

# BMJ Open Effects of natural hazards on early childhood development: a systematic review protocol

Hemavarni Doma,<sup>1</sup> Thach Tran ,<sup>1</sup> Lorena Romero,<sup>2</sup> Shelly Makleff,<sup>1</sup> Revathi Nuggehalli Krishna,<sup>1</sup> Karan Varshney,<sup>1</sup> Jane Fisher <sup>1</sup>

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<sup>1</sup>Global and Women's Health, School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia

<sup>2</sup>Ian Potter Library, Alfred Hospital, Melbourne, Victoria, Australia

## Correspondence to

Dr Thach Tran;  
[thach.tran@monash.edu](mailto:thach.tran@monash.edu)

## 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.

**PROSPERO registration number** CRD42022331621.

## INTRODUCTION

The number, severity and unpredictability of natural hazards have increased by a factor of five in the past 50 years,<sup>1</sup> exacerbating the harmful impact of disasters on people.<sup>2</sup> The

## 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.

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.<sup>3</sup> 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.<sup>3</sup>

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),<sup>4-6</sup> which is measured by different indicators including cognitive, physical, motor, language, social and emotional development of children from birth to 5 years.<sup>7</sup>

According to Peek, natural hazards can profoundly impact children's psychological and physical health and education.<sup>8</sup> 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.<sup>9</sup>

Psychological vulnerabilities can include post-traumatic stress disorder (PTSD), depression, anxiety, emotional distress and behavioural and sleep complications.<sup>6 8 10–13</sup> 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.<sup>14</sup> The negative impact of childhood exposure on mental health may persist for months to years after the natural hazard has occurred.<sup>9</sup> Longer-term responses can include more severe psychological stress including PTSD, depression and anxiety, impaired family function, and school performance and social withdrawal.<sup>15</sup>

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.<sup>8 16</sup> They can destroy health infrastructure, making it difficult to treat illnesses or injuries.<sup>9</sup> Moreover, unhygienic conditions and unsafe drinking water can lead to infections.<sup>17</sup> Some health problems may manifest years after exposure to the natural hazard, which can include musculoskeletal complications, and flu-like symptoms in young children.<sup>16</sup>

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.<sup>8</sup> 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.<sup>9</sup>

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.<sup>9 18</sup> Younger children possess less problem-solving skills and coping capacity than older children, adolescents or adults,<sup>18</sup> 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.<sup>9 19</sup>

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.<sup>20</sup> While this review found that higher natural disaster-related prenatal maternal stress was associated with worse cognitive, motor, behavioural, social and emotional

development,<sup>20</sup> 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.<sup>21</sup> 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.<sup>21</sup> 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 2015 (PRISMA-P).<sup>22</sup> The systematic review will be guided by the PRISMA checklist using the PRISMA 2020 guidelines.<sup>23</sup> This protocol has been registered on the Prospective Register of Systematic Reviews (PROSPERO; registration number: CRD42022331621).

### 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.<sup>24</sup> 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.17<sup>25</sup> 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  $\chi^2$  test and  $I^2$  statistic. A low p value ( $\leq 0.05$ ) 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.

## DISCUSSION

This review and meta-analysis will be the first to explore and synthesise the literature available on the association between exposure to natural hazards and ECD in children from birth to 5 years of age. It will synthesise published studies and peer-reviewed literature published globally. The findings from this review will provide policy-makers with an understanding of the effects of natural hazards on different ECD indicators.

We acknowledge that there are potential limitations. First, only studies published in English will be included. While studies with a cross-sectional study design will also be included, we will not be able to determine cause-and-effect relationships from them. If we conduct a meta-analysis, we will also conduct separate analyses for these studies based on time of exposure, which would assist in determining the direction of the association.

Included studies will likely involve self-reported data using either self-administered or interviewer-administered questionnaires. Therefore, the data may be prone to method and response bias. However, we are using the JBI critical appraisal tools, which are well-established, comprehensive risk-of-bias assessment tools, to assess the quality of each study's methodology. If possible, we will also conduct separate analyses based on the quality of the study.

Given natural hazards are increasing in intensity and severity, systematic reviews of the evidence on the effects of natural hazards on ECD are vital yet limited for young children from birth to 5 years of age. This review and meta-analysis will help inform the development of policies and future research to mitigate the effects of natural hazards on ECD, which are likely to increase in the coming years.

**Contributors** HD drafted the manuscript and contributed to the design of the study. TT and JF initiated and designed the study. LR contributed to the development of the systematic review search strategy. SM, RNK and KV contributed to revisions. All authors reviewed and approved the final version of the manuscript.

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**Competing interests** None declared.

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**Patient consent for publication** Not applicable.

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### ORCID iDs

Thach Tran <http://orcid.org/0000-0002-4686-8601>

Jane Fisher <http://orcid.org/0000-0002-1959-6807>

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## Supplementary file 1

Table 1: Ovid MEDLINE Search Strategy

#	Searches	Results
1	natural disasters/ or avalanches/ or cyclonic storms/ or droughts/ or earthquakes/ or floods/ or landslides/ or tidal waves/ or tornadoes/ or wildfires/	
2	(disaster* or avalanche* or cyclonic storm* or drought* or earthquake* or landslide* or land slide* or tidal wave* or tornado* or cyclone* or cyclonic storm* or hurricane* or tropical storm* or typhoon* or catastrophic flood* or flooding* or disastrous flood* or catastrophic storm* or disastrous storm* or catastrophic blizzard* or disastrous blizzard* or catastrophic mudslide* or disastrous mudslide* or catastrophic rockslide* or disastrous rockslide* or bushfire* or bush fire* or wildfire* or wild fire* or forest fire* or wildland fire* or wild land fire* or woodland fire* or wood land fire* or brushfire* or brush fire* or rural fire* or grassfire* or grass fire* or catastrophic fire* or disastrous fire* or disaster victim* or natural catastrophe*).mp.	
3	1 or 2	
4	Stress, Psychological/ or emotional adjustment/ or social behavior/ or social adjustment/ or social isolation/ or social skills/ or personality/ or intelligence/ or emotional intelligence/ or emotional adjustment/ or temperament/ or emotions/ or anxiety/ or emotional regulation/ or psychological distress/ or language development/ or verbal behavior/ or speech/ or speech intelligibility/ or psychomotor/ or motor skills/ or mental processes/ or cognition/ or awareness/ or learning/ or memory/ or spatial learning/ or verbal learning/ or perception/ or social perception/ or social cognition/ or Resilience, Psychological/ or cognition disorders/ or language development disorders/ or anxiety disorders/ or anxiety, separation/ or mood disorders/ or social isolation/ or loneliness/ or Motor Activity/ or Attitude/ or Psychology, Social/ or psychosocial functioning/ or temperance/ or Mental Competency/	
5	(Psycholog stress* or emotional* adjust* or social adjust* or social isolat* or social skill* or personalit* or intelligen* or emotional* maladjust* or maladaptive emotion* or emotional maladaptation or anxiety or language develop* or verbal behavio* or speech intelligibility or motor skill* or mental process* or cognitive rumination or learning abilit* or learning	

	<p>disabilit* or long-term memory or short-term memory or spatial learning or verbal learning or auditory perception* or social perception* or social cognition or visual perception* or psychological resilience or cognit* disorder* or cognitive dysfunction or language development or language disorder* or mental disorder* or mood disorder* or depressive disorder* or consciousness disorder* or social support* or loneliness or Motor Activit* or Attitude or psychological conflict or social psychology or psychosocial functioning or Mental Competenc* or emotional stabilit* or emotional instabilit* or emotionalit* or mental function* or Cognitive symptom* or Cognitive thinking or mental concentration or mental comprehension or mental develop* or language processing* or psychomotor develop* or speech develop* or cognitive develop* or social adaptation* or social behavio* or psychological adjustment* or psychosocial adaptation* or adaptive behavio* or coping behavio* or language abilit* or psychomotor disorder* or psychosocial disorder* or mental capacity* or motor performance or perceptual motor develop* or perceptual motor coordinat* or perceptual motor learning* or perceptual motor process* or motor control* or motor coordinat* or motor skill learning* or physical develop* or motor develop* or intellect* develop* or perceptual develop* or psychologic* develop* or emotional develop* or psychosocial develop* or socioemotional functioning or life skill* or social communicat* or language proficienc* or emotional regulat* or emotional health or emotional response* or emotional process* or cognitive ability* or physical activit* or Cognitive process* or psychosocial support* or Mental health or Problem solving or Psychomotor performance* or Motor skills disorder* or Personality develop* or Personal growth or executive function or Psychological distress* or Social participation or Social attitude* or psychological adaptation*).mp.</p>	
6	<p>(Traumatic stress* or Emotional availab* or Motor develop* or Psychologic* stress* or emotional adaptat* or adjust* behavio* or coping skill* or coping strateg* or psychologic adaptation* or anxious* or hypervigilant* or visual coordinat* or visual motor coordinat* or task performan* or Cognit* function or sensory process* or visual process* or cognit* impairment or mild neurocognit* disorder* or develop* disorder* or language delay* or speech delay* or personality characteristic* or emotional health or emotional attitude* or cognitive growth or mental growth or psychomotor abilit* or language learning or social adaption* or personal adjustment* or language skill* or language proficienc* or</p>	

	Psychomotor deficienc* or Psychomotor impairment* or Mental ability* or Motor function* or Motor ability* or Physical growth or Emotional cognition* or Cognitive function* or Intellectual function* or Motor learning*).mp.	
7	4 or 5 or 6	
8	child/ or child, preschool/ or infant/ or infant, newborn/	
9	((early or young*) adj child*).mp.	
10	(preschool child* or Pre-school child* or pre-school going child* or Pre-schooler* or Preschooler or Infant or Baby or Newborn or Toddler* or Preschool student* or Kindergarten student* or nursery school child*).mp.	
11	(first year of life or first 1 y of life or first 1y of life or first two years of life or first 2 y of life or first 2y of life or first three years of life or first 3 y of life or first 3y of life or first four years of life or first 4 y of life or first 4y of life or first five years of life or first 5y of life or first 5 y of life).mp.	
12	(1000 day window or first 1000 days or first thousand days).mp.	
13	(child* adj4 (6 month* or 12 month* or 24 month* or 36 month* or 48 month* or 59 month* or 1 Year or 2 Years or 3 Years or 4 Years or 5 Years)).mp.	
14	("under" or less than or below or younger than) adj five years of age).mp.	
15	(child* adj3 (under five or below five or younger than five)).mp.	
16	8 or 9 or 10 or 11 or 12 or 13 or 14 or 15	
17	3 and 7 and 16	
18	Child Health/ or Child Health Services/ or Child Behavior/ or Infant Behavior/ or Child Behavior Disorders/ or Child Development/ or Child Language/ or Child Psychiatry/ or Child Welfare/ or Infant Welfare/ or Psychology, Child/ or Infant Health/	
19	((Infant or Child) adj (develop* or welfare or language* or behavio* or psych* or temperament)).mp.	
20	((child* or toddler* or preschool* or pre-school* or offspring or infant*) adj (growth* or development* or behavio* or socioemotional or socio-emotional or social emotion* or emotion* adjustment or emotion* regulation or emotion* function* or emotion* dysfunction* or emotion* problem* or emotion* difficult* or emotional distress or dysregulation* or dysregulated emotion* or socialization or maladaptive emotion* or social	



	acceptance rating* or cognitive or neurodevelopment* or mental ability* or executive function* or language or psych* or mental health or mental wellbeing or mental well-being or depress* or withdrawal or separation anxiety or social functioning or resilience or engagement or attachment or motor or psychomotor or attention deficit or hyperactivity or temperament or negative affect* or functioning)).mp.	
21	18 or 19 or 20	
22	3 and 21	
23	3 and 7	
24	limit 23 to ("newborn infant (birth to 1 month)" or "infant (1 to 23 months)" or "preschool child (2 to 5 years)")	
25	17 or 22 or 24	
26	limit 25 to yr="1992 - 2022"	
27	limit 26 to english language	
28	limit 27 to (autobiography or bibliography or biography or case reports or comment or dictionary or directory or editorial or letter or news or newspaper article)	
29	27 not 28	
30	29 not (abstract collection or opinion or encyclopedia entry or interview or anecdote or case study or commentary).mp.	1460