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Associations between extreme weather events and resource insecurities with depression and anxiety symptoms among older adults in Moshi, Tanzania: Cross-sectional analyses

Andie MacNeil[1], Carmen Helen Logie[1,2,3], Karen Yeates[4], Nicola West[5], Frannie MacKenzie[1], Hamza Rajabu[5], Anisia Kiwelu[5], Oswald Urassa[5] and Zerihun Admassu[1]

[1]Factor-Inwentash Faculty of Social Work, University of Toronto, Canada; [2]Women's College Research Institute, Women's College Hospital, Toronto, Canada; [3]United Nations University Institute for Water Environment and Health (UNU-INWEH), Richmond Hill, Canada; [4]Department of Medicine, Queen's University, Canada and [5]Pamoja Tunaweza Women's Centre/Wema Health Innovation Tanzania, United Republic of Tanzania

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Corresponding author:
Carmen Helen Logie;
Email: carmen.logie@utoronto.ca

Abstract

Extreme weather events (EWEs) and resource insecurities are associated with adverse mental health outcomes, yet little is known about their impacts on older adults in climate-affected settings. We conducted a community-based cross-sectional survey 250 randomly sampled older adults from the Prospective Urban Rural Epidemiology cohort in Moshi, Tanzania (mean age 60.6 years, SD 11.1). Multivariable linear regression examined resource insecurity (food, water, sanitation), EWE exposure, social support, and resilience associations with depressive and anxiety symptoms. In adjusted analyses, low food security ($a\beta$=0.86, 95% CI: 0.54, 1.18), very low food security ($a\beta$=1.07, 95% CI: 0.73, 1.41), sanitation insecurity ($a\beta$=0.05, 95% CI: 0.01, 0.09p = 0.022 e), and past-year EWE exposure ($a\beta$=0.39, 95% CI: 0.07, 0.70) were associated with higher depressive symptoms. Low food security ($a\beta$=0.51, 95% CI: 0.22, 0.79), very low food security ($a\beta$=0.62, 95% CI: 0.32, 0.93), and water insecurity ($a\beta$=0.53, 95% CI: 0.02, 1.03) were associated with higher anxiety ssymptoms, while resilience was associated with lower anxiety symptoms ($a\beta$= −0.07, 95% CI: −0.14,−0.01). Findings highlight interconnected environmental and resource insecurity-related mental health vulnerabilities among older adults, underscoring the importance of integrating resource security and mental health into climate adaptation strategies for older adults in climate-affected low and middle-income settings.

Impact statement

This study provides unique insight into the mental health of older adults in Tanzania at the intersections of climate change, extreme weather, and resource insecurity (e.g., food, water, sanitation). Despite the growing recognition that extreme weather and resource insecurity have detrimental impacts on mental health in climate-affected contexts, like Tanzania, older adults have been largely overlooked in this research. This represents a pressing gap in the literature, as older adults face unique social and physical vulnerabilities in relation to climate change, resource insecurity, and mental health, and these needs will continue to grow alongside the aging of the population. To address this critical gap, this study examined associations between resource insecurities (food, water, sanitation), extreme weather event exposure, socio-demographics, and protective factors (social support, resilience) with depressive symptoms and anxiety symptoms among older adults in Moshi, Tanzania. We found that various forms of resource insecurity and exposure to extreme weather events were associated with adverse mental health outcomes. In particular, low levels of food security, low levels of sanitation security, and experiencing a past-year extreme weather event were significantly associated with higher depression scores, while low levels of both food security and water security were significantly associated with higher anxiety scores. Understanding these relationships is essential in order to develop targeted interventions that can support the mental health of older people at the nexus of extreme weather and multiple resource scarcities. By highlighting the mental health needs of this population, this research underscores the importance of developing mental health policies and programs that integrate the needs of older people in climate-affected contexts.

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Introduction

Climate change and related extreme weather events (EWEs) are recognized to have detrimental impacts on the mental health of people living in climate-affected areas, increasing the risk of psychological distress, mood disorders, anxiety disorders, posttraumatic stress disorder and substance use disorders (Cianconi et al., 2020; Walinski et al., 2023). People living in sub-Saharan Africa may face particular vulnerabilities related to climate change and adverse mental health outcomes due to the extreme impacts of climate change (Atwoli et al., 2022). For instance, climate change is causing severe increases in drought, extreme heat, heavy rain and flooding throughout these regions (Ayugi et al., 2022; Intergovernmental Panel On Climate Change (IPCC), 2023), disrupting water access and agricultural yield, increasing food and water insecurity, and exacerbating climate-related stress (Ngcamu and Chari, 2020; Reed et al., 2022).

Food and water insecurity have been identified as significant risk factors for adverse mental health outcomes in diverse global settings (Pourmotabbed et al., 2020; Wutich et al., 2020), including in sub-Saharan Africa (Trudell et al., 2021; Kimutai et al., 2023). For instance, a systematic review by Trudell et al. (2021) examined the impacts of food insecurity on mental health based on 68 studies in Africa, six of which were from Tanzania, and they consistently found a dose-response relationship between food insecurity and worsening psychological health. Kimutai et al. (2023) conducted a systematic review and meta-analysis on the relationship between water and sanitation insecurity and adverse mental health outcomes across 25 studies, the majority of which were from sub-Saharan Africa, and found a significant association between both water and sanitation insecurity and depression and anxiety. Notably, none of the 25 studies were conducted in Tanzania, highlighting a significant gap in the literature. There is a dearth of studies that examine the association between multiple resource insecurities – such as water, food, and sanitation – and mental health outcomes in climate-affected contexts.

Tanzania provides an important context to further examine this nexus of climate change-related EWEs, resource insecurities, and mental health outcomes. Tanzania is highly vulnerable to climate risks due to extensive dry spells and rising sea levels (World Bank Group, 2025). Between 2010 and 2020, Tanzania experienced a 45% increase in flood frequency (International Monetary Fund African, 2023). Additionally, between November 2023 and June 2024, over 14 regions in Tanzania experienced severe rain, flooding, and landslides, causing displacement, death, and extensive damage to homes, agricultural lands, and public infrastructure (International Federation of Red Cross and Red Crescent Societies, 2025). Further, approximately 70%–80% of Tanzanians live in informal settlements that are highly susceptible to drought, extreme heat, and flooding, and often have limited capacity to respond to increasing resource scarcity and EWE-related infrastructure damage (Changula and Guya, 2024).

Some existing research has examined the relationships between EWEs, resource insecurities, and mental health outcomes in Tanzania. Prencipe et al. (2021) examined the relationship between EWEs and depressive symptoms in the Iringa and Mbeya regions, and found that youth living in households affected by droughts or floods had significantly higher depression scores than those living in unaffected households. An additional study by Prencipe et al. (2023) explored the impacts of climate change-related stress on mental health among youth in the same regions, and found that those who were extremely distressed by climate change had depression scores that were 18 percentage points higher than those who reported no climate-related distress based on the CES-D-10. This study also examined the impacts of food and water insecurity on mental health, and found that both forms of insecurity were independently associated with depression scores that were 23 percentage points higher than those who were not food or water insecure (Prencipe et al., 2023). Additionally, a study examined mental health outcomes among pregnant women living with HIV in the Kilimanjaro region and found that participants reporting food insecurity had double the odds of depression compared to those who were food secure (Ngocho et al., 2019). Further, an additional study on maternal mental health in Mwanza found that mothers with severe food insecurity had five times the odds of depression and more than double the odds of anxiety when compared to those who were food secure (Decaro et al., 2016). Together, these studies document how environmental and resource insecurity-related factors are social-environmental drivers of mental health in Tanzania.

While the existing research provides an important foundation for understanding some of the relationships between EWEs, resource insecurities, and adverse mental health outcomes in Tanzania, critical knowledge gaps remain. First, there remains limited research that examines the impacts of multiple resource insecurities, EWE, and mental health in Tanzania. Additionally, existing mental health research on EWEs and resource insecurity-related factors has focused predominantly on youth and younger adults, while older adults have been largely overlooked.

The lack of research focusing on older adults comprises a pressing gap in research within and beyond the Tanzanian context reflecting significant knowledge gaps in climate change in sub-Saharan Africa more broadly. In the systematic review by Trudell et al. (2021) that examined 64 studies on food insecurity and mental health across Africa, they noted that only one study had a sample of respondents above 50 years of age, even though the effects of food insecurity on mental health are hypothesized to be amplified among older adults due to increased physical, economic, and social vulnerability (Matlakala et al., 2024). A recent scoping review explored how older people may be more vulnerable during climate-induced disasters in sub-Saharan Africa due to compounding effects of physical and economic dependence, social exclusion, less access to resources, vulnerability to EWE-related illness (e.g., heat exhaustion), and limitations in physical functioning (e.g., challenges fleeing an area affected by climate shock) (Matlakala et al., 2024). This highlights how climate-related vulnerability may be critically impacted by age and other related factors, and ultimately signals an urgent need for research focused on older adult mental wellbeing in contexts of ecological and resource insecurity-related challenges in Africa at large.

It is key to approach vulnerability to EWEs and resource (water, food, sanitation) access with consideration for how social categories shape needs, priorities, and capacities to respond to stressors (Chaplin et al., 2019). Understanding EWE and resource-related vulnerability is important to help inform approaches to building resilience and to promote better mental health outcomes among people and communities affected by polycrises of extreme weather and multiple resource scarcities (Chaplin et al., 2019). Recent perspectives on climate change and mental well-being have asserted the importance of considering how older age acts as a social category that impacts experiences of climate-related adversity, as well as the capacity to respond to such adversities (Ayalon et al., 2021; Ayalon, 2024). However, the lack of research on the effects of EWEs and resource insecurities on older people reflects a

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significant knowledge gap and ultimately impedes our ability to respond to climate change, EWEs, resource insecurities, and related mental health challenges that can meet the lived realities and priorities of older people. Therefore, to address these urgent gaps in the literature, the current study examines mental health outcomes among older adults in Moshi, Tanzania. Specifically, we examined associations between resource insecurity (food, water and sanitation), EWE exposure, socio-demographics and protective factors (social support, resilience) and depressive and anxiety symptoms.

Methods

Study design

We conducted a community-based cross-sectional survey in Moshi, Tanzania (March–November 2024). Moshi is located in the Kilimanjaro region in Northeastern Tanzania near the Kenyan border. Moshi has a tropical wet and dry climate with significant climate change impacts, including flooding and drought (Said et al., 2019). We leveraged the ongoing Prospective Urban Rural Epidemiology (PURE) study cohort in Tanzania. The PURE study is a large, ongoing global cohort survey that has enrolled more than 200,000 adults aged 35–70 at baseline in 2003. Participants were recruited from both urban and rural contexts in 27 low-, middle-, and high-income countries, to examine how modernization, urbanization, and globalization impact health outcomes (Shupler et al., 2019, 2022; Corsi et al., 2024). Within each community included in the PURE study, the sampling procedures are designed to achieve a sample that is broadly representative of adults aged 35–70 within that community (Teo et al., 2009). Although the PURE study is not designed to be nationally representative, sampling efforts are made to avoid systematic biases and to select communities with a diverse range of socioeconomic and environmental conditions that are similar to the larger population (Corsi et al., 2013). We utilized a random sample of n = 250 participants drawn from the larger PURE cohort in Tanzania (n = 2,047). To select a random sample from this cohort, Excel was used to randomly generate a number for each cohort participant. Participants were then sorted in ascending order, and the first 250 participants listed comprised the random sample and were asked to participate. If a participant declined to participate, the next person on the list was invited until the target number of 250 was reached. Approximately 15% of potential participants who were invited declined to participate, and approximately 4% of participants who agreed could not be reached to participate. This sample size is sufficient for multiple linear regression; a power analysis conducted in G*Power 3.1(Faul et al., 2007, 2009) indicated that a minimum of 194 participants were required to detect a medium effect size ($f^2 = 0.15$) with 14 predictors, $\alpha = 0.05$, and power = 0.95.

Participants were invited by community health workers engaged with the PURE cohort. Tablet-based surveys were administered face-to-face by trained research assistants in Swahili using SurveyCTO software and took approximately 60 min to complete. Prior to study implementation, the research team conducted study-specific training sessions to review the objectives of the research, informed consent procedures, confidentiality and participant privacy, interviewing techniques, and administration of the study tools. These training sessions also included discussion of culturally appropriate communication approaches, management of sensitive and stigmatized topics, minimizing interviewer bias, and procedures for responding to participant distress. As part of the training process, members of the research team trialed the survey tools with one another to ensure that questions were appropriately translated, culturally relevant, and clearly understood within the local context. This process also helped refine the wording of survey items, improve consistency in survey administration, and ensure that research assistants had familiarity with the study instruments prior to participant recruitment. We also utilized quality check measures through the SurveyCTO software, including automated quality checks for outliers, missing values, abnormally high and low values, or data discrepancies between individual surveyors and the larger team. REB approvals were obtained from the University of Toronto (#41615) and the United Republic of Tanzania (NIMR/HQ/R.8c/Vol.1 /2538). Participants were compensated the equivalent of $10 CAD for the survey participation.

These specific analyses focus on assessing associations between resource insecurity and EWE-related variables and mental health outcomes of (a) depressive symptoms and (b) anxiety symptoms. While we initially planned to include alcohol use disorder as an outcome, we report only descriptive statistics for this variable due to the low scale reliability results.

Measurement

Study outcomes

Mental health was assessed using validated brief screening tools for depression, anxiety, and alcohol use disorder. Depressive symptoms were measured using the Patient Health Questionnaire-2 (PHQ-2, Cronbach's alpha [α]= 0.80) (Manea et al., 2016), which evaluates the frequency of depressed mood and anhedonia over the past two weeks. Anxiety symptoms were assessed using the Generalized Anxiety Disorder 2-item scale (GAD-2, $\alpha = 0.86$) (Kroenke et al., 2007), a brief screening instrument for generalized anxiety. For both scales, items are scored from 0 ("not at all") to 3 ("nearly every day"), yielding a total score ranging from 0 to 6. Higher scores indicate greater symptom severity. For descriptive statistics, a score of ≥3 was used to identify a positive screen for Major Depressive Disorder (Manea et al., 2016) and Generalized Anxiety Disorder (Kroenke et al., 2007). For the multivariable linear regression analyses, depressive symptoms and anxiety symptoms were treated as a continuous outcome, and therefore a cut-off was not applied.

We initially intended to examine possible alcohol use disorder as a study outcome using the four-item CAGE (Cut-down, Annoyed, Guilty, Eye-opener) (Bush et al., 1987), however, this measure was not included as an outcome in the multivariable analysis due to having a reliability score below the acceptable cutoff (acceptable $\alpha = 0.70$ [Tavakol and Dennick, 2011; CAGE $\alpha = 0.61$).

Exposure variables *included socio-demographic variables, resource insecurities, and EWEs*

We assessed *socio-demographic variables* including age (continuous), gender (categorical: woman [cisgender], man [cisgender]), education (categorical: less than secondary vs. secondary or higher), relationship status (categorical: married/dating, no partner, separated/widowed), employment status (categorical: unemployed vs. employed), parenthood (categorical: yes vs. no)

Resource insecurity was assessed through water insecurity (12-item HWISE scale, with Cronbach's alpha ($\alpha = 0.84$); scores ≥12 classified as insecure) (Young et al., 2019), food insecurity (6-item HFSSM; $\alpha = 0.86$, scores categorized as high/marginal [0–1], low [2–4], or very low [5–6]) (Blumberg et al., 1999), and sanitation insecurity (Caruso et al., 2017) (10-item scale, past 30 days, $\alpha = 0.88$).

Extreme weather events (EWEs) were assessed using the question: "In the last year what have you experienced with regard to weather?" with a range of events (extreme rain/flooding; changes in

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expected rain patterns in a season; changes in expected temperature (heat, cold) in a season; drought; extreme heat; extreme wind; extreme cold; fire (home fire, wildfire); storm (hurricane); landslide; earthquake). Responses were categorized into three groups: none, one and more than one EWE.

We also assessed *protective factors* including resilience (4-item adapted Response to Stressful Experiences Scale [RSES-4], $\alpha = 0.73$ Scale) (De La Rosa et al., 2016) and social support (12-item Multidimensional Scale of Perceived Social Support PSS, $\alpha = 0.87$) (Zimet et al., 1988).

Analysis

Descriptive statistics were conducted to summarize participants' socio-demographic characteristics, resource insecurity outcomes and EWEs, disaggregated by gender. Categorical variables were presented as frequencies and percentages, and comparisons by gender were assessed using chi-square tests or Fisher's exact tests where appropriate. Continuous variables were summarized using means and standard deviations, and differences by gender were examined using independent t-tests. A p-value of <0.05 was considered statistically significant.

Multivariable linear regression analyses were conducted to identify factors associated with study outcomes. For both models, we first performed unadjusted (bivariate) regressions to assess associations between each independent variable and the mental health outcome. All variables with a p-value <0.2 in the unadjusted analysis were considered for inclusion in the multivariable model. Final adjusted models were derived using backward stepwise regression, retaining predictors significant at $p < 0.05$. Adjusted beta coefficients ($a\beta$) with 95% confidence intervals and p-values are reported.

Model diagnostics were checked to assess multicollinearity and overall model fit. Multicollinearity was assessed by examining Variance Inflation Factors (VIFs); all variables retained in the final models had VIF values below 2, indicating no concerning multicollinearity. Model fit was evaluated using adjusted R-squared values to determine the proportion of variance in the outcome explained by the predictors. Results were interpreted with attention to effect sizes, confidence intervals, and p-values to ensure both statistical and practical significance. There were no missing data for the variables included in the analyses. All analyses were conducted using Stata SE version 18.0 (STATA Corp., Texas, USA).

Results

Socio-demographic characteristics by gender

A total of 250 participants were included in the analysis, most of whom were women (72.8%, $n = 182$) (Table 1). The mean age of participants was 60.6 years (SD = 11.1), with no statistically significant difference between women and men (60.2 vs. 61.5 years, $p = 0.444$). Most participants (89.2%, $n = 223$) had less than secondary education, with a slightly higher proportion among women (90.7%, $n = 165$) compared to men (85.3%, $n = 58$), though this difference was not statistically significant ($p = 0.224$). Unemployment was common across the sample (95.6%, $n = 239$), and again, there were no significant gender differences ($p = 0.164$).

Table 1. Descriptive statistics of socio-demographic characteristics, resource insecurity outcomes, extreme weather events and mental health among adults in Moshi, Tanzania, disaggregated by gender ($n = 250$; mean age = 60.6; SD = 11.1)

Characteristics	Frequency (n, %)	Range	Woman	Man	p-value
Socio-demographic variables					
Age	60.6 (11.1)	36–82	60.2 (11.3)	61.5 (10.8)	0.4442
Gender					
Woman (cisgender)	182 (72.8%)				
Man (cisgender)	68 (27.2%)				
Education					0.224
Less than secondary	223 (89.2%)		165 (90.7%)	58 (85.3%)	
Secondary completed & higher	27 (10.8%)		17 (9.3%)	10 (14.7%)	
Employment					0.164
Unemployed	239 (95.6%)		176 (96.7%)	63 (92.6%)	
Employed	11 (4.4%)		6 (3.3%)	5 (7.4%)	
Relationship status					< 0.001
Married/dating	161 (64.4%)		100 (55.2%)	61 (89.7%)	
No current partner	69 (27.6%)		65 (35.9%)	4 (5.9%)	
Multiple partners/polyamorous	1 (0.4%)				
Separated/widow/widowed	19 (7.6%)		16 (8.8%)	3 (4.4%)	
Household latrine (toilet)					0.793
In home/dwelling	46 (18.4%)		35 (19.2%)	11 (16.2%)	
In compound/yard	195 (78.0%)		140 (76.9%)	55 (80.9%)	
Outside compound	9 (3.6%)		7 (3.9%)	2 (2.9%)	

(*Continued*)

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Table 1. (*Continued*)

Characteristics	Frequency (*n*, %)	Range	Woman	Man	*p*-value
Primary drinking water source					0.887
In home/dwelling	36 (14.4%)		25 (13.7%)	11 (16.2%)	
In compound/yard	195 (78.0%)		143 (78.6%)	52 (76.5%)	
Outside compound	19 (7.6%)		14 (7.7%)	5 (7.3%)	
Having children (Yes)	247(98.8%)		180 (98.9%)	67 (98.5%)	0.810
Resource insecurity					
Water insecurity score, mean (SD)	2.8 (4.5)	0–36			0.213
Insecure	15 (6.0%)		13 (7.1%)	2 (2.9%)	
Secure	235 (94.0%)		169 (92.9%)	66 (97.1%)	
Food insecurity score *n* = 8, mean (SD)	2.7 (2.2)	0–6			0.278
High or marginal food security (0–1)	90 (37.2%)		61(34.3%)	29 (45.3%)	
Low food security (2–4)	82 (33.9%)		64 (36.0%)	18 (28.1%)	
Very low food security (5–6)	70 (28.9%)		53 (29.7%)	17 (26.6%)	
Sanitation insecurity (Mean. SD)	13.2 (3.3)	10–40			
Extreme weather events					
Extreme weather events in the past year					0.058
None	50 (20.0%)		43 (23.6%)	7 (10.3%)	
One	60 (24.0%)		43 (23.6%)	17 (25.0%)	
Multiple	140 (56.0%)		96 (52.8%)	44 (64.7%)	
Alcohol use					
Possible alcohol use disorder					0.177
No	198 (79.2%)		148 (81.3%)	50 (73.5%)	
Yes	52 (20.8%)		34 (18.7%)	18 (26.5%)	
Clinically significant alcohol use					0.003
No	228 (91.2%)		172 (94.5%)	56 (82.4%)	
Yes	22 (8.8%)		10 (5.5%)	12 (17.6%)	
Mental health					
Depression (PHQ-2)					0.928
None	231 (92.4%)		168 (92.3%)	63 (92.6%)	
Major depressive disorder	19 (7.6%)		14 (7.7%)	5 (7.4%)	
Generalized anxiety disorder (GAD 2)					
None	245 (98.0%)		177 (97.2%)	68 (100%)	
Generalized anxiety disorder	5 (2.0%)		5 (2.8%)	0	
Protective factors					
Resilience	11.7 (1.9)	3–16	11.6 (1.8)	11.8 (2.4)	0.7097
Social support	45.0 (6.4)	18–60	44.9 (6.6)	45.2 (5.8)	0.7821

Relationship status, however, differed significantly by gender ($p < 0.001$): nearly 90% ($n = 61$) of men were married or dating compared to 55.2% ($n = 100$) of women. Conversely, a higher proportion of women reported having no current partner (35.9%, $n = 65$) than men ($n = 4$, 5.9%). There was a small proportion of participants who were separated or widowed (7.6%, $n = 19$) and polyamorous (0.4%, $n = 1$). Almost all participants ($n = 247$, 98.8%) reported having children, with no significant difference between women and men.

Descriptive statistics

Outcomes: Depression and anxiety

Among participants, 7.6% ($n = 19$) had depressive symptoms that indicated a positive screen for Major Depressive Disorder, with a similar prevalence among women (7.7%, $n = 14$) and men (7.4%, $n = 5$) ($p = 0.928$). For anxiety, 2.0% ($n = 5$) of participants had anxiety symptoms indicating a positive screen for Generalized Anxiety Disorder, and this was only reported among women.

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Alcohol use

Possible alcohol use disorder was reported by 20.8% (n = 52) of participants, more commonly among men (26.5%, n = 18) than women (18.7%, n = 34), though this was not statistically significant (p = 0.177). Due to the low reliability (α = 0.61), it is possible that these estimates may not accurately reflect the true prevalence of alcohol use disorder in this population, and it was not included further in multivariable analyses.

Resource insecurity

Overall, the prevalence of water insecurity was low, with 6% (n = 16) of participants classified as water insecure. A lower proportion of men (n = 2, 2.9%) reported water insecurity compared to women (7.1%, n = 13), although this difference was not statistically significant (p = 0.213). In contrast, food insecurity was more common: 28.9% (n = 70) of participants reported very low food security, while 33.9% (n = 82) reported low food security. Gender differences in food insecurity were not statistically significant. The mean sanitation insecurity score was 13.2 (range: 10–40) (SD = 3.3), with no gender difference.

Extreme weather events

The majority of participants experienced more than one EWE in the preceding year (56.0%, n = 140), with a higher proportion reported by men (64.7%, n = 44) than women (52.8%, n = 96), approaching statistical significance (p = 0.058). Approximately one quarter of participants experienced one EWE in the preceding year (24.0%, n = 60) and 20% experienced no EWE in the preceding year.

Protective factors

The mean resilience score among participants was 11.7 (range 3–16), and the mean social support score was 45.0 (range 18–60), indicating moderate to high levels of resilience and social support among participants, on average.

Factors associated with mental health outcomes in multivariable analyses

Depression symptoms

In the unadjusted analysis, participants without a current partner reported significantly higher depression scores compared to those who were married or dating (β = 0.34, 95% CI: 0.01, 0.68, p = 0.044), and this association remained significant in the adjusted model (β = 0.33, 95% CI: 0.02, 0.65, p = 0.040) (Table 2). Resource insecurity indicators were strongly associated with depression symptoms. Compared to those with high or marginal food security, individuals experiencing low food security had higher depression symptoms ($a\beta$ = 0.86, 95% CI: 0.54, 1.18, p < 0.001), as did those with very low food security ($a\beta$ = 1.07, 95% CI: 0.73, 1.41, p < 0.001). Similarly, higher sanitation insecurity scores were significantly associated with higher depression symptoms ($a\beta$ = 0.05, 95% CI: 0.01, 0.09, p = 0.022). Although water insecurity was significant in the unadjusted model (β = 0.70, 95% CI: 0.08, 1.31, p = 0.026), it was not retained in the final adjusted model. Participants who reported experiencing a single EWE in the past year had significantly higher depression symptoms compared to those with no events in the adjusted model ($a\beta$ = 0.39, 95% CI: 0.07, 0.70, p = 0.017). However, experiencing multiple EWEs did not show a significant adjusted association. Other socio-demographic variables (age, gender, education, employment) and protective factors (resilience, social support) were not significantly associated with depression symptoms in the adjusted model.

Anxiety symptoms

Relationship status was the only significant socio-demographic variable in multivariable analyses (Table 3). Participants without a current partner had significantly higher anxiety symptoms compared to those who were married or dating ($a\beta$ = 0.31, 95% CI: 0.04, 0.58, p = 0.026). Several markers of resource insecurity were independently associated with greater anxiety symptoms. In multivariable analyses, individuals experiencing low food security had higher anxiety symptoms than those with high or marginal food security ($a\beta$ = 0.51, 95% CI: 0.22, 0.79, p = 0.001), while those reporting very low food security had even higher scores ($a\beta$ = 0.62, 95% CI: 0.32, 0.93, p < 0.001). Water insecurity was also significantly associated with increased anxiety symptoms ($a\beta$ = 0.53, 95% CI: 0.02, 1.03, p = 0.040). Sanitation insecurity was not significantly associated with anxiety symptoms. Resilience emerged as a small but statistically significant protective factor associated with lower anxiety symptoms ($a\beta$ = −0.07, 95% CI: −0.14, −0.01, p < 0.001).

Discussion

We conducted a cross-sectional study with a sample of primarily middle-aged and older adults in Moshi, Tanzania, to better understand linkages between resource insecurity and EWE exposure and mental health outcomes. We found that multiple (food, water, sanitation) resource insecurity indicators and exposure to EWEs were associated with adverse mental health outcomes, with some variation observed by resource insecurity type and mental health outcome. In particular, low levels of food security and sanitation security were significantly associated with higher depression symptoms. Additionally, while experiencing one past-year EWE was associated with significantly higher depression symptoms, experiencing more than one EWE was not associated with depression symptoms. When looking at anxiety, both low levels of food security and water security were significantly associated with higher anxiety symptoms, while no association was found with sanitation insecurity and experiences of EWEs. These findings can inform future research and interventions with older adults in LMIC climate-affected regions such as Tanzania to understand and address socio-environmental stressors that can harm mental health.

The findings of this study align with existing research demonstrating that food insecurity, sanitation insecurity, and experiences of EWEs are associated with depression among people living in climate-affected areas, such as sub-Saharan Africa (Trudell et al., 2021; Deglon et al., 2023; Kimutai et al., 2023). While previous research has identified these associations specifically among people living in Tanzania, this research has been conducted predominantly among youth (Prencipe et al., 2021, 2023), as well as pregnant women and mothers (Decaro et al., 2016; Ngocho et al., 2019). Although this research provides valuable insight into the relationships between resource insecurities, EWEs, and mental health, these findings may not necessarily be generalizable to older adults, as their exclusion from research overlooks the unique climate-related vulnerabilities among this population (Matlakala et al., 2024). Our study makes an important contribution by adding to the very limited body of literature focused specifically on the mental health correlates of resource scarcity among middle-aged and older adults in sub-Saharan Africa. Our findings align with a 2020 study among adults aged 50 and older in South Africa, which found that severe food insecurity increased the odds of depression approximately five-fold (Bishwajit et al., 2020). While direct comparison

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Table 2. Factors associated with depressive symptoms among adults in Moshi, Tanzania (n = 250)

Characteristics	Depression (PHQ-2) (continuous score)			
	Unadjusted β (95% CI)	p-value	Adjusted β [a] (95% CI)	p-value
Socio-demographic variables				
Age	–0.01 (−0.02, 0.01)	0.480		
Gender				
Man (cisgender)	Ref			
Woman (cisgender)	−0.05 (−0.38, 0.28)	0.755		
Education				
Less than secondary	Ref			
Secondary and higher	−0.26 (−0.74, 0.21)	0.280		
Employment				
Unemployed vs. employed	0.36 (−0.36, 1.08)	0.325		
Relationship status				
Married/dating	Ref			
No current partner	0.34 (0.01, 0.68)	0.044	0.33 (0.02, 0.65)	0.040
Separated/widow/widowed	0.13 (−0.43, 0.69)	0.644		
Having children				
Yes vs. No	−0.66 (−2.02, 0.69)	0.335		
Resource insecurity				
Water insecure (vs. secure)	0.70 (0.08, 1.31)	0.026		
Food insecurity				
High or marginal food security				
Low food security	0.88 (0.55, 1.20)	< 0.001	0.86 (0.54, 1.18)	<0.001
Very low food security	1.11 (0.77, 1.45)	< 0.001	1.07 (0.73, 1.41)	<0.001
Sanitation insecurity (higher)	0.05 (0.01, 0.10)	0.016	0.05 (0.01, 0.09)	0.022
Extreme weather events				
None	Ref		Ref	
One	0.08 (−0.36, 0.52)	0.732	0.39 (0.07, 0.70)	0.017
Multiple	−0.38 (−0.76, −0.01)	0.048		
Protective factors				
Resilience	−0.03 (−0.11, 0.04)	0.372		
Social support	−0.02 (−0.04, 0.01)	0.110		

Note: [a] Adjusted analysis used backward stepwise regression.

with studies using binary depression outcomes is not possible, the observed increase in PHQ-2 scores associated with very low food security represents a meaningful shift in depressive symptom severity. This magnitude is consistent with prior research in sub-Saharan Africa using continuous measures, where food insecurity has been linked with clinically relevant increases in depressive symptoms (Prencipe et al., 2023). The limited amount of research that has focused specifically on older adults represents a critical research gap, as older adults in low- and middle-income countries are recognized to have a higher likelihood of experiencing climate-related disasters (Sarkar et al., 2023), as well as heightened vulnerability to resource scarcity during climate-induced disasters (Matlakala et al., 2024). There is also a high burden of mental health issues among older adults in these regions. A recent systematic review and meta-analysis estimated the prevalence of depression to be 26% among older adults in Africa (Bedaso et al., 2022), and an additional meta-analysis in Africa estimated the prevalence to range from 13% to 38%, depending on the assessment method (diagnostic vs. screening) and study setting (community vs. condition-specific) (Mdluli et al., 2025). The high prevalence of depression among older adults in these regions is a growing concern because it is recognized to increase the risk of cognitive impairment (Muhammad and Meher, 2021; Yang et al., 2023). Our findings that older adults in Tanzania with food insecurity, sanitation insecurity, and past-year EWEs reported significantly higher levels of depression symptoms provide important empirical evidence to this burgeoning area of research on the mental health vulnerabilities of older adults in climate-affected contexts.

Our findings that water and food insecurity were associated with higher levels of anxiety also align with existing research that has

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Table 3. Factors associated with anxiety symptoms among adults in Moshi, Tanzania (n = 250)

	Generalized anxiety disorder			
Variable	Unadjusted β (95% CI)	p-value	Adjusted β (95% CI)	p-value
Socio-demographic variables				
Age	0.01 (−0.01, 0.02)	0.250		
Gender				
Man (cisgender)	Ref			
Woman (cisgender)	0.10 (−0.19, 0.39)	0.509		
Education				
Less than secondary	Ref			
Secondary and higher	−0.16 (−0.58, 0.25)	0.439		
Employment				
Unemployed vs. employed	0.40 (−0.23, 1.02)	0.216		
Relationship status				
Married/dating	Ref			
No current partner	0.32 (0.03, 0.61)	0.031	0.31 (0.04, 0.58)	0.026
Separated/widow/widowed	−0.10 (−0.59, 0.39)	0.684		
Having children				
Yes vs. No	−0.08 (−1.26, 1.11)	0.899		
Resource insecurity				
Water insecurity (vs. secure)	0.79 (0.25, 1.32)	0.004	0.53 (0.02, 1.03)	0.040
Food insecurity				
High or marginal food security	Ref			
Low food security	0.58 (0.29,0.88)	<0.001	0.51 (0.22, 0.79)	0.001
Very low food security	0.80 (0.49, 1.10)	<0.001	0.62 (0.32, 0.93)	< 0.001
Sanitation insecurity (higher)	−0.01 (−0.05, 0.02)	0.465		
Extreme weather events				
None	Ref			
One	0.02 (−0.37, 0.41)	0.919		
Multiple	−0.29 (−0.62, 0.05)	0.092		
Protective factors				
Resilience	−0.09 (−0.16, −0.03)	0.004	−0.07 (−0.14, −0.01)	<0.001
Social support	−0.02 (−0.04, 0.01)	0.110		

Note: Adjusted analysis used backward stepwise regression.

identified strong associations between resource scarcity and anxiety levels in sub-Saharan Africa (Trudell et al., 2021; Deglon et al., 2023; Kimutai et al., 2023). Anxiety and uncertainty about accessing food and water may be particularly pronounced among middle-aged and older adults, as they face intersecting vulnerabilities of increased dependence, less access to resources, and increased vulnerability to physical effects of resource scarcity (e.g., dehydration, heat exhaustion, malnutrition) (Matlakala et al., 2024). A 2020 study of adults aged 50 and older in Ghana found that participants experienced increasing psychological distress due to food insecurity, specifically around the stress of hunger, and this relationship was particularly strong among men and among the oldest respondents (i.e., 65+) (Gyasi et al., 2020). One hypothesized mechanism underscoring this relationship is that older adults may be particularly susceptible to feelings of shame surrounding hunger and food insecurity, exacerbating psychological distress (Gyasi et al., 2020). Other approaches, such as the resource insecurity framework, discuss that resource insecurities can harm mental health *via* pathways of uncertainty and unpredictability, feelings of stigma and social failure, and perceptions of social injustice and inequity (Wutich and Brewis, 2014; Wutich et al. 2020).

Addressing mental health-related vulnerabilities in climate-affected areas requires consideration of how interlocking social categories will shape experiences and capacities to respond to EWEs and resource scarcity (Chaplin et al., 2019). Previous research has called attention to how older age may be overlooked as a social category in the context of climate change and mental health (Ayalon et al., 2021). This critical gap highlights the need for more research that examines age in the context of EWE, resource insecurities, and mental health. In climate-affected areas, older

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people may face unique vulnerabilities to the mental health consequences of EWEs and resource scarcity, such as guilt over seeing children and grandchildren struggle to access resources and feelings of powerlessness in responding to these issues (Ayalon et al., 2021). Older age also intersects with other social categories, such as poverty and gender, which has implications for the mental health of older people at the nexus of EWEs and resource scarcity. For instance, girls and women already face particular stressors due to the disproportionate burden of caregiving responsibilities in the context of natural disasters, and for older women this can be exacerbated by having to navigate caregiving for an aging spouse and/or their own changes in health status and physical functioning (Sarkar et al., 2023; Matlakala et al., 2024). We did not, however, note differences in the likelihood of reporting depression or anxiety symptoms by gender, signaling the need for further research applying sex and gender-based analyses (Tannenbaum et al., 2016) to better understand shared and different needs and priorities to promote health among older adults in Tanzania. Previous research on the mental health of older people in sub-Saharan Africa has found older women to be at higher risk for depression (Nwakasi et al., 2021), underscoring the need for future research to examine what may drive the differences or lack thereof in mental health outcomes among older people in sub-Saharan Africa. Additionally, those living in poverty may face the most severe restrictions in access to essential resources in the face of water and food insecurity, which creates particular challenges for older adults who may be more vulnerable to heat exhaustion, dehydration, and malnutrition (Sarkar et al., 2023; Matlakala et al., 2024). This underscores the urgency to integrate age into broader understandings of mental health in climate-affected contexts.

These findings have important practice implications for supporting the mental well-being of older adults in the context of EWEs and resource scarcity. Implementing age-friendly responses to EWEs and multidimensional poverty requires consideration of the particular needs of older adults. This can include developing community-based preparedness during periods of drought or food insecurity, such as ensuring collective responsibility for older adults who may be unable to travel long distances to fetch water or access food. Drawing on the community to support the mental well-being of older adults in climate-affected areas is particularly important when considering their increased vulnerability to social isolation in these contexts (Matlakala et al., 2024; Patrick et al., 2025). Further, utilizing accessible, age-friendly spaces can support the needs of older adults, both in the general community and as a strategy incorporated into emergency shelters in periods of evacuation due to extreme weather (Matlakala et al., 2024). Additionally, it is also important to engage older adults themselves in research on EWE preparedness and responses to resource scarcity. Many older adults have a wealth of knowledge on how to respond to these challenges in their community, yet their voices and contributions are often overlooked due to ageism and assumptions that older adults are victims, rather than active community members (Patrick et al., 2025).

Our findings on the role of protective factors in reducing mental health symptoms were somewhat surprising. While resilience was associated with reduced anxiety symptoms, it was not associated with reduced depressive symptoms. Additionally, we did not identify social support as a protective factor for depression or anxiety, raising questions regarding what protective factors might look like for older adults in Tanzania. Resilience refers to the capacity for people to "bounce back" from stressful situations and effectively cope with stressors (De La Rosa et al., 2016). In the context of later life depression, there has been increasing recognition that resilience is not a stable personality trait or characteristic, but a multidimensional and dynamic capacity that is impacted by internal (e.g., health, cognitive capacity) and external (e.g., social and environmental context) factors (Laird et al., 2019). The increasing severity of climate-related EWE and resource scarcity may undermine the capacity for psychological resilience to reduce depressive symptoms in these contexts. Resilience is also linked with self-efficacy, which may be undermined when the presenting stressors, such as EWE, are outside of one's control. Further research is needed to better understand resilience in the context of climate change and mental health among older adults.

The finding that social support was not protective against depression or anxiety symptoms was also surprising. We did, however, find that participants without a current partner had significantly higher depression and anxiety scores than those who were married, suggesting that the presence of a spouse may provide a source of mental health support. Although our measure of social support examined the presence of social support from numerous sources (family, friends, significant other), future research with older adults in climate-affected contexts may consider differentiating dimensions of social support, for instance, emotional and informational, tangible, affectionate, and positive social interaction (Sherbourne and Stewart, 1991). This may provide valuable insight into protective factors for older people at the nexus of EWE, resource insecurities, and mental health. Others have noted that social capital is associated with positive mental health among older adults in South Africa (Ramlagan et al., 2013), so this could also be a direction for future research. In addition, future mixed-methods research could explore other potentially mental health-promoting factors such as disaster adaptation (First et al., 2021).

Limitations

The current study has some limitations to consider. First, the reliance on cross-sectional data prohibits determining causality in these relationships. Second, the sample was predominantly women, which may limit the generalizability of the findings to older men. Additional research using nationally representative samples of middle-aged and older adults in Tanzania is warranted to help strengthen our understanding of the associations between EWE, resource scarcity, and mental health. Further research with larger subsamples of the older adult population in Tanzania may also allow for more specific interaction analyses (e.g., gender and food insecurity, gender and water insecurity) to increase our understanding of the nuance of the associations between sociodemographic, climate-related factors, and mental health. Third, these findings may be impacted by social desirability bias, which can contribute to the underreporting of mental health symptoms (Van de Mortel, 2008). Fourth, our EWE measure focused solely on the number of EWEs, and thus we were not able to distinguish the effects of types of EWE and/or EWE severity, which has implications for the interpretation of our findings. For instance, in the adjusted analyses, we found that experiencing one EWE was associated with depression, while experiencing multiple EWEs was not. This is a counterintuitive finding, underscoring the need for additional research that considers how the type and severity of an EWE may impact mental health associations. Finally, the CAGE measure had a low reliability score, limiting the utility of alcohol use-related findings and underscoring the need for future research to explore alcohol use among older people in Tanzania and other climate-affected areas in the context of extreme weather and resource

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scarcity. This is a pressing research gap in Tanzania; hazardous alcohol use is a growing concern, with most recent available national data indicating that among the population aged 15 and older, 6.8% met the criteria for an alcohol use disorder and 2.4% met the criteria for alcohol dependence, both of which are approximately double the average of the African region (World Health Organization, 2018). Additionally, further research is needed to determine why the CAGE measure may have low reliability in this context, and to prioritize the development of culturally and contextually appropriate indicators of alcohol use disorder.

Conclusions

Despite these limitations, our study makes an important contribution to the literature by examining associations between EWEs and resource scarcity indicators with mental health outcomes in Tanzania. Our focus on middle-aged and older adults fills an important gap in the existing literature, as this population has been largely overlooked in existing mental health research on climate-affected contexts at large and in sub-Saharan Africa specifically. Findings point to the need to better understand older age as an important yet often overlooked social category that may shape experiences of extreme weather and resource scarcity. Our findings help inform the need to consider the needs of an aging population alongside climate vulnerability.

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