Received: 30 July 2022 | Revised: 1 November 2022 | Accepted: 9 December 2022

DOI: 10.1111/joca.12505

RESEARCH ARTICLE

the journal of consumer affairs

WILEY

Financial inclusion and food insecurity: Examining linkages and potential pathways

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Abstract

Considering the worsening levels of food insecurity globally, studies exploring the link between financial inclusion and food insecurity have become imperative. This paper contributes to the literature by examining the effect of financial inclusion on food insecurity using a multidimensional index of financial inclusion and a food insecurity construct obtained from the Food Insecurity Experience Scale. Based on data extracted from the seventh round of the Ghana Living Standards Survey, our preferred endogeneity-corrected results indicate that improvements in financial inclusion is associated with a reduction in food insecurity. This finding is consistent across different conceptualisations of food insecurity, alternative weighting schemes and cut-offs for the financial inclusion index and different quasi-experimental methods. Financial inclusion is mainly effective in reducing food insecurity in male-headed and rural-located households. Our findings reveal that entrepreneurship is an important pathway through which financial inclusion influences food insecurity.

KEYWORDS

financial inclusion, food insecurity, gender, Ghana, rural

1 | INTRODUCTION

Despite the global commitment to achieve the sustainable development goal 2 (SDG2) of zero hunger by 2030, food insecurity remains a challenge, especially in Africa and in other resource-poor countries (FAO et al., 2021). In 2020, an estimated 768 million people faced hunger globally (FAO et al., 2021). Apart from the world not being on track to achieving the SDG2, 660 million people (representing an extra 30 million) are estimated to still face hunger due to the COVID-19 pandemic (FAO et al., 2021). Between 2019 and 2020 Africa recorded about 46 million more people being hungry but in all parts of the world, the prevalence of food insecurity is higher among women than men (FAO et al., 2021). Food insecurity harms health and wellbeing (Gundersen & Ziliak, 2015; Weaver et al., 2021), children's school engagement learning outcomes (Johnson & Markowitz, 2018; Mohammed, 2021), labor productivity and wage earnings (Mishra & Rampal, 2020) and other welfare outcomes (Johnson & Markowitz, 2018; Weaver et al., 2021). To achieve zero hunger, an in-depth context-specific situation analysis by FAO et al. (2021) point to six broad key elements of a portfolio of policy measures and investments which include the promotion of peace to avoid conflict, scaling up climate resilience, strengthening economic resilience, reducing cost of nutritious food, addressing poverty and inequality, and shifting toward sustainable consumption patterns.

Available evidence shows that financial inclusion (FI) has the potential to positively influence these policies (Birkenmaier et al., 2016; Koomson et al., 2020; Peprah et al., 2020) but research linking FI to food insecurity remains scant. FI can reduce food insecurity indirectly by first enhancing entrepreneurship and employment in general (Koomson, Martey, & Etwire, 2022). It also can reduce food insecurity by increasing asset accumulation and incomes required to invest in education and health for increased productivity (Koomson, Villano, & Hadley, 2022; Peprah et al., 2020) but researchers are yet to empirically analyze such pathways.

A review of empirical studies on the FI-food insecurity nexus points to several gaps. First, most of these studies have separately analyzed the effect of some specific dimensions of FI, such as account ownership (Birkenmaier et al., 2016; Fitzpatrick, 2017), credit access (Ayantoke, 2010), remittance (Mora-Rivera & van Gameren, 2021; Smith & Floro, 2021) and agricultural insurance (Mârza et al., 2015) but have not employed an FI index despite the recent advancements in the conceptualization of FI as a multidimensional construct (Demirgüç-Kunt et al., 2018; Koomson et al., 2020; Koomson & Danquah, 2021). We address this by using a multidimensional FI index built on the Alkire and Foster (2011) methodology. Second, some studies have employed endogeneity-correcting methods (Mora-Rivera & van Gameren, 2021; Smith & Floro, 2021), while other studies have not applied such methods (Birkenmaier et al., 2016; Carter et al., 2018), but the potential endogeneity of FI has been highlighted as a key methodological issue which can result in inconsistent estimates of the link between FI and food insecurity. This calls for more studies on this topic that resolve endogeneity. Third, there are persistent gender and locational disparities in global FI rates despite the worldwide progress in FI levels from 51% (in 2011) to 69% (in 2017) (Demirgüç-Kunt et al., 2018). This makes it imperative to decompose findings along gender and locational dimensions when empirically assessing the link between FI and food insecurity. Fourth, the potential pathways/channels through which FI influences food insecurity is yet to be empirically examined.

We contribute to the literature by estimating the direct effect of FI on food insecurity in Ghana using a multidimensional FI index which cuts across four dimensions. Based on comprehensive living standards survey data, we obtain three measures of food insecurity derived from the widely accepted Food Insecurity Experience Scale (FIES) which was developed and

validated by the Food and Agriculture Organization (FAO). Consistent with previous studies, we resolve the endogeneity associated with FI using distance to the nearest bank as an instrument and by performing numerous robustness checks to ensure consistency in findings. We engage in gender and rural-urban subsampled modeling to explore heterogeneities in the effect of FI on food insecurity. This is informed by the evidence of gender and geographic disparities in the rates of food insecurity and FI across the globe. It also supports the SDG's primary goal of "leaving no one behind" by urging researchers to engage in analysis at their decomposed levels if data permits. Finally, we explore the potential of entrepreneurship and durable assets accumulation as pathways/channels through which FI transmits to food insecurity.

The following reasons inform our choice of Ghana as a case study. First, Ghana has a considerably high rate of food insecurity despite its downward trajectory over time. The rate of food insecurity in Ghana was 50% in 2016/2017, but this reduced to 47.7% in June 2020 and further to 47.0% in September 2020 (GSS, 2021). Second, Ghana has made significant strides toward universal financial access and demonstrated political will by joining over 90 developing countries to sign the 2010 Maya Declaration, which aimed to reduce poverty by increasing FI (AFI, 2015). From these efforts, Ghana's FI rate improved by 29% between 2011 and 2017 (Demirgüç-Kunt et al., 2018). To improve on the gains made, Ghana's government has developed a National Financial Inclusion and Development Strategy (NFIDS), with the goal of increasing FI from 58% to 85% of Ghana's adult population by 2023. Gender and geographical disparities exist in the FI rates in Ghana. Account ownership stands at 54% for females and 62% for males. In terms of the urban dimension, 54% of males have a transaction account, compared to 46% of females. Conversely, males hold 61% of accounts in the rural areas, compared to 39% for their female counterparts (GSS, 2014). Loan applications from rural residents in Ghana are refused more than those of their urban counterparts (Koomson et al., 2016). This study can help to identify the potential gains in food security that can be realized as we inch closer to achieving the targets set by the NFIDS. Given Ghana's FI and food insecurity statistics, it is deemed appropriate to use the Ghanaian case to represent a typical developing country scenario.

The remaining parts of this research are organized as follows. Section 2 focuses on the theoretical literature on FI and food insecurity and discusses potential pathways. The data and variable definitions are covered in Section 3, while Section 4 presents the analytical procedures used. Section 5 presents the results, while Section 6 concludes.

2 | THEORETICAL LITERATURE ON FI AND FOOD INSECURITY

The link between FI and food insecurity can be drawn from the theory of financial development (King & Levine, 1993; Rajan & Zingales, 1998). Financial development is associated with expansion in the financial system, which is associated with improvements in the indicators of FI—financial product ownership and usage (i.e., credit and debit cards, ATMs, e-banking, etc.), ownership of insurance (risk management), access to credit and receipt of financial remittance (Demirgüç-Kunt et al., 2015, 2018; King & Levine, 1993; Koomson et al., 2020; Koomson & Ibrahim, 2018; Rajan & Zingales, 1998). It can be deduced from these theories (King & Levine, 1993; Rajan & Zingales, 1998) that improvements in the indicators of FI for individuals and households can influence FI through two pathways. The first pathway is how FI can directly influence food insecurity by providing the financial resources needed to cater for daily food consumption needs. The second pathway includes indirect means through which financial

resources from FI can be invested in businesses (entrepreneurship), new technologies, durables asset accumulation, education, health, and others to provide sustainable income-generating portfolios capable of sustaining food consumption over time. In the ensuing subsections, we discuss some of the indirect pathways through which FI can potentially influence food insecurity.

2.1 | Entrepreneurship

Financial constraint remains one of the most cited factors hampering entrepreneurship and growth of small businesses, especially in developing countries (Daniels et al., 2016; Koomson & Ibrahim, 2018). This notwithstanding, FI has been highlighted as a key facilitator of entrepreneurship because it ensures that all economic agents have equal opportunities (Jiang et al., 2019; Koomson & Ibrahim, 2018). Entrepreneurship improves household income which can be spent on household food consumption (Sinyolo & Mudhara, 2018). Dedehouanou and Araar (2020) have also shown that entrepreneurship in nonfarm activities is associated with increased availability and accessibility to food, especially when the enterprise is female-managed. This is supported by Demirgüç-Kunt et al. (2008) who indicated that increased FI has the potential to boost recipients' entrepreneurial opportunities, as well as their food consumption income. From the evidence above, we can deduce that entrepreneurship serves as a potential transmission mechanism between FI and food insecurity.

2.2 | Asset accumulation

Asset accumulation has been identified as a sustainable means of consumption smoothing (Aryeetey, 2004; Doss et al., 2011). Financially included household can build up savings which can be used for food consumption in times of economic hardship (Bartfeld & Collins, 2017). Through FI, households can obtain the financial resources needed to accumulate durable productive and nonproductive assets (Jalilian & Kirkpatrick, 2002). Between the two types of assets commonly accumulated, financial assets are associated with greater opportunity costs, particularly in emerging nations with less established financial institutions (Aryeetey, 2004). As a result, most households in resource-poor countries prefer to acquire productive and nonproductive durable assets since they both have the risk-coping potential of being sold for cash to meet food consumption needs in times of financial difficulty (Aryeetey, 2004; Doss et al., 2011). In developing countries like Ghana, asset accumulation presents households with the opportunity of diversifying their income portfolios with nonfarm economic activities (Peprah & Koomson, 2015; Senadza, 2014), which contributes to the income required for food consumption. This also shows that FI can transmit to food insecurity through durable asset accumulation.

2.3 | Other pathways—Education, health, and income

There is ample evidence that FI provides the means to acquire financial resources that are used to invest in education, health and other forms of human capital accumulation, which further increases household income in the long run (Abosedra et al., 2016; Heckman et al., 2018; Perotti, 1993). Poor people's investments in education and health improve their chances of achieving sustainable livelihoods (World Bank, 2001). The returns to education model indicate

that increased years of schooling is associated with increases in income (Heckman et al., 2018; Mishra & Smyth, 2015). Regarding health, available evidence shows that good health is associated with increased productivity and income (Bubonya et al., 2017; Tu et al., 2020). This means that FI can indirectly influence food insecurity through its effect on education, health, income, and other human capital indicators.

2.4 | Over-indebtedness

Despite the favorable evidence in support of FI and food insecurity, FI can also worsen food insecurity if improved access to financial products is abused. For instance, excess use of novel financial instruments that facilitate transactions (such as credit cards, ATMs, and online banking) can lead to excessive debt and financial vulnerability (Lyons & Hunt, 2003), resulting in food insecurity.

Based on the theoretical and contextual expositions, Figure 1 presents the FI, entrepreneurship, asset accumulation, other pathways, and food insecurity.

3 | DATA AND VARIABLES

The data for this study comes from round seven of the Ghana Living Standards Survey (GLSS7), which is the most extensive cross-sectional nationally representative data gathered by the Ghana Statistical Service (GSS, 2019) from October 2016 to October 2017. Our analysis is restricted to GLSS7 because earlier rounds of the survey do not capture data on food insecurity. Apart from food insecurity, the GLSS7 gathered extensive data on various topics, including household demographics, ethnic groupings, health, assets, and households' perceptions of governance, peace, and security (GSS, 2019). The study enumerated 15,000 households throughout the then 10 (now 16) regions of Ghana, but the final sample size was 14,009 households due to a 93.4% response rate. After merging sections containing our variables of interest, we had a workable sample of 13,781 households. After the regression analysis, the model with the highest number of observations was 6901 households. This can be explained by the 6880 missing observations caused by nonresponses to the indicators that comprised the FI index (especially related to remittance).

3.1 | Food insecurity

In this study, we use three measures of food insecurity obtained through the application of different methods consistent with the extant literature.

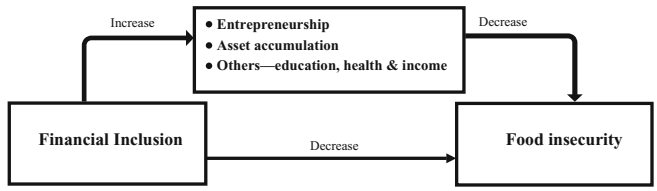

FIGURE 1 Conceptual link between FI, entrepreneurship, asset accumulation, other pathways, and food insecurity (*Source*: Authors' construct)

Our first and key measure of food insecurity (FIES) is obtained by applying the Rasch model to the standard set of eight simple yes/no questions (yes = 1; and no = 0 in Table A1) that make up the FIES (Ballard et al., 2013; Cafiero et al., 2018; FAO, 2013; Koomson & Awaworyi Churchill, 2021). The FIES was created and tested by the FAO and has since been used extensively in the literature as an objective measure of households' deprivations in access to food (Ballard et al., 2013; Cafiero et al., 2018; FAO, 2013; Koomson & Awaworyi Churchill, 2021).

The formula for the Rasch model (also built on the one parameter logistic model), which is used to determine the degree of food insecurity in a household, is specified in Equation (1):

$$P_{ij} = P(X_{ij} = 1|\theta_j, \beta_i) = \frac{\exp(\theta_j - \beta_i)}{1 + \exp(\theta_j - \beta_i)} \quad (1)$$

Where X_{ij} is to the probability that household i gives affirmative response to FIES item j, β_i is the difficulty level or the severity parameter of the various FIES items, and $\theta_j$represents the capacity of an individual to respond correctly to the FIES item. It also indicates the extent of food insecurity in the household. Food insecurity will become more likely if the value of β remains constant and θ rises (Koomson & Awaworyi Churchill, 2021).

Since the predicted coefficients for the difficulty levels of the FIES items are all significant at the 1% alpha level, we incorporate all eight items in calculating our measure of food insecurity (see Table A2). As a desirable condition to satisfy, the steepness of our generated item characteristic curves at the mid-point shows equal discriminatory strength of FIES items (see Figure A1) (Cafiero et al., 2018; Koomson & Awaworyi Churchill, 2021). The test characteristic curve in Figure A2 also shows that, for 95% of randomly selected households, the total score ranges from 0 to 8 (or 0.000037 and 7.96). Further detailed explanations into the tests and concepts above can be obtained from Cafiero et al. (2018); and Koomson and Awaworyi Churchill (2021).

The second measure of food insecurity [FIES(Factor)] is generated by applying principal factor analysis to all FIES items and retaining only factors with eigenvalues greater than or equal to one (Helmi et al., 2020; Koomson & Awaworyi Churchill, 2021). Premised on the Bartlett test of sphericity reported in Table A3, we reject the null hypothesis of non-collinearity among the eight items (at the 5% alpha level). The 0.930 Kaiser-Meyer-Olkin (KMO) score in Table A3 is adequate for factor analysis because it is greater than the commonly recommended value of 0.8 required for sampling adequacy (Koomson & Awaworyi Churchill, 2021; Lahai & Koomson, 2020). This indicates that the food insecurity index created through principal factor analysis is accurate and presents more evidence in favor of the FIES's validity.

The third measure of food insecurity [FIES(RS)] follows the method in the existing literature by summing up affirmative responses from all eight FIES items to generates a raw score ranging from the least (0) to the most (8) food-insecure household (Ballard et al., 2013; Cafiero et al., 2018; Koomson & Awaworyi Churchill, 2021). A score of eight indicates that all eight indicators of food insecurity were experienced or suffered by the household, and vice versa.

All three measures of food insecurity are continuous variables for which a unit increase reflects an increase in food insecurity. Since all three measures are based on the same underlying construct of food insecurity, the correlation matrix in Table A4 shows a significant positive relationship between them, with correlation coefficients ranging from 0.997 to 1.000.

3.2 | Financial inclusion (FI)

Following recent studies which measure FI using multidimensional approaches (Koomson et al., 2020; Koomson et al., 2021; Koomson & Danquah, 2021; Zhang & Posso, 2017), we employ four dimensions of FI. These are bank or mobile money account ownership, ownership of insurance, access to credit/loans, and receipt of financial remittances via bank or through mobile money. Assigning an equal weight of 0.25 to each dimension, we apply the formula stated in Equation (2) to produce an FI score for which a unit increase signifies an improvement in FI. Consistent with previous studies (Awaworyi Churchill & Marisetty, 2020; Koomson & Danquah, 2021; Zhang & Posso, 2017), we utilize a 0.5 cut-off to create a binary variable that is 1 when a household's FI score is more than 0.5 and 0 when it is not. In robustness checks, we use different weighting systems and different cut-offs to ensure consistency in findings (see Subsection 5.3).

$$\mathrm{FI}_i = w_1 I_1 + w_2 I_2 + \cdots + w_n I_n \tag{2}$$

Where FI_i represents a household's FI score, and $I_i = 1$ if a household provides an affirmative response for indicator i and $I_i = 0$ if otherwise. w_i is the weight attached to indicator i with $\sum_{i=1}^{d} w_i = 1$. The description and summary statistics of the variables employed in this study can be found in Table A5.

4 | ESTIMATION METHODS

We use the ordinary least squares method to estimate the link between FI and household food insecurity.

This notwithstanding, the potential endogeneity of FI is highlighted as a key methodological concern in existing studies that have explored the empirical link between FI and household food insecurity, poverty and other welfare outcomes (Awaworyi Churchill & Marisetty, 2020; Koomson et al., 2020; Koomson et al., 2021; Koomson & Danquah, 2021; Mora-Rivera & van Gameren, 2021; Smith & Floro, 2021). As in previous studies, we consider the possible bi-causal connection between FI and food insecurity to be the source of endogeneity. On the one hand, increased financial resources resulting from improved FI can boost households' capacity to spend on food. On the other hand, household heads who intend to smoothing their household's food consumption over time may be motivated to become financially included by either saving for it or seeking credit/loan from a bank. Others may manage risk by insuring against a loss of business/farm revenue or by avoiding the danger of losing their livelihoods, which generate incomes for food purchases.

Following previous studies, we address this possible endogeneity problem by estimating a standard two-stage least squares (2SLS or IV) model that employs distance to the nearest bank as an instrument (Awaworyi Churchill & Marisetty, 2020; Koomson & Danquah, 2021). Considering the relevance of the instrument, there is ample evidence in support of a direct inverse relationship between distance to bank and FI (Demirgüç-Kunt & Klapper, 2012; Koomson et al., 2020; Koomson et al., 2021). Regarding validity, the distance it takes to reach a bank is not expected to directly influence food insecurity unless it indirectly does so through FI. Using Equation 3 in the first stage, FI is regressed on distance to bank and all control variables and is

used to obtain the estimated values of FI. In the second stage, the estimated FI is employed to determine its effect on food insecurity.

$$\mathrm{FI}_i = \beta_1 \mathrm{Dist}_i + \sum_n \beta_n X_{n,i} + \mu_z + \vartheta_m + \varepsilon_i \tag{3}$$

$$\mathrm{FDinsec}_i = \beta_1 \widehat{\mathrm{FI}}_i + \sum_n \beta_n X_{n,i} + \mu_z + \vartheta_m + \varepsilon_i \tag{4}$$

Where FDinsec is the food insecurity level for household i and FI represents the FI status of a household. $\widehat{\mathrm{FI}}$ is the estimated version of a household's FI status. Dist is the distance to the nearest bank. X is a vector of control variables indicated in previous studies as being determinants of household food insecurity (Koomson & Awaworyi Churchill, 2021; Lahai & Koomson, 2020; Sriram & Tarasuk, 2016). These covariates include age, gender (1 = female; 0 = male), location (1 = rural; 0 = urban), household size and household size squared, education (1 = educated; 0 = not educated), marital status, farm household status (1 = farm household; 0 = nonfarm household), food price index, ethnic diversity, ecological zones, and month of survey fixed effects. μ_z and ϑ_m represent ecological zone and month of survey fixed effects respectively, while ε is a random error term. We account for ecological zone fixed effects because the ecological zone in which a household is located can have an impact on its level of food insecurity (Koomson & Awaworyi Churchill, 2021). Given that these zones cut across Ghana's administrative regions and districts, their inclusion in the model serves as proxies for the administrative regions and districts. The month of survey fixed effect is also important because glut and shortages in food supply and food prices in Ghana are driven by rainy and dry seasons associated with different months of the year and harvest periods.

Apart from the standard 2SLS model, we also employ other widely used methods to resolve endogeneity to ensure consistency in findings. These methods include the control function approach (CFA), propensity score matching (PSM) together with the Inverse-Probability-Weighted Regression Adjustment (IPWRA) approach. Details of these methods are provided in Subsection 5.3, where they are applied.

5 | RESULTS

In Table 1, we report the baseline estimates for the association between FI and food insecurity. Estimates for the FIES, FIES (Factor) and FIES (RS) are presented in Columns 1 to 3, respectively. Overall, our findings indicate that financially included households are less likely to be food insecure. Specifically, we can see in Column 1 that food insecurity is 0.092 lower in financially included households. In Columns 2 and 3, we observe that being financially included is associated with 0.119 and 0.094 lower levels of food insecurity. We can deduce that FI facilitates the acquisition and accumulation of resources needed to increase households' food purchasing power (Dedehouanou & Araar, 2020; Sinyolo & Mudhara, 2018). The risk management associated with savings and insurance ownership enables households to smoothing food consumption over time (Bartfeld & Collins, 2017).

Apart from FI, interesting inferences can be drawn from the results of the control variables. Rural and farm households are more food insecure. A unit increase in food price and ethnic diversity are associated with an increase in food insecurity. Household size has a nonlinear

TABLE 1 FI and food insecurity (OLS results)

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
Financial inclusion	−0.092***	−0.119***	−0.094***
	(0.020)	(0.023)	(0.018)
Age	−0.001	−0.001	−0.002
	(0.001)	(0.001)	(0.002)
Female	0.012	0.017	0.048
	(0.025)	(0.028)	(0.089)
Rural	0.215***	0.230***	0.745***
	(0.024)	(0.027)	(0.085)
Household size	0.048***	0.056***	0.172***
	(0.009)	(0.010)	(0.031)
Household size squared	−0.002***	−0.003***	−0.008***
	(0.001)	(0.001)	(0.002)
Educated	−0.321***	−0.353***	−1.116***
	(0.023)	(0.026)	(0.080)
Marital Status (Base = Never married)			
Married	−0.129***	−0.140***	−0.444***
	(0.029)	(0.032)	(0.101)
Separated/Divorced	0.075**	0.087**	0.291**
	(0.035)	(0.040)	(0.125)
Farm household	0.201***	0.238***	0.729***
	(0.026)	(0.029)	(0.090)
Food price index	0.235	0.282	0.989
	(0.213)	(0.232)	(0.744)
Ethnic diversity	0.449***	0.585***	1.787***
	(0.081)	(0.090)	(0.288)
Ecological zone fixed effect (Base = Accra)			
Coastal	0.361***	0.408***	1.284***
	(0.042)	(0.046)	(0.146)
Forest	0.097**	0.135***	0.401***
	(0.038)	(0.043)	(0.134)
Savannah	0.479***	0.481***	1.584***
	(0.049)	(0.054)	(0.171)
Month of survey fixed effects			
Observations	6901	6872	6901
R-squared	0.256	0.244	0.248

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 2 FI and food insecurity (IV results)

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
Financial inclusion	−2.928***	−2.720***	−2.353***
	(0.715)	(0.698)	(0.586)
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
First stage			
Distance to the nearest bank(km)	−0.009***	−0.009***	−0.009***
	(0.002)	(0.002)	(0.002)
F-statistic	19.70	19.70	19.70
Observations	6901	6872	6901

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$.

(inverted-U) relationship with food insecurity. The possible reason for this is that as household membership becomes larger, some members become economically active and contribute financial resources toward consumption. Even in cases where child laborers are involved, evidence has shown that economically active children in Ghana contribute significantly to household farm and nonfarm income (Koomson & Asongu, 2016). Households with educated heads are less likely to experience food insecurity. Compared to the not married, the married are less likely to experience food insecurity, while the separated/divorced are more likely to be food insecure. Relative to households in Accra, households in other locations are more likely to be food insecure.

5.1 | Endogeneity-corrected estimates

In Table 2, we report the 2SLS results for models in which distance to the nearest bank is employed as an instrument to address the endogeneity problem associated with FI. For all three models, the F-statistics of the first stage estimates are all greater than 10, so we infer that our instrument is not weakly associated with FI (Stock & Yogo, 2002). Consistent with previous studies, we observe from the first stage results that the farther away a household is from the nearest bank, the less likely it is to be financially included (Koomson et al., 2020; Koomson et al., 2021). We find in Column 1 that food insecurity is 2.928 lower in financially included households. From Columns 2 and 3, we see that FI is associated with 2.720 and 0.094 lower levels of food insecurity, respectively. A look at the 2SLS estimates shows that they are bigger than the baseline results, implying that the endogeneity associated with FI causes a downward bias in the OLS estimates. This makes the consistent estimates from the 2SLS model more reliable. Overall, our finding supports the use of FI as a reliable policy in the fight against food insecurity. Our findings support previous studies that have found that FI is associated with decreasing levels of food insecurity (see, e.g., Ayantoke, 2010; Mora-Rivera & van

TABLE 3 FI and food insecurity (IV results): Male–Female

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
Panel A: Male sample			
Financial inclusion	−3.905***	−3.797***	−3.260***
	(1.147)	(1.114)	(0.962)
Female	No	No	No
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
First stage			
Distance to the nearest bank(km)	−0.008***	−0.008***	−0.008***
	(0.002)	(0.002)	(0.002)
F-statistic	13.12	13.12	13.12
Observations	4732	4711	4732
Panel B: Female sample			
Financial inclusion	−1.125	−0.508	−0.624
	(0.699)	(0.732)	(0.570)
Female	No	No	No
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
First stage			
Distance to the nearest bank(km)	−0.010***	−0.010***	−0.010***
	(0.004)	(0.004)	(0.004)
F-statistic	7.35	7.35	7.35
Observations	2169	2161	2169

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$.

Gameren, 2021; Smith & Floro, 2021), but we employ a multidimensional FI index as a contribution. It also supports studies related to the financial development framework (King & Levine, 1993; Rajan & Zingales, 1998), which posit that FI has the capability to enhance household welfare through increased food consumption.

5.2 | Gender and location analyses

To explore the gender and location dynamics in the FI-food insecurity nexus, we analyze and report rural-urban and male- and female-headed household subsampled results in this section.

TABLE 4 FI and food insecurity (IV results): Rural–Urban

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
Panel A: Rural sample			
Financial inclusion	−3.026***	−2.888***	−2.505***
	(0.791)	(0.783)	(0.665)
Rural	No	No	No
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
First stage			
Distance to the nearest bank(km)	−0.009***	−0.009***	−0.009***
	−0.0078	−0.0078	(0.002)
F-statistic	18.17	18.17	18.17
Observations	3956	3940	3956
Panel B: Urban sample			
Financial inclusion	−0.741	−0.274	−0.307
	(0.801)	(0.869)	(0.673)
Rural	No	No	No
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
First stage			
Distance to the nearest bank(km)	−0.008**	−0.008**	−0.008**
	(0.004)	(0.004)	(0.004)
F-statistic	4.69	4.69	4.69
Observations	2945	2932	2945

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$; **$p < 0.05$.

In Table 3, results for the male and female samples are respectively reported in Panels A and B. From Columns 1 to 3 of Panel A, we find that in male-headed households, FI is associated with 3.905, 3.797 and 3.260 lower levels of food insecurity. For all Columns in Panel B, we find that FI is not significantly associated with food insecurity in female-headed households. In Ghana, male-headed households are poorer than female-headed homes while women are more entrepreneurial than men (GSS, 2014, 2019), so an improvement in FI for men is expected to make more difference in reducing food insecurity for men than women.

From Columns 1 to 3 of Panel A in Table 4, we see that FI is associated with 3.026, 2.888 and 2.505 lower levels of food insecurity in rural-located households, respectively. For all Columns in Panel B, we find that FI is not significantly associated with food insecurity in urban

TABLE 5 FI and food insecurity (control function approach)

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
Financial inclusion	−2.929***	−2.718***	−2.353***
	(0.379)	(0.424)	(0.335)
Residual	2.845***	2.606***	2.266***
	(0.380)	(0.425)	(0.336)
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
First stage			
Distance to the nearest bank(km)	−0.009***	−0.009***	−0.009***
	(0.002)	(0.002)	(0.002)
F-statistic	19.70	19.70	19.70
Observations	6901	6872	6901

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$.

households. With rural folks being more financially excluded (GSS, 2014; Koomson et al., 2016), improved access to modern payment systems for rural households provides more avenues to increase their financial resources needed to buy food.

5.3 | Robustness/sensitivity checks

In this section, we run various tests to ensure that our results are robust. First, we use the CFA method, which is fundamentally an instrumental variable method but involves predicting the residual of the first stage model and including it in the second stage model as an extra control variable (Wooldridge, 2015). Compared to the standard 2SLS technique, the CFA produces more efficient second-stage estimators in rare cases (Tchetgen, 2014). In Column 1 of Table 5, we find that food insecurity is 2.929 lower in financially included households. In Columns 2 and 3, we observe that FI is associated with 2.718 and 2.353 lower levels of food insecurity. The CFA results are consistent with those produced from the standard 2SLS method, implying that the food insecurity-reducing effect of FI is robust to different approaches used in addressing endogeneity.

Second, we apply the PSM method which has been used extensively in the literature to resolve biasedness or endogeneity induced by self-selection (Awaworyi Churchill & Marisetty, 2020; Koomson et al., 2020; Koomson & Danquah, 2021). We used four distinct matching approaches (i.e., nearest neighbor, radius, kernel, and local linear regression) as well as an Inverse-Probability-Weighted Regression Adjustment (IPWRA) procedure and present the findings in Table 6. Contrary to the PSM procedure, the IPWRA uses weighted regression coefficients to create average treatment level anticipated results, giving it a double-robust

TABLE 6 PSM results with different matching methods

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
1 – Nearest Neighbor (1:1)	−0.103***	−0.155***	−0.103***
	(0.034)	(0.038)	(0.030)
5 – Nearest Neighbor (1:5)	−0.084***	−0.115***	−0.088***
	(0.025)	(0.028)	(0.024)
Radius	−0.204***	−0.239***	−0.191***
	(0.026)	(0.029)	(0.024)
Kernel	−0.091***	−0.117***	−0.093***
	(0.018)	(0.020)	(0.020)
Local linear regression	−0.078***	−0.103***	−0.082***
	(0.022)	(0.022)	(0.021)
IPW Regression Adjustment (IPWRA)	−0.105***	−0.134***	−0.106***
	(0.020)	(0.023)	(0.018)
Observations	6901	6872	6901

Note: Robust standard errors in parentheses.
Abbreviations: FIES(Factor), Food insecurity index from factor analysis; FI(Rasch), Food insecurity index from Rasch model; FI(RS), Raw score (additive) of food insecurity.
***$p < 0.01$.

TABLE 7 FI and food insecurity (using FI score)

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
Financial inclusion	−5.408***	−5.045***	−4.345***
	(1.244)	(1.234)	(1.025)
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
First stage			
Distance to the nearest bank(km)	−0.005***	−0.005***	−0.005***
	(0.001)	(0.001)	(0.001)
F-statistic	24.46	24.46	24.46
Observations	6901	6872	6901

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$.

characteristic (Martey et al., 2019; Wooldridge, 2008). To guarantee consistency in our PSM estimates, we apply all the matching methods listed and report the results in Table 6. Figure A3 displays the region of common support which shows that financially included households have

TABLE 8 FI and food insecurity (alternative weights for FI indicators)

Variables	(1) FIES	(2) FIES(Factor)	(3) FIES(RS)
Panel A: Weight of 0.4 for bank account			
Financial inclusion	−0.119***	−0.145***	−0.114***
	(0.021)	(0.023)	(0.018)
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
Observations	6901	6872	6901
R-squared	0.257	0.245	0.250
Panel B: Weight of 0.4 for access to credit			
Financial inclusion	−0.044	−0.070**	−0.053**
	(0.027)	(0.031)	(0.024)
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
Observations	6901	6872	6901
R-squared	0.254	0.241	0.246
Panel C: Weight of 0.4 for insurance			
Financial inclusion	−0.111***	−0.147***	−0.117***
	(0.023)	(0.027)	(0.021)
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
Observations	6901	6872	6901
R-squared	0.256	0.244	0.249
Panel D: Weight of 0.4 for remittance			
Financial inclusion	−0.048**	−0.065**	−0.052**
	(0.023)	(0.026)	(0.020)
All other control variables	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes
Observations	6901	6872	6901
R-squared	0.254	0.241	0.246

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$; **$p < 0.05$.

TABLE 9 Effect of FI on entrepreneurship and asset accumulation

Variables	(1) Entrepreneurship	(2) log(value of asset accumulated)
Financial Inclusion	0.847***	3.482***
	(0.287)	(1.153)
All other control variables	Yes	Yes
Ecological zone fixed effect	Yes	Yes
Month of survey fixed effects	Yes	Yes
First stage		
Distance to the nearest bank(km)	−0.008***	−0.008***
	(0.002)	(0.002)
F-statistic	21.05	21.05
Observations	6902	6465

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$.

adequate observations for comparison among the 'nearby' financially excluded households based on the propensity score distribution. The results in Column 1 show that the average treatment effect on the treated (ATT) for the effect of FI on food insecurity ranges from −0.078 to −0.204. This implies that food insecurity levels experienced in financially included households are between 0.078 and 0.204 lower. In Columns 2 and 3, the ATT ranges from −0.103 to −0.239 and from −0.082 to −0.191, respectively. The PSM results are consistent with our 2SLS estimates which show that our main results are robust to alternative approaches used in resolving endogeneity. It also confirms that FI is an important policy option to explore in the fight against food insecurity.

Third, we use the household FI score, as an alternative measure, and analyze it along with all three measures of food insecurity and present the finding in Table 7. In Column 1, food insecurity is 5.408 lower in financially included households. Considering Columns 2 and 3, we find that FI is associated with 5.045 and 4.345 lower levels of food insecurity.

Fourth, we allocate alternative weights to the four dimensions of the FI index. For our main measure used in the analysis above, each dimension was given an equal weight of 0.25. At this stage, we generate four different versions of the FI index. For each version used in Table 8, we assign a relatively bigger weight to each of the four dimensions. In Panel A, we present findings for the FI index in which a weight of 0.4 is assigned to "bank account" while the other three dimensions are allocated an equal weight of 0.2. In Panel B, we use a FI index in which a weight of 0.4 is assigned to "access to credit" while the other three dimensions are allocated an equal weight of 0.2. In Panels C and D, the same steps are applied by assigning bigger weights of 0.4 to "insurance" and "remittance", respectively. The results reported in Table 8 are consistent with our baseline estimates, indicating that our findings are robust to alternative weighting schemes employed in calculating the FI index.

TABLE 10 Effect of entrepreneurship and asset accumulation

	Mediator: Entrepreneurship			Mediator: log(value of asset accumulated)		
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**FIES**	**FIES (Factor)**	**FIES (RS)**	**FIES**	**FIES (Factor)**	**FIES (RS)**
Panel A: Main results						
Financial Inclusion	−2.815***	−2.619***	−2.267***	−3.468***	−3.188***	−2.780***
	(0.685)	(0.671)	(0.564)	(1.050)	(1.004)	(0.856)
Entrepreneurship	−0.134***	−0.119***	−0.101***			
	(0.039)	(0.039)	(0.032)			
log(value of asset accumulated)				0.068	0.044	0.048
				(0.047)	(0.045)	(0.039)
All other control variables	Yes	Yes	Yes	Yes	Yes	Yes
Ecological zone fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Month of survey fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
First stage						
Distance to the nearest bank(km)	−0.008***	−0.008***	−0.008***	−0.008***	−0.008***	−0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
F-statistic	21.42	21.42	21.42	13.16	13.16	13.16
Observations	6901	6872	6901	6464	6444	6464
Panel B: Initial results for comparison						
Financial Inclusion (see Table 2)	−2.928***	−2.720***	−2.353***	−2.928***	−2.720***	−2.353***
	(0.715)	(0.698)	(0.586)	(0.715)	(0.698)	(0.586)

Note: Robust standard errors in parentheses.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
***$p < 0.01$.

5.4 | Potential pathway analyses

In this section, we explore the potential roles of entrepreneurship and asset accumulation as important pathways in the association between FI and food insecurity. To align with previous studies, we measure entrepreneurship using a binary variable to identify the self-employed (Nikolaev et al., 2020; Peprah et al., 2015). Asset accumulation is measured as the total monetary value of all durable assets (productive and nonproductive assets) owned by the household. To avoid bias in the estimation, we use the log value of the asset accumulated. Consistent with the literature, we use a two-staged method to analyze entrepreneurship and asset accumulation as potential pathways (Alesina & Zhuravskaya, 2011; Koomson & Awaworyi Churchill, 2021; Koomson & Danquah, 2021). In the first part, we assess whether FI is significantly linked to entrepreneurship and asset accumulation. In Columns 1 and 2 of Table 9, we see that FI

increases the probability of entrepreneurship and value of asset accumulation by 0.847 and 3.482, respectively, which is consistent with the literature (Daniels et al., 2016; Koomson & Ibrahim, 2018).

In step two, we separately include the entrepreneurship and asset accumulation variables as covariates in the food insecurity model and inspect how the coefficient responds. The variables are acknowledged as potential channels only if their inclusion in the model causes the previously obtained coefficient of FI to shrink in size or become statistically insignificant. Here, we use the standard 2SLS model, so the coefficient used for comparison is drawn from Table 2 and displayed in Panel B of Table 10. In Panel A of Table 10 (Columns 1 to 6), we see that the food insecurity-reducing effect of FI is consistently established at the 1% alpha level. Focusing on the mediators, we see in Columns 1 to 3 that entrepreneurship is associated with 0.134, 0.119 and 0.101 decreases in food insecurity, respectively. On the contrary, the results in Columns 4 to 6 show that the value of accumulated asset does not have a significant relationship with food insecurity.

Comparing the coefficients of FI in Panels A and B shows that the inclusion of entrepreneurship as a covariate in the food insecurity model results in a reduction in the magnitude of the coefficient of FI in Columns 1 to 3. For asset accumulation, not only is it not significantly associated with food insecurity, but its inclusion rather increased the magnitude of the coefficient of FI in Columns 4 to 6. From the two potential mediators explored in this paper, we only confirm entrepreneurship as an important pathway through which FI influences food insecurity. This could confirm the case that when households accrue resources through FI, they mainly invest in businesses to smoothing consumption over time, rather than using the financial resources accrued to accumulate durable assets in a bid to liquidate them in the future to buy food.

6 | CONCLUSION

Considering the current food insecurity rate, the global community is not on track to achieving the SDG2 target of zero hunger by 2030. The onset of the COVI-19 pandemic even threatens to push more people into hunger by 2030. Among the six broad key elements of a portfolio of policy measures and investments being considered by policymakers, financial inclusion (FI) has received little attention despite its potential to positively influence these policies, thereby reducing food insecurity. We fill an important gap in the literature by examining the link between FI and food insecurity. We achieve this objective by extracting data from round seven of the Ghana Living Standards Survey. FI is measured as a multidimensional index across four dimensions using the Alkire-Foster methodology, while food insecurity is obtained by employing the Rasch model, principal factor analysis, and an additive approach to the FIES. To ensure consistency in findings, we used different endogeneity-correcting methods in addition to the standard two-stage least squares in which distance to the nearest bank is employed as an instrument. Our findings show that FI has the potential to decrease food insecurity. This finding is robust to different conceptualisations of food insecurity, alternative weighting schemes, and cut-offs for the FI construct and different quasi-experimental methods. Based on subsamples, we find that FI is mainly effective in reducing food insecurity in male-headed and rural-located households but not in urban and female-headed homes. Finally, we find that entrepreneurship is an important pathway through which FI influences food insecurity.

As the world struggles to meet the SDG2 target of zero hunger, the findings of this paper show that FI can be used as an effective policy tool to reduce food insecurity not only in Ghana but in other developing countries with considerably low levels of FI. Apart from SDG 2, inferences can be drawn from the analyses in this study to cover other SDGs. For instance, FI's ability to enhance entrepreneurship means that it can be employed as a strategic policy to promote decent and productive employment (SDG 8). Revenues from entrepreneurship can provide households with the financial resources necessary to achieve SDG 1, which seeks to end poverty in all its forms. Also, increased savings and access to credit through FI can enhance households' ability to invest in good health and wellbeing (SDG 3) and spend on quality education for children (SDG 4).

Given that food insecurity is higher among rural households who are also known to experience higher levels of financial exclusion, the findings from this paper provides justification for carefully designed policies that can decrease distance to banks and increase the stock of loanable funds available to rural inhabitants. In the case of Ghana and some countries in the West African sub-region, male-headed households are known to be poorer, so finding that FI is more effective in reducing food insecurity for male-headed homes provides another justifiable basis to enhance efforts in shoring up FI in Ghana. It also implies that Ghana and other countries that have implemented national FI and development strategies will experience extended benefits of inching closer to achieving their SDG 2 target. It then makes it timely to encourage policymakers in developing economies to take critical steps in achieving universal financial access in their respective countries. Since entrepreneurship remains a sustainable pathway through which FI can enable households to build resilience against food insecurity, other policies that promote entrepreneurship are also worth promoting. Our study is limited by the number of potential channels that were empirically examined despite the several pathways discussed in the literature. We, therefore, entreat future researchers to empirically explore the other pathways based on contextual variables relevant in their countries of focus.

ACKNOWLEDGMENT

Open access publishing facilitated by The University of Queensland, as part of the Wiley - The University of Queensland agreement via the Council of Australian University Librarians.

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REFERENCES

Abosedra, S., Shahbaz, M. & Nawaz, K. (2016) Modelling causality between financial deepening and poverty reduction in Egypt. *Social Indicators Research*, 126(3), 955–969.

AFI. (2015) *2015 Maya declaration report: commitments into action*. Kuala Lumpur: Alliance for Financial Inclusion. Available at: http://www.afi-global.org/sites/default/files/publications/maya_report_2015-final.pdf

Alesina, A. & Zhuravskaya, E. (2011) Segregation and the quality of government in a cross section of countries. *American Economic Review*, 101(5), 1872–1911.

Alkire, S. & Foster, J. (2011) Counting and multidimensional poverty measurement. *Journal of Public Economics*, 95(7–8), 476–487.

Aryeetey, E. (2004) *Household asset choice among the rural poor in Ghana*. Accra, Ghana: Institute of Statistical, Social and Economic Research, University of Ghana. Available at: http://www.ircwash.org/sites/default/files/Aryeeta-2004-Household.pdf (Accessed: 30 May 2017)

Awaworyi Churchill, S. & Marisetty, V.B. (2020) Financial inclusion and poverty: a tale of forty-five thousand households. *Applied Economics*, 52, 1–12. Available from: https://doi.org/10.1080/00036846.2019.1678732

Ayantoke, K. (2010) Food insecurity dynamics and its correlates among rural households in South-Western Nigeria. *International Journal of Agricultural Economics and Rural Development*, 4(1), 43–55.

Ballard, T.J., Kepple, A.W. & Cafiero, C. (2013) *The food insecurity experience scale: development of a global standard for monitoring hunger worldwide*. Rom: Food and Agriculture Organisation. Available at: http://www.fao.org/3/a-as583e.pdf

Bartfeld, J. & Collins, J.M. (2017) Food insecurity, financial shocks, and financial coping strategies among households with elementary school children in Wisconsin. *Journal of Consumer Affairs*, 51(3), 519–548.

Birkenmaier, J., Huang, J. & Kim, Y. (2016) Food insecurity and financial access during an economic recession: evidence from the 2008 SIPP. *Journal of Poverty*, 20(2), 194–213.

Bubonya, M., Cobb-Clark, D.A. & Wooden, M. (2017) Mental health and productivity at work: does what you do matter? *Labour Economics*, 46, 150–165.

Cafiero, C., Viviani, S. & Nord, M. (2018) Food security measurement in a global context: the food insecurity experience scale. *Measurement*, 116, 146–152.

Carter, M.R., Janzen, S.A. & Stoeffler, Q. (2018) Can insurance help manage climate risk and food insecurity? Evidence from the pastoral regions of East Africa. In: *Climate Smart Agriculture*. Cham: Springer, pp. 201–225.

Daniels, C., Herrington, M. & Kew, P. (2016) *Global entrepreneurship monitor 2015/2016: Special report on entrepreneurial finance*. Global Entrepreneurship Research Association. Available at: https://www.gemconsortium.org (Accessed: 18 February 2019)

Dedehouanou, S.F.A. & Araar, A. (2020) Gender, entrepreneurship and food security in Niger. *Review of Development Economics*, 24(3), 815–830.

Demirgüç-Kunt, A., Beck, T. & Honohan, P. (2008) *Finance for all?: policies and pitfalls in expanding access*. DC: World Bank Washington.

Demirgüç-Kunt, A. & Klapper, L. (2012) Measuring financial inclusion: the global findex database. Available at: https://openknowledge.worldbank.org/handle/10986/6042 (Accessed: 21 May 2014)

Demirgüç-Kunt, A., Klapper, L.F., Singer, D. & Van Oudheusden, P. (2015) *The global findex database 2014: measuring financial inclusion around the world*. Washington, DC: The World Bank. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2594973 (Accessed: 29 May 2017)

Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S. & Hess, J. (2018) *The global findex database 2017: measuring financial inclusion and the Fintech revolution*. Washington, DC: The World Bank. Available at: http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf

Doss, C.R., Deere, C.D., Oduro, A.D., Swaminathan, H., Suchitra, J.Y., Lahoti, R., Baah-Boateng, W., Boakye-Yiadom, L., Contreras, J. & Twyman, J. (2011) The gender asset and wealth gaps: evidence from Ecuador, Ghana, and Karnataka, India. Available at: https://www.flacsoandes.edu.ec/web/imagesFTP/14916.CDL_IIMB_English_Comparitive_Brochure_FINAL.pdf

FAO. (2013) *The food insecurity experience scale—frequently asked questions (FAQs)*. Rom: Food and Agriculture Organisation. Available at: http://www.fao.org/in-action/voices-of-the-hungry/fies/en/

FAO, IFAD, UNICEF, WFP, & WHO. (2021) *The state of food security and nutrition in the world 2020: transforming food systems for affordable healthy diets*. Rome: Food and Agriculture Organisation. Available from: https://doi.org/10.4060/cb4474en

Fitzpatrick, K. (2017) Bank accounts, nonbank financial transaction products, and food insecurity among households with children. *Journal of Consumer Affairs*, 51(3), 631–658.

GSS. (2014) *Ghana living standards survey round 6 (GLSS 6): main report*. Accra: Ghana Statistical Service. Available at: http://www.statsghana.gov.gh/docfiles/glss6/GLSS6_Main%20Report.pdf

GSS. (2019) *Ghana living standards survey round 7 (GLSS 7): main report*. Accra: Ghana Statistical Service. Available at: https://www.statsghana.gov.gh/gssmain/fileUpload/pressrelease/GLSS7%20MAIN%20REPORT_FINAL.pdf

GSS. (2021) *Brief on COVID-19 households and jobs tracker wave 1 & 2*. Accra: Ghana Statistical Service. Available at: https://statsghana.gov.gh/covidtracker/HH_tracker_FIES_WAVE_one_and_two_14_04_2021.pdf

Gundersen, C. & Ziliak, J.P. (2015) Food insecurity and health outcomes. *Health Affairs*, 34(11), 1830–1839.

Heckman, J.J., Humphries, J.E. & Veramendi, G. (2018) Returns to education: the causal effects of education on earnings, health, and smoking. *Journal of Political Economy*, 126(S1), S197–S246.

Helmi, N.Z., Isa, K.A.M. & Masuri, M.G. (2020) Exploratory factor analysis on Food Insecurity Experience Scale (FIES): latest food insecurity measurement tool by FAO. In: *Healthscope: The Official Research Book of Faculty of Health Sciences*, Vol. 3. Shah Alam, Malaysia: UiTM. pp. 31–34.

Jalilian, H. & Kirkpatrick, C. (2002) Financial development and poverty reduction in developing countries. *International journal of finance & economics*, 7(2), 97–108.

Jiang, L., Tong, A., Hu, Z. & Wang, Y. (2019) The impact of the inclusive financial development index on farmer entrepreneurship. *PLoS One*, 14(5), e0216466.

Johnson, A.D. & Markowitz, A.J. (2018) Food insecurity and family well-being outcomes among households with young children. *The Journal of Pediatrics*, 196, 275–282.

King, R.G. & Levine, R. (1993) Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics*, 108(3), 717–737.

Koomson, I., Abdul-Mumuni, A. & Abbam, A. (2021) Effect of financial inclusion on out-of-pocket health expenditure: empirics from Ghana. *The European Journal of Health Economics*, 22, 1–15. Available from: https://doi.org/10.1007/s10198-021-01320-1

Koomson, I., Annim, S.K. & Peprah, J.A. (2016) Loan refusal, household income and savings in Ghana: a dominance analysis approach. *African Journal of Economic and Sustainable Development*, 5(2), 172–191. Available from: https://doi.org/10.1504/AJESD.2016.076095

Koomson, I. & Asongu, S.A. (2016) Relative contribution of child labour to household farm and non-farm income in Ghana: simulation with child's education. *African Development Review*, 28(1), 104–115.

Koomson, I. & Awaworyi Churchill, S. (2021) Ethnic diversity and food insecurity: evidence from Ghana. *The Journal of Development Studies*, 57, 1–15. Available from: https://doi.org/10.1080/00220388.2021.1928641

Koomson, I. & Danquah, M. (2021) Financial inclusion and energy poverty: empirical evidence from Ghana. *Energy Economics*, 94, 105085. Available from: https://doi.org/10.1016/j.eneco.2020.105085

Koomson, I. & Ibrahim, M. (2018) Financial inclusion and growth of non-farm enterprises in Ghana. In: *Financing Sustainable Development in Africa*. Springer, pp. 369–396. Available from: https://doi.org/10.1007/978-3-319-78843-2_14

Koomson, I., Martey, E. & Etwire, P.M. (2022) Mobile money and entrepreneurship in East Africa: the mediating roles of digital savings and access to digital credit. *Information Technology & People*. Available from: https://doi.org/10.1108/ITP-11-2021-0906

Koomson, I., Villano, R.A. & Hadley, D. (2020) Effect of financial inclusion on poverty and vulnerability to poverty: evidence using a multidimensional measure of financial inclusion. *Social Indicators Research*, 25(4), 375–387. Available from: https://doi.org/10.1007/s11205-019-02263-0

Koomson, I., Villano, R.A. & Hadley, D. (2022) The role of financial literacy in households' asset accumulation process: evidence from Ghana. *Review of Economics of the Household*, 1–24. Available from: https://doi.org/10.1007/s11150-022-09603-z

Lahai, J.I. & Koomson, I. (2020) *State fragility and resilience in sub-Saharan Africa: Indicators and interventions*. United Kingdom: Routledge. Available from: https://doi.org/10.4324/9780367853846

Lyons, A.C. & Hunt, J. (2003) The credit practices and financial education needs of community college students. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2265596 (Accessed: 30 May 2017)

Martey, E., Kuwornu, J.K. & Adjebeng-Danquah, J. (2019) Estimating the effect of mineral fertilizer use on land productivity and income: evidence from Ghana. *Land Use Policy*, 85, 463–475.

Mârza, B., Angelescu, C. & Tindeche, C. (2015) Agricultural insurances and food security. The new climate change challenges. *Procedia Economics and Finance*, 27, 594–599. Available from: https://doi.org/10.1016/S2212-5671(15)01038-2

Mishra, K. & Rampal, J. (2020) The COVID-19 pandemic and food insecurity: a viewpoint on India. *World Development*, 135, 105068.

Mishra, V. & Smyth, R. (2015) Estimating returns to schooling in urban China using conventional and heteroskedasticity-based instruments. *Economic Modelling*, 47, 166–173.

Mohammed, A.-R. (2021) Austerity is impeding children's education: a qualitative study of the associations of food insecurity and school engagement in Ghana. *Global Studies of Childhood*, 20436106211027350.

Mora-Rivera, J. & van Gameren, E. (2021) The impact of remittances on food insecurity: evidence from Mexico. *World Development*, 140, 105349.

Nikolaev, B., Shir, N. & Wiklund, J. (2020) Dispositional positive and negative affect and self-employment transitions: the mediating role of job satisfaction. *Entrepreneurship Theory and Practice*, 44(3), 451–474. Available from: https://doi.org/10.1177/1042258718818357

Peprah, J.A., Afoakwah, C. & Koomson, I. (2015) Savings, entrepreneurial trait and self-employment: evidence from selected Ghanaian universities. *Journal of Global Entrepreneurship Research*, 3(1), 1.

Peprah, J.A. & Koomson, I. (2015) Capital and credit sources and household non-farm income in Ghana. *Journal of Arts and Social Science*, 3(1), 74–97.

Peprah, J.A., Koomson, I., Sebu, J. & Bukari, C. (2020) Improving productivity among smallholder farmers in Ghana: does financial inclusion matter? *Agricultural Finance Review*, 81, 481–502. Available from: https://doi.org/10.1108/AFR-12-2019-0132

Perotti, R. (1993) Political equilibrium, income distribution, and growth. *The Review of Economic Studies*, 60(4), 755–776.

Rajan, R. & Zingales, L. (1998) Financial development and growth. *American Economic Review*, 88(3), 559–586.

Senadza, B. (2014) Income diversification strategies among rural households in developing countries: evidence from Ghana. *African Journal of Economic and Management Studies*, 5(1), 75–92.

Sinyolo, S. & Mudhara, M. (2018) The impact of entrepreneurial competencies on household food security among smallholder farmers in KwaZulu Natal, South Africa. *Ecology of Food and Nutrition*, 57(2), 71–93.

Smith, M.D. & Floro, M.S. (2021) The effects of domestic and international remittances on food insecurity in low-and middle-income countries. *The Journal of Development Studies*, 57(7), 1198–1220.

Sriram, U. & Tarasuk, V. (2016) Economic predictors of household food insecurity in Canadian metropolitan areas. *Journal of Hunger & Environmental Nutrition*, 11(1), 1–13.

Stock, J.H. & Yogo, M. (2002) *Testing for weak instruments in linear IV regression*. Cambridge, Massachusetts, United States: National Bureau of Economic Research. Available at: https://www.nber.org/papers/t0284.pdf

Tchetgen, E.T. (2014) A note on the control function approach with an instrumental variable and a binary outcome. *Epidemiologic Methods*, 3(1), 107–112.

Tu, S., Liew, D., Ademi, Z., Owen, A.J. & Zomer, E. (2020) The health and productivity burden of migraines in Australia. *Headache: The Journal of Head and Face Pain*, 60(10), 2291–2303.

Weaver, L.J., Owens, C., Tessema, F., Kebede, A. & Hadley, C. (2021) Unpacking the "black box" of global food insecurity and mental health. *Social Science & Medicine*, 282, 114042.

Wooldridge, J.M. (2008) Instrumental variables estimation of the average treatment effect in the correlated random coefficient model. In: Fomby, T. et al. (Eds.) *Modelling and evaluating treatment effects in econometrics*. Bingley: Emerald Group Publishing Limited, (Advances in Econometrics). pp. 93–116. Available from: https://doi.org/10.1016/S0731-9053(07)00004-7

Wooldridge, J.M. (2015) Control function methods in applied econometrics. *Journal of Human Resources*, 50(2), 420–445.

World Bank. (2001) *World development report 2000–2001: attacking poverty*. World Bank Group. New York: Oxford University Press. Available at: https://openknowledge.worldbank.org/handle/10986/11856

Zhang, Q. & Posso, A. (2017) Thinking inside the box: a closer look at financial inclusion and household income. *The Journal of Development Studies*, 55(7), 1616–1631.

How to cite this article: Koomson, I., Asongu, S. A., & Acheampong, A. O. (2023). Financial inclusion and food insecurity: Examining linkages and potential pathways. *Journal of Consumer Affairs*, *57*(1), 418–444. https://doi.org/10.1111/joca.12505

APPENDIX A: APPENDICES

TABLE A1 Questions used in the Food Insecurity Experience Scale (FIES)

	Indicators		Codes
	During *the last 12 months*:	Code/Acronym	Yes = 1 No = 2 Do not know = 8 Refused = 9
1	Was there a time when you or others in your household *worried about not having enough food to eat* because of a lack of money or other resources?	WANHEF	No = 0; Yes = 1 *[recoded as binary]*
2	Still thinking about the last 12 months, was there a time when you or others in your household *were unable to eat healthy and nutritious food* because of a lack of money or other resources?	UTEHANF	No = 0; Yes = 1 *[recoded as binary]*
3	Was there a time when you or others in your household *ate only a few kinds of foods because* of a lack of money or other resources?	OFKOF	No = 0; Yes = 1 *[recoded as binary]*
4	Was there a time when *you or others in your household had to skip a meal* because there was not enough money or other resources to get food?	SKIPMEAL	No = 0; Yes = 1 *[recoded as binary]*
5	Still thinking about the last 12 months, was there a time when *you or others in your household ate less than you thought you should* because of a lack of money or other resources?	LESSFOOD	No = 0; Yes = 1 *[recoded as binary]*
6	Was there a time when *your household ran out of food* because of a lack of money or other resources?	RANOUTFD	No = 0; Yes = 1 *[recoded as binary]*
7	Was there a time when *you or others in your household were hungry but did not eat* because there was not enough money or other resources for food?	HUNGRYBDNT	No = 0; Yes = 1 *[recoded as binary]*
8	Was there a time when *you or others in your household went without eating for a whole day* because of a lack of money or other resources?	WFOOD_1DAY	No = 0; Yes = 1 *[recoded as binary]*

Source: From the GLSS7 questionnaire.

TABLE A2 Estimated theta coefficients of the Rasch model

	Theta (difficulty parameter level) estimates	
FIES items	**Coef.**	**Std. Err.**
OFKOF	0.062***	(0.009)
WANHEF	0.082***	(0.009)
UTEHANF	0.158***	(0.009)
LESSFOOD	0.222***	(0.009)
SKIPMEAL	0.268***	(0.009)
RANOUTFD	0.420***	(0.009)
HUNGRYBDNT	0.651***	(0.010)
WFOOD_1DAY	1.374***	(0.016)
Observations	13,779	

Note: NB: Full names of codes/acronyms in legend can be found in Table A1.
Abbreviations: Coef., Coefficient; Std. Err., Standard error.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Authors' estimates from the GLSS7 data.

TABLE A3 Principal factor analysis of FIES items

Factor	Eigen value	Difference	Proportion	Cumulative
Factor1	4.919	4.557	1.000	1.000
Factor2	0.362	0.325	0.074	1.074
Factor3	0.038	0.070	0.008	1.082
Factor4	−0.033	0.030	−0.007	1.075
Factor5	−0.063	0.014	−0.013	1.062
Factor6	−0.076	0.007	−0.016	1.047
Factor7	−0.084	0.063	−0.017	1.030
Factor8	−0.146		−0.030	1.000
Kaiser-Meyer-Olkin (KMO)				0.930
Bartlett test of sphericity (Chi2)				81665.694***

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Authors' estimates from the GLSS7 data.

TABLE A4 Correlation matrix of food insecurity measures

Measures	FIES	FIES(Factor)	FIES(RS)
FIES	1.000		
FIES(Factor)	0.997	1.000	
	(0.000)		
FIES(RS)	1.000	0.998	1.000
	(0.000)	(0.000)	

Note: *P*-values in parenthesis.
Abbreviations: FIES, Food insecurity index from Rasch model; FIES(Factor), Food insecurity index from factor analysis; FIES(RS), Raw score (additive) of food insecurity.
Source: Authors' estimates from the GLSS7 data.

TABLE A5 Summary statistics

Variable	Details	Mean	*SD*
FIES	Food insecurity score obtained using the Rasch model	0.150	0.880
FIES(Factor)	Food insecurity measure obtained using principal factor analysis	0.004	0.968
FIES(RS)	Food insecurity score obtained by summing up all 8 items of the FIES scale	3.470	3.068
Financial inclusion (binary)	Dummy variable equals 1 if household financial deprivation score is less than 0.5	0.330	0.470
Financial inclusion score	Continuous variable for household multidimensional financial inclusion score	0.290	0.240
Age of head	Age of the household head	46.330	15.900
Female household head	Binary variable equals 1 if household head is female	0.310	0.460
Rural	Binary variable equals 1 if household is located in a rural area	0.570	0.490
Household size	Number of persons in the household	4.190	2.860
Household size squared	Number of persons in the household squared	25.720	38.850
Educated head	Binary variable equals 1 if household head is educated	0.460	0.500
Married	Binary variable equals 1 if household is married	0.550	0.500
Separated/Divorced/ Widowed	Binary variable equals 1 if household is separated/divorced/ widowed	0.230	0.420
Farm household	Binary variable equals 1 if household is involved in engaged in farming	0.580	0.490
Food price index	Continuous variable for food price index	0.930	0.060
Ethnic diversity	Ethnic diversity index at the district level (2010 PHC data)	0.720	0.140
Distance to the nearest bank	Average distance to the nearest bank measured in kilometers	12.290	6.000
Entrepreneurship	Binary variable equals 1 if household head is an entrepreneur	0.560	0.500
log(value of asset)	Log of household total value of asset	7.450	2.010

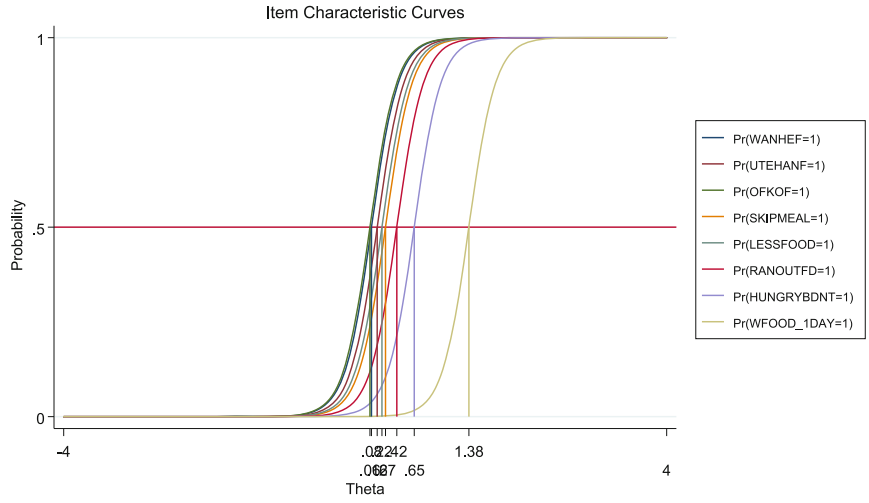

FIGURE A1 Item characteristics curves. NB: Full names of codes/acronyms in legend can be found in Table A1. *Source*: Authors' estimates from the GLSS7 data

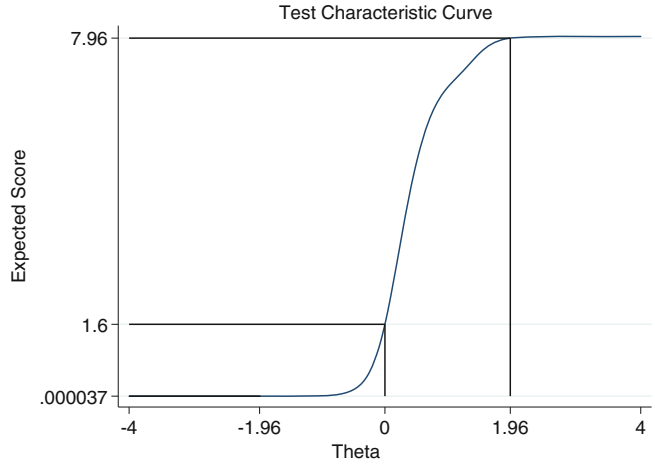

FIGURE A2 Test characteristics curve. *Source*: Authors' estimates from the GLSS7 data

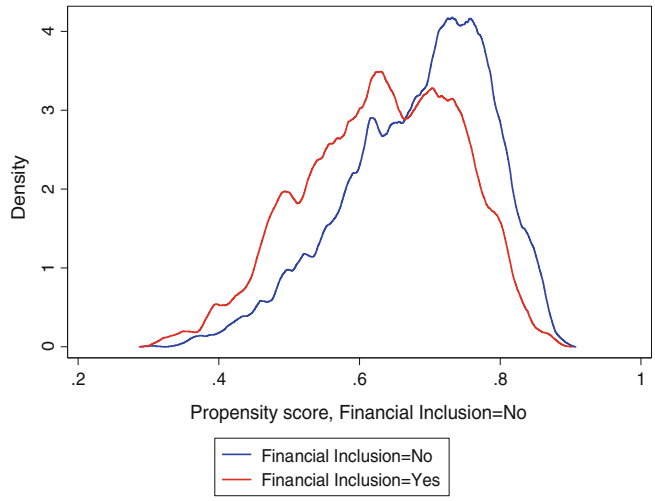

FIGURE A3 Region of common support for PSM