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COVID-19-induced Food Insecurity and Adolescent Wellbeing - One Year Post-COVID

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Abstract

This study examines the relationship between COVID-19-induced food insecurity (C-FI) and adolescent wellbeing one year after the height of the pandemic in Nigeria. Drawing on Pearlin's Stress Process Model, the study investigates how pandemic-related food insecurity relates to three indicators of subjective wellbeing: life satisfaction, perceived life improvement, and optimism. Data were derived from 7,246 adolescents aged 15–17 in the nationally representative 2021 Nigeria Multiple Indicator Cluster Survey (MICS-6). C-FI was measured using the Food Insecurity Experience Scale (FIES), adapted to identify experiences specifically linked to COVID-19 disruptions. Binary logistic regression analyses showed no significant associations between either the experience or severity of C-FI and the selected wellbeing outcomes. However, moderation analysis revealed that regional and gender differences significantly influenced these relationships. Notably, adolescents in the SouthWest and South East zones reported higher life satisfaction and optimism despite experiencing food insecurity, suggesting the presence of contextual protective factors. In contrast, female adolescents experiencing food insecurity were less likely to report optimism, highlighting gender-based disparities in psychosocial vulnerability. Findings suggest that the psychological effects of C-FI may be diminished in contexts where food insecurity is chronic and normalized. The results underscore the importance of considering structural poverty, regional disparities, and gender when evaluating adolescent wellbeing in post-crisis settings. This study contributes to the limited body of research on the mid-term mental health impacts of COVID-19 among adolescents in low-income settings and highlights the need for regionally tailored and gender-sensitive interventions.

Keywords COVID-19 · Food insecurity · Wellbeing · Adolescents · Optimism · Life satisfaction · Nigeria

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1 Introduction

The COVID-19 pandemic brought widespread disruption to the everyday lives of adolescents, particularly in low- and middle-income countries where household resilience and public health infrastructure were already under strain. Evidence from global studies has shown that adolescents experienced declines in wellbeing during the pandemic (Favara et al., 2022; Higashi et al., 2022; Patrick et al., 2020; Samji et al., 2022). A key factor contributing to this decline is food insecurity, a pressing issue that worsened significantly during the pandemic due to income loss and school closures (Favara et al., 2022; Higashi et al., 2022; Ward & Lee, 2022).

Adolescents are particularly vulnerable to the effects of food insecurity (Frongillo et al., 2024; McLaughlin et al., 2012; Shankar-Krishnan et al., 2021), not only because of their developmental needs but also due to their reliance on family systems and institutional supports, such as school feeding programs (Temple et al., 2022). While the short-term effects of COVID-19-induced food insecurity (C-FI) on adolescent mental health have received some attention (Porter et al., 2022; Ward & Lee, 2022), the mid-term psychological consequences in the post-pandemic period especially regarding subjective wellbeing remain underexplored. This study addresses that gap by examining how C-FI relates to adolescent life satisfaction, perceived life improvement, and optimism, one year after the peak of the pandemic. In this study, the pandemic period is defined as the time of COVID −19 movement restriction (lockdown) in Nigeria characterised by school closures, movement restrictions, and economic lockdowns between early 2020 and July 2020 (Ibrahim et al., 2020).

This study is guided by Pearlin's Stress Process Model (SPM), which explains how external stressors, internal resources, and resulting outcomes interact to influence mental health and wellbeing (Pearlin et al., 1981). In this model, stressors such as food insecurity are adverse conditions that threaten functioning, resources refer to personal and social supports that buffer stress, and outcomes are the emotional and psychological consequences, including subjective wellbeing. Within this framework, COVID-19-induced food insecurity (C-FI) functions as a stressor that may compromise adolescent wellbeing if unbuffered by adequate coping resources. The model underscores the need to examine how stress exposure and resilience factors interact, particularly in crises where traditional supports (e.g., school, family networks) are disrupted. Applying this framework allows for a nuanced understanding of how COVID-19–induced food insecurity (C-FI) impacts adolescent wellbeing, while accounting for potential confounders.

Food insecurity is generally categorized into chronic and transitory (incidental) forms (Food and Agriculture Organization of the United Nations, 2008). Chronic food insecurity is a long-term deprivation linked to persistent poverty and limited access to stable food sources. This form of deprivation can have cumulative and detrimental effects on adolescent wellbeing (Cole & Tembo, 2011; Frongillo et al., 2024).

In contrast, transitory food insecurity is short-term, often triggered by abrupt shocks such as economic downturns or natural disasters. While temporary, these episodes can still significantly impact adolescent wellbeing by increasing stress, uncertainty, and emotional distress especially in the absence of adequate coping mechanisms or

social support (Zhang et al., 2023). The psychological toll may include decreased life satisfaction, reduced optimism, and lower perceived improvement in life (Ling et al., 2022). However, the presence of robust familial, community, or institutional support can buffer the negative effects, particularly in regions with stronger safety nets and resilience capacities (Hammami et al., 2020).

COVID-19-induced food insecurity (C-FI) aligns with transitory food insecurity but is distinguished by its unprecedented scale, and global reach. C-FI emerged from pandemic-related factors such as lockdowns, income loss, market disruptions, and school closures all of which disproportionately impacted adolescents in low-income settings (Favara et al., 2022; Ward & Lee, 2022). C-FI thus represents a multidimensional stressor with the potential to shape adolescent development and wellbeing in both the short and medium term.

This study focuses on three subjective constructs, life satisfaction, improved life perception, and optimism as key indicators of adolescent wellbeing and resilience in the post-pandemic context. These constructs are particularly useful for understanding how young people appraise and adapt to adversity. They have been consistently associated with better mental health outcomes, greater resilience, and positive psychological adjustment in adolescents and they offer meaningful insight into psychosocial recovery following crises such as COVID-19.

Life satisfaction, a cognitive evaluation of one's overall life conditions (Diener et al., 1985), is positively associated with reduced emotional distress and higher psychological wellbeing among adolescents (Gilman & Huebner, 2006; Lombardo et al., 2018; Proctor et al., 2009). Research among adolescents facing economic hardship shows that those with higher life satisfaction report fewer symptoms of depression and anxiety, are more likely to engage in adaptive behaviours (Proctor & Linley, 2014; Suldo & Huebner, 2004). A study of Palestinian adolescents exposed to conflict and poverty, reported that higher life satisfaction was found to buffer the psychological effects of trauma and uncertainty (Veronese et al., 2017).

A recent review of literature among adolescents and young adults across five countries reports moderate associations between life satisfaction and resilience (Arifia & Amalia, 2024).

Improved life perception, which reflects adolescents' subjective evaluation of change in their life circumstances over time, is a valuable indicator of recovery and adjustment following crises. A survey of 4444 Portuguese adolescents during the COVID-19 pandemic showed that adolescents who reported improved perception of their life had higher life satisfaction, optimism, resilience and lesser psychological distress (de Matos et al., 2023). People's overall wellbeing is shaped by their perception of how life satisfaction has evolved over time and their expectations for the future. When individuals perceive their wellbeing as improving, they tend to report higher overall wellbeing (Hong et al., 2019). In post-disaster and post-conflict settings, such perceptions are associated with a regained sense of control and hope, which are core dimensions of resilience (Ungar, 2011).

Optimism, defined as the general expectation of positive future outcomes (Kardas et al., 2019; Scheier & Carver, 1985), is a well-established predictor of resilience and psychological wellbeing. Among adolescents, optimism has been shown to reduce the impact of environmental stressors and promote effective coping in the face of

adversity (Bryant & Harrison, 2015). For instance, studies among Swiss adolescents aged 16–20 found that optimism significantly buffered the negative mental health effects of emergency-related stress during crisis periods (Eicher et al., 2014). Similar findings among Indian and Spanish adolescents demonstrate that higher levels of optimism are associated with enhanced subjective wellbeing and lower internalizing symptoms, even in the presence of structural challenges (Maheshwari & Jutta, 2020; Usán Supervía et al., 2020).

Taken together, these constructs are not only markers of psychological health but also indicators of adolescent resilience the capacity to adapt, recover, and grow despite experiencing adversity (Luthar et al., 2000; Ungar, 2011). In the aftermath of COVID-19, where adolescents have faced cumulative stress from disrupted education, economic instability, and social isolation, measuring these constructs offers valuable insight into their short- to mid-term wellbeing and capacity for recovery.

Specific research questions are:

1) Identify the relationship between C-FI and subjective wellbeing one year after the COVID-19 pandemic.
2) Investigate the relationship between C-FI and improved life perception one year after the COVID-19 pandemic;
3) Explore the relationship between C-FI and optimism, one year post-pandemic period.

2 Methods

2.1 Study Design and Data Source

Data for this study was extracted from the 2021 Nigeria UNICEF Multiple Indicator Cluster Survey Round Six (MICS 6) (UNICEF, 2024). MICS are household surveys that provide statistical and internationally comparable socioeconomic and health indicators estimates.(National Bureau of Statistics & United Nations Children's Fund, August, 2022).

The 2021 Nigeria MICS (6) was led by the Demography and Household Statistics Department of the National Bureau of Statistics (NBS) with technical support provided by UNICEF. It includes data on food insecurity due to COVID-19. Data was collected between September 2021 and December 2021. It is a national representative survey of children, men, and women in urban and rural areas across all 36 states and the Federal Capital Territory (FCT) in Nigeria. The survey uses a multi-stage, stratified cluster sampling approach. Five questionnaires were used in the survey to include Households, women, men, under 5 years and ages 5–17 years, respectively. The dataset is available on the MICS website (https://mics.unicef.org/surveys). The full data description and the detailed sampling procedure is available in the MICS 2021 report(National Bureau of Statistics & United Nations Children's Fund, August, 2022).

2.2 Study Sample

The study sample comprised 7,246 adolescents aged 15–17 who had experienced food insecurity, drawn from individual women's and men's datasets and merged with household files.

2.3 Ethics

The survey was approved by the MICS Steering and Review Committee. Verbal consent was obtained for each participant, adult consent was obtained before the child's assent for children aged 15–17.

2.4 Outcome Variables

The dependent variables in this study are: (1) Life satisfaction, (2) Improved life perception, and (3) Optimism. The survey used the approach used in several large-scale surveys, such as the Gallup World Poll, and the Health Behaviour in School-aged Children surveys to measure all the dependent variables (Roberts et al., 2009; Tortora et al., 2010). Missing data for all the outcome variables was low at 0.3%, 0.4%, and 0.5% for life satisfaction, improved life perception and optimism, respectively.

Life Satisfaction *Life Satisfaction was measured with the Cantril's Self-Anchoring Ladder. It is the image of a ladder with steps numbered from '0' at the bottom to '10' at the top. The mean life satisfaction score for the study sample was 6.36 (Standard Deviation = 0.12), so the variable was dichotomised as poor life satisfaction for 0–5 coded as "0" and 6–10 for a satisfied life coded as " 1" in the analysis. Following OECD guidelines (Organisation for Economic Co operation and Development, 2013), the Cantril Ladder was dichotomized into low (0–6) and high (7–10) life satisfaction. Dichotomizing the scale enhances model interpretability in logistic regression, facilitates comparability, and aligns with international standards for measuring subjective wellbeing. This approach, employed in multiple studies (Due et al., 2019; Levin et al., 2011; Wahlström et al., 2021), mitigates bias arising from individual differences in reporting intensity (Diener & Biswas-Diener, 2002) and accounts for cultural variability in scale interpretation (Levin et al., 2011).*

Improved Life Perception This was assessed by "compared to this time last year, would you say that your life (a) has improved, (b) stayed more or less the same, (c) or worsened, overall? Dichotomised for easy of interpretation of result and recoded as "1"- improved for "has improved" and 0 - Not improved for "stayed more or less the same" and "worsened".

Optimism This was assessed by "in one year from now, do you expect that your life will be(a) better, (b) will be more or less the same, (c) or will be worse, overall? This item was used to capture optimism based on availability within the dataset. Implication of its use are discussed in the discussion section. Dichotomised for easy of inter-

pretation of result and recoded as "1"- Optimistic and 0 - Not optimistic for "stayed more or less the same" and "worsened" for easy of interpretation of result.

The independent variable is COVID-19–induced food insecurity (C-FI). This was computed from the Food Insecurity Experience Scale (FIES) scale adapted to capture if the experience was due to COVID − 19. FIES includes eight binary questions (Yes, No) that assess the experience of food insecurity. "Do not know", and "no response" were treated as missing. MICS (6) included further questions on whether each item on the scale was experienced due to the COVID-19 pandemic. An example of the items on the scale is "Did household worried about not having enough food to eat because of a lack of money or other resources" followed by "Was this specifically due to the COVID-19 crisis?" This study (used sample population) extracted cases that responded yes to the any (at least one item) of the FIES items only. The CFI was calculated from the follow up question that assessed whether FIES items were experienced due to COVID-19. This implies that this study compares C-FI to Food insecurity (FI) experienced for other reasons.

The FIES was created by FAO as a global reference measure for food insecurity, as acceptable internal validity and reliability for sub-Saharan Africa (where this study is located), has been used in various studies to include Nigeria and in the annual Gallup World Poll across 147 countries since 2014 (Ballard et al., 2013; Ballard et al., 2014; Wambogo et al., 2018).

In this study, the C-FIES scale was used in two ways to assess our research questions. First, the binary version of the variable, where it was recoded as a binary outcome. Food Insecure was coded as "I" for experience of any item due to COVID − 19 and "0" as Food Secure for not experiencing any form of COVID-19-induced Food insecurity. Missing data for this was 0.2%.

Secondly, the "Probability of moderate severe food insecurity " an international comparable interval variable was derived from the FIES participant's raw score. The participants raw score is an ordinal scale and it's the sum of the yes to all 8 items on the scale. The severity parameter is generated by the FIES application by calibrating the participant's raw score against the FIES global standard. The "Probability of moderate or severe FI" refers to the severity of C-FI, and is used to assess whether the severity of the experience is associated with the outcome variable, including providing internationally comparable evidence. The FAO-recommended guidelines were followed in the calibration and validation of the FIES (Ballard et al., 2013). To ensure that all the Rasch modelling criteria were satisfied, the "Worried" item ("worried about not having enough food to eat because of a lack of money or other resources, especially due to the COVID-19 crisis") on the scale was excluded. Three Item "worried", "skipped a meal" "healthy food" and "hungry "were used as the unique item for equating. See Food and Agriculture Organization of the United Nations (2018) for details about item and labels. Rasch reliability was 0.63, acceptable for a seven-item scale. The correlation between common items was 98.4% ($r = 0.984$), indicating a very strong positive relationship, with approximately 96.8% shared variance ($r^2 = 0.968$). Outfit was between 0.73 to 1.31, and infit was between 0.7 to 1.2, and all residual correlations were less than 0.4. This seven-item FIES calibration only relates to analysis that used the Probability of moderate or severe FI.

Within the sample, only 0.2% were missing responses on all eight FIES items; the rest had partial nonresponse. In line with the Food and Agriculture Organization (FAO)'s technical guidelines, we did not impute missing FIES data. The FAO recommends excluding any cases with missing responses during Rasch calibration to maintain psychometric validity and international comparability (Food and Agriculture Organization of the United Nations, 2018) (FAO, 2018). Accordingly, the FIES App which generates the probability of moderate or severe Food insecurity automatically excludes partially missing cases, resulting in 71% missing data for this score. Missing Value Analysis using Little's MCAR test indicated that the missingness pattern was not significantly different from random ($\chi^2 = 1.187$, df = 1, $p = .276$), suggesting that the data were Missing Completely at Random (MCAR).

While the high level of exclusion is acknowledged, our approach aligns with global standards for deriving FIES indicators. Only respondents with complete FIES data were included in Rasch modeling and subsequent analyses to ensure the validity and comparability of the food insecurity estimates. The potential limitations of excluding partially missing cases are discussed in the relevant section.

Based on the stress process model, participant background and contextual characteristics were captured with the following variables:

Sex: This refers to the binary categorization usually designated at birth. Study data only includes this binary categorisation. Male coded as 0 and female 1.

Age: The weighted mean age is 15.91 years (SE = 0.013, 95% CI [15.89, 15.94]).

Household wealth: This study used the MICS wealth index. The MICS wealth index variable is calculated from participants' household characteristics, possessions, and assets (e.g., internet access, number of rooms for sleeping, ownership of television, radio, vehicles, and access to electricity, among others). Households are then ranked based on individual scores to range between the poorest (0), second quintile (1), middle (2), fourth quintile (3), and richest (4). Details are in Table 1.

Area: Rural is coded as "2"and urban is coded as "1".

Zone of residence: This includes the six geopolitical zones in Nigeria: NorthCentral, NorthEast, NorthWest, SouthSouth, SouthEast, and SouthWest. Each zone consists of six states except for North Central, which includes the Federal Capital Territory and there are cultural differences across the zones.

The model also emphasizes the role of social and institutional resources in moderating the effects of stress. To capture these protective factors, two variables were included:

Children's living arrangement: This variable served as a proxy for family support, a key psychosocial resource. Adolescent were categorised as 1 "living with at least one parent", and living with no parent was coded as "0." This was computed from the questions relating to whether the adolescent's natural mother and father lived within the household.

School attendance in current school year: Coded Yes as "2" and "No" as 1. This variable acts as proxy for access to social and institutional support, particularly relevant in the Nigerian context where out-of-school rates are high (UNESCO,

Table 1 Descriptive statistics for sociodemographic characteristics

Variable	Category	Estimate (%)	SE (%)	95% CI Lower	95% CI Upper
Age	15	38.3	0.8	36.8	39.8
	16	32.0	0.8	30.4	33.6
	17	29.7	0.8	28.2	31.2
Area	Urban	43.1	1.9	39.4	46.9
	Rural	56.9	1.9	53.1	60.6
Geopolitical Zone	North Central	14.9	0.7	13.6	16.3
	North East	14.2	0.8	12.7	15.9
	North West	28.8	1.2	26.5	31.1
	South East	11.3	1.6	8.6	14.8
	South South	14.6	0.9	12.9	16.4
	South West	16.2	0.9	14.6	18.0
Gender	Male	34.3	0.8	32.7	36.0
	Female	65.7	0.8	64.0	67.3
School Attendance	No	20.3	0.9	18.6	22.1
	Yes	79.7	0.9	77.9	81.4
Children's living arrangement	No parent in household	12.8	0.8	11.4	14.3
	At least one parent in household	87.2	0.8	85.7	88.6
Household wealth	Poorest	19.2	1.0	17.3	21.2
	Second	19.1	0.8	17.6	20.8
	Middle	22.8	1.0	20.9	24.7
	Fourth	22.4	1.0	20.4	24.5
	Richest	16.5	1.2	14.3	19.0

2022; UNICEF, 2022). Research shows that positive school environments are linked to adolescent wellbeing (Zullig et al., 2018).

2.5 Data Preparation and Analysis

Data analysis began by recoding the selected variables after appending both male and female datasets. Datasets were checked for missing values and outliers. The data set was weighed to account for the sampling design, and all statistical analyses accounted for the complex survey design. A univariate analysis of study variables was conducted to provide a descriptive statistic of the study sample. Univariate analysis was conducted with SPSS. All other analyses were conducted with STATA. Chi-square association tests was performed to check the association between all variables. Two regression models were conducted for each of the research questions. The first model for each research question assessed the association between experience of any form of C-FI and the outcome variable using the binary version of C-FI measure. In the second model's, the "Probability of moderate or severe FI" variable was used to assess associations between the severity of C-FI outcome variables. This assessment method was necessary to capture the impact of C-FI at all levels to inform policy, including providing nationally and internationally comparable evidence. For descrip-

tive analysis, the binary version, which implies any experience of food insecurity, was used. All statistical tests were two-tailed, associations in logistic analysis are presented as Odds Ratios (OR) and $P<.05$ was considered statistically significant for the analyses. An OR > 1 indicates positive, < 1 indicates negative, and 1 indicated no association.

3 Results

3.1 Descriptive Statistics

Characteristics of the study population are presented in Table 1. Results showed that 58.1% of participants were satisfied with life (SE = 0.9%, 95% CI [56.2%, 59.9%]); 63.2% perceived their life had improved compared to the COVID-19 lockdown period (SE = 0.9%, 95% CI [61.4%, 65.0%]); 89.1% reported being optimistic about life (SE = 0.7%, 95% CI [87.6%, 90.4%]); and 65.7% had experienced at least one form of COVID-19-induced food insecurity (SE = 1.1%, 95% CI [63.6%, 67.8%]).

Analysis of demographic differences in COVID-19-induced food insecurity (C-FI) among adolescents revealed significant associations with household wealth and living arrangement. Adolescents from the richest households reported higher C-FI (71.3%) than those from the poorest (60.8%), $\chi^2(3.53, N=7246)=40.07$, $F=3.10$, $p=.019$. Likewise, those living with at least one parent were more likely to report C-FI (66.7%) than those not living with any parent (59.8%), $\chi^2(1, N=7246)=16.68$, $F=5.74$, $p=.017$. No significant associations were found for age, $\chi^2(1.93, N=7246)=0.55$, $F=0.13$, $p=.870$; sex, $\chi^2(1, N=7246)=0.004$, $F=0.001$, $p=.970$; school attendance, $\chi^2(1, N=7246)=0.96$, $F=0.39$, $p=.532$; area of residence, $\chi^2(1, N=7246)=13.98$, $F=3.41$, $p=.065$; or geopolitical zone, $\chi^2(4.80, N=7246)=35.39$, $F=1.97$, $p=.083$. Associations were also observed between all dependent outcomes, gender, area of residence, and geopolitical zone.Details are in Table 2.

3.1.1 Association between COVID-19-induced Food Insecurity and Life Satisfaction, Perception of Better Life and Optimism

Results of both multivariate regression analyses in Tables 3 and 4 showed that the experience and severity of COVID-19-induced food insecurity (C-FI) were not significantly associated with adolescents' life satisfaction, perception of an improved life, or optimism. In Model 1, the presence of any form of C-FI was not a significant predictor of life satisfaction (OR = 1.01, 95% CI [0.84, 1.21]), improved life perception (OR = 0.98, 95% CI [0.82, 1.17]), or optimism (OR = 1.23, 95% CI [0.91, 1.66]). Similarly, in Model 2, the severity of C-FI was also not significantly associated with life satisfaction (OR = 1.41, 95% CI [0.99, 2.00]), improved life perception (OR = 0.89, 95% CI [0.63, 1.26]), or optimism (OR = 1.02, 95% CI [0.64, 1.63]). These findings suggest that the association between C-FI with adolescent wellbeing outcomes may be limited. However, sex and geographical zone were significantly associated with all the dependent variables. Figures 1, 2, 3, 4, 5, and 6, shows a

Table 2 Chi-square tests of association between demographic characteristics and life satisfaction, perception of a better life, and optimism ($N=7246$)

Variable (N)	Life Satisfaction (%)	Perception of an Improved Life (%)	Optimism (%)
Age	56.5	62.1	89.0
15	59.0	64.5	88.5
16	59.1	63.4	89.8
17	$\chi^2(2, N=7246)=4.43$, $p=.340$	$\chi^2(2, N=7246)=3.18$, $p=.512$	$\chi^2(2, N=7246)=2.16$, $p=.506$
Area	62.3	65.6	90.9
Urban	54.9	61.5	87.7
Rural	$\chi^2(1, N=7246)=39.33$, $p<.001$	$\chi^2(1, N=7246)=13.01$, $p=.049$	$\chi^2(1, N=7246)=19.10$, $p=.060$
Geopolitical Zone	63.7	62.7	85.9
North Central	47.0	49.1	82.9
North East	57.6	61.0	87.7
North West	48.2	54.8	82.2
South East	53.6	75.5	97.8
South South	74.5	74.9	96.8
South West	$\chi^2(5, N=7246)=235.53$, $p<.001$	$\chi^2(5, N=7246)=255.38$, $p<.001$	$\chi^2(5, N=7246)=249.02$, $p<.001$
Sex	67.0	68.1	93.3
Female	41.0	54.0	81.0
Male	$\chi^2(1, N=7246)=449.34$, $p<.001$	$\chi^2(1, N=7246)=138.40$, $p<.001$	$\chi^2(1, N=7246)=253.68$, $p<.001$
Household Wealth	56.7	58.5	86.3
Poorest	54.9	63.2	88.6
Second	55.5	62.1	89.0
Middle	59.5	63.9	90.7
Fourth	65.0	69.5	90.9
Richest	$\chi^2(4, N=7246)=36.06$, $p=.003$	$\chi^2(4, N=7246)=34.40$, $p=.007$	$\chi^2(4, N=7246)=19.47$, $p=.235$
School Attendance	56.0	61.9	89.0
No	59.9	65.0	90.1
Yes	$\chi^2(1, N=7246)=5.84$, $p=.119$	$\chi^2(1, N=7246)=3.99$, $p=.163$	$\chi^2(1, N=7246)=1.24$, $p=.450$
Children Living Arrangement	59.6	69.9	93.6
No Parent in Household	58.1	62.2	88.4
At Least One Parent	$\chi^2(1, N=7246)=0.67$, $p=.657$	$\chi^2(1, N=7246)=6.33$, $p=.012$	$\chi^2(1, N=7246)=7.59$, $p=.006$
COVID-19 Food Insecurity	57.8	65.1	88.5
No Experience	58.2	62.3	89.4
At Least One Experience	$\chi^2(1, N=7246)=0.08$, $p=.866$	$\chi^2(1, N=7246)=2.26$, $p=.133$	$\chi^2(1, N=7246)=0.51$, $p=.474$

Table 3 Associations between experience of any form of COVID-19 food insecurity and outcome variables (Model 1 results)

Variable	Life Satisfaction $N=5697$ Odds Ratio (95% CI)	Perception of a Better Life $N=5728$ Odds Ratio (95% CI)	Optimism $N=5725$ Odds Ratio (95% CI)
COVID-19 Food Insecurity	1.01 (0.84, 1.21)	0.98 (0.82, 1.17)	1.23 (0.91, 1.66)
Sex (Male ref.)	3.01 (2.46, 3.68) *	1.94 (1.58, 2.38) *	3.58 (2.71, 4.72) *
Area (Urban ref.)	0.95 (0.77, 1.17)	1.01 (0.80, 1.27)	0.93 (0.64, 1.34)
Living with Parent (No ref.)	1.20 (0.88, 1.65)	0.84 (0.61, 1.14)	0.75 (0.44, 1.29)
Wealth Quintile (Poorest ref.)			
Second	1.01 (0.79, 1.29)	1.11 (0.85, 1.43)	0.88 (0.61, 1.26)
Middle	0.87 (0.68, 1.12)	0.98 (0.75, 1.29)	0.89 (0.59, 1.34)
Fourth	0.96 (0.73, 1.28)	1.01 (0.75, 1.36)	0.95 (0.62, 1.47)
Richest	1.30 (0.93, 1.82)	1.20 (0.86, 1.67)	0.87 (0.48, 1.57)
Zone (North Central ref.)			
North East	0.51 (0.40, 0.66) *	0.64 (0.50, 0.83) *	0.72 (0.49, 1.05)
North West	0.80 (0.61, 1.05)	0.93 (0.73, 1.18)	1.43 (0.97, 2.09)
South East	0.46 (0.33, 0.64) *	0.70 (0.50, 0.99) **	0.77 (0.43, 1.39)
South South	0.66 (0.51, 0.85) *	1.77 (1.26, 2.49) *	7.47 (3.83, 14.55) *
South West	1.53 (1.11, 2.12) **	1.75 (1.29, 2.38) *	5.10 (2.76, 9.41) *
School Attendance (No ref.)	1.20 (0.97, 1.48)	1.11 (0.91, 1.36)	1.02 (0.77, 1.35)

$p<.001$ is marked with a *; $p<.05$ is marked with a **

diagram of association between the predictor variables and each wellbeing outcome across both models.

Given the absence of statistically significant main effects of COVID-19-induced food insecurity (C-FI) and its severity on subjective wellbeing outcomes in the initial models, a moderation analysis was conducted to further explore the relationship between COVID-19-induced food insecurity (C-FI) and adolescent wellbeing. It is possible that the impact of C-FI varies across key social categories. Therefore, interaction terms between C-FI, sex, and geopolitical zone were tested to examine whether the association between C-FI and wellbeing outcomes life satisfaction, optimism, and perception of an improved life differs by gender and region. This approach is consistent with the Stress Process Model's emphasis on the interplay between stress exposure and social location. By uncovering these differential effects, the analysis enhances our understanding of how structural inequalities shape the psychosocial consequences of food insecurity and informs more targeted policy responses for adolescent populations in post-pandemic contexts.

3.1.2 Moderation Analysis between the Severity of COVID-19-Induced Food Insecurity (C-FI) and Adolescent Wellbeing Outcomes Varied by Sex and Geopolitical Zone

As shown in Table 5 the severity of C-FI was not significantly associated with life satisfaction, perception of improved life, or optimism across the general sample. However, notable interaction effects emerged with geopolitical zone. Specifically, adolescents in the Southwest zone who experienced severe levels of food insecurity

Table 4 Associations between severity of COVID-19 food insecurity and outcome variables (Model 2 results)

Variable	Life Satisfaction ($N=1621$) Odds Ratio (95% CI)	Perception of a Better Life ($N=1636$) Odds Ratio (95% CI)	Optimism ($N=1636$) Odds Ratio (95% CI)
Severity of COVID-19 Food Insecurity	1.41 (0.99, 2.00)	0.89 (0.63, 1.26)	1.02 (0.64, 1.63)
Sex (Male ref.)	2.10 (1.55, 2.86) *	1.87 (1.29, 2.72) *	3.13 (2.04, 4.80) *
Area (Urban ref.)	0.68 (0.48, 0.96) **	0.91 (0.64, 1.28)	0.88 (0.49, 1.58)
Living with Parent (No ref.)	0.68 (0.41, 1.13)	0.94 (0.56, 1.59)	0.66 (0.34, 1.29)
Wealth Quintile (Poorest ref.)			
Second	0.83 (0.55, 1.25)	0.94 (0.61, 1.44)	1.09 (0.63, 1.90)
Middle	0.75 (0.48, 1.17)	0.66 (0.41, 1.05)	0.84 (0.47, 1.50)
Fourth	0.99 (0.58, 1.67)	0.81 (0.48, 1.38)	0.98 (0.48, 2.03)
Richest	1.22 (0.62, 2.42)	0.85 (0.42, 1.74)	0.83 (0.30, 2.27)
Zone (North Central ref.)			
North East	0.59 (0.40, 0.86) **	0.56 (0.37, 0.85) **	0.86 (0.50, 1.50)
North West	0.83 (0.55, 1.25)	0.72 (0.47, 1.11)	1.62 (0.87, 3.00)
South East	0.79 (0.48, 1.31)	0.87 (0.50, 1.51)	1.35 (0.68, 2.69)
South South	0.90 (0.57, 1.45)	2.32 (1.37, 3.91) *	12.94 (3.77, 44.35) *
South West	1.74 (0.99, 3.05) †	1.60 (0.88, 2.94)	7.36 (2.39, 22.63) *
School Attendance (No ref.)	1.28 (0.90, 1.81)	1.08 (0.79, 1.49)	0.91 (0.57, 1.45)

$p<.001$ is marked with a *; $p<.05$ is marked with a **

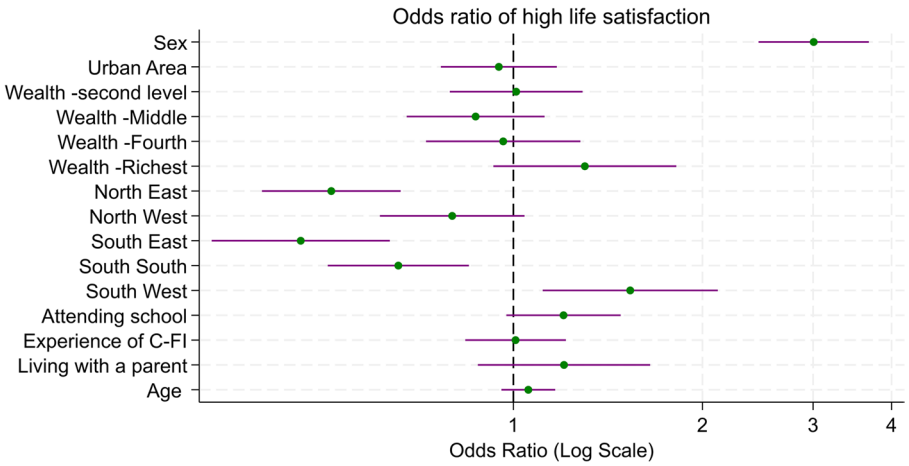

Fig. 1 Association between Life Satisfaction and Experience of C-FI

were significantly more likely to report higher life satisfaction, while no significant interaction was observed between C-FI severity and sex for any of the outcomes. These findings suggest that the impact of food insecurity on wellbeing may be shaped more by regional context than by gender. Margins analysis was conducted to further

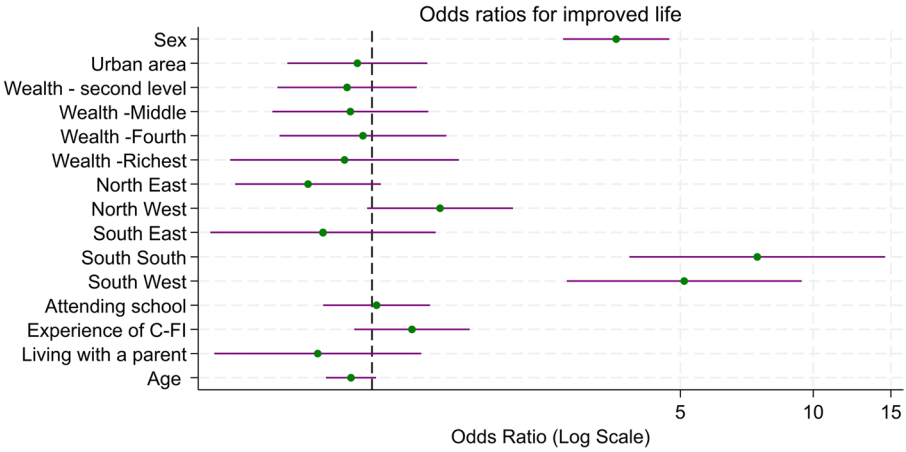

Fig. 2 Association between perception of improved life and experience of C-FI

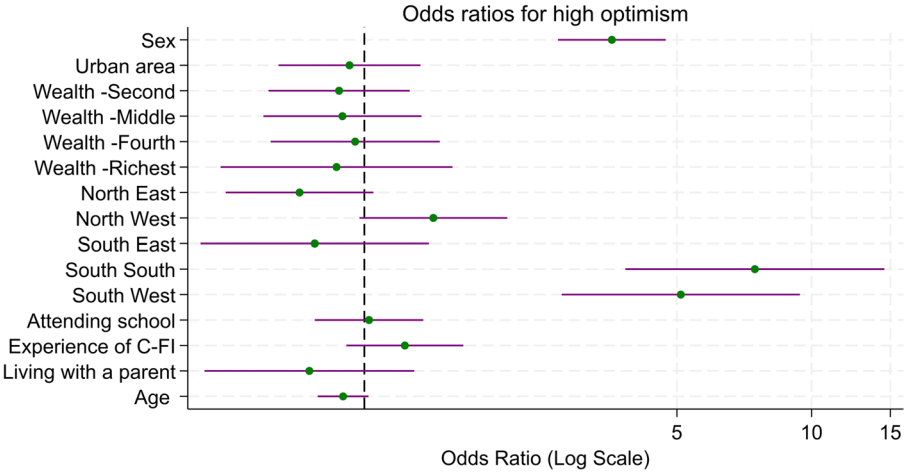

Fig. 3 Association between optimism and experience of C-FI

explore the interaction between severity of food insecurity and geopolitical zone on life satisfaction. In Fig. 7, predicted probabilities of life satisfaction increased with food insecurity severity in the South west zone, whereas the relationship remained flat or declined slightly in most other regions. These findings reinforce the significant interaction effect observed in the regression model, suggesting a region-specific pattern in the relationship between food insecurity and adolescent wellbeing.

3.1.3 Moderation Analysis between any Experience of C-FI and Adolescent Wellbeing Outcomes Varied by Sex and Geopolitical Zone

Table 6 shows the moderation analysis of the relationship between experiencing any form of COVID-19-induced food insecurity (C-FI) and adolescent wellbeing out-

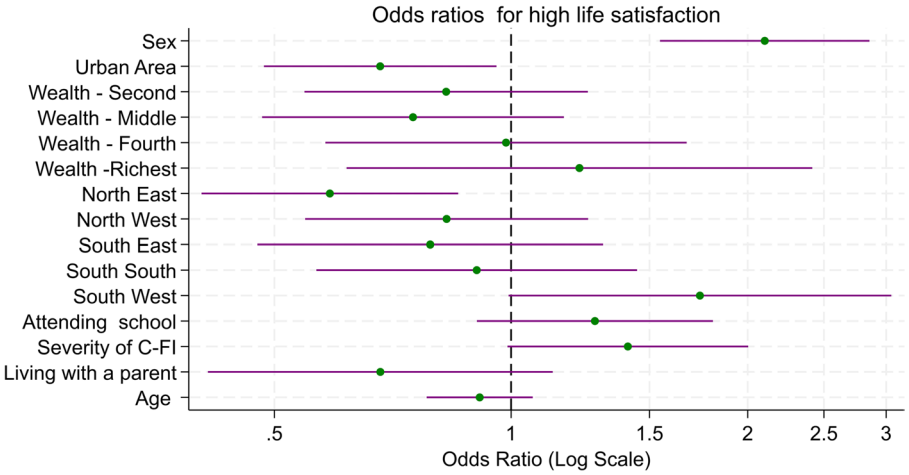

Fig. 4 Association between life satisfaction and severity of C-FI

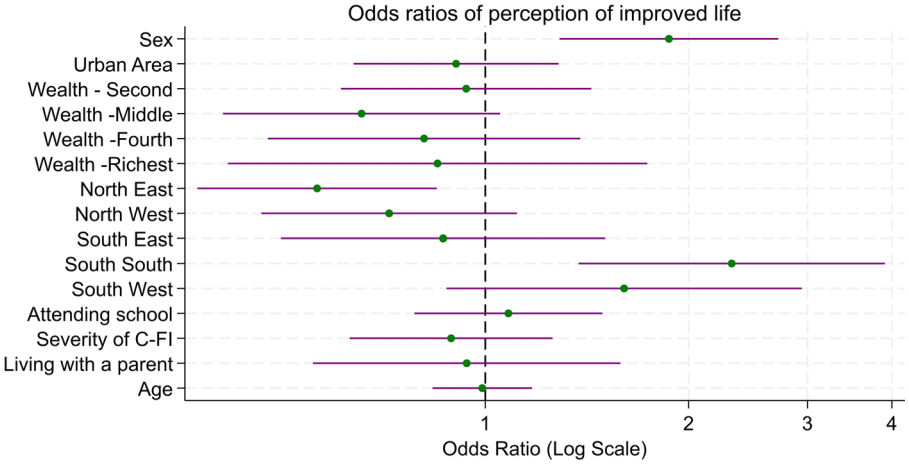

Fig. 5 Association between perception of improved life and severity of C-FI

comes life satisfaction, perception of an improved life, and optimism varied by sex and geopolitical zone. While the main effect of C-FI experience was not statistically significant across outcomes, significant interactions were observed for optimism. Specifically, the association between C-FI and optimism varied significantly by both sex and geopolitical zone. Female adolescents who experienced food insecurity had lower odds of reporting optimism compared to males, suggesting a heightened psychological impact of food insecurity among girls. Additionally, the effect of C-FI on optimism differed by region, with adolescents in the South East zone showing significantly higher odds of optimism when food insecure, compared to those in the North Central zone. No significant moderation effects were found for perception of an improved life, and only a regional moderation was observed for life satisfaction.

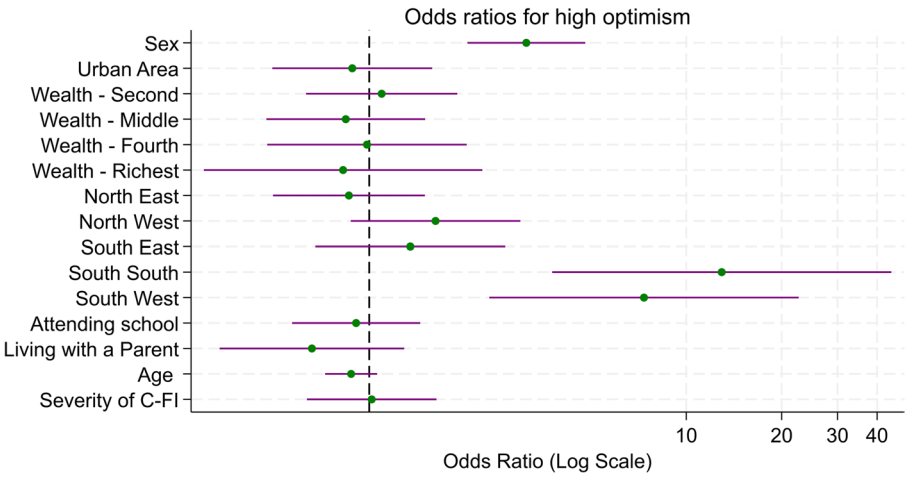

Fig. 6 Association between optimism and severity of C-FI

Table 5 Moderation effects of sex and geopolitical zone on the association between severity of COVID-19-induced food insecurity and wellbeing outcomes

Variable	Life Satisfaction *N*=1621 Odds Ratio (95% CI)	Perception of a Better Life *N*=1636 Odds Ratio (95% CI)	Optimism *N*=1636 Odds Ratio (95% CI)
Severity of C-FI	0.80 (0.38, 1.70)	1.56 (0.73, 3.31)	1.58 (0.54, 4.64)
Sex (Male ref.)	2.13 (1.56, 2.89) *	1.87 (1.29, 2.72) *	3.16 (2.03, 4.92) *
C-FI × Sex (Female)	0.82 (0.42, 1.58)	1.01 (0.49, 2.08)	0.70 (0.28, 1.76)
Zone (North Central ref.)			
North East	0.59 (0.41, 0.85) **	0.58 (0.39, 0.86) **	0.94 (0.54, 1.62)
North West	0.80 (0.53, 1.20)	0.75 (0.49, 1.16)	1.62 (0.87, 2.99)
South East	0.78 (0.46, 1.32)	0.89 (0.51, 1.55)	1.36 (0.70, 2.66)
South South	0.87 (0.54, 1.40)	2.39 (1.43, 4.00) *	12.81 (3.79, 43.31) *
South West	1.87 (1.03, 3.40) **	1.60 (0.88, 2.91)	7.42 (2.40, 22.92) *
C-FI × Zone			
North East	1.20 (0.51, 2.81)	0.64 (0.27, 1.48)	0.44 (0.12, 1.66)
North West	1.87 (0.72, 4.85)	0.44 (0.16, 1.18)	1.06 (0.28, 4.05)
South East	2.84 (0.71, 11.38)	0.59 (0.19, 1.84)	0.75 (0.18, 3.06)
South South	2.07 (0.75, 5.68)	0.57 (0.19, 1.77)	0.34 (0.02, 5.94)
South West	4.04 (1.20, 13.54) **	0.44 (0.15, 1.29)	0.43 (0.03, 5.81)

$p<.001$ is marked with a *; $p<.05$ is marked with a **

For life satisfaction, the relationship between C-FI and wellbeing differed significantly by zone, with adolescents in the South East zone who experienced food insecurity reporting higher odds of life satisfaction compared to their peers in the North Central zone.These patterns are illustrated in the predicted margins plots (Figs. 8 and 9), which show sharp regional differences in optimism levels and a pronounced gender gap among those experiencing food insecurity.

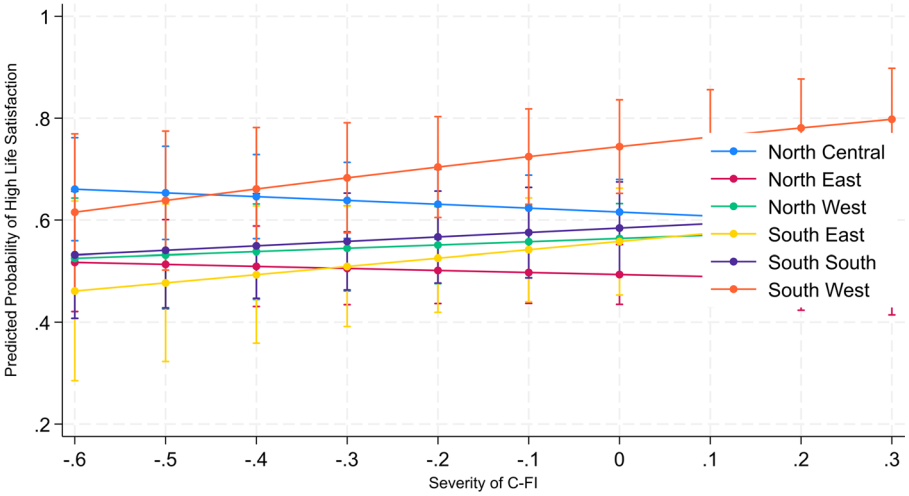

Fig. 7 Predicted probability of high life satisfaction by zone based on severity of C-FI

Table 6 Moderation effects of sex and geopolitical zone on the association between experience of COVID-19-Induced food insecurity and wellbeing outcomes

Variable	Life Satisfaction *N*=5,697 Odds Ratio (95% CI)	Perception of Improved Life *N*=5,728 Odds Ratio (95% CI)	Optimism *N*=5,725 Odds Ratio (95% CI)
C-FI Experience (Yes vs. No)	0.88 (0.59, 1.30)	1.36 (0.87, 2.12)	0.83 (0.41, 1.69)
Sex (Male ref.)	2.99 (2.15, 4.17) *	2.32 (1.69, 3.17) *	5.69 (3.28, 9.87) *
C-FI × Sex (Female)	1.00 (0.67, 1.47)	0.77 (0.53, 1.10)	0.50 (0.26, 0.95) **
Zone (North Central ref.)			
North East	0.58 (0.38, 0.88) **	0.76 (0.48, 1.22)	0.76 (0.36, 1.62)
North West	0.94 (0.61, 1.45)	1.13 (0.72, 1.79)	0.81 (0.39, 1.69)
South East	0.27 (0.13, 0.55) *	0.69 (0.41, 1.17)	0.30 (0.12, 0.78) **
South South	0.58 (0.38, 0.89) **	1.71 (1.07, 2.75) **	4.32 (1.31, 14.19) **
South West	1.22 (0.78, 1.90)	2.49 (1.53, 4.06) *	3.07 (1.03, 9.17) **
C-FI × Zone			
North East	0.86 (0.53, 1.40)	0.78 (0.45, 1.35)	0.96 (0.41, 2.26)
North West	0.79 (0.47, 1.32)	0.75 (0.43, 1.31)	2.17 (0.94, 5.02)
South East	2.22 (1.01, 4.88) **	1.06 (0.59, 1.88)	4.52 (1.78, 11.45) *
South South	1.19 (0.73, 1.92)	1.08 (0.57, 2.05)	2.20 (0.52, 9.28)
South West	1.44 (0.83, 2.47)	0.59 (0.33, 1.05) †	2.04 (0.58, 7.24)

$p<.001$ is marked with a *; $p<.05$ is marked with a **

4 Discussion

Previous studies have reported associations between food insecurity and adolescent wellbeing (Palladino et al., 2024; Salahodjaev & Mirziyoyeva, 2021; Shankar-Krishnan et al., 2021). However, little is known about the associations between COVID-

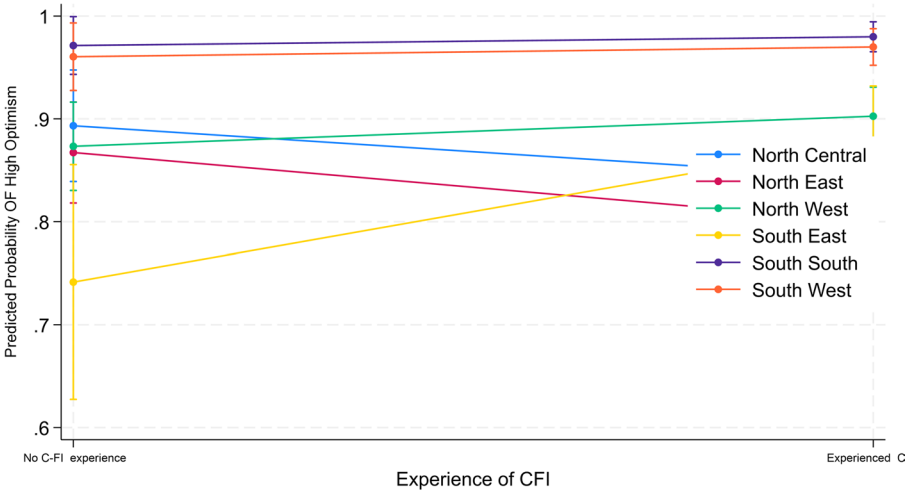

Fig. 8 Predicted probability of high optimism for experience of C-FI by zone

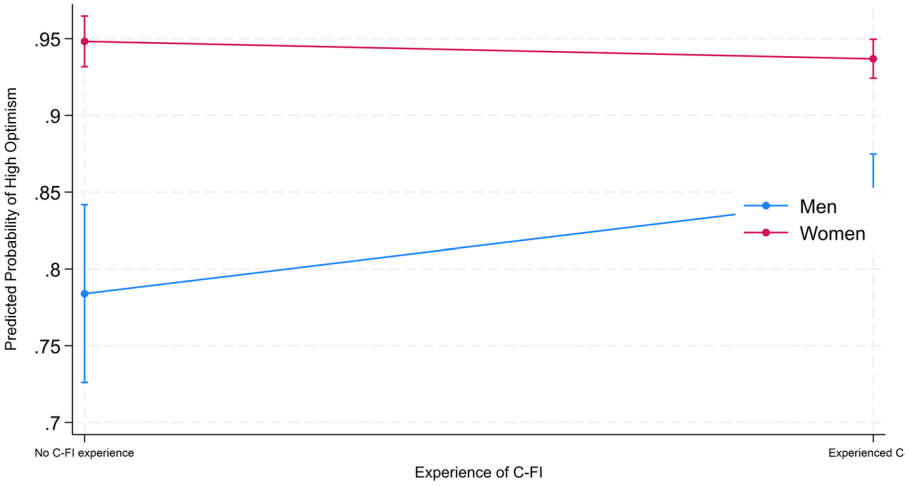

Fig. 9 Predicted probability of high optimism experience of C-FI by sex

19-induced food insecurity (C-FI) and adolescent wellbeing over time. Drawing on the Stress Process Model (Pearlin et al., 1981), this analysis aimed to understand how acute, pandemic-related food insecurity influence wellbeing outcomes, while accounting for background characteristics and social resources. By distinguishing food insecurity due to COVID-19 from other causes, and exploring regional and gender-based moderation effects, this research provides critical insights for both global health and adolescent policy interventions in post-pandemic recovery. Notably, this study is among the first to use nationally representative data to examine pandemic-induced food insecurity and adolescent mental wellbeing in a low-income, high-deprivation context such as Nigeria.

Despite expectations based on extant literature (Asfahani et al., 2019; Elgar et al., 2021b), findings from this large, nationally representative sample of Nigerian adolescents aged 15 to 17 revealed no statistically significant associations between C-FI and the selected wellbeing outcomes. This null effect persisted across both the experience and severity of C-FI. These findings, while counterintuitive, but similar to findings by Lee et al. (2023) underscore the importance of contextualizing psychosocial responses to deprivation within the lived realities of adolescents in structurally poor environments.

In Nigeria, chronic poverty and persistent food insecurity are widespread (Ukonu et al., 2023; World Bank, 2021). Some studies suggest that the mental health consequences of food insecurity are attenuated in settings where deprivation is widespread and normalized (Bergmans & Wegryn-Jones, 2020; Elgar et al., 2021a).Thus, adolescents may be habituated to resource scarcity, blunting the psychological salience of pandemic-induced disruptions. The Stress Process Model posits that the impact of stressors is moderated by both chronic exposure and access to coping resources. In this context, the incidental nature of C-FI may be less potent compared to structural and ongoing economic insecurity. In other words, where food insecurity is prevalent and expected, its marginal psychological impact diminishes (Elgar et al., 2021a; Runciman, 1966).

An important consideration in interpreting the findings is that the entire study sample comprised adolescents who had experienced some form of food insecurity. While this design allowed a focused examination of differences between COVID-19-induced and non-COVID-related food insecurity, this restriction may have narrowed the variability in exposure, making it more difficult to detect significant associations between C-FI and wellbeing. This homogeneity could contribute to the null findings, as the comparison is effectively between different types or intensities of food insecurity, rather than between presence and absence of food insecurity.

Additionally, the insignificant associations may reflect the transitory nature of pandemic-induced food insecurity relative to chronic food deprivation. Preliminary analysis from this study indicated, that C-FI was more likely reported among adolescents from the wealthiest households and those living with a parent. This pattern suggest two possible interpretations. First, adolescents in structurally disadvantaged settings may be more accustomed to persistent scarcity, leading to a form of habituation that reduces the psychological salience of temporary disruptions such as those caused by the pandemic. In contrast, adolescents from wealthier households less familiar with daily deprivation may have experienced pandemic-related food insecurity as novel and a higher likelihood of reporting it. Considering that the data for this study was taken after the pandemic, the effect on their wellbeing may have been neutralised at the time of data collection for this study.

Second, the lesser likelihood of adolescents living without parents to report C-FI may suggest, the buffering effect of strong cultural and communal support systems. In Nigeria, communal coping mechanisms such as food sharing, kinship care, and religious networks are well established (Ezeama et al., 2015). Children in non- parental care may have larger social network (Ariyo et al., 2019; Blakeslee et al., 2017). These systems may mitigate the emotional toll of acute food shortages, particularly among adolescents who remain embedded in extended family and religious networks.

The stress process model (Pearlin et al., 1981) further helps frame these findings by emphasizing the role of contextual and psychosocial moderators. Nigeria's six geopolitical zones represent diverse socio-cultural environments that likely influence both the perception and impact of food insecurity. Notably, significant interaction effects by region and gender were observed, revealing that the impact of food insecurity on wellbeing is not uniform. For instance, in the South West zone, adolescents with higher levels of food insecurity reported higher life satisfaction, suggesting that regional social safety nets or differing pandemic responses may mediate outcomes. It is also interesting to note that although lower life satisfaction and optimism were reported in Southeast Nigeria in comparison to those in the North Central zone, adolescents who had experienced C-FI, in the South East were more likely to report higher life satisfaction and optimism than adolescents who experienced C-FI in the North Central zone. This counterintuitive finding may reflect the presence of stronger community-based support systems, more resilient urban infrastructure, or more responsive local governance in that region.

In Nigeria, there is a significant disparity exists between the North and the South, in religion, economic development, wealth and social structures. The North is primarily Muslim, while the South is largely Christian and there is a strong influence of Christianity in education, and culture across the country (Agwu, 2023). The South is generally more economically developed, with a higher GDP per capita than the North. Socially, the North has seen more conflict and generally has lower access to education and infrastructure compared to the South. The Southwest Nigeria is relatively more urbanized, considered as the richest zone in the country, with lesser wealth disparities (Archibong, 2018), ethnically homogenous, economically dynamic, and higher educational level. Similarly, the South East Nigeria is ethnically homogenous, averagely educated, wealthier in comparison to North Central (Ahmadu, 2023). This characteristic potentially offers greater access to informal social safety nets that may have buffered the impacts of deprivation on adolescent's wellbeing after the pandemic. In contrast, the North Central zone used as the reference group in this study presents a different socio-cultural and environmental context to the South West and South East region. While it is geographically central, it somewhat diverse in terms of ethnicity and religion. North Central Nigeria includes both conflict-prone rural areas and less industrialized towns, which may limit institutional support and coping resources for adolescents facing food insecurity. These regional disparities underscore the importance of contextualizing adolescent wellbeing within local cultural norms, social structures, and institutional capacities. This result indicates the likely influence of economic opportunities, education, social safety nets, and cultural norm in buffering the impact of C-FI.

Conversely, among female adolescents, food insecurity was associated with lower levels of optimism. This suggests that the adverse psychological effects of food insecurity may be more pronounced in females than in their male counterparts. Gendered experiences of deprivation, often shaped by sociocultural expectations and structural inequalities, may contribute to heightened emotional and psychological vulnerability among adolescent girls (Ivers & Cullen, 2011). In many Nigerian contexts, females are disproportionately burdened with domestic responsibilities and may face greater food-related anxieties due to caregiving roles within households (Mueller et al.,

2023). These findings align with broader literature indicating that food insecurity has a more detrimental effect on the mental health of females, particularly in settings marked by socioeconomic disadvantage and limited gender-sensitive support systems (Belachew et al., 2011; Maynard et al., 2019). As such, gender-sensitive interventions that address the distinct experiences and vulnerabilities of adolescent girls are crucial for promoting equitable wellbeing outcomes.

The findings also highlight the possibility of relative deprivation as a mediating factor. Adolescents may evaluate their wellbeing in comparison to their immediate peers rather than objective standards. In environments where scarcity is the norm, subjective wellbeing may remain relatively stable, especially when individual conditions do not deviate markedly from communal experiences (Walker & Smith, 2002).

The strength of this study lies in its use of high-quality, nationally representative data from the 2021 Multiple Indicator Cluster Survey (MICS-6), which includes validated tools such as the Food Insecurity Experience Scale (FIES) and internationally comparable subjective wellbeing measures. The large sample size enhances statistical power and enables disaggregated analysis by gender and geopolitical zone. Additionally, the application of the Stress Process Model allows for a theoretically grounded exploration of how stress, context, and resilience interact to shape adolescent mental health.

However, several limitations must be acknowledged. First, the cross-sectional design precludes causal inference. The directionality of effects cannot be definitively established. Second, the FIES severity score required complete responses for Rasch calibration, resulting in substantial missingness (29%), though Little's MCAR test indicated randomness. This exclusion may bias the analysis toward adolescents with more stable reporting patterns a and possibly underrepresenting certain subgroups. Third, although the optimism and improved life perception measures are drawn from widely used international surveys, both were captured using single-item indicators due to data availability. This may limit their reliability and reduce sensitivity to subtle variations in adolescents' subjective experiences, especially in culturally diverse settings. The dichotomization of outcome variables, while aligned with international standards (OECD, 2013), may have obscured nuanced variation in responses. Finally, unmeasured buffering factors such as religious involvement, peer support, or media exposure may also influence the relationship between food insecurity and wellbeing and were not captured in this analysis.

Despite these limitations, this research offers critical early insights into the indirect consequences of the C-FI on adolescent wellbeing. However, evidence of its direct psychological effects on adolescents in this study were limited. Findings should be interpreted with caution. This study suggests that the context matters: findings underscore the necessity of considering chronic poverty, cultural resilience, and contextual perceptions of wellbeing in interpreting the impacts of acute crises. The regional variations identified indicate areas for more targeted interventions, and the gender gap in optimism demands focused support for female adolescents.

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Data Availability Data for the study was extracted from the 2021 Nigeria UNICEF Multiple Indicator Cluster Survey Round Six (MICS 6) (UNICEF, 2024).The dataset is available on the MICS website (https://mics.unicef.org/surveys). The full data description and the detailed sampling procedure is available in the MICS 2021 report(National Bureau of Statistics & United Nations Children's Fund, August, 2022).

Declarations

Ethical Approval Not applicable (Secondary data analysis was conducted).

Research Involving Human Participants And/or Animals The survey was approved by the UNICEF MICS Steering and Review Committee.

Informed Consent Verbal consent was obtained for each participant; adult consent was obtained before the child's assent for children aged 15–17.

Competing interests The author of this study declare no competing interest.

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