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IMPACT OF MAIZE FARMING SUPPORT ON FOOD SECURITY OF TYPE TWO DIABETES FARMERS IN KIREHE AND KAYONZA DISTRICTS OF EASTERN RWANDA

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ABSTRCT

Food security has been discussed for so long for agricultural communities; and understanding its magnitude to farmers living with chronic diseases is not well known. This study assessed the food security status of maize smallholder farmers with Type 2 Diabetes Mellitus (T2DM) in Kayonza and Kirehe Districts of Rwanda. Data on T2DM patients were accessed through Non-communicable diseases (NCD) program electronic database storage in both Rwinkwavu and Kirehe district hospitals. The study traced all maize farmers based on their livelihood activities and location of residence. The maize support is provided though Programme On Social Economic Right (POSER). By matching the NCD database to POSER database, the support recipients were identified. A sequential quasi-experimental method was used, and the sample size of 254 participants (127 support recipients, and 127 non-recipients) participated in the study. A well-standardized questionnaire was administered to study participants and data on three dimensions of food security: food availability, food access, and food utilization were collected. Descriptive statistics were used to summarize the socio demographic characteristics of the study participants. For each food security dimension, and overall three dimensions food security status, the Factorial Analysis for Mixed Data (FAMD) followed by Hierarchical Clustering of Principal Components (HCPC) were done to categorize participants into food secure, mild, moderate and severely insecure using standard deviations for cut-offs. To assess factors of food security, binary logistic regression was used. Bivariate analysis was done to test the association between food security status and participants' demographic characteristics using chi square for categorical variables and Wilcoxon sum test for continuous variables. Findings revealed differences in individual food security dimensions and overall, three dimensions food security status between support recipients and non-recipients. Non-recipients were more food secure in terms of food access and availability, whereas support recipients were more food secure in terms for food utilization and overall three dimensions food security status. Male-headed households had higher odds of severe food insecurity than female-headed households (AOR = 1.86, 95% CI: 1.07–3.23, p = 0.026), while farmers from Kirehe District had lower odds of severe food insecurity than those from Kayonza District (AOR = 0.44, 95% CI: 0.26–0.74, p = 0.02).

Key words: Food Security, Smallholder Farmers, T2DM, Nutrition, Maize Farming

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AI Usage Declaration: During the preparation of this manuscript, Desire Dushimimana used deep seek tool in order to well and deeply understand some of concepts associated to this article. Thereafter, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

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INTRODUCTION

The Rwandan gross domestic product (GDP) per capita increased in last decade, and agribusiness accounted for approximately 33.6 percent, and 45 percent of exports, while 86.3 percent of agricultural households practice agriculture as the main livelihood activity [1, 2]. Despite their role, small holder farmers are poor [3]. National Institute of Statistics of Rwanda 2024 reported that 65.3 percent of Rwandans were agriculture households with 88.4 percent of them engaged in agriculture as their main livelihood activity [4]. Maize is farmed in all five provinces of Rwanda, it is the main household food and provides more income than other crops [4]. Farming support programs do not pay attention on health status of farmers while healthy farmers improve their food security compared to sick farmers [5]. Farmers with T2DM struggle with the cost of care which increases the risk of poverty [6]. Rural households as accumulate assets, their susceptibility to various shocks such as food insecurity diminishes [7, 8]. Food security ensures that food is available, accessible, well utilized, and stable to people, and distribution must be insured for the current people without promising the future generation [9]. In 1996, the World Food Summit defined the multidimensional nature of food security and redefined food access to economic access (EA) and physical access (PA), physical availability, food utilization, and food stability [10].

Different tools are used to assess the food security. Household Consumption and Expenditure Surveys (HCES) provides proxy measures of food consumption and dietary patterns at the household level. One of its limitations is that it does not contain information about how the consumed food by household is distributed among its members, and it captures only continuous variables [11]. The Food Consumption Score (FCS) is another tool that the World Food Program (WFP) uses to assess food security at the regional and household levels. The FCS focuses on food dietary diversity, frequency of consumption and relative nutritional relevance of diverse food groups over a 7-day recall period [12].The FCS does not inform on quantity available, or if participants have capacity to access the food. It collects only continuous variables [13]. Coping Strategies Index is the predictor of food vulnerability. It identifies vulnerabilities associated with food availability, access and stability; it needs the complementarity with other tools to get a better picture of food security and captures continuous variables [13].

Household Dietary Diversity Score (HDDS) measures number of food groups consumed over a 24 hour or 7-day period, a proxy for a household's average food access. It does not capture actual quantities or nutrient intake and captures only continuous variables. Dietary Intake Assessment (DIA) measures continuous variables of food consumption only, factors like feelings of anxiety, uncertainty regarding access to food and dietary diversity are not considered [14]. The

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Household Food Insecurity Access Scale (HFIAS) and the Household Hunger Scale (HHS) both utilize continuous data and probe the household's experience of food security. Household Food Insecurity Access Scale (HFIAS) analyses respondents' perceptions of household food security experiences over the previous 4 weeks [15]. The HFSS has shown good performance and validity across different contexts and populations. However, implementing the HFSS in surveys can be challenging, especially in surveys with time and space constraints, due to concern about respondent burden and response bias [16].

The Food Insecurity Experience Scale (FIES) measures categorical data of the access dimension of food security a person's lived experience. The FIES survey module uses eight yes/no questions to assess the respondents' place on this continuum in the past 12 months [17]. Each measurement tool has limitations, and scales and cut-offs are variously interpreted at different cross-cultural aspects [13]. Experience-based food security measurement applied together with other indicators can provide better understanding of household and individual food security [14]. Factor Analysis on Mixed Data (FAMD) is the other tool that measures food security. It has the potential of measuring categorical and continuous variables and can be used for longitudinal and cross-sectional studies [35].

Maize is the main crop grown on large scale (94%) in Kayonza and Kirehe districts [18]. However, maize farmers experience maize post-harvest-losses, and poverty in these districts [19, 20]. This affects the crop production, thus shortage of available food at household, which increases the vulnerability to food insecure. Additional to that, these maize farmers also struggle with chronic diseases such as T2DM. In Kirehe district, 71.5 percent of T2DM patients, and 64 percent T2DM patients in Kayonza are maize farmers, and 72.3 percent of all NCD supported T2DM patients come from Kayonza and Kirehe districts [21,23, 24]. Resources that should be invested to agriculture production, and other activities which are essential to household food security, are spent to T2DM medications, disease management, and clinical visits at health facilities, while their entrepreneurship, financial literacy and business development are limited [22]. Majority of T2DM patients, 66 percent practice agriculture on 1 ha of land [23, 24]., and in Kayonza district, most farmers 78.4 percent heavily rely on external support entities such as Non-Governmental Organizations (NGOs) [25], while Kirehe district, maize farmers are challenged by the high cost of maize production compared to ratio of Rwanda's districts [26].

Household food security and nutrition knowledge enable T2DM patients to optimize metabolic self-management and quality of life. The food must not only be availability and accessibility, but it must also be nutritious, and safe as well. The intake of fruits and vegetables has been linked to a reduced likelihood of developing and managing type 2 diabetes [21, 24, 27]. Maize has moderate glycemic index, and the strategy

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to reduce high glycemic index in maize-based food is to take it with vegetables and/or beans [28, 29, 30]. This study assessed the food security status of maize smallholder farmers with T2DM in Kayonza and Kirehe Districts of Eastern Rwanda.

METHODOLOGY

Study area

Kayonza and Kirehe districts (Figure 1) are part of Eastern province, where the prevalence of hyperglycemia is higher than other provinces in Rwanda, and majority of population grow maize [21,24]. Programmes of NCD and POSER work with poor patients in these districts. The two districts cover an area of 1,954 km² and 1,118.5 km² and feature hilly terrain with altitudes ranging from 1,400 to 1,600 meters [31]. The annual temperature is 19.4 °C, with an average rainfall of 898 mm [32]. Agriculture and livestock production are the key economic activities [31, 32].

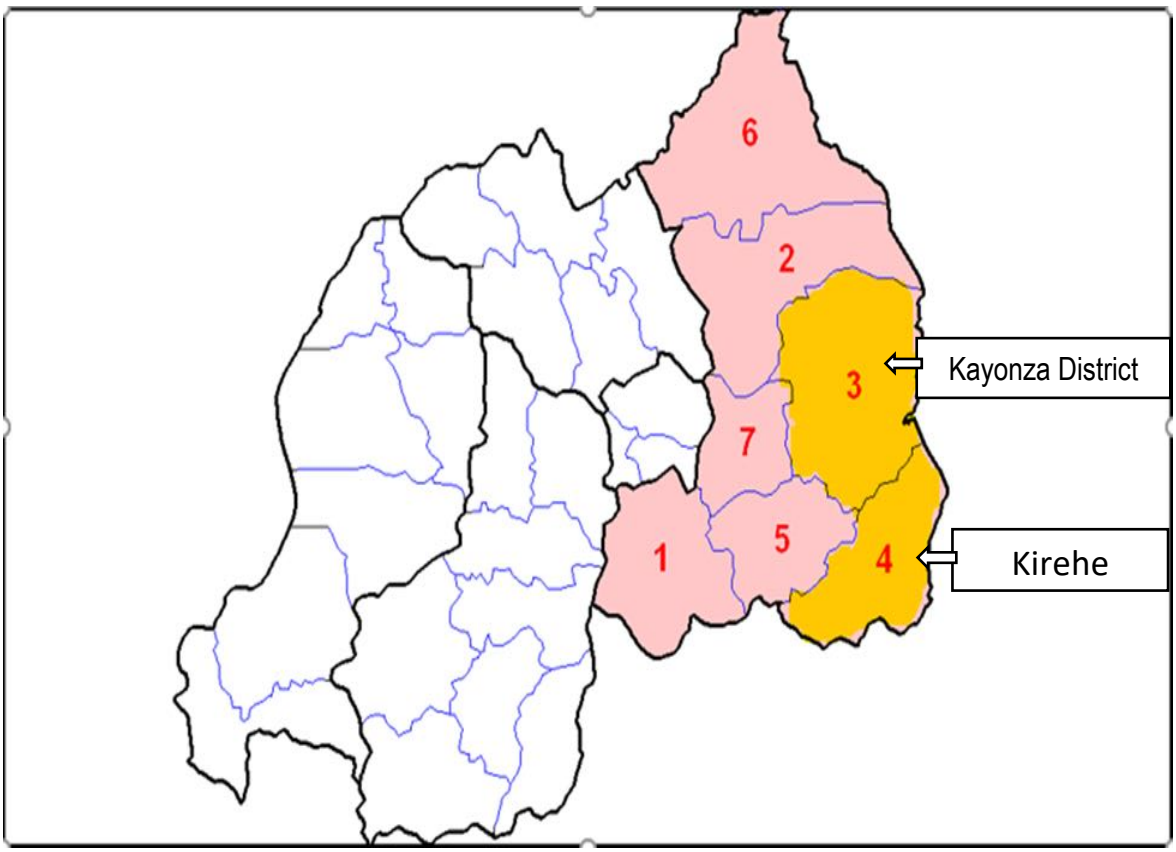


Figure 1: Districts under Study

Source: Adopted by author from https://commons.wikimedia.org/wiki/User:SteveRwanda

Data source and collection

Questionnaires were administered, and data were collected from participants.

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Target group and Sample size

This study targeted maize smallholder farmers with T2DM of age ≥18 years, and authorization to access data was requested. The annual mass T2DM screenings are conducted in study area, and all T2DM patients are identified. The eligibility for enrollment into T2DM medical support from NCD are being T2DM patient, poor from category 2, and 3 of ubudehe categories [33], and resident of Kayonza or Kirehe districts. From all screened patients, the sample of 254 participants was calculated according to Cochran [34]. A sequential quasi-experimental method was used for sampling. The study participants, (n=254), 127 were support recipients who voluntarily enrolled into Self Help Groups (SHG) and cultivated maize on collective hired or local leadership-given fields. Though SHGs, the supporting programme provided maize farming inputs, savings groups support, small livestock, poultry farming, sessions on nutrition education, trainings on food preparations, vegetable seeds, and fruit trees, and 127 non-recipients were eligible farmers but did not voluntarily enroll into the support and practiced the maize farming on their household fields. The shared poverty levels, disease characteristics, and the same residence strengthened the comparability of the two groups.

Ethical and Safety Considerations

Before data collection, written informed consents were obtained from participants. To safeguard confidentiality, personal identifiers were coded. The study was approved by the University of Rwanda, college of Agriculture, Forest and Food Sciences UR/CAFF/DRI/002/2026.

Data analysis

The dataset of this study consisted of both categorical and continuous variables, which explained the utilization of Factorial Analysis on Mixed Data (FAMD) [35]. FAMD combines principal component analysis (PCA) suitable for continuous variables, and multiple correspondence analysis (MCA) suitable for categorical variable. To describe demographic characteristics of participants, descriptive statistics were used. Continuous variables were described using mean and standard deviation while categorical variables were described using frequencies and percentages (Table 1). The FAMD followed by Hierarchical Clustering on Principal Components (HCPC) was done to establish characteristics of food security categories. Variables were first normalized to balance the influence of each variable and allow comparison on the same scale of variability. FAMD output dimensions on individual food security dimensions and overall three dimensions combined 'food security, had eigenvalues that corresponded to the explained variations (Table 2), and the HCPC compressed the variables into a few factors via FAMD which yielded more robust clusters, and grouping them into distinct clusters with unique attributes

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that identify various categories and leads to the creation of typologies which distinguish patterns in populations of heterogeneous smallholder farmers [35, 36].

Based on the eigenvalues (Table 2), principal dimensions were computed as a linear combination of the original variables to better account for the variance in the dataset [37]. Scores were extracted from FAMD results and were used to classify participants into different categories of food security on individual food security dimension (Table 3), and overall, three dimensions food security using standard deviations cut-offs taking being food secure as outcome (Table 5). The selection of standard deviation for cut-offs in food security categorization was associated to the objective of this study, and this method has been applied in other food security studies [38, 39]. Bivariate analysis was done to test the association between food security status and participants' characteristics both at individual dimension and overall, three dimensions combined using chi square for categorical variables and Wilcoxon sum test for continuous variables (Table 4), and (Table 5). To assess overall factors of three dimensions combined food security (Table 6), binary logistic regression was used. All data management and analysis were done in RStudio.

RESULTS AND DISCUSSION

Social Demographic Characteristics of Maize Smallholder Farmers with T2DM in Kayonza and Kirehe

Findings showed that among the study participants (Table 2), those from Kayonza, non-recipients were (n=127), 70(55 percent), and support recipients were (n=127), 57(45 percent). In Kirehe district, non-recipients were (n=127), 57(45 percent), and support recipients were (n=127), 70(55 percent). The average age was 59.9(SD: 10.5) among non-recipients and 50.8(SD: 13.1) among support recipients. The majority of participants were female (n=254), 178(70.1 percent), and most participants had primary education level (n=127), 79 (62.2%) non-support recipients, and (n=127). 60(47.2 percent) support recipients. Household size among non-recipients was 5.1 and lived with T2DM for 8.03 years, for support recipients, household size was 4.9, and lived with T2DM 7.4 years.

Food security analysis by food access

Non-recipients (n=127), 71 (55.9 percent) were food secure and 22(17.32 percent) were mild food insecure compared to support recipients (n=127), 37 (29.13 percent) who were food secure and 42(33.07 percent) who were mild food insecure. Support recipients (n=127) 1(0.78 percent), and non-recipients (n=127), 9(7.08 percent) were moderate food insecure. Support recipients (n=127), 47(37.02 percent) and (n=127), 25(19.7 percent) non-recipients were severely food insecure. The analysis showed that none of the demographic characteristics of participants were associated with food security status. District (p=0.14), age (p=0.716), Gender (p=0.374), Education

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category (p=0.686), Household size (p=0.888), years with T2DM (p=0.666) and visits per month (p=0.068).

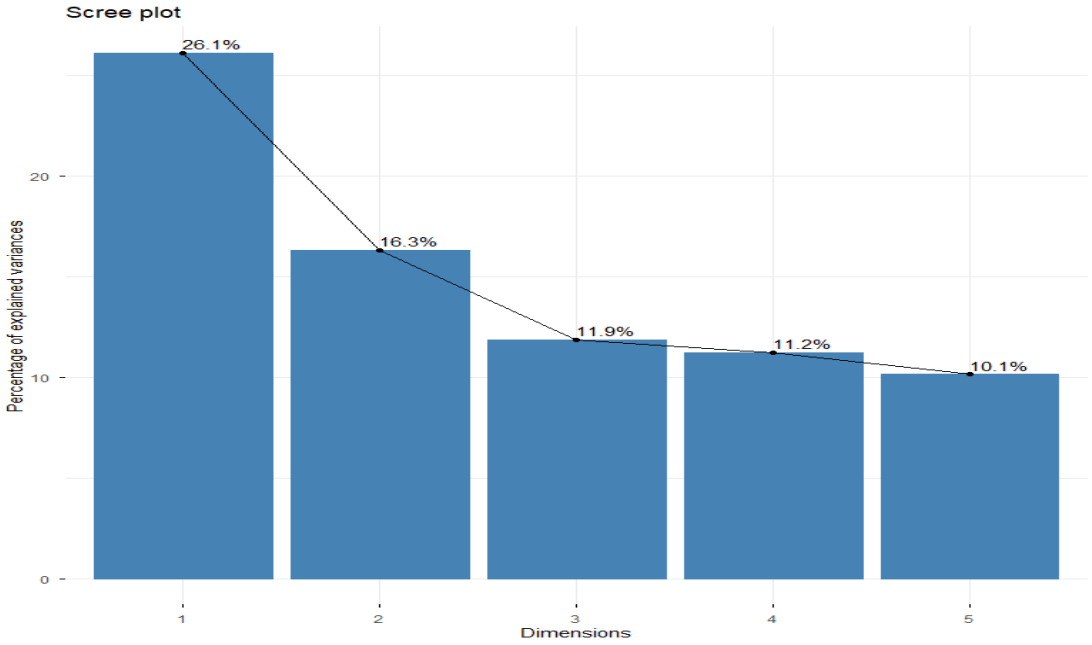


Figure 2: Scree plot for the overall explained components of food access

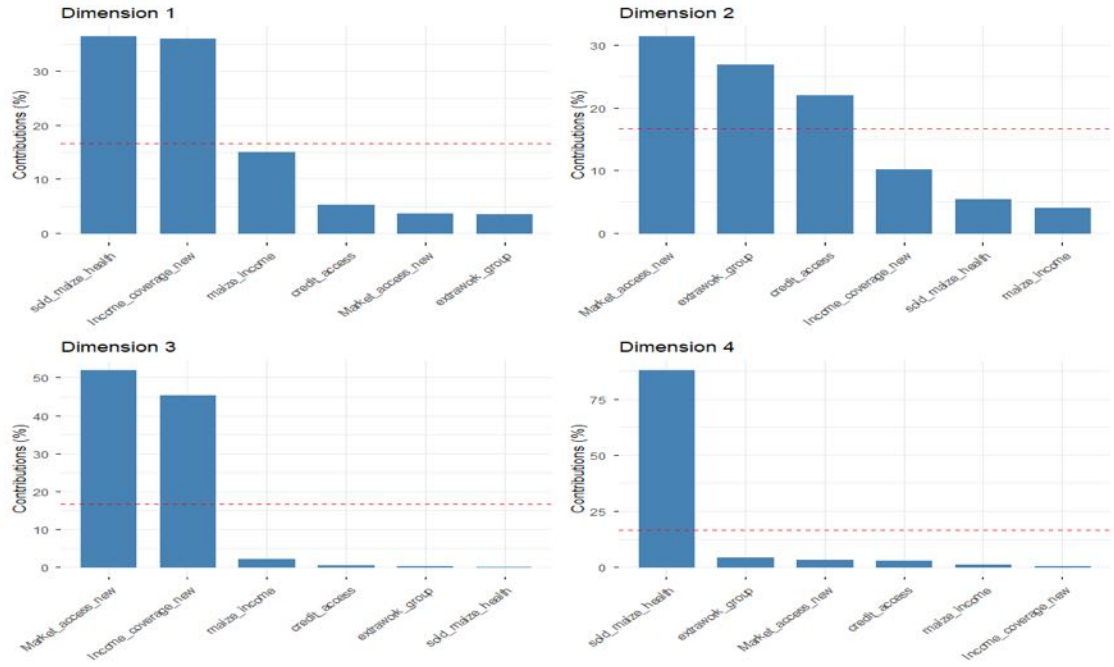


Figure 3: Percentage contribution of each variable in the explained components of food access

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Food security analysis by food availability

The findings demonstrated that (n=127), 63 (49.6 percent) non-recipients, and (n=127), 13(10.23 percent) support recipients were food secure. Age, district of residence and number of clinical visits per month were associated with food security status. A one-year increase in the age (AOR=0.95, 95%CI: 0.93, 0.97) and (*p*-value=0.001) of participant was associated to a 5 percent increase in the odds of being food secure in terms of food availability. Older participants were less likely to be food insecure. Kayonza district taken for reference, being a resident of Kirehe district (AOR=0.504, 95%CI: 0.28, 0.86) and (*p*-value=0.014) was associated to a 49.6 percent increase in the adjusted odds of being food secure. As the number of clinical visits per month (AOR=2.96, 95%CI: 1.58, 5.71), and (*p*-value=0.001) increased, it decreased the odds of being food secure in terms of food availability. This revealed that food insecure patients were sicker and require more frequent care, and non-recipients were more food secure than support recipients (Table 4). Findings support the work of Hill-Briggs [40] who demonstrated that diabetes greatly affects individuals with low-income household, and diabetes is more prevalent in food-insecure households.

Food security analysis by food utilization

The majority support recipients (n=127), 68 (53.54 percent) were food secure and none of non-recipients (n=127), 0(0.00 percent) was food secure. Support recipients (n=127), 46(36.22 percent), and (n=127), 63(49.60 percent) non-recipients were mild food insecure. Among support recipients (n=127), 12(9.44 percent) were moderate food insecure, and 1(0.78 percent) severely food insecure. Among non-recipients (n=127), 12(9.44 percent) were moderate food insecure, and 52(40.94 percent) were severely food insecure. Enrollment in the support (AOR=0.11, 95%CI: 0.05, 0.21) and (*p*-value=0.001) was associated to 89 percent increase of adjusted odds of being food secure in terms of utilization. Number of clinical visits per month, and secondary education level associated with food security status in term of utilization. Compared to participants with primary education, participants with secondary education level had higher adjusted odds of being food secure (AOR=2.93, 95%CI: 1.30, 6.76) and (*p*-value=0.01), that is an increase of 193 percent in the odds of being food secure. Each additional clinical visit per month was associated to a reduction of 63 percent in the adjusted odds of being food secure (AOR=0.37, 95%CI: 0.14, 0.79) and (*p*-value=0.0187). This means that participants who were more food-secure were healthier and require fewer clinical visits, which was an association rather than a causal effect. The dimension of food utilization was based on the knowledge from nutrition education, household knowledge of techniques on food preparation and processing, consumptions of vegetables and fruits. This is supported by studies which showed the relevance of kitchen garden,

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nutrition education, and population enrollment to support programme in reducing food insecurity and improved fruit and vegetable consumption [41].

Overall prevalence of Food security among maize smallholder farmers with T2DM in Kayonza and Kirehe Districts

The overall food security status was defined as a composite construct derived from the analyzed three dimensions of food security. The findings revealed that (n=254), 160 (62.99 percent) participants were food secure (AOR=0.0095, 95%CI: 0.002, 0.027) and (*p*-value=0.001). Among them (n=160), 124(77.5 percent) were support recipients, and (n=160), 36(22.5 percent) were non-recipients. Among food secure participants, (n=160), 68(42.5 percent) participants were from Kayonza district, and (n=160), 92 (57.5 percent) were from Kirehe district. Compared to male-headed households, female-headed households were significantly more food secure (AOR=1.86, 95%CI: 1.07, 3.23) and (*p*-value=0.026). Male-headed households had 86 percent increase in the odds of being food insecure. Each additional year of age among participants was associate with 5.7 percent increase in the adjusted odds of being severely food insecure (AOR=1.057, 95%CI: 1.033, 1083) and (*p*-value=0.001). Overall, every additional clinical visit per month was associated with a 16.7 percent increase in the adjusted odds of being food secure (AOR=1.167, 95%CI: 1.0001, 1.36) and (*p*-value=0.001). Residence in Kirehe district is significantly associated with lower odds of severe food insecurity compared to Kayonza district (AOR=0.44, 95%CI: 0.26, 0.74) and (p-value=0.002). Residents of Kirehe district have a 56 percent increase in the adjusted odds of being food secure. The observed difference in food security between support recipients and non-recipients was primarily explained by difference in food utilization scores. Due to the cross-sectional design, the observed difference was an association between maize support and food security rather than causality. These findings agree with the study of Kenduiwa *et al*. conducted in Kenya which demonstrated that in order to enhance food security among smallholder farmers, promoting homestead food production such as vegetable gardens and fruits, promoting sustainable agricultural practices must be implemented [42]. The female headed households are more food secure than of male headed households. However, this contradicts Kenduiwa *et al*. who showed that male-headed households are more food secure compared to female-headed households [43]. Participants from Kirehe district have more odds of being food secure than patients living in Kayonza district. While this study did not measure food security in terms crop diversification, previous research conducted in Eastern province including Kayonza and Kirehe districts showed that crop diversification is protective against food insecurity [44]. Older age was significantly associated with increased odds of severe insecurity, these findings agree with the study which showed that older farmers are less likely to be food secure in their households compared to young farmers [43]. Age impacts both agricultural productivity and

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household well-being. For instance, farmers accumulate knowledge and experience in agricultural practices over the years, which can positively affect farm productivity and efficiency before getting older. Apart from elderly status, older farmers with T2DM increase more health vulnerability, thus severely food insecure.

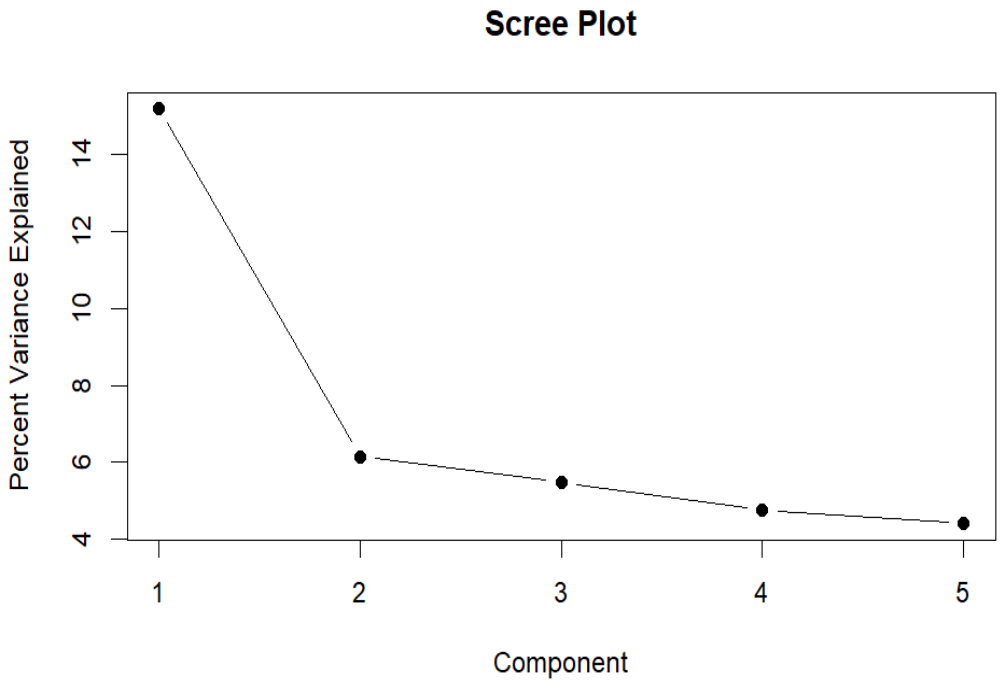


Figure 4: Scree plot for the overall explained components of food security

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

There was association, not causality between support and food security. On overall food availability, access and utilization combined, and food utilization standing alone, support recipients were more food secure than non-recipients. Non-recipients were more food secure in terms of food availability and food access.

Female-headed households had higher adjusted odds of being food secure, reference to male (AOR=1.86, 95%CI: 1.07, 3.23) and (p-value=0.026). Residence in Kirehe district was associated with more adjusted odds of being food secure (AOR=0.44, 95%CI: 0.26, 0.74) and (p-value=0.02). Older age was associated with increased odds of severe food insecurity (AOR=1.057, 95%CI: 1.033, 1.083) and (p-value=0.001), and education level, was not with food security status. The main implication of this study was that food security assessments and interventions targeting farming communities affected by T2DM and non-communicable diseases should consider health status and disease management alongside conventional factors.

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This study used a cross-sectional design. Future longitudinal and mixed method study will examine whether participation in maize farming support is associated to household food security. Future research will explore if other intervention models such as cash transfer, contract farming, or input subsidy programmes show similar findings with food security. There is a need to develop and validate a food security measurement tool that is sensitive to the context of food security, chronic disease and smallholder farming.

CONFLICT OF INTEREST

The author declares no conflict of interests.

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Table 1: Social demographic aspects of the study participants

Observation	Non maize farming support recipient (N=127)	Maize farming support recipient (N=127)
Respondent's district of residence		
Kayonza	70 (55%)	57 (45%)
Kirehe	57 (45%)	70 (55%)
Participant's age: Mean (SD)	59.9 (10.5)	50.8 (13.1)
Respondent's gender		
Male	50 (39.4%)	26 (20.5%)
Female	77 (60.6%)	101 (89.5%)
Respondent's level of education		
No formal education	26 (20.5%)	44 (34.6%)
Primary	79 (62.2%)	60 (47.2%)
Secondary or training	22 (17.3%)	23 (18.2%)
House hold size for the study participant: Mean(SD)	5.1 (2.02)	4.9 (1.8)
Years with T2DM:Mean(SD)	8.03 (6.04)	7.4 (5.6)
Number of health visits per month		
One or less visit	124 (97.6%)	90 (70.9%)
Two or more visits	3 (2.4%)	35 (27.6%)
Missing	0 (0.0%)	2 (1.6%)

Source: Primary data

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Table 2: The explained components of food security in terms of food availability, food access, food utilization, and overall combined three food security dimensions

Component	Eigen values	Variance explained	Cumulative variance explained
Food access			
Comp 1	2.35109	26.1233	26.1233
Comp 2	1.47022	16.3358	42.4591
Comp 3	1.06723	11.8581	54.3172
Comp 4	1.01039	11.2266	65.5437
Comp 5	0.91331	10.1479	75.6916
Food availability			
Comp 1	2.0272	6.75733	6.75733
Comp 2	1.74155	5.80517	12.5625
Comp 3	1.58169	5.27231	17.8348
Comp 4	1.36728	4.5576	22.3924
Comp 5	1.29279	4.30928	26.7017
Food utilization			
Comp 1	2.51827	14.8133	14.8133
Comp 2	1.85959	10.9387	25.7521
Comp 3	1.44864	8.52142	34.2735
Comp 4	1.34008	7.88284	42.1563
Comp 5	1.07658	6.33284	48.4892
Overall food security			
Comp 1	7.29041	15.1883	15.1884
Comp 2	2.9534	6.15291	21.3413
Comp 3	2.63075	5.48073	26.822
Comp 4	2.28317	4.7566	31.5786
Comp 5	2.12129	4.41935	35.9979

Source: Primary data

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Table 3: Food security categories in terms of food availability, food access and food utilization

Food security categories	Support recipient(N=127)	Non-recipients (N=127)
Food access		
Food secured	37(29.13%))	71(55.9%)
Mild insecurity	42(33.07%)	22(17.32%)
Moderate insecurity	1(0.78%)	9(7.08%)
Severely insecurity	47(37.02%)	25(19.7%)
Food availability		
Food secured	13(10.23%)	63(49.60%)
Mild insecurity	38(29.92%)	64(50.39%)
Moderate insecurity	35(27.56%)	0(0.00%)
Severely insecurity	41(32.28%)	0(0.00%)
Food Utilization		
Food secured	68(53.54%)	0(0.00%)
Mild insecurity	46(36.22%)	63(49.60%)
Moderate insecurity	12(9.44%)	12(9.44%)
Severely insecurity	1(0.78%)	52(40.94%)

Source: Primary data

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Table 4: Association between food security status in terms of food availability, food access, and food utilization and participants' characteristics

Food Access			
Variables	**Food insecurity(N=82)**	**Food security(N=172)**	**P- values**
District			0.14
Kayonza	47(57.3%)	80(46.5%)	
Kirehe	35(42.7%)	92(53.5%)	
Age: Mean (SD)	56.2(12.5)	55(12.8)	0.716
Gender			0.374
Male	61(74.4%)	117(68.0%)	
Female	21(25.6%)	55(32.0%)	
Education category			0.686
No formal education	21(25.6%)	49(28.5%)	
Primary education	48(58.5%)	91(52.9%)	
Secondary education	13(15.9%)	32(18.6%)	
Household size: Mean (SD)	5(1.89)	5.1(1.98)	0.888
Years with diabetes: Mean (SD)	7.19(4.87)	7.96(6.22)	0.666
Visits per months: Mean (SD)	1.08(0.35)	1.19(0.45)	0.068
Food availability			
Variables	**Food insecurity(N=76)**	**Food security(N=178)**	**P-values**
District			0.0198
Kayonza	47(61.8%)	80(44.9%)	
Kirehe	39(38.2%)	92(55.1%)	
Age: Mean (SD)	50.6(12.7)	57(12.2)	<0.001
Groups			<0.001
Support recipient	76(100%)	51(28.7%)	
Non-recipient	0(0.0%)	127(71.3%)	
Gender			0.503
Male	20 (26.3%)	56 (31.5%)	
Female	56 (73.7%)	122 (68.5%)	

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Education category			0.166
No formal education	27(35.5%)	43(24.1%)	
Primary education	36(47.4%)	103(57.9%)	
Secondary education	13(17.1%)	32(18.0%)	
Household size: Mean (SD)	5.11(1.95)	4.96(1.95)	0.534
Years with diabetes: Mean (SD)	7.68(5.96)	7.72(5.78)	0.794
Visits per months: Mean (SD)	1.29(0.514)	1.09(0.358)	<0.001
Food Utilization			
Variables	**Food insecurity(N=77)**	**Food security(N=177)**	**P-values**
District			1
Kayonza	39 (50.6%)	88 (49.7%)	
Kirehe	38 (49.4%)	89 (50.3%)	
Age: Mean (SD)	56.7 (10.9)	54.8 (13.4)	0.174
Groups			<0.001
Non-recipient	64 (83.1%)	63 (35.6%)	
Support recipient	13 (16.9%)	114 (64.4%)	
Gender			0.0541
Male	30 (39.0%)	46 (26.0%)	
Female	47 (61.0%)	131 (74.0%)	
Education category			0.0322
No formal education	15 (19.5%)	55 (31.1%)	
Primary education	42 (54.5%)	97 (54.8%)	
Secondary education	20 (26.0%)	25 (14.1%)	
Household size: Mean (SD)	5.30 (1.95)	4.88 (1.94)	0.0719
Years with diabetes: Mean (SD)	7.94 (6.07)	7.61 (5.72)	0.824
Visits per months: Mean (SD)	1.05 (0.322)	1.19 (0.450)	0.00651

Source: Primary data

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Table 5: Association between overall food security status and participants' characteristics

Variables	Food secured (N=160)	Severe food insecurity (N=94)	P values*
District			0.0028
Kayonza	68 (42.5%)	59 (62.8%)	
Kirehe	92 (57.5%)	35 (37.2%)	
Groups			<0.001
Poser support recipient	124 (77.5%)	3 (3.2%)	
Non-support recipient	36 (22.5%)	91 (96.8%)	
Gender			0.0364
Male	40 (25.0%)	36 (38.3%)	
Female	120 (75.0%)	58 (61.7%)	
Education status			0.27
No formal education	49 (30.6%)	21 (22.3%)	
Primary education	86 (53.8%)	53 (56.4%)	
Secondary	25 (15.6%)	20 (21.3%)	
Age (Mean, SD)	52.4 (13.2)	60.5 (10.1)	<0.001
Household size (Median, IQR)	4.97 (1.93)	5.06 (1.99)	0.662
Visits per month (Median, IQR)	1.23 (0.476)	1.02 (0.254)	<0.001
Years of having diabetes (Median, IQR)	7.46 (5.90)	8.14 (5.69)	0.202

Source: Primary data

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Table 6: Factors of food insecurity

Variables	Odds ratio (95% CI)	p-values
Factors of food insecurity per availability		
Age	0.95(0.93,0.97))	<0.001
Number of visits per month	2.96(1.58,5.71)	<0.001
District		
Kayonza (ref)	1	
Kirehe	0.504(0.28,0.86)	0.014
Factors of food insecurity per utilization		
Groups		
Non recipient	1	
Support recipient	0.11(0.05,0.21)	<0.001
Number of visits per month	0.37(0.14,0.79)	0.0187
Education categories		
No formal education	1	
Primary education	1.58(0.82,3.19)	0.18
Secondary education	2.93(1.30,6.76)	0.01
Factors of overall food security status		
	Odds of having severe food insecurity	
Variables	**Odds ratio (95% CI)**	**P-values**
Gender		
Female(ref)	1	
Male	1.86(1.07,3.23)	0.026*
District		
Kayonza(ref)	1	
Kirehe	0.44(0.26,0.74)	0.002
Groups		
Non-support recipient(ref)	1	
Support recipient	0.0095(0.002,0.027)	<0.001
Age	1.057(1.033,1.083)	<0.001*
Number of visits per month	1.167(1.0001,1.36)	<0.001*

Source: Primary data

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REFERENCES

1. **Ndayishimye L and Z Xinling** Analysis of the correlation between Rwanda's agricultural growth and economic development. *Journal of Social Sciences and Economics*. 2025 Jul 12;**4(2)**:109-21.

2. **NISR.** Agricultural Household Survey. 2022.

3. **Weatherspoon D, Miller SR, Niyitanga F, Weatherspoon LJ and JF Oehmke** Rwanda's Commercialization of Smallholder Agriculture: Implications for Rural Food Production and Household Food Choices. *Journal of Agricultural and Food Industrial Organization*, 2021; **19(1)**:51-62. https://doi.org/10.1515/jafio-2021-0011

4. **National Institute of Statistics of Rwanda (NISR).** Agricultural household survey 2024: Main report. Kigali, Rwanda: NISR. 2025. https://www.statistics.gov.rw/sites/default/files/documents/2025-10/AHS%202024_Main%20report.pdf *Accessed April 2026.*

5. **Echebiri RN and DC Nwaogu** Health Status and Productivity Analysis of Rural Farming Households in Abia State, Nigeria. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 2017. https://cabidigitallibrary.org *Accessed April 2026.*

6. **Jayathilaka R, Joachim S, Mallikarachchi V, Perera N and D Ranawaka** Do chronic illnesses and poverty go hand in hand? Plos One, 2020; **15(10)**. https://doi.org/10.1371/journal.pone.0241232

7. **Khan N, Fahad S, Naushad M and S Faisal** Analysis of livelihood in the world and its impact on world economy. Retrieved, 2020; https://ssrn.com/abstract=3717265 *Accessed February 2026.*

8. **Karami Dehkordi M, Bawary SA and G Layani** The Impact of Human Capital on Improving Sustainable Rural Livelihood Using System Dynamics Approach. *In J. Agric. Sci. Technol*, 2023; **25(6)**.

9. **Kunzekweguta M, Pigeon MA, Micheels E, Henry C and MG Nosworthy**. Understanding the role of co-operatives in enhancing food security in East Africa. *In Food Security,* 2025; **17(5)**. https://doi.org/10.1007/s12571-025-01582-0

CC BY NC ND

10. **Adom PK** Determinants of food availability and access in Ghana: What can we learn beyond the regression results? *Studies in Agricultural Economics*, 2014; **116(3)**. https://doi.org/10.7896/j.1423

11. **Russell J, Lechner A, Hanich Q, Delisle A, Campbell B and K Charlton** Assessing food security using household consumption expenditure surveys (HCES): A scoping literature review. *In Public Health Nutrition,* 2018; (pp. 2200–2210). Cambridge University Press. https://doi.org/10.1017/S136898001800068X

12. **Markos K, Dake SK, Bisetegn FS and D Nane** Level of food consumption score and associated factors among households in Konso Zone, Southwestern Ethiopia: a community-based cross-sectional study. *Frontiers in Nutrition*, 2024; **11**. https://doi.org/10.3389/fnut.2024.1481458

13. **Sseguya H, Mazur RE and CB Flora** Social capital dimensions in household food security interventions: implications for rural Uganda. *Agriculture and Human Values*, 2018: **35(1).** https://doi.org/10.1007/s10460-017-9805-9

14. **Cafiero C, Melgar-Quiñonez HR, Ballard TJ and AW Kepple** Validity and reliability of food security measures. *Annals of the New York Academy of Sciences*. 2014 Dec; **1331(1):**230-48.

15. **Pandey R and DK Bardsley** An application of the Household Food Insecurity Access Scale to assess food security in rural communities of Nepal. *Asia and the Pacific Policy Studies*, 2019; **6(2):** 130–150. https://doi.org/10.1002/app5.270

16. **Shaheen T, Liu Y and A Crossa** Validating the Hunger Vital Sign TM and USDA Food Insufficiency Tools Against the HFSS-10 Measure in a New York City Population Survey. *Journal of Health Care for the Poor and Underserved*, 2024; **35(4):** 48–69. https://doi.org/10.1353/hpu.2024.a942868

17. **Allee A, Lynd LR and V Vaze** Cross-national analysis of food security drivers: comparing results based on the Food Insecurity Experience Scale and Global Food Security Index: A. Allee et al. Food Security. 2021Oct; **13(5)**: 1245-61. https://doi.org/10.1007/s12571-021-01156-w/Published

18. **Huggins C, Ochieng C, Khaemba W, Mwaniki R and S Kimotho** Climate Change Adaptation in Rwanda's Agricultural Sector: A Case Study from Kirehe District, Eastern Province Defending the Voiceless. *Climate and Environmental Justice in Africa*, 2017.

CC BY NC ND

19. **Aremu T, Olayide O, Ndagijimana A and JC Mudahunga** Climate Change-Driven Postharvest Losses and Household Food Security in Kayonza District, Rwanda. *In Handbook of Climate Change Management: Research, Leadership, Transformation* Cham: Springer International Publishing, 2020 Nov, **12 (1-19)**.

20. **Nkurunziza P and C Habimana** Factors of adoption of maize post-harvest technologies among farmer cooperative members, Kirehe district, Rwanda. *International Journal of Economics, Commerce and Management,* 2021; **9**:90-103.

21. **Dusabeyezu S, Renzaho JN and N Sani** Prevalence and factors associated with uncontrolled type 2 diabetes among patients in Kirehe District, Rwanda: a cross-sectional study. *Pan African Medical Journal*, 2024; **48**. https://doi.org/10.11604/pamj.2024.48.128.43864

22. **Rubyutsa J M, Achtenhagen L, Stendahl E and C Musekura**. Advancing Rural Entrepreneurship in Rwanda through Informal Training – Insights from Paulo Freire's Pedagogy of the Oppressed. *Entrepreneurship Education and Pedagogy*, 2024; **7(3):** 347–376. https://doi.org/10.1177/25151274231204342

23. **Bavuma CM, Niyibizi JB and S Wild** Prevalence and characteristics associated with diabetes mellitus and impaired fasting glucose among people aged 15 to 64 years in rural and urban Rwanda: secondary data analysis of World Health Organization surveillance data. *Pan African Medical Journal*, 2022; **41**. https://doi.org/10.11604/pamj.2022.41.115.30682

24. **Tapela N, Habineza H, Anoke S, Harerimana E and F Mutabazi** Diabetes in Rwanda: High Retention and Positive Outcomes after 24 Months of Follow-up in the Setting of Chronic Care Integration. *Int J Diabetes Clin Res,* 2016*;* **3:**058. https://doi.org/10.23937/2377-3634/1410058

25. **Phocas N and S Javan** Contribution of Non-Government Organizations (NGOS) Activities in Promoting Socio-economic Development of their Beneficiaries in Rwanda: A Case of African Park Rwanda in Kayonza District (2016-2018). *East African Journal of Science and Technology*, 2021; **11**: 85–107. http://eajournal.unilak.ac.rw/EAJST

26. **Mukeshimana G, Mupenzi C and J Ndayambaje** Analysis of irrigation development to crop production in the Kirehe District case of Nasho Irrigation Schemes. *In East African Journal of Science and Technology*, 2022. **12**.

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27. **Breen C, Ryan M, Gibney M J and D O'Shea** Diabetes-related nutrition knowledge and dietary intake among adults with type 2 diabetes. *British Journal of Nutrition*, 2015; **114(3):** 439–447. https://doi.org/10.1017/S0007114515002068

28. **Minari TP, Tácito LHB, Yugar LBT, Ferreira-Melo SE, Manzano CF, Pires AC, Moreno H, Vilela-Martin JF, Cosenso-Martin LN and JC Yugar-Toledo** Nutritional Strategies for the Management of Type 2 Diabetes Mellitus: A Narrative Review. In Nutrients **15(24)**. *Multidisciplinary Digital Publishing Institute (MDPI)*, 2023. https://doi.org/10.3390/nu15245096

29. **Wolever TMS, Brand-Miller JC, Abernethy J, Astrup A, Atkinson F, Axelsen M, Björck I, Brighenti F, Brown R, Brynes A, Casiraghi MC, Cazaubiel M, Dahlqvist L, Delport E, Denyer GS, Erba D, Frost G, Granfeldt Y, Hampton S and J Zhang** Measuring the glycemic index of foods: Interlaboratory study. *American Journal of Clinical Nutrition*, 2008; **87(1)**. https://doi.org/10.1093/ajcn/87.1.247s

30. **Dada A, Ogbera A, Ogundele S, Fasanmade O and A Ohwovoriole**. Glycaemic responses to corn meals in type 2 diabetics and non-diabetic controls. *Turkish Journal of Endocrinology and Metabolism,* 2015; **19(3)**. https://doi.org/10.4274/tjem.2877

31. **Kayonza District. (2017).** Kayonza District Development Strategy (DDS) 2017–2024. Kayonza, Rwanda: Kayonza District.

32. **Kirehe District. (2018).** Kirehe District Development Strategy (DDS), 2018–2024. Kirehe, Rwanda: Kirehe District.

33. **Sabates-Wheeler R, Yates S, Wylde E and J Gatsinzi** Challenges of measuring graduation in Rwanda. *IDS Bulletin*,2015; **46(2).** 103–114. https://doi.org/10.1111/1759-5436.12133

34. **Cochran WG and WG Cochran** Sampling techniques. *New York wiley*. **1977**: 1807-2584.

35. **Kassambara A** Practical guide to principal component methods in R: PCA, M (CA), FAMD, MFA, HCPC, factoextra. STHDA. 2017

36. **Apanovich N and R Nyairo** Identifying smallholder farming system typologies in southcentral Uganda. *Implications for food security,* 2024. https://doi.org/10.21203/rs.3.rs-4693104/v1

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37. **Zopluoglu C and EC Davenport** A Note on Using Eigenvalues in Dimensionality Assessment. Practical Assessment, Research & Evaluation. 2017; **22(7).**

38. **Maxwell D, Ahiadeke C, Levin C, Armar-Klemesu M, Zakariah S and GM Lamptey** Alternative food-security indicators: revisiting the frequency and severity of "coping strategies." In Food Policy, 1999 **24**. www.elsevier.com/locate/foodpol *Accessed April 2026.*

39. **Maxwell D, Coates J and B Vaitla** How do different indicators of household food security compare? Empirical evidence from Tigray. *Feinstein International Center*, 2013 Aug: 1-9.

40. **Hill-Briggs F, Adler NE, Berkowitz SA, Chin MH, Gary-Webb TL, Navas-Acien A, Thornton PL and D Haire-Joshu** Social determinants of health and diabetes: A scientific review. In *Diabetes Care.* 2021; **44(1)**. https://doi.org/10.2337/dci20-0053

41. **Knox MA, Wallace J, Baquero B, Hara-Hubbard K and J Jones-Smith** Healthy food benefit programs, fruit and vegetable consumption, and food security. *JAMA Network Open*. 2025 Aug 19; **8(8):** e2527601.

42. **Reinbott A, Schelling A, Kuchenbecker J, Jeremias T, Russell I, Kevanna O, Krawinkel MB and Jordan** Nutrition education linked to agricultural interventions improved child dietary diversity in rural Cambodia. *British Journal of Nutrition.* 2016; **116(8):** 1457–1468. https://doi.org/10.1017/S0007114516003433

43. **Kenduiwa AA, Recha CW, Mwonya RA and D Odero-Wanga** Determinants of Household Food Security Status among Smallholder Farmers in Laikipia County, Kenya. *Journal of the Kenya National Commission for UNESCO*. 2025, https://doi.org/10.62049/jkncu.v5i1.395

44. **Kegode H, Karuaihe ST, Fitawek W and D Jourdain** An empirical analysis of the determinants of food insecurity among smallholder farmers in Eastern Rwanda. Agriculture and Food Security, 2025; **14(1).** https://doi.org/10.1186/s40066-025-00557-w

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