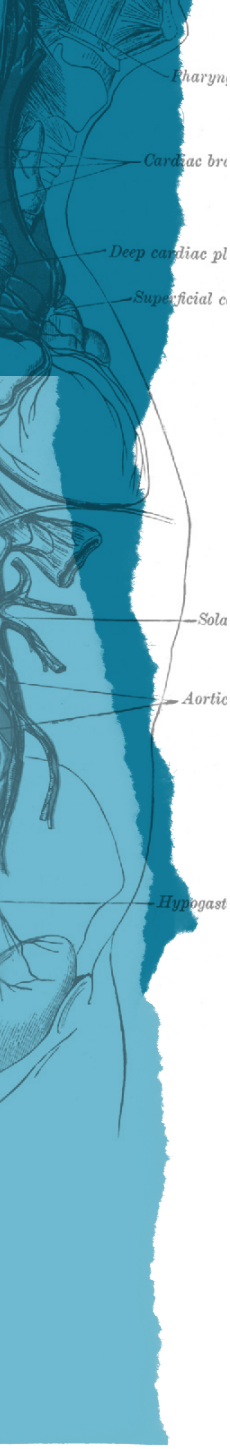

Fecha de recepción: 16 de julio de 2024
Fecha de aceptación: 9 de diciembre de 2024

REVISIÓN SISTEMÁTICA

https://dx.doi.org/10.14482/sun.41.02.345.549

Accidental Injuries in Children and Adolescents: A Systematic Review and Meta-analysis

Lesiones accidentales en niños y adolescentes: Una revisión sistemática y metaanálisis

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ABSTRACT

Objective: To describe the accident mechanisms and types of injuries in children and adolescents.

Methodology: All studies reporting accidental injury cases in populations above one month and under 18 were included. Those reporting self-inflicted, non-accidental, violent injuries and suicide attempts and studies reporting dental or ocular injuries were excluded. We searched the MEDLINE, LILACS, and ScienceDirect databases for studies published after 2000. The meta-analyses were performed to evaluate different effects, such as the overall proportion of accidental injuries by gender, areas of the body, and those occurring at home.

Results: The systematic review included a total of 91 articles. The most frequent accident mechanisms were motor vehicle accidents, falls, and poisonings. Injuries occurred 62% (CI 95% 58% - 66%) in males and 56% (95% CI 46% - 66%) at home. The most affected areas by accidental injuries were the head and neck areas and upper limbs, while the chest and abdomen were the least affected areas.

Conclusion: The most frequent accidental injuries in children and adolescents are associated with motor vehicle accidents and falls. Males have a greater risk of presenting accidental injuries compared to females. The injuries primarily affect the head and neck areas.

Contributions to the field:

- Motor vehicle accidents and falls are the most frequent accidental injuries.
- Males have a greater risk of presenting accidental injuries compared to females.
- The accidents occur most frequently at home and primarily affect the head and neck.

Keywords: Accidental injuries, adolescents, child, accidents, systematic review.

RESUMEN

Objetivo: Describir los mecanismos de accidentes y tipos de lesiones en niños y adolescentes.

Metodología: Se incluyeron estudios que reportaron casos de lesiones accidentales en niños y adolescentes menores de 18 años. Se excluyeron estudios que reportaron lesiones de tipo auto infligidas, no accidentales, violentas, intentos de suicidio, oculares o dentales. Las bases de datos consultadas fueron MEDLINE, LILACS y ScienceDirect para publicaciones posteriores al año 2000. Se evaluó la proporción general de lesiones accidentales por género, partes del cuerpo y aquellas ocurridas en el hogar mediante un metaanálisis.

Resultados: Se incluyeron 91 artículos. Los mecanismos de accidentes más frecuente fueron los accidentes en vehículos de motor, caídas y envenenamiento. El 62 % (IC 95 %, 58 % - 66 %) de las lesiones ocurrieron en hombres, y el 56 % (95 %, IC 46 % - 66 %) de lesiones ocurrieron en casa. Las áreas más afectadas fueron: cabeza, cuello y extremidades superiores, mientras que el tórax y abdomen fueron menos frecuentes.

Conclusión: Las lesiones accidentales más frecuentes en niños y adolescentes están asociadas a accidentes por vehículos de motor y caídas. Los hombres tienen un mayor riesgo de presentar lesiones accidentales en comparación con las mujeres. Las lesiones accidentales afectaron principalmente la cabeza y el cuello.

Aportes para el campo:

- Los accidentes de vehículos de motor y caídas son las lesiones accidentales más frecuentes.
- Los hombres tienen mayor riesgo de presentar lesiones accidentales en comparación con las mujeres.
- Los accidentes ocurren más frecuente en la casa, y principalmente afecta la cabeza y el cuello.

Palabras clave: Lesiones accidentales, adolescentes, niños, accidentes, revisión sistemática.

INTRODUCTION

Accidental injuries are known as physical harm resulting from accidental events, primarily affecting the child population (1). The World Health Organization (WHO) estimates that approximately 100 children die every hour due to injuries, and 90% of these are caused by unintentional factors (2). Consequently, accidental injuries are considered a public health problem, given their high mortality, incidence, and impact on quality of life (3).

According to the latest study on the global burden of disease, in 2017, over 520 million people experienced some type of injury, 92% of which were accidental and mostly occurring in males (4). Additionally, accidental injuries contributed to a loss of approximately 50 million due to years lived with disabilities (4), affecting the extremities, head, and abdominal region (5).

Accidental injuries are more frequent in individuals under 18 compared to adults (6), and in recent years, they have been considered one of the leading causes of death worldwide (7). Over 244,000 children under 5 died from accidental injuries in 2017, with burns, falls, and drowning being the most common causes. It is estimated that accidental injuries in childhood could result in over 77,000 years of life lost, with 68% of these resulting from injuries from motor vehicle accidents (8).

Accidental injuries occur in both public and private settings, with the home and school being the most frequent sites of accidental injuries. Among public settings, the street and sports and recreational centers are where children are most commonly injured (9). The types of injuries differ based on age range. Childhood often involves more falls, burns, and drownings, while teenagers are more likely to be victims of motor vehicle accidents.

Descriptive studies have provided sufficient evidence demonstrating the incidence and prevalence of accidental injuries in individuals under 18 years old, as well as their lethality, and impact on quality of life. However, we did not find a systematic review or meta-analysis summarizing all studies of accidental injuries worldwide that would provide an overview of injury characteristics and accident mechanisms, because a review does not cover all existing databases. Therefore, the objective of this systematic review and meta-analysis was to describe the accident mechanism and types of injuries that occur in children and adolescents.

METHODOLOGY

Search Strategies

We followed the guidelines for systematic review and meta-analysis of observational studies in epidemiology (MOOSE) (10). Literature searches were conducted in the MEDLINE, LILACS, and ScienceDirect databases using the terms "Accidental Injuries", "Children", "Adolescents", "Youth", and "Teens".

Selection Criteria

Ecological, cross-sectional, and retrospective cohort studies reporting the number of accidental injury incidents or prevalent cases in a population over one month of age and under 18 were included, considering articles published in Spanish, English, or Portuguese. The WHO's classification of accidental injuries, which provides for falls, drowning, burns, poisoning, and motor vehicle accidents (vehicle-pedestrian), was used. Case reports, editorials, comments, literature reviews, and articles published before 2000 were excluded. Studies reporting self-inflicted injuries, non-accidental injuries, violent injuries, suicide attempts, as well as dental and ocular injuries were also excluded. We reviewed the reference lists of the included studies to identify additional studies meeting the eligibility criteria.

After running the algorithm on the databases, references were imported into Zotero to eliminate duplicates. Subsequently, they were exported and a matrix was built in Microsoft Excel to review the titles and abstracts. Two researchers independently reviewed each title and abstract of the identified records in the databases to assess eligibility criteria (N=1,550). After reviewing the titles, the inter-observer agreement was 82%; any differences concerning the articles were resolved through discussion and consensus. A third evaluator resolved any persistent discrepancies. After the initial screening, full-text articles (n=409) were reviewed to assess eligibility criteria.

Data Extraction

Three reviewers extracted article information using an established matrix that included the following variables: author, title, year of publication, country, study type, period analyzed, population, distribution by gender and age, the specific type of accident, the number and type of injuries, injury distribution by affected body area, and the number of injuries occurring at home.

Information on mortality in patients with accidental injuries and the severity of the injuries was also obtained.

Information Synthesis

We conducted a qualitative analysis of each article considering the study characteristics, population, accident mechanism, and injury type. The number of research articles published by year, country, and language is reported. Several articles on accident mechanisms, such as road injuries, falls, burns, bites, poisonings, drowning, foreign bodies, lawnmowers, and others, have also been described. The accident location, sex distribution, and affected anatomical area were also analyzed.

Quantitative Analysis

Meta-analyses were performed for proportions to evaluate different effects (11). The first meta-analysis established the overall proportion of accidental injuries by gender (n= 83 articles) and those occurring at home (n= 28). Subsequently, six meta-analyses were conducted to establish the proportion of injuries occurring in six body areas: head and neck (n= 37), chest (n= 31), upper extremities (n= 28), lower extremities (n= 29), face (n= 17), and abdomen (n= 12). Once the meta-analysis of body areas was conducted, the most affected areas were determined and plotted on a body map using the CHOIRBM library. Finally, two meta-analyses were conducted to evaluate the overall proportion of fractures (34 articles) and amputations (5 articles). These two injuries were selected because they were the most commonly reported in the included studies. A random-effects model was used for all proportions, and 95% confidence intervals were calculated. We performed the meta-analyses using RStudio version 4.2.2 with the meta library.

RESULTS

The multiple database search yielded 1,733 records. After removing duplicates, 1,550 were selected for review based on their title and abstract; 1,141 were excluded. In total, 409 research articles met the eligibility criteria for full-text review. The basis for exclusion was mainly studies concerning violent, intentional, or non-accidental injuries, studies involving a population older than 18, failure to report data on incident cases of accidental injuries, and studies conducted in

languages other than English, Spanish, or Portuguese. Ultimately, 91 articles met the eligibility criteria for the systematic review (Figure 1).

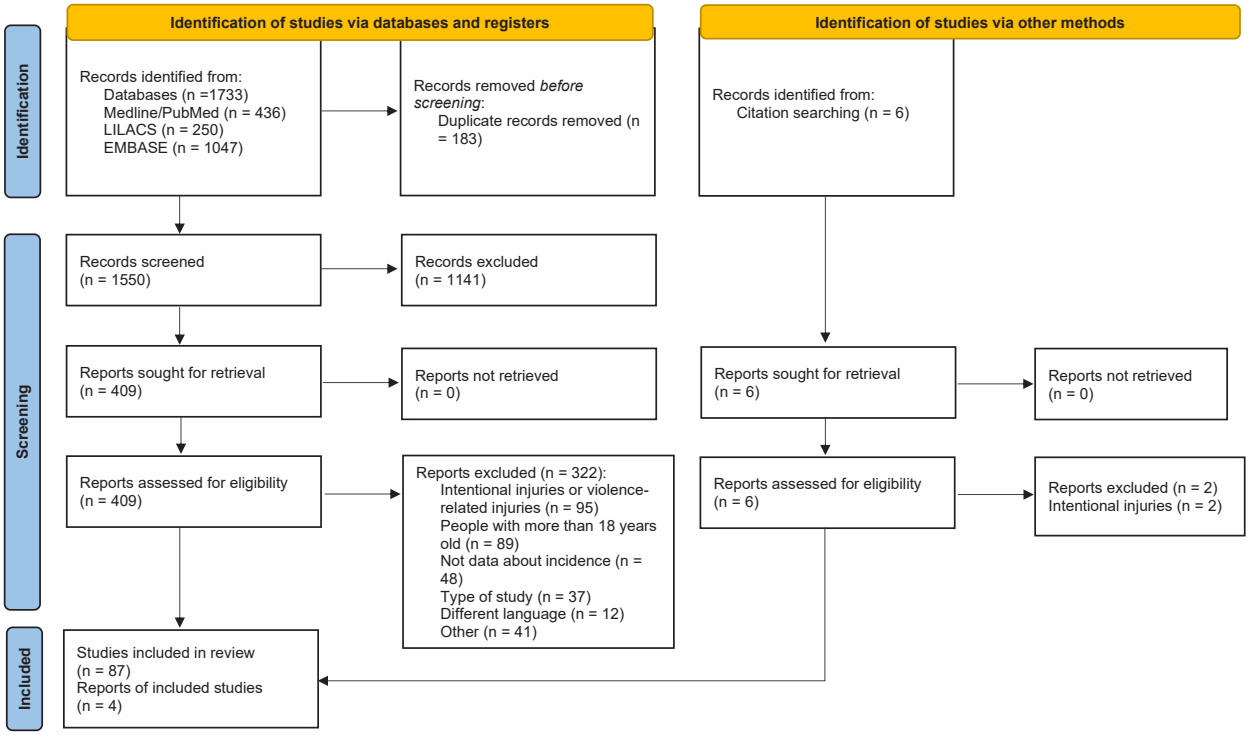

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Figure 1. Study Selection. Preferred Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram

Study Characteristics

The studies included were published between 2001 and 2022 (Table S1). An increase in the number of studies published in the last decade was noted; 25 articles were published between 2000 and 2010, increasing to 51 documents between 2011 and 2020. Most studies were published in English, with only 2 in Spanish (9,12). The countries with the highest publication rates on accidental injuries were the United States (n= 28), Australia (n= 8), Spain (n= 5), and Singapore

(n= 4), accounting for 49.5% of the studies. Latin American and African countries had low scientific production on this topic (Figure 2).

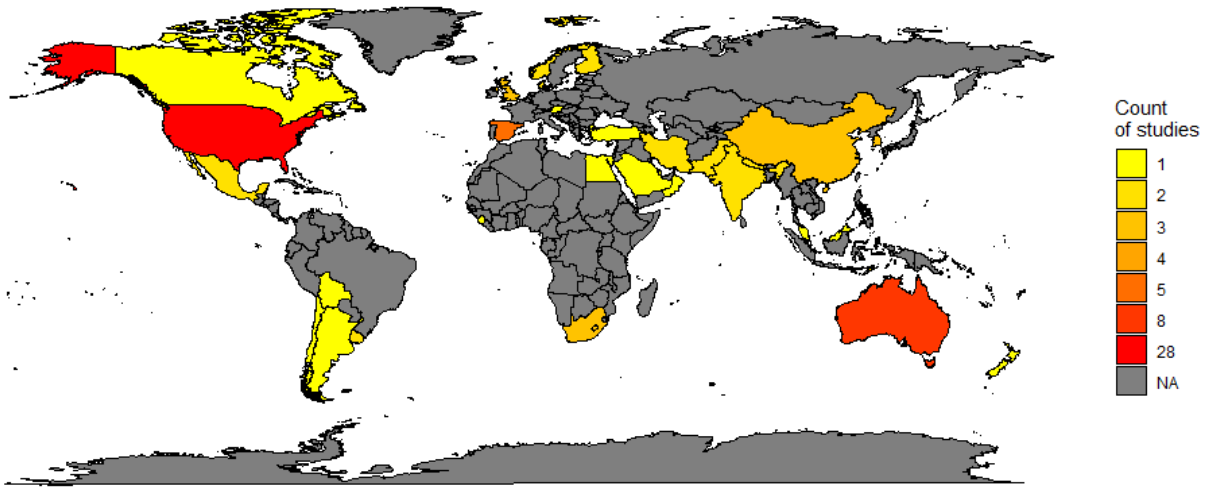

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Figure 2. Geographical Distribution of Studies on Accidental Injuries in Under 18 Years of Age

Accident Characteristics

Accident Mechanisms

Out of the total articles reviewed, 49 analyzed a specific accident mechanism, with motor vehicle accident injuries (n= 14) (13–26), falls (n= 9) (13–21)minor injuries are common and their incidence is increasing. Severe injuries are most commonly head and neck injuries. They may result in long-term morbidity. This study aimed to illustrate these severe injuries and to find out their incidence and risk factors. Materials and Methods This is a population-based, prospective study in the Oulu region of Finland completed over 2 years (May 1, 2015 to April 31, 2017, and poisonings (n= 5) (22–26) representing 57.14% (Figure 3). Among the studies analyzing motor vehicle accidents, the most frequent mechanism involved four-wheel vehicles, either passengers or

pedestrians. Other reported vehicle-related mechanisms included scooters (27,28), train-related injuries (29), bicycles (28,30,31), golf cart accidents (32), and motorcycles (33,34).

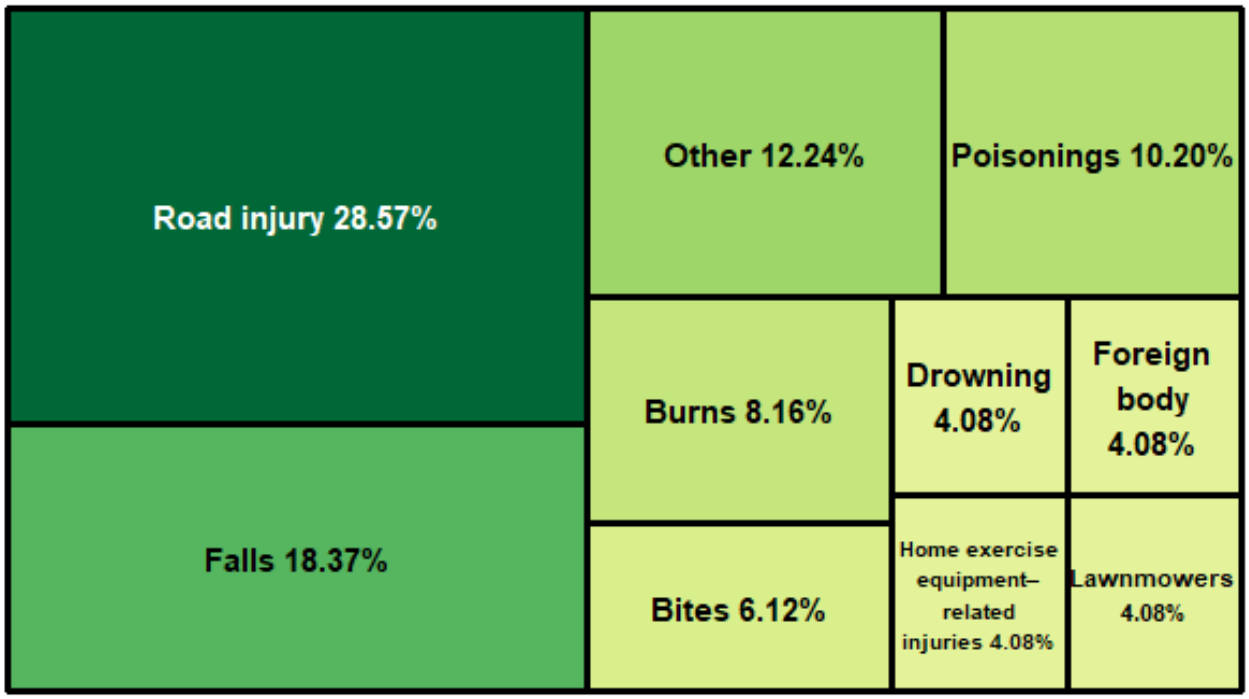

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Figure 3. Type of Accidents Analyzed in the Studies that Report Specific Accidents

Other specific accidents were also reported, such as injuries caused by home exercise equipment (35,36), ceiling fan-related injuries (37), facial injuries from diving or swimming (38), injuries caused by horses (39), genital traumas (40), and accidents related to sleds (41).

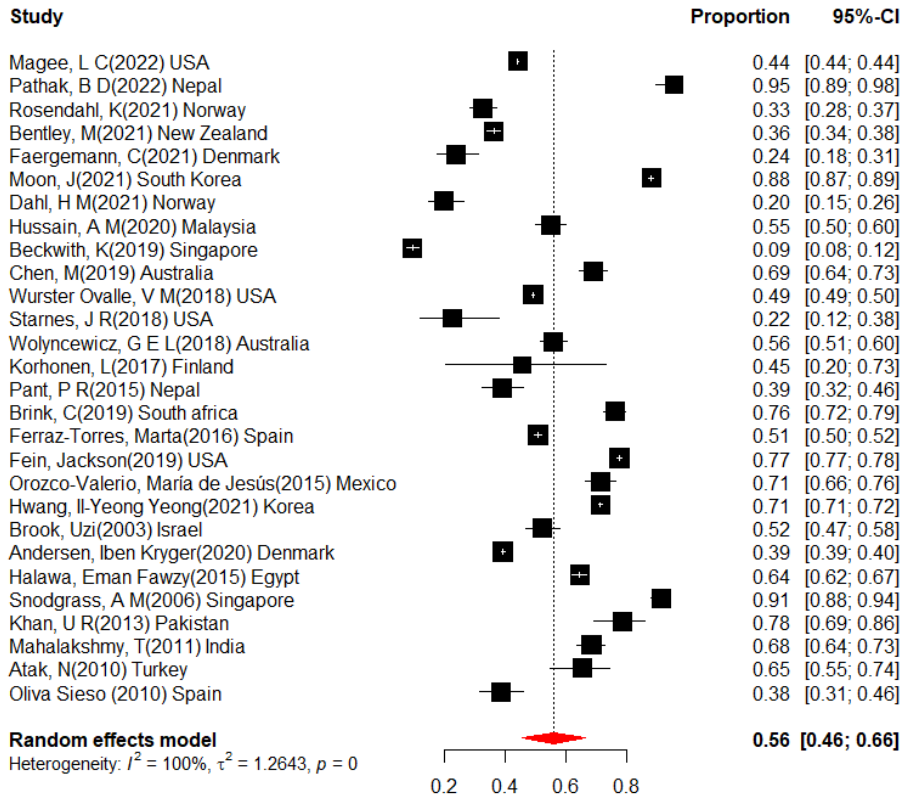
Forty of the articles did not analyze a specific accident mechanism. Instead, accidents were studied in a general sense or involving a specific type of injury. The most frequent in this group were studies researching accidental injuries in children admitted to emergency services, hospitalization, or intensive care (9,42–55); injuries occurring in specific environments, such as the home, a hotel, a farm, or school (56–67); and accidents resulting in severe (5,43,68), brain (69–72) or peripheral nerve injuries (73).

Accident Distribution by Gender

Only 83 of the reviewed studies reported the gender distribution of the injured minors. In 10 articles, the male proportion was below 50%, while in the remaining 73 studies, males accounted for over 50% (Table S1). The meta-analysis found that overall, 62% (95% CI 58% - 66%) of the injuries occurred in males (Figure S1).

Accidents Occurring at Home

Among the reviewed articles, 28 reported the home as one of the locations where the accident occurred. The overall proportion of accidents occurring in the home environment was 56% (95% CI 46% - 66%) (Figure 4).



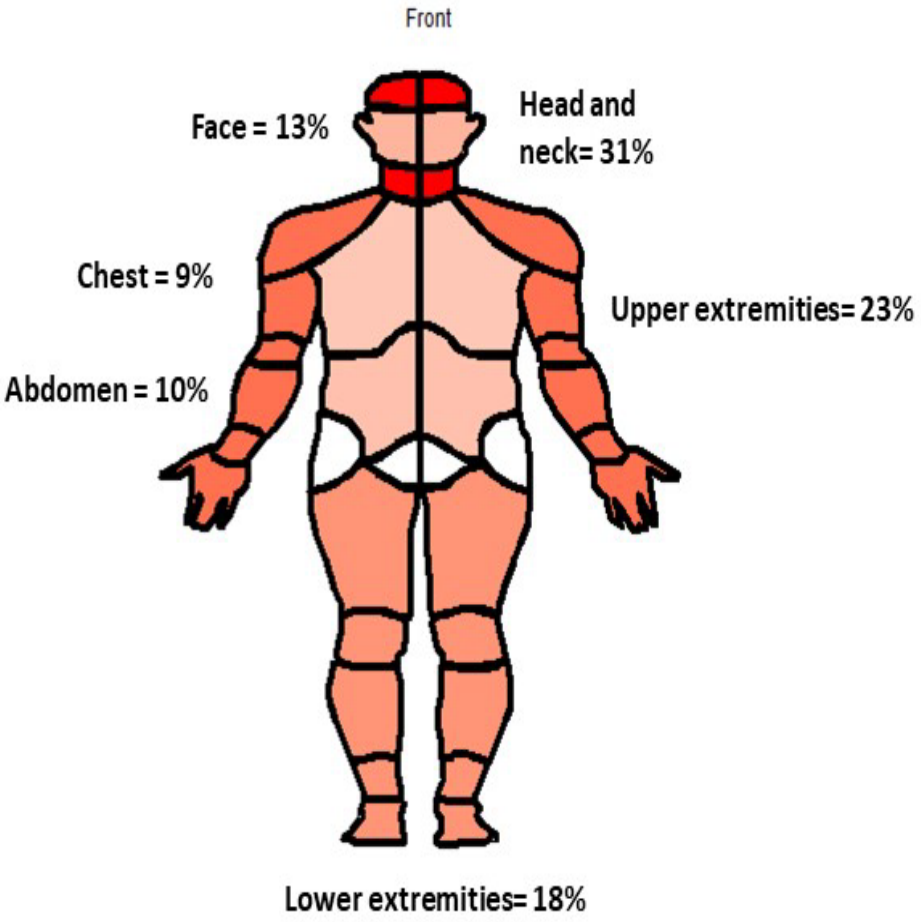
Source: own elaboration.

Figure 4. Incidence of Accidental Injuries in Under 18 Years of Age that Occurred in the Home Environment

Accidental Injuries Characteristics

Injury Location

The most studied anatomical area was the head and neck region (n=37), followed by the chest (n=31). The upper and lower extremities were reported in 28 and 29 studies, respectively. The areas least frequently reported were the face (n=17) and abdomen (n=12). Overall, the most affected areas by injuries observed were the head and neck region and the upper extremities, while the least affected were the chest and abdomen (Figure 5).



Note. Darker color indicates higher incidence of accidental injuries.
Source: own elaboration.

Figure 5. Incidence of Accidental Injuries by Affected Anatomical Area

Injury Types

The most reported injuries in the studies were fractures, described in 34 scientific articles. After a meta-analysis of these 34 articles, we found that 25% (95% CI 17% - 36%) of children under 18 who experienced an accident had some type of fracture (Figure S3). Five studies reported an incidence of 25% (95% CI 11% - 46%) of limb amputations associated with injuries caused by lawnmowers (74,75), fireworks (76), and traumatic injuries with farm equipment (66) (Figure S2).

DISCUSSION

This is the first systematic review and meta-analysis summarizing accidental injuries in children under 18 reported in studies worldwide. We found that the most frequent mechanism is motor vehicle accidents, followed by falls, predominantly resulting in fractures. Moreover, injuries occur more often in males, primarily at home, and the most affected body area is the head and neck region.

According to the latest global burden of disease studies, accidental injuries, including motor vehicle accidents and falls, are the leading cause of morbidity, mortality, and reduced quality of life. These findings are similar to those of this systematic review. However, it has been shown here that injuries occur differently according to age groups (68). Falls are usually the main cause of accidents in children under 14, while older children have a higher risk of motor vehicle accidents (53,68). It should be noted that motor vehicle accidents involving children under 18, as passengers or pedestrians, are the leading cause of death in all age groups (68,72), possibly because, as reported in this study, the head is the most affected area. According to various studies, the main risk factors for motor vehicle accidents are the use of controlled drugs such as methadone (77), mental disorders (78), and alcohol consumption (79); the latter has a different behavior in each country, mainly affecting low-income countries (79).

As reported in other studies (1,80), the meta-analysis found that males had a higher risk of injuries. The previous could be attributed to the exploration stage during childhood development, which occurs after age two and is more pronounced in boys. Furthermore, other studies have reported that the risk of mortality from accidental injuries increases with age, being higher in boys compared to girls (3). The presence of more injuries in boys may be related to the patterns

of upbringing widespread in various regions of the world, which encourages boys to be more risk-taking and daring than girls (81). This also leads boys to prefer activities that involve contact sports, strength, and speed, favoring situations in which they can be injured (81).

This systematic review found that more than half of the studies reporting the accident's location indicated that they occurred at home. It revealed that the site of injury occurrence also varies according to age. Accidents occur most frequently at home and in public parks in children under seven (80), while older children are likelier to have accidents in public places or at school. A recent study found situations related to the risk of accidents at home, such as the environment (swimming pools, containers with water, stairs, terraces, or balconies without railings), access to poisons or potentially toxic substances (cleaning products, batteries, medications, alcoholic beverages, or drugs), and elements that can cause burns due to heat or fire (82).

Based on the results of this systematic review and meta-analysis, it is important to focus on situations that occur most frequently and to develop intervention strategies aimed at the most common causes. This involves health professionals and those who design homes, schools, and public spaces frequented by the children. Additionally, government entities have the mission of developing policies for the protection of minors and regulating the marketing of products that constitute risk. Efforts should continue to improve road safety, especially in Latin American and Asian countries, given that injuries are most frequently related to these events and significantly impact the quality of life. Finally, parents, caregivers, and teachers must anticipate dangers and be trained to provide first aid if required, reducing negative consequences in the medium and long-term.

The systematic review and meta-analysis have some limitations that should be considered. First, assessment of the risk of bias in the included studies was impossible due to methodological differences and the absence of a specific checklist for this review. Furthermore, the meta-analysis showed considerable heterogeneity among the studies; however, considering that we calculated the global effect of a proportion, this statistical heterogeneity was expected (11). It should be noted that the results of this work do not reflect the actual incidence of accidental injuries, as the information was based on published studies. A final limitation of the study is the possibility of not including all the studies reporting incident cases of accidental injuries, given the large number of studies published on the subject.

CONCLUSIONS

The most frequently occurring accidental injuries in children under 18 are associated with motor vehicle accidents and falls. In traffic accidents, injuries suffered by pedestrians and those caused by four-wheeled vehicles predominate over others, such as motorcycles, scooters, or bicycles. Although the home is considered a safe environment, it was identified that most accidents in children and adolescents occur in the home environment. Among some accidents identified and that were less frequent, those that occurred with ceiling fans, gym equipment, sleds, toilets, and elements for practicing aquatic activities were highlighted. Additionally, males are at a higher risk of experiencing injuries compared to females, and the most affected body areas are the head and neck.

Conflict of interests: Authors declare no conflict of interests.

Funding: This work received funding from Universidad Antonio Nariño (project # 2022212), Universidad de Santander, and Universidad Cooperativa de Colombia (project # 3282).

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