

Climate distress, climate-sensitive risk factors, and mental health among Tanzanian youth: a cross-sectional study



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Summary

Background Climate change threatens youth mental health through multiple mechanisms, yet empirical studies typically focus on single pathways. We explored feelings of distress over climate change among Tanzanian youth, considering associations with climate change awareness and climate-sensitive risk factors, and assessed how these factors relate to mental health.

Methods Tanzanian youth (aged 18–23 years) from a cluster randomised controlled trial in Mbeya and Iringa regions of Tanzania were interviewed between Jan 25, and March 3, 2021, and included in this cross-sectional study. A threshold of at least 10 on the ten-item Centre for Epidemiological Studies Depression Scale was used to classify symptom severity indicative of depression. Regardless of climate change awareness, respondents were asked about their feelings of distress on climate change using inclusive language (changing weather patterns or changing seasons). We estimated rate differences in climate change distress (slight or moderate or extreme vs none) by youth characteristics, extent of climate awareness, and climate-sensitive livelihoods (eg, agriculture, tending livestock) and climate-sensitive living conditions (eg, food or water insecurity), using generalised linear models. We compared depression prevalence by extent of climate change distress and climate-sensitive living conditions.

Findings Among 2053 youth (1123 [55%] were male and 930 [45%] were female) included in this analysis, 946 (46%) had reported any distress about climate change. Distress was higher among female, more educated, more religious, older youth, and those working in extreme temperatures. Adjusting for climate awareness—a factor strongly associated with climate distress—helped to explain some of these associations. Depression was 23 percentage points (95% CI 17–28) higher among youth who had severe water insecurity than those who did not. Similarly, youth who had severe food insecurity had 23 percentage points higher depression (95% CI 17–28) compared with those who did not. Those reporting climate change distress also had worse mental health—extremely distressed youth had 18 percentage points (95% CI 6–30) higher depression than those reporting none.

Interpretation Living in conditions worsened by climate change and feeling distressed over climate change have mental health implications among young people from low-resource settings, indicating that climate change can impact youth mental health through multiple pathways.

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Introduction

As the manifestations of climate change intensify,¹ concerns over the future of our planet have also spread. References to eco-anxiety or climate anxiety have surged across newspapers, blogs, documentaries, and social media.² Although the research community is starting to catch up, concepts related to climate-induced distress are only partially understood,³ with much of the existing evidence on climate change and mental health in the context of extreme weather events.⁴

Vulnerability to climate change is linked with other social determinants of health, putting marginalised populations disproportionately at risk.⁴ Food and water shortages, forced migration, and other social and economic consequences of environmental degradation

add to the already mentally taxing experience of living in poverty.⁵ Populations who will be most affected by climate change,⁴ who bear a disproportionate burden of disease for mental health disorders,⁶ are also the least represented in the literature.^{3,7}

From a theoretical perspective, climate change can affect mental health directly, indirectly, and overarchingly. Physical exposure to climate events can affect mental health directly by causing a trauma-induced or stress-induced response, as observed after natural disasters, or indirectly, due to social, economic, and environmental disruptions that, in turn, can lead to worse mental health. Climate change also has overarching mental health impacts, in which the increased understanding of climate change as a threat induces excessive worry or distress for

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Research in context

Evidence before this study

In existing research, impacts on mental health are typically reported in terms of either the direct or indirect consequences of exposure to extreme weather, or as a consequence of the overarching concerns and distress regarding the degradation of the environment, such as climate anxiety or eco-anxiety. However, focusing on climate anxiety alone disregards the harms related to psychological exposure, whereas focusing on eco-anxiety alone minimises the burden among populations most vulnerable to the changing physical environment. Much of the existing empirical evidence identified by our non-systematic review of the literature fails to connect the two, thus overlooking the broader implications of climate change on population health.

To provide a comprehensive overview of the evidence on climate change and mental health, we identified one recent scoping review from each category. The first review considered only large-scale quantitative studies inclusive of a climate exposure as a primary predictor and a measure of mental health as a primary outcome, whereas the second reviewed studies examining the relationship between mental health and measures of worry and concern regarding climate change (eg, climate distress). Neither review identified studies conducted in Africa or South America. Very few studies examined concepts related to climate distress and mental health, and, among them, all relied on convenience sampling or polling among populations in high-resource settings.

Added value of this study

This cross-sectional study is the first, to our knowledge, to measure climate change distress and mental health among

African youth living in extreme poverty, and to further explore associations between climate-sensitive risk factors and mental health. We found a lower extent of climate change distress in our sample compared with other recent studies. However, greater distress was associated with greater climate change awareness, and nearly half of our sample was not familiar with the Swahili term for climate change. Climate-sensitive livelihood activities and living conditions, including recent exposure to environmental shocks, were largely not associated with increased feelings of climate change distress. However, conditions that make populations more vulnerable to, and are worsened by, climate change—namely, water and food insecurity—were associated with a higher risk for depression. Participants who reported feelings of climate change distress also had higher depressive symptomatology.

Implications of all the available evidence

Populations who are most vulnerable to the effects of climate change and have often contributed the least to its anthropogenic drivers are largely absent from the literature on climate change and mental health. Our results suggest that the mental health of young people in low-resource settings is vulnerable to the effects of climate change through multiple pathways, yet these populations might be disproportionately uninformed about the global climate crisis. Conditions that are expected to worsen with climate change, such as extreme food and water insecurity, and feelings of climate change distress, both pose a substantial risk to the mental wellbeing of young people in rural African settings.

the future. Although this phenomenon is sometimes considered a chronic indirect effect,⁷ acknowledging the psycho-emotional responses to climate change distinctly from direct and indirect effects recognises that risks to mental health can occur independent of physical exposure.

Emotions evoked by the overarching threats of climate change include grief, depression, anger, and fear, among others,^{2,8} and numerous terms have been introduced to embody these various psychosocial dimensions.⁹ Notably, eco-anxiety and climate anxiety have come to represent a broad range of negative emotions,³ whereas concepts like ecological grief¹⁰ and solastalgia¹¹ have been used to characterise anguish resulting from the experienced (or in the case of ecological grief, also anticipated) loss or destruction of the natural home environment.

Although often used interchangeably,² some authors distinguish between eco-anxiety and climate anxiety, in which climate anxiety is contingent on understanding that climate change is directly attributable to human activities.^{2,3} In practice, perceptions of human drivers as a catalyst for climate change are not often considered

when measuring climate anxiety.^{12,13} Provided that populations unfamiliar with climate change terminology still observe and experience changes in weather patterns and the consequences of these changes,¹⁴ the more limited definition might further exclude marginalised populations from contributing to the climate anxiety evidence base, and the clinical relevance of these concepts remain unclear.¹² Although chronic stress can trigger a range of adverse physiological and psychological consequences, leading to or exacerbating conditions like depression and anxiety disorders,¹⁵ emotional responses to the climate crisis are not necessarily pathological.^{9,10} Considering potential clinical undertones of anxiety terms,² we refer to climate (change) distress when describing distress regarding climate change in our study sample. This term refrains from pathologising climate-induced feelings and embodies a range of negative emotions.

A recent scoping review identified 56 quantitative studies examining climate change and mental health.⁷ Inclusion was contingent on presence of a climate exposure (predictor) and a measure of mental health

(outcome), addressing potential issues related to causality. Although study heterogeneity precluded the authors from conducting a meta-analysis, the direct effects of climate-related events (eg, extreme heat, hurricanes, and floods) on mental health outcomes (eg, suicide rates, depressive or anxiety disorders) were well represented. Few studies examined indirect effects on mental health and only one study examined perceptions of climate change as a predictor.

A separate scoping review identified four original research studies assessing eco-anxiety.³ Among them, Searle and Gow¹⁶ recruited participants from universities and professional settings in Australia and found a correlation between climate distress and symptoms indicative of depression and related disorders. An analysis of a national survey in Australia found associations between eco-emotions, including eco-anxiety, with feelings of depression, anxiety, and stress.⁸ Overall, neither review identified studies conducted in Africa.

Although greater concern might be expected among populations relying directly on the natural environment,¹⁰ understanding the long-term ramifications of climate change might increase feelings of distress regardless of explicit risk and exposure,⁵ particularly among children and young people.¹⁷ Furthermore, as perceptions and beliefs about climate change are largely influenced by demographics, religion, barriers to knowledge, and lack of capacity (ie, more pressing issues),¹⁸ pervasive research gaps preclude us from understanding perspectives within African contexts.

This study aimed to measure self-perceived climate change distress among young people living in rural, low-resource communities of Tanzania, and to identify whether climate-sensitive risk factors and climate distress were associated with worse mental health in this population.

Methods

Study design and participants

We did a cross-sectional secondary analysis of survey data collected between Jan 25, and March 3, 2021, as part of a longitudinal evaluation of the Tanzania Adolescent Cash Plus Intervention in a cluster randomised controlled trial (2017–21).¹⁹ The primary sampling units were 130 villages (clusters) within four districts of mainland Tanzania, stratified by region (Iringa and Mbeya). The number of clusters was calculated on the basis of the primary evaluation outcomes (ie, pregnancy and experience of physical violence). Village size and local capacity to support the intervention were also considered before enrolment.

Known as *Ujana Salama* (Swahili for safe youth), the intervention comprised life skills and livelihood training, mentoring, productive grants, and linkages to improved government health services. The intervention, which was designed to promote healthy and productive transitions into adulthood among youths enrolled in Tanzania's

national cash transfer programme (living near or below the extreme poverty line), did not pursue goals related to climate resilience or climate literacy.

In 2017, adolescents aged 14–19 years in households already enrolled in the national cash transfer programme were invited to participate in the baseline survey, with 2458 eligible participants recruited for the evaluation. In 2021, we interviewed eligible participants (aged 18–23 years) who were able to attend a follow-up interview for this analysis (appendix p 2). The proportion of participants retained is consistent with other longitudinal studies of adolescents in eastern Africa.²⁰ The quantitative instruments were translated into Swahili, reviewed by field staff during a 2-week training, and pilot tested among youth in Kagera region. To ensure common understanding of relevant terms and concepts, an interactive lecture on climate change was also provided during training.

Written informed consent was obtained from participants. Ethical approval was granted by the National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/2784) and the Tanzania Commission for Science and Technology (COSTECH). The intervention, study design, and data used for this cross-sectional study are described in more detail elsewhere.¹⁹ STROBE guidelines were used to ensure the reporting of this observational study.²¹

Measures

Depressive symptomology was measured using the ten-item Centre for Epidemiological Studies Depression Scale (CES-D10;²² appendix p 3). This short form of the CES-D20 quantifies depressive symptom severity using ten questions on frequency of feelings and behaviours experienced during the previous 7 days. Scores ranged from zero to 30, with higher scores on the CES-D10 indicating worse mental health. Respondents scoring 10 or higher were classified as symptomatic of depression. Although not a diagnostic measure, this threshold has been used to indicate clinical levels of depressive symptomatology and has been validated among Tanzanian youth.²³ Cronbach's alpha produced a value of 0.80, indicating good consistency across items.²⁴

To measure awareness of climate change we used a Gallup World Poll survey item.²⁵ Youth were asked "How much do you know about global warming or climate change?" Responses included (1) "I have never heard of it", (2) "I know something about it", and (3) "I know a great deal about it".

For our main distress measure, respondents were asked "How distressed, if at all, are you about changing weather patterns (eg, increases in heat, rain) or changing seasons (eg, length of agricultural season)?" By using the definition, we were able to include respondents unfamiliar with the Swahili term for climate change (*mabadiliko ya tabianchi*). Presumably, rural or agricultural populations might be

See Online for appendix

familiar with climate change and its effects but unfamiliar with the terms used to describe it. We asked the question again using the Swahili term among youth who reported having any awareness. Responses ranged from (1) "Not at all" to (4) "Extremely".

To better understand characteristics associated with climate change awareness or distress in our sample, we included demographic (age, sex, region) and sociocultural indicators (education level, marital status, and frequency of religious attendance) that were previously identified as relevant factors for perceptions and attitudes regarding climate change.²⁵ Data on ethnicity were not collected.

For insights on climate change distress among individuals more vulnerable to its effects, we included two categories of climate-sensitive risk factors: livelihood activities (farming, caring for livestock, collecting water, working in extreme temperatures or near or on a body of water) and living conditions (food and water insecurity, exposures to floods or droughts and crop or livestock disease). Livelihood activities were dichotomised to represent whether the respondent reported any hours engaged in said activity during the previous 7 days. This reference period was selected to improve recall and for comparability with previous surveys. Living conditions were measured using household surveys. Severe water insecurity was defined as 4 or higher (range 0–12) on the four-item Household Water Insecurity Experiences (HWISE-4).²⁶ Household Food Insecurity Access Scale (HFIAS) categories²⁷ and number of meals usually eaten per day (two or fewer or three or more) were used to measure food insecurity. Exposures to floods or droughts and crop or livestock disease were dichotomised to denote whether the household reported being negatively affected by these occurrences during the previous 12 months.

Statistical analysis

We provided descriptive statistics summarising the sample characteristics and other study measures, accompanied by graphical representations of climate change awareness and climate change distress for each characteristic. We estimated rate differences in prevalence of awareness (some or a great deal *vs* none) and distress (slight or moderate or extreme *vs* none) using generalised linear models with identity link and binomial distribution. We treated climate change awareness and climate change distress as dichotomised dependent measures for interpretability, consistency, and to promote comparability.²⁵ Given the importance of sociocultural factors in shaping perspectives related to climate change,^{25,28} we provided unadjusted rate differences and rate differences adjusted for youth characteristics (eg, sex, age, marital status, and religious attendance) to understand their relevance *vis-à-vis* our sample.

As greater climate change awareness was strongly and positively aligned with greater climate change distress, we hypothesised that differences in distress for a given characteristic (eg, sex) or risk factor (eg, engaged in

farming) could be partially or fully explained by the level of climate change awareness among that subpopulation. Therefore, we fitted three models to examine rate differences in climate change distress: unadjusted, partially adjusted (controlled for youth characteristics), and fully adjusted (also controlled for climate change awareness in addition to youth characteristics). Missing values were treated pairwise, with minor variations in *n* for adjusted models.

Finally, to understand the relationship between climate change and mental health, we examined associations between climate change distress and climate-sensitive living conditions with depression as our dependent variable. Providing unadjusted, partially adjusted, and fully adjusted models allowed for us to estimate differences in depression by extent of climate change distress and by climate-sensitive living condition categories. Livelihood activities were excluded as they are not inherently negative (eg, tending own livestock could indicate greater wealth), whereas climate-sensitive living conditions represent both risk factors for, and negative effects of, climate change. Standard errors were adjusted for clustering at the village level. As the data for this study originated from an impact evaluation, as described above, as a sensitivity analysis we replicated fully adjusted models, also adjusting for intervention status.

Data management and analysis were performed using Stata version 16.1. Rate differences were displayed using R version 4.0.2.

Role of the funding source

The funders had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Among 2053 participants included in this analysis, 1123 (55%) were male and 930 (45%) were female (appendix p 4). The sample was proportional by region, with 997 (49%) respondents from Mbeya and 1056 (51%) from Iringa. 1221 (59%) were younger than 21 years and 1078 (53%) had at least some secondary education. Only 227 (13%) were married, whereas 1782 (87%) attended religious services regularly.

906 (44%) youth were not aware of the Swahili term for climate change (figure 1), whereas 546 (27%) reported some and 601 (29%) reported a great deal of climate change awareness. Youth who completed secondary school had the greatest awareness (465/637 [73%]), which was 26 percentage points (95% CI 21 to 31) higher than those with only primary education (appendix pp 5–6) after adjusting for other characteristics. Age was negatively associated, with the oldest reporting 10 percentage points (95% CI –17 to –2) less climate change awareness than the youngest (appendix pp 5–6). Youth who rarely or never attended religious services had the lowest awareness (103/271 [38%]; figure 1). Although religiosity was associated with greater climate change awareness in both

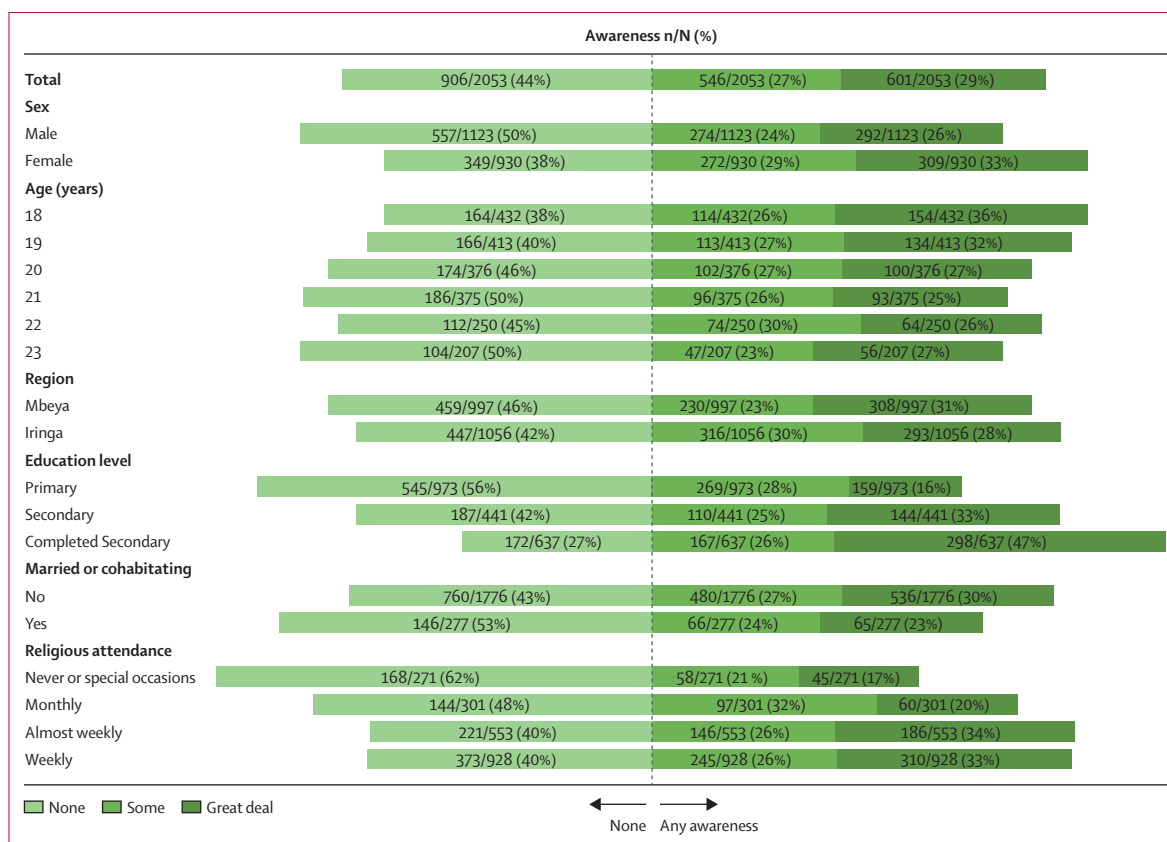


Figure 1: Climate change awareness by sample characteristics
 N varies due to missing values (two missing values for educational level).

models (appendix pp 5–6), controlling for other characteristics reduced the strength of this association, with an 11 percentage point (95% CI 3 to 19) higher prevalence among weekly attenders, compared with those who rarely or never attended. Female youths were more aware of climate change than were male youths (rate difference 7% [95% CI 1 to 13]; appendix pp 5–6). Married youth had 9 percentage points (95% CI –17 to –1) lower climate change awareness than did their single counterparts (appendix pp 5–6).

946 [46%] youth reported any distress over climate change (changing weather patterns, changing seasons), with 80 [4%] reporting extreme distress (figure 2). Youth who reported a great deal of awareness about climate change had the greatest distress (423/601 [70%]), which was 36 percentage points (95% CI 29–42) higher than those who reported no climate change awareness in the fully adjusted model (figure 3; appendix p 7). Among youth with any climate change awareness, the prevalence of distress was lower when using the Swahili term for climate change compared with the measure provided here (results not shown; 613/1147 [53%] vs 662/1147 [58%]; $p < 0.0001$).

Educational attainment was associated with a higher prevalence of distress in unadjusted and partially

adjusted models (figure 3; appendix p 7). This association was explained after controlling for climate awareness. Although female youths had 11 percentage points (95% CI 5–16) higher distress than did male youths in unadjusted models, adjusting for other characteristics completely attenuated this difference. There were no marked differences in distress by age, except for a higher prevalence among the oldest youth (aged 23 years) in the fully adjusted model. Distress over climate change was higher among youth who frequently attended religious services (16 percentage points [95% CI 8–24] higher among weekly in the fully adjusted model vs never or special occasions).

Climate-sensitive risk factors were largely not associated with climate change distress (appendix pp 8–10). Distress was only higher among youth working in extreme temperatures, with consistent results across models. 30% of youths had depression symptomatology (CES-D10 ≥ 10); however, those who reported extreme climate change distress had a 40% prevalence of depression (figure 4). Compared with youth reporting no climate change distress, extremely distressed youth had a 16 percentage point (95% CI 5–28) and 18 percentage point (95% CI 6–30) greater depression prevalence in the partially and fully adjusted models, respectively (figure 5;

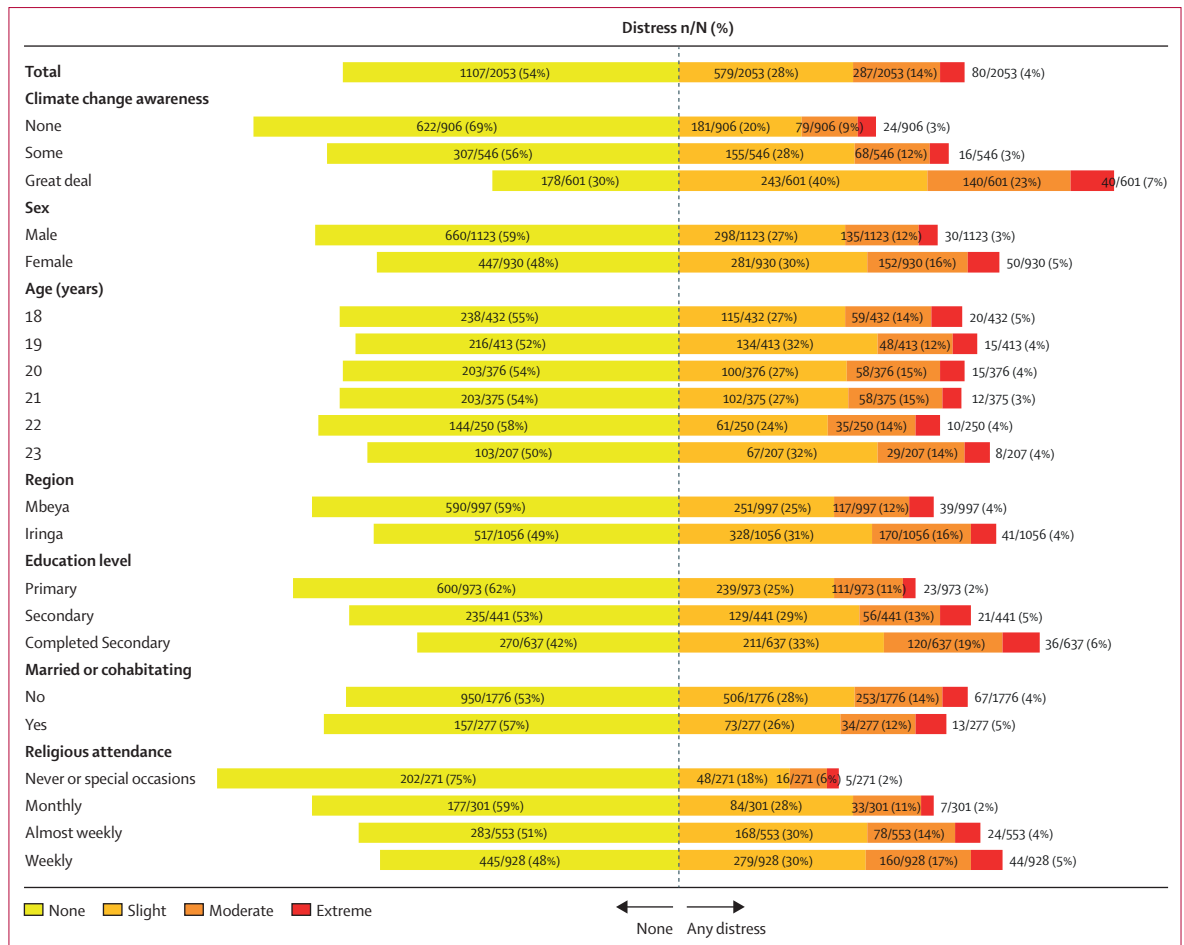


Figure 2: Climate change distress by extent of climate change awareness and sample characteristics
 N varies due to missing values (two missing values for educational level).

appendix p 11). Slightly distressed respondents also had higher depression in adjusted models. Depression was highest among youth who reported severe water and food insecurity (figure 4; 181/365 [50%] and 302/685 [44%], respectively). In the fully adjusted model, youths who had severe water insecurity had 23 percentage points (95% CI 17–28) higher depression than those who did not, with little variation between models (figure 5; appendix p 11). Youths with severe and moderate food insecurity had 23 percentage points (95% CI 17–28) and 8 percentage points (95% CI 3–13) higher prevalence of depression, respectively, than did youths who were food secure in the fully adjusted models.

When including intervention status in the fully adjusted models, no meaningful differences were found (appendix pp 12–15).

Discussion

This cross-sectional study adds to the evidence on climate change and mental health and, to our knowledge, is the first to examine climate change distress among youth in eastern Africa. Higher education, more frequent religious

attendance, and being female, younger, and unmarried, were associated with greater climate change awareness. Similarly, climate change distress was higher among those who were higher educated, more religious, and females. After controlling for climate change awareness, a salient predictor of climate change distress, and other youth characteristics, important factors for distress included region and religiosity. Measures of climate change vulnerability, such as engaging in agricultural activities and living in households recently affected by droughts or flooding, were not associated with climate change distress, except for working in extreme temperatures. Severe food and severe water insecurity, although not associated with higher climate distress, were associated with higher depression. Youth who reported feelings of distress over climate change, especially extreme distress, also had higher depression prevalence.

Our findings are somewhat in contrast with a recent multicountry study examining climate anxiety among children and young people.¹³ Results from 10 000 online survey participants aged 16–25 years found most (95%) were at least slightly worried about climate change,

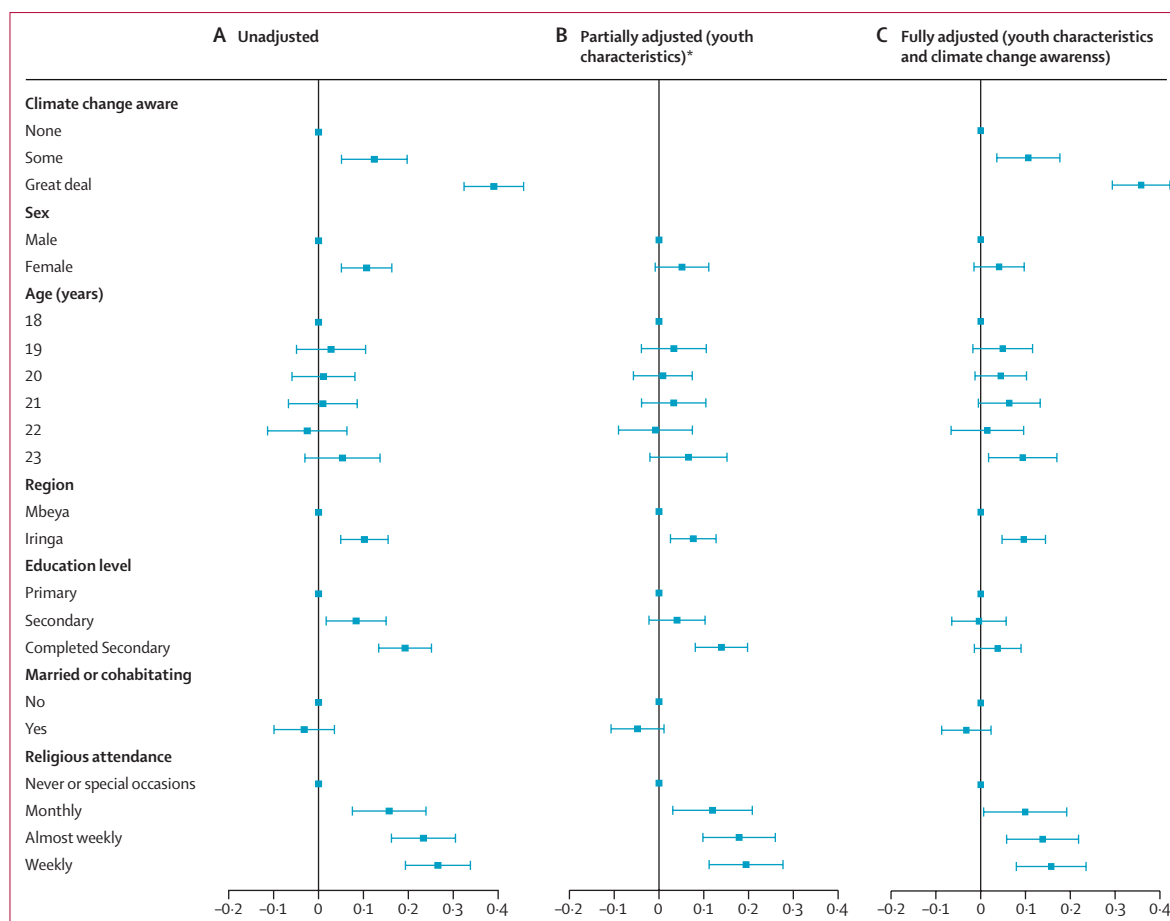


Figure 3: Characteristics associated with climate distress

Forest plots show rate differences in any distress (slight or moderate or extreme vs none) and corresponding 95% CIs as depicted by blue point estimates and whiskers, as compared with the reference category. (A) Unadjusted, (B) partially adjusted (all youth characteristics: sex, age, region, education level, marital status, and religious attendance), and (C) fully adjusted (youth characteristics and climate change awareness) rate differences are shown. SEs were adjusted for clustering at the village level. *No rate differences for climate awareness were reported as results are duplicated in the fully adjusted model since both control for youth characteristics and climate awareness. Corresponding rate differences and 95% CIs are provided numerically in the appendix (p 7).

compared with 46% in our study. Although the previous study included countries with varying socioeconomical, cultural, and climate risk profiles, using online survey data most certainly led to some bias. Participation would require internet access, use of a computer or smartphone, literacy skills, and, in some cases, understanding of a non-native language; among four Global South countries, respondents in India, Nigeria, and the Philippines were provided English surveys. Additionally, online access and improved literacy could increase exposure to climate change information, news, and media, which has been associated with climate anxiety.¹²

Although greater climate change distress among female individuals and more educated groups is consistent with previous literature, the evidence for religiosity is mixed.²⁸ Religious values in Tanzania have been found to support conservation efforts, whereby the preservation of nature is prioritised and traditions regulate the exploitation of natural resources and habitat

loss.²⁹ Therefore, increased distress among frequent attenders could suggest a deeper spiritual connection to the environment.

Although some religious institutions have promoted scepticism about climate change, religious communities are increasingly visible in the field of ecological sustainability in Africa.³⁰ Religion has an important role in Tanzanian society and has been instrumental in advancing public health initiatives, promoting healthy behaviours, and disseminating disease awareness during the COVID-19 pandemic.³¹ Perhaps increased engagement in the religious community has exposed young people to concepts relating to climate change, although this is speculative.

Despite virtually no associations between climate-sensitive risk factors and climate distress detected in our study, we did find worse mental health among youths with severe water and food insecurity. The relationships between food³² and water insecurity³³ with mental health

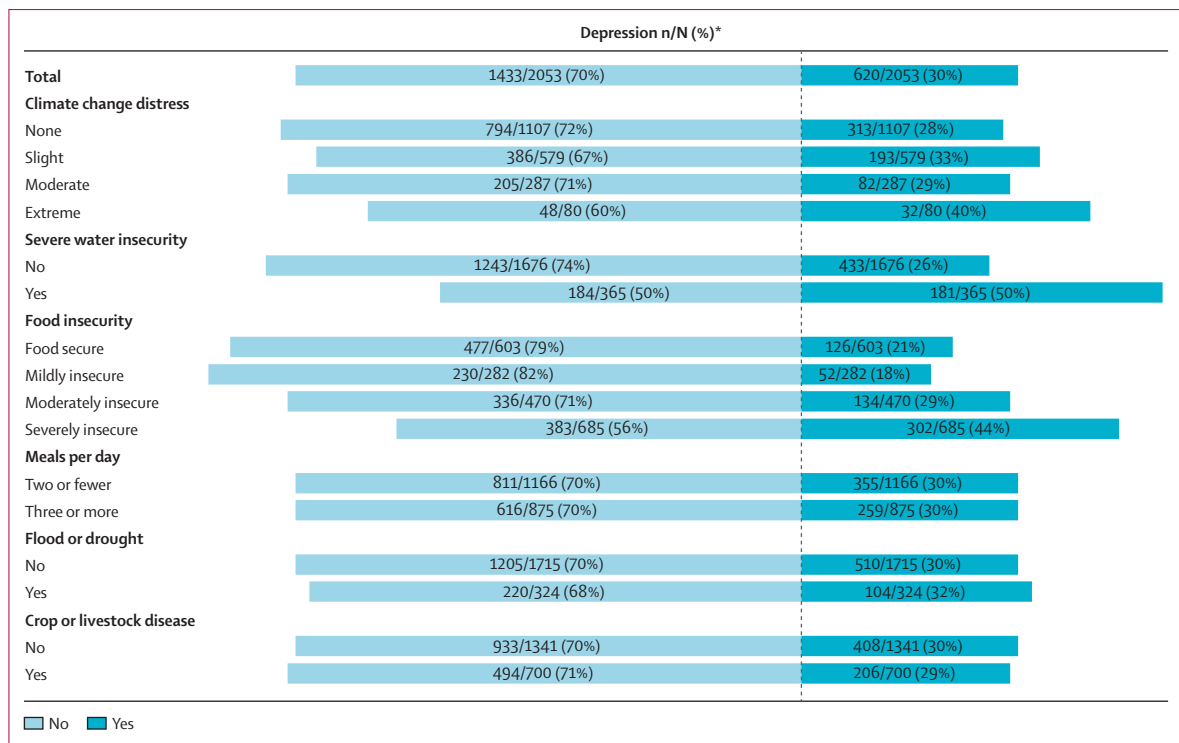


Figure 4: Prevalence of depression by extent of climate change distress and climate-sensitive risk factors (living conditions)
 N varies: 12 missing values for water insecurity, meals per day, crop or livestock disease; 13 missing values for food security categories; and 14 missing values for flood or drought). *Depression was defined as ≥ 10 on the ten-item Centre for Epidemiological Studies Depression Scale.

have been previously established. Deprivations of basic needs might increase stress, contribute to feelings of powerlessness, incite conflict, and harm physical health, which are all potential pathways for resource scarcity to influence mental health. Although we found no relationship between drought or flooding exposure and depression, the effects of climate events on wellbeing are highly dependent on severity, duration, and recovery time.³⁴ A study that used data from a previous wave of this sample found a relationship between extreme precipitation and depressive symptoms.³⁵ As both studies use a 12-month recall, it is possible that the severity and time since exposure varied between waves. Furthermore, the percentage of youth who had this negative shock halved between the earlier study (32%) and the current study (16%), which could indicate less severe weather in the study regions overall during the period assessed in our study.

Our results highlight the importance of demographic and sociocultural factors in awareness and perceptions about climate change, emphasising the need for varied perspectives to inform policy. Considering differences in distress by region and religiosity, community-led initiatives and religious institutions can serve as entry points for interventions that encourage climate change knowledge while supporting young people’s psychosocial wellbeing. Guidance on how to reduce household-level susceptibility to climate events, improve infrastructure

and defences (eg, vegetation, water channelling), facilitate climate-resilient income-generating activities, and address the social and gender vulnerabilities that further exacerbate risks³⁶ could be implemented within more traditional education and livelihood intervention curricula.

People in Africa are increasingly being exposed to the negative effects of climate change, yet not everyone understands the risks. Enhancing public understanding facilitates adaptation and resilience efforts within national and subnational government sectors and can harness local knowledge to develop climate-responsive protocols.³⁷ Considering the low rates of climate change awareness, efforts should be made to increase climate change literacy and include marginalised populations in the concerns and ideas in the global and local climate conversations.

The study’s main strengths are its inclusivity of an under-represented population, enabled by face-to-face interviews in remote settings, and the inclusion of a validated mental health measure. Previous studies assessing perceptions of climate change typically come from the Global North and overwhelmingly rely on polling data.³⁸

Limitations of this study are common to others examining climate change and mental health. First, variations in climate change distress constructs contribute to ambiguity across the field.¹³ Conversely, relying on standardised measures designed with de facto climate change awareness and validated in high-resource

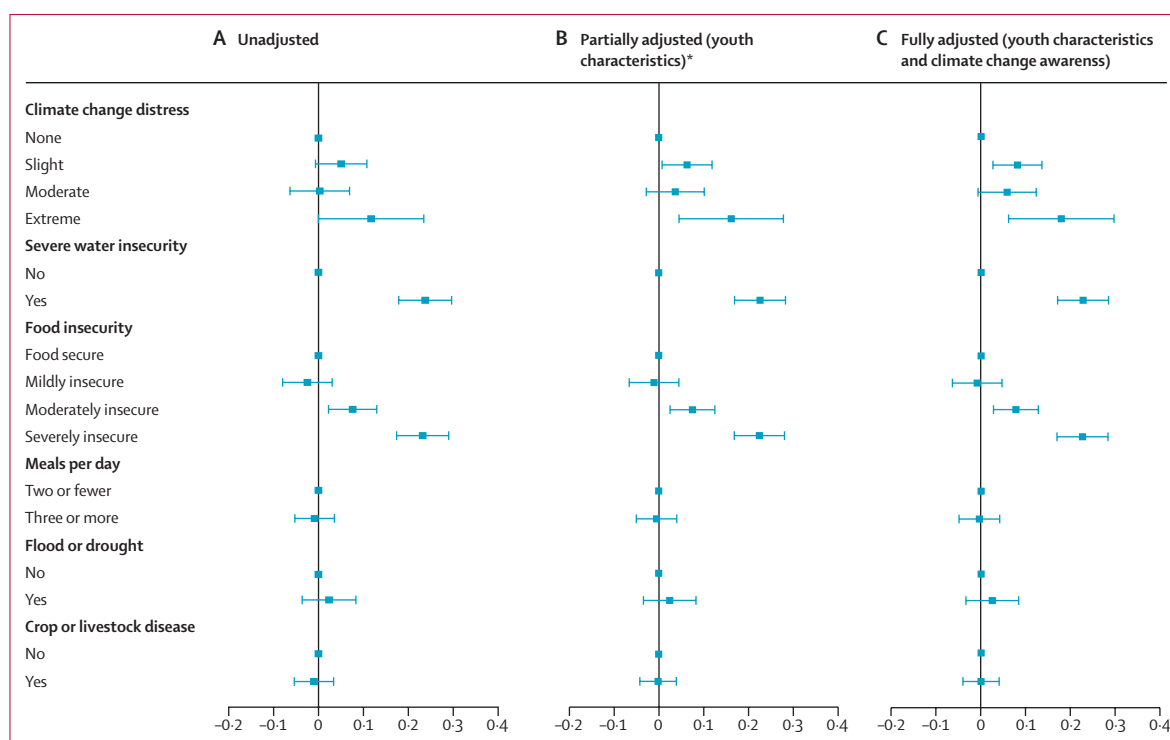


Figure 5: Climate change distress and climate-sensitive living conditions associations with depression

Forest plots show rate differences of prevalence of depression, defined as ≥ 10 on the ten-item Centre for Epidemiological Studies Depression Scale for each subpopulation, as compared with the reference category. (A) Unadjusted, (B) partially adjusted (all youth characteristics: sex, age, region, education level, marital status, and religious attendance), and (C) fully adjusted (youth characteristics and climate change awareness). SEs were adjusted for clustering at the village level. Corresponding rate differences and 95% CIs are provided numerically in the appendix (p 11).

settings might be unsuitable for remote or culturally diverse populations. Our climate distress question was modelled from a validated construct measuring distress over other pertinent issues for young Tanzanians living in poverty.²² Due to this phrasing, we did not specify focus of distress (eg, for you or your family) nor context (eg, for the future). Additionally, as the general awareness of climate change was unknown, we explored distress over climate change using the definition (eg, changing weather patterns) and examples (eg, increased heat and rain), enabling us to include perceptions from respondents unfamiliar with the Swahili term. Among those who were familiar, however, a greater percentage reported distress when using the more inclusive measure. This finding suggests that the inclusive phrasing, per se, did not lead to under-reporting of distress, and that observable effects of climate change, such as increased weather severity and changes in the lengths of the rainy and dry seasons, might be more distressful than the abstract term for our sample.

Secondly, although we attempted to measure the more indirect effects of climate change on climate distress by analysing measures such as water and food insecurity, we cannot conclude that these associations are causal. The use of cross-sectional data also precluded us from finding a direct effect of climate distress on depression. Relatedly, although this cross-sectional analysis used survey data

from a longitudinal impact evaluation, sensitivity tests indicated that the intervention being assessed did not introduce bias in our study. However, our results might have been subject to other sources of bias (eg, unmeasured confounding). For example, if increased food insecurity and depression were both independently driven by the COVID-19 pandemic, the association between these two variables could be partially or fully attributable to the social and economic conditions of the global crisis. Considering the context, it is also possible that low distress was driven by competing risks (eg, COVID-19, food insecurity) taking higher precedence in communities at the time of the survey.³⁹ Moreover, our results might be ungeneralisable to less deprived populations.

There is a strong association between climate change awareness and climate change distress. Although controlling for awareness might have provided better estimates for associations with distress, this model does not fully explain the mechanisms of these associations. For example, although female individuals and educated youth reported higher distress in unadjusted models, controlling for other characteristics fully attenuated the difference between male and female individuals, while differences by level of education were only reduced when climate change awareness was introduced to the model. Conversely, religiosity remains important in all models. These results suggest that greater distress

among some populations might be dependent on underlying characteristics or understanding of climate change, whereas some groups might be vulnerable through other mechanisms. Future studies could explore how predictors of climate change distress are mediated through climate change awareness using longitudinal multilevel structural equation models or other causal mediation methodologies.

Several research recommendations follow this exploratory study. To comprehensively measure the effects of climate change on mental health, researchers should consider the overlap between various pathways. Efforts should be made to conduct inclusive research, capturing perceptions from vulnerable populations. Identifying initiatives that strengthen individual coping strategies and mitigate adverse effects on mental health is important, but these will likely not supplant efforts which reduce susceptibility to adverse climate events, and subsequently distress over these events, in the first place. These initiatives might include national measures to reduce emissions and simultaneously strengthen social protection for affected populations, or initiatives to address susceptibilities locally.

In conclusion, our results suggest that the mental health of young people in Africa is being negatively affected by climate change across multiple pathways, yet many are largely uninformed about, and subsequently excluded from, the global climate change conversations.

Contributors

LP and TAJH conceptualised the Article. TP, LP, and LK supported data collection activities and instrument development. LK provided the interactive lecture on climate change to field staff and was instrumental in assuring quality of Swahili translations during trainings, piloting, and in the initial weeks of fieldwork. LP and TP verified the underlying data. LP was responsible for the literature review, data management and analysis, and all data visualisation activities. TAJH completed an audit of all final source materials, software scripts, log files, and outputs. LP, TAJH, FJvL, LK, and TP contributed to drafting the manuscript and approved the final version. Members of the evaluation team further contributed to study design and data collection. Due to strict data sharing agreements, only members of the Tanzania Adolescent Cash Plus Evaluation team can access the data in this study at the time of this publication.

Declaration of interests

We declare no competing interests.

Data sharing

Data analysed for this study are not publicly available but can become available, subject to approval of the Tanzanian Government, after completion of the main Cash Plus evaluation. All other analytical files, including data management documentation, software scripts, log files, and outputs, are available on request from the corresponding author and will be stored from 30 days of publication at the Erasmus MC Department of Public Health Secretariat (contact email: secretariaat.mgz@erasmusmc.nl).

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