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Investigating Associations Between Climate Change Anxiety and Children's Mental Health in Pakistan: Impacts and Priority Actions*

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Abstract

Objectives: Climate anxiety has a negative impact on the mental health and psychological wellbeing of the vulnerable population. The goal is to assess many factors that affect mental health and psychological wellbeing, as well as how climate change affects mental health in Pakistan's vulnerable population.

Methods: This study provides evidence-based insights on the long- and medium-term impacts of extreme weather events on mental health. To obtain information on these variables, this research uses a quantitative approach and a cross-sectional survey design with a multivariate regression model for empirical tests on a sample of parents and children with an impact on mental health from climate change anxiety.

Results: Results indicate that individuals experience shock and climate change anxiety, and their effects on mental health and psychological wellbeing. Climate change can have detrimental effects on children's mental health. (1) disaster risk health (2) children's stress index (3) public health concerns, (4) climate change anxiety, (5) generalized anxiety disorder, and (6) major depression disorder, as reported by the children with mental health outcomes.

Conclusions: The findings of this study show that climate change has a stressful effect on mental health. The paper concludes with a discussion on strategies to address the anticipated mental health issues among children due to climate change.

Climate change and mental health are recognized globally as major challenges, yet the links and shared drivers between these issues remain underexplored. Authorities in global health, such as the World Health Organization, have acknowledged the profound effects of the climate crisis on public health.¹ Additionally, recent findings from the Intergovernmental Panel on Climate Change highlight the drastic impacts of increasing global temperatures on human well-being.² Although there is widespread recognition of the impact of climate change on physical health, its influence on mental health has historically received less attention. However, recent years have seen an increase in reviews and policy briefings focusing on this topic.^{3,4} Mental health extends beyond mental illnesses and disorders; it also covers aspects of mental wellness, emotional resilience, and psychological well-being.^{5,6} Various social and psychological factors play a role in shaping psychological well-being, contributing to overall human welfare. This encompasses a spectrum from positive mental health to mental challenges and disorders.^{4,7}

Research increasingly shows that climate change impacts human health, including mental health.^{8,9} Numerous studies have analyzed the relationship between climate change and mental health, particularly in connection with natural disasters. These analyses have found elevated rates of psychiatric conditions, such as major depressive disorder (MDD) and generalized anxiety disorder (GAD). Additionally, emerging research suggests that rising temperatures may negatively affect mental well-being and increase the risk of suicidal tendencies.¹⁰ Children in Pakistan and around the world are already being impacted negatively by climate change, which is predicted to worsen in the future. Rising temperatures, severe storms, heat waves, floods, disruption of agricultural cycles, drought, and deteriorating water and air quality are just a few of the environmental concerns Pakistan is facing today. These problems have obvious socio-economic effects and a big impact on people's quality of life. Because they are still growing physically and intellectually and are more prone to sickness and environmental stressors, children are especially exposed to the harmful effects of climate change.¹¹ Heat waves present a considerable threat to children, and drought-related food shortages can negatively impact their nutrition and overall health. Extreme weather conditions can be particularly unsettling for young children, affecting their emotional and psychological well-being. With prolonged heat waves, there is growing concern that children may face limitations on outdoor activities, increasing the risk of obesity.^{12,13}

Previous Studies have shown that there is a link between climate change and psychological distress. This research suggest that the effects of climate change can be seen in various aspects of a person's mental health. Children are disproportionately affected by the direct impacts of climate change at a period when they are growing physically, psychologically, socially, and neurologically. Recent studies have shown that young children are most affected by the indirect consequences of climate change, such as environmental anxiety, which can harm social and psychological health and well-being, and may exacerbate the mental health problems of children who already have these problems.¹⁴ We are already seeing the effects of wildfires, storms, floods, heat waves, and droughts. The slow changes in average temperature, sea level, and precipitation patterns that determine the climate in the coming decades may not be as obvious, but ultimately are more important because they will harm more people. Even though polar bears have been thought of as being the primary victims of climate change in several cases,¹⁵ it is increasingly apparent that human well-being is concerned. In addition to the severe impact of natural disasters and the social effects of forced migration and conflict, increased heat and vector-borne diseases, as well as malnutrition, will threaten physical and mental health.¹⁵⁻¹⁷

It is important to recognize that extensive research has highlighted the link between climate change and various negative effects on the mental health of children and young people.¹⁸ There are several possible explanations for the relationship between the above-mentioned health outcomes; it may result from researchers and experts of climate change and environmental education increasing public awareness of its potential to include other than just skill full information for example (affective and attitudinal) children response to action climate change outcomes psychological well-being.^{19,20} It is important to develop climate change education strategies that promote children's overall well-being and constructivist climate change participation instead of steering clear of this subject in classes and at school events. It is imperative to comprehend the entire spectrum of children's psychological experiences about climate change.²¹⁻²³ Furthermore, investigating the attitudinal and affective aspects of children's involvement in climate change may reveal potential context-specific effects of climate change education.¹⁸

This study examines the existing knowledge and research on the impact of climate change on mental health, with a particular emphasis on the disproportionate effects experienced by marginalized and vulnerable communities. Despite evidence of the high prevalence of children's stress among vulnerable children in Pakistan, it is unclear to what extent this stress is related to variables such as children's perceptions of generalized anxiety disorder and major depressive disorder. In this study, we examine the most recent findings about climate change's impact on children's mental health in relation to both direct and indirect effects. It's crucial to consider how children learn about climate change and how children cope with climate anxieties such as fear, phobia, and stress and relate it to their mental health. Anxiety over climate change though CCA has gained increasing attention in the popular press;²⁴ however, not much study has looked at the relationship between CCA and disaster risk for health, public health concerns, and mental health symptoms, such as GAD and MDD symptoms. Furthermore, because more people—especially young people—are taking action to combat climate change, additional study is required to determine the potential relationships between action and symptoms of mental health as well as anxiety related to climate change.

This study aims to examine the significant effects of exposure to extreme weather events linked to climate change on physical,

mental, and psychological well-being. While previous research has thoroughly documented these impacts, this study presents a novel approach by focusing on how climate change affects children's mental health, specifically evaluating Pakistan's climate resilience. The study also examines the less well-documented effects of climate change on children's physical health, as well as how it affects their psychological and mental well-being. It also investigates how mental health may be affected by climate change in the present and the future through emotional reactions like elevated worry. We aim to understand the factors that trigger children's anxiety about the climate and its impact on their psychological and mental well-being. Finally, we discuss the most recent research on the psychological implications of climate change on kids and the direct and indirect effects it has on mental and physical health.

Climate Change Education and Action

Although education and literacy were highly valued in Pakistan both before and after independence, they were unable to transcend rhetoric and become tangible. The general public's understanding of environmental literacy and climate change education is thought to be at an extremely low level. Because it is a post-colonial country, little has been done to adapt the country's educational system to regional or national needs. However, Pakistan's higher educational institutions have introduced degree courses associated with environmental studies for postgraduate and graduate program students. In the process of primary to high school education grades 1-10, children still face a lack of environmental textbooks and courses to develop awareness and knowledge at an early stage.²⁵ According to a review of the country's elementary school curricula, textbooks issued by the Government of Pakistan for social study or general science subjects contain chapters on basic environmental phenomena. The study found that chapters dealing with these issues are often completely ignored in classroom curricula and receive only secondary attention from teachers in favor of theories based on physics and chemistry. This method of practice provides insights into the priorities of educators. The study examined existing policies and children's attitudes towards environmental and climate change among the public and private schools' textbooks of science, geography, and social studies for grades 5-8 and 9-10. It has been reported that these textbooks lack knowledge and awareness about the environment and climate change.²⁶

To address the relevant issues of climatic and environmental degradation, educational policymakers concluded that there is no effective framework in place, let alone one that would provide background and policies for climatic adaptation and mitigation at different levels. Pakistan's educational system was decentralized to answer the 18th amendment, and the authority to create and execute education literacy curricula was shifted to the provinces. To provide knowledge of climate change and environmental challenges to pupils as well as a framework that fosters the innovation and critical thinking required to develop a climate-positive attitude, provinces could take advantage of this fantastic opportunity to customize their regional curricula.²⁵ It is explained in climate change education, a field that is still in its infancy and must be included in school curricula all around the world, particularly in underdeveloped nations like Pakistan. While some measures have been taken, relevant policies and policymakers appear to be insensitive to the possibility of strengthening processes that may contribute to climate change adaptation and mitigation. This is despite the importance and necessity of integrating climate change into basic education in Pakistan. In addition, there is a need to develop policy guidelines for

integrating climate change adaptation and mitigation strategies into elementary education curricula through coordinated education and environmental governance mechanisms at the federal and provincial levels.

Psychological Trauma and Mental Health in the Context of Climate Change

Research on the impacts of climate change on mental health and well-being is expanding rapidly. This study seeks to evaluate the scope and characteristics of existing interventions aimed at addressing psychological trauma and mental health issues linked to climate change. Increasingly, there is an urgent recognition of the need to tackle climate-related public health crises. Beyond its widely recognized effects on physical health, climate change significantly impacts mental well-being.²⁷ Studies have demonstrated a strong link between climate events and severe mental health outcomes, including depression, post-traumatic stress disorder (PTSD), and suicide.²⁸ Experts have identified several high-risk groups, including children and adolescents, the elderly, pregnant women, individuals with chronic conditions, and marginalized communities.^{28,29} Indigenous communities around the world have spoken of sentiments of despair, rage, grief, fear, and powerlessness brought on by forced migration, worry due to climate change, broken cultural continuity, and past and present disempowerment.³⁰

Researchers have extensively studied the psychological responses and coping mechanisms associated with climate change. However, evidence-based interventions to effectively mitigate these adverse impacts for both individuals and communities remain limited. A comprehensive review of the link between climate change and mental health identified 120 original studies, mostly cross-sectional, exploring the impact of climate change on mental health outcomes.²⁸ Among these, 8 studies focused on interventions but were mainly theoretical and lacked robust data. Only 2 studies on eco-anxiety therapies included empirical evaluations, while the others were conceptual reflections.³¹ The 2020 evaluation by Palinkas et al., which included 23 studies, is considered the most thorough to date. However, it did not distinguish between interventions for climate-related events and those for other scenarios, such as armed conflicts, which are theoretically relevant to climate change.³² We limited our review to scholarly works and initiatives that specifically address the treatment or prevention of recognized mental illnesses. According to the World Health Organization (WHO), mental health is defined as overall well-being, not merely the absence of a specific condition.²⁷ In the face of climate stress, interventions that foster psychological strengths and emotional resilience may be easier to identify with the aid of a more comprehensive conceptual framework.

Cognitive Climate Change Anxiety and Mental Health

Climate change information has a variety of effects on individuals' psychological views, whereas different types of climate change events are associated with distinct patterns of emotional regulation. Occasionally, people may feel distress due to climate change without realizing it, merely feeling a general sense of unease with the ongoing environmental changes.³³ Multiple severe weather events in one's area can elicit a stronger response because people perceive the danger as tangible and nearby,³⁴ whereas direct observations of climate change often perceive it as more abstract

and distant.³⁵ Consequently, a decrease in "psychological distress" correlates with an increased level of concern and stronger intentions to act in an environmentally friendly manner, leading to improved adaptations. Climate change's effects on mental health can be categorized as acute or chronic; however, some effects may overlap. Stress levels can range from mild concerns to severe issues. Extreme weather events or natural disasters, such as hurricanes, floods, wildfires, tornadoes, and droughts, often have immediate and profound effects. These events can strike unexpectedly, leading to tragic outcomes, including loss of life, resources, social support, and community networks. Acute stress disorders typically classify symptoms that emerge within 4 weeks of such traumatic events. If these symptoms persist, they may lead to diagnoses of post-traumatic stress disorder (PTSD), anxiety, or depression.³³

Arguably, cognitive evolution should have favored processes that foster not only individuals but group effectiveness. For example, collective functioning is crucial when it comes to hunting big game. Thus, cognitive heuristics should be able to integrate information about the intra-individual sphere and the individual-environment relationship sphere. Climate change's impacts on adults' physical and mental health have been significant and wide ranging. The research on how climate change affects children and youths psychologically is still very modest, but it is indeed expanding. Not all children will be affected in the same way. Those living in areas that are most vulnerable to climate change, with poor infrastructure and fewer supports and services, are most likely to be affected.³⁶ The study analyzed how Pakistan's educational outcomes were severely affected by extreme weather events. Every year, increasing climate change risks are demonstrated through powerful extreme weather events, including heat waves, heavy rainfall, and droughts that severely affect children and people. The likelihood and severity of occurrences are increasing, which has detrimental repercussions on people, property, and the environment. Extreme weather events are distinct from other climate change consequences in that they are noticeable immediately and are poorly defined by the climatological methods investigated in many projections.³⁷ Unfortunately, there are no standardized methods or efforts to systematically document hazards associated with climate change. Pakistan has been affected by severe monsoon weather since mid-June 2022. Since then, the situation has deteriorated significantly as the rainfall has been equivalent to nearly 3 times the national 30-year average.

Rapidly growing research has revealed a connection between climate change and schooling in recent years, as well as several psychological effects, including those on children and adolescents. Floods are the main consequence of extreme rainfall. Changes in flood risk caused by heavy precipitation differ in other factors, including language changes, river management, and regional sensitivity to floods,³⁸ and some climate-related factors such as snowmelt, soil moisture, and storm size.³⁷ Although there are large regional and subregional variations in river flow trends, many of the observed changes can only be accounted for by anthropogenic climate change. According to evidence from the literature on attribution science, the consequences of climate change precipitation are increasing flood frequency and severity. In August 2022, unusually strong monsoon rains triggered one of the worst floods in Pakistan's history, affecting approximately 33 million people nationwide.³⁹ As a result, 85% of children living in developing countries, as well as a small number of disadvantaged children in developed countries, will be the most severely affected.

Climate Change Anxiety's Direct Impact on Children's Mental Health

Climate change-driven severe extreme weather events are likely to significantly impact children's mental health and psychological well-being. The literature extensively addresses the impact of such traumatic events on children, who are particularly vulnerable to disaster effects. These events often result in family strain, disruption of social support systems, and displacement from homes and communities. There is significant risk of acquiring additional mental health issues such as attachment disorders, phobias, anxiety, panic attacks, and depression.³⁶ A substantial body of scientific evidence shows that human activities are driving climate change, which is already adversely affecting ecosystems and threatening global food security. The recent increase in floods and other extreme events across South Asia, particularly in Pakistan, has resulted in significant losses and widespread devastation.

Beyond the impact of extreme weather events (EWEs) on mental health, climate-related anxiety and the associated disruptions can lead to a range of psychological effects. These may include emotional regulation difficulties, cognitive impairments, behavioral issues, learning difficulties, developmental delays, language skill deficiencies, adjustment challenges, and negative effects on academic performance.³⁶ EWEs' and disasters' impacts on children's academic lives range from disrupting their performance in school and students dropping out due to stress to complete destruction of school infrastructure.^{40,41} The available statistical data show that disaster damage to school buildings is intense, and several school buildings have been affected by heavy rainfall events.⁴² For the approximately 1.6 billion students worldwide, unexpected and sudden transitions from physical activities in the classroom to online learning present a significant barrier. Thus, it is important to comprehend how natural disasters affect students' mental health, psychological well-being, and safety, as well as their ability to study and how any possible losses in learning quality can be identified and efficiently addressed.

Climate Change Anxiety and Activism Among Children

Children experience more climate anxiety because of climate change, and these feelings might include anger, fear, sadness, despair, concern, guilt, shame, and hope, although the presence of these emotions varies between individuals. Certain emotions, particularly grief, anxiety, and worry related to recent and upcoming losses, have gained increased attention as the area of study develops. Research on other emotions, such as how people feel guilty about their contributions to climate change or ashamed of the greater climatic damage caused by humans, has only recently started;¹⁴ among participants, most children's perceptions of climate-related anxiety have significantly negative effects on mental health and psychological well-being. These studies have experimented with a variety of pedagogical approaches to address and examine the psychological experiences of a wider range of learners in relation to climate change and climate-related anxiety to increase the informational potential of climate change education. For instance, political and justice aspects of climate change have received more focus in climate change education.⁴³⁻⁴⁵ However, integrating creative expression and the arts may improve climate change education and help children cope with climate-related mental health and anxiety.

According to this research, allowing for critical reflection, collaborative meaning-making, agentic action, and creative

experimentation can lead to more transformational outcomes than methods that only emphasize knowledge.^{18,46,47} However, most current methods of educating people about climate change still emphasize how to teach young children and adults the scientific aspects of the problems facing our society rather than how to approach and resolve issues relating to social or traditional aspects. In addition, current research on climate change education has students participate in real-world climate change activities that are connected to their studies, inquiring into the transformational effects of climate change education to reframe students' perceptions or engaging them in cooperative, community-based climate change activities.^{44,48} Incorporating climate change adaptation strategies into primary education curricula and providing environmentally friendly information and scientific knowledge to promote a climate-compatible development agenda is one of the challenges of environmental governance. By raising children's and young people's understanding of pertinent actions, triple-win solutions can be used to promote development that is compatible with climate change. Particularly in poor countries, basic education has yet to address the most serious problems of climate change by developing environmental knowledge, transmitting the necessary skills and fostering emotional attitudes at a young age.

Methodology

In order to gather descriptive data for their research, researchers frequently employ questionnaires, observations, and interviews, in addition to applying relevant literature and creating well-structured questionnaires.⁴⁹ This research was founded on a survey. In order to extrapolate to the full population, survey research examines the relationships between variables and population subjects.^{50,51} This study investigated the relationship between children's perceptions of the impact of climate change on mental health. Drawing on the children's adjustment and adaptation response theoretical model, this study examined climate change education, action, and stress levels in children, encompassing various factors that may contribute to overall stress. This study investigated the impact of disaster risk for health, stress index, and public health concern on climate change anxiety. The study also examines the relationship between climate change anxiety and mental health, drawing on the children's adjustment and adaptation response theoretical model and examining the association between 3 capacity variables: cognitive emotional impairment, functional impairment, and coping mechanism.

We hypothesized that both parental perceptions of children's vulnerability and climate change experience would be significantly related to children's mental health beyond the impact of the children's characteristics. We used a cross-sectional survey design with a sample of parents and children to obtain information on these variables. According to Darbyshire et al. (2005), interviews facilitate interactive conversation, evoke memories, help participants in expressing their answers, and allow for the assessment of statements' consistency.⁵² We used consensus quantitative research approaches. As previously mentioned, the consensus quantitative research approach developed by Hill et al.⁵³ is centered on the varying perspectives and experiences of the research team members as well as the inferences they can make from their assumptions. The researchers conducted multiple visits to both male and female participants over a period of 4-10 weeks to collect data for the study. Secondly, sampling was done in the education sector of Sindh to select a small portion of the total population. It was ensured that the ethnic composition of the sample was distributed equally.¹³

Study Setting, Sampling, and Participants

A population is a group of people that the researcher is interested in learning more about, according to Mendenhall.⁵⁴ Sampling involves gathering data from a subset of a larger population. This study utilized a purposive sampling method, chosen because the relevant data was only accessible from a specific subset of the population. The methodology outlines the various approaches used for non-probability sampling. Data collection took place between September and December 2022. The study used a questionnaire survey for this aim, and the method of collecting the data applied by the researchers was a conducted random distribution of about 400 versions of the questionnaire. The study's target demographic included pupils in vulnerable areas of Pakistan's Sindh province between the ages of 6-19 as well as the parents. The participants were selected from all types of primary, secondary, and high schools from different regions of Sindh province because these regions are among the most affected by climate change (e.g., Dadu, Jacobabad, Kambar, Shahad Kot, and Khairpur). A total of 356 completed questionnaires were returned by respondents, representing 89% of the response rate. The screening phase of the questionnaire revealed around 34 responses with missing answers, which require excluding them. The questionnaire included an angled set of questions to assess the existing flood emergency in Sindh primary, secondary, and high schools. This study adopted multistage sampling techniques to select the flood-affected students and household heads during the floods in 2022. After selecting Sindh province as the study area, purposive sampling was used to select 6 districts of 29 districts that were severely climate change affected. In the final stage of sampling, respondents were students and their parents, randomly selected from each district and school by using an updated list from education officers and school management staff that was provided by the relevant district education sector. The sample size issue as stated by Krejcie & Morgan (1970) indicated that the adequate numbers of the questionnaires appropriately represent the population.⁵⁵ Considering the circumstances, the sample size was assessed using structural equation modeling (SEM) following the approach of Chuan and Penyelidikan (2006) to validate the study's hypotheses. The study employed SmartPLS 4 to conduct the final path model analysis and evaluate the measurement model.⁵⁶

Participants

This section offers an overview of the demographic and educational characteristics of the survey respondents, aiding in understanding the sample composition and identifying potential patterns or trends within the data. Table 1 presents the demographic details of the respondents.

Measures

A scale developed by Clayton and Karazsia in 2020 was used to measure anxiety levels related to climate change.⁵⁷ We used a 7-point Likert scale to score the items, which offered a broad variety of answer alternatives from (1) strongly disagree to (7) strongly agree. We selected this scale to offer respondents a diverse and logical selection of choices. In addition to the fixed-response Likert-scale questions, respondents had the opportunity to provide explanations in comment boxes following each question. The researcher efficiently distributed the questionnaire, offering guidance on its completion and providing additional assistance to respondents under the age of 20.

Table 1. Demographic characteristics of the sample

Demographic characteristics	Numbers	Percent (%)
Gender		
Male	77	22%
Female	65	18%
Boy	111	31%
Girl	103	29%
Respondent's age		
Less than 20 years	214	60%
21–30 years	33	9%
31–40 years	55	15%
41–50 years	14	4%
51 to 60 years	17	5%
More than 61 years	23	6%
Children's education		
Pre-Primary	33	15%
Primary	55	26%
Middle School	85	40%
High School	41	19%
Parents employed		
Yes	112	79%
No	30	21%
Parent's work experience		
Less than 1 year	18	13%
2–5 years	43	30%
5–10 years	31	22%
11–15 years	22	15%
More than 16 years	28	20%
Parent's educational background		
Never went to school	12	8%
Less than Matriculation	44	31%
Undergraduate (Bachelors)	59	42%
Postgraduate (Masters)	22	15%
Postgraduate (PhD)	5	4%
Children diagnosed		
Yes	143	87%
No	22	13%
Trauma treatment		
Yes	149	83%
No	30	17%
Stress after treatment		
Yes	55	28%
No	145	73%
Health concerns		
Yes	170	79%
No	45	21%

Statistical Analysis

In this point, the procedures of the data analysis were considered the approach of Equation Modeling through the Partial Least Squares-Structural using the software SmartPLS. Following data collection, the analyses were carried out using a 2-step assessment process, which included testing both the measurement model and the structural model.⁵⁸ Selecting this method is traced to some justifications. Firstly, if the study relies on an existing theory, a preference is suggested to use PLS-SEM.⁵⁹ PLS-SEM can assist in effectively managing and handling exploratory works that have complex issues and interrelationships between different concepts.⁶⁰ PLS-SEM can conduct the whole analysis for the complete suggested model at once rather than separated analyses.⁶¹ Additionally, PLS-SEM provides the benefit of simultaneously analyzing both the structural and measurement models, yielding comprehensive results.⁶² To determine the significant factors, regression analysis was used. By eliminating unnecessary predictors, streamlining the data, and raising the projected accuracy, multiple regression analysis enables researchers to extract a more manageable set of variables from a huge number of predictors.⁶³ The dependability of the questionnaire serves as a gauge for the consistency of the computation method utilized to get the results. The survey results as well as the conclusions drawn from the 5 tested hypotheses are displayed below.

Results

Survey Results

Before conducting hypothesis testing with exploratory factor analysis, the psychometric properties of each construct were evaluated. This assessment included examining the constructs' reliability, validity, and dimensionality by analyzing the square root of the average variance extracted (AVE), the AVE itself, and the correlations between them.

Evaluation of Measurement Model

The study defines the children's stress index as a comprehensive concept, comprising 3 key elements: cognitive-emotional impairment, functional impairment, and coping mechanisms. The public health concern construct is primarily composed of environmental health and health-related issues. Table 2 outlines the 3 dimensions that collectively form the higher-order construct. Climate change anxiety is evaluated by considering 2 key factors: personal experiences with climate change and individual vulnerability. Mental health is understood as a multifaceted concept, encompassing symptoms of generalized anxiety disorder (GAD) and major depressive disorder (MDD). Additionally, the risk of health-related disasters is acknowledged as a core component.

Reliability and Validity

We evaluate the dependability of individual items by examining standardized factor loadings, and commonly accept a general benchmark of 0.707. Table 2 shows the data, which include the standardized factor loadings for all first-order constructs. All of them were tested with a high level of significance ($P < 0.001$), which means they were significant above the threshold. To assess the reliability and consistency of the constructs, Cronbach's alpha and composite reliability were analyzed. While the recommended threshold for these measures is 0.70, a range of 0.60–0.70 is often acceptable in exploratory studies. Cronbach's alpha scores range

from 0.60–0.92, and composite reliability scores range from 0.81–0.93, indicating a satisfactory level of internal consistency and convergence. Table 2 also includes the means, standard deviations, correlations, and the square root of the AVE (shown on the diagonals) for each construct. The average values suggest minimal correlation between the independent variables, and most constructs are above their respective midpoints.

The AVE, which assesses convergent validity, should ideally be 0.50 or higher, indicating that at least 50% of the variance in the indicators is explained by the construct. As shown in Table 2, all constructs surpass this minimum threshold. Three commonly used methods were employed to evaluate discriminant validity: the Fornell-Larcker criterion, cross-loadings analysis, and the heterotrait-monotrait (HTMT) ratio. As shown in Table 3, the square root of the AVE for each construct pair is greater than their correlation's absolute value. The cross-loading analysis indicates that each item is more strongly associated with its respective construct than with others, with differences in cross-loadings well exceeding the recommended threshold of 0.10. The HTMT ratio results in Table 3 confirm that all values are below the thresholds of 0.85 or 0.90, supporting the validation of discriminant validity.

Assessing of Hierarchical Second-Order Constructs

This study used a 2-phase approach to evaluate hierarchical second-order composites (Mode A). The correlation weights for the first-order composites (Mode A) are shown in Table 3. The measurement model was also analyzed after the second-order composites (Mode A) were made. There is a strong correlation between the first-order composites—cognitive-emotional impairment, functional impairment, and coping mechanisms—and the second-order composite, children's stress index. Similarly, the weights for the first-order composites, climate change experience (0.79) and personal vulnerability (0.86), demonstrate a positive influence on the second-order composite, climate change anxiety. Lastly, the weights assigned to the first-order composites—GAD symptoms (0.88) and MDD symptoms (0.80)—demonstrate a positive influence on the second-order composite, mental health. At a very low level of significance, all weights are highly significant.

Evaluation of Structural Model

In this study, we employed the PLS-SEM technique to estimate the structural model, which differs from traditional methods used to assess goodness-of-fit. Assessing collinearity among constructs within the structural model is a key consideration. The VIF (Variance Inflation Factor) is an essential metric for detecting collinearity issues. This study examined 2 sets of predictor constructs to identify potential collinearity. Using SPSS software (version 22.0), VIF calculations were performed to evaluate multicollinearity. The findings indicate no collinearity issues in the structural model, as all VIF values are well below the commonly accepted threshold of 5–10. Subsequently, the predictability of the structural model is assessed through the computation of R^2 values, representing the variance explained for the dependent latent constructs. It's important to note that suggested R^2 values for substantiveness, moderation, and weakness may vary depending on the specific research area. In this context, benchmarks of 0.67, 0.33, and 0.19 are recommended as indicators of substantial, moderate, and weak explanatory power, respectively. The R^2 (Climate change anxiety) = 0.65, and R^2 (Mental Health) = 0.59; as a result, these values are consequently regarded as reasonable and acceptable.

Table 2. Results of the measurement model

Step I: Evaluation of the measurement model for first-order constructs						
First-order composite mode A	SFL	SE	t-value	CR	α	AVE
Disaster Risk for Health (first-order composite Mode A)				0.91	0.92	0.77
DRH1	0.84	0.02	22.11			
DRH2	0.83	0.02	41.78			
DRH3	0.88	0.01	33.22			
DRH4	0.81	0.02	43.11			
Cognitive Emotional Impairment (first-order composite Mode A)				0.92	0.92	0.75
CEI1	0.88	0.02	44.11			
CEI2	0.87	0.01	60.43			
CEI3	0.87	0.01	43.21			
CEI4	0.88	0.02	41.22			
Functional Impairment (first-order composite Mode A)				0.88	0.90	0.73
FI1	0.83	0.02	33.56			
FI2	0.85	0.02	41.22			
FI3	0.88	0.02	40.93			
FI4	0.81	0.02	41.76			
Coping Mechanism (first-order composite Mode A)				0.91	0.92	0.77
CM1	0.82	0.02	22.53			
CM2	0.87	0.02	31.49			
CM3	0.86	0.02	34.04			
CM4	0.88	0.01	60.01			
Environmental Health (first-order composite Mode A)				0.89	0.90	0.75
EH1	0.84	0.02	30.36			
EH2	0.81	0.01	60.56			
EH3	0.85	0.02	37.2			
EH4	0.83	0.02	33.76			
Health Disparities (first-order composite Mode A)				0.93	0.93	0.72
HD1	0.87	0.02	43.22			
HD2	0.89	0.01	62.43			
HD3	0.80	0.02	36.10			
HD4	0.86	0.01	44.12			
Climate Change Experience (first-order composite Mode A)				0.91	0.94	0.77
CCE1	0.88	0.02	34.04			
CCE2	0.87	0.01	60.56			
CCE3	0.77	0.03	62.43			
CCE4	0.83	0.01	53.11			
Personal Vulnerability (first-order composite Mode A)				0.90	0.91	0.78
PV1	0.85	0.02	51.44			
PV2	0.82	0.02	52.1			
PV3	0.88	0.02	54.11			
PV4	0.81	0.01	72.44			
GAD Symtoms (first-order composite Mode A)				0.88	0.87	0.70
GAD1	0.79	0.01	33.9			

(Continued)

Table 2. (Continued)

Step I: Evaluation of the measurement model for first-order constructs						
First-order composite mode A	SFL	SE	t-value	CR	α	AVE
GAD2	0.8	0.02	62.15			
GAD3	0.74	0.01	35.3			
GAD4	0.8	0.01	53.21			
MDD Symptoms (first-order composite Mode A)				0.90	0.93	0.74
MDD1	0.84	0.02	41.36			
MDD2	0.74	0.01	31.33			
MDD3	0.87	0.01	40.24			
MDD4	0.8	0.01	22.35			
The second step is to generate second-order constructs and evaluate the measurement model.						
Second-order composite Mode A	CW	SE	t-value	CR	α	AVE
Children Stress Index (second-order composite Mode A)			33.48	0.90	0.92	0.70
Cognitive Emotional Impairment	0.85	0.08	26.70			
Functional Impairment	0.83	0.08	21.67			
Coping Mechanism	0.82	0.08	31.41			
Climate Change Anxiety (second-order composite Mode A)				0.92	0.93	0.69
Climate Change Experience	0.79	0.03	14.76			
Personal Vulnerability	0.86	0.02	18.41			
Mental Health (second-order composite Mode A)			13.76	0.91	0.91	0.72
GAD Symptoms	0.88	0.03	11.44			
MDD Symptoms	0.80	0.04	12.11			

Note: The abbreviations used in this context: SFL (Standard Factor Loading), SE (Standard Error), CR (Composite Reliability), α (Cronbach's Alpha), AVE (Average Variance Extracted), and CW (Correlational Weights of the First-Order Composite on the Second-Order Composite).

Table 3. Discriminant validity results, correlations, standard deviations, and means

	Mean	SD	1	2	3	4	5	6	7	8	9	10
1 Disaster risk for health	3.11	0.63	0.88	0.72	0.75	0.80	0.70	0.71	0.66	0.73	0.84	0.88
<i>Children stress index</i>												
2 Cognitive Emotional Impairment	3.33	0.72	0.42 **	0.87	0.77	0.71	0.73	0.78	0.78	0.75	0.68	0.70
3 Functional Impairment	3.54	0.69	0.50 **	0.42 **	0.85	0.74	0.77	0.80	0.73	0.83	0.77	0.79
4 Coping Mechanism	3.22	0.71	0.44 **	0.44 **	0.35 **	0.88	0.8	0.76	0.75	0.69	0.74	0.74
<i>Public health concern</i>												
5 Environmental health	3.80	0.74	0.41 **	0.55 **	0.63 **	0.83 **	0.87	0.75	0.79	0.77	0.83	0.80
6 Health disparities	3.80	0.74	0.41 **	0.55 **	0.63 **	0.83 **	0.84	0.84	0.79	0.77	0.83	0.72
<i>Climate change anxiety</i>												
7 Climate change experience	3.66	0.93	0.55 **	0.60 **	0.47 **	0.59 **	0.68 **	0.80	0.88	0.88	0.76	0.82
8 Personal vulnerability	3.21	0.86	0.52 **	0.45 **	0.73 **	0.68 **	0.80 **	0.77 **	0.77	0.88	0.70	0.79
<i>Mental health</i>												
9 GAD symptoms	3.44	0.82	0.35 **	0.72 **	0.66 **	0.50 **	0.51 **	0.40 **	0.56 **	74	0.83	0.77
10 MDD symptoms	3.12	0.76	0.43 **	0.68 **	0.45 **	0.48 **	0.54 **	0.69 **	0.50 **	0.64 **	0.77	0.86

Note: ** $|t| \geq$ must be equal to or greater than 2.33 at the P 0.01 level. SD refers to Standard Deviation. The diagonal, italicized elements represent the square roots of the AVE (Average Variance Extracted), while the correlations between the constructs are shown below the diagonal. HTMT values are located above the diagonal elements.

Table 4. Results of the structural model

Structural path	Hypotheses		Path coefficient	<i>t</i> -value (bootstrap)	95% BCa Confidence interval	<i>f</i> ² value
	number	Sign				
Disaster risk for health → Climate change anxiety	H1	+	0.47 ***	6.21	(0.06, 0.21)	0.33
Children stress level → Climate change anxiety	H2	+	0.51 ***	5.87	(0.31, 0.68)	0.27
Public health concern → Climate change anxiety	H3	+	0.67 ***	11.34	(0.03, 0.15)	0.44
Climate change anxiety → Mental health	H4	+	0.63 ***	15.60	(0.42, 0.66)	0.53
SRMR composite model = 0.057						
<i>R</i> ² (Climate change anxiety) = 0.65; <i>Q</i> ² (Climate change anxiety) = 0.53						
<i>R</i> ² (mental health) = 0.59; <i>Q</i> ² (mental health) = 0.41						

Note that *t* values should be greater than or equal to 2.33 for a significance level of 0.01, and greater than or equal to 3.09 for a significance level of 0.001. These thresholds are based on a 1-tailed test with *t* (4999). The abbreviations BCa, SRMR, *R*², and *Q*² are commonly used in professional contexts. The standardized root-mean square residual (SRMR) refers to the “bias-corrected and accelerated” approach. The determination coefficient (*R*²) and predictive relevance (*Q*²) both pertain to assessing the model’s performance. An *R*² value can be categorized as weak if it is ≥ 0.25 , moderate if it is ≥ 0.50 , and substantial if it is ≥ 0.75 . Meanwhile, a *Q*² value greater than 0 indicates predictive relevance.

Additionally, this study analyzed the sizes and significance of the path coefficients corresponding to the formulated hypotheses. The significance levels of these path coefficients were determined using the bootstrapping procedure, which involved 5000 bootstrap samples and 356 bootstrap cases with no sign changes. Table 4 presents the path coefficients, *t* statistics, significance levels, *P* values, and corresponding 95% bootstrap confidence intervals. All direct effects are significant, as indicated by the analysis of path coefficients and significance levels. Statistical inferences were made using 1-tailed tests and their corresponding *P* values. However, other explanatory constructs can influence the size of effects across the model when comparing them solely based on path coefficients. To address this, the study utilized effect size (*f*²) as a metric to evaluate the impact of an explanatory construct on a dependent variable. Effect sizes of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively. Table 4 provides a detailed overview of the *f*² effect sizes for each relationship within the structural model. To obtain *Q*² values, a professional blindfolding procedure was employed, using a sample reuse technique that selectively omits portions of the data matrix and predicts the missing data based on model estimates. A *Q*² value greater than zero in the cross-validated redundancy report indicates predictive relevance in PLS-SEM models. The *Q*² values for each dependent construct are listed in Table 4, and it’s important to note that all *Q*² values are significantly above zero, strongly supporting the model’s predictive relevance for out-of-sample predictions.

Model Fit

This study employs the standardized root-mean square residual (SRMR) to assess the overall model fit. Due to its accuracy, model validation commonly uses the SRMR, which measures the root mean square discrepancy between the observed and model-implied correlations. Ideally, SRMR values should be below 0.08, as values below this threshold are generally considered favorable. In this study, the PLS-SEM model produced an SRMR value of 0.057, indicating a satisfactory overall fit for the PLS path model.

Predictive Validity

The *R*² value measures how effectively the proposed structural model explains the variance in the endogenous construct, while the *Q*² value assesses the model’s predictive accuracy. It is important to note that the structural model does not directly explain the impact of external factors on interest outcomes. Relying solely on model fit to evaluate predictive validity may not always be reliable. Therefore, a comprehensive assessment of out-of-sample prediction, predictive validity, and PLS model performance is necessary. In this context, predictive validity refers to the model’s ability to accurately predict outcomes with different data samples. This study assesses predictive validity through cross-validation tests using holdout samples. The procedure involves standardizing each sample case with the holdout sample, creating construct scores for the holdout sample by linearly combining the corresponding samples with weights derived from the extreme weather occurrence sample, and standardizing these construct scores. The structural model then generates predictive scores for the 2 endogenous components using path coefficients from the training sample. The holdout sample is used to look at the relationship between the predictive scores and the construct scores for the 2 endogenous constructs: climate change anxiety ($r = 0.80$, $P < 0.01$) and mental health ($r = 0.76$, $P < 0.01$). The significant correlations indicate that the study’s structural model possesses an acceptable level of predictive validity.

Discussion

While long-term effects are more challenging to assess, reactions to extreme weather events are like the trauma experienced from natural disasters. The pressures of climate change could lead to climate-related mental disorders (CRMD), new adaptations, and emerging forms of mental health challenges and distress.³³ This study examined 5 factors affecting children in Pakistan: disaster risk to health, public health concern, climate change anxiety, generalized anxiety disorder, and major depressive disorder. The discussion underscores the critical link between disaster risk and public

health outcomes, emphasizing the need for robust preparedness and strong health systems to mitigate the negative impacts of disasters on public health. It also highlights the importance of well-coordinated public health strategies to effectively address widespread health concerns. By developing a comprehensive understanding and taking a proactive approach to these factors, we can improve health outcomes and strengthen community resilience in the face of disasters and public health threats. This study specifically aimed to investigate the relationship between children's stress levels and their perceptions of climate change anxiety, disaster risk to health, public health concern, generalized anxiety disorder, and major depressive disorder, after controlling for various child characteristics. The findings revealed that a significant number of children experienced clinical levels of stress.⁶⁴ This study highlights the substantial impact of climate change on the mental health of children in Pakistan, affecting both rural and urban schoolchildren. As a major threat to psychological, physical, and mental well-being in the 21st century, it is essential to deepen our understanding of how climate change influences mental health and develop strategies to prevent these related challenges.

In the context of climate change, advocate for mental health by engaging in clinical work with children, parents, communities, and society. Many qualitative researchers assume that open-ended questions are more likely to elicit richer data or encourage more storytelling. This study explored the relationship between schoolchildren's actions and their perceptions of the psychological impacts of climate change on their mental health. The literature comparing open versus closed questions and focus groups provides a more comprehensive understanding of children's perspectives in interviews. Notably, recent evidence suggests that the negative emotions experienced by poor and marginalized communities, both directly and indirectly impacted by climate change, contribute to children's feelings of concern and distress in their daily lives. The findings of this study indicate a rising sense of unease among children in Pakistan due to climate change, linked to concerns about public health, mental well-being, and the risk of disorders such as generalized anxiety disorder (GAD) and major depressive disorder (MDD). The significant impact of climate change on children's mental health and well-being underscores the need for careful attention and proactive measures. Climate change profoundly affects the emotional and psychological well-being of children.

In Pakistan, an underdeveloped country, children in marginalized communities face numerous educational challenges, including inadequate infrastructure, lack of awareness, insufficient textbooks, limited access to information on science and social studies, and a shortage of qualified teachers. Additionally, there is a lack of education on climate change and environmental issues across all levels of this vulnerable population. Many scholars have highlighted these problems. Children, particularly those aged 10-20, are experiencing climate change anxiety (CCA), exacerbated by the severe floods in Pakistan in 2022, which were among the worst in the country's history. Climate change anxiety is characterized by deep concern about the effects of climate change on the environment and human health. This anxiety can also have a significant impact on mental health, leading to broader eco-anxiety, which affects those who are deeply concerned about the state of the climate and environment. Enhancing climate education for children is clearly necessary to better address the issues affecting their psychological and mental health. However, our study revealed significant differences in coping with climate change and its psychological impacts based on gender, education, and socioeconomic status. Girls seemed to be more sensitive in both thought and action compared to boys, possibly due to their stronger pro-environmental attitudes.

This study identified a positive correlation between climate change anxiety and various factors such as children's mental health, disaster risk to health, public health concerns, and the GAD and MDD subscales. Previous research suggests that gender differences, such as the gender pay gap's influence on value systems like altruism and consideration, may link to the increase in climate change anxiety. Research has shown that girls tend to express heightened concern about specific environmental issues, particularly those that are local and significantly affect mental well-being. Effective communication is vital for decision-making, reflection, and action in addressing these challenges, as climate change impacts both public health and children's mental health.¹³ This study highlights the importance of acknowledging climate change anxiety's effects on children's mental health and emphasizes the need to understand their psychological experiences in relation to climate change. Such understanding is crucial for developing strategies that encourage positive engagement and support mental well-being. Furthermore, children are well-informed about climate change and the efforts to combat it, with family actions playing a key role in motivating both children and their families to act.

Implications and Limitations

While this study makes significant contributions to the field, several limitations should be acknowledged. First, our reliance on cross-sectional data restricts our ability to determine causal relationships between the constructs, allowing us only to describe associations. For example, individuals experiencing mental health challenges may be less able to engage in group activities and more vulnerable to the impacts of climate change anxiety and disaster risk on their health. Additionally, the instrument used to assess climate change education and action had certain shortcomings that may have affected the results. Several factors were considered in this study, including the need for both emotional and action-orientated responses. However, the measure used did not fully capture the wide range of individual actions described in respondents' open-ended answers. We also recruited participants from support groups, suggesting that the children in our sample might have experienced heightened distress or concern about climate change anxiety and its effects on mental health, especially compared to those not involved in support groups. Furthermore, it is important to recognize that children may have diverse perspectives on climate anxiety, climate change education, and mental health. To develop more comprehensive strategies for individual efforts in mitigating climate change and to explore whether broader interventions could lead to different outcomes, we need additional research. While the quantitative data provided some insight into the participants' opinions, the qualitative data offered a more comprehensive understanding. However, conducting in-depth interviews with focus groups could provide even deeper insights into their experiences with climate change anxiety. Despite these limitations, this research makes a significant contribution to understanding the emerging anxiety children experience due to climate change and its correlation with clinical measures of GAD and MDD. Additionally, it highlights the potential for community engagement to improve the well-being of those affected by climate change-related anxiety.

Conclusion

There is growing recognition of the negative impact climate change has on mental health and psychological well-being. This research explored the factors contributing to climate-related anxiety and its

effects on the mental health and psychological well-being of children in Pakistan. Our findings suggest that climate anxiety significantly affects the mental well-being of young children, underscoring the need to address this psychological issue. Additionally, the importance of children's evolving perspectives on climate change education becomes clear when considering the influence of climate-related anxiety. Whether in classroom learning or other environments, children's emotional, psychological, and mental health inevitably influence their development beyond academics. Our findings indicate that children's perceptions of climate change are not always negative, particularly when they receive opportunities for critical dialogue, reflection, and action alongside their knowledge. The study revealed a significant impact of climate change anxiety on children's mental health, both directly and indirectly, across urban and rural areas. Studies have shown that effective climate change education programs significantly reduce children's climate anxiety, with notable differences observed based on gender, educational background, and socioeconomic status. Experts in environmental and mental health have been instrumental in addressing climate change and devising strategies to help children cope with its effects. We recommend further research into the impact of climate change on children's public health, as studies indicate their heightened vulnerability to psychological well-being issues. This study found that children aged 10–16 exhibited a deeper understanding of climate change and its effects, including those on mental and psychological health. They also showed increased interest in and respect for the environment, along with a stronger sense of responsibility toward it.

Although environmental issues have gained more attention in recent years, relatively few young people recognize the importance of climate change education and its impact on mental health. Given the growing body of evidence, it is crucial to seriously consider the potential harm climate change poses to psychological and mental well-being. Environmental experts and psychological professionals should prioritize climate change in their work. This suggests that school curricula, as well as training programs for parents and communities through psychology and health clinics, should integrate awareness and education about environmental issues. The focus should be on developing best practices to help children and adolescents who are experiencing climate change-related anxiety to reflect, understand, and act.

Data availability statement. The data supporting the findings of this study are available upon reasonable request from the authors.

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Ethical standard. Ethical considerations were prioritized throughout the study's implementation. The research was conducted in accordance with the ethical principles set forth by the Institutional Review Board (IRB) at Anhui

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Informed consent was obtained from all individual participants included in the study.

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