Hhsize	Hhhsex	Location	lnIncome	Marst	Hhhedu
LNfoodx	1							
hhhage	−0.017	1						
Hhsize	0.348**	0.088**	1					
Hhhsex	0.116**	−0.172**	0.158**	1				
Location	−0.197**	0.091**	0.137**	0.036**	1			
LnIncome	0.106**	−0.125**	−0.001**	0.070**	−0.138**	1		
Marst	0.147**	−0.129	0.290**	0.582**	0.091**	0.047**	1	
Hhheduc	0.185**	−0.135**	−0.117**	0.044**	−0.281**	0.248**	0.017	1

LNfoodx, lnIncome represents natural logarithms of household food expenditure and household income; Hhhage = age of household head, Hhsize = household size, Hhhsex = sex of household head, Marst = marital status, Location = dummy (1 = residing in rural areas, 0 = urban areas)

** represents significant at $p < 0.01$

food expenditure. During the analysis, some variables including Food^E and I_i were transformed into natural logarithm, because the inclusion of these variables was the major cause for the observed heteroscedasticity. To estimate the effect of food expenditure on household's food security, Eq. 4 was estimated using the instrumental variables expressed in Eqs. 2 and 3:

$$FI_i = \alpha_i + \beta_i \text{Food}_i^E + \omega_i X_i + \delta_i \qquad (4)$$

where FI is the continuous variable representing household food insecurity access scale ranging from 0 to 27, Food^E is equal to household monthly food expenditure expressed in Tanzania shillings (TZS), X_i is household characteristics, β_i and ω_i are parameters to be estimated in this study. The variable δ_i represents the disturbance term which includes unobservable variables not included in the model but which influences household food expenditure. In this equation, income was not included, since food expenditure is a function of income which might cause a multicollinearity problem.

Based on the extant literature [29, 42], household's assets ownership, and group membership as sources of social network were used to instrument household income. Household's asset ownership influences households to engage in income generating activities including off-farm income activities but not directly affecting food expenditure. Social networks through group membership act as a source of information that helps the household in making informed decisions with regard to productive activities that assists a household in earning income.

Results

Socioeconomic and demographic characteristics of sampled households

Table 2 presents the results on the socio-demographic factors of the households consulted during the 2017/18 survey. The results show that majority of the respondents (72.7%) were males, while only 27.27% of the sampled household head constituted of females. On average, a typical household head had about 47 years signifying that most of the respondents were young adults in their active age group of which most of them (50.2%) had formal education, while the rest had no formal education. About 11.2% were employed either in the public sector or private sector.

In addition, most of the respondents (70.65%) were from rural areas. About 67.8% of the respondents were married either in a monogamous or polygamous family, while 32.2% were not married in the sense that they were either divorced, widowed, never married at all, separated or living together in cohabitation relationship. The households' monthly food expenditure averages at TZS 159,072.80. Own produced monthly food expenditure averages at TZS 42673.01 while that involving expenditure from purchased food averaged at 96,429.53 TZS implying that households spend more on purchased foods compared to own produced food expenditure. This could be attributed by low agricultural yield which forces households to find alternatives to feed the members of households consisting on average about 5 persons [28].

Table 6 presents the pairwise correlation matrix showing the degree of association between the variables. Correlation results show that income, household head sex, marital status, household size and education level of household head had weak, positive and significant relationship with household food expenditure. In addition, location (living in rural areas) is negatively associated with household food expenditure. No signs of

Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 10 of 16

multicollinearity was observed, since the Pearson's correlation coefficient values for all variables were below 0.8 [60].

Table 3 shows that over half of the respondents encountered at least one of the food insecurity conditions increasing in order of extremity from condition one "worried about not having enough food" to "eating a smaller meal" and thereafter trend declined from "eating fewer meals a day" to the lowest "go a whole day and night without eating" which constituted only 2.4% of households included in the sample. This signifies that, food insecurity is still a problem to a sample of households examined.

On the frequency of occurrence presented in Table 4, most of the households reported to have sometimes experienced food insecurity incidences as represented by relatively large proportion of respondents who "sometimes" experienced food insecurity conditions as expressed by the nine food insecurity incidence questions. From Table 4, 50.94% of households sometimes worried about having no enough food, 56.62% ate fewer meals a day, 49.84% had no food of any kind in a day, while only 2% sometimes went a whole day and night without food. However, there was a downward trend along the continuum of food extremities of households which "often" experienced food insecurity from 34.41% to 2.1% and an upward trend of households experiencing no or rarely food insecurity from 17.45% to 85.9%.

Figure 2 shows that only 23% of households included in the sample were food secure, while 18.2% experienced severe food insecurity. The largest proportion of households experienced mild food insecurity (30.3%) followed moderately food insecurity (28. 5%).

Empirical results and discussion
Determinants of household income
Table 7 presents results of the 2SLS regression model to determine the determinants of household income and food expenditure in Tanzania. The test for joint significant, F test show that the model has fitted well with the data at $p < 0.0000$. Before embarking on analyzing the determinants of household food expenditure, the Wu-Hausman and Durbin Watson tests for endogeneity, F-joint test for weak instruments and the Sargan and Basmann tests for over-identification were performed. From Table 7, results from these tests show that accordingly, income is endogenously determined shown by the significant Wu-Hausman ($F = 237.3$, $p = 0.0000$) and Durbin Watson ($F = 230.1$, $p = 0.0000$) statistics. Similarly, the instruments were found to be strong predictors of income given by the F value greater than the critical values as suggested by (Baum et al. 2007). In the same context, the model was identified as shown by the Sargan ($\chi^2 = 0.1593$,

$p = 0.6898$) and Basmann ($\chi^2 = 0.1592$, $p = 0.6899$) tests. Results from Table 7 show that household income is determined by several factors, including age and education of household head, household size, and location of household, group membership, asset ownership and sex of household head.

The coefficients for household head age and age squared were positive and statistically significant with respect to household income implying that household head age and income are concave and non-linearly related. Initially, when the household's head age increases by 1 year, income increases by about 1.7% holding other factors constant. Beyond the threshold of 55 years, income decreases by about 0.02% with age implying that older people tend to have lower income compared to young people, since their productivity and health stock decreases making them unable to work more for the earning unlike young ones who are still energetic. This finding corroborates with those by previous studies [23, 29, 52] which found both positive and negative relationship between age of household head and household income.

Consistent with previous studies [23, 29, 40] which found a positive relationship between household size and income, in this study, household income significantly increases with household size. As the household increases by one member, household income increases by about 8.5% holding other factors constant. This suggests that larger households particularly those with more workforce than dependents provide more labour force and thus are likely to engage more in productive activities thereby earning more income. In the Tanzanian context, households depend largely on family labour in farming activities as sources of income and thus more family members particularly those in productive age implies more work force that could be devoted in more income generating activities. However, if there are more dependents than workforce in a household, then this could lead to a decrease in household income as found by Tuyen [52] in Vietnam.

The coefficient for location of household was negative and significantly affecting household income level. The results show that, rural households have relatively lower income than their urban counterparts. Rural households had about 26.1% lower income than those in urban areas. This can be explained by the reason that rural households' main source of income is agriculture which is prone to lower prices of agricultural produce and have less exposure to information and resources on off-farm activities unlike urban households. This result is consistent with that of Omotayo et al. [40] study in South Africa's North-Western Province which revealed

Table 7 2SLS results on the determinants of household income and food expenditure Source: Author computation from HBS (2017/18) data

Dependent variable: ln(food expenditure)		
Independent variables	**LN (income)**	**LN (food expenditure)**
	1st Stage	**2nd stage**
Age of household head (years)	0.0177***	0.0178***
	(0.00285)	(0.00367)
Age of household head (years)^2	− 0.000160***	− 0.000142***
	(0.0000282)	(0.0000363)
Household size	0.0853***	0.0857***
	(0.00286)	(0.00371)
Sex of household head (1 = male, 0 = female)	0.0562*	0.0678**
	(0.0083)	(0.0037)
Household location (1 = rural, 0 = urban)	− 0.302***	− 0.242***
	(0.0162)	(0.0227)
Marital status (1 = married, 0 = not married)	0.0287	0.0352
	(0.0199)	(0.0219)
Education (1 ≥ secondary, 0 = primary + no formal education)	0.229***	0.148***
	(0.0224)	(0.0108)
Group membership (1 = yes, 0 = no)	0.151***	
	(0.0241)	
Asset Ownership(1 = yes, 0 = no)	0.208***	
	(0.0542)	
Ln (Annual household income in TZS)	–	0.722***
		(0.0588)
Constant	10.92***	1.274
	(0.152)	(0.816)
R^2	0.1982	0.0471
$F_{(9, 7325)}$; prob > F	201.2; 0.0000	
Breusch–Pagan χ^2 (1); prob > χ^2	0.06; 0.8083	
Durbin χ^2 (1)		230.1 ($p = 0.0000$)
Wu-Hausman F (1, 7327)		237.3 ($p = 0.0000$)
First stage summary statistics		
$F_{(9, 7325)}$; prob > F (H_0 = weak IV)		180.96; 0.0000
Sargan χ^2 (1)		0.1593 ($p = 0.6898$)
Basmann χ^2 (1)		0.1592 ($p = 0.6899$)
N	7335	7335

*, **, ***denotes significant at $p < 0.05$, $p < 0.01$, and $p < 0.001$; figures in parentheses under the coefficients are standard errors, while those in the test statistics are *p* values

that farming households had lower income than those involving in off-farm income.

Education level of the household head had positive and significant effect on household level of income. From the results, households headed by heads with at least secondary education earned about 25.7% more income than those with primary or lower education holding other factors constant. This can be explained by the fact that, education provides information to households with regard to opportunities, knowledge and skills including entrepreneurial skills which in turn increases their productive capacity based on informed decisions thereby increasing their incomes. This is in-line with previous studies [23, 36] which also found a positive effect of education on household's income level.

In the similar vein, group membership positively and significantly influences household income. Those households headed by a head belonging to a socio-economic group had about 16.3% higher income than those with

Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 12 of 16

no groups. This suggests that group membership provides social networks and social capital that aids the flow of information and resources which increases productive capacities, access to socio-economic services including credits which in turn increases the household's income level. The results are consistent with those of Rashid et al. (2020) in Mbarali district of Tanzania which found that group membership increases the likelihood of participating in agricultural commercialization and thereby positively influencing household income.

Asset ownership also exhibited positive and statistically significant effect on household income. Households which owns assets had approximately 23.1% more income than those without assets, ceteris paribus. Assets acts as safety nets against social and economic shocks by reducing the households' vulnerability to risks brought by unforeseen negative events including inflation, floods, and decline in market price for agricultural produce. Similarly, assets including ownership of mobile phones used as a proxy for asset ownership in this study increases access to information and financial resources through mobile money which in turn increases consumption of well-informed food groups, improves health and agricultural yield leading to improvement in household's income [32, 45].

The coefficient of sex of household head was also positive and significantly influencing household's income. Male headed households had 5.78% higher income than female headed households. This is attributed by the difference in access to productive resources between males and females in Tanzania, where males have more access to resources than females. This is due to cultural aspects including inheritance of land, where males are allowed to inherit and not females who are expected to vacate from the family after marriage. Similarly, there is also gender gap in access to other resources including information as evidenced by FAO [16] report which revealed that there is a gender gap in access to mobile internet connectivity, falling from 25% in 2017 to 16% in 2021. These have also translated in gender gap in agricultural productivity between males and females obtained on the same plot size of about 24% and hence lower income [16].

Determinants of household food expenditure
Of the hypothesized variables included in the model (Table 7), age of household head, household size, education level of household head, sex of household head, location of household, marital status and household income level had significant effects as determinants of household food expenditure.

Results show that, household head's age is non-linearly associated with household's food expenditure. Households headed by heads with ages below 62.7 years showed

an increase in food expenditure of about 1.78%, while those headed by heads with above this threshold experienced a decrease in food expenditure of about 0.01% holding other factors constant. This is explained by the reason that, as ones age increases before reaching age 62.7 which is at the end tire of working age in Tanzania, they has been exposed to more opportunities, accumulated variety of skills which make him/her more productive, earn more income by engaging in more income earning activities. Similarly, below 62.7 years, household heads are still in their reproductive ages and hence have more dependents to feed and on themselves leading to more expenditure unlike elders who are in their unproductive age. The result corroborates with those findings obtained by previous studies which reached similar conclusion that household food expenditure is positively affected by age of household head but tend to be affected negatively upon reaching certain age [8, 27, 28].

Results show that, the number of members in the household positively and significantly affects household food expenditure. The results indicate that as the household increases by one member, on average, the level of household food expenditure increases by about 8.6% ceteris paribus. Having larger household size imply that more food is needed to feed the ever-increasing number of household members. This results is supported by results from previous studies [25, 27, 53] which revealed that there was a positive association between household size and food expenditure.

Similarly, sex of household head positively and significantly affect household's food expenditure, where male headed households had a relatively 7.02% higher food expenditure than female headed households. This is explained by the reason that, there is gender disparity in access to productive resources, where males have more access than females reflecting also a higher income to male headed households than their female counterparts. Since income play a major role in determining household food expenditure, having lower income signifies lower food expenditure by a household. Furthermore, in making informed decisions on suitable food baskets, males are less knowledgeable and sensitive which in turn cause them to have more expenditure on food items as well as on per capita non-food products relative to females [6]. The result is similar to those obtained by Addai et al. [1] in Ghana which found that there was a gender disparity in household food consumption expenditure of 28.2% and a dietary diversity of 18.1% between male headed and female headed households, respectively.

With at most primary level of education as a reference group, household heads with at least secondary education tend to have more food expenditure than those with at most primary education. This implies that education

Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 13 of 16

has positive influence on household food expenditure. For example, those with at least secondary education spend about 15.95% more on food than those with at most primary education.[1] This implies that higher education stimulates more food expenditure, where highly educated household heads tend to spend on diversified food products by focusing on dietary diversity to improve their health status thereby leading to an increase in expenditure. In Tanzanian context, it has been shown that, households located in the bread basket regions are the one faced with both food poverty and low dietary diversity which brings food availability–nutrition paradox [31]. Lack of food and nutrition education particularly in rural areas has been shown to be the major cause of this situation (*ibid*). The result is consistent with previous studies by [3, 22] which also found that education was a significant factor in improving household food expenditure. However, the result is contrary to findings by Umar et al. [53] who found a negative and significant effect of education on household food expenditure.

With regard to location of household head, rural located households tend to spend less on food than their urban counterpart. Households in rural areas spend about 21.5% less on food than their urban counterpart. As pointed out by Wenban-Smith et al. [58], this situation is explained by the reason that, in most cases rural households spend most of their own produced foods with no access to variety of foods and income generating opportunities compared to those in urban areas who have access to variety of foods from various parts of the country and with more income generating activities.

Furthermore, the findings show that being married positively and significantly affects household's food expenditure level, though it was not significant. With not married as a reference group, those married spend about 3.5% more than those not married. The result imply that, being in a marriage leads to an increase in the share of food expenditure as a percentage of total household expenditure. This is explained by the reason that, with a typical household size of about 5 persons, a married consumers spend slightly higher than those not married, since they have to feed more people. The result corroborates with those from previous studies which reached similar positive causal–effect between marital status and food expenditure [14, 28].

As expected, household total income positively and significantly affects household's food expenditure. An increase in household's income by 1% leads to an increase in household's food expenditure by 0.72% holding other

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Table 8 Effect of food expenditure on household's food security Source: Author computation from HBS (2017/18) data

Dependent variable: household food insecurity access score (HFIAS)

Variables	OLS	2SLS
LN (Household total food expenditure)	− 0.606***	− 1.604*
	(− 4.98)	(− 2.42)
Age of household head (years)	− 0.00818	0.0743
	(− 0.31)	(0.85)
Age of household head (years)^2	0.000168	− 0.000132
	(0.69)	(− 0.19)
Household size	0.0617*	0.0508
	(2.07)	(0.60)
Sex of household head (1 = male, 0 = female)	− 0.283	− 0.938
	(− 1.43)	(− 1.39)
Household location (1 = rural, 0 = urban)	− 1.034***	1.378
	(− 5.93)	(0.95)
Marital status (1 = married, 0 = not married)	− 0.253	− 0.992
	(− 1.26)	(− 1.40)
Education (1 ≥ secondary, 0 = primary + no formal education)	0.111	3.401
	(0.73)	(1.78)
Constant	26.61***	− 167.1
	(12.91)	(− 1.53)

*, **, ***denotes significant at $p < 0.05$, $p < 0.01$, and $p < 0.001$; figures in parentheses under the coefficients are standard errors, while those in the test statistics are p values

factors constant. The positive income elasticity implies that food is a normal good for the households under analysis in this study. This further implies that, when a household income increases, more of it is spent on food items showing that food is an important component of household's budget. This finding supports those of Murendo et al. [33] study in Zimbabwe using a sample of 32,256 households which found that income elasticity of food groups expenditure shares were positive though with different intensities between food groups and across household's socio-economic characteristics. The finding is also consistent with previous studies [11, 24] which found also a positive effect of household's income on food expenditure.

Effect of food expenditure on household's food security

The effect of food expenditure on household's food security is presented in Table 8. The dependent variable is the household food insecurity access scale (HFIAS) which is a continuous variable, while the dependent variable of interest is the household's food expenditure level expressed in Tanzania shillings per month. Table 8 presents the second stage of the 2SLS model which is compared with the OLS. Results show that, both in the 2SLS and OLS, food expenditure was significant

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[1] For log-linear models (LnY = $\beta_0 + \beta_1$Dummy), the semi-elasticity with respect to the dummy variable is calculated by the formula ($e^{\beta 1} − 1$)*100, where e = 2.71828 [20].

Rashid *et al. Agriculture & Food Security* (2024) 13:13

Page 14 of 16

and negatively affecting household's food insecurity. An increase in household's monthly food expenditure by 1% leads to a decrease in household's food insecurity by a score of 0.01–0.02. This suggests that when a household spend more on food items, the level of food insecurity decreases or in other words, the level of food security improves. This is explained by the reason that, household's food expenditure particularly from purchasing foods from the market supplements own produced foods thereby increasing the amount and variety of food held by a household for an active and healthy life [39]. Similarly, an increase in expenditure on own produced food items particularly to households which diversify their farm production increases availability, access, utilization and stability of food in terms of quantity and quality (food security) at household level [48].

It is worth noting that, in Tanzania, 32% and 8% of rural and urban household total food consumption expenditure originates from own farm production, while 58% and 85% in rural and urban areas, respectively, involve purchase from the market. The rest 10% comes from gifts and in-kind payments [13]. This signifies that, markets provides over half food spent by households in rural areas and over three-third in urban areas showing the importance of market channel as opposed to own food production in enhancing household's food security in Tanzania.

However, with a recent observed spike in food prices due to high demand relative to production particularly in developing countries, including Tanzania, poor households will be forced to spend on poor quality diets, rely on staples as well as reducing the budget allocated to expenditure on food or skipping some foods previously consumed [33].

As pointed out by Smith and Subandoro [49], households spending between 50% and 75% of their income on food as with the case of this study estimated at 62.5% are regarded as food insecure households. Therefore, policies aimed at enhancing food security should focus on improving households' income, family planning and reducing rural–urban inequality in access to resources that will further improve expenditure on food and food security, respectively.

Diagnostic tests

In this study, two tests were carried out. Since heteroscedasticity and multicollinearity are the common problems in cross-sectional data, these were tested. Results from the variance inflation factor (VIF) for normality yielded an average value of 3.53 implying that there was no problem of multicollinearity among the independent variables [47]. Similarly, a test for heteroscedasticity (Breusch–Pagan test) yielded a *p* value of 0.8621 which is greater

than all the chosen levels of significance (5%, 1% and 0.1%) signifying that we cannot reject the null hypothesis of constant variance which implies that errors were homoscedastic following [44].

Conclusion and policy implications

This study aimed at examining the determinants of household food expenditure in Tanzania using secondary data from the 2017/18 household budget survey. Using descriptive and 2SLS analysis, the findings show that, the average household in Tanzania spend about TZS 159,072.80 per month for food expenditure. However, monthly value of own produced food expenditure is low compared to the expenditure on purchased food implying that household's own produced food does not suffice its demand. Households spend more on cereals and starchy foods (36.43%) and vegetables (24.24%) relative to protein rich foods with a rural–urban divide in food expenditure. Similarly, based on the household food insecurity access prevalence, only 23% of households were food secure, while 30.3%, 28.5% and 18.2% were mildly, moderately and severely food insecure.

From the 2SLS regression analysis with income as an endogenous variable, determinants of household food expenditure included household size, income, education, group membership, asset ownership and marital status positively and significantly affects household food expenditure. Age of the household head had non-linear relationship with food expenditure, while location of household especially being in rural areas negatively and significantly affects household food expenditure. This implies that, policies, strategies and programs that aims at improving the level of household living standard through stimulating food expenditure, should consider these factors as determining factors program success. In addition, food expenditure reduces the level of household food insecurity by a score of 0.01–0.02. This implies that, an increase in household food expenditure enhanced by increased access to economic resources including income will help to improve household food security.

This study's contribution to the existing literature is twofold. First, it examines the household level determinants of food expenditure by employing a two-stage least square (2SLS) technique which takes into account endogeneity problem unlike most of the previous studies which used an ordinary least square which is prone to various assumption including exogeneity of variables which is not always the case as observed in this study. The study has also found new evidence that some variables which were found by previous studies to have a linear relationship with food expenditure including age of household head have non-linear relationship. Second, it examines the implications of household food expenditure

Rashid *et al. Agriculture & Food Security*   (2024) 13:13

Page 15 of 16

on food security with evidence from Tanzania using nationally representative. The multifaceted nature of food expenditure underscores a need for a holistic approach that takes into account education, income and household demographics and unique challenges of faced by both rural and urban residents. Addressing these factors is a necessary and significant step towards improving food security in Tanzania.

Author contributions
Conceptualization: FR, RL and EM. Data curation: FR, JS, EM. Methodology: FR, RL, EM. Writing and reviewing the drafts: FR, RL, JS, EM. All authors read and approved the final manuscript.

Availability of data and materials
Data may be available upon request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that there is not any known conflict of interest that might have influenced this work.

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