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Original Article

The association between food insecurity and functional disability among older adults: the mediating effects of childhood and adult socioeconomic status in a ten-year follow-up longitudinal study in Ghana and South Africa

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ABSTRACT

Objectives: This study examined the association between food insecurity (FI) and functional disability (FD) among older adults over time in Ghana and South Africa (SA), and the mediating roles of childhood parental employment (CPE) and adult education (AE) statuses.

Methods: Data were from 6,569 and 4,663 older adults (60+years) who participated in WHO-SAGE Ghana and SA (Waves 1–3), respectively, between 2007−2019. Multivariable-adjusted logistic mixed effects models were performed to examine the roles of CPE and AE statuses on the associations between FI, in general, and its measures – hunger and food insufficiency – with FD in older adults.

Results: After adjusting for significant covariates, older adults who reported being food insecure (Ghana: aOR = 1.20, 95%CI: 1.03, 1.41, p = 0.024; SA: aOR = 1.98, 95%CI:1.54, 2.56, p < 0.001) and those who reported consuming insufficient food (Ghana: aOR = 1.21, 95%CI: 1.03, 1.42, p = 0.018; SA: aOR = 1.96, 95%CI:1.52, 2.53, p < 0.001) had higher odds of FD over time, compared with those who were food secure. For both Ghana and SA, hunger was associated with higher odds of FD. However, the association remained statistically significant only for SA. CPE and AE statuses proved to be relevant pathways through which FI was associated with increased odds of FD among older adults in Ghana and SA.

Conclusion: CPE and AE statuses mediated the associations between FI and FD among older adults in Ghana and SA. This highlights the importance of adopting early–late-life interventions to support the health and economic wellbeing of families to accumulate wealth for food security and functional wellbeing in later life.

1. Introduction

Food insecurity (FI), defined as experiencing hunger or food insufficiency due to limited financial resources, is a critical global health and social issue [1,2]. In 2023, an estimated 2.33 billion people globally experienced moderate to severe FI, with Africa bearing a disproportionate burden [2]. In sub-Saharan Africa, approximately 39% of the population is affected [3], including Ghana, where a significant prevalence of moderate-to-severe FI (44% to 9%) and hunger (23.8%) has been report [4]. Similarly, in South Africa, nearly 20% of households face moderate to severe FI [5,48], despite social protection investments [6].

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Among older adults, FI contributes not only to poor nutritional outcomes but also to functional decline and disability (FD)—the difficulty or inability to perform essential daily tasks, which is a major determinant of independence and quality of life in older age [4]. Studies from Italy, Brazil, and Japan have demonstrated that limited food access can accelerate functional decline by worsening chronic diseases, cognitive decline, and psychological distress [3,7,8]. In low- and middle-income countries (LMICs), evidence linking FI to FD remains limited, with existing studies focusing on outcomes such as depression, falls, and sarcopenia [9]. However, longitudinal evidence from Africa examining how much of the FI-FD association is explained by childhood parental employment (CPE) and adult education (AE) statuses is lacking.

While a direct pathway from FI to poor health has been established, a life-course perspective suggests that this relationship is complex and influenced by both early- and late-life socioeconomic conditions [10,11]. Central to this perspective is socioeconomic status (SES). Childhood SES, including CPE, and adult SES, such as AE status, are significant potential mediators. Studies from Global North confirm that childhood SES is linked to later-life health and FI [12,13], and that adult SES mediates the FI-FD association [14,15]. However, no studies have systematically examined whether and how CPE and AE statuses mediate the longitudinal relationship between FI and FD in sub-Saharan African countries such as Ghana and South Africa. Therefore, using longitudinal data from the WHO's Study on global AGEing and adult health (SAGE), this study aims to address these gaps by examining whether FI affects FD over time, and whether this association is mediated by CPE and AE statuses. The findings have important policy implications for achieving Sustainable Development Goal 2 (Zero Hunger).

2. Methods

2.1. Data source and study population

Data from the WHO Study on global AGEing and adult health (SAGE) was used for the analyses. SAGE is a longitudinal household and individual survey that sampled respondents aged 50+ years from nationally representative samples in selected low-middle income countries: China, Ghana, India, Mexico, Russia, and South Africa [16]. The World Health Organisation Ethical Review Committee and the local ethics review boards provided ethical approval for each country.

In the present paper, a longitudinal design was employed with data from the first three waves of SAGE Ghana and South Africa. The total sample sizes (60+ years) for each wave, for Ghana was Wave 1 (W1: 2007–2010) n = 2,841; Wave 2 (W2: 2014–2015) n = 2,280 and Wave 3 (W3: 2018–2020) n = 2,074) and for South Africa; Wave 1 = 2,145, Wave 2 = 1,342, and Wave 3 = 1,176. A total sample of 6,249 (Ghana) and 4,663 (South Africa) (aged 60 years and older) with valid data on functional disability (dependent variable) and food insecurity was used in the analysis. Table 1 presents the sample size with summary statistics of selected variables, by wave.

2.2. Measures

2.2.1. Functional disability

Functional disability, the dependent variable, was measured using the World Health Organisation Disability Schedule (WHODAS 2.0) 12-item questionnaire, which was answered on a five-point Likert scale (none = 0, mild = 1, moderate = 2, severe = 3, and extreme/cannot = 4). WHODAS 2.0 (see Appendix Table S1) measures functioning from six domains, including: participation in society, life activities, getting along, self-care, mobility, and cognition [17]. For this study, WHODAS 2.0 was scored on a scale of 0 to 100, with lower scores indicating lower disability and higher scores indicating higher disability. Following the convention of previous studies [4,18–21], the top 10th percentile of the score indicated severity. As a result, all scores that fell below 89.7% and 89.5% for Ghana and South Africa, respectively, were considered as

Table 1
Descriptive statistics of respondents aged 60+ years in Ghana and South Africa, by study wave.

	Ghana			South Africa		
	Wave 1 (N = 2,841)	Wave 2 (N = 2,280)	Wave 3 (N = 2,074)	Wave 1 (N = 2,145)	Wave 2 (N = 1,342)	Wave 3 (N = 1,176)
Age						
Mean (SD)	71 (8.5)	71 (8.6)	71 (8.6)	70 (7.6)	70 (7.3)	70 (8.0)
Sex						
Male	1,358 (47.8)	1,015 (44.5)	859 (41.4)	880 (41.0)	421 (31.4)	380 (32.3)
Female	1,483 (52.2)	1,265 (55.5)	1,215 (58.6)	1,265 (559.0)	921 (68.6)	796 (67.7)
Marital status						
Never married	32 (1.13)	59 (2.6)	17 (0.82)	213 (10.1)	233 (17.4)	153 (13.1)
Married/ cohabiting	1,401 (49.7)	1,116 (49.0)	1,029 (49.6)	1,014 (48.2)	412 (30.7)	351 (29.9)
Separated/ divorced	363 (12.9)	257 (11.3)	243 (11.7)	101 (4.8)	104 (7.8)	114 (9.7)
Widowed	1,026 (36.4)	848 (37.2)	785 (37.9)	779 (37.0)	593 (44.2)	558 (47.5)
Locality of residence						
Urban	1,096 (38.6)	901 (39.5)	969 (46.7)	1,393 (65.0)	1,056 (78.7)	783 (66.6)
Rural	1,745 (61.4)	1,379 (60.5)	1,105 (53.3)	749 (35.0)	286 (21.3)	393 (33.4)
Alcohol (ever used alcohol)						
Yes	1,454 (58.2)	686 (30.4)	905 (43.7)	548 (26.8)	196 (15.2)	321 (27.4)
No	1,044 (41.8)	1,572 (69.6)	1,166 (56.3)	1,497 (73.2)	1,094 (84.8)	851 (72.6)
Smoking status (ever smoked)						
Yes	631 (25.3)	178 (7.9)	278 (13.4)	711 (34.7)	213 (16.5)	317 (27.1)
No	1,866 (74.7)	2,080 (92.1)	1,793 (86.6)	1,338 (65.3)	1,078 (83.5)	855 (73.0)
Physical activity						
Yes	2,148 (75.6)	1,585 (69.5)	1,024 (49.4)	1,100 (51.3)	517 (38.5)	576 (49.0)
No	693 (24.4)	695 (30.5)	1,050 (50.6)	1,045 (38.5)	825 (61.5)	600 (51.0)
Sleep duration						
Short sleep (≤6 h)	473 (21.7)	83 (3.7)	375 (20.6)	188 (9.5)	74 (5.9)	180 (19.7)
Intermediate sleep (6–9 h)	1,480 (67.9)	1,399 (62.2)	1,184 (65.5)	1,117 (56.2)	655 (51.8)	617 (67.4)
Long sleep (>9 h)	226 (10.4)	768 (34.1)	248 (13.7)	681 (34.3)	535 (42.3)	118 (12.9)
BMI						
Underweight	473 (16.7)	333 (14.6)	223 (10.8)	118 (5.50)	35 (2.61)	66 (5.61)
Normal weight	1,441 (50.7)	1,199 (52.6)	906 (43.7)	517 (24.1)	222 (16.5)	219 (18.6)
Overweight	420 (14.8)	380 (16.7)	473 (22.8)	567 (26.4)	276 (20.6)	287 (24.4)
Obese	507 (17.9)	368 (16.1)	472 (22.8)	943 (44.0)	809 (60.3)	604 (51.4)
Self-reported health status						
Good	823 (31.5)	1,177 (52.0)	1,212 (58.5)	688 (32.6)	577 (43.9)	558 (47.5)
Moderate	1,211 (46.4)	789 (34.8)	684 (33.0)	1,041 (49.3)	559 (42.5)	429 (36.5)
Bad	579 (22.2)	299 (13.2)	177 (8.54)	381 (18.1)	180 (13.7)	187 (15.9)
Multimorbidity (9 conditions)						
No morbidity	1,580 (55.6)	1,087 (47.7)	1,190 (57.4)	906 (42.2)	463 (34.5)	394 (33.5)
Any one morbidity	669 (23.6)	371 (16.3)	567 (27.3)	601 (28.0)	311 (23.2)	355 (30.2)
2 or more morbidities	592 (20.8)	822 (36.1)	317 (15.3)	638 (29.7)	568 (42.3)	427 (36.3)
Social Networks						

(continued on next page)

Table 1 (*continued*)

	Ghana			South Africa		
	Wave 1 (N = 2,841)	Wave 2 (N = 2,280)	Wave 3 (N = 2,074)	Wave 1 (N = 2,145)	Wave 2 (N = 1,342)	Wave 3 (N = 1,176)
Never	134 (4.72)	101 (4.43)	99 (4.8)	60 (2.80)	105 (7.82)	74 (6.3)
At least once or twice per year	2,707 (95.3)	2,179 (95.6)	1,975 (95.2)	2,085 (97.2)	1,237 (92.2)	1,102 (93.7)
Household financial situation						
Good	147 (5.2)	297 (13.1)	500 (24.3)	211 (10.1)	271 (20.9)	–
Moderate	793 (28.2)	952 (42.0)	778 (37.8)	870 (41.6)	596 (45.9)	–
Bad	1,868 (66.5)	1,020 (45.0)	781 (37.9)	1,013 (48.4)	431 (33.2)	–
Household regular income						
Yes, regular source	1,205 (43.5)	1,025 (45.2)	474 (23.0)	1,896 (90.0)	868 (66.0)	–
Yes, regular but seasonal	1,219 (44.0)	665 (29.3)	652 (31.7)	130 (6.17)	46 (3.50)	–
No	349 (12.6)	577 (25.5)	933 (45.3)	81 (3.84)	402 (30.6)	–
Functional Disability						
No disability	2,010 (81.2)	1,769 (84.0)	1,645 (82.7)	1,664 (84.2)	954 (81.0)	891 (83.3)
With disability	464 (18.8)	336 (15.9)	345 (17.3)	312 (15.8)	224 (19.0)	179 (16.7)
Hunger						
Yes	749 (30.1)	419 (18.6)	710 (3.3)	471 (23.2)	363 (28.2)	403 (34.4)
No	1,737 (69.9)	1,839 (81.4)	1,361 (65.7)	1,562 (76.8)	926 (71.8)	768 (65.6)
Insufficient food						
Yes	1,086 (43.7)	545 (24.1)	802 (38.7)	523 (25.7)	407 (31.60)	440 (37.6)
No	1,399 (56.3)	1,713 (75.9)	1,269 (61.3)	1,512 (74.3)	881 (68.4)	731 (62.4)
Food insecurity						
No food insecurity	1,358 (54.7)	1,663 (73.7)	1,229 (59.3)	1,498 (73.7)	865 (67.2)	713 (60.9)
Moderate food insecurity	632 (25.4)	428 (19.0)	337 (16.3)	394 (19.4)	353 (27.4)	390 (33.3)
Severe food insecurity	494 (19.9)	167 (7.40)	505 (24.4)	140 (6.9)	70 (5.43)	68 (5.81)
Food insecurity (dichotomous variable)						
Food secure	1,358 (54.7)	1,663 (73.7)	1,229 (59.3)	1,498 (73.7)	865 (67.2)	713 (60.9)
Food insecure	1,126 (45.3)	595 (26.4)	842 (40.7)	534 (26.3)	423 (32.9)	458 (39.1)
Childhood SES – parental employment						
Father employment						
Yes	2,521 (96.6)	1,483 (95.2)	1,094 (53.6)	1,532 (84.6)	546 (55.5)	571 (59.8)
No	89 (3.41)	75 (4.81)	947 (46.4)	280 (15.5)	438 (44.5)	384 (40.2)
Mother employment						
Yes	2,488 (95.3)	1,453 (93.1)	1,012 (49.3)	806 (43.9)	314 (31.4)	330 (31.8)
No	124 (4.8)	107 (6.86)	1,040 (50.6)	1,032 (56.2)	685 (68.6)	709 (68.2)
Adult SES - Ever attended School						
Yes	881 (33.9)	1,015 (44.5)	1,172 (56.5)	1,258 (69.2)	933 (69.5)	984 (83.7)
No	1,727 (66.2)	1,265 (55.5)	901 (43.5)	561 (30.8)	409 (30.5)	191 (16.3)

having “no disability”.

2.2.2. Food insecurity

Food insecurity was measured by two questions included in each of the three waves of WHO SAGE questionnaire; (1) “In the last 12 months, how often did you ever eat less than you felt you should because there wasn't enough food?” (food insufficiency); and (2) “In the last 12 months, were you ever hungry, but didn't eat because you couldn't afford enough food?” (hunger). Each question used five response options: “every month” = 1; “almost every month” = 2; “some months, but not every month” = 3; “only in 1 or 2 months” = 4; and, “never” = 5. “Severely food insecure” was defined as” 1, 2 or 3 selected as the response options for the two questions or 1 to either of the questions [22]. Respondents who did not satisfy the severe food insecurity criteria were considered to have “moderate food insecurity”. Finally, all respondents who selected 5 for both questions were considered “food secure”. The responses were dichotomised for analysis in the mixed-effect logistic models, as food secure versus food insecure – severely food insecure and moderate food insecurity – for easier interpretability [4,9].

2.2.3. Childhood parental employment

Childhood parental employment (mother and/or father), a measure of childhood SES, was estimated based on the employment status of both or any of the parents during the respondents' childhood. All three WHO SAGE waves asked respondents to recall and provide information related to their parents' employment during childhood. Specifically, respondents were asked to respond to the question “Was your mother ever employed when you were about 10 years old?”, with the response categories 1= “yes” and 2= “no”. Also, respondents were asked to either respond “yes = 1 or “no = 2 to the question “Was your father ever employed when you were about 10 years old?”. The internal consistency of the questions was high for Ghana (Cronbach's alpha of 0.91) and quite low for South Africa (Cronbach's alpha of 0.51).

2.2.4. Adult education status

Respondents' education status was used as a proxy for adults' socioeconomic status. Respondents were asked the question “Have you ever been to school” with a response categorised as 1 = yes”, and 2 = no”, in all three waves of WHO SAGE.

2.2.5. Covariates

The selection of covariates was informed by previous studies examining associations between food insecurity and functional disability [4,23]. Demographic variables included age, sex (male; female), marital status (never married; married/cohabiting; separated/cohabiting; widowed), ever attended school (yes; no), and location of residence (urban; rural). Lifestyle and health behaviour were ever used alcohol (yes; no), ever smoked (yes; no), and physical activity (yes; no). Physical activity engagement was measured from three items: a) does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate for at least 10 min continuously (yes; no); b) does your work involve moderate-intensity activity that causes small increases in breathing or heart rate for at least 10 min continuously? (yes; no); and c) Do you walk or use a bicycle (pedal cycle) for at least 10 min continuously to get to and from places? (yes; no). Respondents who responded “yes” to at least one of the three questions were considered “Yes” to physical activity, and all those who did not satisfy these criteria were considered “No” physical activity engagement. Sleep duration was initially recorded in hours, and then categorised into three responses (short sleep, ≤ 6 h; intermediate sleep, 6−9 h; long sleep, >9 h).

Health related variables included were Body Mass Index (underweight (BMI < 18.5); normal weight (BMI 18.5–<25); overweight (BMI 25 –<30), and obese (BMI ≥ 30)); diabetes (yes; no), multimorbidity (no NCDs; 1 NCD; 2+ NCDs and health status (good; moderate and bad). Multimorbidity was measured from nine chronic conditions, including cataracts, hypertension, depression, asthma, chronic lung disease, diabetes, angina, stroke, and arthritis. For each of these chronic conditions, respondents were asked “Have you ever been diagnosed with/told you have …….?” with response categories “yes = 1” and “no = 2”. Three categories were created for the variable: “No morbidity”, “Any one morbidity”, and “2 or more morbidities”.

We included household-related variables for Ghana, including

household financial situation (good, moderate, bad) and regular household income (yes, regular source; yes, regular but seasonal; no).

Finally, a measure of social network that was initially measured from nine questions, each with a response category "never = 1", "once or twice per year = 2", "once or twice per month = 3", "once or twice per week = 4", and "daily = 5" (See Appendix Table S2 questions). A composite score was created for the social network variable and was re-categorized as "never" and "at least once or twice per year".

2.3. Statistical analysis

Descriptive statistics were generated – absolute frequencies and percentages or mean and standard deviation where appropriate – and stratified by wave. Chi-square test and p-value were employed to examine the relationship between all categorical variables.

Four logistic mixed effects models with a random slope and a random y-intercept were used to examine the association between functional disability, outcome variable, and food insecurity and its measures – hunger and food insufficiency. Specifically, a univariate model was fitted to examine the association between food insecurity and its measures as independent variables and functional disability as a dependent variable. Subsequently, a multivariate model was employed, controlling for socio-demographic characteristics, then lifestyle, behavioural and health-related variables, and then finally, adjusting for household-related variables. The literature informed the selection of all covariates on food insecurity and functional disability. All covariates were considered as fixed effects after examining collinearity. All four models within logistic mixed effects were tested for fitness using Akaike Information Criteria (AIC), resulting in the choice of a random slope and a random y-intercept model because of the robustness of the model.

With regards to the mediation analysis, a two-stage approach was employed, a method consistently described in the literature on mediation analysis [24], to investigate whether childhood parental employment and adult education status mediate the relationship between food insecurity and functional disability in adulthood. In the first stage, there should be a significant association between food insecurity, childhood parental employment, and adult education status before proceeding to the second stage. After fulfilling the first-stage condition, the second-stage analysis included either childhood parental employment or adult education status, a potential mediator(s), as an additional variable in the regression model linking food insecurity to functional disability. To conclude that childhood parental employment or adult education status is a mediator, the ORs of food insecurity should become statistically insignificant, or the ORs of food insecurity should be reduced in size ($\delta_1 < \beta_1$) after controlling for the effect of childhood parental employment and adult education status [24].

All statistical analyses were performed using STATA 16.1 (StataCorp, College Station, Texas). For all tests and models, a two-tailed p-value of <0.05 was considered as statistically significant.

3. Results

Table 1 presents the sample characteristics by wave. Across the three waves, the total sample aged 60+ years was 7,195 for Ghana and 4,663 for South Africa.

In Ghana, the mean age of respondents was approximately 71 years (SD = 8.6) across the three waves. Respondents were predominantly female and married or cohabiting across all three waves. In terms of education, most respondents reported having no formal education in Waves 1 and 2. Most respondents lived in rural areas across the three waves (W1: 61.4%; W2: 60.1%; W3: 53.3%). Regarding lifestyle and behavioural factors, most respondents had never used alcohol (W2 and W3), never smoked cigarettes (all waves), engaged in work-related physical activity (W1 and W2), reported a sleep duration of 7–9 h (all waves), and had a normal BMI (all waves). Regarding health, most respondents reported good overall health (W2 and W3), and more than half lived without any chronic conditions. Almost all the respondents had a strong social network across the three waves. In terms of household factors, most respondents reported their financial situations as bad, although most lived in a household with a regular source of income across the three waves. Most respondents reported being food secure, specifically reporting no hunger and insufficient food across the three waves. Functional disability declined from 18.8% in W1 to 16.0% in W2 but then increased to 17.3% in W3.

In South Africa, the mean age of respondents was 70 years (SD = 7.6), with the majority being females, and most being widowed across two waves (W2 and W3). Moreover, most respondents had never attended school and resided in urban areas (in all waves). With regards to the lifestyle and behavioural variables, the majority had never used alcohol, never smoked cigarettes, had not engaged in work-related physical activity (W2 and W3), enjoyed a sleep duration of 7–9 h, while many were obese across the three waves. In terms of health, most respondents reported moderate health (W1) to good overall general health (W2 and W3). Many respondents lived without diabetes, but with two or more chronic conditions (W2 and W3). In terms of social networks, almost all respondents had a strong social network. Most respondents were food secure and had lived without experiencing hunger nor food insufficiency in all three waves. Functional disability increased from W1 (15.7%) to W2 (19.0%) and subsequently declined to W3 (16.7%).

3.1. Association between food insecurity and functional disability

There was a significant increase in functional disability prevalence among those reporting moderate to severe food insecurity, experiencing hunger and insufficient food across the three waves, with a trend test p-value of 0.0001 (Fig. 1a,b, Fig. 2a,b, and Fig. 3a,b). In South Africa, the functional disability prevalence among moderate to severe food insecure respondents increased in W2 from W1 and later declined in W3. In Supplementary Table S3, being food insecure was significantly associated with functional disability in W2 and W3 but not in W1. Specifically, experiencing hunger was significantly associated with functional disability in W2 and W3 but not in W1. Similarly, food insufficiency showed a statistically significant association in W2 and W3 but not in W1 (see Supplementary Table S3). For South Africa, food insecurity was significantly associated with functional disability in W1 and W2, but not in W3. The association of hunger and food insufficiency with functional disability followed similar findings with a significant association in W1 and W2 but not in W3 see Supplementary Table S3).

Logistic mixed effects regression model with random slope and random y-intercept found an association between food insecurity, hunger, insufficient food, and functional disability in all Models 1−4. In the unadjusted model, subjects being food insecure, experiencing hunger, or consuming insufficient food had higher odds of functional disability compared to their respective counterparts for both Ghana and South Africa (Table 2). This significant difference remained for food insecurity and food insufficiency for Ghana and South Africa after adjusting for socio-demographic variables (Model 2), health, lifestyle, and behaviour factors (Model 3), and household-related factors (Model 4). Regarding hunger, although the significant association remained for South Africa in Model 2 and Model 3, while the association in Ghana was not statistically significant after adjusting for covariates (Model 2-Model 4).

3.2. Examining the mediating role of childhood parental employment and adult education

The mediating role of childhood parental employment and adult education status (i.e. SES) in the association between food insecurity and functional disability in adulthood among adults in Ghana and South Africa was explored (See Table 3). For Ghana, the first-stage test presented in the Columns 1–3 shows the effects of exposure to food

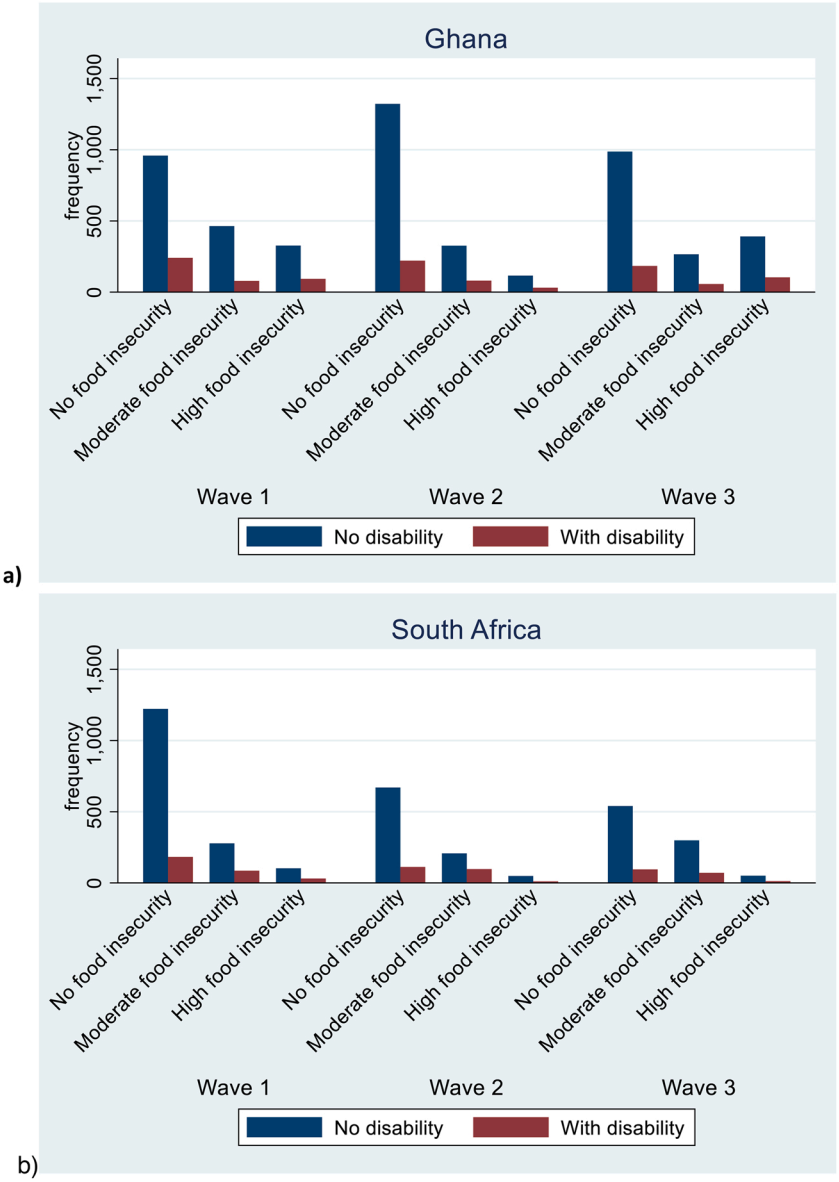


Fig. 1. Functional disability according to the category of food insecurity among older adults (60+ years), by study wave.

insecurity, hunger, and food insufficiency on parental employment (mothers and fathers) and adult education. Food insecurity and its measures had a statistically significant association with childhood parental employment and adult education status. The second test showed that parental employment and adult education status independently have a statistically significant association with lower odds of functional disability in adulthood, indicating that childhood parental employment and adult education reduce functional disability. However, the inclusion of childhood parental employment and adult education status in Columns 4–6 made the associations between food insecurity and its measures with functional disability statistically insignificant. The mediation analysis results support that childhood parental employment and adult education status are important mediators through which exposure to food insecurity and its measures influence functional disability in adulthood.

Similarly, in South Africa, the first-stage test depicted in Columns 1–3 shows the effects of exposure to food insecurity, hunger, and food insufficiency on childhood parental employment and adults' education. Food insecurity, hunger, and food insufficiency were significantly associated with higher odds of childhood parental employment and adult socioeconomic status. The second test depicted that childhood mother employment, not father employment, and adult socioeconomic status were statistically significantly associated with lower odds of functional disability in adulthood, indicating that childhood mother employment and adult SES reduce functional disability in adulthood. However, the inclusion of mother employment during childhood and adult socioeconomic status (i.e. education) in Columns 4–6 resulted in the associations between food insecurity, hunger, and food insufficiency, and functional disability becoming statistically insignificant. The mediation analysis results support that childhood mother employment and adult SES are relevant pathways through which exposure to food insecurity and its measures influence functional disability in adulthood.

4. Discussion and implications

This study provides strong evidence that food insecurity is a significant predictor of functional disability among older adults in two countries in sub-Saharan Africa. Childhood parental employment and adult socioeconomic status were found to be mediators in the association between food insecurity and functional disability. The longitudinal

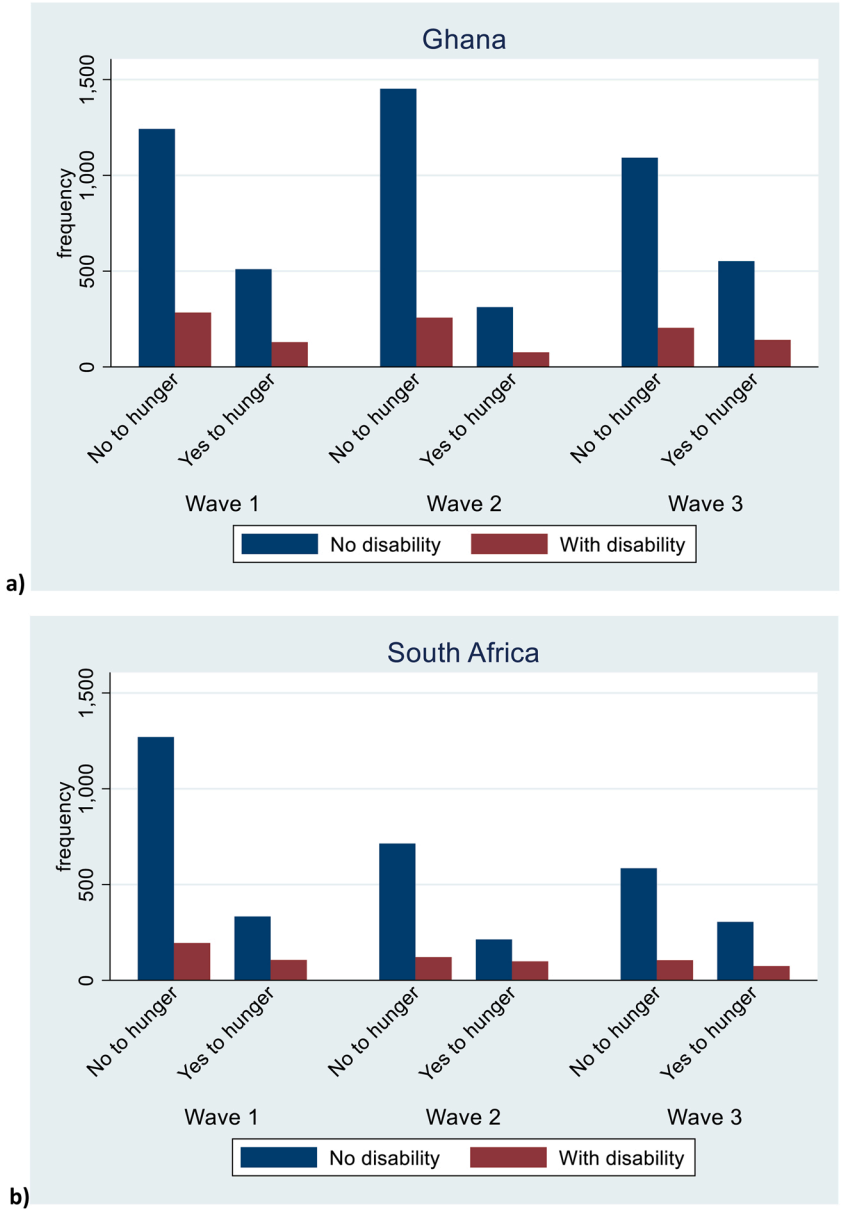


Fig. 2. Functional disability according to the category of hunger among older adults (60+ years), by study wave.

design of the WHO-SAGE study that tracked respondents over a decade strengthens the causal inference that food insecurity precedes and contributes to functional decline among older adults, rather than merely being a consequence of it. Notably, food insecurity prevalence increased across the three waves for the South African cohort, but for Ghana, it declined in Wave 2 and increased again in Wave 3. The strength of the association between food insecurity and functional disability was notably consistent, yet it was distinctively stronger in South Africa than in Ghana. Additionally, the experience of hunger remained a powerful independent predictor of functional disability in South Africa, even after full adjustment of many covariates, but not in Ghana. These findings highlight food insecurity as a critical, modifiable risk factor for loss of functional independence in later life within resource-limited settings. Our results align with and significantly extend the existing body of evidence, which has primarily been established in high-income countries [25,26]

The current evidence strongly supports a full mediation model, wherein the effect of food insecurity is entirely channelled through socioeconomic pathways, namely childhood parental employment and adult education status, yet with critical nuances between the two countries. The mediators are perfectly aligned with the concept of socioeconomic status as a "fundamental cause" of disease, as articulated by Link and Phelan [27], wherein resources such as money, knowledge, and social connections determine health outcomes by providing the means to avoid risks and mitigate health threats. This framework is particularly relevant in sub-Saharan African contexts, where formal social safety nets are often limited, and families must rely on their own socioeconomic resources to buffer against health shocks. As noted in the literature, even where social protection measures exist, they may be insufficient to fully protect households from food insecurity [6]. The current study results operationalize this theory across the lifespan. Parental employment represents the upstream resource that provides financial stability, buffers against crises, and enables investments in a child's health and cognitive development [28,29]. Its significant role underscores that a family's economic capacity is a primary defence against the long-term health consequences of food insecurity [30]. Simultaneously, adult educational attainment represents the downstream resource that an individual carries into adulthood—as a powerful determinant of health, it

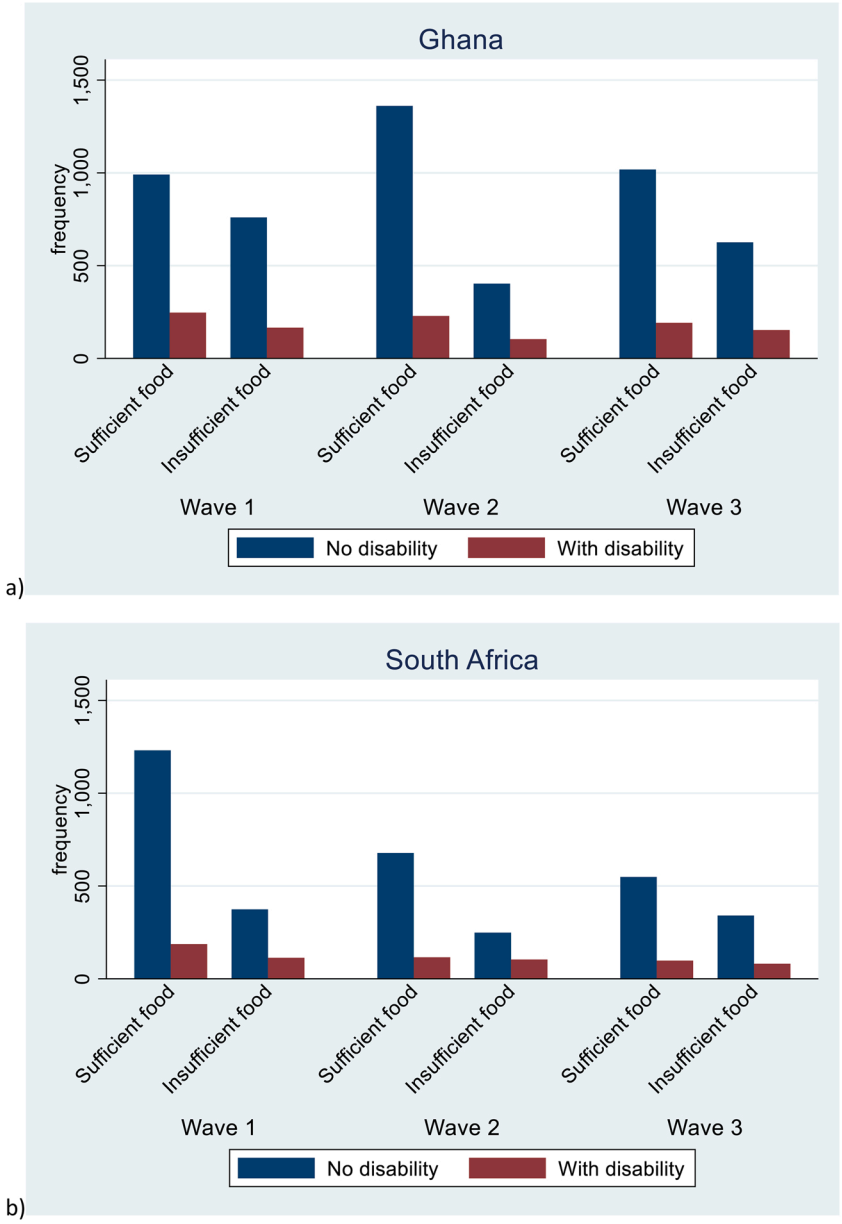


Fig. 3. Functional disability according to the category of insufficient food among older adults (60+ years), by study wave.

shapes future employment opportunities, health literacy, and problem-solving skills [31]. Education equips individuals with the knowledge and agency to navigate health systems, adopt preventive health behaviours, and secure better livelihoods, thereby breaking the cycle of disadvantage. This aligns with evidence that adult socioeconomic status, including education, mediates the food insecurity-disability association [14,15]. The findings confirm previous studies in Ghana that food insecurity is associated with increased functional limitations among older adults [4,23]. The new finding of a strong, independent link between low education and higher functional disability risk illustrates how an early nutritional shock can "get under the skin" by first limiting future opportunities, thereby increasing the likelihood of occupational hazards, chronic stress, and poor health behaviours in adulthood [32].

The consistent observation of full mediation in both national contexts challenges a purely direct or physiological link and strongly supports a life course perspective, where early factors such as childhood parental employment contribute to a chain of socioeconomic disadvantage that culminates in poor health outcomes later in life [33,34]. This chain of risk model suggests that disadvantage at one life stage increases the probability of subsequent disadvantage, creating a cumulative effect that ultimately manifests as functional decline in old age [10,11]. The results demonstrate that food insecurity in adulthood does not operate in isolation but is influenced by parents' employment during childhood. This finding also aligns with a growing body of literature from other Sub-Saharan African countries, which shows that household economic shocks have lasting intergenerational impacts on child health and human capital [35,36]. Furthermore, studies confirm that childhood socioeconomic status is a potent mediator, as food insecurity results from and contributes to low socioeconomic status in childhood [12,13].

While the overarching mediating mechanism is consistent, the differential role of parental employment in Ghana versus South Africa offers a compelling insight into contextual socio-economic structures. In Ghana, the significant mediating role of both mothers' and fathers' employment suggests a model where the total household economic resource pool is paramount. This pattern is often observed in settings where dual incomes are necessary for financial resilience and where

Table 2
Results of logistic mixed effects models with random slope and a random y-intercept of functional disability and food insecurity.

	Model 1	Model 2	Model 3	Model 4
Ghana				
N	6,249	6,228	5,688	6,168
Food insecurity (ref = food secure)	(OR = 1.20, 95% CI: 1.03, 1.40, **p = 0.019)**	(aOR = 1.25, 95% CI: 1.07, 1.47, p = **0.005)**	(aOR = 1.13, 95%CI: 1.05, 1.44, p = **0.009)**	(aOR = 1.20, 5% CI: 1.03, 1.41, p = **0.024)**
N	6,251	6,230	6,251	6,170
Hunger (ref = No)	(OR = 1.31, 95% CI: 1.12, 1.55, p=**0.001)**	(aOR = 1.35, 95%CI: 1.15, 1.60, p**<0.001**)	(aOR = 1.18, 95%CI: 0.86, 1.64, p = 0.307	(aOR = 1.15, 95% CI: 0.83, 1.61, p = 0.403)
N	6,250	6,250	6,250	6,169
Insufficient food (ref = No)	(OR = 1.21, 95% CI: 1.03, 1.41, p=**0.018)**	(aOR = 1.25, 95%CI: 1.07, 1.47, p=**0.006)**	(aOR = 1.23, 95%CI: 1.05, 1.44, p = **0.010)**	(aOR = 1.21, 95% CI: 1.03, 1.42, p = **0.018)**
South Africa				
N	4,119	3,826	3,548	2,603
Food insecurity (ref = food secure)	(OR = 2.08, 95%CI:1.70, 2.54, **p < 0.001**)	(aOR = 2.16, 95%CI:1.71, 2.73, **p < 0.001)**	(aOR = 1.98, 95%CI:1.54, 2.56, **p < 0.001)**	–
N	4,120	3,827	3,549	2,604
Hunger (ref = No)	(OR = 2.15, 95%CI:1.75, 2.65, **p < 0.001**)	(aOR = 2.24, 95%CI:1.76, 2.86, **p < 0.001**)	(aOR = 2.01, 95%CI:1.55, 2.62, **p < 0.001**)	–
N	4,121	3,828	3,549	2,604
Insufficient food (ref = No)	(OR = 2.02, 95%CI:1.65, 2.46, **p < 0.001**)	(aOR = 2.09, 95%CI: 1.65, 2.64, **p < 0.001**)	(aOR = 1.96, 95%CI:1.52, 2.53, **p < 0.001**)	–

Model 1. Univariate model with food insecurity, hunger or food insufficiency as the independent variables and functional disability as the dependent variable.
Model 2. Model 1 adjusted for sociodemographic variables: **sex, location of residence, marital status, age.**
Model 3. Model 2 adjusted health, lifestyle and risk behaviours: **ever drank alcohol, ever smoked, sleep duration, health status, multimorbidity, BMI, social network, and physical activity.**
Model 4. Model 3 adjusted for household related factors: **household regular income and household financial situation.**

investments in children are perceived as a collective household responsibility [37]. In contrast, the South African finding that only maternal employment mediates the relationship echoes a well-documented phenomenon in poverty research, sometimes referred to as the "feminization of poverty" and its consequences [38,39]. Extensive evidence indicates that mothers are more likely to allocate additional income directly towards children's nutrition, health, and educational expenses [40,41]. This maternal investment effect may be particularly pronounced in South Africa due to the historical legacy of male labour migration, which disrupted traditional family structures and placed women at the centre of household survival strategies [42]. This effect may be particularly pronounced in contexts like South Africa, which has a high prevalence of female-headed households and a history of male labour migration that can disrupt the direct link between fathers' employment and daily household well-being [42].

When situated within the broader global literature, these findings converge with and diverge from patterns observed in high-income countries (HICs). The central role of adult educational attainment as a potent mediator is a universally consistent finding. Research from HICs has long established that early-life disadvantage impairs educational achievement, which in turn is a fundamental cause of health disparities, including functional limitations, in later life [43,44]. However, the pronounced mediating role of childhood parental employment observed in this study may be more specific to lower- and middle-income country (LMIC) settings. In many HICs with strong social safety nets (e.g., unemployment benefits, child tax credits), the immediate link between parental job loss and severe household food insecurity may be partially buffered [45,46]. In contrast, in contexts like Ghana and South Africa, where informal employment is prevalent and social protection is often limited, parental unemployment can directly and catastrophically impact a household's ability to secure basic needs, creating a more direct pathway to the developmental disruptions that precede adult disability [47]. This underscores the need for context-specific policy responses that strengthen not only individual-level resources but also the broader structural supports available to families. Such responses are crucial for achieving Sustainable Development Goal 2 (Zero Hunger) and informing public and social policies on healthy aging and long-term care [4].

5. Limitations and future research

The strengths of this study include its longitudinal design, the use of large, nationally representative samples from two African countries, and the examination of the mediating roles of childhood and adulthood socioeconomic factors. However, several limitations should be acknowledged. First, the measures of both food insecurity, functional disability, and childhood socioeconomic status were self-reported, which may introduce recall bias and social desirability bias. Second, the measure of childhood parental employment relied on retrospective recall of circumstances at age 10, which may be subject to memory decay or inaccurate recollection, particularly among the oldest respondents.

Third, given the number of questionnaire items and statistical tests performed, the issue of multiple comparisons should be considered. WHODAS 2.0 includes 12 items across six domains of functioning, and the social network measure comprises nine items, thereby increasing the number of analyses conducted. This raises the potential for inflated Type I error (false positive findings). However, it is important to note that these items were not treated as independent Likert-scale responses for separate hypothesis testing. Rather, they were combined into composite scores (WHODAS 2.0 total score and social network composite score) using established scoring protocols [17], which reduced the number of statistical comparisons. Furthermore, the primary analyses focused on pre-specified hypotheses derived from the life-course perspective and existing literature, rather than exploratory data-driven testing. While we acknowledge this limitation, future studies should aim to replicate these results in independent samples.

Fourth, despite extensive adjustments, residual confounding is possible from unmeasured factors, such as specific dietary patterns, the quality of social support, or underlying genetic predispositions. Fifth, as with any long-term study, attrition over the 10-year follow-up could have introduced selection bias if those who dropped out were systematically different in their health and food security status. Finally, while the two-country comparison is a strength, the findings may not be generalizable to other sub-Saharan African countries with different socioeconomic and cultural contexts, given that the prevalence and experience of food insecurity vary across the region. Therefore, future research should focus on longitudinal studies that incorporate objective biomarkers of nutrition, qualitative research to understand the lived experiences of food insecurity in these populations, and intervention trials to evaluate the effectiveness of integrated food-based programs in preventing disability among vulnerable older adults.

6. Conclusion

This study from two African countries demonstrates that the association between food insecurity and functional disability in older adults is fundamentally socioeconomic in nature. The cross-national comparison identifies that, while the mediating pathway through adult education is a common mechanism, the specific role of childhood parental

Table 3
The mediating role of childhood parental employment and adult education status on food insecurity and functional disability associations.

Ghana	(1) Father employment	(2) Mother employment	(3) Adult education status	(4) Functional disability	(5)	(6)
Father employment				(aOR = 0.49, 95%CI: 0.40, 0.69) **		
Mother employment					(aOR = 0.55, 95% CI: 0.42, 0.72) **	
Adulthood education status						(aOR = 0.57, 95% CI: 0.46, 0.69) **
Food insecurity (overall)	(aOR = 0.50, 95%CI: 0.38, 0.64) **	(aOR = 0.50, 95% CI: 0.39, 0.64) **	(aOR = 0.70, 95%CI: 0.55, 0.91) **	(aOR = 0.80, 95%CI: 0.59, 1.09, p = 0.155)	(aOR = 0.82, 95% CI: 0.60, 1.11)	(aOR = 0.89, 95% CI: 0.68, 1.16)
Hunger	(aOR = 0.45, 95%CI: 0.34, 0.59) **	(aOR = 0.51, 95%CI: 0.39, 0.66) **	(aOR = 0.68, 95%CI: 0.51, 0.90) **	(aOR = 0.87, 95%CI: 0.61, 1.25, p = 0.456)	(aOR = 0.92, 95% CI: 0.65, 1.30)	(aOR = 0.93, 95% CI: 0.69, 1.26)
Food insufficiency	(aOR = 0.47, 95%CI: 0.37, 0.62) **	(aOR = 0.47, 95%CI: 0.37, 0.61) **	(aOR = 0.74, 95%CI: 0.57, 0.96) **	(aOR = 0.79, 95%CI: 0.57, 1.09, p = 0.146)	(aOR = 0.80, 95% CI: 0.58, 1.11)	(aOR = 0.56, 95% CI: 0.45, 0.68)
South Africa	Father employment	Mother employment	Adult education status	Functional disability		
Father employment				(aOR = 0.84, 95% CI: 0.60, 1.17)		
Mother employment					(aOR = 0.73, 95%CI: 0.54, 0.99) *	
Adulthood education status						(aOR = 0.69, 95% CI:0.50, 0.94) *
Food insecurity - overall	(aOR = 0.01, 95%CI: 0.00, 0.05) **	(aOR = 0.04, 95%CI: 0.02, 0.11)	(aOR = 0.46, 95%CI: 0.22, 0.96) *	–	(aOR = 0.21, 95%CI: 0.83, 2.37)	(aOR = 1.50, 95%CI: 0.91, 2.46)
Hunger	(aOR = 0.04, 95%CI: 0.02, 0.11) **	(aOR = 0.51, 95%CI: 0.39, 0.66)	(aOR = 0.45, 95%CI: 0.25, 0.83) *	–	(aOR = 0.51, 95%CI: 0.88, 2.58)	(aOR = 1.60, 95%CI: 0.96, 2.67)
Food insufficiency	(aOR = 0.01, 95%CI: 0.00, 0.03) **	(aOR = 0.47, 95%CI: 0.37, 0.61)	(aOR = 0.48, 95%CI: 0.23, 0.99) *	–	(aOR = 1.33, 95%CI: 0.78, 2.28,)	(aOR = 1.37, 95%CI: 0.82, 2.29)
Control variables						
Marital status	YES	YES	YES	YES	YES	YES
Age	YES	YES	YES	YES	YES	YES
Location of residence	YES	YES	YES	YES	YES	YES
Sex	YES	YES	YES	YES	YES	YES
Ever smoke	YES	YES	YES	YES	YES	YES
Ever used alcohol	YES	YES	YES	YES	YES	YES
Health - self-report	YES	YES	YES	YES	YES	YES
Multimorbidity	YES	YES	YES	YES	YES	YES
Sleep duration	YES	YES	YES	YES	YES	YES
Body mass index	YES	YES	YES	YES	YES	YES
Physical activity	YES	YES	YES	YES	YES	YES
Social network	YES	YES	YES	YES	YES	YES
Household financial situation	YES	YES	YES	YES	YES	YES
Household regular income	YES	YES	YES	YES	YES	YES
Wave effect	YES	YES	YES	YES	YES	YES

*$p < 0.05$, **$p < 0.01$.

employment is shaped by local gendered and economic structures. The findings reinforce the importance of adopting a life-course approach to healthy ageing, recognizing that interventions to prevent functional disability must begin early in life. Policy interventions aimed at breaking this cycle need to be multifaceted, combining social protection to safeguard parental livelihoods, particularly for mothers, with investments in education to ensure that children from vulnerable households are equipped with the socioeconomic resources to maintain their functional health throughout adulthood.

CRediT authorship contribution statement

All authors meet the authorship criteria as outlined in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. [Kofi Awuviry-Newton]: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft, Supervision; [Jacob Oppong Nkansah, Samuel Ampadu Oteng, Daniel Doh, Bernadette Saunders, Nestor Asiamah]: Project administration, Resources, Validation, Writing – Review & Editing; [Barbara Corso, Karen Chalton]: Formal Analysis, Writing – Review & Editing; [Paul Kowal]: Supervision, Project Administration, Data Curation, Funding Acquisition, Investigation, Resources, Writing – Review & Editing. All authors have reviewed and approved the final manuscript.

Declaration of Generative AI and AI-assisted technologies in the writing process

The authors did not use ChatGPT (OpenAI) to either improve readability or write any section of the manuscript.

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Data statement

The data that support the findings of this study are from the WHO Study on global AGEing and adult health (SAGE) for Ghana and South Africa (Waves 1–3). These data are publicly available through the World Health Organization (WHO) SAGE Data Archive (http://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/sage) and can be accessed upon completion of a data request form and subject to WHO data usage terms and conditions. Further information is available at https://www.who.int/data/data-collection-tools/study-on-global-ageing-and-adult-health/sage-waves

Declaration of competing interest

The authors declare no conflict of interest

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jnha.2026.100884.

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