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RESEARCH ARTICLE

Working but hungry: precarious employment and household food insecurity in Ghana

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Abstract
Workers and food systems are integral to economic progress in Africa, where food insecurity is rising alongside exacerbating levels of precarious employment conditions. However, empirical literature remains scant on this relationship. This study examines the link between precarious employment and food insecurity in Ghana using the country's first Annual Household Income and Expenditure Panel Survey. Precarious employment is a multidimensional index of income inadequacy, employment insecurity, lack of rights and protection, and an unsafe or unhealthy work environment, whereas food insecurity is measured using the Food Insecurity Experience Scale. The main finding, adjusted for endogeneity, indicates that precarious employment increases household food insecurity, a finding that is robust to alternative measures of precarious employment and food insecurity. We further find that precarious employment increases food insecurity more among female-headed households in rural areas. Relatively, employment insecurity has the biggest effect in increasing food insecurity followed by lack of rights and protection, income inadequacy, and unsafe or unhealthy work environment. These findings further demonstrate that health shocks and household asset accumulation are important channels through which precarious employment affects food insecurity. We suggest policies to mitigate health shocks and bolster household asset accumulation among workers in precarious employment to safeguard household food security.

Keywords Precarious employment · Food insecurity · Rural · Gender · Ghana

JEL Classification I32 · I38 · J21 · O55

1 Introduction

Despite the worldwide pledge to realize Sustainable Development Goal 2 (SDG2) of eradicating hunger by 2030, the path to achieving food security remains a paramount developmental challenge globally (FAO et al. 2023). In 2022, a projected 735

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million people globally faced hunger, reflecting a 122 million increase from 2019 (FAO et al. 2023). While significant progress was made towards decreasing hunger in Latin America and Asia, hunger rates continued to rise in Africa (FAO et al. 2023). In Africa, approximately 24 percent of the total population is currently facing severe food insecurity, and 60.9 percent face either moderate or severe food insecurity (FAO et al. 2023). Projections indicate a significant increase in hunger across the continent by 2030, with nearly 600 million people expected to be chronically malnourished, stressing the formidable challenge of meeting the SDG target to eliminate hunger (GRFC 2023).

Several studies have identified numerous factors that affect food (in)security, including safety-net programs (Singleton 2023; Rizvi et al. 2021; Gundersen et al. 2019), remittances (Smith and Floro 2021; Mora-Rivera and van Gameren 2021), conflict (Muriuki et al. 2023), climate change (Bedasa and Bedemo 2023; Kralovec 2020), poverty and income inequality (Debebe and Zekarias 2020), ethnic diversity (Koomson and Churchill 2021; Akay et al. 2017), COVID-19 (Cardarelli et al. 2021; Almohamad et al. 2020), public transportation accessibility (Baek 2016), housing instability (Yousefi-Rizi et al. 2021), crime (Kaila and Azad 2023), paid family leave (Lenhart 2021), access to ICT (Oluwatayo and Ojo 2019), social cohesion (Denney et al. 2017), financial inclusion (Koomson et al. 2023; Gajdaand Jezewska-Zychowicz 2021), employment status and policies (Santos et al. 2022; Loopstra and Tarasuk 2013), wage-setting policies (Reeves et al. 2021), formal/ informal employment (Vu and Rammohan 2022; Blekking et al. 2020) and unemployment (Milovanska-Farrington 2022; Etana and Tolossa 2017). Despite the burgeoning literature that investigates the determinants of food insecurity, relatively less is known about the effects of precarious employment on food insecurity within the context of a developing country. The limited evidence may stem from several factors. Key among them is the lack of comprehensive data, especially in developing nations where data collection processes may be less robust, which could impede research on precarious employment and its repercussions on food (in)security. Moreover, the complexity of the issue poses a formidable challenge, as precarious employment's effects are often intricately intertwined with various structural conditions, such as access to basic services and social safety nets and other socio-economic factors, making it difficult to disentangle its specific impact from these interconnected variables.

Given this backdrop, our study aims to investigate the effect of precarious employment on household food insecurity. Precarious employment describes a work characterized by low wages, job insecurity, lack of social security, limited or no job benefits, absence of protection against dismissals, insufficient health and safety provisions, and absence of trade union representation (International Labour Organisation 2012). Traditional full-time, permanent employment arrangements have become less common. Instead, there has been a rise in temporary, part-time, and contract-based work through employment agencies. Moreover, in developing nations, a substantial portion of the workforce operates in the informal economy, outside legal regulations and without access to social security benefits (Duman 2024). This type of employment has far-reaching consequences beyond the workplace that significantly impact workers' ability to support their households (Birnbaum and De Wispelaere 2021; Kalleberg 2011). As households progressively depend more on

purchased food, income from employment has become increasingly crucial (Blekking et al. 2020; Rahman and Mishra 2020). A higher household income not only enhances the ability to afford food but also enables capital accumulation and reinvestment into agricultural production activities (Yazdanpanah et al. 2021). However, workers in precarious jobs frequently earn unreliable, low incomes with irregular schedules, making it difficult for them to consistently afford nutritious food. Furthermore, without benefits like paid leave, income is lost due to health shocks or family responsibilities, increasing household vulnerability. The financial instability caused by precarious work ultimately limits workers' ability to consistently provide their households with an adequate, healthy diet (Kalleberg 2011).

Our study makes several significant contributions to the existing literature on the relationship between precarious employment and food insecurity, particularly within the context of a developing country. First, we develop a multidimensional index of precarious employment that encompasses four key dimensions: inadequate income, employment insecurity, unsafe or unhealthy work environments, and lack of rights and protection. This comprehensive approach extends beyond the common focus on just income, job security, and lack of legal rights observed in previous studies (see Nkansah 2023; Koomson and Churchill 2022; González et al. 2021). By including the crucial aspect of unsafe or unhealthy work environment, our index provides a more holistic assessment of the various facets of precarious work and their implications for the well-being of workers and their households. Existing research have shown that exposure to hazardous working conditions can not only negatively impact physical health, but also increase stress and anxiety levels, leading to financial strain and difficulties in securing adequate and nutritious food (Burgard and Lin 2013; Sparks et al. 2001). This comprehensive approach responds to calls in the literature for a deeper understanding of the multidimensional nature of precarious employment and its nuanced impacts on household well-being, including food security (Kalleberg, 2011; Coleman-Jensen et al. 2011).

Second, we examine the disaggregated effects of these distinct dimensions of precarious employment on food insecurity. Employing dominance analysis, we are able to assess the relative importance of each aspect, providing deeper insights into the mechanisms through which the different facets of precarious work influence a household's ability to access adequate and nutritious food. This heterogeneous analysis is crucial, as previous empirical studies have highlighted the need to examine the nuanced impacts of the various components of precarious employment, as they may have varying effects on household well-being (Kalleberg, 2011; Coleman-Jensen et al. 2011). While inadequate income and employment insecurity may directly affect a household's purchasing power for food, aspects like lack of rights and protection, and unsafe or unhealthy work environment can indirectly contribute to food insecurity by exacerbating financial strain, reducing productivity, and increasing health-related expenses. Third, we address endogeneity concerns associated with precarious employment by utilising the level of neighbourhood precarious employment (PEWN) as an instrument in a two-stage least squares (2SLS) regression. This instrument captures the density of precarious workers within a household's neighbourhood and highlights the household's proclivity towards precarious related jobs

(Immergluck 1998). Residents are also more exposed to precarious work through job-related social networks within their communities (Hopkins 2016).

As a fourth contribution, we augment the AHIES household survey data with rich and important administrative data collected at the district level. These district-level data provide valuable contextual information and structural conditions that complement the household-level survey data, allowing us to examine the potential influence of the broader geographic and community-level factors on household food security. Specifically, the administrative data include the share of a district's housing density, the number of basic schools in a district, and district electricity access, which were obtained from the 2021 Population and Housing Census conducted by the Ghana Statistical Service (2021). Integrating these administrative data with the AHIES household survey is a crucial component of our study, as it allows us to capture the complex interplay between individual, household, and contextual determinants of food insecurity to ensure internal consistency of our food insecurity models. Moreover, integrating administrative data in our analyses overcomes the sole reliance on self-reported information from households, and as such strengthens the validity of our outcomes (Ravallion 2020).

Finally, we investigate the role of health shock and household asset accumulation as potential pathways through which precarious employment influences food insecurity. Health shocks can act as an important channel through which precarious employment affects household food insecurity. Workers in precarious arrangements frequently lack provisions like paid sick leave, health insurance or job protections (Matilla-Santander et al. 2020). As a result, unexpected illness or injury can severely burden these households financially. Also, without savings or social protections as a buffer, out-of-pocket medical costs arising from health issues may force sacrificing food purchases or nutrition quality. On the other hand, precarious employment may also lower household asset accumulation. With irregular or insufficient wages, precariously employed households have limited resources available to save and build up assets. Lower asset accumulation, in turn, worsens household food insecurity, as these households lack the financial cushion to withstand shocks and ensure stable access to adequate and nutritious foods. Hence, our potential channel analyses test two main hypotheses: (1) precarious employment engenders health shocks among workers, and such health shocks tend to increase household food insecurity, and (2) precarious employment lowers asset accumulation, and lower asset accumulation worsens household food insecurity.

Our study found that higher levels of precarious employment are linked with increased food insecurity. The results indicate that precarious employment increases food insecurity more among female and rural workers compared to male and urban workers. Further, relative importance of various precariousness dimensions was found to have an increasing effect on food insecurity. The dominance analysis also showed that employment insecurity is the most important predictor of food insecurity, followed by lack of rights and protection, income inadequacy, and unsafe or unhealthy work environment. Importantly, the analysis across the location-gender divide revealed that the detrimental impact of precarious employment on food insecurity is most pronounced for rural female-headed households. The study identifies

health shocks and household asset accumulation as critical channels through which precarious employment affects food insecurity.

Ghana serves as a compelling case to unravel this relationship for several reasons. Despite the agricultural industry being the second-largest contributor to the country's GDP, Ghana continues to suffer food insecurity concerns. In 2016/2017, the rate of food insecurity was 50%, which reduced to 47.7% in June 2020 and 47.0 percent in September 2020. (Ghana Statistical Service 2018). In the first quarter of 2022, over half of the population (49.1%, or 15.1 million people) were food insecure, a figure that fell to 13.0 million (42.1%) in the second quarter (Ghana Statistical Service 2022). In the first quarter of 2022, almost half of the population (15.1 million people) faced food insecurity, which is higher in rural areas (Ghana Statistical Service 2023). Second, Ghana's workforce faces significant challenges, including underemployment, job insecurity, low wages, limited workplace rights, and a lack of social protection (Baffour and Abbey 2023; Benach et al. 2014). In 2022, almost two-thirds of Ghana's working population is in vulnerable employment, with 23.6 percentage points higher in rural areas compared to urban centres (Ghana Statistical Service 2023). In the second quarter of 2022, 445,000 new individuals were joining the ranks of the unemployed, while 850,000 previously employed individuals became unemployed. Additionally, approximately 380,000 people aged 15 and above in the labour force experienced challenges of food insecurity, multidimensional poverty, and unemployment (Ghana Statistical Service 2023).

The following parts comprise the remainder of this research paper: Sect. 2 looks further into the conceptual linkage between precarious employment and food insecurity. Section 3 describes the analytical methodologies used. The results are presented in Sect. 4, and the conclusion and policy implications are presented in Sect. 5.

2 Conceptual link between precarious employment and food insecurity

The link between precarious employment and household food insecurity can be direct or indirect (see Fig. 1). The direct link between precarious employment and household food insecurity stems from the limited income associated with such work arrangements. Precarious employment, characterized by informal, temporary, or nonstandard work arrangements, often results in lower wages, irregular incomes, and a lack of job security. This income instability and insufficiency directly constrain the resources available for households to spend on food, thereby increasing their vulnerability to food insecurity (Loopstra and Tarasuk 2013). Precarious jobs are highly associated with lower household incomes, irregular pay, and few protections that compromise stable finances (Koomson and Churchill 2022; Albiston and Fisk 2021). With limited and unpredictable financial means, households engaged in precarious employment face challenges in affording adequate, nutritious food and maintaining a consistent level of food access (Han and Hart, 2021). Indirectly, precarious employment can influence

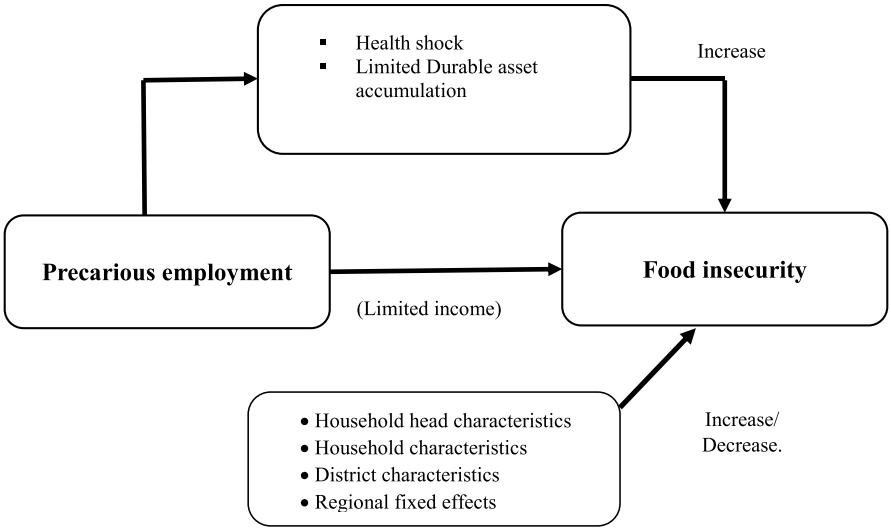

Fig. 1 Conceptual link between health shock, asset accumulation and food insecurity Source: Authors' construct

household food insecurity through several channels. In the subsections below, we discuss health shock, durable asset accumulation, and other channels.

2.1 Health shock

Precarious employment significantly causes household food insecurity by disrupting income stability due to irregular and low earnings (Fernandes 2023; Lewchuk 2016). In Ghana, families reliant on precarious work often struggle to maintain a steady income, making it challenging to afford a sufficient diet and consistent access to food, making such households more food insecure. Meanwhile, precarious employment can worsen food insecurity through health shocks. The absence of health insurance coverage, particularly prevalent among precarious workers, leaves households financially vulnerable to unexpected medical expenses (Ghana Statistical Service 2023). When faced with illness or injury, households must cover medical costs, primarily relying on resources from within the household itself (Ghana Statistical Service 2018). This financial strain diminishes families' ability to purchase food, leading to food insecurity. Additionally, disruptions to work and earnings during health crises further compound the issue, as the loss of income emanating from higher health expenses during recovery periods leaves households unable to afford essential food items (García-Gómez et al. 2013). Consequently, as health deteriorates and medical

expenses accumulate, households experience a cycle of worsening food insecurity alongside declining health.

2.2 Durable asset accumulation

Precarious employment can have a detrimental impact on household food security by constraining the household's ability to accumulate durable assets. Asset accumulation has been identified as a sustainable means of consumption smoothing, as households with individuals in stable employment can build up savings and invest in assets that can be used for food consumption during times of economic hardship (Bartfeld and Collins 2017; Doss et al. 2011; Aryeetey 2004). However, individuals in precarious work arrangements often lack the financial resources and stability needed to accumulate these productive and non-productive durable assets (Jalilian and Kirkpatrick 2002). In developing countries like Ghana, where a significant proportion of the working population is categorized as 'working poor', households often lack the resources and financial stability needed to accumulate tangible durable assets, which serve as a crucial risk-coping mechanism that can be sold for cash to meet food consumption needs during hardship (Doss et al. 2011; Aryeetey 2004). The financial constraints faced by working poor households engaged in precarious employment limit their ability to build up these types of assets, undermining their capacity to smoothen consumption and maintain food security. Moreover, the inability of precarious workers to accumulate durable assets also restricts the household's ability to diversify its income portfolio, reducing the overall income available for food consumption (Kofinti et al. 2023; Senadza 2014).

2.3 Other channels

Precarious employment can impact household food insecurity in Ghana through multiple pathways beyond the constraint of durable asset accumulation. One additional channel is impeding the ability of these households to engage in entrepreneurial activities. The instability and lack of financial resources associated with precarious work arrangements provide little opportunity for workers to save surplus income or start small businesses that could generate stable alternative sources of revenue (Conen and Schippers, 2019). This, in turn, limits the household's capacity to diversify its income streams and improve its overall food security. Furthermore, the precariousness of employment and low wages can induce these households to take on debt to cover basic needs, such as purchasing groceries (Baey and Yeoh 2015). Sustained debt obligations over the long run can exacerbate the household's financial insecurity (Elliot and Lindblom 2019) and further threaten its ability to afford healthy and nutritious diets (Brewer 2020). This over-indebtedness pathway can trap precarious worker households in a cycle of food insecurity, as the need for service debt payments reduces the resources available for food consumption.

3 Data and variables

The research used panel data from Ghana's Annual Household Income and Expenditure Survey (AHIES). The AHIES household panel survey is Ghana's first representative sample household panel survey. This survey collects comprehensive information on household expenditure, income, and living conditions at both the national and regional levels. Its primary objective is to facilitate evidence-based decision-making for development by gathering data on household consumption expenditure, demographics, economics, employment, and welfare indicators. AHIES contributes to various Sustainable Development Goals (SDGs) and provides disaggregated data for diverse targets such as labour statistics, food insecurity, multidimensional poverty, and health status. For this study, we analysed the first two quarters of data of the Annual Household Income and Expenditure Survey of 2023 (that is waves 1 and 2). As shown in Fig. 2, wave 1 included 10,761 households while wave 2 had 10,628 households, comprising a total sample of 21,389 households across the two waves, with a balanced panel of 21,240 households. To arrive at the analytical sample, we first restricted the sample to working individuals aged 18–60 who reported working at least 7 days in the survey reference week. This reduced the sample to 17,232 households across the two waves. We then merged the datasets using unique household identifiers. Observations with missing data on key variables were dropped. This resulted in a final sample 15,596 households. Appendix A1 presents the descriptive statistics of variables used in our estimation.

3.1 Household food insecurity

In this study, food insecurity is measured using the Rasch model applied to a standardized set of eight basic Yes/No questions (where "Yes" is coded as 1 and "No" as 0, as shown in Appendix Table S1). Based on these questions, the Food Insecurity Experience Scale (FIES) which has been extensively embraced in the literature as an objective assessment of households' food insecurity was used (Koomson and

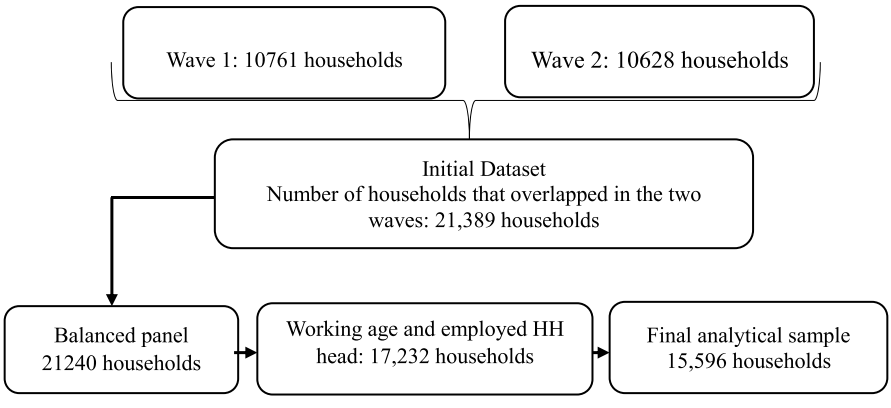

Fig. 2 Sample selection process

Churchill 2021; Cafiero et al. 2018; FAO 2013). Household food insecurity is measured using a model developed by Rasch that is based on the one-parameter logistic model. Equation (1) describes the Rasch model formula:

$$P_{ij} = P\left(X_{ij} = 1|\omega_j, \beta_i\right) = \frac{\exp\left(\vartheta_j - \beta_i\right)}{1 + \exp\left(\vartheta_j - \beta_i\right)} \tag{1}$$

where, X_{ij} to the probability that household i gives affirmative response to FIES item j. The level of difficulty or severity component of the FIES items is expressed by β_i, while ϑ_j reflects an individual's capacity to accurately reply to the FIES question and shows the extent of food insecurity within the household. If β remains constant and ϑ increases, food insecurity is more likely (Koomson and Churchill 2021). The total food insecurity score goes from 0 to 1, with a higher value indicating greater food insecurity. In addition, the study incorporated established measures of food insecurity in addition to Rasch's modelling of the FIES, including the multidimensional index, principal component analysis, and raw score (additive index). This allowed the researchers to validate the Rasch results by comparing them to other measures, providing a more robust assessment by leveraging each technique's strengths (Koomson et al. 2023). These multiple measures from the FIES engender a more comprehensive cardinal and ordinal insights into the nature, prevalence, and impact of food insecurity.

3.2 Precarious employment

In this study, we adapt the precarious employment measurement using the most current conceptualization of precarity as a multidimensional construct (Fernandes 2023; González et al. 2021; García-Pérez et al. 2017). Our multidimensional measure incorporates employment categorization and summarises precariousness features of various types of work that imply high levels of precarity (Baek et al. 2023; Burgess and Campbell 1998). Four dimensions (see Table S2) are considered in this study: (i) income inadequacy, (ii) employment insecurity, (iii) lack of rights and protection and (iv) unsafe or unhealthy work environment (González et al. 2021; Rönnblad et al. 2019; García-Pérez et al. 2017). To signify precarity or deprivation, each dimension is represented as a binary variable ("No" = 0; "Yes" = 1). Following Alkire and Foster's (2011) technique, we gave equal weight (1/4) to each category and computed a multidimensional precarious employment score (González et al. 2021; García-Pérez et al. 2017). As a result, a rise in the precarity score suggests a greater intensity of precarious employment.

$$PE_i = w_1 I_{1i} + w_2 I_{2i} + w_3 I_{3i} + \ldots + w_d I_{di} \tag{2}$$

where PE_i denote a household precarious employment score, I_{di}= 1 if household i is deprived in indicator d (and I_{di}= 0 otherwise) and w_d is the weight associated with indicator i with $\sum_{d=1}^{D} w_d = 1$.

We use a dual threshold technique and set the cut-off at 0.5, as in prior research (Nkansah 2023; Koomson and Churchill 2022). This implies that if a household's

precarity score exceeds 0.5, we give a value of 1 to represent more precarity; otherwise, we assign a value of 0. While the precarity score is our main analytical metric, we also use a binary version for robustness tests and other weighting and cut-off as a sensitivity analyses.

4 Empirical strategy

In this facet, we outline the empirical model that examines the relationship between precarious employment (PE) and food insecurity in Ghana. Specifically, we specify the household demand function for PE as follows:

$$FII = H(PE, Z) \tag{3}$$

where *FII* is the food insecurity level for the household, *PE* is the precarious employment status of a household, and *Z* compresses the household head characteristics, household variables, district variables and ecological zone. These variables include gender, age, education level, marital status, household size, dependents, safety net program, sector of employment, location, ecological zones, farm households, basic schools in a district, share of a district's housing density, and district electricity access. Based on Eq. 3, the explicit econometric model that can be estimated is expressed as follows:

$$FII_{it} = \alpha + \gamma \widehat{PE}_{it} + \eta Z_{it} + \psi_p + \mu_t + \nu_{it} \tag{4}$$

Aside *FII, PE* and *Z* that is explained above, *i* and *t* denote specific household and time respectively. Furthermore, the model accounts for fixed effects, including ψ_p representing ecological zone fixed effects and μ_t representing month-fixed effects. The random error term is denoted as ν.

4.1 Estimation strategy

The data has a panel structure with quarterly household observations. However, a pooled OLS is appropriate because key explanatory variables exhibit little variation over short periods. Precarious employment is measured at the household level and inspection found no substantial changes quarter-to-quarter. Other covariates like demographics, location, and education are also predominantly time-invariant. As the model identifies cross-sectional rather than within-household relationships over a quarter, fixed or random effects models may not meaningfully improve pooled OLS efficiency. Based on this, we utilise the ordinary least squares (OLS) to estimate empirical model 4 as our baseline model. In line with the existing studies on the effect of precarious employment on wellbeing. We acknowledge the presence of an endogeneity problem linked with precarious employment (Nkansah, 2023; Koomson and Churchill 2022). We suspect potential endogeneity between PE and food insecurity linkage due to possible bi-directional causality. Precarious working conditions frequently result in households having limited financial resources, thereby

reducing their ability to afford food and increasing food insecurity. Simultaneously, inadequate resources for food expenses can drive household heads to accept precarious employment or take on multiple jobs to secure sufficient income for their basic needs, including food (Nunoo et al. 2018).

We remedy the potential endogeneity using the Two Stage Least Square (2SLS) instrumental variable approach as specified in Eqs. (5) and (6):

The Eq. (5) specifies the reduced form equation in stage 1:

$$PE_{it} = \psi + \phi PEWN_{it} + \beta X_{it} + \gamma_{jt} + \vartheta_{it} + \varepsilon_{it} \tag{5}$$

whereas Eq. (6) specifies the structural equation in stage 2 as:

$$FII_{it} = \beta_0 + \beta_1 \widehat{PE}_{it} + \beta_2 X_{it} + \gamma_{jt} + \vartheta_{it} + \varepsilon_{it} \tag{6}$$

The variables in Eqs. (3) and (4) are as explained in Eq. (5) except for the Precarious neighbourhood employment (PEWN) which denotes neighbourhood precarious employment. In Eq. (5), PEWN is used as an instrument for PE. The validity of the instrument is based on the expectation that neighbourhood precarious employment is directly related to precarious employment experienced. On the contrary, higher neighbourhood precarious employment is associated with a greater acceptance of precarious employment conditions (Hopkins 2016). However, the study does not anticipate a direct influence of neighbourhood precarious employment on food insecurity status unless it operates indirectly through precarious employment. Besides the instrumental variable, we have leveraged our results with two additional quasi-experimental approaches using the propensity score matching technique, kinky regression and Lewbel's (2012) heteroscedastic-adjusted instrument method. Whereas the former has the potency of further resolving endogeneity and sample selectivity concerns, as shown in previous studies (Essel-Gaisey et al. 2023; Koomson and Churchill 2022), the latter has demonstrated consistent estimates by combining both internal and external instruments to address endogeneity (Kofinti et al. 2023).

4.2 Potential pathway analysis

This study aims to investigate the link between precarious employment and food insecurity, focusing on the role of health shock and asset accumulation as potential pathways. This study used a two-step approach to examine how precarious employment, health shock and asset accumulation interact to affect food insecurity. Consequently, in the first step, a significant link is established between precarious employment, health shock (*shck*) and asset accumulation (*asset*).

$$FII_{it} = \alpha + \gamma PE_{it} + shck_{it} + \eta Z_{it} + \psi_p + \mu_t + \nu_{it} \tag{7}$$

$$FII_{it} = \alpha + \gamma PE_{it} + \propto asset_{it} + \eta Z_{it} + \psi_p + \mu_t + \nu_{it} \tag{8}$$

In the next stage, the health shock and assets accumulation variables were added separately as covariates in the food insecurity model (Eqs. 7 and 8) to assess their impact on the coefficient of precarious employment. This study provides valued intuitions into how health shock and asset accumulation may help explain the link between precarious employment and food insecurity.

5 Summary statistics

The summary statistics are presented in Table 11 in the Appendix. The first two columns show the statistics for the entire sample, whereas the remaining columns, 3 and 4, and 5 and 6 show the statistics for waves 1 and 2 respectively. The statistics show that, on average, households reported a moderate mean FIES score of 0.030, with around 50% of households classified as food insecure. Almost two-thirds of sampled household heads were in PE. The data shows that the average age of the household head is 41.032 years, with 28.7% being female-headed; 25.8% of household heads have no formal education, while 9.3% have tertiary education. The average household size is 5.280, with 50.4% of households located in rural areas; 75.9% of household heads are married, and the average number of dependents is 2.586. Most household heads are employed in the agricultural sector (45.8%), and 76.3% are covered by the safety net program (national health insurance scheme), while 48.1% of households are involved in farming, and 19.7% have disabled household members. The mean asset accumulation index is 0.485, and the multidimensional precarity sub-indices range from 0.484 for unsafe or unhealthy work environment to 0.927 for lack of rights and protections.

6 Main results and discussions

6.1 Baseline results

Table 1 presents the baseline estimates for the relationship between precarious employment (PE) and food insecurity. The estimates for various measures of food insecurity, namely FIES, FIES (MPI), FIES (RS), and FIES (PCA), are reported in Columns 1 to 4, respectively. Standardised coefficients are interpreted because they allow for easy comparison between various estimates of both PE and food insecurity. In Column 1, we observe that a one standard deviation increase in PE corresponds to a 0.067 standard deviation increase in household food insecurity. Similarly, Columns 2, 3, and 4 show one standard deviation increase in PE is associated with 0.064, 0.060 and 0.064 standard deviations increase in household food insecurity, respectively. These findings suggest that households become more vulnerable to inadequate access to nutritious food when the job of the primary wage earner is unstable and lacks protections, making it difficult to reliably budget for basic nutritional needs. It is worth noting that these results align with previous studies that have also demonstrated the adverse impact of PE conditions on household welfare

Table 1 Effect of precarious employment on food insecurity (OLS results)

Variables	(1) FIES	(2) FIES (MPI)	(3) FIES (PCA)	(4) FIES (RS)
PE	0.031***	0.012***	0.031***	0.094***
	(0.004)	(0.002)	(0.005)	(0.014)
	[0.067]	[0.064]	[0.060]	[0.064]
Age of head	−0.004***	−0.002***	−0.003***	−0.014***
	(0.001)	(0.000)	(0.001)	(0.002)
	[−0.065]	[−0.064]	[−0.044]	[−0.064]
Head is female	0.115***	0.047***	0.113***	0.380***
	(0.020)	(0.008)	(0.023)	(0.066)
	[0.059]	[0.060]	[0.051]	[0.060]
Primary	−0.030	−0.013	−0.040	−0.104
	(0.024)	(0.010)	(0.027)	(0.078)
	[−0.012]	[−0.013]	[−0.015]	[−0.013]
JHS/Middle	−0.112***	−0.044***	−0.108***	−0.349***
	(0.022)	(0.009)	(0.025)	(0.071)
	[−0.059]	[−0.057]	[−0.051]	[−0.057]
Secondary/MSE	−0.251***	−0.101***	−0.239***	−0.808***
	(0.027)	(0.011)	(0.030)	(0.086)
	[−0.104]	[−0.103]	[−0.088]	[−0.103]
Tertiary	−0.547***	−0.217***	−0.526***	−1.735***
	(0.032)	(0.013)	(0.037)	(0.101)
	[−0.179]	[−0.175]	[−0.152]	[−0.175]
Rural household	0.179***	0.072***	0.146***	0.575***
	(0.017)	(0.007)	(0.019)	(0.055)
	[0.101]	[0.100]	0.073	[0.100]
Household size	0.043***	0.018***	0.037***	0.146***
	(0.011)	(0.004)	(0.011)	(0.034)
	[0.138]	[0.145]	[0.105]	[0.145]
Household size squared	−0.003***	−0.001***	−0.003***	−0.009***
	(0.001)	(0.000)	(0.001)	(0.002)
	[−0.132]	[−0.133]	[−0.124]	[−0.133]
Married	−0.060*	−0.029**	−0.046	−0.235**
	(0.034)	(0.013)	(0.037)	(0.107)
	[−0.029]	[−0.035]	[−0.020]	[−0.035]
Separated	0.029	0.007	0.047	0.059
	(0.038)	(0.015)	(0.041)	(0.120)
	[0.012]	[0.008]	[0.018]	[0.008]
Dependents	0.023***	0.009***	0.033***	0.071***
	(0.008)	(0.003)	(0.008)	(0.024)
	[0.052]	[0.050]	[0.067]	[0.050]
Social safety net program (SP)	−0.051***	−0.019***	−0.038*	−0.155***
	(0.018)	(0.007)	(0.020)	(0.058)
	[−0.025]	[−0.023]	[−0.016]	−0.023

Table 1 (continued)

Variables	(1) FIES	(2) FIES (MPI)	(3) FIES (PCA)	(4) FIES (RS)
Industry	0.013	0.006	−0.020	[0.044]
	(0.025)	(0.010)	(0.028)	(0.081)
	[0.005]	[0.005]	[−0.007]	[0.005]
Service	−0.053***	−0.022***	−0.068***	−0.177***
	(0.020)	(0.008)	(0.023)	(0.065)
	[−0.029]	[−0.030]	[−0.033]	[−0.030]
Savannah	0.309***	0.119***	0.249***	0.954***
	(0.035)	(0.014)	(0.040)	(0.114)
	[0.161]	[0.153]	[0.115]	[0.153]
Coastal	0.250***	0.096***	0.234***	0.771***
	(0.032)	(0.013)	(0.037)	(0.103)
	[0.125]	[0.120]	[0.104]	[0.120]
Forest	0.136***	0.050***	0.137***	0.403***
	(0.032)	(0.013)	(0.037)	(0.104)
	[0.072]	[0.066]	[0.065]	[0.066]
Farm household	−0.136***	−0.055***	−0.098***	−0.443***
	(0.015)	(0.006)	(0.017)	(0.049)
	[−0.076]	[−0.077]	[−0.049]	[−0.077]
Households with disable worker	0.107***	0.041***	0.116***	0.324***
	(0.019)	(0.008)	(0.022)	(0.063)
	[0.048]	[0.045]	[0.046]	[0.045]
Number of basic schools per district	−0.025***	−0.009***	0.004	−0.076***
	(0.008)	(0.003)	(0.009)	(0.027)
	−0.035	[−0.032]	[0.005]	[−0.032]
Share of district's housing density	0.409***	0.161***	0.181***	1.284***
	(0.057)	(0.023)	(0.059)	(0.181)
	[0.231]	[0.224]	[0.091]	[0.224]
District access to electricity	−0.297***	−0.116***	−0.112**	−0.929***
	(0.048)	(0.019)	(0.048)	(0.149)
	[−0.215]	[−0.208]	[−0.072]	[−0.208]
Constant	−1.216***	−0.029	−0.996***	−0.229
	(0.175)	(0.070)	(0.201)	(0.564)
Month of survey FE	Yes	Yes	Yes	Yes
Observations	15,596	15,596	15,596	15,596
R-squared	0.137	0.145	0.093	0.145
F-statistics	100.9	114.6	66.57	114.6

Robust standard errors in parentheses; sex (base: male). education level (base: illiterate), marital status (base: never married), sector of employment (base: agriculture), ecological zone (base: Greater Accra),. Standardised coefficients in square bracket

FE, fixed effect

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

(Nor 2022; Koomson and Churchill 2022; Albiston and Fisk 2021; Rönnblad et al. 2019).

Aside from PE, the results show that food insecurity is more predominant in rural households, female-headed households, households in savannah and forest ecological zones, households with dependents and households with disabled workers. Household size exhibits a non-linear (inverted-U) significant relationship with food insecurity. This suggests that as household size increases, there is a lower likelihood of experiencing food insecurity. One possible explanation is that larger households often have economically active members who contribute financially to household consumption. This includes cases where child labourers are involved, as economically active children in Ghana have been observed to contribute significantly to household farm and nonfarm income (Koomson and Churchill 2022). Moreover, the results show that compared to illiterate household heads, educated heads and households that own a farm experienced significantly lower levels of food insecurity. Compared to workers in the agriculture sector, workers in the service sector are associated with a decreasing level of food insecurity. These findings suggest certain household characteristics can either mitigate or exacerbate challenges in accessing adequate nutrition. The study also found that social safety net programs (health insurance) can effectively reduce household food insecurity. This finding aligns with previous research that has demonstrated the positive impacts of social safety net programs on food security and overall well-being (Schmidt, Shore-Sheppard, and Watson, 2016).

6.2 Endogeneity-corrected results

We acknowledge that the potential endogeneity related to PE could introduce bias into these estimates. To address this concern, we employ a 2SLS regression framework, utilizing neighbourhood precarious employment (PEWN) as an instrumental variable. In Table 2, we present the results of the 2SLS regression. Consistent with our expectations, the first-stage regression demonstrates that higher levels of precarious neighbourhood employment correlate with increased PE at the household level points to neighbourhood influences on households' employment circumstances. Importantly, all the first-stage results exhibit F-statistics greater than 10, indicating that our instrument is not weakly associated with PE (Stock and Yogo 2002).

In Column 1, we observe that a one standard deviation increase in PE corresponds to a 0.118 standard deviation increase in household food insecurity. Similarly, Columns 2, 3, and 4 show one standard deviation increase in PE is associated with 0.118, 0.095 and 0.119 standard deviations increase in household food insecurity, respectively. Comparing our 2SLS results with the baseline, the latter produces a relatively lower coefficient, indicating that endogeneity poses a downward bias in our estimates. This relationship can be explained by the inherent characteristics of precarious employment, which is often marked by unpredictable income, limited access to benefits and social protection, and job insecurity. These conditions make it challenging for individuals and their households to consistently access and afford an adequate amount of nutritious food. The findings are consistent with earlier studies

Table 2 Precarious employment and food insecurity (IV results)

Variables	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
PE	0.054***	0.022***	0.049***	0.176***
	(0.007)	(0.003)	(0.009)	(0.023)
	[0.118]	[0.118]	[0.095]	[0.119]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
First stage				
Neighbourhood precarious employment	0.206***	0.206***	0.206***	0.206***
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	15,596	15,596	15,596	15,596
R-squared	0.135	0.143	0.092	0.143
F-statistics	115.2***	115.2***	115.2***	115.2***
Anderson-Rubin Wald test	52.23***	27.71***	31.56***	55.42***

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p<0.01$, **$p<0.05$, *$p<0.1$

in developed countries, underscoring the detrimental impact of precarious work arrangements on household food security (Coleman-Jensen 2011; Gruber 2001).

6.2.1 Gender and locational dimensions of PE and food insecurity

In line with the SDG's central goal of "leaving no one behind," we provide findings across gender lines of household headship and locational dimensions. Panels A and B of Table 3 present the estimates for male–female households, respectively. In Panel A (Column 1 of Table 3), an increase in PE increases food insecurity by 0.203 standard deviations for male-headed households. The estimate aligns with that of Columns 2–4. Panel B (Column 1) shows that an increase in PE correlates with a 0.126 standard deviation increase in food insecurity for female-headed households. Precarious employment (PE) consistently reduces food security more in households headed by women compared to those headed by men. This aligns with evidence that employment precarity disproportionately affects the well-being of female-headed households (Koomson and Churchill 2022). The gender disparity can be attributed to the compounded vulnerabilities of female-headed households, including lower incomes, limited resources, and sociocultural norms hindering their economic empowerment (Essilfie et al. 2021).

Moreover, focusing on the locational dimensions in Table 4, our results indicate that a one standard deviation increase in PE is associated with a 0.085 standard deviation increase in food insecurity for households in rural areas (Column 1 of Panel A). Likewise, in Column 1 of Panel B, the results show one standard

Table 3 Precarious employment and food insecurity (IV results): Male–female heads

Variables	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
Panel A: male-headed household				
PE	0.093***	0.037***	0.091***	0.296***
	(0.007)	(0.003)	(0.009)	(0.024)
	[0.203]	[0.201]	[0.177]	[0.201]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
First stage				
Neighbourhood precarious employment	0.225***	0.225***	0.225***	0.225***
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	11,116	11,116	11,116	11,116
R-squared	0.109	0.117	0.073	0.117
Panel B: female-headed household				
PE	0.057***	0.024***	0.051***	0.190***
	(0.016)	(0.006)	(0.018)	(0.051)
	[0.126]	[0.129]	[0.100]	[0.129]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
First stage				
Neighbourhood precarious employment	0.194***	0.194***	0.194***	0.194***
	(0.006)	(0.006)	(0.006)	(0.006)
Observations	4480	4480	4480	4480
R-squared	0.130	0.141	0.083	0.141

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p<0.01$,**$p<0.05$, *$p<0.1$

deviation increase in PE is associated with a 0.142 standard deviation increase in household food insecurity, respectively. This result is consistent across all models from columns 1–4 in Panels A and B of Table 4. The detrimental impact of precarious employment on food insecurity is pervasive across rural and urban settings, corroborating previous research (Ramsey et al. 2012). In rural areas, precarious work conditions in agriculture and informal sectors, directly undermine households' ability to secure stable incomes and access adequate, nutritious food. Similarly, in urban areas, the informal sector and low-skilled jobs are sources of

Table 4 Precarious employment and food insecurity (IV results): location dummies

Variables	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
Panel A: rural sample				
PE	0.044***	0.018***	0.038**	0.143***
	(0.015)	(0.006)	(0.017)	(0.047)
	[0.085]	[0.084]	[0.066]	[0.084]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
First stage				
Neighbourhood precarious employment	0.225***	0.225***	0.225***	0.225***
	(0.006)	(0.006)	(0.006)	(0.006)
Observations	7856	7856	7856	7856
R-squared	0.086	0.094	0.052	0.094
Panel B: urban sample				
PE	0.058***	0.024***	0.054***	0.192***
	(0.009)	(0.003)	(0.010)	(0.028)
	[0.142]	[0.145]	[0.112]	[0.145]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
First stage				
Neighbourhood precarious employment	0.197***	0.197***	0.197***	0.197***
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	7740	7740	7740	7740
R-squared	0.119	0.129	0.088	0.129

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p<0.01$, **$p<0.05$, *$p<0.1$

precarious employment making it difficult for households to afford a diverse diet, exacerbated by rising costs.

The analysis further examines the differential effects of precarious employment on food insecurity across the location-gender divide. Focusing on only main model (Rasch), the results show that a one standard deviation increase in precarious employment leads to a 0.062 standard deviation increase in food insecurity for rural male workers, a 0.163 standard deviation increase for rural female workers, a 0.147 standard deviation increase for urban male workers, and a 0.126 standard deviation increase for urban female workers. The Chow test indicates that these effects are

significantly different across the four groups. While urban workers, both male and female, also experience the negative impacts of precarious employment on their households' food security, the effect is less pronounced than for rural female-headed households, likely due to their limited access to resources, persistent sociocultural norms, and the disproportionate burden of unpaid care work (Essilfie et al. 2021). This suggests the need for tailored policy interventions that address the unique circumstances and needs of different demographic groups to effectively mitigate the food insecurity risks associated with precarious work (Ramsey et al. 2012) (Table 5).

6.2.2 Dimensions of precarious employment and food insecurity

Furthermore, we examine the effect of precarious employment on food insecurity across various dimensions of precarious employment in Table 6. The findings consistently demonstrate that precarious employment dimensions are associated with an increased level of food insecurity in all models. We observe that employment insecurity, income inadequacy, a lack of rights and protections, and an unsafe or unhealthy work environment are linked with 0.175, 0.127, 0.104, and 0.327 standard deviations increase in household food insecurity, respectively. These findings fill the

Table 5 Precarious employment and food insecurity (IV results): location-gender divide

Variables	(1) Rural male Rasch	(2) Rural female Rasch	(3) Urban male Rasch	(4) Urban female Rasch
PE	0.033**	0.081**	0.059***	0.054***
	(0.016)	(0.034)	(0.010)	(0.018)
	[0.062]	[0.163]	[0.147]	[0.126]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
First stage				
Neighbourhood precarious employment	0.229***	0.199***	0.198***	0.193***
	(0.007)	(0.013)	(0.004)	(0.007)
Observations	6010	1846	5106	2634
R-squared	0.094	0.072	0.116	0.122
Chow test: LR chi2: (1)	27.08***			
Chow test: LR chi2: (2)		13.85***		
Chow test: LR chi2: (3)			10.64***	
Chow test: LR chi2: (4)				10.64***

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p<0.01$, **$p<0.05$, *$p<0.1$

Table 6 Precarious employment and food insecurity (dimensions of precarious employment)

Variables	(1) FIES	(2) FIES	(3) FIES	(4) FIES
Employment insecurity	0.056***			
	(0.008)			
	[0.175]			
Income inadequacy		0.053***		
		(0.007)		
		[0.127]		
Lack of rights and protection			0.040***	
			(0.006)	
			[0.104]	
Unsafe or unhealthy work environment				0.063***
				(0.009)
				[0.327]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
First stage				
Neighbourhood precarious employment	0.198***	0.207***	0.278***	0.175***
	(0.005)	(0.005)	(0.008)	(0.007)
Observations	15,596	15,596	15,596	15,596
R-squared	0.137	0.130	0.136	0.034
F-statistics	86.08	86.08	86.08	86.08

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p<0.01$, **$p<0.05$, *$p<0.1$

gap highlighted by precarious studies calling for the need to move beyond composite and unidimensional conceptualizations (Kalleberg and Vallas, 2018; Coleman-Jensen et al. 2011). These studies argue that the distinct dimensions of precarious work can have varying effects on household well-being, including food security outcomes. While inadequate income and employment insecurity may directly constrain a household's ability to afford adequate food, the lack of rights and protections, as well as unsafe or unhealthy work environments, can indirectly contribute to food insecurity by exacerbating financial strain, reducing productivity, and increasing health-related expenses Table 12.

In Table 13 in the appendix, we present the results further assessing the relative importance of the dimensions of precarious employment. From the general dominance analysis, we observed that among the four dimensions of precarious employment, employment insecurity is the most important predictor of food

insecurity, followed by income inadequacy, lack of rights and protection and unsafe or unhealthy work environment. This finding implies that, if the focus of the household is to reduce food insecurity, then interventions that promote more stable employment opportunities, strengthen income protection mechanisms, and enhance workplace safety would be most effective at addressing food insecurity.

6.3 Robustness checks

In this segment, we conducted multiple robustness tests of our results in Tables 7, 8, 9 and 10. First, we subject our standard 2SLS estimates to a robustness test using Lewbel's (2012) heteroscedastic-adjusted instrument method. We evaluate the robustness of the model via internally generated instruments. The Craig-Donald Wald F-statistic surpasses the 10 thresholds, signifying the significance and absence of a weak relationship between the internal instruments with financial resilience (Stock and Yogo, 2002). Our findings demonstrate that a household head in PE has

Table 7 Precarious employment and food insecurity: Lewbel 2SLS and KLS Results

Variables	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
Panel A: Lewbel 2SLS with internal instruments				
PE	0.092***	0.037***	0.097***	0.299***
	(0.012)	(0.005)	(0.014)	(0.038)
	[0.201]	[0.203]	[0.189]	[0.203]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
Observations	15,596	15,596	15,596	15,596
R-squared	0.110	0.118	0.074	0.118
Panel B: Kinky Regression				
PE	0.397***	0.159***	0.454***	1.272***
	(0.016)	(0.006)	(0.018)	(0.050)
	[0.870]	[0.863]	[0.883]	[0.863]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
Postulated Endogeneity of FR	−0.50	−0.50	−0.50	−0.50
Observations	15,596	15,596	15,596	15,596

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p<0.01$, **$p<0.05$, *$p<0.1$

Table 8 PSM results (with different matching methods)

Variables	(ATT) FIES	(ATT) FIES (MPI)	(ATT) FIES (PCA)	(ATT) FIES (RS)
Nearest neighbour (1:1)	0.405***	0.161***	0.385***	1.289***
	(0.027)	(0.011)	(0.031)	(0.088)
Nearest neighbour (1:5)	0.411***	0.163***	0.400***	1.301***
	(0.027)	(0.010)	(0.028)	(0.080)
Radius	0.465***	0.184***	0.461***	1.473***
	(0.007)	(0.003)	(0.009)	(0.025)
Kernel	0.419***	0.166***	0.414***	1.327***
	(0.022)	(0.009)	(0.027)	(0.075)
Local linear regression	0.402***	0.159***	0.392	1.278***
	(0.028)	(0.011)	(0.033)	(0.051)
IPW regression adjustment (IPWRA)	0.398***	0. 158***	0.391***	1.262***
	(0.029)	(0.011)	(0.031)	(0.090)
Observations	15,596	15,596	15,596	15,596

Robust Standard errors in parentheses. Number of bootstrap replications (50)

FE, fixed effect

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 9 Precarious employment, health shock and asset accumulation

Variables	Health shock	Durable assets accumulation
PE	0.012***	− 0.752***
	(0.004)	(0.070)
	[0.049]	[− 0.193]
Household head x'tics	Yes	Yes
Household x'tics	Yes	Yes
District x'tics	Yes	Yes
Ecological zone FE	Yes	Yes
Month of survey FE	Yes	Yes
First stage		
Neighbourhood precarious employment	0.218***	0.218***
	(0.003)	(0.003)
Observations	15,596	15,596
R-squared	0.029	0.196
F-statistics	229	229

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 10 Precarious employment, income and food insecurity (IV mediation analysis)

Variables	Section A-mediator: health shock				Section B-mediator: asset accumulation			
	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
Panel A: results for mechanism								
pe_scow2	0.035***	0.014***	0.035***	0.115***	0.042***	0.017***	0.040***	0.138***
	(0.007)	(0.003)	(0.008)	(0.022)	(0.007)	(0.003)	(0.008)	(0.023)
	[0.078]	[0.076]	[0.068]	[0.078]	[0.092]	[0.094]	[0.078]	[0.094]
Health shock	0.121***	0.047***	0.139***	0.382***				
	(0.016)	(0.006)	(0.018)	(0.051)	No	No	No	No
	[0.064]	[0.062]	[0.065]	[0.062]				
Asset accumulation	No	No	No	No	− 0.017***	− 0.007***	− 0.014***	− 0.054***
					(0.001)	(0.000)	(0.001)	(0.003)
					[− 0.147]	[− 0.143]	[− 0.104]	[− 0.143]
Household head x'tics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District x'tics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First stage								
Neighbourhood precarious employment	0.116***	0.116***	0.116***	0.116***	0.206***	0.206***	0.206***	0.206***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	15,596	15,596	15,596	15,596	15,596	15,596	15,596	15,596
R-squared	0.132	0.122	0.093	0.140	0.148	0.156	0.099	0.156
F-statistics	127.5	127.5	127.5	127.5	134.3	134.3	134.3	134.3
Anderson-Rubin Wald test	12.23	57.56	10.73	13.02	33.09	35.74	21.97	35.74

Table 10 (continued)

Variables	Section A-mediator: health shock				Section B-mediator: asset accumulation			
	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
Panel B: initial results for comparison								
PE	0.054***	0.022***	0.049***	0.176***	0.054***	0.022***	0.049***	0.176***
	(0.007)	(0.003)	(0.009)	(0.023)	(0.007)	(0.003)	(0.009)	(0.023)
	0.054***	0.022***	0.049***	0.176***	0.054***	0.022***	0.049***	0.176***

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

a positive and significant effect on household food insecurity. Consistently, the Lewbel 2SLS estimates match our baseline and standard 2SLS estimates. This is consistent with prior research that utilizes similar approaches (Kofinti et al. 2023; Koomson et al. 2023; Martey 2022; Marisetty, 2022).

Second, we use Kinky Least Squares (KLS) which has the advantage of being instrument-free (see, Voordeckers et al. 2023; Kripfganz and Kiviet 2021). Given that our results suggest that the OLS estimates are biased downward, we expect that the association between PE and the error term should be negative. Hence, we set the postulated endogeneity range of PE for the KLS analysis to range from −0.5 to zero. We present the KLS figures for the relationship between PE and food insecurity in Table 7. The point estimate for PE is positive and significant over the postulated range and the magnitudes of the point estimates decrease with the postulated degree of endogeneity. The KLS results complement the previous estimates and consistently show that precarious employment is positively correlated with food insecurity among households.

6.3.1 Precarious employment and food insecurity (propensity score matching)

Regarding the third sensitivity test, to address self-selection bias and answer the counterfactual question of what food insecurity levels would be for households facing PE conditions compared to if they had not, we utilize Propensity Score Matching (PSM), which is widely employed in academic studies, to address the issue of self-selection bias (Kofinti et al. 2023; Koomson et al. 2023). To ensure reliable PSM estimates, we employ five matching methods (nearest neighbour, kernel, radius, local linear regression) and Inverse-Probability Weighting Regression Adjustment (IPWRA). Unlike the PSM technique, the Inverse Probability Weighted Regression Adjustment (IPWRA) generates predicted results for the average treatment effect using weighted regression coefficients, thereby providing double-robustness (Bandyopadhyay et al. 2023; Negi and Wooldridge 2022). Based on the covariate balancing in this context, the variables included in the first-stage propensity score model were age, sex of the household head, dependency ratio, participation in a social safety net program (national health insurance), presence of a disabled household member, and Share of a district's housing density. The study passed the covariate balancing test and the common support (overlapping) test for PSM, which are presented in Appendix Table 14 and Fig. 3, respectively. In Table 8, the results reveal the Average Treatment Effect on the Treated (ATT) for the impact of precarious employment (PE) on food insecurity, ranging from 0.158 to 1.473 across different estimation methods. Specifically, Column 1 shows the ATT estimates ranging from 0.398 to 0.465, indicating that PE is linked to an increased level of food insecurity. The results from the PSM remain consistent regardless of the method used to address the endogeneity of precarious employment.

Fourthly, we conducted a sensitivity test by using average adult household characteristics (Appendix Table 15). The characteristics included the average number of adults in PE relative to working adults, in addition to average age, female share, education level, and marital status. The results across all four models consistently and support the main finding. For a fifth sensitivity test (Appendix Table 16), we

assessed our results applying a union cut-off of 0.33 for the PE index and the corresponding outcomes are reported. In Panel B, we assigned an equal weight to each dimension of PE and analysed its relationship with our primary measure of food insecurity. Panel C utilized the additive index, or score, of PE in conjunction with the main indicator of food insecurity. Across all model specifications, the results continued to strongly support our primary finding that PE contributes to higher household food insecurity. Lastly, we subject our results to different thresholds and weights for measuring food insecurity (see Table 17 Panel D and E). In contrast to the conventional cutoff of 0.5 used in constructing the food insecurity index (Martey 2022; Adusah-Poku and Takeuchi 2019), we adopt the approach utilized in previous studies (Kofinti et al. 2023; Koomson and Churchill 2022) and apply alternative thresholds of 0.33. in Table 17 in Panel D, the results show that all the estimates align with our initial findings, demonstrating consistency. Moreover, we conduct additional tests by assigning higher weights of 0.20 to the dimension "GOING A WHOLE DAY WITHOUT FOOD" (WFOOD_1DAY), which contributes to the food insecurity construct. In Panel B of Table 17, our primary findings receive further support, indicating that PE exacerbates food insecurity in the overall sample. These findings remain robust across the different measures, techniques and thresholds used.

6.4 Potential channel analyses

Following a two-step methodology used in prior studies (Koomson and Churchill 2021, 2022; Alesina and Zhuravskaya 2011), we examined the link between PE and health shocks as well as household asset accumulation. Household health shock is a binary variable that looks at whether any member of the household suffered from either an illness or injury. It captures if there was an unexpected medical event affecting one individual within the household, especially the household head. In addition, we measured household asset accumulation following the approach developed by Filmer and Pritchett (2001). A variety of durable goods owned by each household were catalogued, consisting of possessions that could potentially be sold or used as collateral in times of financial need. Examples included electronics like televisions and computers, vehicles, land ownership, household items, jewellery, and more. These assets were then subjected to principal component analysis to synthesize them into a single wealth index measuring overall asset accumulation. This technique for deriving an index from multiple indicators of durable assets and housing quality was similarly applied by Seshan (2020). The resulting asset accumulation score serves as a proxy for households' capacity to withstand economic hardship through capital resources.

In Table 9, Column 1, the results revealed a statistically significant negative relationship (at a 1% level) between PE and health shocks. Column 2 findings showed a statistically significant positive relationship (at a 1% level) between PE and asset accumulation. Our findings align with prior research that has established links between job precarity and worse health outcomes (e.g. Matilla-Santander et al. 2020). More precarious employment is associated with an increased incidence of

health issues for workers. Separately, the relationship we observed between precariousness and household financial behaviours is consistent with the results reported by Nkansah (2023), who also documented the impacts of unstable, low-quality jobs on financial decision-making and resources at the family level.

In the second step, we introduce the health shock and asset accumulation variable as an additional covariate in the food insecurity model (Eqs. 7 and 8). We consider the variable a relevant pathway if its inclusion in the model leads to a reduction in the earlier estimated coefficient of PE or renders it statistically insignificant. To conduct this analysis, we employ the 2SLS model, comparing the coefficients from Table 2 (Panel B) with the coefficients in Panel A of Table 10 (Section A, Columns 1–4). The results in Section A, Columns 1–4 indicate that increased health shock is linked with increased food insecurity. Furthermore, we observe that in column 1 the estimates for PE are consistently lower in Panel A compared to Panel B. This suggests that including health shock as an additional predictor in the food insecurity model reduces the magnitude of PE. Similarly, the results in Panel A of Table 10 show that higher asset accumulation is linked to a decreased level of food insecurity. We observe that the estimates of PE (in Panel A) are consistently smaller than those in Panel B (Section B, Columns 1–4). This suggests that incorporating asset accumulation as an additional covariate in the food insecurity regression diminishes the magnitude of PE. Based on the results obtained, we infer that health shock and asset accumulation are important pathways through which PE affects food insecurity.

7 Conclusion and policy implication

Workers across the globe play a vital role in sustaining the world's food supply, with many depending on earnings from their labour to meet their own nutritional needs. Nonetheless, these individuals, who are integral to the food system from source to plate, often grapple with substandard working conditions. However, researchers have not yet examined the effect of PE conditions on food insecurity. Our study adds to the existing works by examining the link between PE and food insecurity using panel data from Ghana, called the Annual Household Income and Expenditure Survey. Our measurement of food insecurity primarily relies on the Rasch model, although we also employ the MPI, principal component analysis, and an additive approach for the Food Insecurity Experience Scale (FIES). Potential endogeneity related to PE is addressed using neighbourhood precarious employment.

Our findings reveal a significant and positive link between PE and food insecurity. This finding remains consistent across different dimensions of PE and is robust to various approaches employed to address endogeneity and alternative methods employed to capture the food insecurity index. We further find that precarious employment increases food insecurity more among rural female-headed households. Relatively, employment insecurity has the biggest effect in increasing food insecurity followed by lack of rights and protection, income inadequacy, and unsafe or unhealthy work environment. These findings further demonstrate that health shocks and household asset accumulation are important channels through which precarious employment affects food insecurity.

These findings accentuate the need for policies aimed at ensuring decent working conditions and removing obstacles that prevent workers from renegotiating their contracts, particularly among vulnerable rural and female-headed households. Such initiatives could significantly boost workers' earnings and health as well as contribute to achieving the SDGs. Strategies to formalize unstable jobs and guarantee consistent living incomes through regulations on working conditions and social safety nets. This can help buffer the financial impact of economic shocks and ensure households have reliable access to nutritious foods. Directly, these measures contribute to SDG 8, which promotes decent work and economic growth. Indirectly, by reducing PE and thereby food insecurity (SDG 2), we can further support the attainment of SDG 8, ensuring all workers have access to legal and social protections, job security, safe workplaces, and the capacity to voice concerns or negotiate working conditions. Improved working conditions can also contribute to alleviating poverty (SDG 1), reducing inequality (SDG 10), promoting quality education (SDG 4), and advancing good health and wellbeing (SDG 3). Our study resonates with the primary aim of the SDGs, which is to leave no one behind. It highlights the potential of policies that eliminate PE conditions to provide individuals and households with a reliable income source, helping them fulfil their basic needs, access nutritious food, and enhance their overall well-being.

Data limitations meant this study could only assess direct impacts, not other potential channels linking PE to food insecurity. Further research should explore context-specific indirect pathways to broaden understanding of this relationship.

Appendix

See Fig. 3 and Tables 11, 12, 13, 14, 15, 16, 17.

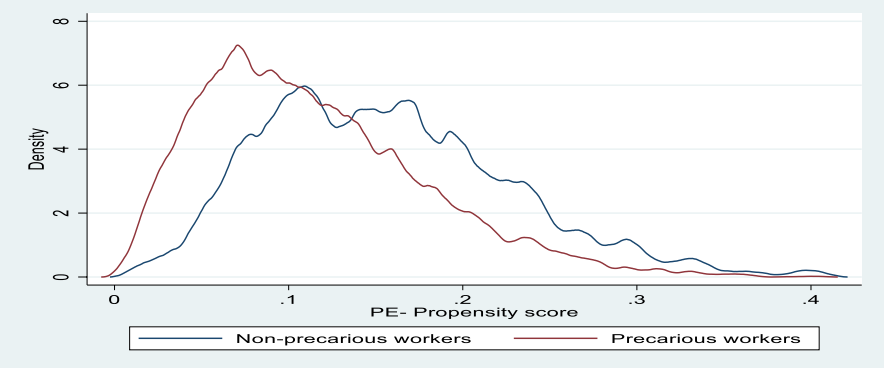

Fig. 3 Overlapping test

Table 11 Summary statistics

Variable		Mean	Stardard deviation	Mean	Stardard deviation	Mean	Stardard deviation
FIES	Food insecurity score estimated using Rasch model scaling	0.030	0.890	0.050	0.894	0.010	0.885
FIES Dummy (0/1)	Binary variable (1 = food insecurity scores below 0.5 cut-off based on Rasch model)	0.500	0.500	0.543	0.498	0.457	0.498
FIES (MPI)	Multidimensional measure of household food insecurity on 0 to 1 scale	0.428	0.360	0.469	0.369	0.387	0.345
FIES (RS)	Food insecurity score calculated by adding all eight elements on the FIES scale	3.422	2.878	3.750	2.956	3.094	2.761
FIES (PCA)	The food insecurity index was calculated using principal factor analysis	−0.013	1.003	0.010	0.999	−0.036	1.006
Precarious employment score	Multidimensional Index of employment precarity on continuous 0 to 1 scale	0.473	0.195	0.435	0.195	0.473	0.195
Precarious employment (0/1)	Binary variable (1 = precarity score exceeds 0.5 threshold)	0.623	0.129	0.623	0.129	0.623	0.129
Precarious employment (Add)	Employment precarity accumulates as measured by the additive index for all four measures	102.90	28.065	102.82	28.075	102.98	28.057
Age	Age in years of household (HH) head	41.032	10.261	41.032	10.262	41.032	10.262
Female	Binary (1 = HH head is female)	0.287	0.452	0.287	0.453	0.287	0.453
No formal education	Binary (1 if HH head has no formal education)	0.258	0.437	0.258	0.437	0.258	0.437
Primary	Binary (1 if HH head has primary education)	0.161	0.368	0.161	0.368	0.161	0.368
JHS/middle	Binary (1 if HH head has Junior high school education)	0.327	0.469	0.327	0.469	0.327	0.469

Table 11 (continued)

Variable		Mean	Stardard deviation	Mean	Stardard deviation	Mean	Stardard deviation
secondary	Binary (1 if HH head has secondary education)	0.160	0.367	0.160	0.367	0.160	0.367
Tertiary	Binary (1 if HH head has tertiary education)	0.093	0.291	0.093	0.291	0.093	0.291
Rural Household	Binary (1 if HH is located in a rural area)	0.504	0.500	0.504	0.500	0.504	0.500
Household size	Number of persons in the household	5.280	2.857	5.211	2.836	5.348	2.877
Household size squared	Square of household size value	36.038	44.687	35.201	44.014	36.875	45.338
Never married	Binary (1 if HH head is never married)	0.068	0.252	0.068	0.252	0.068	0.252
Married	Binary (1 if HH head is married)	0.759	0.428	0.759	0.428	0.759	0.428
Separated	Binary (1 if HH head is widowed/divorced/separated)	0.173	0.378	0.173	0.378	0.173	0.378
Dependents	Number of members of the household below 16 and above 65	2.586	2.017	2.541	2.000	2.630	2.034
Social safety net program	Binary (1 if HH head is covered under National health insurance)	0.763	0.425	0.761	0.426	0.765	0.424
Agriculture	Binary (1 if HH head is Agriculture)	0.458	0.498	0.458	0.498	0.458	0.498
Industry	Binary (1 if HH head is Industry)	0.141	0.348	0.141	0.349	0.141	0.349
Service	Binary (1 if HH head is service)	0.400	0.490	0.400	0.490	0.400	0.490
Greater Accra	Binary (1 if household is located in Greater Accra areas)	0.074	0.262	0.074	0.262	0.074	0.262
Savannah	Binary (1 if household is located in Savannah areas)	0.309	0.462	0.309	0.462	0.309	0.462
Coastal	Binary (1 if household is located in Coastal areas)	0.276	0.447	0.276	0.447	0.276	0.447

Table 11 (continued)

Variable		Mean	Stardard deviation	Mean	Stardard deviation	Mean	Stardard deviation
Forest	Binary (1 if HH is located in forest areas)	0.340	0.474	0.340	0.474	0.340	0.474
Household farm	Binary (1 if HH is involved in engaged in farming)	0.481	0.500	0.486	0.500	0.476	0.499
Household with Disable worker	Binary (1 if HH has a disabled worker)	0.197	0.398	0.195	0.396	0.199	0.399
Health shock	Binary (1 if household member is illness or injury)	0.327	0.469	0.327	0.469	0.327	0.469
Asset accumulation index	Household asset index computed using PCA	0.485	0.103	0.506	0.091	0.463	0.109
Employment instability	Multidimensional of Employment instability score ranging from 0 to 1	0.650	0.280	0.649	0.280	0.650	0.280
Income inadequacy	Multidimensional of Income inadequacy score ranging from 0 to 1	0.870	0.213	0.870	0.213	0.871	0.213
Lack of right and protections	Multidimensional of lack of right and protections score ranging from 0 to 1	0.927	0.232	0.927	0.232	0.927	0.231
Unsafe or unhealthy work environment	Multidimensional of unsafe or unhealthy work environment score ranging from 0 to 1	0.484	0.461	0.483	0.461	0.485	0.461
Basic schools	Number of basic schools in a district	5.404	1.231	5.404	1.231	5.404	1.231
Share of a district's housing density	Number of housings in a district	9.368	0.502	9.368	0.502	9.368	0.502
Access to electricity	Access to electricity in a district	9.121	0.645	9.121	0.645	9.121	0.645
N	Observation	15,596		7798		7798	

Table 12 Correlation matrix (food insecurity measures)

	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
FIES	1			
FIES (MPI)	0.982	1		
	0.000			
FIES (PCA)	0.794	0.7906	1	
	0.000	0.000		
FIES (RS)	0.982	1.000	0.7906	1
	0.000	0.000	0.000	

Table 13 Precarious employment and food insecurity (dimensions of precarious employment)

FIES	Dominance statistics	Standardized dominance statistics	Ranking
Employment insecurity	0.019	0.398	1
Income inadequacy	0.007	0.145	3
Lack of rights and protection	0.018	0.377	2
Unsafe or unhealthy work environment	0.004	0.080	4

Table 14 Treatment-effects estimation

Rasch	Coefficient	Standard error	t-value	*p*-value	[95% Conf	Interval]	Sig
ATE PE (yes versus no)	0.398	0.029	13.81	0.000	0.342	0.455	***
POmean PE (No)	−0.322	0.028	−11.52	0.000	−0.376	−0.267	***
OME0 (constant)	−0.322	0.028	−11.52	0.000	−0.376	−0.267	***
OME1 (constant)	0.077	0.008	10.16	0.000	0.062	0.092	***
Age	0.01	0.002	4.73	0.000	0.006	0.014	***
Female	−0.048	0.055	−0.87	0.385	−0.157	0.06	
Dependents	0.284	0.017	16.88	0.000	0.251	0.317	***
Safety net program	−0.528	0.065	−8.17	0.000	−0.655	−0.401	***
Household with disabled worker	0.329	0.074	4.47	0.000	0.185	0.473	***
District access to electricity	−0.552	0.051	−10.74	0.000	−0.653	−0.451	***
Wave	−0.009	0.051	−0.18	0.861	−0.108	0.09	
Constant	6.546	0.509	12.87	0.000	5.549	7.543	***
Balancing test	chi2(8)	9.974					
	Prob > chi2 = 0.2668						
Mean dependent variable	0.030	SD dependent var	0.890				

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 15 Precarious employment and food insecurity (average household adult characteristics)

Variables	(1) FIES (Rasch)	(2) FIES (MPI)	(3) FIES (PCA)	(4) FIES (RS)
Average precarious employment of adult in the household	14.547***	5.849***	13.605***	46.790***
	(2.358)	(0.948)	(2.295)	(7.581)
	1.998	1.986	1.658	1.986
Average working age in a household	0.018***	0.007***	0.018***	0.057***
	(0.004)	(0.002)	(0.004)	(0.013)
	0.178	0.176	0.160	0.176
Average number of females in a household	0.593***	0.241***	0.576***	1.932***
	(0.094)	(0.038)	(0.092)	(0.303)
	0.234	0.235	0.201	0.235
Average level of education in the household	−0.429***	−0.169***	−0.393***	−1.353***
	(0.061)	(0.024)	(0.059)	(0.195)
	−0.177	−0.172	−0.144	−0.172
Rural household	0.303***	0.121***	0.265***	0.971***
	(0.038)	(0.015)	(0.037)	(0.121)
	0.170	0.169	0.132	0.169
Household size	0.000	0.001	−0.000	0.006
	(0.019)	(0.008)	(0.019)	(0.061)
	0.001	0.006	−0.001	0.006
Household size squared	−0.002**	−0.001**	−0.003***	−0.007**
	(0.001)	(0.000)	(0.001)	(0.003)
	−0.115	−0.115	−0.112	−0.115
Averaged married adult in the household	0.176***	0.068***	0.160**	0.546***
	(0.065)	(0.026)	(0.063)	(0.208)
	0.083	0.079	0.067	0.079
Dependents	0.088***	0.035***	0.092***	0.279***
	(0.016)	(0.007)	(0.016)	(0.053)
	0.199	0.196	0.185	0.196
Social safety net program (SP)	−0.039	−0.014	−0.028	−0.115
	(0.038)	(0.015)	(0.037)	(0.121)
	−0.018	−0.017	−0.012	−0.017
Industry	−0.922***	−0.370***	−0.896***	−2.958***
	(0.155)	(0.062)	(0.150)	(0.498)
	−0.361	−0.358	−0.311	−0.358
Service	−0.543***	−0.218***	−0.529***	−1.748***
	(0.073)	(0.029)	(0.071)	(0.235)
	−0.299	−0.297	−0.258	−0.297
Savannah	0.553***	0.217***	0.483***	1.735***
	(0.081)	(0.033)	(0.079)	(0.261)
	0.287	0.279	0.223	0.279

Table 15 (continued)

Variables	(1) FIES (Rasch)	(2) FIES (MPI)	(3) FIES (PCA)	(4) FIES (RS)
Coastal	0.085	0.030	0.081	0.238
	(0.078)	(0.031)	(0.076)	(0.251)
	0.043	0.037	0.036	0.037
Forest	−0.057	−0.028	−0.041	−0.223
	(0.081)	(0.032)	(0.079)	(0.260)
	−0.031	−0.037	−0.019	−0.037
Household own farm	0.525***	0.209***	0.519***	1.674***
	(0.098)	(0.039)	(0.096)	(0.315)
	0.295	0.291	0.259	0.291
Household with disabled worker	0.082**	0.030**	0.097***	0.243**
	(0.037)	(0.015)	(0.036)	(0.119)
	0.037	0.034	0.039	0.034
Number of basic schools per district	−0.015	−0.005	0.015	−0.042
	(0.017)	(0.007)	(0.017)	(0.054)
	−0.020	−0.018	0.019	−0.018
Share of a district's housing density	0.651***	0.258***	0.411***	2.067***
	(0.113)	(0.045)	(0.110)	(0.362)
	0.368	0.361	0.206	0.361
District access to electricity	−0.556***	−0.221***	−0.357***	−1.765***
	(0.094)	(0.038)	(0.092)	(0.302)
	−0.403	−0.395	−0.230	−0.395
Neighbourhood precarious employment	0.001***	0.001***	0.001***	0.001***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Constant	−4.630***	−1.342***	−4.214***	−10.737***
	(0.695)	(0.280)	(0.679)	(2.238)
Month of survey FE	Yes	Yes	Yes	Yes
Observations	15,596	15,596	15,596	15,596

Robust standard errors in parentheses

FE, fixed effect

*$p < 0.05$, **$p < 0.01$, *$p < 0.001$

Table 16 Precarious employment and food insecurity (union cut-off and alternative measures for PE)

Variables	FIES	FIES (MPI)	FIES (PCA)	FIES (RS)
Panel A: PE: union cut-off (0.33)				
PE	0.054***	0.022***	0.049***	0.176***
	(0.007)	(0.003)	(0.009)	(0.023)
	[0.118]	[0.119]	[0.095]	[0.119]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
Observations	15,596	15,596	15,596	15,596
R-squared	0.135	0.143	0.092	0.143
Panel B: Equal weights for PES				
PE	0.054***	0.022***	0.049***	0.175***
	(0.007)	(0.003)	(0.009)	(0.023)
	[0.121]	[0.122]	[0.097]	[0.122]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
Observations	15,596	15,596	15,596	15,596
R-squared	0.133	0.141	0.090	0.141
Panel C: PE score (additive)				
PE	0.038***	0.015***	0.034***	0.124***
	(0.005)	(0.002)	(0.006)	(0.017)
	[0.119]	[0.121]	[0.096]	[0.121]
Household head x'tics	Yes	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes	Yes
Ecological zone FE	Yes	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes	Yes
Observations	15,596	15,596	15,596	15,596
R-squared	0.133	0.141	0.091	0.141

Robust standard errors in parentheses; standardised coefficients in square bracket

FE, fixed effect

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 17 Precarious employment and food insecurity (union cut-off and alternative measures for FIES)

	FIES All	FIES Rural	FIES Urban
Panel D: FIES cut off (0.33)			
PE	0.219***	0.178***	0.240***
	(0.029)	(0.052)	(0.032)
	[0.119]	[0.084]	[0.145]
Household head x'tics	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes
Location	Yes	No	No
Ecological zone FE	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes
Observations	15,596	7856	7740
R-squared	0.143	0.094	0.129
Panel E: more weight on WFOOD_1DAY			
PE	0.208***	0.169***	0.227***
	(0.027)	(0.049)	(0.030)
	[0.119]	[0.084]	[0.145]
Household head x'tics	Yes	Yes	Yes
Household x'tics	Yes	Yes	Yes
Location	Yes	No	No
Ecological zone FE	Yes	Yes	Yes
Month of survey FE	Yes	Yes	Yes
F-statistics	28	28	28
Observations	15,596	7856	7740
R-squared	0.145	0.098	0.129

Robust standard errors in parentheses

FE, fixed effect

*$p < 0.05$, **$p < 0.01$, *$p < 0.001$

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Data availability The data was collected by Ghana Statistical Service and the authors thus do not have permission to share it. However, access to the data can be requested from Ghana Statistical Service at https://statsghana.gov.gh/gssdatadownloadspage.php] https://microdata.statsghana.gov.gh/index.php/catalog/119.

Declarations

Conflict of interest The authors declare no competing interests.

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