



REVIEW ARTICLE

# Interventions to reduce accidents in childhood: a systematic review<sup>☆</sup>



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## KEYWORDS

Injuries;  
Accidental injuries;  
Childhood;  
Experimental studies

## Abstract

**Objective:** To review the literature on interventions planned to prevent the incidence of injuries in childhood.

**Source of data:** The PubMed, Web of Science, and Bireme databases were searched by two independent reviewers, employing the single terms *accidents*, *accident*, *injuries*, *injury*, *clinical trial*, *intervention*, *educational intervention*, and *multiple interventions*, and their combinations, present in the article title or abstract, with no limits except period of publication (2006–2016) and studies in human subjects.

**Synthesis of data:** Initially, 11,097 titles were located. Fifteen articles were selected for the review. Eleven were randomized trials (four carried out at the children's households, five in pediatric healthcare services, and two at schools), and four were non-randomized trials carried out at the children's households. Four of the randomized trials were analyzed by intention-to-treat and a protective effect of the intervention was observed: decrease in the number of risk factors, decrease in the number of medical consultations due to injuries, decrease in the prevalence of risk behaviors, and increase of the parents' knowledge regarding injury prevention in childhood.

**Conclusion:** Traumatic injuries in childhood are amenable to primary prevention through strategies that consider the child's age and level of development, as well as structural aspects of the environment.

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**PALAVRAS-CHAVE**

Acidentes;  
Lesões acidentais;  
Infância;  
Estudos  
experimentais

**Intervenções para redução de acidentes na infância: revisão sistemática****Resumo**

**Objetivo:** Revisar a literatura sobre intervenções voltadas à prevenção de acidentes na infância. **Fonte dos dados:** As bases PubMed, Web of Science e Bireme foram rastreadas por dois revisores independentes, utilizando os termos *accidents, accident, injuries, injury, clinical trial, intervention, educational intervention e multiple interventions*, e suas combinações, presentes no título ou resumo do artigo, sem limites, exceto o período de publicação (2006-2016) e estudos realizados em humanos.

**Síntese dos dados:** Foram localizados inicialmente 11.097 títulos. Foram selecionados 15 artigos para esta revisão, dos quais 11 eram ensaios randomizados (quatro realizados em domicílios, cinco em serviços de saúde e dois em escolas) e quatro, ensaios não randomizados realizados em domicílios. Quatro dos estudos randomizados foram analisados por intenção de tratar e mostraram efeito favorável da intervenção: redução de fatores de risco para acidentes, diminuição do número de atendimentos médicos por acidentes, menor frequência de comportamentos de risco e maior conhecimento dos pais sobre prevenção de acidentes na infância.

**Conclusão:** As lesões traumáticas na infância são passíveis de prevenção primária por meio de estratégias que levem em conta a idade e o nível de desenvolvimento da criança, bem como aspectos estruturais do ambiente.

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**Introduction**

Accidents are a global health problem and the leading cause of death in children and young adults in almost all countries.<sup>1</sup> It is a growing problem, involving years of potential life lost, as it affects mostly the younger population.<sup>2</sup> Most childhood accidents include traffic accidents, falls, burns, drownings, poisonings, and intoxications,<sup>3</sup> ranging from temporary physical incapacity to more severe and permanent sequelae, or even death.<sup>4</sup> Data from the Brazilian Ministry of Health regarding the years 2013 and 2014 showed that 122,000 injured children were hospitalized in Brazil; in all age groups, the main cause was accidents involving falls.<sup>5</sup> A total of 4578 children, aged between 0 and 14 years, died of accidents and R\$ 83 million were spent by the Brazilian Unified Health System to cover expenses with the victims.<sup>5</sup>

Childhood accidents result from an interaction between genetic, behavioral, and environmental factors, as well as parental characteristics.<sup>6-8</sup> A study carried out in southern Brazil showed that accidents occur more frequently in boys.<sup>9</sup> Effective preventive measures include a wide range of approaches. A model proposed by the World Health Organization in 2008 includes: (a) prevention of new injuries (primary prevention); (b) reduction of injury severity (secondary prevention); and (c) decreased frequency and severity after an injury (tertiary prevention).<sup>1</sup>

Given the high incidence and severe potential morbidity of the accidents, this study aimed to review the literature in search of interventions aimed at their prevention.

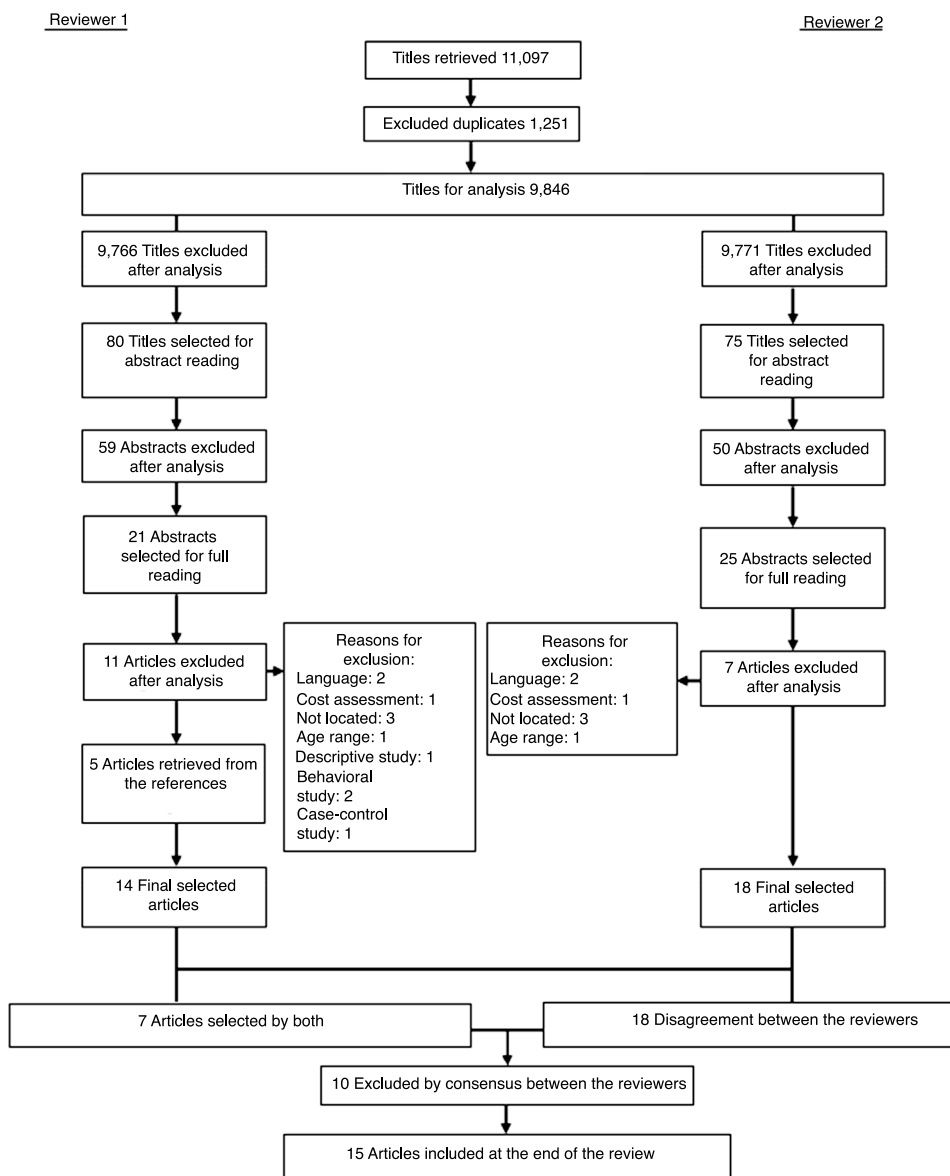
**Methods**

A systematic review was carried out in the international databases PubMed and Web of Science, as well as in the Latin

American and Caribbean database (Bireme). The terms used in the search were: accidents, accident, injuries, injury, clinical trial, intervention, educational intervention and multiple interventions, and their combinations, present in the article title or abstract. In the Web of Science and Bireme databases, which did not allow selecting the studied population by age, the following terms were added: newborn, child, infant, and preschool. The last search update was performed on December 9, 2016. After limiting the search for articles regarding studies with human subjects only, the number of identified publications was over 20,000 articles. Thus, the search limitation of articles published in the last 10 years was added. The eligibility criteria included: experimental studies, carried out with children and/or adolescents aged 0–18 years, with aiming to prevent the occurrence of accidents in childhood/adolescence, published from January 2006 onwards. Articles on interventions to prevent accidents in physical education classes, during the practice of sports (such as riding a bicycle, scooter), in traffic, or during activities capable of causing specific traumatic injuries (such as nose or limb fractures), were excluded after reading the titles.

The literature review was independently carried out by two reviewers, from the search in the databases, to the reading and selection of titles, abstracts, and full articles. At the end of the selection, disagreements were settled by consensus between the two reviewers. All references to the selected articles were verified to find other studies eligible for this review that had not been retrieved during the previous process. The references of systematic reviews and meta-analyses published on the topic were also reviewed.

Information was extracted from the articles selected for the review, regarding year and country of publication, participants' selection criteria, who applied the intervention, who underwent the intervention, losses to follow-up,

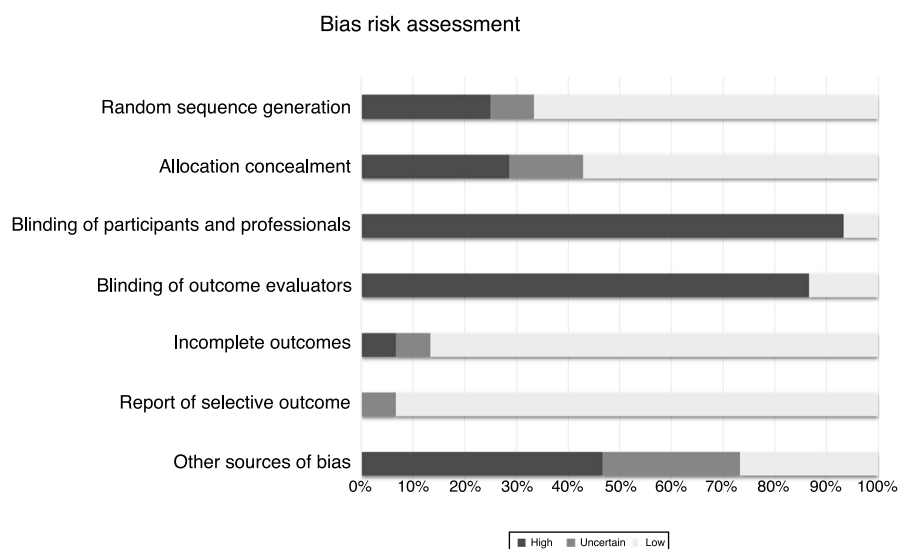


**Figure 1** Flowchart of the systematic review process.

time elapsed between intervention and outcome evaluation, blinding process, assessed primary and secondary outcomes, and magnitude of effects. Finally, the methodological quality of each study was evaluated through a risk assessment tool suggested by the Cochrane Library, consisting of seven domains,<sup>10</sup> applicable to randomized trials, non-randomized trials, and controlled before-and-after studies. The domains evaluated as low, high, and uncertain risk for biases include: (1) random sequence generation; (2) allocation concealment; (3) blinding of participants and professionals; (4) blinding of outcome evaluators; (5) incomplete outcomes; (6) report of selective outcome; and (7) other sources of bias.

## Results

A total of 11,097 titles were retrieved (3673 in PubMed, 5988 in Web of Science, and 1436 in Bireme), of which 1251 were duplicates. After exclusions, 9846 titles were selected for reading. Based on the eligibility criteria, reviewer 1 excluded 9766 titles and reviewer 2, 9771 titles (Fig. 1). After 80 and 75 abstracts were read by reviewers 1 and 2, respectively, 14 articles were selected by reviewer 1 and 18 articles by reviewer 2. The screening of these articles' references resulted in the addition of four articles, which were maintained after being read in full. A total of seven articles were concordant between the two reviewers, and



**Figure 2** Bias risk assessment in selected intervention studies.

18 were discordant. At this stage, the authors entered a consensus and excluded 10 articles, and 15 were included in this systematic review.

The evaluation of the articles' methodological quality showed that the most frequent preventable risk of bias was the non-blinding of the outcome evaluators, observed in 13 of the 15 studies (87.0%; Fig. 2). Blinding of the participants and professionals who applied the intervention was not possible, as they were educational interventions.

All 15 articles were published in English. Four studies were carried out in the United States,<sup>11–14</sup> four in Canada,<sup>15–18</sup> two in South Africa,<sup>19,20</sup> followed by one each in England,<sup>21</sup> Sweden,<sup>22</sup> India,<sup>23</sup> the Netherlands,<sup>24</sup> and Iran.<sup>25</sup> Most were randomized trials.<sup>12–15,17–21,24,25</sup> Most interventions were applied only to parents,<sup>11–17,22–25</sup> two studies applied them to parents and children,<sup>19,20</sup> and two others, only to the children.<sup>18,21</sup> As for the sample size, the number of participants ranged from 62<sup>11</sup> to 1292.<sup>24</sup> The intervention site included households,<sup>11,13,15,16,19,20,22,23</sup> healthcare services,<sup>12,14,17,24,25</sup> and schools.<sup>18,21</sup>

Table 1 describes some of the characteristics of the selected articles: author/country, objective, intervention content, what type of intervention the control and the intervention groups received, sample size (*n*), and results. The next sections will briefly present the characteristics according to the type of study (randomized or not) and intervention site.

## Randomized trials

Among the 11 randomized studies, four were performed in households,<sup>13,15,19,20</sup> five in healthcare services,<sup>12,14,17,24,25</sup> and two in schools.<sup>18,21</sup>

## Interventions performed in households

Swart et al.<sup>19</sup> evaluated the effectiveness of an intervention program aimed at reducing household risks for childhood

traumatic injuries. At the baseline assessment, a questionnaire was applied to assess the risk of traumatic injuries at the household. Participants of the intervention and control groups received safety devices, such as safety locks and container lids with paraffin, together with demonstrations on how to use each of them. The intervention group received four visits after the baseline visit by trained professionals to instruct parents/caregivers on the prevention of specific injuries, such as burns, intoxications/poisoning, and falls, as well as to perform home inspections to identify sources of risk for the traumatic injuries being assessed. The evaluated outcomes were risk factors for paraffin and electric burns, safety practices against burns, intoxication/poisoning, and falls. Risk reduction was observed only for safety practices related to burns (mean of the control group = 2.5; mean of the intervention group = 2.9). The study showed a low risk of bias, and the only domains considered as having a high risk of bias were those related to the blinding of participants and outcome evaluators.

Odendaal et al.<sup>20</sup> evaluated the effectiveness of a program aimed at reducing household risks for burns, intoxication/poisoning, and falls. The intervention included four home visits (child development, prevention of burns, intoxication/poisoning, and falls). Materials related to the topics were given to the parents and, in order to get the children involved, images for coloring were provided, illustrating the typical dangers of the household for each type of injury. Parents/caregivers were encouraged to introduce changes in behavior and in the environment through a checklist containing the household hazards. Safety devices, such as electrical insulation tape and nails to fix electrical cables, containers with lids and labels for paraffin storage, and bags to keep toxic substances safely out of reach were provided. At the end of the intervention, the families from the control group received a visit during which the same information and at least one of the safety devices given to the intervention group were offered to them. The assessed outcomes included household risks associated with burns, intoxication/poisoning, and falls. The families of the

**Table 1** Characterization of the according to the intervention site to reduce childhood accidents.

Author/country	Objective	Intervention	Controls	Sample	Results
<i>Randomized studies carried out at the household</i>					
Swart, <sup>19</sup> 2008; South Africa	To evaluate the effectiveness of the Home Visiting Program (HVP) in the reduction of household risks for injuries related to burns, intoxications, and falls in children aged $\leq 10$ years.	IG received safety devices (safety locks and paraffin container caps) with demonstrations on how to use each one. Four visits were carried out by trained professionals to instruct parents/caregivers on the prevention of specific traumatic injuries, such as burns (by paraffin and electric), intoxications/poisonings, and falls, as well as to perform home inspections to identify sources of risk for the assessed injuries.	The CG received the visit at the baseline and at the outcome evaluation, when the same devices that the IG received were delivered.	Households visited = 731 Eligible = 515 Participated = 410 Lost = 33 Completed the study = 377 (189 from IG and 188 from CG)	Reductions were observed for the risks of traumatic injuries related to safety practices for burns. At the baseline, IG showed a mean of 3.4 risks and after the intervention, this mean value decreased to 2.5 ( $p$ -value = 0.02).
Odendaal, <sup>20</sup> 2009; South Africa	To evaluate the effectiveness of the Home Visiting Program (HVP) in a community with similar socioeconomic characteristics as the Swart study (2008), <sup>20</sup> verifying whether there was a decrease in the household risks associated with burns, intoxication, and falls.	Visit 1 (Assessment of child development): Caregivers were provided with information on child development stages, household hazards, and emergency treatment for traumatic injuries; Visit 2 (Assessment of burn risks): caregivers received information about the risks for burns at home; Visit 3 (Assessment of intoxication and poisoning hazards): information on the risk of intoxication and poisoning at home was passed on to the caregivers; Visit 4 (Assessment of falls hazards): Families received a first aid kit.	There were no visits.	Eligible households = 391 Visited = 265 Excluded = 54 Randomized = 211 (99 CG and 112 IG) Completed the study = 91 CG and 101 IG	A reduction in the risks associated with the use of electrical appliances and paraffin (candles?) was observed, as well as those related to poisoning. Differences were observed for total burns between IG (mean = 12.4) and CG (mean = 14.3) and poisonings (IG mean = 2.0 and CG mean = 4.0).

Table 1 (Continued)

Author/country	Objective	Intervention	Controls	Sample	Results
Phelan, <sup>13</sup> 2011; USA	To test the efficacy of safety devices installed at home to reduce risks related to traumatic injuries in childhood.	Subjects received instructions based on the The Injury Prevention Program of the American Academy of Pediatrics. During a home visit, interviewers showed safety products to the families. After this stage, the interviewers installed all safety products when the family agreed.	Subjects received only general information about child development provided by the American Academy of Pediatrics on the Injury Prevention Program.	Eligible = 1,263 Baseline = 413 Randomized = 355 (181 IG and 174 CG) Completed the study = 167 IG families and 159 CG families.	Risks for <i>traumatic injuries</i> decreased in the households of the IG, but not in the controls between the 12th and 24th months of the study. At the 12-month visit, the same risks decreased by 15% in IG when compared with CG. At 24 months, only the mean number of hazards remained significant in the IG. The rate of injuries treated by health professionals at the end of the study was reduced by 2.3/100 children in the IG and 7.7/100 children in the CG.
Babul, <sup>15</sup> 2007; Canada	To test the efficacy of the safety kit intervention to promote parental safety behaviors and reduce childhood traumatic injuries.	Both groups received: (1) Safety kit + a home visit: walking around the house and identifying potential risks; when the latter were identified, parents were taught to remove or modify them (2) Safety kit only: no home visit. * Kit contents: smoke alarm, 50% discount for a safety gate, table corner guards, cabinet locks, and bearings for loose cables.	Received the standard service offered by the health unit for families with newborns (growth assessment, information and advice on feeding, child development, and vaccination).	811 parents were eligible; of these, 600 agreed to participate in the study. 483 parents (80.5%) completed the questionnaires in the three follow-up periods.	Of the 14 safety behaviors, an increase in the rate of use was observed for two of them among the parents of the IG. In the IG that received only the safety kit, 69.3% reported being careful regarding the water temperature. vs. 53.7% in the CG (OR = 2.21 95% CI: 1.32–3.69). In the IG that received a safety kit + home visit, both at the six-month visit (OR = 2.25 and 95% CI: 1.37–3.71) and at the 12-month visit (OR = 2.6 and 95% CI: 1.57–4.46), an increase in care related to water temperature was observed.

Table 1 (Continued)

Author/country	Objective	Intervention	Controls	Sample	Results
<i>Randomized studies carried out in healthcare services</i>					
Pless, <sup>17</sup> 2007; Canada	To determine how much posters in physicians' offices alert parents to the dangers associated with strings or cords (strangulation) and whether changes in behavior occur when they are alerted. Assess the parents' knowledge of the "Health Canada" site and document other sources of information on safety.	Intervention week: two posters were placed in the waiting rooms of the physicians' offices (one on the dangers of curtain ropes and the other on garment strings) about the risk of strangulation.	Control week: no procedure was done.	Selected medical practices = 115 Refusals = 28 Did not respond = 64 Total number of participating medical practices = 23 Selected parents = 1188 Parents who agreed to participate = 940 Interviewed parents = 808	No differences were observed between the changes reported in poster-related behaviors. Even after adjusting for the socioeconomic level, no differences were found. None of the parents mentioned the posters, websites, or pediatricians as the main source of information on dangerous products.
Gielen, <sup>12</sup> 2007; United States	To evaluate a theory based on an intervention called "Safety in seconds," providing parents with knowledge about child safety, use of the car seat, smoke alarm, and storage of products that cause poisoning.	A questionnaire with 10 to 12 items, which assess child safety, was implemented on a computer in a kiosk. Based on the parents' responses, a report was printed and delivered with safety information. The report contained the child's name, ethnicity, and age, and was adapted to the parents' profile. Parents with good safety behavior were given incentives in the report.	Subjects answered a questionnaire, with the same duration of the IG, on overall demographic and child health issues. At the end of the tool, they received printed information about the family's behavioral profile, identified with the child's name.	Eligible parents = 1412 Excluded = 239 Refusals = 201 Losses = 69 Interviewees = 901 (448 in the IG and 453 in the CG).	The subjects in the IG group had a higher knowledge score, which were related to smoke alarms (mean = 82.5 ± 23.6) and to toxic product storage (mean = 81.2 ± 21.6), as well as a higher total score = 72.6 ± 13.9).

Table 1 (Continued)

Author/country	Objective	Intervention	Controls	Sample	Results
Nansel, <sup>14</sup> 2008; United States	To evaluate the effectiveness of information transmission on traumatic injury prevention to parents and to parents and physicians regarding the implementation of safety practices (age-appropriate behaviors and devices recommended by the American Academy of Pediatrics).	Subjects received personalized information (with the child's name) aimed at the prevention of traumatic injuries to parents (T-IPI), as well as material for the children. They also received motivational messages about safety practices. Information given to parents plus personalized supplemental material with additional information (T-IPI + P): the abovementioned information and one page including charts with traumatic injury risk scores for each of the six addressed areas. The interviewers encouraged parents and reinforced their importance in behavior changes.	Generic injury prevention information given to parents (G-IPI) according to the child's age.	Invited parents = 892 Accepted = 601 Completed the baseline questionnaire = 594. Group G-IPI: <i>n</i> = 98 (90 losses) Group T-IPI: <i>n</i> = 107 (85 losses) Group T-IPI + P: <i>n</i> = 100 (121 losses).	Parents who received T-IPI or T-IPI + P were more likely to report the use of preventive behaviors for new traumatic injuries than those in the G-IPI group (T-IPI = 48.6%; T-IPI + P = 45.0%, G-IPI = 31.6%); these effects were higher in parents with higher educational level.
Cheraghi, <sup>25</sup> 2014; Iran	To evaluate the effect of the Health Belief Model (HBM) related to education on maternal knowledge, attitudes, and practices to increase safety and prevention of traumatic injuries in children under 5 years of age, focusing on prognostic factors and safety behaviors.	One-hour sessions were held two times/week. The focus of the sessions were the factors present at home that affected maternal practices and knowledge, as well as the perception of severity, barriers, cues for action, and self-efficacy on child safety. The sessions consisted of presentations with drawings and images and, in the end, a discussion occurred.	The authors did not mention what was done in the control group.	Participants = 120 Refusals = 9	The mean difference in knowledge, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues for action, self-efficacy, and practices after the intervention between the two groups were 3.98, 3.57, 3.97, 1.57, -7.08, 0.82, 2.95, and 2.47, respectively.



Table 1 (Continued)

Author/country	Objective	Intervention	Controls	Sample	Results
Van Beelen, <sup>24</sup> 2014; The Netherlands	Assess the effect of the E-Health4Uth Home Safety Program on parents' safety behaviors regarding prevention of falls, poisoning, drowning and burns.	They received the usual care of newborn care clinics and, in addition, a username and password to access a website and answer questions about safety behaviors regarding prevention of falls, poisoning, drownings, and burns. On the following visit to the clinic, the parents had the opportunity to discuss the internet approach with a healthcare professional.	They received the usual care at the newborn care clinic with the usual health information	Baseline = 1409 Completed follow-up = 1292 (687 from CG and 696 from IG)	The IG was less likely to have unsafe behaviors, when compared with the CG regarding: stored cleaning products (30.33% vs. 39.91%, OR = 0.67, 95% CI: 0.53–0.85); water temperature of the child's bath (23.46% vs. 32.25%, OR = 0.65, 95% CI: 0.51–0.84); ingestion of hot liquids (34.84% vs. 41.73%, OR = 0.76, 95% CI: 0.61–0.96); and access to stoves (79.34% vs. 85.27%, OR = 0.67, 95% CI: 0.50–0.90).
<i>Randomized studies carried out in schools</i>					
Kendrick, <sup>21</sup> 2007; England	To evaluate the efficacy of the Risk Watch program on the increase in safety knowledge, skills, and self-reported safety behavior.	Teachers, trained by firefighters, delivered Risk Watch leaflets (specific to each age group) with a brief introduction, lessons and activities for their students. Each leaflet covered eight topics, four of which were chosen for evaluation (bicycle and pedestrian safety, falls, intoxications/poisonings, fire and burns). They also offered "Risky Boxes" with extra materials for the lessons.	The GC schools also participated in the same program, but in a period after the IG.	Selected schools = 22 Refusals = 2 In total, 20 schools and 459 children (7–10 years old) participated in the trial.	The IG children correctly answered more questions about fire and burn prevention knowledge than those of the CG (difference between averages = 7.0%, 95% CI: 1.5–12.6%). IG children were more prone to show correct actions in case of fire, regarding clothing and use of helmets (difference between averages = 35.3%, 95% CI: 22.7–47.9% and 6.3%, 95% CI: 1.4–11.1%, respectively). They were also more prone to show correct actions in case of fire at home and when finding medications (OR = 2.80; 95% CI: 1.08–7.22 and OR = 3.50 95% CI: 1.18–10.38, respectively).

Table 1 (Continued)

Author/country	Objective	Intervention	Controls	Sample	Results
Morrongiello, <sup>18</sup> 2007; Canada	To evaluate the impact of an intervention to reduce risk behaviors regarding falls in playgrounds, in children aged 6–10 years.	There were three intervention sessions: Session 1: colored pictures were shown to the children, with child actors performing two of each of the risk behaviors (moderate and high risk), who had received training on how to perform the assessed behaviors before being photographed. Six photos were produced for each equipment (two without risk, two moderate, and two high risk), comprising a set of 24 pictures to create posters. Session 2: Videos with children playing in the playground equipment and generating falls were shown to the children participating in the study. Session 3: The posters made in Session 1 were shown and children were allowed to change and decorate the pictures; it was also recalled that they would have to go to the playground once again and perform the behaviors.	Subjects underwent only sessions 1 and 3.	GI = 191 GC = 67	A decrease in the risk behaviors was observed in the IG when compared with the CG, mainly regarding those of medium and high risk (mean = 1.04 and 1.49, SD ± 1.89 and ± 2.50, respectively, <i>p</i> -value < 0.001).

Table 1 (Continued)

Author/country	Objective	Intervention	Controls	Sample	Results
<i>Non-randomized studies carried out at the household</i>					
Cagle, <sup>11</sup> 2006; United States	To evaluate the efficacy of the intervention program called "Children Safe at Home Project"	Participants attended 1-to-2-hour lectures on scalding burns, using pictures and images. Afterwards, a discussion was held on how to prevent scalding burns at home. A bingo game about home safety and a game of scoring the risks at home were applied to parents. At the end of the lectures, parents were given a refrigerator magnet with preventive measures for burns and burn treatment. At the first home visit, anti-scalding burn devices were installed.	None.	Selected = 900 Accepted to participate in the study = 173 Completed the study = 62	The initial study visit disclosed an average of seven (SD ± 2) scalding burn risks per household. During the follow-up period, this average decreased to two (SD ± 1). Anti-scalding burn devices were installed in 37 homes and remained in 60% of households. Prior to the program, the admission rate in hospitals for burns among children aged 0–5 years was 137/100,000 and, after the program, it decreased to 59/100,000. No new scalding burns were observed in the houses that participated in the program.
Carlsson, <sup>22</sup> 2011; Sweden	To investigate to what extent information given to mothers individually in low educational settings can improve precautions (taken by mothers) to prevent burns involving young children at home and compare with a group of mothers who did not receive any information.	Mothers were invited to participate in workshops with other mothers. The workshops focused on discussing how to prevent traumatic injuries caused by scalding and burns incidents at home. Mothers were led to reflect on precautions in descending order of risk. Later, the mothers received a single home visit to teach them about prevention of childhood injuries at home.	Did not participate in the workshops, but received the home visit.	Agreed to participate = 100 (50 in IG and 49 in the CG (1 loss)  At the end, 39 individuals from IG and 31 from the CG remained.	The results showed that the intervention had an impact on the improvement among the participating mothers' precautions against burns related to stove protection and stove fixation to the floor (OR = 3.08, 95% CI: 1.1–8.7 and OR = 2.3, 95% CI: 0.8–6.6, respectively) in relation to the CG.

Table 1 (Continued)

Author/country	Objective	Intervention	Controls	Sample	Results
Jetten, <sup>23</sup> 2011; India	To measure the efficacy and use of the burn prevention program among young children in Indore, India.	Information film, which was delivered to the families after the intervention. A playpen was given to families who lived in a single room and cooked in it and a baby safety gate was given to those who had rooms separate from the kitchen.	None.	Participated in the study = 42 families Losses = 8 Included in the analysis = 34	A decrease in burns was reported: 18 burns occurred before the intervention and after, only two. Home hazard situations also decreased.
Stewart, <sup>16</sup> 2016; Canada	To evaluate the Home Safety Program (HSP) for injury prevention in children up to 2 years of age.	The intervention consisted of delivering a kit with nine safety products to parents, a checklist for parents to evaluate their home, and a video entitled: "Give your child a safe start."	No controls were mentioned.	Invited parents = 3458 Answered the questionnaire = 696	81% of the parents considered the electrical outlet plugs as being the most useful product in the kit, followed by water thermometers. 95% used measures to reduce risks. The most common risks reported were electrical outlets, followed by stairs, cabinets, and drawers.

IG, intervention group; CG, control group; CI, confidence interval.

intervention group showed a greater reduction in the risk profile when compared with the control group; the risk of burns accounted for over 50% of this reduction. Only the two domains related to the blinding process showed a high risk for bias.

Phelan et al.<sup>13</sup> aimed to test the effectiveness of safety devices in reducing the risk of traumatic injuries in children up to 3 years of age. A home visit was carried out by trained interviewers to show the household hazards and deliver the safety items. After the interview, all safety items allowed by the families were installed. The families from the control group received only general information about childcare from the American Academy of Pediatrics' trauma prevention program. The risks evaluated in the households were bath water temperature above 49°C; absence or malfunction of smoke alarms; cabinets, drawers, stairs, or medicines accessible to children; and unstable television furniture or racks, among others. The outcome included the occurrence of traumatic injuries treated by a healthcare professional. The mean risk in the intervention group decreased during follow-up (−10% at 12 months and −15% at 24 months) when compared with the control group. The injury rate was reduced by 70% in children from the intervention group (2.3 injuries per 100 children in the intervention group, 7.7 injuries per 100 children in the control group). Blinding of participants was the only assessed item with a high risk for bias.

Babul et al.<sup>15</sup> applied an educational intervention to parents of children aged 2–12 months to promote safe behaviors and reduce traumatic injuries in childhood. The control group received the standard care given by the healthcare service to newborn families. Three groups were set up: one group received a safety kit and a home visit; another group received only the safety kit; and a control group. The safety kit consisted of a smoke alarm, 50% discount on the purchase of a baby safety gate, table and cabinet corner guards, safety locks for cabinets, and bearings for loose cables. The home visit included a home assessment to identify potential risks for traumatic injuries, accompanied by a recommendation to remove or modify the risk behavior. Parents' self-reported safety behaviors, risk removal, use of safety kit items, parents' attitudes in relation to injuries, and the occurrence of traumatic injuries were assessed. When comparing the intervention group (safety kit + visit) with the control group at 6 and 12 months, the odds ratio (OR) was higher for the bath water temperature adjustment in the intervention group (6 months: OR = 2.25, 95% CI 1.37–3.71 and 12 months: OR = 2.6, 95% CI 1.57–4.46). No differences were observed in traumatic injury rates among the three evaluated groups. Among the evaluated domains, the blinding of the participants and outcome evaluators were the only ones classified as having a high risk for bias.

### Interventions performed in healthcare services

Pless et al.<sup>17</sup> carried out a randomized crossover trial aiming to assess the effectiveness of warnings about the risk of strangulation represented by window curtain or blind cords, shoelaces, and clothing drawstrings exposed in pediatric offices. The intervention was applied through posters placed in the waiting rooms of physicians' offices. In one

week, the physician's office participated as intervention and in the other, as its own control. No procedure was performed during the control week. At the end, a questionnaire was administered to the parents by telephone to assess their knowledge of the risks and behavior changes after the warnings in the waiting rooms. After the intervention period, a total of 85% of the parents in the intervention group and 79% of the control group reported having curtain/blind cords, shoelaces, and clothing drawstrings within the reach of the children, with no difference between the two groups. Of the seven evaluated items for risk of bias, four showed high risk.

Gielen et al.<sup>12</sup> carried out an intervention based on the "Safety in seconds" program, aiming to improve parents' knowledge about the risks of traumatic injuries in children. Parents were contacted in the pediatric emergency rooms. At baseline, parents were classified into four safety behavior profiles according to safe use of the car seat, use of smoke alarms, and storage of toxic products. A personalized report containing warning and incentive messages was printed and delivered to the parents. The control group also answered a baseline questionnaire in the same setting as the intervention group, but the questions were only about sociodemographic data and health characteristics of the child. The assessed outcomes were: knowledge about safety, behavioral profile, reason for the visit to the medical emergency room, and parental anxiety. The intervention group showed greater knowledge about smoke alarms, storage of products that cause poisoning, general safety behaviors, and correct use of the safety seat in the car. The study had low risk of bias in most items.

Nansel et al.<sup>14</sup> applied an educational intervention on the prevention of traumatic injuries and safety practices recommended by the American Academy of Pediatrics to parents of children aged ≤4 years, who were treated at three pediatric clinics. At baseline, parents were evaluated with the help of a computer set up in a kiosk in the clinic waiting room. The intervention was applied by the physicians. The T-IPi intervention group received guidance on traumatic injury prevention and a three-page folder with charts to guide them. The T-IPi+P intervention group received the same information as the T-IPi group, as well as one supplemental material, with additional information in one page, including charts showing the risk of traumatic injuries. The control group (G-IPi) received generic information on the prevention of traumatic injuries according to the child's age. The post-intervention evaluation was performed by telephone on the behaviors and beliefs regarding the prevention of traumatic injuries. In the intervention group, parental adherence to safety behaviors increased from 39% at baseline to 98% after the intervention. Among the seven items assessed for risk of bias, the study presented a low risk in five of them.

Cheraghi et al.<sup>25</sup> evaluated the effect of the Health Belief Model (HBM), which correlates changes in maternal behaviors and knowledge, attitudes, and practices to increase safety and prevention of traumatic injuries in children under 5 years of age. The intervention was based on an educational program that included one-hour sessions twice a week. The focus of these sessions were the factors present at home that affected maternal practices and knowledge, as well as the perception of severity, barriers, cues for action, and self-efficacy on children's safety. The authors did not report the procedure applied to the control group.

Before the intervention, seven traumatic injuries of any type were reported by the mothers in the intervention group and four by those in the control group; after the intervention, the number reduced to two in the intervention group and increased to seven in the control group. The means for knowledge, susceptibility perception, severity, benefits, cues for action, self-efficacy, and adoption of new practices were higher in the intervention group. Only the perception of safety barriers was higher in the control group.<sup>15</sup> In the evaluation of bias risk, the study indicated that four items, of a total of seven, had low risk.

Van Beelen et al.<sup>24</sup> carried out a study to evaluate the effect of the E-Health4Uth home safety study program, an intervention based on the safety behaviors of the parents of children around 10 months of age, regarding fall prevention, intoxication, drowning, and burns. Parents allocated to the intervention group received a username and password to access a website and answer questions about safety behaviors, prevention of falls, poisoning, drowning, and burns. Afterwards, they were invited to answer the program questionnaire at home. In the first part of the questionnaire, parents answered questions about safety, which were used to generate customized safety alerts. After reading the alerts, parents were invited to plan changes regarding their children's safety. The parents from the control group received the standard health and care information, with general safety information. Six months after the intervention, a questionnaire was applied to evaluate the parents' safety behaviors in relation to falls, intoxication, drowning, and burns. The parents from the intervention group presented a safer behavior than those from the control group. Among the total domains evaluated for risk of bias, the study showed a low risk for most items.

### Interventions carried out at schools

Kendrick et al.<sup>21</sup> evaluated the Risk Watch program, which aimed to increase children's knowledge and skills on safety. Program folders were provided, which were specific to each age group. Each folder addressed the safety of cyclists and pedestrians, falls, intoxications/poisonings, fires, and burns. A Risky Boxes box with extra materials was also offered to teachers to be used in class. The schools that participated as a control group received the materials of the Risk Watch program only at the end of the intervention group follow-up. The collected outcomes included knowledge on safety and self-reported safety behavior. Compared to the control group, the intervention group had a high rate of correct responses for the questions regarding fires and burns. The children in the intervention group also knew how to perform the correct actions in case of burning clothing and home fires. According to the items assessed for risk of bias, the study was classified as having low risk.

Morrongiello and Matheis<sup>18</sup> developed an intervention to reduce the risk of falls in playgrounds in children aged 6–10 years. The intervention was applied in three sessions, which were carried out with the children creating posters with pictures and demonstrated the correct and incorrect use of each equipment in the playground. During the first session, the children were presented with photos of child actors performing high and moderate risk behaviors

in playgrounds. After that, they were instructed on how to behave adequately in the equipment. After the instructions, the children were photographed while actually using the equipment and, at the end, safe use, as well as high and moderate risk use photos were produced for each equipment. In the second session, videos depicting risk situations in the playgrounds were shown. In the third session, the children were invited to go to the playground to perform the behaviors that were taught. The children from the control group participated in sessions 1 and 3, only. At the end, changes in risk behaviors were evaluated. A reduction was observed in the risk behaviors in the intervention group when compared with the control group, especially regarding the medium and high-risk behaviors. However, the study showed a high risk of bias in most assessed items.

### Non-randomized studies

Cagle et al.<sup>11</sup> carried out an educational intervention aiming to evaluate an intervention program called Children Safe at Home Project. The parents of the intervention group received one-to-two-hour lectures on burns. After the lectures, the parents were given a refrigerator magnet with preventive measures of burns and treatment. At the end, a home visit was carried out to install burn safety devices. The initial visit to the household showed an average of seven ( $SD \pm 2$ ) scalding burn risks per household in the intervention group. During follow-up, this average decreased to two ( $SD \pm 1$ ). Prior to the program, the rate of hospital admission for burns in children aged 0–5 years was 137/100,000. After the program, it decreased to 59/100,000. Of the seven domains assessed for risk of bias, this study had four domains with high risk, two with uncertain risk and only one with low risk.

Carlsson et al.<sup>22</sup> carried out an intervention that aimed to assess how information given to mothers with low level of schooling can improve home care measures to avoid burns. The intervention was carried out in the form of lectures. Subsequently, a home visit was made to evaluate the outcome. The mothers from the control group received only the home visit to measure the outcome. After the intervention, 70% of the mothers in the intervention group reported having placed protection devices in the stove, taken measures to prevent the child from climbing the stove or sink, and kept wires from electric iron and water heaters out of the reach of the children. Regarding the random sequence generation, allocation concealment and blinding of the participants and evaluators, this study was evaluated as having high risk for bias.

Jetten et al.<sup>23</sup> measured the effectiveness of a home burn prevention program in young children through a before-and-after study, with no control group. The families of the intervention group watched a video on burn prevention and received baby safety gates and playpens to be used at home. A playpen was given to families who only had one room and cooked in it. A baby safety gate was given to families who had separate rooms from the kitchen.

The main outcome was the number of burns. A total of 18 burns were reported before the intervention. After the gates and playpens were installed, the number of burns decreased

to only two. This study had a high risk of bias for most of the evaluated quality criteria.

Stewart et al.<sup>16</sup> evaluated the Home safety program (HSP), an educational intervention applied to the parents of children up to two years of age for the prevention of traumatic home injuries. The program was evaluated through emergency room visits for traumatic home injuries five years before and two years after the program implementation. The intervention was implemented through a kit with nine safety items and a film entitled "Give your child a safe start". The nine items in the kit included a door knob cover, oven lock, bath water thermometer, cabinet locks, safety locks and latches, cabinet stoppers, electrical outlet plugs, furniture protection cushions, and safety locks for windows. Additionally, a list of items to assess whether the family home was safe for the child was distributed to the parents. There was a decrease in visits to emergency service for traumatic domestic injuries after the intervention. This study had a low risk for bias in five of the seven evaluated items, showing a high risk for the blinding domain of the participants and outcome evaluators.

## Discussion

Family counseling, changes in the home environment, and identification of risk factors, according to the stage of the child development and behavioral habits common to the age period, were important factors for devising effective interventions in the prevention of childhood accidents. Of the four randomized studies and analyzed by intention-to-treat, two performed at home<sup>13,20</sup> and two in healthcare services,<sup>12,24</sup> all found a favorable effect regarding the intervention: reduction of risk factors for accidents,<sup>20</sup> reduction in the number of medical consultations due to accidents,<sup>13</sup> lower frequency of risk behaviors,<sup>24</sup> and greater knowledge of parents about childhood accident prevention, even when safety devices had not been provided to the families.<sup>12</sup>

In most of the reviewed studies, educational interventions to reduce risk factors and behaviors for childhood traumatic injuries were effective. These findings were consistent with randomized trials that used intention-to-treat analysis, which found a greater reduction in the risk for traumatic injuries<sup>13,20,24</sup> and greater knowledge about safety<sup>12,24</sup> in the intervention groups when compared with the control groups.

Significant reductions in the risks and rates of traumatic injuries, as well as improvement in the knowledge of parents/caregivers and children regarding the prevention of accidents were observed in home- and school-based studies. The home and the school are high-risk places for accidents, since they are the environments most often frequented by children, but also an ideal place for preventive interventions, since they are adapted to the context where the risk factors are found. The most commonly addressed risk factors for home-based accident prevention were those identified in previous etiological studies of childhood accidents, such as the presence of bunk beds, stoves, stairs, electrical outlets, and toxic products within easy reach<sup>26,27</sup>; in the school environment, toys and playgrounds.<sup>26</sup>

The distribution of safety devices was frequent among the identified studies.<sup>11,13,15,16,19,20,23</sup> However, the benefit of

the intervention was not always the result of the presence of these devices at home, but of the educational component provided by the trained professional.<sup>11,13,15,16,19,20,23</sup> This finding is consistent with a systematic review published in 2010<sup>28</sup> on the prevention of traumatic injuries at home through programs that provided or installed safety devices. That review showed that few interventions achieved a reduction in the rates of childhood traumatic injuries, except when the installation of these devices was accompanied by educational guidance.

North American data show that, every year, 20 school-age and preschool children die from accidents in playgrounds, mainly due to injuries involving falls.<sup>29</sup> This information is consistent with the results of a systematic review on risk factors for falls among children aged 0–6 years.<sup>26</sup> In the present review, Morrongiello et al.,<sup>18</sup> who evaluated an educational intervention at school, found a significant reduction in risk behaviors in playground installations among children in the intervention group.

Burn injuries result in large expenses to healthcare systems, due to medical care and types of treatment, in addition to the possibility of causing permanent sequelae.<sup>30</sup> A population-based study carried out in the South of Brazil found a 23% incidence of burns in children aged 48 months.<sup>9</sup> In Turkey, Atak et al.,<sup>27</sup> in a study of children under 5 years of age, verified that burns were the second most frequent type of accident causing injuries. Interventions aimed at reducing risk behaviors and burn injuries were the focus of four home-based studies assessed in the current review,<sup>11,19,20,23</sup> and three of them detected reductions in home risks and rates of burn injuries in the intervention group.<sup>11,19,23</sup>

Of the 11 randomized trials, ten showed that the intervention reduced the number of risk factors for accidents and/or increased parental knowledge about prevention. Randomized studies have great potential for causal inference, since randomization aims to ensure that the groups are well-balanced, for both known and unknown factors, with the only difference being the exposure to intervention. Therefore, the differences observed between the two groups can be attributed to the intervention.<sup>30,31</sup> However, results from non-randomized experimental trials<sup>11,16,22,23</sup> should be considered with caution.

One of the limitations in this review arises from the analysis methodology used in most studies. Only four of the fifteen studies performed an intention-to-treat analysis, whose absence annuls the advantage obtained from the randomized allocation process of study participants. When assessing the outcome, most of the studies used the parents' reporting to assess the occurrence of traumatic injuries and behavior changes, which may have led to information bias and, consequently, overestimation of the interventions' effect. Moreover, given the variety of investigated outcomes and the measurement methods, it was not possible to perform a meta-analysis. Furthermore, other databases such as EMBASE, CINAHL, POPLINE, and Google Scholar were not searched, because they are not free of charge or due to their inherent limitations in accounting for identified articles.

The strengths of this review include the use of a wide range of terms, both in relation to the children's age and the subject to whom the intervention was applied and the environment where it was carried out, in articles published in the last ten years. The literature review identified ten previous

reviews, which, except for one published in Mandarin<sup>32</sup> that could not be read, were specifically focused on some types of accidents, such as falls,<sup>33,34</sup> poisoning,<sup>35,36</sup> burns,<sup>37</sup> or on interventions directed only at the parents,<sup>38</sup> among others.<sup>28,39,40</sup>

In summary, this literature review has demonstrated that childhood traumatic injuries can be primarily prevented through strategies that consider the child's age and level of development, as well as structural aspects of the environment.

## Conflicts of interest

The authors declare no conflicts of interest.

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