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Systematic Review

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School-Based Education Programs for Preparing Children for Natural Hazards: A Systematic Review

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Abstract

Schools have a significant role in disaster education to children. This study investigates the research works about school-based education programs in order to discover challenges and best practices. We conducted a systematic review of English language papers published in peer-review journals.

The search identified 2577 publications and 61 articles meeting selection criteria and included in the review. Reviewed studies indicated that disaster education in schools is effective but yet insufficient in many countries. Lack of equipment, financial resources, policy gaps, and teachers' knowledge are common problems in programs. Main outcomes of this systematic review are showing methods used for health emergency preparedness of children of different ages and gender differences in school-based disaster preparedness, as well as the difference in their lifesaving skills in disasters.

This study shows that some disaster education programs reported in the papers reviewed were not high-quality enough, which may lead to insufficient preparedness of children in disasters and consequently may put their health at risk, considering the increasing number of natural hazards.

Introduction

In the past 2 decades, the number of natural hazards has risen dramatically worldwide.[1] Natural hazards such as earthquake, flood, and tsunami have affected a large number of people around the world.[2] Disaster risks are dependent on the type of hazard, exposure, and vulnerability.[3,4]

Vulnerable groups who are exposed to disasters encounter greater dangers and hazards in their life.[5] Children are one of the most vulnerable groups. Disasters affect children in different ways, directly or indirectly.[6] Reducing vulnerability is one way for protecting children in disasters.[7,8] Children are more susceptible to injury, and they are dependent on others for lifesaving, livelihood, decision-making, and emotional support, and this makes them vulnerable.[7,9-11] Attention to children before disasters is part of the disaster preparedness phase and will reduce their vulnerability.[12,13] An important factor for children's disaster preparedness is disaster education.[14,15] Disaster education has a major role in enhancing awareness of children about disasters and their risk perception.[14] By raising awareness of children about disasters, the children can share their knowledge with adults, which may help raise adults' preparedness.[16] Disaster education for children can be conducted in schools.[17] Schools have a critical role in disaster risk reduction providing an ideal space for children disaster preparedness by using policy frameworks, skilled teachers, textbooks and curriculum for learning, and peer education.[18] It is mentioned in global treaties that: "Children and youth are agents of change and should be given the space and modalities to contribute to disaster risk reduction, in accordance with legislation, national practice and educational curricula."[19] The United Nations members committed to 5 essential dimensions of disaster education, including understanding the science and mechanisms of natural hazards, learning and practicing safety measures and procedures, understanding risk drivers and how hazards can become disasters, building community risk education capacity, and building an institutional culture of safety and resilience.[20] For school-based disaster education, several programs should be defined, such as integrating disaster risk reduction in textbooks, preparing teachers for training students, and applying practical education (ie, drills). Education could be classified into *formal*, *non-formal*,

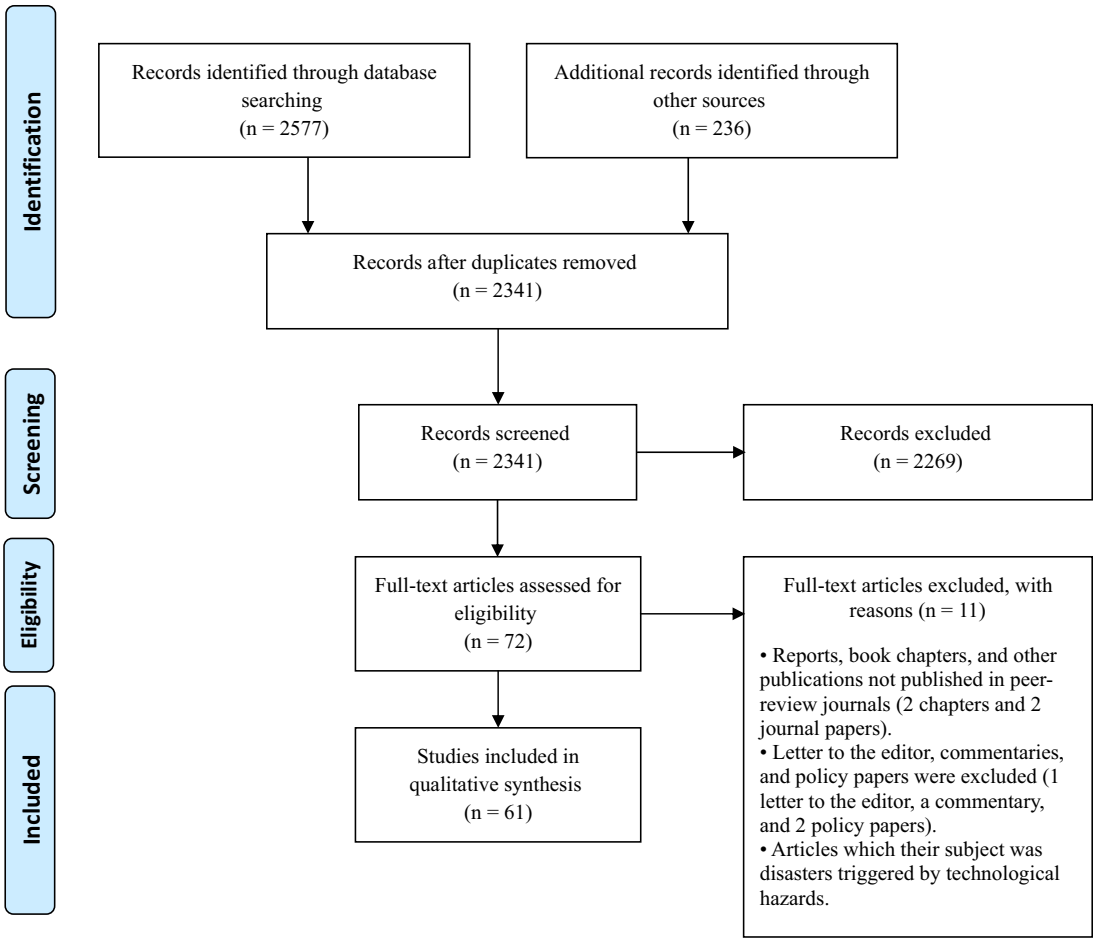

Figure 1. Flow chart of study selection process.

and *informal* education.[21] Formal education, such as education in schools, is an institutionalized education system. Non-formal education is any organized and systematic education outside the framework of the formal education. Informal education is the knowledge that every person acquires in their life. In this study, our focus is on non-formal education, mostly including the disaster education that is happening in schools outside the formal education framework, such as drills and lectures.[22] There are several studies on outcomes of school-based disaster education to children in different countries, yet no comprehensive review has been conducted to find the strengths and limitations of these programs. This systematic review aims to explore outcomes of school-based disaster education programs in reviewed articles, to find barriers of school-based disaster education programs, to explore geographic differences in school-based disaster education, and to find approaches of disaster education in schools in reviewed articles.

Methodology

This study is a systematic review of English language papers published in peer-review journals. This systematic review complies with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist.[23] Qualitative studies (those evaluating the process of school-based disaster education), observational studies (including case-control, cohort, and cross-sectional studies), and clinical trials (including non-randomized and randomized controlled trials) examining the effect of disaster preparedness education to knowledge, attitude, and preparedness of school students at all levels were eligible for inclusion in this review.

The studies included in the systematic review are those describing disasters preparedness in schools, different intervention in school before natural hazards, and the problems experienced because of improper preparedness in schools. The systematic search has included the papers published from 2000 (because the change in technology and communication that helped education) to October 2020. Articles should be published in the English language and in peer-review journals. Furthermore, only articles about natural hazards were included in this systematic review.

The initial literature search was organized in June 2019 to identify peer-reviewed and English articles on providing evidences about change in knowledge, attitude, and preparedness of school students as the result of school-based disaster preparedness education and ended in October 2020.

During the initial literature search, different keywords were identified. Researchers from various disciplines, depending on their academic field, use completely different keywords in their studies about disaster and children. Main concepts for searching were natural hazards, children, school, and preparedness. The terms applied to retrieve qualified articles are shown in Supplementary File 1.

At the first screening, a total of 2577 articles were found from PubMed (104 articles), Cochrane Library (150), Scopus (1335 citations), and Web of Science (988 citations) databases. Besides searching in the above databases, the references of

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reviewed papers were also checked. Figure 1 provides more information on the screening process. The reasons of exclusion are shown in Figure 1.

In order to decide on inclusion or exclusion of the papers, the titles and abstracts were assessed, respectively.

The studies retrieved during the search were screened for relevance, and those identified as potentially eligible were fully assessed against the inclusion/exclusion criteria to be accepted or rejected. PRISMA guidelines were applied to appraise the papers. The following data were extracted from the qualified studies: authors, year of publication, population, study design, country, type of disaster, assessment tools, outcomes, age, and diversity.

Given the heterogeneity of research in this topic, a meta-analysis was not possible. Therefore, the collected data were analyzed in a narrative synthesis. In the narrative synthesis, authors explored and described the results of any interventions that happened in disaster preparedness of children in schools. The MAXQDA 2018 software was used for data analysis. The method for the systematic review was registered through PROSPERO with registration number CRD42020146536.

Results

Search Results

The search identified 2577 publications, of which 236 duplicates were removed (see Figure 1). During title/abstract screening, 2270 articles were excluded. At full-text screening, 11 publications were excluded due to not been published in peer-review journals, article format, and type of disaster. A final number of 61 articles met the selection criteria and were included in the review. Article characteristics are shown in Table 1.

Description of Geographical Region

As shown in Table 2, among the reviewed articles, 11 were related to New Zealand,[52-62] 9 to Indonesia,[16,33-38,78,79] 5 to Japan,[43-46,77] 3 to Israel,[40-42] 3 to Pakistan,[63-65] 2 to Nepal,[50,51] 2 to Romania,[24,25] 2 to the United States,[74,75] 2 to Italy,[18,32] 2 to Timor-Leste,[24,25] 2 to China,[29,30] 1 to Serbia,[67] 1 to Bangladesh,[49] 1 to Turks and Caicos Islands,[73] 1 to Ghana,[31] 1 to Tanzania,[69] 1 to Lao PDR,[48] 1 to Australia,[24] 1 to Chile,[28] 1 to Iceland,[32] 1 to Portugal,[32] 1 to Taiwan,[68] 1 to the Netherlands,[70] 1 to Ecuador,[80] 1 to Iran,[39] 1 to South Korea,[81] and 3 papers focused on school-based disaster preparedness in Turkey.[14,24,29]

There are different results found about the relation of school-based disaster education and the geographical region within and between countries. Codreanu et al. (2015) claimed that the students who live in the low disaster risk and high-income country members of the Organisation for Economic Co-operation and Development (OECD) seem to be discussing more on disasters.[25] In addition, they found that predictors such as country disaster risk index and level of economic development are not good predictors for discussing disasters among teenagers. Musacchio et al. (2016) compared disaster education in schools of Italy, Iceland, and Portugal.[32] Their results show that these 3 countries have laid emphasis on the disaster education, but they are somehow different in education of specific disasters (such as earthquake), number of drills, resources, and tools for education. In another study about secondary school students' disaster awareness, the level of development of the country has been indicated as a determinant for disaster management.[71] Another study showed that there were regional differences in students' education about tsunami in Ecuador.[80] In addition, researchers concluded that a standard procedure of education was not followed in different regions in Ecuador.[80]

Figure 2 shows a comparison of disaster education in schools across various continents.

Description of Participants

The ages of the children in this study were classified as primary school (6-11 years) and secondary school or adolescence (12-18 years). As shown in Table 2, the most prevalent age group of participants was the adolescents (34 studies). Twenty-four studies have participants living in the middle childhood age, and 6 studies researched about child preparedness in early childhood age.

Rahman's (2019) findings show that the awareness of students in the upper grades is higher.[27] In another study, Bandecchi et al. (2019) emphasize that the children's awareness about disasters is relatively adequate according to their age range but that this awareness does not increase as the children grow older.[18] Also, Codreanu et al. (2015) concludes that there is no significant relationship between disaster discussion and the age of students.[25] Wei et al. (2020) observed that students in lower grades (or ages) were less prepared for disasters and more vulnerable.[30]

Among 48 reviewed papers, many of them, excluding 14 papers,[16,28,43,44,46,49-51,56,57,60,66,69,73] note under their methodology sections that their samples are coeducational (combinations of female and male students), but only 4 studies indicate the importance of gender differences in school-based disaster preparedness education.[25,27,30,40] Rahman (2019) observed that girls' awareness about disasters in Bangladesh are higher than boys', and also that they communicate more with their family about preparedness.[27] Peleg et al. (2018) and Wei et al. (2020) indicate that boys have more preparedness and resilience than girls in Israel and China, respectively.[30,40]

Only 1 study mentioned ethnic differences in students' preparedness. Wei et al. (2020) indicated that students from ethnic minorities were less prepared for an earthquake in China.[30]

Description of Outcomes

Among the reviewed studies, 24 papers confirm that disaster education for children in schools is useful and beneficial.[14,16,29,30,33,41-45,50,52,53,57,60,67,69,77,78] They point out that hazard education raises children's perception, knowledge, and awareness about disasters. Nevertheless, researchers in 14 studies argue that disaster education in schools is both positive and effective but yet insufficient.[28,29,45,46,50,51,53,55,59,61,63,66,74-76] They propose that lectures in schools can raise awareness but cannot prepare students,[50,75,76,79] that education is not comprehensive and is poor in some aspects of hazard awareness,[53,61] that education methods are not proper,[18,51,75] that there is ambiguity in legislative requirements for school-based education,[56,59] that there are gaps between disaster awareness and disaster preparedness in action,[18,45,76,79] and that there is lack of education resources and tools.[16,24,25,28,29,41,43,45,46,50,53,55,56,59,61,63,66,67,73] Researchers in 3 studies indicated that disaster education should be organized periodically and regularly.[29,41,50]

School-based disaster education needs resources and tools. The strongest facilitator factor for disaster preparedness is the wide use of various tools and resources.[55] Researchers in many reviewed articles argue over this topic.[16,24,25,28,29,34,39,41-43,45,46,50,53,55,56,59,61,63,66,67,69,73] Findings from 6 studies indicate that relying on textbooks and pictures for

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Table 1. Characteristics of the reviewed studies

No.	Author(s)	Country	Method	Population	Finding
1	Codreanu et al. (2016)[24]	Australia	Quantitative/cross-sectional study/ questionnaire survey	Total 829 final year high school students	Training is not enough and there is a need for more methods to prepare children.
2	Codreanu et al. (2015)[25]	Bahrain, Croatia, Cyprus, Egypt, Greece, Italy, Portugal, Romania, and Timor-Leste	Quantitative/cross-sectional study/ questionnaire survey	Total 3829 students, ages 14-21 M = 17.3	There was no significant relationship between age, knowledge about disasters, and between the country and readiness.
3	Codreanu (2019)[26]	Bahrain, Croatia, Cyprus, Egypt, Greece, Italy, Portugal, Romania, and Timor-Leste	Quantitative/cross-sectional study/ questionnaire survey	Total 3829 students, ages 14-21 M = 17.3	Children's disaster preparedness is linked to the relationship between parents and NGOs in schools.
4	Rahman (2019)[27]	Bangladesh	Quantitative/cross-sectional study	Sample size: 307 students/ 159 male, 148 female/ 15 to 17 years	Boys are more prepared than girls, girls are more knowledgeable than boys. Readiness increases with age, but not accordingly.
5	Vásquez et al. (2018)[28]	Chile	Qualitative study	Total 31 students/ 11-18 years old	Further training in emergency evacuation and earthquake shelter is needed.
6	Zhu and Zhang (2017)[29]	China	Quantitative/ correlational – observational study/ questionnaire survey	Total 758 students, 16 elementary and secondary schools, 376 male and 382 female	Training is not enough, and it has not been possible to prepare students with the current education system.
7	Wei et al. (2020)[30]	China	Quantitative	Total 1164 high school students, 39.3% male, 56% female	Gender and ethnic differences in students' preparedness were observed/female and lower grades were less prepared for disasters/ emergency response drills were effective specially for vulnerable students/ disaster education in schools should be part of community preparedness for disasters.
8	Apronti et al. (2015)[31]	Ghana	Mixed method/ correlational – observational study/ qualitative study	Total 144 students, 43 female and 101 male, 11-13 years old	One of the reasons for the unpreparedness of students has been the lack of sufficient knowledge of teachers.
9	Bernhardsdottir et al. (2016)[32]	Iceland, Italy, and Portugal	Quantitative/ correlational – observational study/ questionnaire survey	Iceland 255: preschool (ages 2–5 years) 137, elementary school (ages 6–16 years) 82, health/ welfare institution 36 Italy: 37 schools (6-9 years old and 10-13) Portugal 35 schools: 30 primary schools (6-9 years old), 5 kindergarteners (3-5 years old)	The equipment was the strongest predictor of the readiness of children in different countries against disasters.
10	Sakurai et al. (2018)[16]	Indonesia	Qualitative	Total 113 students/ 47 schools/10-12 years old	Due to financial problems, schools did not continue disaster preparedness activities.
11	Adiyoso and Kanegae (2012)[33]	Indonesia	Quantitative correlational – observational study/ questionnaire survey	Total 167 children, 87 male, 80 female, 10-13 years old	Education in schools has led to the readiness of children.
12	Fadhila et al. (2019)[34]	Indonesia	Quantitative/quasi-experimental - one group pretest-posttest design/questionnaire survey	Total 30 students	This program has increased the readiness of children.
13	Sujarwo et al. (2018)[35]	Indonesia	Quantitative/ observational, correlative analytics with a cross-sectional approach/ questionnaire survey	Total 109 students from fifth and sixth grades in 3 elementary schools in Sipora, Mentawai Island district.	This program increased education.

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Table 1. (*Continued*)

No.	Author(s)	Country	Method	Population	Finding
14	Shoji et al. (2020)[36]	Indonesia	Quantitative/quasi-experimental-treatment and control/ questionnaire survey	Total 843 high school students	A dance-based program for disaster education (eg, evacuation behavior) had a positive effect on participants' abilities to prepare for disasters; this program was effective even for children with poor learning backgrounds in schools.
15	Kamil et al. (2020)[37]	Indonesia	Qualitative study	Total 24 senior high school students	Disaster education through geographic literacy was effective.
16	Shoji et al. (2020)[38]	Indonesia	Quantitative/ correlational study/ questionnaire survey	Total 963 primary school students	There is a positive association between learning "sciences" and students' risk perception, perceived coping ability, knowledge about the disaster mechanism and response, and propensity to respond appropriately. Attitude to "religious" class was not related to none of the mentioned outcomes. Students' disaster preparedness could vary with school curriculum.
17	Moradian and Mehraein Nazdik (2019)[39]	Iran	Quantitative/quasi-experimental pretest–posttest designs/ questionnaire survey	Total 332 students (166 boys, 166 girls)	The educational method of the game is more effective on the students' knowledge than the traditional speech method.
18	Peleg et al. (2018)[40]	Israel	Quantitative/ correlational study/ questionnaire survey	Total 1758 students, 821 female, 932 male, 16 years old	Boys are more prepared for disasters than girls.
19	Bodas et al. (2019)[41]	Israel	Quantitative/ correlational study/ questionnaire survey	Total 1989 students, 891 female, 1061 male, 10th grader	Education has prepared children for earthquakes in the long run.
20	Soffer et al. (2010)[42]	Israel	Questionnaire survey/ quasi-experimental - treatment and control/ questionnaire survey	Total 2648 children from the 5th and 6th grades in 120 schools nationwide (of these, 1123 were male and 1421 female)	The combined intervention of lectures and exercises led to the greatest readiness.
21	Bandecchi et al. (2019)[18]	Italy	Quantitative/ correlational – observational study/ questionnaire survey	Total 5079 students, 3-18 years	With age and responsibility, awareness and preparation do not increase proportionately.
22	Shaw et al. (2004)[43]	Japan	Quantitative/ exploratory study/ questionnaire survey	Sample size: 1065 students/ 15-16 years old/ 28 schools	Education is effective in schools, and the use of visual effects can help prepare.
23	Shiwaku and Shaw (2008)[44]	Japan	Quantitative/ exploratory study/ questionnaire survey	Sample size: 1065 students/ 12 schools	Students were more aware of risk and readiness.
24	Adiyoso and Kanegae (2013)[45]	Japan	Quantitative/quasi-experimental-treatment and control/ questionnaire survey	239 students /The median student age was the same at 17 years old.	This program was effective in increasing knowledge and preparing for disasters.
25	Hayashi (2014)[46]	Japan/	Quantitative/ correlational – observational study/ questionnaire survey	Sample size: 548 students/ 10-13 years old	Disaster education in schools is effective but insufficient for students.
26	Issa et al. (2019)[47]	Jordan	Quantitative/quasi-experimental-treatment and control (intact groups)/ questionnaire survey	Students ages 10-12 completed in an earthquake-prone region of Jordan.	Disaster risk reduction training programs can improve students' understanding of risk, awareness, and attitudes toward preparedness.
27	Kanyasan et al. (2018)[48]	Lao PDR	Qualitative	Total 869 grade 7 students	Lack of sufficient rules is the biggest reason for the failure of children's preparation programs.
28	Baytiyeh (2014)[49]	Lebanon	Qualitative	Total 10 students and school managers	Schools need to be more involved in earthquake preparedness.
29	Shiwaku et al. (2007)[50]	Nepal	Quantitative/ exploratory study/ questionnaire survey	Total 452 students/6 schools/15-16 years old	Classrooms in schools can increase understanding of risk but not increase preparedness.

(*Continued*)

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Table 1. (*Continued*)

No.	Author(s)	Country	Method	Population	Finding
30	Tuladhar et al. (2014)[51]	Nepal	Quantitative correlational – observational study/ questionnaire survey	Sample size: 124 students /17 districts /10 to 18 years old	Training is not enough and it has not been possible to prepare.
31	Ronan and Johnston (2001)[52]	New Zealand	Quantitative/ Correlational – observational study/ questionnaire survey	Total 560; 258 female, 244 male/ 7 to 13 years	Education can increase children's resilience to natural hazards.
32	Finnis et al. (2010)[53]	New Zealand	Quantitative/ exploratory study/ questionnaire survey	Total 282 students/137 male and 135 female/ 13-18 years old	Readiness training is helpful, but some aspects of risk awareness and preparation are poor.
33	Ronan and Johnston (2003)[54]	New Zealand	Quantitative/ correlational studies	Total 219 /105 were female, 86 were male/11 to 13 years	Risk education seems to be useful and helps create more resilient children and communities.
34	Johnson et al. (2014)[55]	New Zealand	Qualitative study	Total 31 schools	The use of information technology and the integration of educational materials are effective in various subjects.
35	Tipler et al. (2017)[56]	New Zealand	Quantitative correlational – observational study/ questionnaire survey	Sample size: 355 schools/ (years 0–8; n = 274); secondary (years 9–13; n = 55); and other (years 0–13; n = 26)	Ambiguity in legal requirements for preparing children in schools.
36	Mutch and Gawith (2014)[57]	New Zealand	Qualitative study	Three schools	Schools play an important role in preparing children.
37	MacDonald et al. (2017)[58]	New Zealand	Quantitative correlational – observational study/ questionnaire survey	Sample size: n = 432/ages 10–11/girls	The students' visit to the museum by the schools was effective in preparing the children.
38	Tipler et al. (2017)[59]	New Zealand	New Zealand/ qualitative	The rules in schools are insufficient to prepare children for natural hazards.	
39	Johnston et al. (2011)[60]	New Zealand	Qualitative	Participants were 200 children/1-8 and 5-13 years of age.	The program increases children's preparedness for disasters.
40	Johnston et al. (2016)[61]	New Zealand	Quantitative/ correlational – observational study/ questionnaire survey	Ten full primary (ages 1-8 years), 5 contributing primary (ages 1-6), 1 composite (ages 1-13), 1 secondary (ages 9-13)	Obstacles include insufficient time, insufficient resources, and lack of teacher knowledge.
41	Ronan et al. (2012)[62]	New Zealand	Quantitative/quasi-experimental pretest–posttest designs/ questionnaire survey	Total 215 primary and intermediate students (52.6% female, 47.4% male)	Disaster education in schools should be part of community preparedness for disasters.
42	Shah et al. (2018)[63]	Pakistan	Quantitative/ exploratory study/ questionnaire survey	Sample size: students/ schools/ age and girls	More action is needed to prepare for a disaster.
43	Shah et al. (2020)[64]	Pakistan	Quantitative	Total 100 students of grade 5	Students need more awareness and training programs at school to increase their preparedness for floods.
44	Khan et al. (2020)[65]	Pakistan	Quantitative/ correlational study/ questionnaire survey	Total 486 high school students (51% male, 49% female)	Poor risk perception of high school students
45	Martins et al. (2019)[66]	Portugal	Quantitative/ correlational study/ questionnaire survey	Total 308 students in grade 9, ages 14-16 years	Students have difficulty understanding the concepts needed to prepare for disasters.
46	Cvetković et al. (2015)[67]	Serbia	Quantitative/ correlational study/ questionnaire survey	Total 3063 students, 1519 male, 1544 female, secondary school, grade 1 to grade 4	Students received information about disasters from school, television, and the media.
47	Chang and Chang (2010)[68]	Taiwan	Quantitative/2-group quasi-experimental design	Total 80 high school students	Curriculum module and group discussion activities were effective in learning achievement and attitude toward typhoon hazards mitigation.

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Table 1. (*Continued*)

No.	Author(s)	Country	Method	Population	Finding
48	Haulle (2012)[69]	Tanzania	Qualitative	Total 75 pupils from 6 schools	Traditional and modern technologies are more effective in preparing children for disasters.
49	Bosschaart et al. (2013)[70]	The Netherlands	Quantitative/ correlational study/ questionnaire survey	Total 617 students, age 15 (49% female, 51% male)	Students showed low flood-risk perception and they had a low level of flood-related knowledge. Fear, knowledge of flooding in the surroundings of the school, and the awareness of environmental cues were predictors of personal flood-risk perception.
50	Pinar (2017)[71]	Turkey	Qualitative study	Total 50 students (27 girls, 23 boys), average age 18 years	Disaster education must begin in the family and be developed through local municipalities and non-governmental organizations to raise awareness about disasters.
51	Mermer et al. (2018)[14]	Turkey	Quantitative/quasi-experimental pretest–posttest designs/ questionnaire survey	Total 1151 students, grades 6 and 7	The training made a significant difference in the level of knowledge about earthquake victims and family preparation programs.
52	Mermer et al. (2018)[72]	Turkey	Quantitative/quasi-experimental pretest–posttest designs/ questionnaire survey	Total 1151 students, 559 (48.5%) in grade 6 and 592 (51.4%) in grade 7	Targeted training has significantly changed the level of knowledge about earthquake victims and family disaster preparedness programs.
53	Clerveaux et al. (2010)[73]	Turks and Caicos Islands	Quantitative/quasi-experimental pretest–posttest designs	Sample size: 75 participants/ages 9-12 years	Training is effective in this way.
54	Ramirez et al. (2009)[74]	United States	Qualitative	Total 19 schools	Children are not prepared enough with the existing programs.
55	Johnson et al. (2014)[75]	United States	Quantitative/quasi-experimental pretest–posttest designs/ questionnaire survey	Total 574 students, ages 12-18 years	Children have a great deal of knowledge about earthquake protection measures.
56	Lownsbery and Flick (2020)[76]	United States	Qualitative	Total 12 students in grades 7 and 8	Results of this study indicated that geoscience curriculum about tsunami and earthquake should be accompanied with preparedness actions.
57	Sakurai et al. (2020)[77]	Japan	Mixed method/ correlational – observational study/ qualitative study	Total 515 students, grades 4 and 9	Disaster education was effective in short term and requires long-lasting efforts to cultivate children as "agents of change" to ensure they are disaster-resilient.
58	Noviana et al. (2020)[78]	Indonesia	Quantitative/quasi-experiment with a 1-group pretest-posttest design/questionnaire survey	Total 72 primary school students	Comic media was effective in disaster education of primary school students.
59	Andespa and Fauzi (2019)[79]	Indonesia	Quantitative/ descriptive study/ questionnaire survey	Total 30 senior high school students in the Mentawai island	Students had a high degree of disaster knowledge and low degree of early warnings preparedness.
60	Edler et al. (2020)[80]	Ecuador	Quantitative/ descriptive study/ questionnaire survey	Total 314 high school students (187 female, 127 male)	There are regional differences in students' knowledge about tsunamis. In addition, it was concluded that there is not a standard in the educational system of Ecuador to prepare students for tsunamis.
61	Yeon et al. (2020)[81]	South Korea	Quantitative/ correlational – observational study	Total 3316 middle-school and high-school students	It was indicated that disaster education after Pohang earthquake was effective because students were motivated to learn protective actions.

teaching disaster prevention is ineffective.[29,39,42,46,50,68] Some reviewed papers emphasized using different tools, for instance, technology-based visual resources and emergency equipment,[16,29,32,55,63,66,69] and dance-based education in schools.[36] Besides, developing disaster curricula and compulsory curricula, and designing special textbooks for children disaster education are of inevitable importance.[34] Cvetković et al. (2015) indicate that radio, video games, or stories told by family are not effective in

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Table 2. Results characteristics

Results Characteristics		Articles	Frequency	Percent
Continent	Asia	14,16,24-27,29,30,33-39,43-51,63,64,68,71,77-79,81	31	48
	Africa	24,25,31,69	4	6
	North America	73-75	3	5
	South America	28,80,82	3	5
	Europe	17,24,25,32,40-42,66,67,70	10	16
	Australia	24,52-54,56-62,75	12	19
Type of hazard	All hazards	14,18,24-29,31,33,35-42,44-46,48,50-54,56-59,63,66,69,71,73-75,78,79	40	63
	Earthquake	30,32,36,43,47,49,60,65,67,75,77,81	12	17
	Tsunami	16,61,62,75,77,80	6	9
	Landslide	34,65,82	3	5
	Typhoon	68	1	5
	Flood	64,65,70	3	2
Research method	Quantitative	16,18,24-33,35,36,38-48,50-54,56,58,60-68,70,71,73-75,77-81	50	81
	Qualitative	16,31,34,37,49,57,59,69,75,82	11	19
Age of participants	6-11 years	14,16,32,33,35-38,42,47,51,52,54,56,58,60-62,64,73,77,78,82	24	41
	12-18 years	18,24-32,35,39-41,43,45,46,48,50,51,53,56,61,63,65-68,70,71,74,75,79-82	35	59

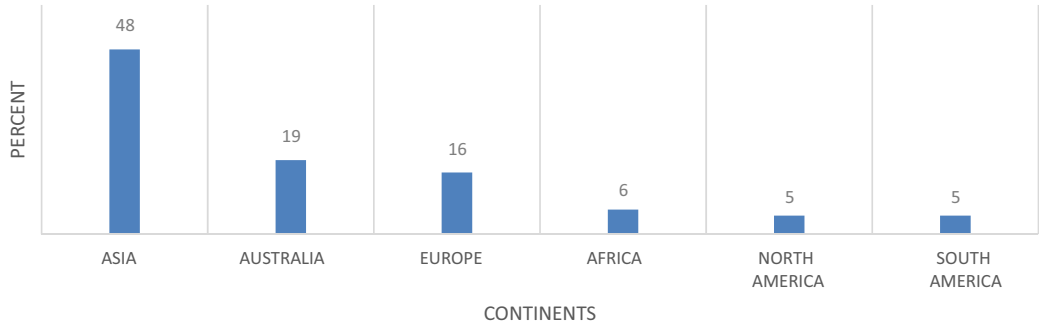

Figure 2. Comparison of students' education about natural hazards in various continents.

disaster education.[67] Moradian (2019) remarks in his study that disaster education by using games can be more effective than lectures.[39] The schools that are benefiting using the necessary equipment are facing some other issues, including the maintenance of these equipment, the quantity of tools, and the budget.[16] Bernhardsdottir et al. (2016) emphasize that the availability of equipment for earthquake preparedness causes the greatest difference among studied countries.[32] Researchers in reviewed studies suggest that lack of teaching resources has a great effect not only on student knowledge of disaster preparedness but also on the knowledge of teachers.[34,40,55,59,66] Bodas et al. (2019) found that disaster preparedness education improves student knowledge and preparedness even 6 months after the training.[41] However, Ramirez (2009) shows that drills and equipment do not improve school children's preparedness if it is performed poorly.[74]

Researchers in 8 studies argue that disaster education for children should not be limited to schools; they consider that different stakeholders, including families, communities, fundraisers, and teachers, should support school-based disaster education.[25,30,31,41,46,51,56,62] Codreanu et al. (2016) observe that the interactions of families and charitable organizations with schools have a significant influence on disaster risk education.[24] Other reviewed studies found that, although predictors such as national educational budget, national disaster program, school lessons, gender, ability to list examples of disasters, country's disaster risk index, and level of economic development are significant, they are insufficient to predict disaster knowledge and discussion among students.[24,25,71]

Description of Natural Hazards

Among 60 reviewed studies, as shown in Table 2, 40 studies applied the all-hazard approach and a specific natural hazard was not mentioned in their study. In addition, 11 papers researched about earthquakes, 6 papers focused on tsunamis, 3 studies on landslide preparedness, 3 studies on floods, and 1 study focused on typhoons preparedness among students.[64] Figure 3 shows the comparison of natural hazards education in schools according to reviewed articles.

Discussion

This study aimed to investigate disaster education programs in schools by reviewing the studies published in peer-review journals during 2000–2020.

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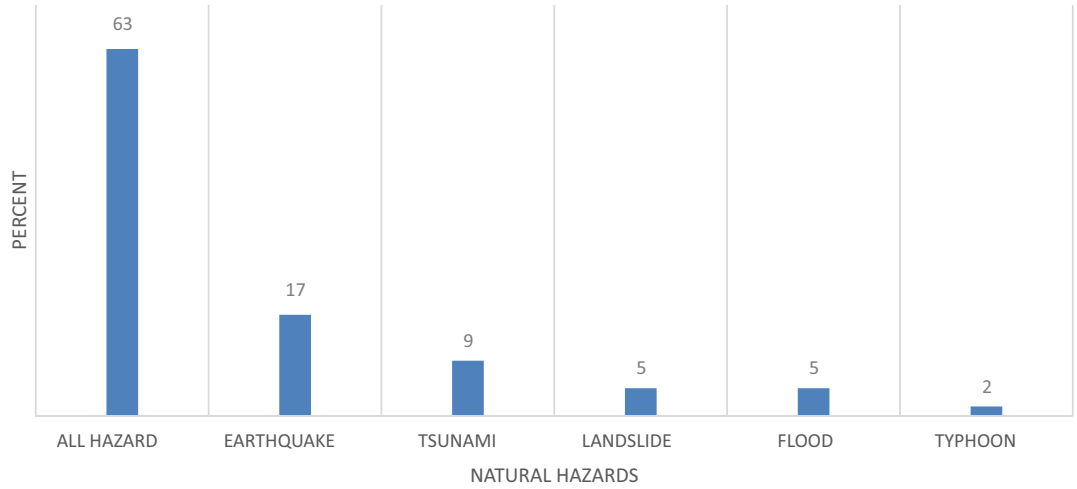

Figure 3. The comparison of natural hazards education in schools according to reviewed articles.

This study revealed that hazards education was not sufficient for disaster preparedness. Reviewed articles mentioned several challenges for student preparedness, including quality of education, teaching methods (ie, lecture and drill), learning materials, policy gaps and silences, and socioeconomic status.

Empowerment and Preparedness

One way to discuss these challenges of children's preparedness for disasters is through an empowerment perspective. Alsop et al. (2005) defined empowerment "as a group's or individual's capacity to make effective choices, that is, to make choices and then to transform those choices into desired actions and outcomes."[83,84] The capacity is influenced by agency (the child must be able to make purposeful decisions) and opportunity structure (institutions that influence children's behaviors and lead to the success or failure of their choices).[85] Children's agency can be predicted based on their assets, which include the accumulation of resources such as economic, social, psychological, educational, and emotional resources.[86]

To prepare children for disasters, it is necessary to pay attention to their access to various resources.[87] This article revealed that children's access to resources and materials for education was one of the determinants of their readiness. Psychological resources are another necessary asset for children's agency.[88] Another finding of this article was that children's perception of risk had a significant impact on children's preparedness for disasters. Children with low-risk perceptions were less prepared for disasters, even with the same natural hazards' education.

Another finding of our paper is that regulations and policies should be adapted to prepare children, and that standards should be considered by governments for educating students in different areas. Empowerment on this issue emphasizes that the structure of opportunity should provide this situation.[89] Challenges of children's preparedness in this article in terms of opportunity structure include short-term education (natural hazards' education was not sustainable), insufficient budget allocation, lack of proper curriculum, and lack of proper teacher training.

This approach emphasizes that empowerment must take place at various levels, including the individual, family, community, national, and international.[90] This article revealed that children's preparedness is a challenge that needs to be improved with only individual-level interventions. The reviewed articles suggested that educational programs at the family and community levels should also be defined to prepare children for disasters. In this case, these interventions will be more effective.

Natural Hazards' Education and Disasters' Preparedness

This review indicates that, although school-based disaster education can raise awareness of children, it will not necessarily lead to disaster preparedness of children. Researchers mentioned several factors affecting disaster preparedness, including risk perception,[91] available resources,[30,92] self-efficacy,[93] and community participation.[94] In lessons learned from previous studies, knowledge, perception, comprehension, and actions were found to be vital to disaster education of children.[95] Family, community, and self-education are 3 main factors in the comprehension of knowledge and preparedness.[96] An important issue revealed in the reviewed papers is the methods of education. Lectures in class and reading textbooks may raise awareness only when they come accompanied by practical education (eg, equipment, games, and multimedia).

This study revealed that, in some countries, disaster education was not reflected properly in national policies. It was indicated that an effective disaster education for children needs to a holistic education in different levels and policy integration.[95] In the OECD Policy Handbook on Natural Hazard Awareness and Disaster Risk Reduction Education, a long-term and sustained strategy was emphasized by governments for disaster education. In addition, risk awareness and risk education should be integrated into national policy with collaborating different sectors at different levels.[97]

Education Resources

Using equipment for disaster education is identified as an important factor for children preparedness. Disaster preparedness should be presented in different levels, including individual, family, community, and national levels. For example, in Cuba, implementing national hurricane preparedness programs for people, including children, resulted in an enormous decrease in the number of casualties. Children learned about early warning, evacuation, and safety via school-based education, media, and their families.[98] On the other hand, it seems that, in many countries, special textbooks are not designed to be used in schools and therefore results in poor awareness. Continuity of disaster education is another factor for better preparedness.

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Social Determinants of Inequality in Disaster Preparedness

Results of this study show that preparedness of boys is higher than that of girls, whereas girls have more awareness than boys. This could also be influenced by the sociopolitical context. More research on gender differences of children disaster preparedness is needed in order to better understand the possible gender differences in disaster impacts. In a systematic review of literature with investigating 60 000 survivors of disasters, female survivors were found to be more adversely affected, especially having posttraumatic stress disorder (PTSD) and other disorders.[99] Another systematic review about gender differences in children's mental disorders after earthquakes in Iran found that girls reported symptoms of PTSD more than boys, except anger symptoms.[6]

When it comes to the mutual relation of age and preparedness, there are no solid findings for a concrete conclusion. Most papers studying school-based disaster preparedness focused on teenagers, and only a few papers dealt with earlier ages. However, one cannot conclude from the studies that there are fewer disaster education programs for children of ages 5-11, although it may be realized as an alarm. Age factor is important because many children between 5 and 11 years old, especially in developing countries, are caught in disasters and it is vital to teach them how to prepare for disasters in schools.

The geographic distribution of school-based disaster education varied. Studies in America were less than in other continents, and only 3 papers in America focused on school-based disaster education. It seems that the number of studies on children's disaster preparedness in North America, South America, and Africa is less than that in Asia, Europe, and Australia. Reports indicated that flooding was the first cause of mortality by disasters in South Africa, South America, and South of Asia.[100] The storm has been the deadliest disaster during the last decade in North America.[100] These statistics reveal that focusing on children's preparedness is important, especially in disaster-prone countries. Investigating articles about preparedness based on geographical region is relevant because the pattern of disaster strike is different around the world. Natural hazards had the most human impact in Asia.[101] The death comparisons by natural hazards in Asia were 50.2%, America, 35.4%; Europe, 9.6%; Africa, 4.5%; and Oceania, 0.2%.[101]

Natural Hazards

The method of investigation of disaster is important because some preparedness knowledge and skills are specific to a certain disaster. Between 2008 and 2018, a near 348 natural hazards occurred globally per year.[101] Flood was the most prevalent natural hazard, occurring 153 times during these years. Next prevalent disaster was hurricanes, which happened 101 times, then earthquake, extreme temperature, landslide, drought, wildfire, volcanic activity, and mass movement (dry).[101] Earthquake was the deadliest natural hazard between 2008 and 2017 with 35 197 deaths, storm was next with 16 762 deaths, then extreme temperature with 7388, flood with 5039, and drought, landslide, wildfire, volcanic eruption, and mass movement (dry) with the least fatalities.[101] The number of people affected by natural hazards who needed help was different.[101] Drought affected an average of 73.9 million people between 2008 and 2017; flood, 73.1 million people; storm, 9 million; earthquake, 8.3 million; landslide, 0.3 million; volcanic activity, 0.2 million; wildfire, 0.1 million; and mass movement (dry), 0.1 million people.[101]

Limitation

In this study, we included English language papers published in peer-review journals. However, there are other related articles that were published in other languages that we couldn't translate.

Conclusion

This systematic review revealed that school-based disaster education raises the awareness but does not necessarily result in children preparedness. Different methods in disaster education should be used, and continuity in education is vital for preparedness education to children. Lecture and reading textbooks for disaster education are not effective in themselves, and these methods should come together with disaster exercises and drills. Using different tools and equipment is vital for disaster preparedness. Comprehensive and exclusive textbooks of school-based disaster education are required for better results. School-based disaster education should be an integral part of community-based disaster preparedness programs.

There is little evidence indicating how schoolchildren's disaster knowledge is influenced by some elements, including gender, diversity, and socioeconomic position. Therefore, more investigation is required for applying preparedness education to protect different groups of children form disasters. Also, more research on children's disaster preparedness should be carried out in North America, South America, and Africa.

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