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Analysis of the dietary diversity status of agricultural households in the Nkomazi Local Municipality, South Africa

T. A. Sambo, J. W. Oguttu and T. P. Mbombo-Dweba*

Abstract

Background: Dietary diversity is a good alternative measure of the nutritional adequacy and food security. The present study assessed the household dietary diversity status and its determinants among agricultural households in the Nkomazi Local Municipality, South Africa.

Methods: Out of 543 households in the study area that were supported by the Phezukomkhono Mlimi programme during the 2018/19 production season, only 355 met the inclusion criteria and consented to participate in this study. The data were analysed using descriptive statistics, computation of the Household Dietary Diversity Score (HDDS) and the ordered logit regression model.

Results: Most of the respondents were elderly (56.10%) and females (59.44%). Most had low levels of education (43.66%) and low farm income (96.34%). In addition, most (65.35%) had large households. The majority (49.86%) of the households in the study area had a HDDS of 4.40, while the median HDDS in the study area was 3.90. Over the recall period, the majority of households consumed cereals (100%) and vegetable (78.31%) food types. Households headed by respondents with no formal education had lower odds (OR = 0.20; 95% CI 0.06–0.61) of having a higher dietary diversity compared to those headed by heads who had attained tertiary education. Households with income ≤ R3000.00 had lower odds (OR = 0.51; 95% CI 0.31–0.85) of having a higher dietary diversity as compared to those with income > R3000.00. Households with 1–5 members had higher odds (OR = 10.41; 95% CI 1.05–103.20) of having a higher dietary diversity as compared to larger households. With every unit increase in the age of the household head, the odds of the household of having a higher dietary diversity increased by 1.03 (OR = 1.03; 95% CI 1.01–1.05).

Conclusion: Since cereals and vegetables dominated the diets of the respondents, findings of this study highlight the need for improved access to sources of protein among the respondents. Therefore, there is a need for programmes to educate respondents on the dangers of inadequate nutrition (lacking in protein). Strategies that enhance farm income and the level of education among respondents should be prioritised because of their potential to boost Household Dietary Diversity (HDD) in the study area. Collaborations between different stakeholders, such as nutritionists, extension workers and researchers, should be encouraged so as to develop a holistic approach to improving the HDD in the study area.

Keywords: Diet, Nutritional adequacy, Food consumption, Food groups, Household dietary diversity, Food security

*Correspondence: mbombtp@unisa.ac.za

Department of Agriculture and Animal Health, University of South Africa, Florida Campus, Roodepoort, South Africa

Background

No specific food group provides all the essential nutrients, and therefore, healthy dietary practices require individuals to consume food from all food groups [1]. Available studies show that dietary diversity is a good alternative measure of nutritional adequacy and food security in the household [2–5].

Nutrition or nutritional adequacy is defined as the adequate consumption of different food groups to maintain a balanced diet and meet daily nutrient needs [6]. Food security exists when all people at all times are able to access sufficient, safe and nutritious food to meet their dietary needs and food preferences, thus ensuring an active and healthy life [7]. Hence, food security is realised when every person has stable and continuous access to different foods that are of good quality and are safe, affordable and in sufficient amounts [7, 8].

Determination of household dietary diversity score (HDDS) refers to the process whereby food groups that a household has consumed are counted over a specific period of time, usually over a 24-h period [9]. The HDDS is a useful indicator of the household's economic ability to access a variety of foods [2, 10]. The score is calculated from the dietary diversity questionnaire [10]. The HDDS can be used to assess access to food and as a result, it is commonly applied qualitatively to determine food consumption by households [11].

Low dietary diversity is most prevalent among households in developing countries [11, 12]. Although South Africa is food secure at national level [13], a large proportion of households in the country experience food insecurity [14]. Food insecurity is defined as a state whereby people and individuals lack the necessary physical and economic access to adequate, safe and nutritious food to sustain a healthy and active life [7]. Household food insecurity is the result of the application of this concept at household level [15].

Available evidence suggests that food insecurity inversely correlates with HDDS (i.e. the number of different types of foods consumed by the household) [16]. For example, households in four rural districts of Prey Veng Province, Cambodia that had high levels of food insecurity (82%), had low HDDSs (< 3) [17].

In a study carried out in the Eastern Cape province of South Africa, it was observed that the majority (61%) of the households had low dietary diversity, and that their diets consisted mainly of pulses, milk and cereals [18]. This implies that the households in the study conducted in the Eastern Cape province, consumed an average of three food groups. This is lower than the minimum dietary diversity score of six (i.e. six food groups) suggested by Cheteni et al. [18] to be a high dietary diversity status.

Available evidence suggests a relationship between poor dietary diversity and increasing under-nutrition [19]. This is because low dietary diversity scores are associated with low nutrients in the diet [20], domination of starchy foods, and lack of fruits, vegetables and animal products [11, 12]. High dietary diversity score is correlated with nutrient adequacy. Nutrient adequacy is essential for body maintenance, growth, strength, physical work, cognitive ability, immunity and good health in human beings [6]. Poor dietary diversity has proved to be associated with a high risk of chronic diseases, such as cardiovascular disease, diabetes and obesity in addition to depression and anxiety [21]. A poor diet is one of the leading causative factors of illness and mortality around the world [22].

According to previous studies in South Africa, low dietary diversity is mainly prevalent among rural households and informal urban settlements [1, 14, 15, 20]. This is attributed to the fact that the majority of households in such areas depend on government social grants and as a result are not able to afford diverse foods [23].

Participation in agricultural activities provides households with the opportunity to diversify their diets [23]. However, most rural households lack the resources to produce their own food [24]. In view of this, rural communities are not able to produce their own food [20, 21] and hence, the Mpumalanga Provincial Government introduced the Phezukomkhono Mlimi (PKM) programme in 2005 with the aim of improving availability and accessibility of food among rural households in the province [25]. The PKM programme supports rural households with production inputs (i.e. seeds, fertilisers and chemicals; mechanisation during land preparation; support with basic infrastructure for farming, such as fencing, boreholes and irrigation pipes, and extension and advisory assistance) to enable households to produce their own food. Despite the massive funds that have been invested in this programme since its inception in 2005, in several municipalities of the Mpumalanga Province, no assessment of food accessibility among the beneficiaries has been conducted. Currently little empirical evidence is available on how such programmes affect food access. A previous study that was conducted around this topic did not make use of HDDS or any of the published standardised methods [26]. Therefore, answers are needed for following questions: (i) what is the household dietary diversity score of these beneficiaries? and (ii) what factors are associated with the dietary diversity in these households?

Therefore, this paper investigates the HDDS and identifies the factors associated with dietary diversity among the agricultural households that are supported by the

PKM programme in the Nkomazi Local Municipality (NKLM), South Africa.

Study area

This study was carried out in NKLM, which is situated in the Mpumalanga province of South Africa. The municipality shares its borders with Mozambique and the Kingdom of Eswatini (formerly known as Swaziland) (Fig. 1). The population in the study area is approximately 410,900 people [27]. It has a subtropical climate, with a mean annual rainfall of 755 mm and a mean temperature of 28 °C [28]. The municipality is predominantly rural, and most people depend on agriculture for a living [29]. The main agricultural activities in the study area include growing vegetables, sugar cane, bananas and citrus, with subtropical fruit farming under irrigation and maize and cotton cultivation on dry land [30]. The study area is characterised by high levels of poverty and unemployment [31].

Methods and materials

Study population

The target population in this study was all agricultural households in the NKLM that benefitted from the PKM programme in the 2018/19 production season (i.e. April 2018 to March 2019). According to the Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA), the number of agricultural households supported by the PKM programme in the study area during the 2018/19 production season was 543.

However, only household heads who were involved in food preparation or were present and ate the food prepared in the household during the reference period were included in this study. Therefore, out of the 543 households in the study area, only 355 agricultural households supported by the PKM programme during the 2018/19 production season met the inclusion criteria were thus included in this study.

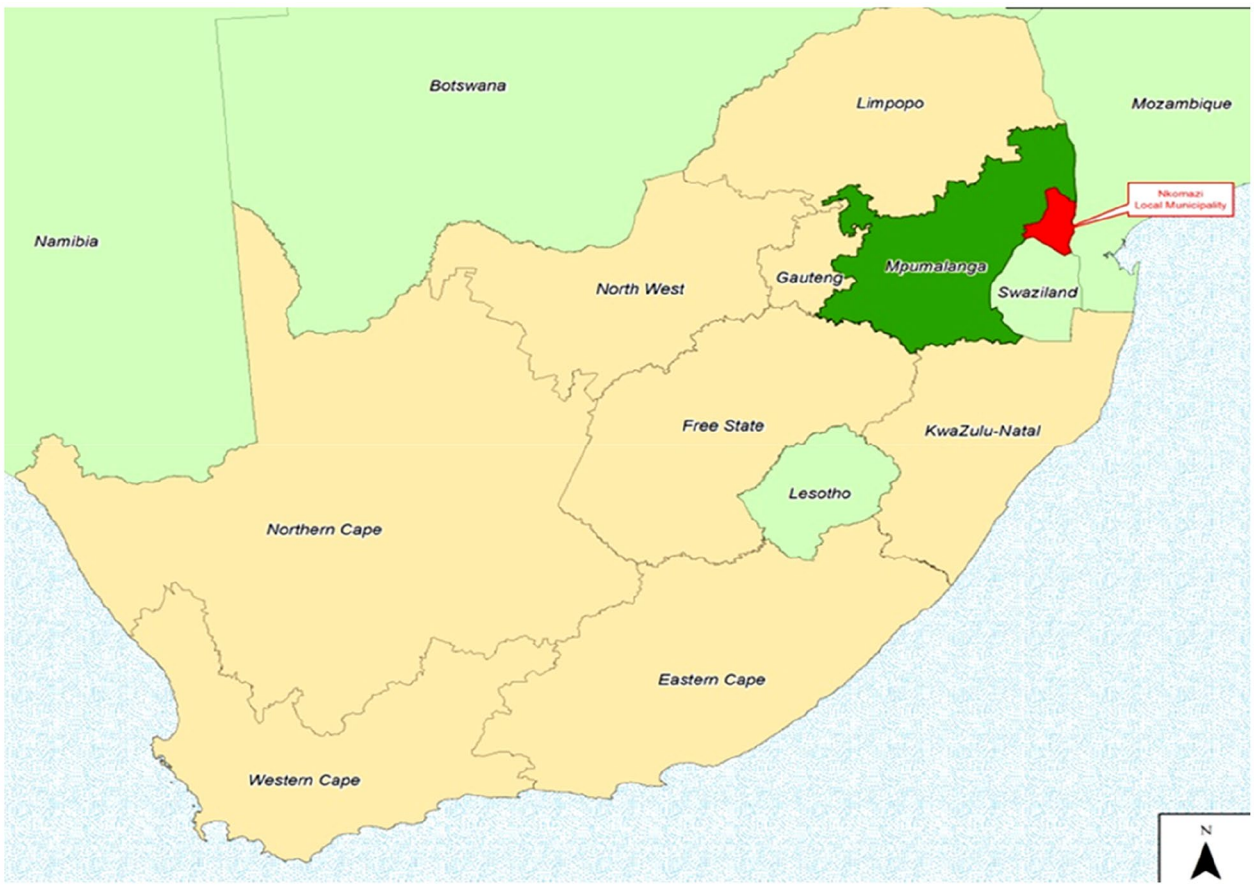

Fig. 1 Map of the study area showing the location of Nkomazi Local Municipality (coloured red) [29]

Data collection

A pre-tested structured questionnaire was administered by four trained enumerators to collect data on the socio-economic characteristics and dietary diversity of the respondents through face-to-face interviews. The four enumerators were selected based on their educational qualifications in the field of agriculture. Enumerators had to have a National Diploma in Agriculture (Crop production) as the minimum qualification to be enlisted as an enumerator. In fact, one of the enumerators had graduated with a Bachelor of Agricultural Management. The enumerators were trained on how to execute their task competently and to be able to explain the nature and scope of the research. The numerators were also trained on ethical issues that needed to be observed during the data collection phase.

Each interview session lasted approximately 45 min and the data were collected from 01 February to 24 March 2020. The data collection exercise was carried out in the different villages of the NKLM. The participants were invited to a central venue in their respective villages to participate. Although the data collection was conducted mainly by the hired numerators, where the number of respondents eligible to participate in the study was high, the principal researcher also participated in the data collection. This was done to speed up the process of data collection and avoid keeping the participants waiting for a long time to be interviewed.

As suggested by Swindale and Bilinsky [10], the Household Dietary Diversity (HDD) was assessed using a 24-h recall of food groups eaten by members of the household as either a shared meal in the home or as food prepared at home to be eaten by household members outside the home.

The HDDS in the present study was based on 12 food groups, using the guidelines for measuring HDD developed by Swindale and Bilinsky [10]. The 12 food groups included cereals, tubers, vegetables, fruits, meat, eggs, fish, beans, dairy products, fats/oils, sugar/honey and condiments. One point was allocated if the food group was consumed, whereas no points were allocated if the food group was not consumed over the reference period. The sum of all the points for each household was then computed.

Data management and data analysis

Data management

The completed questionnaires were thoroughly checked by the principal researcher for any omissions at the end of each data collection session. Data were thereafter captured in Microsoft Excel by the enumerators and later imported into the Statistical Package for the Social Sciences (SPSS version 25). Thereafter, the principal researcher checked the data for missing values, duplicate observations and inconsistencies across all the variables before it was analysed.

The HDDS was measured on an ordinal scale (0 = low dietary diversity; 1 = medium dietary diversity; 2 = high dietary diversity). The marital status variable was reclassified as described by Subramanian et al. [32] into a dichotomous variable (0 = otherwise; 1 = married) by collapsing the original categories (single, divorced or widowed) into otherwise (coded 0), while the original category (married) remained (coded 1). The income of the household was recategorised into a binary variable (1 = ≤ R3000, while 2 = > R3000).

Data analysis

Descriptive statistics, computation of the HDDS and the ordered logit regression model were employed to analyse the data. The ordered logit regression model was adopted for this study because the data meet the following assumptions: the outcome or dependent variable (HDD) was measured on an ordinal level, and one or more of the independent variables were either continuous or categorical. In addition, there was no multicollinearity between the independent variables.

All categorical variables were summarised and presented as percentages in the form of tables. The HDDS was computed by adding the points allocated to the different food groups consumed by the households over the 24-h recall period. Thereafter, households were categorised based on their HDDS using the method described by Swindale and Bilinsky [10] into the following categories: low dietary diversity category (≤ 3 food groups); medium diversity category (4–5 food groups) and high diversity category (≥ 6 food groups). Adoption of this categorisation of the HDDS in this study is further justified by the fact that several studies conducted in South Africa [9, 33] and other parts of Africa [34, 35] have also adopted the same categorisation of the HDDS.

The ordered logistic regression model was fitted to the data to identify the factors that were significantly associated with the dietary diversity of the households.

The equation of the ordered logit model regression is specified as [36]

$$Y* = \sum_{k=1}^{k} \beta_k X_k + \varepsilon, \quad (1)$$

where Y^* is unobserved, X_k is a vector of independent variables, β denotes coefficients to be estimated and ε denotes a random error term.

From the above model, the observed or defined categorical variable Yi is determined as follows:

$y = 1$ if $y^* \leq \mu 1$.

$y = 2$ if $\mu 1 < y^* \leq \mu 2$.
$y = 3$ if $\mu 2 < y^* \leq \mu 3$.
$y = j$ if $\mu_{j-1} < y^*$.

In case y is observed in j number of ordered categories, μs are unknown threshold parameters differentiating the adjacent categories to be assessed with βs; then μ1, μ2 and μ3 represent the different levels of the HDDS that are to be estimated. The general form for the probability that the observed y falls into category j and the μs and the βs are to be estimated with an ordered logit model is

$$\text{Prob}(y = j)1 - L\left(\mu_{j-1} - \sum_{k=1}^{k} \beta_k X_k\right), \quad (2)$$

where L (·) represents cumulative logistic distribution.

Additional file 1: Table S1 presents all the variables included in the ordered logit regression model. Furthermore, the expected relationship between the outcome (HDDS) and each predictor variable is also indicated in Additional file 1: Table S1.

The model building process was carried out in two phases. The first phase involved univariate analysis to identify the variables that were significantly associated with the outcome. All variables with a p value of ≤ 0.20 in the univariate model were included in the multivariable ordinal logit model. A cut-off value of 0.20 is supported by literature [37, 38].

In the second phase, a multivariable ordinal logit regression model was fitted using the manual backward selection method. Confounding was tested in the model by checking for changes in the model coefficients and the model fit when a specific variable was removed from the model. A particular variable was considered a confounder if its removal or addition resulted in a change in the coefficient of the other variables that was greater than 10% [39]. All identified confounders were retained in the model.

Multicollinearity in the final model was tested by computation of the variance inflation factor (VIF) at a cut-off value of 3 [40]. The VIFs of all independent variables were less than 3, which confirmed that the model did not suffer from multicollinearity. The test for parallel lines was conducted, and the assumption of proportional odds was satisfied at $p = 0.10$ [41]. Several procedures of model suitability tests were carried out to check the model fit to the data. The likelihood ratio test that is based on the − 2 Log Likelihood was used to assess the goodness of fit of the model. The results of the likelihood ratio Chi-square test [$x^2(9) = 35.13$; $p = 0.00$] proved that there was a significant improvement in the fit of the model with predictor variables over the model without predictor variables [42]. Furthermore, the deviance and Pearson's Chi-square test were used to check the goodness of fit of the model. The results of the Pearson's Chi-square test [$x^2(523) = 518.56$; $p = 0.55$] and the deviance test [$x^2(523) = 592.73$; $p = 0.83$] were not significant, which suggests that the model fit the data well [42].

Results

Socio-economic characteristics of respondents

The socio-economic details of the respondents are summarised in Table 1. The respondents were household heads supported by the PKM programme during the 2018/19 production season. A total of 355 households agreed to participate in this study and of this, more than half (56.10%; $n = 199$) were over 60 years old. Females made up 59.44% ($n = 211$) of the study population.

Half (49.86%; $n = 177$) of the respondents were married and 5.63% ($n = 20$) were divorced. The largest proportion (43.66%; $n = 155$) of the respondents had attained primary education, followed by 41.97% ($n = 149$) who were uneducated. Very few respondents (4.51%; $n = 16$) had tertiary education.

Most respondents (52.39%; $n = 186$) were members of a large household that consisted of between six and ten members. The majority (60.28%; $n = 214$) of households farmed on less than three hectares of land and only 3.38% ($n = 12$) of the households had more than 10 hectares of land.

Food groups consumed by the respondents

The results of the present study show that all the households (100%; $n = 355$) consumed cereals in the 24-h recall period (Table 2). Over two-thirds (69.01%; $n = 245$) of the households in the present study reported having consumed condiments, beverages, such as tea and coffee, and soft drinks, such as cool drink and juices. This was followed by 42.25% ($n = 150$) who indicated that they had consumed sugar and honey. A small proportion of respondents indicated that they had consumed food from the following groups: beans (16. 62%; $n = 59$); fruits (10.14%; $n = 36$); fats and oils (10.14%; $n = 36$); dairy products (8.17%; $n = 29$); tubers (5.35%; $n = 19$); fish (3.66%; $n = 13$) and eggs (3.10%; $n = 11$).

Dietary diversity status of the households

Table 3 shows the distribution of households by HDD. Forty percent (40.28%; $n = 143$) of the households had a low dietary diversity level (i.e. consumed 1–3 food groups), half of the households (49.86%; $n = 177$) had a medium dietary diversity score (i.e. consumed 4–6 food groups) and only 9.86% ($n = 35$) of households had a high dietary diversity (i.e. consumed 7–8 food groups).

Overall, the dietary diversity scores of the households ranged between one and eight food groups with a mean of 3.90 (SD = 1.34) (Table 3). These results show that on

Table 1 The socio-economic profile of respondents ($n=355$)

Variable	Frequency (*n*)	Percentage (%)
Age in years		
22–30	10	2.82
31–40	15	4.23
41–50	43	12.11
51–60	88	24.79
61–70	99	27.89
71–79	71	20.00
> 80	29	8.17
Gender		
Male	144	40.56
Female	211	59.44
Marital status		
Single	44	12.39
Married	177	49.86
Divorced	20	5.63
Widowed	114	32.11
Education level		
No formal education	149	41.97
Less than Grade 12	155	43.66
Grade 12/matric certificate	35	9.86
Tertiary education	16	4.51
Household size[a]		
1–5	123	34.65
6–10	186	52.39
11–15	40	11.27
16–20	6	1.69
Farming experience[b]		
1–5	56	15.78
6–10	62	17.47
11–15	28	7.89
16–20	39	11.99
> 21	170	47.89
Farm size[c]		
< 3	214	60.28
3–5	99	27.89
5–10	30	8.45
> 10	12	3.38
Annual farm income[d]		
< R40,000	342	96.34
R40,001–R80,000	10	2.82
R80,001–R120,000	1	0.28
> R120,000	2	0.56

[a] Number of people residing in the household

[b] Number of years respondent has been farming

[c] Land size in hectares

[d] Farm income in South Africa Rands

Table 2 The distribution of households by food groups consumed in the preceding 24 h ($n=355$)

Food type consumed	Frequency	Percentage (%)
A. Cereals	355	100
B. Tubers	19	5.35
C. Vegetables	278	78.31
D. Fruits	36	10.14
E. Meat	138	38.87
F. Eggs	11	3.10
G. Fish	13	3.66
H. Beans	59	16.62
I. Dairy products	29	8.17
J. Fats/Oils	36	10.14
K. Sugar and honey	150	42.25
L. Condiments	245	69.01

Table 3 Distribution of households by level of household dietary diversity ($n=355$)

HDDS level	Range	Frequency	%	Mean	SD[a]
Low	1–3	143	40.28	2.60	0.51
Medium	4–5	177	49.86	4.40	0.48
High	6–12	35	9.86	5.50	0.70
Total	1–12	355	100	3.90	1.34

[a] Standard deviation of the mean

average, households in the study area consume on average four food groups. Based on a mean HDDS of 3.90, it implies that the households in the study area have a medium dietary diversity level.

Factors associated with the dietary diversity of the households

The results of multivariate ordered logit model (Table 4) revealed that households headed by respondents with no formal education had lower odds (OR = 0.20; 95% CI 0.06–0.61) of having a higher dietary diversity compared to households headed by heads who had tertiary education. Similarly, households with income ≤ R3000.00 had lower odds (OR = 0.51; 95% CI 0.31–0.85) of having a higher dietary diversity as compared to households that had income > R3000.00. On the other hand, households with 1–5 members had higher odds (OR = 10.41; 95% CI 1.05–103.20) of having a higher dietary diversity as compared to larger households (i.e. had 16–20 members). With every unit increase in the age (expressed in years) of the household head, the odds of the household of having a higher dietary diversity increased by 1.03 (OR = 1.03; 95% CI 1.01–1.05).

Table 4 Results of the Ordered logit regression model showing factors that were correlated with dietary diversity among the households in the Phezukomkhono Mlimi programme ($n = 355$)

Variable	Coefficient	Std error	Wald	p value	Odds Ratio	95% CI[a]
Level of education						
No formal education	− 1.63	0.58	7.90	0.01	0.20	0.06–0.61
Less than grade 12	− 0.93	0.54	2.93	0.09	0.39	0.14–1.14
Grade 12	− 0.10	0.60	0.03	0.87	0.90	0.28–2.93
Tertiary education	Ref					
Marital status						
Not married	− 0.17	0.35	0.23	0.63	0.84	0.43–1.68
Married	Ref					
Household income						
≤ R3000	− 0.67	0.26	6.59	0.01	0.51	0.31–0.85
> R3000	Ref					
Household size						
1–5 members	2.34	1.17	4.00	0.04	10.41	1.05–103.20
6–10 members	2.30	1.17	3.90	0.05	10.02	1.02–98.56
11–15 members	2.23	1.20	3.47	0.06	9.31	0.89–97.28
16–20 members	Ref					
Age in years	0.03	0.01	9.03	0.00	1.03	1.01–1.05

[a] 95% Confidence Interval

Discussion

The results show that all the households consumed cereals in the 24-h recall period. The dominance of cereals in the diets of the respondents in the present study was anticipated given that cereals, such as maize, are a common staple food throughout South Africa [43] and more so among emerging farmers [44]. Similar results were observed by Jebessa et al. [45] who noted that the diet of the households in Yayu Biosphere Reserve, Ethiopia consisted mainly of cereals.

While previous studies carried out in Tanzania and South Africa observed that only a few participants had consumed vegetables [9, 43], over three-quarters of respondents in the present study indicated that they had consumed vegetables over the recall period. The results reported in the present study suggest that participation in the PKM programme by households encourages food production throughout the year (from April to March of the following year). This could explain the differences observed in this study and that conducted in Tanzania. It is possible that participation in the PKM programme led to increased availability and accessibility of vegetables in the study area, with the resultant high proportion of respondents in the study reporting having consumed vegetables. This view is supported by studies that observed that home food production leads to improved access to vegetables and subsequent increased dietary diversity [46, 47]. Since vegetables are a good source of vitamins and minerals [48], an increased intake of vegetables has the potential to translate into improved diet quality. This is confirmed by Ochieng et al. [49] who are of the view that vegetable production is essential in increasing dietary diversity.

Over two-thirds of the households in the present study reported having consumed condiments, beverages, such as tea and coffee, and soft drinks, such as cool drink and juices. These findings are consistent with those reported in a study by Udoh and Udoh [50] on the dietary diversity of households in Akwa Ibom State, Nigeria that also observed that a high number (80.7%) of households consumed condiments.

However, with respect to consumption of honey and sugars, the results of the present study contrast with the findings of the same study by Udoh and Udoh [50] that indicated that the number (82.7%) of households that consumed honey and sugar was double the number (42.25%) observed in this study. The low level of consumption of condiments and sugar and honey observed in the present study could be attributed to the fact that the majority of farmers in this study were unemployed and had low farm income. This has the potential to limit the ability of the respondents to afford food groups, such as condiments, honey and sugar [23].

Consistent with the findings by Mekuria et al. [37] and Sinyolo et al. [51], food from groups such beans, fruits, fats and oils, dairy products, tubers, fish and eggs were consumed by very few respondents in this study. This could be due to the low education level of

the respondents. It has been reported that households headed by persons with no formal education lack understanding of nutrition [43] and the health benefits of a well-balanced diet. As a result, they are less likely to diversify their diet as compared to farmers with formal education [9, 45]. Contrary to the findings of this study, Udoh and Udoh [50] reported that more than 80% of the households in their study consumed food from these groups. The study by Udoh and Udoh [50] has a higher proportion (91.25%) of married respondents as compared to this study (49.86%). Other authors have shown that access to different food groups increases when the head of the household is married [52]. The findings of this study suggest that the diet of the majority of households in the study area was deficient in proteins that could be sourced from fish, eggs and beans [53]. The low consumption of proteins by respondents in the study area was concerning, especially considering that beans and other legumes are excellent sources of protein that can easily be grown [54]. This further suggests that beneficiaries and programme planners require assistance to be able to select appropriate crop varieties with potential to make a significant contribution towards food security. Previous studies have shown that collaboration between different stakeholders is important for knowledge sharing and the subsequent design of innovative approaches [55]. This view is supported by Falcone [56] who noted that stakeholder collaboration is critical in resolving differing and sometimes conflicting views. Because of this stakeholder collaboration has the potential to create an enabling environment to design well-suited policy interventions. In addition, collaboration between different stakeholders has also been proven to be beneficial in formulating effective interventions especially for farmers [57].

The low consumption of fats and oils in this study is worth noting, and this practice should be encouraged to reduce the risk of obesity and diseases of the lifestyle [58]. This finding was, however, unexpected since previous research on dietary diversity showed dominance of fats and oils in the diets of most households in South Africa [18, 35, 43].

The findings of the present study revealed that most of the households had a medium dietary diversity score which contrasts with the findings by Megbowon and Mushunje [43] in the study conducted in the Eastern Cape province of South Africa in which they reported a higher proportion (61.75%) of respondents with high dietary diversity. The HDD observed in this study could be attributed to a high proportion (42.97%; $n=149$) of respondents in the present study not having formal education. Past studies have observed that education has a positive influence on dietary diversity, with higher education levels associated with higher HDD [59, 60]. Secondly, the HHD observed in the present study could be attributed to the predominantly large households in the study area. Previous research has observed that household size and dietary diversity are negatively correlated [61]. In addition to this, households in this study could be constrained to improve their HDDS due to the small farming plots. It has been demonstrated that households farming on larger plots tend to have a higher HDDS [49]. In view of this, a land reform programme aimed at increasing the farm size could be instrumental in improving the HDDS in the study area. For example, available evidence indicates that the HDDS of farmers who benefitted from the land reform programme in the Waterberg District Municipality, South Africa is higher than the HHDS of those who did not benefit from the land reform programme [62]. Furthermore, due to the increase in the number of people who were able to access land through the land reform programme, the number of households in the area with adequate food quantity increased together with their HDDS [63]. It is also possible that the medium dietary diversity score observed in the study could be attributed to post-harvest losses. In Sub-Saharan Africa, losses due to lack of appropriate post-harvest techniques among small-scale farming is estimated to be around 40–50% [64]. This undermines the food production efforts by leading to food losses and subsequent food insecurity in this sector [64, 65]. Literature suggests that introduction of appropriate low-cost post-harvest techniques among small-scale farmers could contribute to economic accessibility of fresh produce, food security and graduation of subsistence farmers to commercial farming [64].

The medium HDDS observed in this study is consistent with the findings reported by Shisana et al. [66] who observed that generally households in the Mpumalanga province of South Africa (where the present study was also conducted) tend to have a medium HDDS. However, the results reported in this study suggest that the HDDS in the study area was better than that reported in the Eastern Cape province of South Africa by Cheteni et al. [18], who observed a low dietary diversity among households (with a mean HDDS of 3). Therefore, the difference between these two studies could be attributed to the fact that some households in the study by Cheteni et al. [18] were not beneficiaries of government supported food security programmes. It has been shown in literature that government programmes do assist in improving the food security status of vulnerable households [67].

Findings reported here are consistent with what other authors have observed. For example, some authors have previously reported that the age of the household head is a significant predictor of HDD [43]. It has been suggested

that as the head of household becomes older, he or she is likely to become more aware of their diets due to old-age-related health challenges that older people tend to experience [51]. In contrast with the findings of this study, other studies [59, 60] have showed that age of household head is negatively correlated with HDD. This view is also supported by Oduniyi and Tekana [68] who noted that the adoption of improved farming technology tends to very low among older heads of household. Therefore, this has a negative effect on food production and, as a result, little income to spend on food items.

It was observed that households headed by household heads with no formal education were less likely to have higher HDD. This is supported by previous studies [35, 43] that demonstrated a positive correlation between the level of education and a higher HDD. This is because the more educated the head of the household is, the better their understanding of nutrition [43] and the health benefits of a well-balanced diet. As a result, they are more likely to diversify their diet as compared to farmers with less formal education or farmers who totally lack formal education [9, 45]. Moreover, it has been shown that the higher the formal education status attained by members of a household, the higher the likelihood of such members gaining employment [61]. Being employed has been shown to positively influence the HDD [69].

Consistent with previous studies [59, 70, 71], this study also observed that household income was positively and significantly associated with HDD. This was expected because according to Jebessa et al. [45] households with resources and of a higher income status can afford to diversify their diets. Several other authors also hold a similar view that the economic status of a household positively influences dietary diversity and food security [35, 72, 73].

The household size is among various socio-demographic factors that showed association with HDD in this study. The odds of belonging to a higher dietary diversity was 10.40 times higher for households with 1–5 members than that for larger households (16–20 members). This is consistent with previous studies [61] that observed that household size was negatively and significantly correlated with HDD.

Limitations of the study

Seasonal variation influences food availability, and this could lead to variation of HDDS of the households, with the pre-harvest season having the lowest HDD. In view of this, since this study was conducted during the pre-harvest season, a period when households normally face food shortages, the results reported here should be interpreted with caution given that they do not cover both pre- and post-harvest seasons. Furthermore, it is possible that there was under-reporting because the data were collected at one recall period. Nonetheless, this study presents baseline information on HDD of agricultural households participating in the PKM programme, which has previously not been available in the study area. It also provides baseline information upon which future research can be developed.

Conclusion and recommendations

The diets of the residents of the study area are characterised by very low protein intake (i.e. are unbalanced) and low dietary diversity. In view of this, programmes aimed at creating awareness about cheaper sources of protein are recommended. Awareness about these sources of protein could trigger interest in growing such crops and their subsequent inclusion in the diets of the beneficiaries. In addition, studies that assess the barriers to utilisation of these cheap sources of proteins are needed to help improve understanding of of the low utilisation in this study. Since the PKM programme offers only assistance in form of production inputs, mechanisation and infrastructure, it is recommended that the programme should include education of the beneficiaries about the benefits of consuming a diet with a higher HDD as one of its objectives. This will foster adoption of diets with a higher HDD. Furthermore, to enhance inclusion of the new foods in the diets of the recipients, the programme should consider introducing training of the beneficiaries on how to prepare the new foods types that the programme introduces in the study area. Policy measures aimed at improving the dietary diversity status of the households in the study area should prioritise the following: (i) strategies that enhance farm income and level of education, and (ii) agricultural training and nutrition education awareness programmes that provide knowledge on the importance of food and nutrition, as well as practical guidance on how to grow and prepare nutritious foods. Furthermore, collaborations between different stakeholders, such as nutritionists, extension workers and researchers, should be encouraged in order to develop a holistic approach to address HDD. Integrating legumes in the existing gardens (e.g. chickpeas, beans and lentils) as part of the programme could help address the low intake of protein identified in the study area. Secondly, nutrition education which includes meal plans, and meal preparation of the suggested protein sources could be initiated by nutritionists for this community to help improve on protein intake among the respondents. Lastly, post-harvest losses could be investigated in future studies so that the introduction of low-cost harvest techniques can be explored.

Abbreviations
DARDLEA: Department of Agriculture, Rural Development, Land and Environmental Affairs; HDD: Household dietary diversity; HDDS: Household dietary diversity score; NKLM: Nkomazi Local Municipality; PKM: Phezukomkhono Mlimi; VIF: Variance inflation factor.

Supplementary Information

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Additional file 1: Table S1. Definition of the independent variables used in the ordered logit model.

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Author contributions
TAS was involved in the study design, data collection, data management, data analysis, interpretation of results and writing of the manuscript. JWO and TPMD were involved in the study design, the data analysis and the interpretation and extensive reviewing of the manuscript draft. All the authors read and approved the manuscript.

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Availability of data and materials
The data are available and will be provided on official request.

Declarations

Ethics approval and consent to participate
Approval to conduct this study was granted by the Mpumalanga Provincial Department of Agriculture. In addition, permission to carry out the study was granted by the Ethics Committee of the College of Agriculture and Environmental Science, University of South Africa prior to commencement of the study (Ref #: 2019/CAES_HREC/178). The respondents were informed about the purpose, the nature and the procedure of the study and were advised of any possible inconvenience through participation in this study. They were also informed that participation in the study was voluntary and that they were free to exit the study at any time. Respondents gave their consent by completing and signing the informed consent form before completing the questionnaire.

Consent for publication
All the authors provided consent for the publication of this paper.

Competing interests
The authors declare that they have no competing interests.

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References

1. Labadarios D, Steyn NP, Nel J. How diverse is the diet of adult South Africans? Nutr J. 2011;10(1):1–11.
2. Kennedy G, Ballard T, Dop M. Guidelines for measuring household and individual dietary diversity. Rome: Food and Agriculture Organisation; 2010.
3. Leonard K, Dela Luna G, Ostonal JM, Teresa A, Orillo O. Dietary diversity as a component of food security among households with preschool children in a Coastal Municipality in Batangas, Philippines. Asia Pac J Multidiscip Res. 2020;8(3):63–75.
4. Hussein FM, Ahmed AY, Muhammed OS. Household food insecurity access scale and dietary diversity score as a proxy indicator of nutritional status among people living with HIV/AIDS, Bahir Dar, Ethiopia, 2017. PLoS ONE. 2018. https://doi.org/10.1371/journal.pone.0199511.
5. Sarkar S. Households' dietary diversity: a study of rural households in West Bengal. India Eur Acad Res. 2014;2(6):8307–25.
6. Habte TY, Krawinkel M. Dietary diversity score: a measure of nutritional adequacy or an indicator of healthy diet? J Nutr Heal Sci. 2016;3(3):303.
7. FAO (Food and Agriculture Organisation). The state of food insecurity in the world 2001. Rome: Food and Agriculture Organisation; 2001.
8. USAID (United States Agency for International Development). Definition of Food Security. 2012. http://transition.usaid.gov/policy/ads/200/pd19.pdf. Accessed 30 Jan 2021.
9. Mbwana HA, Kinabo J, Lambert C, Biesalski HK. Determinants of household dietary practices in rural Tanzania: implications for nutrition interventions. Cogent Food Agric. 2016;2(1):1–13.
10. Swindale A, Bilinsky P. Household Dietary Diversity Score (HDDS) for measurement of household food access: Indicator guide. Food and Nutrition Technical Assistance Project (FANTA). Washington, DC: Food and Nutrition Technical Assistance; 2006.
11. Vaitla B, Coates J, Glaeser L, Hillbruner C, Biswal P, Maxwell D. The measurement of household food security: correlation and latent variable analysis of alternative indicators in a large multi-country dataset. Food Policy. 2017;68:193–205.
12. Amugsi DA, Lartey A, Kimani E, Mberu BU. Women's participation in household decision-making and higher dietary diversity: findings from nationally representative data from Ghana. J Health Popul Nutr. 2016. https://doi.org/10.1186/s41043-016-0053-1.
13. EIU (Economists Intelligence Unit). Global food security index. 2019. https://foodsecurityindex.eiu.com/Home/Methodology. Accessed Jan 10 2019.
14. Masuku M, Selepe M, Ngcobo N. Small scale agriculture in enhancing household food security in rural areas. J Hum Ecol. 2017;58(3):153–61. https://doi.org/10.1080/09709274.2017.1317504.
15. FAO Food and Agriculture Organisation of the United Nations. The State of food insecurity in the world, economic crises—impacts and lessons learned. Rome: Food and Agriculture Organisation of the United Nations; 2009.
16. Hashmi S, Safdar NF, Zaheer S, Shafique K. Association between dietary diversity and food insecurity in urban households: a cross-sectional survey of various ethnic populations of Karachi, Pakistan. Risk Manag Healthc Policy. 2021;14(April):3025–35.
17. McDonald CM, McLean J, Kroeun H, Talukder A, Lynd LD, Green TJ. Correlates of household food insecurity and low dietary diversity in rural Cambodia. Asia Pac J Clin Nutr. 2015;24(4):720–30.
18. Cheteni P, Khamfula Y, Mah G. Exploring food security and household dietary diversity in the Eastern Cape Province, South Africa. Sustainability. 2020;12(5):1851.
19. NFNSP (National Food and Nutrition Security Plan). National food and nutrition security plan 2018–2023 for South Africa: Version 7 November 2017. Pretoria: The Government of the Republic of South Africa; 2019.
20. FAO (Food and Agriculture Organisation of the United Nations). Guidelines for measuring household and individual dietary diversity. Rome: Food and Agriculture Organisation; 2010.
21. Lawal KM, Katsina KP. Covid-19 lockdown: measures on food choices and dietary diversity in Nigeria. Al-Hikmah J Educ. 2020;7(1):288–92.
22. Murray CJL, Aravkin AY, Zheng P, Abbafati C, Abbas KM, Abbasi-Kangevari M, et al. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396:1223–49.
23. Govender L, Pillay K, Siwela M, Modi A, Mabhaudhi T. Food and nutrition insecurity in selected rural communities of KwaZulu-Natal, South Africa—linking human nutrition and agriculture. Int J Environ Res Public Health. 2017. https://doi.org/10.3390/ijerph14010017.
24. Temple NJ, Steyn N. Community nutrition for developing countries. 1st ed. Athabasca University: AU Press; 2016.
25. DALA (Department of Agriculture and Land Administration). Strategic plan 2007/2008–2009/2010. Nelspruit: Department of Agriculture and Land Administration; 2007.
26. Shabangu RR. Effect of Masibuyele Emasimini programme on food security at new forestry irrigation scheme at Bushbuckridge Municipality of Ehlanzeni District of Mpumalanga Province. Univerisity of Limpopo; 2015.

27. SSA (Statistics South Africa). Provincial profile: Mpumalanga: community survey 2016. Pretoria: Statistics South Africa; 2016.
28. Adeola AM, Botai OJ, Olwoch JM. Environmental factors and population at risk of malaria in Nkomazi municipality, South Africa. Trop Med Int Heal. 2016;21(5):675–86.
29. NKLM (Nkomazi Local Municipality). Integrated development plan 2016/17. Malelane: Nkomazi Local Municipality; 2016.
30. van Niekerk G. Farms in Mpumalanga achieving high investment. 2015. https://www.pamgolding.co.za/property-news/2015/3/13/farms-in-mpumalanga-achieving-high-return-on-investment. Accessed 17 Jun 2019.
31. MPT (Mpumalanga Provincial Treasury). Ehlanzeni soico-economic profiles march 2015. Nelspruit: Mpumalanga Provincial Treasury; 2015.
32. Subramanian SV, Kawachi I, Kennedy B. Does the state you live in make a difference? Multilevel analysis of self-rated health in the US. Soc Sci Med. 2001;53(1):9–19.
33. Ngema PZ, Sibanda M, Musemwa L. Household food security status and its determinants in Maphumulo Local Municipality, South Africa. Sustainability. 2018;10:3307. https://doi.org/10.3390/su10093307.
34. Getaneh Y, Alemu A, Ganewo Z, Haile A. Food security status and determinants in North-Eastern rift valley of Ethiopia. J Agric Food Res. 2022. https://doi.org/10.1016/j.jafr.2022.100290.
35. Taruvinga A, Muchenje A, Mushunje V. Determinants of rural household dietary diversity: the case of Amatole and Nyandeni districts. Int J Dev Sustain. 2013;2(4):2233–47.
36. Green WH. Econometric analysis. 6th ed. New Jersey: Prentice hall, Inc.; 2008.
37. Mekuria G, Wubneh Y, Tewabe T. Household dietary diversity and associated factors among residents of finote selam town, north west Ethiopia: a cross sectional study. BMC Nutr. 2017. https://doi.org/10.1186/s40795-017-0148-0.
38. Oguttu JW, Mbombo-Dweba TP, Ncayiyana JR. Factors Correlated with Home Gardening in Gauteng Province, South Africa. Int J Environ Res Public Health. 2021;18:2737. https://doi.org/10.3390/ijerph18052737.
39. Kamangar F. Confounding variables in epidemiologic studies: basics and beyond. Arch Iran Med. 2012;15(8):508–16.
40. Daoud JI. Multicollinearity and regression analysis. J Phys Conf Ser. 2017;949:012009.
41. Mathew AC, Siby E, Tom A, Senthil KR. Applications of proportional odds ordinal logistic regression models and continuation ratio models in examining the association of physical inactivity with erectile dysfunction among type 2 diabetic patients. Phys Act Nutr. 2021;25(1):30–4. https://doi.org/10.20463/pan.2021.0005.
42. Elamir E, Sadeq H. Ordinal regression to analyze employees'attitudes towards the application of total quality management. J Appl Qualit Methods. 2010;5(4):647.
43. Megbowon ET, Mushunje A. Assessment of food security among households in Eastern Cape Province, South Africa: evidence from general household survey, 2014. Int J Soc Econ. 2018;45(1):2–17.
44. Rajendran S, Afari-Sefa V, Shee A, Bocher T, Bekunda M, Dominick I, et al. Does crop diversity contribute to dietary diversity? Evidence from integration of vegetables into maize-based farming systems. Agric Food Secur. 2017. https://doi.org/10.1186/s40066-017-0127-3.
45. Jebessa GM, Sima AD, Wondimagegnehu BA. Determinants of household dietary diversity in Yayu Biosphere Reserve. Southwest Ethiopia Ethiop J Sci Technol. 2019;12(1):45–68.
46. Pradhan A, Sathanandhan R, Panda AK, Wagh R. Improving household diet diversity through promotion of nutrition gardens in India. Am J Food Sci Nutr. 2018;5(2):43–51.
47. Rammohan A, Pritchard B, Dibley M. Home gardens as a predictor of enhanced dietary diversity and food security in rural Myanmar. BMC Public Health. 2019. https://doi.org/10.1186/s12889-019-7440-7.
48. Hernandez A. Why are fruits & vegetables important? 2018. https://healthyeating.sfgate.com/fruits-vegetables-important-4703.html. Accessed 21 Feb 2021.
49. Ochieng J, Afari-Sefa V, Lukumay PJ, Dubois T. Determinants of dietary diversity and the potential role of men in improving household nutrition in Tanzania. PLoS ONE. 2017. https://doi.org/10.1371/journal.pone.0189022.
50. Udoh ES, Udoh EJ. Dietary diversity of households in Akwa Ibom State, Nigeria. Int J Dev Sustain. 2019;8(11):722–36.
51. Sinyolo S, Murendo C, Nyamwanza AM, Sinyolo SA, Ndinda C, Nwosu CO. Farm production diversification and dietary diversity among subsistence farming households: panel data evidence from South Africa. Sustainability. 2021. https://doi.org/10.3390/su131810325.
52. Agboola PT, Oyekale AS, Samuel OO. Assessment of welfare shocks and food insecurity in Ephraim Mogale and Greater Tubatse Municipality of Sekhukhune Districts, Limpopo Province, South Africa. IOSR J Agric Vet Sci. 2017;10(04):23–32. https://doi.org/10.9790/2380-1004022332.
53. Chardigny JM, Walrand S. Plant protein for food: opportunities and bottlenecks. Oilseeds Fats Crop Lipids. 2016;23(4):1–6.
54. Ganesan K, Xu B. Polyphenol-rich dry common beans (*Phaseolus vulgaris* L.) and their health benefits. Int J Mol Sci. 2017. https://doi.org/10.3390/ijms18112331.
55. Morone P, Falcone PM, Tartiu VE. Food waste valorisation: assessing the effectiveness of collaborative research networks through the lenses of a COST action. J Clean Prod. 2019;238:117868. https://doi.org/10.1016/j.jclepro.2019.117868.
56. Falcone PM. Analysing stakeholders' perspectives towards a socio-technical change: the energy transition journey in Gela Municipality. AIMS Energy. 2018;6(4):645–57. https://doi.org/10.3934/energy.2018.4.645.
57. Falcone PM, Imbert E, Sica E, Morone P. Towards a bioenergy transition in Italy? Exploring regional stakeholder perspectives towards the Gela and Porto Marghera biorefineries. Energy Res Soc Sci. 2021. https://doi.org/10.1016/j.erss.2021.102238.
58. Chandler B. What are the dangers of eating food with large amount of fats & oils?. 2018. https://healthyeating.sfgate.com/dangers-eating-food-large-amount-fats-oils-6693.html. Accessed Feb 27 2021.
59. Iftikhar M, Yasin MA, Ali R, Khan MI, Iftikhar N. Factors affecting the household dietary diversity pattern in rural areas of Southern Punjab, Pakistan. Int Trans J Eng. 2020;11(7):11A07D.
60. Magaji BD, Oladimeji YU, Sunday H, Abdulkarim AG. Dietary diversity score and its determinants among rural households in Panshekara, Kano. J Agric Econ Environ Soc Sci. 2020;6(2):46–56.
61. Obayelu OA, Osho FR. How diverse are the diets of low-income urban households in Nigeria? J Agric Food Res. 2020. https://doi.org/10.1016/j.jafr.2019.100018.
62. Mantsho SM. Effect of land restitution programme on households' food security in Limpopo Province of South Africa: a case study of Waterberg District. University of Limpopo; 2018.
63. Mutabazi A. Redistributive land reform in Rwanda : the impact on household food security. Rwanda J. 2011;22:129–57.
64. Sibanda S, Workneh TS. Potential causes of postharvest losses, low-cost cooling technology for fresh produce farmers in Sub-Sahara Africa. Afr J Agric Res. 2020;16(5):553–66. https://doi.org/10.5897/AJAR2020.14714.
65. Chegere MJ. Post-harvest losses reduction by small-scale maize farmers: the role of handling practices. Food Policy. 2018;77:103–15. https://doi.org/10.1016/j.foodpol.2018.05.001.
66. Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K, Dhansay A, et al. South African national health and nutrition examination survey (SANHANES-1). 2nd ed. Cape Town: HSRC Press; 2014. p. 524.
67. Ngomane TS, Sebola MP. Women in agricultural co-operatives for poverty alleviation in Mpumalanga Province: challenges , strategies and opportunities. In: the 4th annual international conference on public administration and development alternatives. 2019. p. 127–33.
68. Oduniyi OS, Tekana SS. Status and socioeconomic determinants of farming households' food security in Ngaka Modiri Molema District, South Africa. Soc Ind Res. 2020;149(2):719–32. https://doi.org/10.1007/s11205-020-02266-2.
69. Grobler WCJ. Socio economic determinants of household dietary diversity in a low income neighbourhood in South Africa. In: international business research conference. 2015. p. 978–9.
70. Adewumi MO, Animashaun JO. Households' dietary diversity, farm income and technical efficiency correlates: empirical evidence from small-scale farming households in Nigeria. Agris On-line Pap Econ Informatics. 2014;5(4):3–11.
71. Laskar FS, Rakib M. Determinants of household dietary diversity in Bangladesh. Glob J Human-Social Sci. 2019;19(9):25–32.
72. Huluka AT, Wondimagegnhu BA. Determinants of household dietary diversity in the Yayo biosphere reserve of Ethiopia: an empirical analysis using sustainable livelihood framework. Cogent Food Agric. 2019;5(1):1690829.

73. Mulugeta M, Tiruneh G, Alemu ZA. Magnitude and associated factors of household food insecurity in Fedis Woreda East Hararghe zone, Oromia region, Ethiopia. Agric Food Secur. 2018;7(1):1–8.

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