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Research Article

Climate Change and the Rising Risk of Childhood Undernutrition in Low- And Middle-Income Countries

Ishfaque Ali[1], Shabnam Phul[2], Danish Nawaz Phul[3], Tabish Akbar[4], Sahar Anjum[5], Ayaz Hussain[6*]
[1]Senior Lecturer, Department of Community Medicine, Gambat Medical College @ Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences, Gambat, Khairpur Mir's Sindh, Pakistan.
[2]Demonstrator, Department of Community Medicine, Khairpur Medical College, Khairpur Mir's, Sindh Pakistan.
[3]Medical Officer, PPHI Khairpur Mir's, Sindh, Pakistan.
[4]Deputy District Health Officer Nutrition, Health Department, Government of Sindh, Pakistan.
[5]Medical Officer, RHC Gadani Balochistan, Pakistan.
[6*]Assistant Director Medical Services, Ministry of Defense Pakistan.
Correspondence: Dr. Ayaz Hussain
Assistant Director Medical Services, Ministry of Defense Pakistan.
Email: drayazphul96@gmail.com
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ABSTRACT
Background: Climate change is increasingly affecting child health and nutrition through food insecurity, extreme weather events, displacement, unsafe water, infectious diseases, and disruption of health services.
Objectives: To assess the impact of climate-related household exposures on childhood undernutrition and to identify major environmental, socioeconomic, and health-related factors associated with stunting, wasting, and underweight.
Methods: This analytical cross-sectional study was conducted at District Khairpur Mir's Sindh, Pakistan from 1st October 2025 to 30th April 2026 among 295 children aged 6–59 months. Data regarding sociodemographic characteristics, feeding practices, household food security, water and sanitation, recent illnesses, and exposure to climate-related events during the previous 12 months were collected from caregivers using a structured questionnaire.
Results: There were 119 (40.3%) stunted, 52 (17.6%) wasted and 85 (28.8%) underweight, while 151 (51.2%) had at least one form of undernutrition. Climate-related household shocks were reported by 213 (72.2%) families. Undernutrition was more frequent among children exposed to at least one climate-related shock than among those without such exposure (59.2% vs. 30.5%, p<0.001). Flood exposure, extreme heat, drought or water shortage, food supply disruption, displacement, and household food insecurity were significantly associated with undernutrition. On multivariable analysis, climate-related household exposure remained independently associated with undernutrition (adjusted OR 2.65; 95% CI 1.45–4.85; p=0.002). Household food insecurity (adjusted OR 2.31; 95% CI 1.39–3.84), recent diarrheal illness (adjusted OR 1.89; 95% CI 1.06–3.36), lower maternal education (adjusted OR 1.76; 95% CI 1.05–2.95), and unsafe drinking water (adjusted OR 1.68; 95% CI 1.00–2.82) were also significant predictors.
Conclusion: The childhood under-nutrition was strongly associated with climate-related household shocks, particularly through food insecurity, unsafe water, displacement, and increased infectious disease risk.

Keywords: Childhood Under-Nutrition, Climate Change, Food Insecurity, Stunting, Wasting, Low- And Middle-Income Countries.

INTRODUCTION

Child health and nutrition is a growing concern in the context of climate change, especially in low and middle-income countries (LMICs). The children in these environments already face a heavy and disproportionate burden of poverty, food insecurity, infectious diseases, poor sanitation and inadequate health care.[1] Existing vulnerabilities can be exacerbated by climate-related events like droughts, floods, heat waves, crop failures, and changes in rainfall, which can drive further risks of undernutrition. The impacts are particularly significant in the early years of life when insufficient nutrition may affect growth, immunity, cognitive function, school achievement and health outcomes.[2] Childhood undernutrition refers to stunting, wasting, underweight and micronutrient deficiencies. They are caused by both immediate and underlying conditions.[3]

Their direct causes are inadequate dietary intake and repeated infections, and indirect causes are household food insecurity, poor maternal nutrition, unsafe water, inadequate sanitation, limited health services and socioeconomic disadvantage. Almost all of these pathways can be impacted by climate change.[4] Limited food production could impact the availability of staple foods, fruits and vegetables, and foods from animal sources, whereas disruptions to food supply chains may lead to higher food prices and lower dietary diversity. The poor are especially hit as a high share of their income is used to buy food.[5]

Nutritional risk can also be exacerbated by the impact of extreme weather conditions on crops, livestock, homes, water systems, roads, and health facilities. Flooding can lead to poor nutrient absorption due to diarrhea and other infectious diseases, and can also contaminate drinking water, further leading to worsening weight loss.[6] Household food production and income can decrease during droughts, and heat stress during extended droughts can impact crop yields and livestock productivity. Higher temperatures could also affect the spread of vector-borne and water-borne diseases and lead to more cases of disease in children. Sustained infection and poor nutrition may lead to a vicious cycle of malnutrition and infection that is difficult to overcome.[7] Another crucial connection between climate change and childhood undernutrition is maternal nutrition. Pregnancy food insecurity can also be associated with poor maternal weight gain, micronutrient deficiencies, fetal growth restriction, and low weight. These early life disadvantages could make it more likely that a child or infant will experience poor growth.[8] Taking care of antenatal care, breastfeeding, immunization, food assistance, and treatment of childhood illnesses are also disrupted if displacement and migration are related to climate. The impact of such effects is often more pronounced in rural communities, conflict-affected areas, and those households reliant on agriculture and natural resource-based livelihoods.[9] Undernutrition in children is a significant public health problem worldwide and is becoming a growing threat due to climate-induced food insecurity, displacement, infectious diseases, and disrupted health and nutrition services.[10] In 2024, the UNICEF/WHO/World Bank Joint Child Malnutrition Estimates (JCE) estimated 150.2 million (23.2%) children under 5 years were stunted and 42.8 million (6.6%) wasted, with 12.2 million children having severe wasting, and the burden was overwhelmingly in Asia and Africa. Childhood under nutrition is a highly prevalent problem in Pakistan.[2] There are high nutritional risks in children facing stunting, wasting and underweight status, with 40.2%, 17.7%, and 28.9% of children under five respectively being stunted, wasted, and underweight, as reported by the National Nutrition Survey (NNS) 2018, and worse nutritional outcomes in rural areas, with stunting prevalence reaching 43.2% and wasting affecting 18.6% of children. These figures are especially alarming in light of the recurrent flooding, droughts, extreme temperatures, and climate sensitive food systems in Pakistan that can further make children more susceptible to inadequate dietary intake and undernutrition.[3,11]

MATERIALS AND METHODS

This analytical cross-sectional study was conducted at District Khairpur Mir's, Sindh Pakistan from 1st October 2025 to 30th April 2026. A total of 295 children were studied. Non-probability consecutive sampling method was used to recruit the participants from the selected study area in pediatric and community health services. Children aged 6-59 months accompanied by their mother or main care taker was included. Children were included if informed consent was obtained from their caretakers and complete demographic, nutritional and climate-exposure data was available. Major congenital abnormalities, chronic disease with a known impact on growth and missing anthropometric data were not included.

A structured questionnaire was used to collect data from the mother or primary caregiver. Data on age, sex, birth history, breastfeeding/complementary feeding, recent illness, parental education, socioeconomic status, household size, food security, access to health services, safe drinking water and sanitation was collected. Household exposure to climate was measured by the presence of flood, drought, and extreme heat, loss of crops or livestock, displacement, disruption of food supply, and rise in food prices in the last year. Standard anthropometric practices were used for measuring weight and length (or height). Nutritional status was determined based on the WHO child growth standards. Stunting was classified as below −2 SDs on the HAZ score, wasting as below −2 SDs on the WHZ score, and underweight as below −2 SDs on the WAZ

score. Children meeting any of these criteria were deemed as undernourished. The main outcome was the presence of childhood undernutrition. Other outcomes were secondary such as stunting, wasting and underweight. The primary exposure variable was one or more SHs experienced in the last year of the household.

The data was entered and analyzed through SPSS-26. Association between exposure to climate change and nutrition outcomes was evaluated using the chi-square test or Fisher's exact test. Multivariable logistic regression analysis was performed on the variables that were clinically or statistically significant, to detect the independent predictors of childhood undernutrition. Adjusted odds ratios with 95% confidence intervals were reported and $p < 0.05$ were considered to be statistically significant.

RESULTS

The mean age of the children was 31.6±15.4 months. There were 154 (52.2%) males and 141 (47.8%) females. Most children belonged to rural areas, accounting for 183 (62%), while 112 (38%) were from urban areas. Low socioeconomic status was observed in 129 (43.7%) families, followed by middle socioeconomic status in 123 (41.7%) and high socioeconomic status in 43 (14.6%). Regarding maternal education, 91 (30.8%) mothers had no formal education, 65 (22%) had primary education, 96 (32.5%) had secondary education, and 43 (14.6%) had higher education. A history of exclusive breastfeeding was reported in 188 (63.7%) children (Table 1).

At least one climate-related household shock was reported by 213 (72.2%) families. Increased food prices were the most frequently reported exposure, affecting 210 (71.2%) households, followed by extreme heat in 191 (64.7%) and disruption of food supply in 151 (51.2%). Flood exposure was reported by 123 (41.7%) households, while 98 (33.2%) experienced crop or livestock loss and 88 (29.8%) reported drought or water shortage (Table 2).

More than half of the children had at least one form of undernutrition, with 151 (51.2%) affected and 144 (48.8%) having no identified undernutrition. Stunting was the most common nutritional abnormality, observed in 119 (40.3%) children. Underweight was present in 85 (28.8%) children, while wasting was identified in 52 (17.6%)[Table 3].

Among children exposed to at least one climate-related shock, 126 of 213 (59.2%) were undernourished compared with 25 of 82 (30.5%) children without such exposure, showing a statistically significant association ($p<0.001$). Undernutrition was also more frequent among children exposed to flooding compared with those without flood exposure (61.8% vs. 43.6%, $p=0.002$) and among those exposed to extreme heat compared with unexposed children (58.1% vs. 38.5%, $p=0.001$) [Table 4].

On multivariable logistic regression analysis, exposure to at least one climate-related household shock was independently associated with childhood undernutrition, with an adjusted odds ratio of 2.65 (95% CI: 1.45–4.85; $p=0.002$). Household food insecurity was also a significant independent predictor, with affected children having 2.31 times higher odds of undernutrition (95% CI: 1.39–3.84; $p=0.001$). Recent diarrheal illness was associated with increased odds of undernutrition (adjusted OR=1.89; 95% CI: 1.06–3.36; $p=0.031$), while maternal education below secondary level was associated with 1.76 times higher odds (95% CI: 1.05–2.95; $p=0.032$) [Table 5].

Table 1: Sociodemographic, household and clinical characteristics of participants

Variable	n (%) / Mean±SD
Age (months)	31.6±15.4
Male	154 (52.2%)
Female	141 (47.8%)
Rural residence	183 (62.0%)
Urban residence	112 (38.0%)
Low socioeconomic status	129 (43.7%)
Middle socioeconomic status	123 (41.7%)
High socioeconomic status	43 (14.6%)
Mother with no formal education	91 (30.8%)
Primary maternal education	65 (22.0%)
Secondary maternal education	96 (32.5%)
Higher maternal education	43 (14.6%)

Exclusive breastfeeding history	188 (63.7%)
Household food insecurity	142 (48.1%)
Unsafe drinking water	109 (36.9%)
Inadequate sanitation	121 (41.0%)
Recent diarrheal illness	84 (28.5%)
Recent respiratory infection	71 (24.1%)

Table 2: Climate-related household exposures during the previous 12 months

Climate related exposure	**No.**	**%**
Extreme heat	191	64.7
Flooding	123	41.7
Drought/water shortage	88	*29.8*
Crop or livestock loss	98	33.2
Disruption of food supply	151	51.2
Increased food prices	210	71.2
Temporary displacement	58	19.7
At least one climate-related household shock	213	72.2

Table 3: Nutritional status of children

Nutritional outcome	**No.**	**%**
Stunting	119	40.3
Wasting	52	17.6
Underweight	85	28.8
Any form of undernutrition	151	51.2
No identified undernutrition	144	48.8

Table 4: Association of climate and household factors with childhood undernutrition

Factor	**Undernutrition n/N (%)**	**No undernutrition n/N (%)**	**p-value**
Any climate-related shock	126/213 (59.2%)	87/213 (40.8%)	<0.001
No climate-related shock	25/82 (30.5%)	57/82 (69.5%)	
Flood exposure	76/123 (61.8%)	47/123 (38.2%)	0.002
No flood exposure	75/172 (43.6%)	97/172 (56.4%)	
Extreme heat exposure	111/191 (58.1%)	80/191 (41.9%)	0.001
No extreme heat exposure	40/104 (38.5%)	64/104 (61.5%)	
Drought/water shortage	53/88 (60.2%)	35/88 (39.8%)	0.044
No drought/water shortage	98/207 (47.3%)	109/207 (52.7%)	
Crop/livestock loss	61/98 (62.2%)	37/98 (37.8%)	0.008
No crop/livestock loss	90/197 (45.7%)	107/197 (54.3%)	
Food supply disruption	93/151 (61.6%)	58/151 (38.4%)	<0.001
No food supply disruption	58/144 (40.3%)	86/144 (59.7%)	
Temporary displacement	39/58 (67.2%)	19/58 (32.8%)	0.007
No displacement	112/237 (47.3%)	125/237 (52.7%)	
Household food insecurity	91/142 (64.1%)	51/142 (35.9%)	<0.001
Food-secure household	60/153 (39.2%)	93/153 (60.8%)	
Recent diarrheal illness	55/84 (65.5%)	29/84 (34.5%)	0.002
No recent diarrheal illness	96/211 (45.5%)	115/211 (54.5%)	

Table 5: Multivariable logistic regression analysis of factors associated with childhood undernutrition

Predictor	Adjusted OR (95% CI)	p-value
Exposure to ≥1 climate-related shock	2.65 (1.45–4.85)	0.002
Household food insecurity	2.31 (1.39–3.84)	0.001
Recent diarrheal illness	1.89 (1.06–3.36)	0.031
Maternal education below secondary level	1.76 (1.05–2.95)	0.032
Unsafe drinking water	1.68 (1.00–2.82)	0.049
Rural residence	1.52 (0.91–2.55)	0.109

DISCUSSION

The present study showed that there was a significant level of undernutrition among children, as 51.2% of them had at least one type of undernutrition. The most common nutrition problem was stunting (40.3%) followed by underweight (28.8%) and wasting (17.6%). The results are very similar to the results of the National Nutrition Survey of Pakistan (NNP) 2018, which showed that 40.2% of under-5 children were stunted, 28.9% were underweight, and 17.7% were wasted. The national survey also demonstrated higher prevalence of stunting, wasting, and underweight in rural communities when compared to urban communities, reflecting disparities in nutrition status across urban and rural areas and by socioeconomic status. Households experienced climate related shocks regularly; 72.2% of families experienced at least one of these shocks over the past year. Higher food prices, extreme heat, disruption of food supplies, flooding, drought or water shortage, crop or livestock losses and displacement were regular mentions. Undernutrition was significantly more common among children living in households exposed to at least one climate-related shock (59.2%) than among those that were not exposed to such shocks (30.5%). The odds ratio for climate-related shock remained significant after adjusting for other variables: adjusted odds ratio 2.65. The findings indicate that there are multiple interlinked pathways through which climate events can affect child nutrition, such as decreasing food availability, loss of household income, displacement, disruption of health services, and decreasing water and sanitation conditions.[12]

Flood exposure was significantly associated with childhood undernutrition with 61.8% of the flood-exposed children being undernourished, while 43.6% of the nonexposed children were undernourished. The link is especially significant in Pakistan, where frequent flooding has caused significant impacts on food security, water quality, access to health services, and child nutrition. After the 2022 floods, UNICEF reported that over 12.5% of children under five screened in health clinics in flood-hit districts of the province Sindh and Balochistan were severely malnourished.[13] The floods also affected food systems, healthcare services, breastfeeding, water supply, and sanitation, adding to the nutrition vulnerability of young children. The presence of household food insecurity was also an important independent factor associated with undernutrition. The adjusted odds of undernutrition were over twice as high for children from food-insecure households as for children from food-secure households. In the bivariate analysis, significant associations with undernutrition were also found for disruption of food supplies, and for losses in crops or livestock.[14] They corroborate the food insecurity pathway as a significant link between climate change and poor nutrition outcomes. Households' financial resources can be depleted by climate shocks, which can also drive up food prices, leading to lower quantities of food in the diet, less dietary diversity and less consumption of nutrient-rich foods by younger children.[15,16]

Drinking water quality and recent diarrheal illnesses were also independently linked to childhood undernutrition. Undernutrition was associated with 1.89 times higher adjusted odds in children with recent diarrheal illness, and with around 1.7 times higher odds in children with unsafe drinking water. These findings are supported by biological plausibility as recurrent diarrheal illness can lower nutrient and energy uptake, cause loss from the body, decrease appetite, and cause weight loss and growth retardation.[17,18] Due to the massive floods that hit the nation, millions of people were deprived of access to safe drinking water, and polluted water posed a risk of waterborne diseases and associated malnutrition in children. These results reinforce the importance of integrated interventions that combine food-based interventions for children with adaptation strategies.[19] Disaster-related climate shocks can negatively affect child

growth, which may be mitigated through efforts to increase the food security of households, build resilience to climate-related impacts on agriculture, improve maternal education, ensure access to safe water and sanitation, and ensure continuous provision of nutrition services during disasters, as well as through early management of child infections. Children from poor, rural, food-insecure and disaster-affected households should be highlighted, as they are likely to have multiple overlapping risks.[20]

Limitations

The first limitation was the cross-sectional design and the inability to establish a causal relationship between exposures to climate and childhood undernutrition. Secondly, the study was conducted in a limited number of 295 children from the selected setting, which might have limited the generalizability of the findings to other parts of Pakistan and other LMICs. Third, data on floods, drought, extreme heat, food supply disruption, displacement, and household food insecurity was collected from caregivers, and is potentially subject to recall bias and subjectivity. Fourth, climate exposure was measured at the household level and was not tied directly to objective climate measures like temperatures, rainfall, drought measures, or flood measures. Repeated nutritional assessment of prospective multicenter studies is recommended that are larger and utilize objective climate indicators to confirm these findings.

CONCLUSION

The exposure to climate-related shocks in the home was correlated with an increased risk of undernutrition, especially among children who lived in homes affected by flooding, extreme heat, drought or water shortage, food supply disruption, and displacement. Other factors important to the risk were house food insecurity, recent diarrhea, and low maternal education and access to unsafe drinking water. These findings suggest that climate change could also exacerbate childhood undernutrition, through impacts on the food available, the resources of households, the water and sanitation situation, and the health of children. Enhancing food security, climate-smart health and nutrition services, safe water and sanitation, maternal education, and specific support for vulnerable households could mitigate the nutrition impacts of climate-related events on children.

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