REVIEW ARTICLE

Risk factors and prevention of falls in children under 3 years: a systematic review

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Abstract

Background and Study Aim: Falls are one of the leading causes of injuries among children under the age of three, potentially leading to a reduced quality of life and various health consequences. Investigating the mechanisms of falls and their possible outcomes is a promising and crucial area for reducing childhood injury rates. The aim of this systematic review is to identify key patterns and factors associated with falls in young children, as well as to propose preventive strategies to minimize the risk of injuries.

Material and Methods: The source of information was the Web of Science Core Collection database for the period 2014–2024. The search was conducted using key terms related to falls, injuries, and risk factors. A total of 9,681 article records were retrieved. For evidence-based automated extraction of relevant documents, the Latent Dirichlet Allocation (LDA) model was employed. Relevance criteria were used to assess the significance of the texts. The reliability of the document extraction methodology was evaluated using coherence score and perplexity. The coherence score for word pairs was 0.8185, while perplexity was -2.9333, indicating a high interpretability of topics. Data processing was carried out using the Python programming language and the PyCharm CE development environment.

Results: The analysis of the selected publications identified four main areas related to falls in children under the age of three. The majority of falls occur in domestic settings, particularly from furniture and during the use of infant products. Significant risks are associated with parental fatigue and postpartum depression, which contribute to falls from caregivers' hands and accidents during newborn care. Falls often result in severe traumatic brain injuries, as evidenced by a high rate of hospitalizations. Effective preventive measures include parental education programs, improvements in maternity ward conditions, and enhancements in home safety.

Conclusions: Falls in children under the age of three represent a serious issue that requires a comprehensive approach to prevention. The identified patterns and risk factors highlight the need for the implementation of preventive measures. Effective strategies should include parental education programs, improvements in home and healthcare facility safety. The implementation of these measures will help reduce the incidence of falls and related injuries, ultimately improving the quality of life for young children.

Keywords: parental education, home safety, traumatic brain injuries, caregiver fatigue, preventive strategies

Introduction

Falls are one of the leading causes of injuries among young children, particularly those under the age of three. During this period, children actively develop motor skills, increasing the likelihood of falls both in domestic settings and beyond. The consequences of such falls can range from minor bruises to severe traumatic brain injuries, significantly affecting health and quality of life. Therefore, finding effective solutions to the problem of child falls requires a thorough analysis and synthesis of existing research findings.

In this context, numerous studies explore various directions and approaches related to children's motor activity, parental supervision, and environmental factors. Analyzing the results of these studies has revealed several key areas associated with falls in children under three years old:

- *Characteristics and Mechanisms of Falls* – Examination of the circumstances and situations leading to infant falls, including falls from furniture, caregivers' hands, and during the use of child equipment [1, 2, 3, 4, 5, 6, 7, 8].
- *Head Injuries and Contributing Factors* – Investigation of the severity of traumatic brain injuries depending on fall height, surface hardness, and the child's age [2, 4, 9, 10, 11, 12, 13, 14].
- *Parental Risk Factors* – The impact of parental fatigue, postpartum depression, and other factors on the frequency and severity of infant falls [6, 8, 15, 16].
- *Preventive Measures and Interventions* – Development of educational programs for parents, use of mobile applications and monitoring systems, engagement through

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social media, and implementation of safe sleep practices to prevent falls [2, 3, 8, 16, 17, 18, 19, 20, 21, 22, 23, 24].

These areas encompass a wide range of factors influencing falls in young children. A more detailed analysis of the identified aspects allows for the determination of the most effective prevention strategies and improvements in the quality of life for both children and their parents.

The analysis of publications indicates that falls in children under the age of three occur in various domestic contexts, including falls from furniture, caregivers' hands, and during the use of infant products, as well as in maternity wards:

1. *Falls from furniture and household risks.* Infants most commonly fall from beds, changing tables, and other pieces of furniture [2, 3, 7, 10]. For instance, a study by Mitchell et al. [7] found that falls from beds account for up to 33% of incidents, with traumatic brain injuries occurring in 70–85% of these cases. Other studies also confirm that traumatic brain injuries are widespread [2, 4, 13]. The height of the furniture and the hardness of the surface onto which the child falls are particularly significant factors [1, 9, 25, 26, 27, 28].
2. *Falls from caregivers' hands.* Parental fatigue, improper carrying techniques, and postpartum depression are important risk factors for falls from caregivers' hands [3, 6, 8, 15, 16]. Research findings confirm that such falls significantly increase the likelihood of hospitalization and severe injuries. In maternity wards, most falls occur at night, which is associated with maternal fatigue and the absence of support persons.
3. *Use of infant equipment.* Falls also occur during the use of baby walkers, strollers, and other infant devices [3, 7, 17]. Studies indicate that improper use or design flaws of infant equipment can lead to injuries, especially when parents underestimate the risks or become distracted.
4. *Risks associated with newborn falls.* In maternity wards and during the first days of life, newborns are also at risk of falling [8, 16, 17, 29]. Research findings suggest that these falls often occur because mothers fall asleep while feeding or caring for their infants [30, 31]. Increased awareness and educational programs for mothers can help reduce this risk.

Thus, studies cover a wide range of mechanisms and contexts related to falls in children under the age of three. The identified risk factors highlight the need for a comprehensive approach to prevention, including improving home safety, educating parents, and enhancing conditions in healthcare facilities.

Another common cause of falls in young children is falls from caregivers' hands. Research analysis indicates that such falls are among the most dangerous causes of injuries in children. These incidents occur for various reasons, including parental fatigue, postpartum depression, inattentiveness, and improper infant carrying techniques.

Several studies have found that falls from caregivers' hands often occur at night or on weekends when mothers experience the highest levels of fatigue [6, 8, 15, 16]. In maternity wards, most falls are associated with mothers falling asleep while feeding their infants. This is supported by findings showing that 82% of newborn falls occur at night [8].

Postpartum depression is also a significant risk factor. Research indicates that mothers with depressive symptoms are more likely to expose their children to fall risks [15, 16, 29]. Specifically, the likelihood of falls among these mothers increases significantly. Parental inattentiveness and emotional instability contribute to errors in handling infants, which in turn leads to falls [6, 7].

Trauma resulting from falls from caregivers' hands often leads to severe traumatic brain injuries [2, 10, 11, 25]. Researchers emphasize that the majority of infant hospitalizations are associated with such injuries. Moreover, falls from heights, which are characteristic of falls from caregivers' hands, increase the severity of skull fractures and the risk of intracranial hemorrhages.

Thus, falls from caregivers' hands pose a serious threat to infant health and require comprehensive preventive measures. These measures include parental education programs, increased awareness of risks, improved conditions in maternity wards, and support for mothers suffering from fatigue and postpartum depression.

Another key area of children falls is the use of infant equipment. An analysis of publications indicates that the use of walkers, strollers, cribs, and changing tables is associated with a significant risk of falls. These risks are influenced both by the structural design of the equipment and by improper use by parents.

Research findings show that falls from beds and changing tables are among the most common incidents [2, 3, 7, 17]. Specifically, up to 33% of infant falls are associated with beds [7]. Furthermore, improper use of protective railings or their absence can lead to serious injuries, including traumatic brain damage [10].

The use of baby walkers and strollers also carries risks. Studies indicate that falls occur when walkers or strollers tip over on uneven surfaces or when parents fail to provide adequate supervision [1, 6, 11, 12, 17]. These incidents often result in severe head and neck injuries, as infants are unable to protect themselves during a fall.

At the same time, other studies highlight the dangers of co-sleeping on an adult bed without special safety devices [8, 16, 25, 29, 30]. Researchers note that infants may fall during feeding or

sleep, especially when parents are fatigued or unintentionally fall asleep with their child.

Thus, the use of infant equipment requires special caution and strict adherence to safety recommendations. In this context, the implementation of educational programs for parents on the safe use of baby equipment and the development of improved safety standards can be highly beneficial in preventing falls and injuries in infants.

Another important aspect involves the risks associated with newborn falls. An analysis of studies indicates that newborns are at risk of falling both at home and in medical facilities, particularly in maternity wards. These risks are exacerbated by factors related to the physical and emotional state of mothers, the organization of newborn care, and environmental conditions. The nature and characteristics of these risks have been extensively examined from various perspectives.

Falls in maternity wards represent a distinct category, largely influenced by environmental conditions and the support provided by medical staff and family members. Studies have shown that newborn falls frequently occur at night due to maternal fatigue and the absence of companions [8, 16, 17, 29]. In most cases, falls happen when mothers fall asleep while breastfeeding [8]. Additionally, the incidence of newborn falls in hospitals ranges from 12.1 to 17 per 10,000 births [16]. In this context, vulnerable groups include mothers from socioeconomically disadvantaged backgrounds and those who received inadequate prenatal care [29].

Another contributing factor to infant falls is maternal fatigue and postpartum depression. Maternal exhaustion and emotional burnout are significant risk factors [6, 15, 16, 18]. Researchers note that postpartum depression increases the likelihood of newborn falls due to reduced attentiveness and impaired motor coordination. Mothers experiencing depression are more likely to expose their infants to fall risks [15].

Proper support and supervision are crucial factors in preventing infant falls. A lack of assistance and monitoring from medical staff or family members increases the risk of falls [7, 8, 16, 17]. Researchers recommend enhancing maternal supervision at night and implementing programs for safe mother-newborn cohabitation. Studies highlight that educational initiatives and safety agreements in maternity wards have successfully reduced fall risks to zero in some facilities [17].

Safety concerns when caring for newborns at home are also among the most common causes of infant falls [2, 3, 6, 12]. Research findings indicate that at home, newborn falls frequently occur during feeding or diaper changes. Studies show that falls from beds and changing tables are among the most common incidents. Additionally, parents often underestimate the risk of falls when placing infants at elevated positions or become distracted during caregiving.

Overall, the risks of newborn falls are associated with maternal fatigue and emotional state, inadequate support from medical staff, and unsafe caregiving practices. In this context, the need for implementing educational programs, improving conditions in maternity wards, and increasing parental awareness is evident to prevent such incidents.

Thus, falls in children under the age of three represent a significant issue, often leading to severe injuries and requiring close attention. The analysis of research findings highlights multiple contributing factors, including fall mechanisms, the use of infant products, parental fatigue, and newborn care practices, all of which increase the risk of injuries. Despite existing preventive measures, the incidence of falls remains high, emphasizing the need for a comprehensive approach to addressing this problem.

The aim of this systematic review is to analyze existing studies, identify key patterns and risk factors for falls, and propose effective preventive strategies to minimize injuries among young children.

Methodology

Information Sources

To conduct this systematic review, data were obtained from the authoritative database Web of Science Core Collection (WoS). The search query included the following key terms:

(*«infant»* OR «toddler*» OR «babies» OR «young children» OR «small children» OR «children aged 0-3» OR «children under three» OR «children aged 0-36 months» OR «early childhood (0-3 years)» OR «preschooler*» OR «nursery-aged children» OR «neonate*» OR «children under age three» OR «children aged 0 to 3 years» OR «early years» OR «infant and toddler*»)

As a result of the search, 422,712 article records were identified for the period from January 1, 2014, to December 14, 2024. The refined search included the following terms:

(*«fall»* OR «slip*» OR «trip*» OR «stumble*» OR «tumble*» OR «misstep*» OR «loss of balance» OR «losing balance*»)

The refined search yielded 9,681 records, which were exported in text format for further processing and analysis. The limitations of Web of Science (WoS) were taken into account, as the system allows downloading records only in batches of up to 1,000. Therefore, multiple files were downloaded.

For each record, a set of metadata fields provided by the WoS system was selected, including:

1. Author(s).
2. Title.
3. Source.

4. Times Cited Count.
5. Accession Number.
6. Abstract.
7. Keywords.
8. Cited References.
9. Cited Reference Count.
10. Usage Count.
11. Hot Paper.

For the automated processing and filtering of article records extracted from Web of Science (WoS), an algorithm was developed using the Python programming language. The algorithm included sequential steps aimed at data integration, thematic modeling, filtering of irrelevant records, and saving relevant results for further analysis (Figure 1).

1. Merging data from multiple files and adding missing keys (DE, ID).
2. Creating a combined text field based on titles (TI), abstracts (AB), and keywords (DE).
3. Thematic modeling using the Latent Dirichlet Allocation (LDA) model to identify key topics.
4. Filtering irrelevant data based on specially developed exclusion dictionaries.
5. Analyzing keywords and calculating the WeightedPairCount metric to determine record relevance.
6. Comparing results based on coherence score (Coherence Score) and perplexity score (Perplexity Score).
7. Checking text accuracy and removing irrelevant documents.
8. Extracting and saving relevant records for further analysis.

During the development of the algorithm, recommendations for text analysis [32, 33, 34, 35] and keyword visualization [36, 37] were utilized. The Latent Dirichlet Allocation (LDA) model [36, 38, 39, 40, 41] was applied to identify key topics, while recommendations [42] were followed for working with keyword pairs.

Keyword visualization and analysis were based on algorithms proposed in [43, 44]. Data processing was performed using the Python programming language in the PyCharm CE development environment, following recommendations [45] and data processing examples [46].

Examples of data processing are presented in an interactive Jupyter Notebook environment as files containing Python code, textual explanations, visualizations, and execution results.

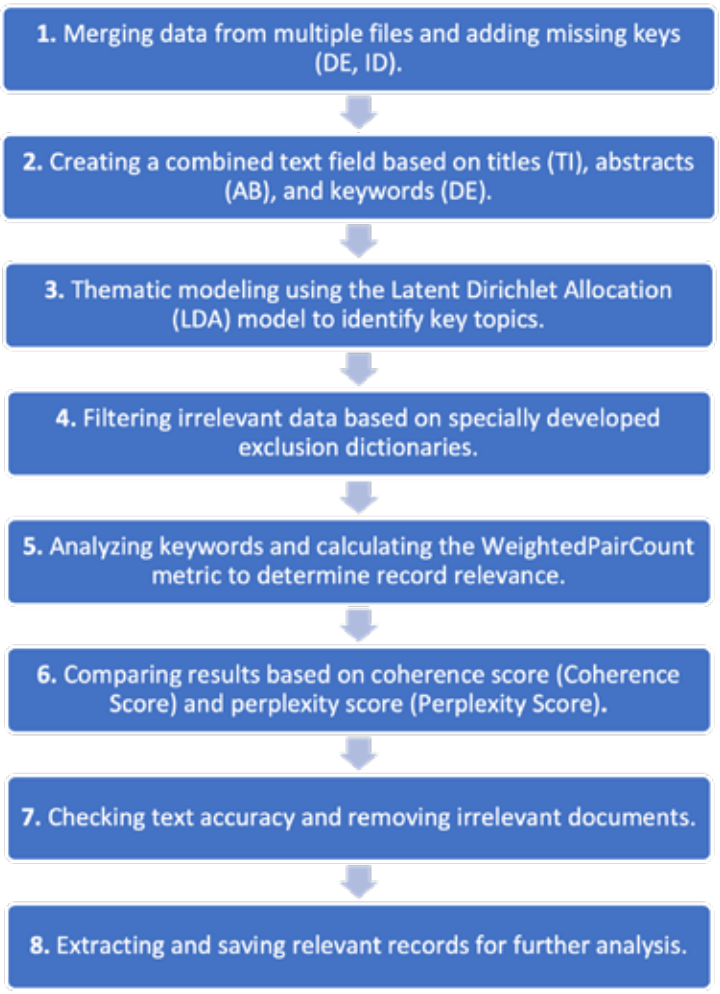

Figure 1. Algorithm for Automated Processing and Filtering of Extracted Document Data

The processing algorithm for the extracted 9,681 records is based on a Python script.

Step 1. Merging data into a single file.

Step 2. Missing keys DE, ID (keywords) were added to the final text file.

Step 3. Converting the text file into a csv table. The following key columns were retained: UT, TC, Z9, TI, AB, DE.

Step 4. Creating a csv table by combining data from the TI, AB, and DE fields (title, abstract, keywords) into a new column named "CombinedText."

Step 5. Preliminary data processing was performed using the Latent Dirichlet Allocation (LDA) topic modeling technique to analyze texts related to falls in children under the age of three. To improve filtering accuracy, three sets of keywords were created:

- Table 1 includes words related to falls, slipping, and loss of balance.
- Table 2 contains words referring to children of different age groups.
- Table 3 represents exclusion terms for contexts where «fall» is irrelevant (e.g., fall in tone, voice, or voltage).

The analysis produced two output files:

- An interactive visualization of the topic model, allowing the exploration of identified topics and their keywords (Figure 2).
- A csv table containing topics with corresponding keywords and their weights, enabling the assessment of term significance for each topic (Table 4).

Step 5.2. Creating the «word pairs» table, containing Topics 1-5 with corresponding keywords and their weights (Table 5). Word pairs were generated based on the data from Table 4.

Step 5.3. Topic modeling of textual data using Latent Dirichlet Allocation (LDA) to identify relevant topics related to falls in children under the age of three.

Building and Evaluating the Topic Model Based on Single Keywords

During the analysis, textual data were loaded and preprocessed, with unwanted words filtered out (Table 3). Additionally, single keywords with their weights (Table 4) were used for topic construction and interpretation. Based on these keywords and their weights, an LDA model was built and its quality was evaluated using two metrics: Coherence Score and Perplexity Score.

The obtained coherence score of 0.5137 indicates good interpretability of the identified topics, while the perplexity score of -7.8255 confirms the model's adequate quality for text analysis. As a result of the analysis, 9,162 texts containing keyword pairs were

Table 1. Keywords Related to Falls, Slipping, and Loss of Balance

Term	Term	Term	Term	Term	Term
accident	dropping	injury	plummet	slips	trip
collapse	drops	loss of balance	plummeting	stumble	tripping
collapses	fall	loss of stability	plummets	stumbles	trips
collapsing	falling	misstep	slip	stumbling	tumble
drop	falls	missteps	slipping	term	tumbles
					tumbling

Table 2. Keywords Referring to Children of Different Age Groups

Term	Term	Term	Term	Term	Term
0-3 years	children	kid	minor	preschooler	under three
babies	early childhood	kids	minors	preschoolers	young child
baby	infant	little one	newborn	toddler	young children
child	infants	little ones	newborns	toddlers	

Table 3. Keywords Representing Exclusions for Terms Related to Falls in Irrelevant Contexts (e.g., Fall in Tone, Voice, or Voltage).

Term	Term	Term	Term	Term	Term
connection	intonation	network	prices	sound	term
current	market	performance	productivity	spirits	tone
economy	melody	phonetics	sales	stocks	voice
electricity	modulation	pitch	signal	system	voltage
emotion	mood	pressure	sleep	tension	volume

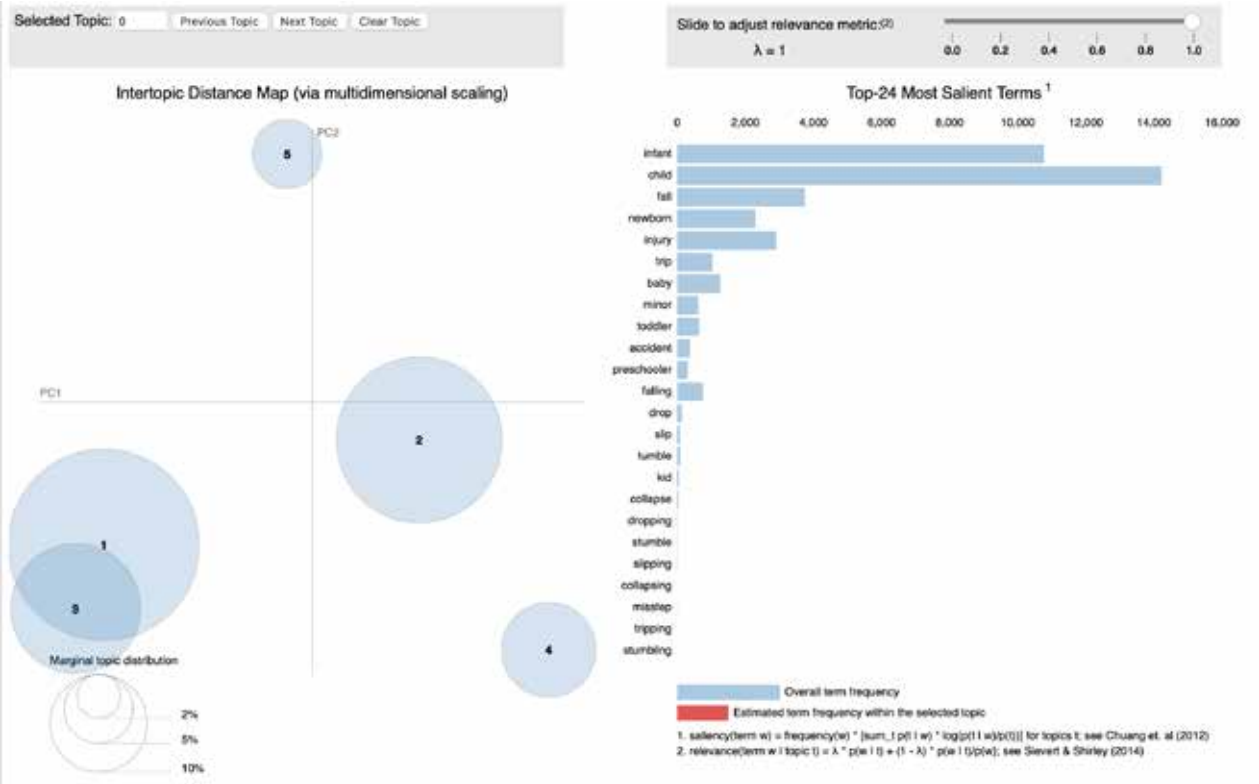

Figure 2. Visualization of the LDA Topic Model

Table 4. Topics 1-5 with Corresponding Keywords and Their Weights

Topic	Word	Weight	Topic	Word	Weight	Topic	Word	Weight
1	trip	0.51776624	2	fall	0.49146256	3	child	0.92646277
1	minor	0.3109011	2	injury	0.41545394	3	preschooler	0.020624485
1	toddler	0.14663507	2	accident	0.053672247	3	fall	0.018069744
1	dropping	0.0102854315	2	slip	0.013783207	3	falling	0.015137653
1	stumble	0.007417748	2	kid	0.0088882195	3	toddler	0.014641935
1	collapsing	0.0016901668	2	falling	0.006551952	3	tumble	0.0045594224
1	child	0.0005535626	2	toddler	0.0048607984	3	tripping	0.0002632921
1	tripping	0.00028341226	2	child	0.004840822	3	infant	2.8433058e-05
1	preschooler	0.00028195884	2	tripping	3.194148e-05	3	stumbling	1.3577792e-05
1	falling	0.00028068954	2	infant	3.169092e-05	3	kid	1.348228e-05
Topic	**Word**	**Weight**	**Topic**	**Word**	**Weight**	**Topic**	**Word**	**Weight**
4	newborn	0.6196446	5	infant	0.9363925			
4	baby	0.33841112	5	falling	0.0387131			
4	falling	0.013646641	5	drop	0.012827579			
4	collapse	0.010727893	5	toddler	0.008445616			
4	tumble	0.008627171	5	fall	0.00230526			
4	slipping	0.0050322046	5	misstep	0.0007479259			
4	fall	0.0013785487	5	stumbling	0.00023597914			
4	infant	0.0013492565	5	child	2.5719393e-05			
4	child	7.597436e-05	5	slipping	1.9695673e-05			
4	drop	7.483887e-05	5	tripping	1.9487621e-05			

Table 5. Pairs of Keywords (Fragment Based on the Word «Fall» in Combination with Others).

Source	Target	Weight	Topic
fall	injury	0.45345825	2
fall	accident	0.27256740349999997	2
fall	slip	0.2526228835	2
fall	kid	0.25017538975	2
fall	falling	0.249007256	2
fall	toddler	0.24816167919999998	2
fall	child	0.248151691	2
fall	tripping	0.24574725074	2
fall	infant	0.24574712546	2

Note. A total of 224 word pairs.

filtered, and a dictionary including 59,760 unique terms was created. These results demonstrate that the model successfully identifies meaningful topics and can be used for further text analysis and classification based on keyword weights.

Building and Evaluating the Topic Model Based on Keyword Pairs

The preprocessing and modeling algorithm is similar to the approach used for single keywords: text cleaning, filtering of unwanted words, and the creation of a dictionary and corpus for training the model. As a result of the analysis, 298 texts containing keyword pairs were filtered, and a dictionary including 37 unique terms was generated.

The modeling results produced the following metrics: a coherence score of 0.8185, indicating a high interpretability of topics, and a perplexity score of -2.9333, confirming the model's predictive quality. These results demonstrate that the model effectively identifies meaningful topics for further analysis based on both single words and keyword pairs.

Thus, the use of single keywords covers a large number of texts, providing a broad thematic overview. However, given the review's focus, the most suitable analytical approach is based on the use of keyword pairs.

Step 5.4. To identify the most relevant texts, an analysis method based on weighted keyword pairs is used (Table 5). Each text is cleaned of stop words, numbers, and punctuation marks, after which the «WeightedPairCount» metric is calculated—the total weight of all keyword pairs found in the text. Texts with the highest «WeightedPairCount» values are selected as the most relevant and analyzed for further research.

As a result of the processing, the Top 30 documents were identified, with their text containing the highest WeightedPairCount values. These Top 30 documents were then checked for the presence or absence of only the word «fall». This verification aimed to test the assumption that documents containing only the word «fall» (including its synonyms) are less likely to be relevant to the review topic. Additionally, this step helped eliminate potential errors in the automated selection of relevant documents that do not pertain to the physical falls of children.

The verification established the following:

- Out of 30 documents, 4 did not contain the word «fall». Content analysis revealed that these documents were not related to the physical falls of children.
- The word «fall» appeared as a single keyword in 9 documents. Among them, 2 documents described rare cases of injuries resulting from the fall of only one child. The remaining 7 documents were not related to the review topic.

This analysis led to refinements in the Python script. A repeated verification identified 17 relevant documents. These documents were manually reviewed by the authors for alignment with the review topic. The analysis confirmed that all 17 documents were relevant to the subject of the review.

Evaluation of Filtering Quality

A comprehensive approach was used to assess the quality of filtering the extracted documents. Coherence and perplexity metrics were applied (Coherence Score = 0.8185, Perplexity Score = -2.9333), calculated for both single and paired keywords, taking into account their weights. Topic visualization using pyLDAvis confirmed the interpretability and stability of the topic modeling results.

Additionally, frequency-based filtering was performed to identify the most commonly occurring keywords and their distribution across topics. The analysis revealed that relevant terms such as *falling, children, injury,* and *walking* consistently appeared in the identified topics, confirming the correctness of the filtering process.

To improve the accuracy of selecting relevant documents, filtering by thematic directions and keyword group combinations was applied (e.g., *fall and child; fall, child, and injury*). This approach ensured coverage of all key aspects of the research topic and allowed the selection of the 30 most relevant documents from the overall dataset.

For result verification, a repeated filtering was performed on different data subsets, demonstrating

a high degree of reproducibility (over 90%). This confirms the reliability and stability of the filtering algorithm. Additionally, an expert analysis of the selected documents was conducted, which verified that the identified articles corresponded to the stated research topic.

Results

Based on the analysis, 17 documents relevant to the review topic were selected. The results of the automated process demonstrated a high coherence score (0.5137) and a low perplexity score (-7.8255), indicating the quality of the identified topics and their alignment with the research problem (Table 6). These findings confirm the effectiveness of the proposed approach for extracting relevant documents.

The analysis identified the main mechanisms of falls and associated injuries in children of different age groups. Common causes of falls include falls from furniture, during carrying, and at ground level [3]. The risk of hospitalization increases in cases where infants fall from caregivers' hands [6]. Falls from beds are the most frequently recorded [7], especially at night and on weekends [16].

Factors influencing injuries include fall height, impact force, and body orientation at the time of the fall [9]. The number of hospitalizations due to falls increased from 342 to 469 cases over a ten-year period [10]. Traumatic brain injury was diagnosed in 85% of children [12], while 56.4% sustained minor injuries such as bruises and abrasions [2].

Preventive measures, such as comprehensive safety programs, have proven effective, reducing the risk of falls to zero during the observation period [17]. Additionally, targeted strategies have been identified, including adequate maternal rest and safe feeding practices [18].

It was also found that falls are associated with other injury risks, such as intracranial injuries and skull base fractures in motorcycle accidents [48]. Furthermore, a link has been established between falls and postpartum depression in mothers [15].

The distribution of articles across the main topics is presented in the diagram (Figure 3).

The distribution of articles reveals several key trends (Figure 2). The largest share of research focuses on head injuries and the factors influencing their occurrence, highlighting the severity of fall-related consequences. Significant attention is also given to the context and causes of falls, emphasizing the importance of understanding the circumstances and mechanisms leading to these incidents.

Topics related to preventive measures and other risk factors are less represented, indicating the need for further research in the field of prevention and additional factors affecting falls in young children.

The automated analysis based on the WeightedPairCount metric enabled the identification of the most relevant documents and key word pairs related to falls in young children.

Figure 4 presents the Top 17 documents with the highest WeightedPairCount values, indicating their strongest alignment with relevance criteria. These documents were selected for further content analysis.

Figure 5 displays the Top 20-word pairs with the highest WeightedPairCount values, reflecting the key contextual relationships and essential terms

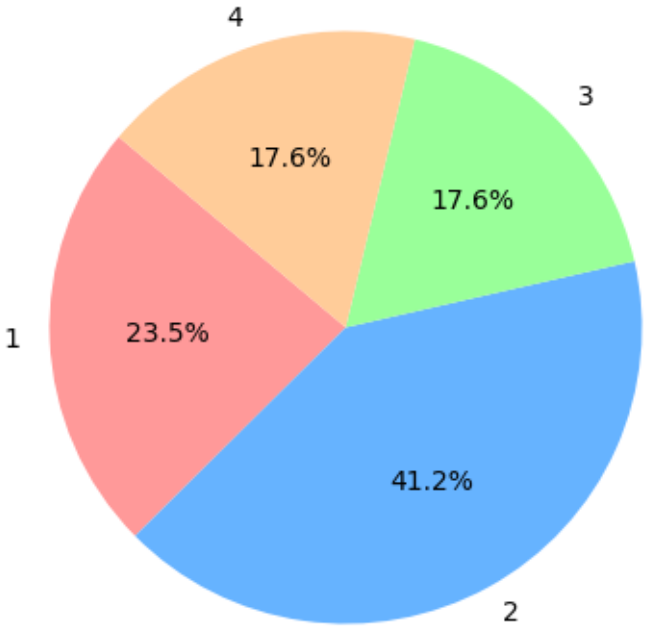

Figure 3. Distribution of Articles by Main Themes: Topic 1. Content and Causes of Falls; Topic 2. Injuries and Significant Factors; Topic 3. Preventive Measures; Topic 4. Risk Factors.

Table 6. Results of the Automated Selection of Relevant Documents

ID	Research Objective	Participants	Age	Methods (Tests and Equipment)	Results	Conclusions
	Topic 1. Content and Causes of Falls					
3	Investigate contextual factors of infant falls using online parenting forums.	461 cases of infant falls.	Up to 12 months.	Data collection from online forums; qualitative analysis of discussions using Google Search and a programmatic script.	Common fall mechanisms: from furniture, during carrying, while using infant products, and at ground level. Factors: motor development, inattention, obstacles.	Strategies to modify parental behavior are needed to prevent falls. Online forums serve as a valuable source of information for injury prevention.
6	Study the mechanisms of falls and injury patterns in infants under 1 year old.	916 infants	Infants (<1 year)	Retrospective analysis of pediatric trauma center data in Sydney (2011-2013).	11.6% were hospitalized, 85% sustained traumatic brain injuries. Infants dropped by adults were three times more likely to be hospitalized.	Falls from caregivers' hands and furniture pose the greatest risk. Preventive measures should focus on these mechanisms and improving the safety of the infant's environment.
7	Identify circumstances leading to medically recorded fall-related injuries in children under 4 years old.	Young children (0-4 years).	0-4 years.	Cross-sectional study of data from the National Injury Surveillance System. Analysis of 4,546 fall incident descriptions.	Falls from beds were common (33% in infants, 13% in toddlers, and 12% in preschoolers).	Effective communication with parents is necessary to prevent fall-related injuries in children. Fall prevention is crucial for child safety.
16	Study cases of newborn falls in a hospital serving an ethnically diverse and socioeconomically disadvantaged population in New Zealand.	32 cases of newborn falls.	Newborns.	Retrospective analysis of incidents from 2015-2018, based on medical records and incident reporting system data.	Incidence: 12.1 per 10,000 live births. Falls occurred more frequently at night and on weekends. In 84% of cases, the mother fell asleep with the infant on the bed during breastfeeding. No severe injuries were reported.	Preventive measures should be integrated into safe sleep programs to reduce newborn fall incidents. Special attention should be given to mothers with late prenatal care, smokers, and those with obesity.
	Topic 2. Injuries and Significant Factors					
9	Investigate the impact of fall parameters and child characteristics on dynamics and potential injuries when falling from a bed.	Computer model of a bed fall.	12 months.	Computer simulation of falls using an anthropomorphic model, analyzing parameters (height, surface hardness, mass, neck and head stiffness).	The most influential factors for injuries were fall height, initial impact force, and model mass. Fall dynamics and impact orientation played a key role in the risk of head and neck injuries.	Environmental factors (bed height, surface hardness) have a greater effect on injury outcomes than model parameters (neck and head stiffness). These factors are crucial for injury assessment.

Table 6. Continued.

ID	Research Objective	Participants	Age	Methods (Tests and Equipment)	Results	Conclusions
10	Determine the prevalence of infant hospitalizations after falls and examine demographic and injury-related characteristics.	4,380 hospitalized infants.	Up to 12 months.	Retrospective study of hospitalization data in New South Wales (2002-2013). Analysis of fall causes, injury types, and socio-demographic data.	The number of hospitalizations increased from 342 (2002) to 469 (2013). 85% sustained head injuries, 70% of them had traumatic brain injuries. Falls from furniture and during carrying were the most common.	The hospitalization rate is not decreasing. Effective preventive measures are needed to reduce infant falls, particularly to prevent head and brain injuries.
12	Assess the occurrence of severe traumatic brain injuries (e.g., subdural hematomas) in children due to falls from low heights.	1,494 infants and toddlers.	Up to 2 years.	Retrospective analysis of hospital records. Comparison of groups of children with falls witnessed by non-relatives and those that were not witnessed.	Subdural hematomas were absent in the group with witnessed falls ($p = 0.027$). Retinal hemorrhages and neurological consequences were also not observed in this group.	Severe injuries such as subdural hematomas and retinal hemorrhages do not occur from low-height falls when witnessed by non-relatives.
11	Determine how infant age and parameters of low-height falls influence the nature of skull fractures.	231 skull reconstructions (CT scans).	Infants.	CT scan analysis with 3D reconstruction, measurement of fracture length and nonlinearity, regression analysis to assess the influence of age and fall parameters.	Younger age and greater fall height affect the complexity of fractures. The impact surface influences the number of fractures. Fracture length increases with fall height.	Age-related characteristics of the infant skull determine unique fracture patterns. Understanding these patterns helps differentiate accidental falls from trauma caused by abuse.
25	Compare the risk of midline brain structure shift in TBI among children depending on fall height.	Children under 18 years.	Not specified.	Analysis of data from the Pediatric Trauma Quality Improvement program; logistic regression to assess displacement risk.	Falls from ground level were associated with a threefold reduction in the risk of midline structure shift compared to falls from height. In older children, falls from height increased the risk of midline structure displacement.	Falls from height in children are linked to a higher risk of midline brain structure shift in TBI compared to ground-level falls. Fall height should be considered when assessing injury severity.
2	Determine the frequency and characteristics of injuries related to infant falls from beds or other furniture.	1,439 infants (54.3% boys, 45.7% girls).	Infants under 1 year.	Retrospective analysis of fall cases over four years (2016-2019), including demographic and clinical data.	56.4% had minor injuries (abrasions, bruises). 9.4% had significant injuries (skull fractures, arm fractures, dislocations). 6% of children were hospitalized due to traumatic brain injuries.	Falling from a bed can cause skull fractures and brain injuries. Parents should be informed about risks and use protective equipment such as bed rails.

Table 6. Continued.

ID	Research Objective	Participants	Age	Methods (Tests and Equipment)	Results	Conclusions
47	Investigate the characteristics and outcomes of head injuries in children after falls from height.	520 children with neurotrauma.	Up to 16 years.	Retrospective analysis of demographic data, clinical parameters, imaging results, and Glasgow Outcome Scale scores.	67% of falls were from low heights. Mild TBI in 82.8%, moderate in 13.8%, severe in 3.2%. CT findings: normal results (59%), subgaleal hematomas (18.6%), epidural hematomas (9.9%). Mortality rate: 2.3%. Average GOS-E score: 1.	Age, gender, fall height, loss of consciousness, and seizures predict injury severity. Midline structure displacement and associated injuries influence treatment outcomes.
Topic 3. Preventive Measures						
17	Develop a comprehensive safety program for newborns to prevent falls and ensure safe sleep.	Mothers and their newborns.	Newborns.	Infant fall risk assessment, safety agreements, education on safe sleep practices, and fall reporting system.	Before implementation, 14% of infants were at risk of falling; after implementation, no falls were recorded until May 2017.	Raising parental awareness and implementing safe sleep practices help prevent falls and create a safer environment for newborns.
8	Assess the clinical characteristics of newborns who experienced falls in maternity wards and identify near-miss fall events in the postpartum period.	17 newborns and 804 mothers.	Newborns (< 72 hours).	Retrospective analysis of newborn falls over six years and a prospective study of near-miss falls over four weeks.	17 fall cases (1.8–2.4 per 10,000 births). Most falls occurred at night (82%). 67 mothers (8.3%) experienced near-miss falls. 86% of mothers had no companions.	Newborn falls frequently occur at night due to maternal fatigue. Increased nighttime supervision of mothers is needed to prevent falls in maternity wards.
18	Develop a digital intervention for parents in the form of a mobile application based on behavior change theory to prevent infant falls during feeding.	Parents of infants.	Infants.	Theoretical framework: Behaviour Change Wheel; mobile app development; user testing (think-aloud interviews and comprehension assessment).	Identified target behaviors: adequate maternal rest and safe feeding practices (preparation, positioning, and infant placement). Users found the information useful, and tracking and support features effective.	Behaviour Change Wheel was applied for the first time in developing a mobile app for infant injury prevention. The study highlights the importance of theory-based approaches to improving infant safety.
	Topic 4. Risk Factors					

Table 6. Continued.

ID	Research Objective	Participants	Age	Methods (Tests and Equipment)	Results	Conclusions
29	Analyze trends in child injury mortality in Korea from 2006 to 2016 and develop preventive measures.	Children in Korea.	0-14 years.	Microdata from Korea's mortality statistics, classification based on KCD-7.	In 2016, 270 child injury-related deaths were recorded. The mortality rate decreased from 8.1 per 100,000 (2006) to 3.9 (2016). Boys had a 1.7 times higher risk of death. 72.6% of deaths were due to unintentional injuries, while 27.4% were intentional. The leading cause of unintentional injury-related death in infants (under 1 year) was suffocation, whereas in children aged 1 to 14 years, it was traffic accidents. The second leading cause of death in infants was traffic accidents, while for children aged 1 to 4 years, it was falls.	Nationwide measures and targeted interventions are needed to prevent child injury-related deaths based on their causes.
48	Assess the impact of road traffic accidents (RTAs) on traumatic brain injuries (TBIs) in children and identify risk factors.	948 children with TBI.	Under 15 years.	Retrospective study, statistical analysis of factors (injury mechanism, clinical signs, intracranial pathologies).	Motorcycle RTAs were associated with an increased risk of intracranial injury (OR 1.73). Other factors: hemiparesis (OR 5.69), signs of skull base fracture (OR 15.66), fixed pupil response (OR 5.74). Mortality rate: 3.2%, correlating with motorcycle RTAs and severe TBI.	Motorcycle RTAs are a major risk factor for TBI in children in Southern Thailand. Prevention programs are needed to reduce mortality and disability among children.
15	Investigate the relationship between postpartum depression in mothers and unintentional injuries in infants.	6,534 mothers.	Up to 4 months.	Questionnaire, Edinburgh Postnatal Depression Scale (EPDS), logistic regression.	9.8% of infants sustained injuries (falls – 5.6%, near-drowning – 1.2%). 9.5% of mothers had postpartum depression. Falls were associated with depression (OR 1.41, 95% CI 1.02-1.95).	Postpartum depression may be a risk factor for unintentional injuries in infants up to 4 months old. Further research is needed to confirm this association.

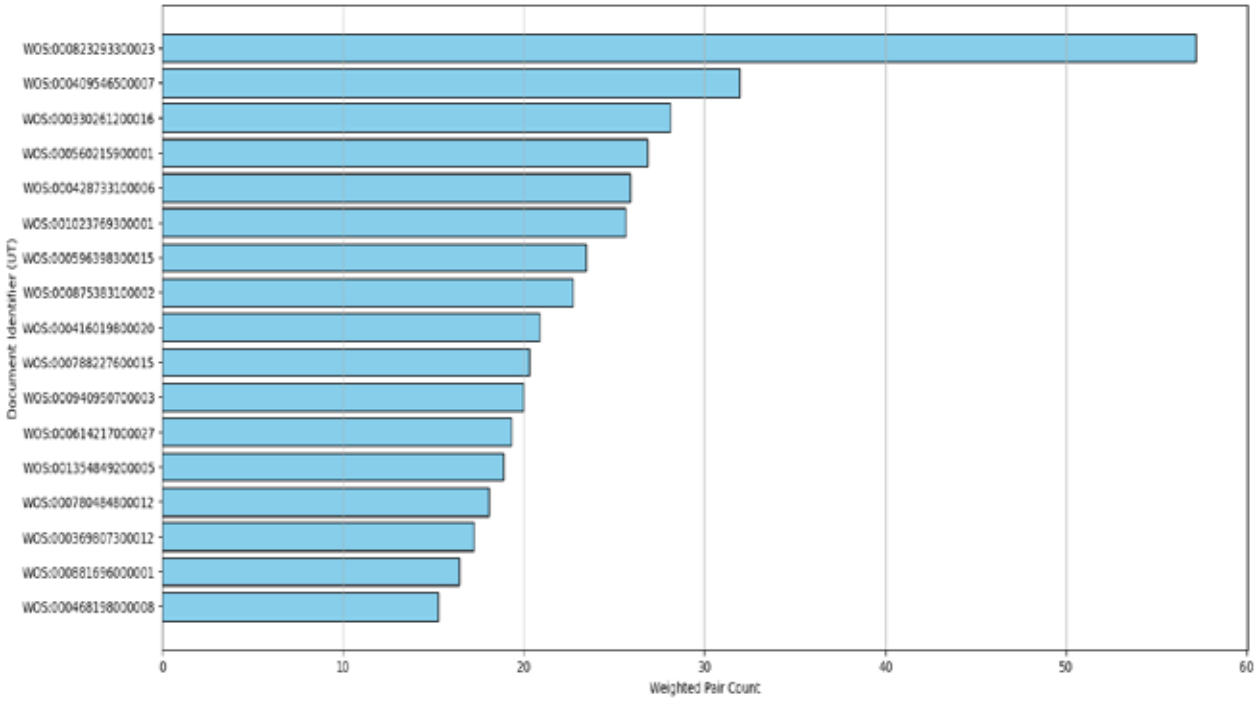

Figure 4. Top 17 Documents with the Highest WeightedPairCount Values

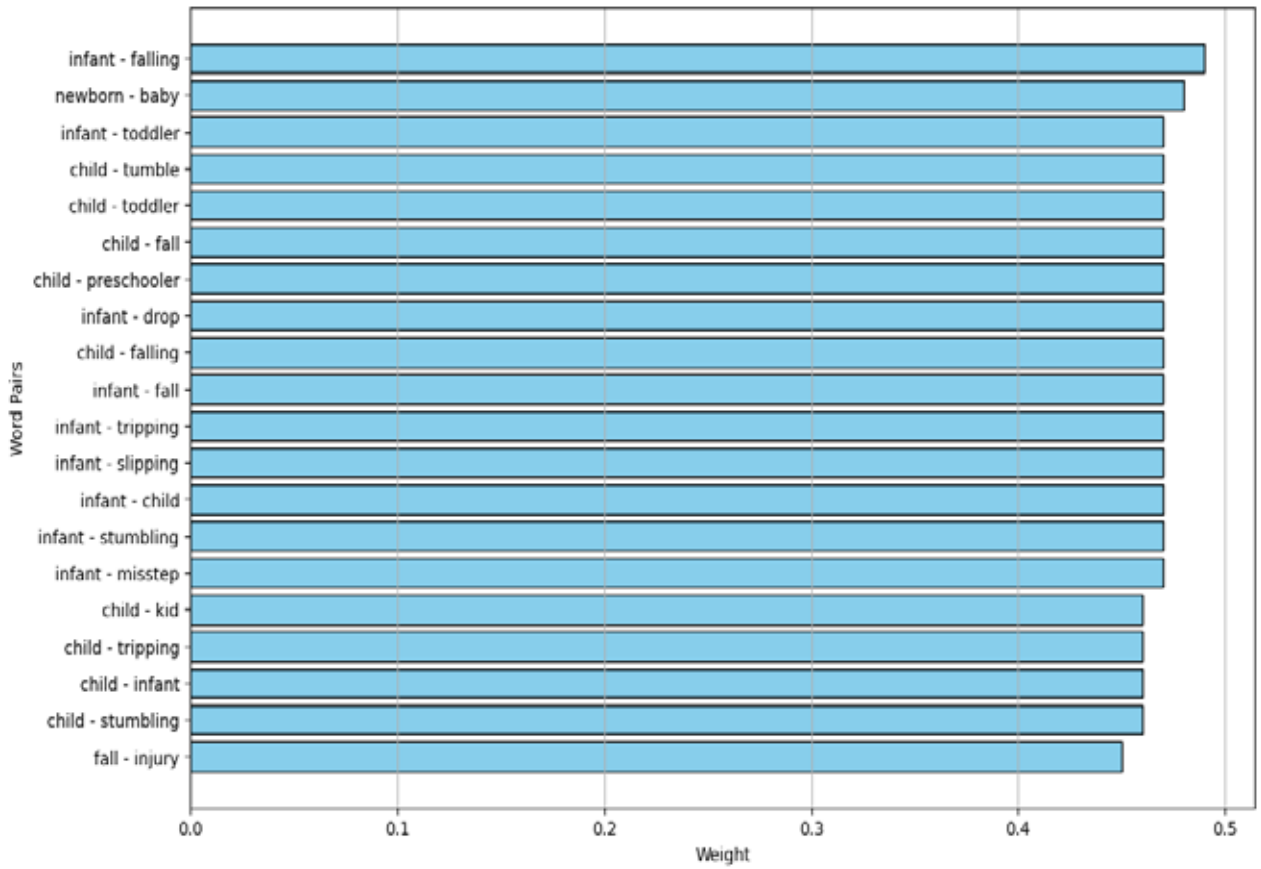

Figure 5. Top 20 Word Pairs with the Highest WeightedPairCount Values

associated with child falls. These word pairs help identify dominant themes and research directions in the analyzed articles.

A graph was constructed based on the weighted word pairs from the analyzed text, visualizing word connections and their relevance (*Figure 6*). The nodes of the graph represent words, while the edges between them reflect paired associations. The thickness of the edges is proportional to the weight of the word pair: the greater the weight, the more significant the influence of that pair in the analyzed context.

The central position of nodes with thick edges indicates a high degree of connectivity and importance, whereas peripheral nodes and thin lines represent less significant word pairs.

Figure 6. Visualization of Weighted Word Pairs Reflecting the Significance of Connections and Their Relevance in Text Analysis

Discussion

The aim of this study was to identify key patterns and factors influencing falls in children under the age of three, as well as to assess the severity of injuries and potential preventive measures. The results of our analysis revealed several key aspects:

- *Topic 1.* Content and Causes of Falls;
- *Topic 2.* Head Injuries and Significant Factors;
- *Topic 3.* Preventive Measures;
- *Topic 4.* Risk Factors.

1. *Content and Causes of Falls*

- Infant falls most commonly occur from furniture, caregivers' hands, or while using infant equipment.
- The highest risk comes from falls off beds and other surfaces due to height and impact force.
- Nighttime falls are associated with parental fatigue, particularly in the postpartum period.

2. *Injuries and Significant Factors*

- Traumatic brain injuries are the most common and account for a significant proportion of infant hospitalizations.
- The complexity of skull fractures depends on fall height and the child's age.
- Severe injuries rarely occur from falls at low heights.

3. *Preventive Measures*

- Implementing educational programs for parents and raising awareness of safe practices can effectively reduce fall frequency.
- The use of mobile applications based on behavior change theory helps parents adhere to safety measures.
- Increased supervision in maternity wards, especially at night, is recommended to prevent newborn falls.

4. *Risk Factors*

- Falls often occur due to parental fatigue or insufficient supervision during feeding and carrying.
- Postpartum depression in mothers increases the risk of unintentional infant injuries.
- Road traffic accidents, environmental factors, medical staff qualifications, and socioeconomic conditions are also contributing risk factors for child falls.

The analysis of included studies revealed that falls from furniture and caregivers' hands pose the greatest danger [6]. In the study by Cooray et al. [10], the most common incidents were falls from furniture and during carrying, with 85% of children sustaining traumatic brain injuries. Findings from a study of 672 children conducted by Kendrick et al. [49] also confirmed the prevalence of falls from furniture.

Shimony-Kanat et al. [4] found that falls from furniture were the leading cause of injuries in children aged 0 to 12 months (estimated probability 37.9%), whereas slipping was the primary cause in children aged 13 to 36 months (estimated probability 38.4%).

Other studies also report frequent cases of falls from furniture [1, 2, 3, 50, 51], including falls from caregivers' hands [5, 51]. Additionally, common fall scenarios were identified, such as falls from beds and the use of unsafe equipment [3, 52, 53].

Supporting evidence comes from other studies with slightly lower relevance, including falls resulting in traumatic brain injuries [2, 4, 13] and falls from unsafe equipment (including beds) [2, 7, 16, 54, 55].

The reviewed studies highlight agreements or consistencies with the findings of another research. For example, Sullivan et al. [25] noted that their results align with previous studies, confirming that falls from heights (e.g., furniture) lead to more severe injuries than falls at ground level. Additionally, computer modeling demonstrated that fall height and surface hardness significantly influence the risk of head and neck injuries [9]. A similar consistency in findings was observed in the study by Ruiz-Maldonado et al. [11], where the authors stated that their results matched clinical studies showing that higher falls increased the complexity of skull fractures.

Other studies analyzed in this review confirmed that modifications in the home environment can significantly reduce fall risks [17]. For example, the use of bed rails and educating parents on safe infant carrying methods contribute to a decrease in injury cases [2]. Furthermore, it is important to consider that falls occur more frequently at night due to maternal fatigue, emphasizing the need for enhanced supervision in maternity wards [8].

Supporting evidence comes from other studies with slightly lower relevance, including the creation of a child-safe home environment [19], such as installing bed rails [2]; parent education and awareness programs [2, 3, 55]; and initiatives to reduce maternal fatigue, especially at night [16].

The limitations of the studies presented in the reviews highlight several key issues. Arumalla et al. [47] stated that some studies lacked information on the long-term consequences of injuries. Cooray et al. [3] identified that a significant limitation of the included studies was the retrospective nature of data collection and reliance on parental self-reports, which could lead to inaccuracies. Supporting evidence comes from other studies with slightly lower relevance, including the use of parental surveys [31, 56, 57, 58, 59].

The practical significance noted in the analyzed studies focuses on several directions. One study [18] emphasizes the need for the development of educational programs for parents aimed at fall prevention. Another study highlights that mobile applications have proven effective in increasing parental awareness [18]. Cooray et al. [8] stress the importance of implementing measures to ensure safe sleep for newborns and prevent falls in maternity wards.

Supporting evidence comes from other studies with slightly lower relevance, including fall prevention in the context of child safety [7, 16] and the use of mobile applications [24, 56].

In the analyzed studies, the authors also emphasize directions for future research. Future studies should focus on the development and evaluation of preventive measures across different social and cultural contexts. Additionally, a more in-depth analysis of the impact of postpartum depression on fall risk is required [15].

It would also be beneficial to examine the long-term consequences of traumatic brain injuries on the development of children under the age of three [11] and the effects of road traffic accidents [49].

Supporting evidence comes from other studies with slightly lower relevance, including prevention strategies considering social and cultural practices [1, 60].

Thus, the analysis of studies has shown that falls in children under the age of three represent a significant issue requiring a comprehensive approach to prevention. The most hazardous fall mechanisms are associated with household environments, parental fatigue, and improper use of infant products.

Traumatic brain injuries account for a substantial proportion of fall-related consequences, highlighting the importance of timely identification of risk factors and the implementation of effective preventive measures.

Key steps to reduce the frequency and severity of falls include:

- Developing educational programs for parents,
- Improving home safety,
- Enhancing supervision in medical facilities.

Future research should consider the socio-cultural characteristics of families and the long-term consequences of injuries on children's health.

Study Limitations

Despite the obtained results, there are certain limitations in the analyzed studies.

First, many studies have a retrospective design and rely on parental self-reports, which may lead to inaccuracies and incomplete data.

Second, some studies lack information on the long-term consequences of traumatic brain injuries. Additionally, certain studies are limited in their geographic and socio-economic context, making it difficult to generalize findings to other populations.

Third, several methodological and data quality limitations should be considered. Specifically, the algorithm relies on the presence of keywords and their synonyms to identify relevant texts, which may result in the exclusion of important documents if they use non-standard or rarely occurring terms. Furthermore, texts with ambiguous contexts, where the word «fall» is used metaphorically, may be erroneously classified as irrelevant.

Finally, limitations may also stem from data quality and database completeness, which can influence the final selection of articles.

Conclusions

Falls in children under the age of three represent a serious issue, leading to significant injuries and posing a threat to the health and quality of life of infants and young children. To reduce the incidence of falls, comprehensive preventive measures are necessary. These include:

- Educational programs for parents,
- Improvement of conditions in maternity wards,
- Safe use of infant products,
- Enhancement of safety standards in home environments.

Future research should focus on the development and implementation of effective prevention strategies, taking into account the socio-economic and cultural characteristics of families, as well as improving data collection methods for a more accurate assessment of risks.

Conflict of interests

The author declare that there is no conflict of interests.

References

1. Tian J, Cheng PX, Wang XN, Xiang H, Gao Q, Zhu HP. Exploring home fall events among infants and toddlers using social media information: an infodemiology study in China. *Injury Prevention*, 2025;31(3): 229–235. https://doi.org/10.1136/ip-2023-045014
2. Kokulu K, Algin A, Özdemir S, Akça HS. Characteristics of injuries among infants who fall from bed. *Injury-international Journal of The Care of The Injured*, 2021;52(2): 281–285. https://doi.org/10.1016/j.injury.2020.10.015
3. Cooray N, Sun SL, Adams S, Keay L, Nassar N, Brown J. Exploring Infant Fall Events Using Online Parenting Discussion Forums: Infodemiology Study. *Jmir Pediatrics and Parenting*, 2022;5(2): e34413. https://doi.org/10.2196/34413
4. Shimony-Kanat S, Benbenishty J. Age, Ethnicity, and Socioeconomic Factors Impacting Infant and Toddler Fall-Related Trauma. *Pediatric Emergency Care*, 2018;34(10): 696–701. https://doi.org/10.1097/PEC.0000000000000865
5. Burrows P, Trefan L, Houston R, Hughes J, Pearson G, Edwards RJ, et al. Head injury from falls in children younger than 6 years of age. *Archives of Disease in Childhood*, 2015;100(11): 1032–1037. https://doi.org/10.1136/archdischild-2014-307119
6. Mulligan CS, Adams S, Tzioumi D, Brown J. Injury from falls in infants under one year. *Journal of Paediatrics and Child Health*, 2017;53(8): 754–760. https://doi.org/10.1111/jpc.13568
7. Omaki E, Shields W, Rouhizadeh M, Delgado-Barroso P, Stefanos R, Gielen A. Understanding the circumstances of paediatric fall injuries: a machine learning analysis of NEISS narratives. *Injury Prevention*, 2023;29(5): 384–388. https://doi.org/10.1136/ip-2023-044858
8. Unal S, Demirel N, Tokgoz-Cuni B, Iyigun F, Tekin OM, Bas AY. In-Hospital Newborn Falls and Near Miss Events: A Need to Report. *American Journal of Perinatology*, 2024;41: e1378–e1383. https://doi.org/10.1055/s-0043-1764209
9. Thompson A, Bertocci G. Pediatric bed fall computer simulation model: Parametric sensitivity analysis. *Medical Engineering & Physics*, 2014;36(1): 110–118. https://doi.org/10.1016/j.medengphy.2013.10.006
10. Cooray N, Adams S, Zeltzer J, Nassar N, Brown J. Hospitalised infants due to falls aged less 12 months in New South Wales from 2002 to 2013. *Journal of Paediatrics and Child Health*, 2020;56(12): 1885–1890. https://doi.org/10.1111/jpc.15071
11. Ruiz-Maldonado TM, Alsanea Y, Coats B. Age-related skull fracture patterns in infants after low-height falls. *Pediatric Research*, 2023;93(7): 1990–1998. https://doi.org/10.1038/s41390-022-02345-9
12. Amagasa S, Uematsu S, Tsuji S. Occurrence of traumatic brain injury due to short falls with or without a witness by a nonrelative in children younger than 2 years. *Journal of Neurosurgery-pediatrics*, 2020;26(6): 696–700. https://doi.org/10.3171/2020.6.PEDS20314
13. Balogun JA, Koko AM, Adebayo A, Aniaku I, Lasseini A, Balogun FM, et al. Fall-related traumatic brain injury in a Nigerian pediatric population. *Journal of Clinical Neuroscience*, 2023;109: 26–31. https://doi.org/10.1016/j.jocn.2023.01.007
14. Reisz Z, Radics BL, Nemes P, Laxton R, Kaizer L, Gabor KM, et al. Case Report: Brainstem angiocentric glioma presenting in a toddler child-diagnostic and therapeutic challenges. *Pathology & Oncology Research*, 2023;29: 1611231. https://doi.org/10.3389/pore.2023.1611231
15. Yamaoka Y, Fujiwara T, Tamiya N. Association Between Maternal Postpartum Depression and Unintentional Injury Among 4-Month-Old Infants in Japan. *Maternal and Child Health Journal*, 2016;20(2): 326–336. https://doi.org/10.1007/s10995-015-1832-9
16. Mitchell EA, Rajay A, Freeman L, McIntosh C. Falls of newborn infants in a New Zealand hospital: A case series. *Journal of Paediatrics and Child Health*, 2023;59(2): 253–257. https://doi.org/10.1111/jpc.16275
17. Lipke B, Gilbert G, Shimer H, Consenstein L, Aris C, Ponto L, et al. Newborn Safety Bundle to Prevent Falls and Promote Safe Sleep. *Mcn-the American Journal of Maternal-child Nursing*, 2018;43(1): 32–37. https://doi.org/10.1097/NMC.0000000000000402
18. Cooray N, Sun SL, Ho C, Adams S, Keay L, Nassar N, et al. Toward a Behavior Theory-Informed and User-Centered Mobile App for Parents to Prevent Infant Falls: Development and Usability Study. *Jmir Pediatrics and Parenting*, 2021;4(4): e29731. https://doi.org/10.2196/29731
19. Gyedu A, Boakye G, Quansah R, Donkor P, Mock C. Unintentional falls among children in rural Ghana and associated factors: a cluster-randomized, population-based household survey. *Pan African Medical Journal*, 2021;38: 401. https://doi.org/10.11604/pamj.2021.38.401.28313
20. Fakhri AB, Gharghan SK, Zubaidi SL. Accurate Infants Remote Temperature Monitoring System based on Contactless Temperature Sensor and GSM Network. *2020 13th International Conference on Developments in Esystems*, 2020;: 177–182. https://doi.org/10.1109/DeSE51703.2020.9450733
21. Kalina RM, Dlubacz N, Zachwieja J, Pilarska E, Dobosz D, Walczak BG, et al. Innovative method of diagnosing the susceptibility to the body injuries during the fall of children from 2 to 6 years. *Archives of Budo Science of Martial Arts and Extreme Sports*, 2022;18: 211–228.
22. Ossmy O, Han DY, Macalpine P, Hoch J, Stone P, Adolph KE. Walking and falling: Using robot simulations to model the role of errors in infant walking. *Developmental Science*, 2024;27(2):. https://doi.org/10.1111/desc.13449
23. Bisi MC, Stagni R. Evaluation of toddler different strategies during the first six-months of independent walking: A longitudinal study. *Gait & Posture*, 2015;41(2): 574–579. https://doi.org/10.1016/j.gaitpost.2014.11.017

24. Cooray N, Ho CTRE, Bestman A, Adams S, Nassar N, Keay L, et al. Exploring the Potential of a Behavior Theory-Informed Digital Intervention for Infant Fall Prevention: Mixed Methods Longitudinal Study. *Jmir Pediatrics and Parenting*, 2024;7: e47361. https://doi.org/10.2196/47361
25. Sullivan BG, Grigorian A, Lekawa M, Dolich MO, Schubl SD, Barrios C, et al. Comparison of Same and Different Level Height Falls on Subsequent Midline Shift in Pediatric Traumatic Brain Injury. *Pediatric Emergency Care*, 2022;38(5): E1262–E1265. https://doi.org/10.1097/PEC.0000000000002588
26. Han DY, Cole WG, Joh AS, Liu YQ, Robinson SR, Adolph KE. Pitfall or Pratfall? Behavioral Differences in Infant Learning From Falling. *Journal of Experimental Psychology-general*, 2023;152(11): 3243–3265. https://doi.org/10.1037/xge0001453
27. Sullivan S, Coats B, Margulies SS. Biofidelic neck influences head kinematics of parietal and occipital impacts following short falls in infants. *Accident Analysis and Prevention*, 2015;82: 143–153. https://doi.org/10.1016/j.aap.2015.05.020
28. Molocznik A, Omaki E, Wagner K, Shields WC, McDonald EM, Solomon BS, et al. «Before I Could Get Him, He Fell»: Experiences, Concerns, and Fall Prevention Strategies of Parents With Young Children. *Clinical Pediatrics*, 2023;62(11): 1426–1434. https://doi.org/10.1177/00099228231161018
29. Shin HY, Lee JY, Kim LE, Lee S, Huh S. Child injury death statistics from 2006 to 2016 in the Republic of Korea. *Journal of The Korean Medical Association*, 2019;62(5): 283–292. https://doi.org/10.5124/jkma.2019.62.5.283
30. Bartick M, Smith LJ. Speaking Out on Safe Sleep: Evidence-Based Infant Sleep Recommendations. *Breastfeeding Medicine*, 2014;9(9): 417–422. https://doi.org/10.1089/bfm.2014.0113
31. Messayke S, Franco P, Forhan A, Dufourg MN, Charles MA, Plancoulaine S. Sleep habits and sleep characteristics at age one year in the ELFE birth cohort study. *Sleep Medicine*, 2020;67: 200–206. https://doi.org/10.1016/j.sleep.2019.11.1255
32. Afonso AR, Duque CG. Automated Text Clustering of Newspaper and Scientific Texts in Brazilian Portuguese: Analysis and Comparison of Methods. *Journal of Information Systems and Technology Management*, 2014;11(2): 415–436. https://doi.org/10.4301/S1807-17752014000200011
33. Wadnare RJ, Sherekar DrSS, Thakare DrVM. Development of Text Clustering Method with K-Means for Analysis of Text Data. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, 2021; 143–151. https://doi.org/10.32628/CSEIT217237
34. Fan W. Application and analysis of text similarity in text clustering in the Chinese context. *Applied and Computational Engineering*, 2023;21(1): 71–77. https://doi.org/10.54254/2755-2721/21/20231120
35. Tahvili S, Hatvani L, Felderer M, Gomes F, Feldt R. *Comparative Analysis of Text Mining and Clustering Techniques for Assessing Functional Dependency between Manual Test Cases*. 2024. https://doi.org/10.21203/rs.3.rs-4014160/v1
36. Xie T, Qin P, Zhu L. Study on the Topic Mining and Dynamic Visualization in View of LDA Model. *Modern Applied Science*, 2018;13(1): 204. https://doi.org/10.5539/mas.v13n1p204
37. Bascur JP, Verberne S, van Eck NJ, Waltman L. Which topics are best represented by science maps? An analysis of clustering effectiveness for citation and text similarity networks. 2024; https://doi.org/10.48550/ARXIV.2406.06454
38. Li C, Yang C, Jiang Q. The research on text clustering based on LDA joint model. Mishra KK (ed.) *Journal of Intelligent & Fuzzy Systems*, 2017;32(5): 3655–3667. https://doi.org/10.3233/JIFS-169300
39. Zhang W, Zhai G, Zhong B, Kong X. Text Semantic Analysis Algorithm Based on LDA Model and Doc2vec. In: Hou Z (ed.) *Advances in Transdisciplinary Engineering*, IOS Press; 2024. https://doi.org/10.3233/ATDE231269
40. Hidayat EY, Firdausillah F, Hastuti K, Dewi IN, Azhari A. Automatic Text Summarization Using Latent Drichlet Allocation (LDA) for Document Clustering. *International Journal of Advances in Intelligent Informatics*, 2015;1(3): 132. https://doi.org/10.26555/ijain.v1i3.43
41. Mittal M, Battineni G, Usharani B, Goyal LM. *Text Analysis with Python: A Research Oriented Guide*. Bentham Science Publishers; 2022. https://doi.org/10.2174/9789815049602122010l
42. Wu D, Yang R, Shen C. Sentiment word co-occurrence and knowledge pair feature extraction based LDA short text clustering algorithm. *Journal of Intelligent Information Systems*, 2021;56(1): 1–23. https://doi.org/10.1007/s10844-020-00597-7
43. Chuang J, Manning CD, Heer J. Termite: visualization techniques for assessing textual topic models. In: *Proceedings of the International Working Conference on Advanced Visual Interfaces*, Capri Island Italy: ACM; 2012. p. 74–77. https://doi.org/10.1145/2254556.2254572
44. Sievert C, Shirley K. LDAvis: A method for visualizing and interpreting topics. In: *Proceedings of the Workshop on Interactive Language Learning, Visualization, and Interfaces*, Baltimore, Maryland, USA: Association for Computational Linguistics; 2014.P.63–70. https://doi.org/10.3115/v1/W14-3110
45. Hovy D. *Text Analysis in Python for Social Scientists: Discovery and Exploration*. 1st ed. Cambridge University Press; 2021. https://doi.org/10.1017/9781108873352
46. Hovy D. *Text Analysis in Python for Social Scientists* [Internet]. 2024 [updated 2024 Jun; cited 2024 Dec 28]. Available from: https://github.com/dirkhovy/text_analysis_for_social_science
47. Arumalla K, Kulkarni A, Sadashiva N, Konar S, Singh GJ, Gopalakrishna N, et al. Fall from Height in Pediatric Age Group: A Retrospective Review from a Tertiary Neurosurgical Center in India. *Journal of Pediatric Neurosciences*, 2023;18(4): 283–290. https://doi.org/10.4103/jpn.jpn_40_23
48. Tunthanathip T, Phuenpathom N. Impact of Road Traffic Injury to Pediatric Traumatic Brain Injury in Southern Thailand. *Journal of*

Neurosciences in Rural Practice, 2017;8(4): 601–608. https://doi.org/10.4103/jnrp.jnrp_381_17
49. Kendrick D, Maula A, Reading R, Hindmarch P, Coupland C, Watson M, et al. Risk and Protective Factors for Falls From Furniture in Young Children Multicenter Case-Control Study. *Jama Pediatrics*, 2015;169(2): 145–153. https://doi.org/10.1001/jamapediatrics.2014.2374
50. Benford P, Young B, Coupland C, Watson M, Hindmarch P, Hayes M, et al. Risk and protective factors for falls on one level in young children: multicentre case-control study. *Injury Prevention*, 2015;21(6): 381–388. https://doi.org/10.1136/injuryprev-2015-041581
51. Morrongiello BA, Corbett M. Parents' perspectives on preschool children's in-home falls: implications for injury prevention. *Vulnerable Children and Youth Studies*, 2016;11(2): 136–145. https://doi.org/10.1080/17450128.2016.1173754
52. Solaiman RH, Navarro SM, Irfanullah E, Zhang J, Tompkins M, Harmon J. Sofa and bed-related pediatric trauma injuries treated in United States emergency departments. *American Journal of Emergency Medicine*, 2023;68: 155–160. https://doi.org/10.1016/j.ajem.2023.03.055
53. Yang ZQ, Tsui BY, Wu ZH. Assessment System for Child Head Injury from Falls Based on Neural Network Learning. *Sensors*, 2023;23(18): 7896. https://doi.org/10.3390/s23187896
54. Cox A, Morrongiello BA. A pilot randomized trial evaluating the Cool 2 Be Safe Junior Playground Safety Program for preschool children. *Journal of Pediatric Psychology*, 2024;49(4): 279–289. https://doi.org/10.1093/jpepsy/jsae003
55. Ghanem MAH, Moustafa TA, Megahed HM, Salama N, Ghitani SA. A descriptive study of accidental skeletal injuries and non-accidental skeletal injuries of child maltreatment. *Journal of Forensic and Legal Medicine*, 2018;54: 14–22. https://doi.org/10.1016/j.jflm.2017.12.006
56. Pietrzak J, Kurdys P, Surówka L, Obuchowicz A. Use of white noise-emitting devices in infants and small children as assessed by their parents. *Pediatria I Medycyna Rodzinna-paediatrics and Family Medicine*, 2019;15(3): 291–296. https://doi.org/10.15557/PiMR.2019.0049
57. DeMasi A, Horger MN, Scher A, Berger SE. Infant motor development predicts the dynamics of movement during sleep. *Infancy*, 2023;28(2): 367–387. https://doi.org/10.1111/infa.12519
58. Feng WW, Zhang Y, Wang HS, Pan XP, Jin X, Xu T, et al. Understanding the Choice of Sleep Arrangements and Soothing Methods and Their Associations with Sleep Problems among Children Under 3 Years Old: A Chinese PopulationBased Study. *Biomedical and Environmental Sciences*, 2022;35(3): 225–233. https://doi.org/10.3967/bes2022.031
59. Akar AS, Yavuzer IH. Investigating the Factors Affecting the Sleep of Babies Between 0-2 Years of Age. *Journal of Child - Cocuk Dergisi*, 2023;23(2): 129–136. https://doi.org/10.26650/jchild.2023.1208970
60. Wadhwaniya S, Alonge O, Ul Baset MK, Chowdhury S, Bhuiyan A, Hyder AA. Epidemiology of Fall Injury in Rural Bangladesh. *International Journal of Environmental Research and Public Health*, 2017;14(8): 900. https://doi.org/10.3390/ijerph14080900

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