

Flood and Its Impact on Children's Mortality and Morbidity: A Systematic Review

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Received: 4th June 2023

Accepted: 5th October 2023

Published: 20th October 2023

Abstract

Flood is the commonest natural disaster experienced by children especially in low- and middle-income countries causing direct and indirect consequences. This article aimed to provide systematic evidence on the mortality and morbidity experienced by children affected by floods. Systematic review of literatures was conducted using PRISMA. Eligible articles from 2020 to 2022 were retrieved from PUBMED and SCOPUS which discusses the morbidity and mortality experienced by flood affected children. The initial search yielded 82360 articles which were subsequently screened for eligibility according to the inclusion criteria. The final synthesis included three systemic review and meta-analysis, three cross sectionals, one scoping review, one retrospective and one case control. Except for one study, the other articles were from low and middle income countries. Only one study addressed flood-related mortality. Emerging morbidity issues reported from recent studies were of nutrition, gastrointestinal infections and psychological disorder post flood disaster. A multidisciplinary approach is essential in managing children affected by floods.

Keywords

Flood, children, mortality, morbidity

Introduction

Globally, 500 million children are living in flood-prone areas especially in Asia with almost one third living are living in high risk zone of tropical cyclones¹. The burden is amplified as these countries also have high prevalence of diarrhoea and malaria deaths, poverty and low access to safe water and sanitation. Pre-existing data reports an estimated half a billion children died from malaria and diarrhoea alone especially in children less than 5 years old. Flood affects children in various ways from direct and indirect consequences. Mortality in flood-affected children are commonly due to direct injury such as drowning and electrocution. Countries with unreliable public health system are seeing peaks of morbidities related to

communicable diseases in particular water and vector borne diseases such as cholera and dysentery. With the disruption of health care access, treatment and intervention are delayed. Furthermore, with the insurgence of climate change, children are estimated to bear the heaviest burden particularly among those living in poverty, the disabled, younger age groups and those who are displaced from their conflict-torn home country¹. Climate change brings along riverine, coastal and urban flooding on top of acceleration of communicable diseases due to changing rainfall pattern that favours the growth of certain pathogens. Damage to sewer systems, contaminated water and food supply are an established risk factors and children are more at risk as they consume more water with increased energy demands compared to adults.

As a result of flooding, crops were destroyed leading to food insecurity and malnutrition. Households who are dependent on agriculture as source of living will be greatly affected putting children at risk of starvation without immediate aid. In addition, disruption to basic services such as health care and education further exposes children to psychosocial distress². Damage to school buildings and interrupted access to school cause children to be left out from the mainstream education. Gap in inequities due to floods will enlarge between the privileged and non-privileged populations as a result of social limitations, increase rates of violence and abuse and withdrawal from school. This article will examine the impact of floods among affected children and also identifies significant research gaps for further interventions.

Methodology

This part explained the method, the process of getting articles and data analysis for this study.

Publication standard

We applied publication standard named PRISMA, known as Preferred Reporting Items for Systematic Reviews and Meta-Analyses, to lead the Systematic Literature Review. The advantage of using PRISMA is that it allows inclusion criteria in the screening phase that can clearly elucidate the research question.

Resources

Literature searches were done using major databases of SCOPUS and PUBMED.

Searching process for relevance articles.

The systematic searching process consisted of three phase which are identification, screening and eligibility.

Phase 1: Identification

During the identification phase, we used keywords, related terms, synonyms, suggestion by databases and expert opinion regarding our topic of interest. By using dictionaries, thesaurus and preceding studies, the final search string that we used is TITLE-ABS-KEY (("Children" OR "Flood" OR "Mortality" OR "Morbidity" AND "Child Flood")). With that, we succeed to discover 82360 full articles assessed. The initial screening used 2 keywords (flood and children) as searching using 4 keywords (flood, children, morbidity and mortality) revealed minimal results. Following the initial search, all retrieved articles were screened for issues related to morbidity and mortality in alignment of the inclusion criteria

Phase 2: Screening

The second phase is screening. The screening phase comprised elimination of redundant articles and based on the specified criteria. First, we only eliminated 17 duplicate articles. Then, we disqualified articles based on several inclusion and exclusion criteria which are data not pertaining to review of interest, lack of details for adequate evaluation, not related to articles and not specific to children population. We considered 2 years of previous publication (2020-2022) containing information regarding impact of flood in children were retrieved. A sum of 23 had been excluded based on these criteria.

Eligibility

Through this phase, we carefully looked for more details from the title, abstract, and main content to ensure that the articles meet the research objective. Eight articles had been eliminated as the articles were not relevant to research question/insufficient data. Nine articles were ready to be analysed at the end of the screening process.

Inclusion and exclusion criteria

The study included children aged less than 18 years old according to the definition of United Convention of Children's Rights who were affected by flood.

Data Analysis

This study conducted an integrative review, which explore and synthesize quantitative, qualitative. Data extracted according to author, year of publication, location, age of respondents, type of flood, morbidity and mortality.

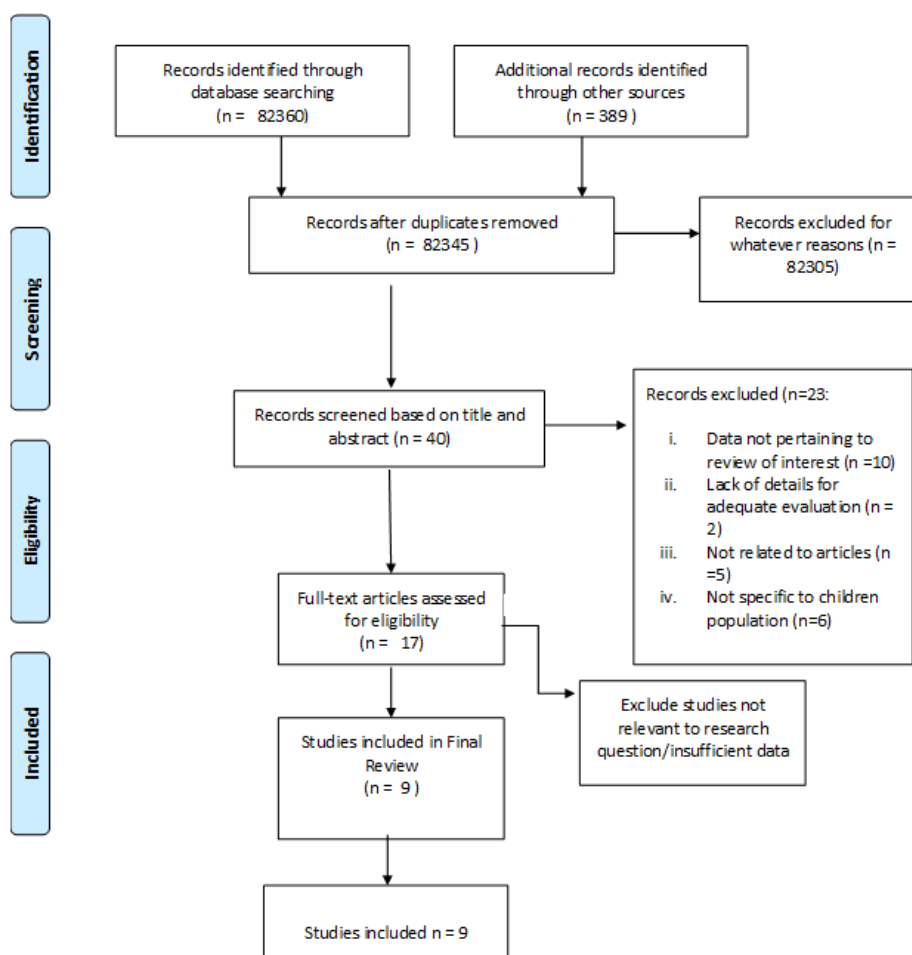


Figure 1: PRISMA flow diagram

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Results

Characteristics of the study

All the studies were published within the past 2 years dated from 2020 to 2022 to provide an updated view of flood-related effects on children. They were mostly conducted in low and middle income countries with the majority in South Asia regions. These countries are demographically similar with high density population with large proportion of under 18 years old, frequently suffers from regional conflicts and have high poverty and malnutrition rates. None of the studies discussed the impact of floods on children in developed countries or other flood-prone regions such as South East Asia. The final synthesis of articles includes three systemic review and meta-analysis, three cross sectionals, one retrospective, one scoping review and one case control.

Type of morbidity and mortality

Only one study discusses flood-related mortality. The remaining studies reported morbidities related to gastrointestinal infections, nutrition and psychological impact.

Table 1- Reported previous studies of Morbidity and Mortality in Children

Author	Location	Study design	Population	Objective	Results
Colston et al, 2020	Peru	Observational	Children < 24 months	Relative risk of high burden common enteropathogens	<i>Enterotoxigenic E. coli</i> (ST-EPEC) (RR = 1.73 [1.10, 2.71]) <i>Rotavirus</i> (RR = 5.30 [2.70, 10.40]) <i>Sapovirus</i> (RR = 2.47 [1.79, 3.41]) <i>Shigella</i> (RR = 2.86 [1.81, 4.52]) <i>Campylobacter spp.</i> (RR = 1.41 (1.01, 1.07).
Arash et al, 2020	-	Systematic review & meta-analysis	Children & adolescent < 21 years old	Prevalence of PTSD among survivors of earthquakes & flood	Pooled prevalence: Highest 30.0% (95%CI = 29.5 -- 30.6%) in the second six-month intervals after the disaster, may last until 24-month post disaster More prevalent among girls (p < 0.001).
Haq et al, 2021	Pakistan	Cross sectional	Children 6-59 months	Prevalence of malnutrition using MUAC and risk factors	Prevalence 46%, female 52.1% (CI 49.3-54.8) Significant determinants: child and maternal age, family size, income level, mother education (p< 0.05)
Yari et al, 2021	Iran	Case control	<18 years, 18-58 years, >58 years	Behavioural, health related and demographic risk factors	Higher risk of death in <18 years old (OR=9.15, 95% CI:3.12-11.97; p<0.03) Low literacy (OR=3.03; 95% CI:1.36-

					associated with flood deaths	13.67; p<0.03) High risk behaviours (OR=37.92;95% CI:12.34-23.37;p<0.02)
Haq al,2021	et	Pakistan	Cross sectional	Pre-school and school going children	Prevalence of micronutrient deficiencies in flood-hit areas	High prevalence of zinc deficiency 88.3%,vitamin A 53.5%, Iron 26.7%
Deka al,2021	et	India	Cross sectional	5-13 years	Prevalence of soil transmitted helminths infection and its risk factors	16.3% were infected with ≥ 1 soil transmitted helminths [95% CI=12.9-19.8] Risk factors: flood affected area, open defecation, improper hand washing, age 8-10 years old
Ma al,2021	et	China	Retrospective	Adults/ Children	Association between floods and daily bacillary dysentery cases	Cumulative relative risk over 7-day lag period 1.393 (95% CI 1.216-1.596) Risk factors: male, < 5 years old, 15-64 years old, students
Lieber al,2022	et	South Asia	Systematic review and meta-analysis	Children	Prevalence of stunting, wasting and underweight	Flood-exposed children in rural India were 86% more likely to be stunted than flood-unexposed children Statistically significant (Adjusted prevalence ratio 1.86; 95% CI = 1.04–3.30)
Sharpe,Davi son,2022		LMICs	Scoping review	Children	Effect of climate change, climate related disaster and mental disorders	23 studies, most common is PTSD followed by depression PTSD ranges between 2% to 83%

- Precipitation, run-off volume, humidity, soil moisture, solar radiation, air pressure, temperature and wind speed
- Post-traumatic stress disorder
- Mid upper arm circumference

Discussion

Floods and its related morbidity and mortality

Risk assessments for flood related morbidity and mortality can be categorised according to time of complications from the onset of flood. Mortality usually occurs early in the form of direct injury e.g. electrocution and drowning. Yari et al reported that children less than 18 years old have a higher risk of death compared to other age groups³. Similarly, a long term study examining deaths due to flood in Algeria observed drowning as the commonest cause followed by physical trauma, hypothermia and electrocution⁴. Children are more vulnerable to danger as they are either fully or partially dependent on caretakers, less capable to resist harm and have poor knowledge or understanding regarding safety measures during natural disasters.

During and after the flood event, affected children have a higher risk of exposure to infections via the spread of water and vector borne diseases. Damage to sewer systems causing water supply contamination, limited clean water for food preparation and lack of refrigeration for food storage are factors contributing to faecal-oral transmission of gastrointestinal pathogens e.g. Shigella and cholera. From a study conducted in China, risk of contracting bacillary dysentery was high during the first 7 days of flood, favouring the growth of Shigella due to its short incubation period⁵. Meanwhile, during a La-Nina flood, Colston and his team observed spikes of heat stable enterotoxigenic E. coli diarrhea during the early period of floods followed by rotavirus, sapovirus, Shigella and Campylobacter diarrhea during the later part of the floods. This study defines early period from December to February when the communities were displaced due to the floods and later period from March to May of the same year when displaced communities returned but the rain and flooding continues throughout⁶. From a study in India, children in flood-prone regions are likely to contract soil transmitted helminths infections commonly caused by Ascaris lumbricoides, hookworm and Trichuris trichiuria. Children between 8-10 years are likely to be infected and very closely related to wash and sanitation practices with open defecation and improper handwashing as significant risk factors⁷.

Malnutrition is a common issue in flood affected region. It may occur acutely in the form of wasting and underweight or chronically in the form of stunting. Neonates and younger children are at most risk for both malnutrition and infection due to unhygienic feeding practices as a result of contaminated water supply⁸. Furthermore, limited supply of complementary feeds and reduced milk production due to maternal reduced intake and stress contributes to the problem. Based on a recent systematic review, wasting is commonly seen in children less than 24 months old and stunting being more prevalent in those aged 12 months and above⁹. Duration of diarrhea affects incidence of stunting. In a separate study, certain demographics are statistically significant in predicting malnutrition in those less than 5 years old namely the child and maternal age, family size, income level and level of maternal education¹⁰. The same author also observed high prevalence of micronutrient deficiencies in the preschool and school going children. These two studies were conducted in Pakistan where the malnutrition rate is high and fortified foods are not readily available¹¹. A relatively similar finding is observed in India where almost 90% of the flood exposed children suffered from stunting¹². Floods further exacerbates degree of malnutrition with the destruction of crops causing food insecurities as raw materials is reduced in supply and effect of food inflation.

In recent years, psychological consequences of floods have received more attention. Natural disasters are putting children at risk for psychological disturbances in the short and long term. Post-traumatic stress disorder (PTSD) is the commonest sequelae seen post disaster followed by depression¹³. A study reported high prevalence of (PTSD) among the survivors of floods and earthquakes. Girls were predominantly affected and symptoms were readily apparent during the first year of trauma and may last for 24-month post disaster¹⁴. A similar scenario is also seen in children residing in slums in Indonesia that observed reduced emotional functioning scores¹⁵.

Research gaps

Majority of the studies involve the heavily populated South Asia with limited data on the impacts of flood in other regions e.g. South East Asia. Countries like Malaysia and Thailand suffer from monsoonal floods regularly and have demographic differences from South Asia regions. Very few studies examined flood related mortality in children even though children are the most likely to die from its consequences. Meanwhile, none of the articles studied the association between flood and respiratory complications which is a common phenomenon after the water recedes. The residual mud will be transformed into dust, scientifically measured as particulate matter measuring 10um which is hazardous to lungs. Active movement of heavy vehicles post flood and nitrification processes in agriculture areas that incorporate ammonia fertilisers contribute to increased nitrogen dioxide levels in the surrounding air¹⁶. Level of awareness need to be explored for the school going children as well to nurture advocacy on the issue.

Recommendations

Creation of a module is essential in handling children affected by all types of natural disasters encompassing both the medical and non-medical perspectives. It requires interdisciplinary approach to involve health, wash and sanitation, nutrition, education and protection. Children at high risk of complications e.g. PTSD needs to be recognized early to enable early intervention and social support. Spiritual measures can be applied to help overcome the anxiety and distress e.g. Qur'anic teachings for the Muslim population. Promoting literacy on natural disasters among children is an important factor as part of disaster risk reduction. This can be done via promotion of safety in flood prone areas, education and training of youth based on school learning materials e.g. incorporation of survival strategies into school curriculum and issues related to climate change. Simple measures such as proper handwashing and toileting habits are the all-time important measures. Populations at risk for crop loss need to be educated on sustainable agriculture and water irrigation practices.

Conclusion

Floods affect children in various ways. An interdisciplinary and integrated approach is essential in managing flood affected children.

Acknowledgment

The authors wish to widen our genuine appreciation to the University Sultan Zainal Abidin, particularly the Faculty of Medicine for the given countless support.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this articles.

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