ABSTRACT

Introduction Natural hazards are damaging environmental events, such as fires, droughts and floods, which have negative impacts on human lives, livelihoods and health. Natural hazards are increasing in intensity and severity, and may potentially have harmful effects on the health and development of children who experience them. There are few syntheses of the evidence about the effects of natural hazards on the early development of children aged from birth to 5 years old. The aim of this systematic review and meta-analysis is to determine the impact of natural hazards on the cognitive, motor, language, social and emotional development of children from birth to 5 years old.

Methods and analysis Comprehensive searches will be conducted in five bibliographic databases: Ovid MEDLINE, Ovid PsycINFO, CINAHL Plus, Scopus and Ovid EMBASE, using predefined search terms to identify the relevant studies. The review will follow the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. Eligible studies will be included if they report on the association between exposure to natural hazards and at least one indicator of early childhood development (ECD). Extracted data will include: main study findings, characteristics of the study design, measures of natural hazards and ECD indicators. Observational studies with cross-sectional, case–control, prospective or retrospective cohort designs will be included in this review. Case descriptions and qualitative studies will be excluded. Study quality will be assessed using the Joanna Briggs Institute critical appraisal tools. We will conduct a meta-analysis if the reviewed studies are sufficiently homogeneous according to research design, exposure, participants and outcome measures. The meta-analysis will include subgroup analyses (eg, length of exposure to natural hazard, type of natural hazard, ECD indicator).

Ethics and dissemination The findings will be disseminated through a peer-review publication, policy brief, technical report and report published on institutional stakeholder websites.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The review will follow standardised guideline.
⇒ The search strategy is designed by a specialist information analyst.
⇒ All papers will be reviewed independently for inclusion by at least two reviewers, and differences of opinion will be resolved by consensus with the whole author team.
⇒ Data will be extracted from each paper meeting inclusion criteria by two authors independently of each other using the Covidence system, and differences will be resolved by consensus with a third reviewer.
⇒ The study is limited to publications in English, and it is possible that relevant publications in other languages will be missed.

INTRODUCTION

The number, severity and unpredictability of natural hazards have increased by a factor of five in the past 50 years,1 exacerbating the harmful impact of disasters on people.2 The combination of increases in extreme weather events and low-density housing in regions prone to natural hazards, such as in areas near flammable forests, will lead to more disasters.3 Analysis of more than 23 million fires found clusters of fires that caused significant disaster were concentrated in suburban areas surrounded by flammable forests in regions of western USA and south-eastern Australia.3 This increase in intensity and severity of natural hazards in areas where there are houses, schools, childcare centres and local healthcare centres will adversely affect early childhood development (ECD),4–6 which is measured by different indicators including cognitive, physical, motor, language, social and emotional development of children from birth to 5 years.7–9

According to Peek, natural hazards can profoundly impact children’s psychological and physical health and education.8 The extent of impact can vary depending on many factors that result from natural hazards such as the death of a loved one, family separation, displacement, low social support, unsafe and unsanitary shelter environments, inaccessibility to medical care and psychological
support, delayed enrolment in school, and parental distress.  

Psychological vulnerabilities can include post-traumatic stress disorder (PTSD), depression, anxiety, emotional distress and behavioural and sleep complications. Common short-term responses to natural hazards in infants and young children between 1 and 4 years old may include problems associated with irritability, aggressive behaviour, dependence and separation anxiety. The negative impact of childhood exposure on mental health may persist for months to years after the natural hazard has occurred. Longer-term responses can include more severe psychological stress including PTSD, depression and anxiety, impaired family function, and school performance and social withdrawal.

The impact of natural hazards on physical health can occur immediately after exposure and may persist for the long term. Natural hazards can directly cause illness, physical injury or death. They can destroy health infrastructure, making it difficult to treat illnesses or injuries. Moreover, unhygienic conditions and unsafe drinking water can lead to infections. Some health problems may manifest years after exposure to the natural hazard, which can include musculoskeletal complications, and flu-like symptoms in young children.

Natural hazards may damage educational institutions and displace children from their homes which may impact their ability to attend school and perform academically which can lead to delayed progress and failure to complete education. Particularly in low-and-middle-income countries, children are more likely to enter the labour force and reduce school attendance due to loss of household income through unemployment.

Exposure to natural hazards, which affect parents, teachers or other caregivers, may disrupt children’s support and protection systems and may indirectly affect their development. Younger children possess less problem-solving skills and coping capacity than older children, adolescents or adults; thus, they are more dependent on their caregivers for protection and care. Some evidence may suggest support and care provided by caregivers post hazard may act as a buffer for the long-term impact of natural hazards on the different ECD indicators.

While the literature on the impact of natural hazards on different areas of child development has been published, to date no systematic review has synthesised the evidence on exposure to natural hazards in young children less than 5 years old, and how it influences all the indicators of ECD. Previous systematic reviews have included a meta-analysis on maternal exposure to natural hazards and ECD quantified the effects of natural hazard-related prenatal maternal stress on different indicators of ECD including birth outcomes, motor, physical, cognitive, social, emotional and behavioural development. While this review found that higher natural disaster-related prenatal maternal stress was associated with worse cognitive, motor, behavioural, social and emotional development, it focused only on prenatal maternal exposure to natural hazards and not child exposure.

Another review was conducted, summarising the evidence from 1981 to 2001 on disaster exposure and development of children. However, only four studies that sampled preschool-aged children were identified in that review and it was therefore concluded that there was not enough evidence available for synthesis for that age group. Hence, the authors were not able to summarise the effects of natural hazards on ECD of young children at the time. In this systematic review, we aim to determine the impact of natural hazards on the cognitive, motor, language, social and emotional development of children from birth to 5 years old. Given the increase in intensity and severity of natural hazards and their broad impact on health, this review will assist in informing policy and programmes to lessen the effects of natural hazards on ECD.

**METHODS AND ANALYSIS**

**Protocol and registration**

This protocol is for a systematic review on the available evidence about the impact of natural hazards on ECD. It has been produced according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses for Protocols (PRISMA-P). The systematic review will be guided by the PRISMA checklist using the PRISMA 2020 guidelines. This protocol has been registered on the PROSPERO; registration number: CRD4202231621.

**Study eligibility criteria**

**Participants**

Participants will include children aged from birth to 5 years old at the time of exposure to a natural hazard. Teachers, parents or other caregivers or practitioners reporting on children aged between birth and 5 years at the time of exposure will also be included. Included studies will measure developmental outcomes 0–5 years after exposure.

**Studies**

All countries where eligible studies have been conducted will be included in this review, regardless of income and socioeconomic level. Studies will be included if they have been peer-reviewed and published with full-text available. We will include quantitative, observational studies such as prospective and retrospective cohort studies, cross-sectional studies, case–control studies and any other form of follow-up or longitudinal studies. All forms of qualitative studies such as those using or collecting data by focus group discussions, in-depth or semi-structured interviews will be excluded as this review will focus on quantitative measures of the effects of natural hazards on ECD. The studies included in this review are limited to those published in the past 30 years (between 1992 and 2022).
Unpublished studies or technical reports in the grey literature will not be included in this review.

**Exposure**
Only studies investigating experiences of naturally occurring hazards will be included in this review. Studies included in this review will not be limited based on the length of exposure to natural hazards. Subjective (self-reported questionnaire) and objective (eg, total land area affected, number of buildings damaged/destroyed) measures of natural hazards will be included. Studies investigating human-made, technological and terrorism-related disasters will be excluded.

**Outcome**
Studies measuring primary outcomes of at least one indicator of ECD (ie, cognitive, language, social, emotional and motor development) will be included in this review. Additional outcomes of physical health and growth will also be included. Both subjective (eg, self-reported questionnaire) and objective measures (eg, height and weight) of development will be included. The effect of natural hazards on these indicators of development will be measured quantitatively in terms of relative risks, ORs, risk differences and mean differences. All outcomes that have been measured using standardised continuous, binary or categorical scales will be included.

**Search strategy**
The search strategy will aim to find English language studies in five databases (Ovid MEDLINE, Ovid EMBASE, Ovid PsycINFO, Scopus and CINAHL Plus). An initial search will be undertaken in MEDLINE and EMBASE to identify relevant subject terms and phrases. Searches will be adapted according to the specifications of each database. The search strategies will use a combination of Subject Headings and free text terms that cover the areas of (1) natural hazards and (2) children’s developmental conditions (eg, behaviours, cognitive and language development). Reference checking of citations and reference lists will be undertaken. The Ovid MEDLINE search strategy is provided in online supplemental table 1.

**Data management**
All records and extracted data will be managed in Covidence (https://www.covidence.org/), a screening and data extraction tool. The extracted data will also be stored and made available through Open Science Framework (OSF), a repository that allows researchers to collaborate, document, register and share their research projects. Please visit the website at https://osf.io/ for further details on OSF.

**Study selection**
Study screening, deduplication and management of the records retrieved from databases will be conducted in Covidence. The screening and selection will follow a two-step approach to identify eligible studies. In the first step, two reviewers will screen the titles and abstracts to identify studies that meet the inclusion criteria. In the second phase, the full text of potentially eligible studies will be retrieved, reviewed and assessed for final inclusion. Any disagreement over the eligibility of certain studies will be resolved through discussion with a third reviewer.

**Data extraction**
Data will be extracted independently by two reviewers through Covidence. Data extracted from the studies will include study design; type, measure and timing of natural hazard; time from exposure to outcome assessment; ECD outcomes (measures and criteria); setting of study (ie, country where the study was conducted and gross domestic product); type of comparator used (ie, low or no exposure to natural hazard); baseline characteristics and other potential confounders; and main findings. Where necessary, study authors may be contacted to obtain any missing data and additional resources. Discrepancies between reviewers in terms of data extraction will be resolved by consensus in discussion with a third reviewer.

**Risk of bias**
Assessment of bias within the methodologies of the included studies will be assessed using the Joanna Briggs Institute (JBI) critical appraisal tools.24 There are individual checklists for study designs to assess the internal validity and risk of bias of eligible studies. The checklist items include assessment of confounding factors, validity and reliability of tools used to measure exposure and outcome, and appropriate use of statistical analyses. Two reviewers will independently assess each study, and any conflicts will be resolved by a third reviewer.

**Data synthesis**
Data from the included studies will be extracted and, after consensus has been reached among all authors regarding discrepancies, a qualitative synthesis will be conducted. If possible, a meta-analysis will also be conducted. The qualitative synthesis will be structured around the effect of natural hazards on indicators of ECD (ie, cognitive, language, social, emotional and motor development) and further analysed based on the subgroups identified below, such as the types and time of exposure to natural hazards, the developmental indicators and the quality of studies.

If the quality of evidence and number of studies with data available allows for a meta-analysis to be conducted, Stata V.1725 will be used. The pooled effect size (ie, relative risks ratios, ORs, risk differences and/or standardised mean difference) of natural hazards on ECD will be reported. Random effects meta-analysis model will be used to calculate pooled effect estimates with a 95% CI. Heterogeneity will be estimated using the χ^2 test and I^2 statistic. A low p value (≤0.05) provides evidence of heterogeneity of exposure effect; if I^2>75%, heterogeneity is considered to be considerable. The estimated effect size and CIs will be summarised and presented in a forest plot. Publication bias will be investigated through
visual asymmetry detection after analysing the funnel plot and Egger test for asymmetry.

**Planned subgroup analyses**
Subgroup analyses will be undertaken to determine whether the impact of natural hazards on ECD differs depending on participant characteristics and study designs. We will examine the following characteristics:
1. ECD indicators (ie, cognitive, language, social, emotional and motor development).
2. Types of natural hazards.
3. Time since exposure to natural hazard (eg, 6 months, 1 year).
4. Income level of the country (eg, low income, middle income, high income).
5. Sex differences (male or female).
6. Type and measure of ECD outcome used (eg, self-reported/parent-reported or teacher-reported, direct assessment).
7. Type and measure of the comparator (low exposure or no exposure).
8. Quality of the study (eg, low, medium and high).

**Ethics and dissemination**
Ethical approval is not required for this study as it is a review of already published work. The findings of this review will be disseminated through a peer-review publication, policy brief, technical report and report published on institutional stakeholder websites.

**Patient and public involvement**
There will be no patient or public involvement in the design of this study as the review will be of previously published data.

**Timeline**
This study was started on 1 April 2022 and will be completed on 31 December 2023. The searches will be conducted from 1 February 2023 to 10 February 2023.

**REFERENCES**


25 StataCorp L. _Stata Statistical Software: Release 17_. College Station, TX: StataCorp, 2021.