SYSTEMATIC REVIEW

Risk factors for unintentional injuries due to falls in children aged 0–6 years: a systematic review

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Tables 1 and 3 are available on our website at <http://ip.bmj.com/supplemental>

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Objective: To identify risk factors for unintentional injuries due to falls in children aged 0–6 years.

Design: A systematic review of the literature.

Methods: Electronic databases from 1966 to March 2005 were comprehensively searched to identify empirical research that evaluated risk factors for unintentional injuries due to falls in children aged 0–6 years and included a comparison group.

Results: 14 studies met the inclusion criteria. Studies varied by the type of fall injury that was considered (ie, bunk bed, stairway, playground or infant walker) and with respect to the quality of evidence. In general, major risk factors for the incidence or severity of injuries due to falls in children included age of the child, sex, height of the fall, type of surface, mechanism (dropped, stairway or using a walker), setting (day care v home care) and socioeconomic status.

Conclusion: Despite a high burden, few controlled studies have examined the risk and protective factors for injuries due to falls in children aged 0–6 years. The only study to examine falls from a population health perspective suggests that age, sex and poverty are independent risk factors for injuries due to falls in children.

As a measure of burden, disability-adjusted life years quantify the total amount of healthy life lost because of disease or injury.¹ In high-income countries, injuries due to falls (hereafter termed fall injuries) are the 14th leading cause of disability-adjusted life years for all age groups combined.¹ Among children, deaths due to fall injuries are rare (0.3/100 000/year in the age group 0–5 years); however, rates of hospitalization (200/100 000/year) and visits to the emergency department (5000/100 000/year) as a result of fall injuries are high.^{2–4} As many as 60% of all visits to the emergency department due to unintentional injuries in children aged <1 year are because of falls.⁵ In developing countries, falls are usually the most common cause of injury seen in hospitals, accounting for 25–52% of all treated child injuries.⁶

Although fall injuries comprise a major health burden, the risk factors for such injuries have not been examined in a systematic, comprehensive manner. Identification of modifiable risk factors is the first step in the development of effective intervention programs. Systematic reviews use systematic and explicit methods to identify, select and critically appraise relevant research; data from eligible studies are abstracted and analyzed. This systematic review identifies risk factors for unintentional fall injuries in young children (aged 0–6 years).

METHODS

Inclusion criteria

Studies were included in the systematic review if they met the following criteria: (1) empirical research that examined risk factors for unintentional fall injuries; (2) study included a comparison group (or tested for differences across groups in cross-sectional surveys); (3) study population included children aged 0–6 years, with data available for this age group; and (4) study examined incidence or severity of injury as an outcome. The search was international, with no language restrictions, and both published and unpublished research were considered for inclusion. There was no formal definition for falls—that is, studies were included if the fall was defined according to the

International classification of disease codes, observation, or by clinician, parent or proxy reporting.

Selection strategy

A search filter and electronic search strategy were developed in collaboration with a librarian with experience in systematic reviews. The search filter used a series of fall-injury related keywords to identify potentially relevant articles from 12 electronic databases: Medline (1966–2005), Embase, PsycINFO (1985–2005), Cinahl (1982–2005), ERIC, Sociological Abstracts, Cochrane Controlled Trial Register, Cochrane Injuries Review Group Database, Dissertation Abstracts, Web of Science, Expanded Academic and ICONDA. All databases were searched for all languages and age groups, and from the earliest records available. Medical subject headings and text words “accidental falls/ or accidents, home”, “accidental falls/pcⁱ or accidents, home/pc or accidental falls/epⁱⁱ or accidents, home/ep” were used.

Additional hand-searched sources (2000–5) included reference lists (from selected papers or reviews), selected journals—*Pediatrics*, *Injury Prevention* and *Accident Analysis and Prevention*—and abstracts from the six World Conferences on Injury Prevention and Control. The membership of national and international injury organizations (Safe Kids Canada, CIRNet, ISCAIP) were requested to identify relevant studies. Lastly, injury-related websites (Google searches) were also reviewed.

Two members of the research team independently screened abstracts for eligible studies and assessed the full text of potentially eligible studies using a standardized inclusion form. Discrepancies were resolved through discussion or consensus agreement involving a third reviewer. Data were extracted directly into tables by one reviewer and checked for completeness and accuracy by a second reviewer. Data on

ⁱPrevention and control

ⁱⁱEpidemiology

year of publication, study design, time period, country, sampling frame, data collection method, putative risk factors, analysis, sample size, outcome definition and key findings were abstracted using a standardized tool. Given the lack of validated tools to assess the quality of observational studies, an ad hoc quality-assessment form was developed based on four criteria: sampling, response rate, study design and adjustment for confounders.

RESULTS

The search strategy identified 3819 unique documents. Injury conference proceedings identified 49 references and a broad-based web search provided 250 websites with fall-related information. Screening of abstracts eliminated 3483 references that did not meet inclusion criteria, largely because of study design (no comparison group). Of the 336 potentially relevant articles, only 14 met the inclusion criteria (fig 1).

Of the relevant articles, one was conducted in Norway, one in Korea, two in Canada and 10 in the US. One was a prospective cohort study, three were prospective case-control studies, nine were cross-sectional surveys and one was a retrospective chart review (table 1). Only one of the studies examined risk factors from a population health perspective.⁷ Of the remaining studies, one examined risk factors for injuries from bunk bed falls,⁸ three examined falls from heights,^{9–11} three examined the risk of fall injuries associated with walkers,^{12–14} two compared fall injuries in daycare versus homecare settings^{15 16} and five examined playground fall injuries.^{17–21}

Of the 14 studies, quality-assessment scores were strong for one study and weak or weak-moderate for six studies (table 2). The heterogeneity of study design and circumstance of fall made it difficult to identify general risk factors for falls in young children. Only one study⁷ used multilevel modeling to identify individual and community-level risk factors for falls in this age group. Table 3 shows findings from the studies considered in this review.

Population health

The population-based study by Shenassa *et al*⁷ used multilevel analysis to show that the risk of fall injury in children 0–6 years was highest in young infant boys, living in rented homes built before 1950 and in communities with a high concentration of populations of ethnic minorities.

Bunk beds

Results of the study examining risk factors for injuries from falls from bunk beds showed that among children who use bunk beds, the risk of a fall injury is increased for younger

children (<6 years), of lower socioeconomic status, in newer beds and who fall on non-carpeted floors.⁸

Height of falls

Results from all three studies on the height of falls suggested that short vertical falls (<5 feet) do not commonly cause multiple or visceral injuries in young children. Being dropped by a care taker, however, is a risk factor for severe injury, compared with children rolling off a bed or furniture.¹⁰

Walkers

Of the three studies that examined the increased risk of fall injuries associated with walkers, Partington *et al*¹³ showed a fourfold risk of a stairway fall injury (relative risk (RR) 4.26) and a twofold risk of a stairway-related fall fracture (RR 1.83) among children in walkers compared with children who did not use walkers. Ridenour¹⁴ showed that the use of a walker lowered the median age of falling down stairs from 12 months among children using natural locomotion to 8 months among infants using walkers.

Day care

The two studies comparing fall injuries in day care versus home care settings showed that the risk of a fall injury at home in infants and young children was double the risk of a fall injury in the day care setting.^{15 16}

Playgrounds and playground equipment

Four studies on playground fall injuries indicated that such injuries were associated with the height of equipment and the nature of the undersurface.^{17–21} The risk of fall injury was increased 2–3-fold for equipment >2 m high, and 1–2-fold for non-impact absorbing undersurfaces beneath the equipment.

DISCUSSION

Across the studies identified in this systematic review, young age (0–6 years), male sex and low socioeconomic status were consistent risk factors for fall injuries. Shenassa *et al*⁷ assessed the influence of individual-level and community-level factors on injury occurrence in young children using a “determinants of health” or “population health” framework. They provided evidence that young children living in families with a low socioeconomic status in older communities with a low socioeconomic status have a high risk for fall injuries. Targeted interventions to reduce fall injuries in this specific population may be warranted. It is difficult to identify general risk factors for falls in young children, given the heterogeneity of study design and fall circumstance across the studies in the systematic review. In other words, many of the studies narrowly examined risk factors directly related to specific products or environments (eg, bunk beds, walkers, playgrounds, day care).

Therefore, recommendations based on the findings from this systematic review are related to the type of fall injury examined. Results of the single study on bunk beds in this review support North American and European recommendations pertaining to bed characteristics, safety standards and restricting use of the upper level of the bunk bed to children aged 0–6 years. All three studies on height of fall suggested that a short-distance fall as an explanation for severe injuries in a young child may require further investigation to rule out the possibility of child abuse as the underlying etiology.

The data from infant walker studies clearly support the use of stationary activity centers rather than walkers with wheels for infants. The Consumer and Corporate Affairs Canada agreed to a voluntary industry standard for baby walkers (the standard came into effect from 1 June 1989) concerning design, safety testing and labeling. The most important feature was that all walkers had to have a base of at least 900 mm (greater than the width of a conventional doorway). This resulted in a de facto ban on the sale of new walkers in

Figure 1 Inclusion and exclusion flow chart for risk factor studies.

Table 1 Study characteristics by type of fall injury examined

Type of fall injury	First author, year	Design	Period	Country	Sampling frame	Data collection method	Risk factors	Type of analysis	Sample size	Outcome definition
Population health	Shenassa, ⁷ 2004	Cross-sectional survey	1 January 1990 to 30 September 2000	US	US census and hospital discharge database in State of Illinois	Database enquiry	Age, sex, poverty, racial minority, tenancy, age of housing	Multivariate	11 735 fall injuries	Medically attended injuries with ICD9 codes 800–888
Bunk beds	Selbst, ⁸ 1990	Prospective case-control	February 1987 to February 1988	US	ED of a children's hospital	Face-to-face or telephone questionnaire	Age, sex, race, payment source, age of bed, bunk bed characteristics	Univariate	122 bunk bed falls	Fall injuries related to bunk beds
Height of falls	Parks, ⁹ 2004	Cross-sectional survey	From 1994 to 1999	Korea	ED in a single hospital	Chart review	Age, sex, height of fall, type of head injury, Glasgow Coma Scale at admission and Glasgow Outcome Scale	Univariate	68 head injuries from falls	Non-intentional head injuries from falls presenting to a pediatric ED
Height of falls	Taratino, ¹⁰ 1999	Retrospective chart review	January 1990 to December 1992	US	Pediatric ED in a single center	Chart review	Age, sex, race, insurance status	Univariate	167 in-hospital falls	Short (<5 feet) vertical in-hospital fall
Height of falls	Williams, ¹¹ 1991	Cross-sectional survey	2-year period (dates unspecified)	US	Pediatric ED in a single center	Chart review	Height of fall	Univariate	106 fall injuries	Witnessed free-fall injury requiring hospital admission
Walkers	Fazen, ¹² 1982	Prospective cohort	6 months (year not specified)	US	Private pediatric practice	Questionnaire (parent report)	Age, period of walker use	Univariate	49 walker injuries	Parent-reported baby walker incident (tip over, fall down stairs, finger entrapment)
Walkers	Parrington, ¹³ 1991	Prospective cohort	From 1986 to 1988	US	Single medical clinic	Chart review	Stairway falls/fractures associated with walkers	Univariate	118 head trauma injuries	Head trauma evaluated in the ED or outpatient clinic
Walkers	Ridenour, ¹⁴ 1999	Cross-sectional survey	January to June 1985	US	Single site	Consumer Product Safety Surveillance System National sample of EDs	Stairway falls associated with walkers	Univariate	597 falls down stairs	Falls down stairs
Day care	Kapjar, ¹⁵ 1996	Prospective population-based case-control	1992	Norway	EDs in a single town	ED injury databases	Setting (day care home)	Univariate	177 fall injuries	Medically attended injuries with ICD9 codes 800–995
Day care	Rivara, ¹⁶ 1989	Prospective population-based case-control	October 1985 to October 1986	US	Single medical center	Database enquiry and mailed questionnaire	Setting (day care v home)	Univariate	262 fall injuries	Medically attended injuries with ICD9 codes 800–995
Playground and playground equipment	Bris, ¹⁷ 1995	Cross-sectional survey	October to December 1990	US	Random sample of licensed day care centers in 50 states and District of Columbia	Telephone interviews of directors of day care centers	Center size, center fee, playground surface, height of equipment	Multivariate	1740 centers	Fall injuries that occurred on a playground, involved climbing equipment and required a visit to a medical professional in the 2 months before the interview
Playground and playground equipment	LaForest, ¹⁸ 2000	Cross-sectional survey	Summer (1991 and 1995)	Canada	EDs of two children's hospitals in Montreal	ED injury surveillance databases and telephone interview	Age, sex, type of surface, location of playground, equipment, supervision, playground use	Multivariate	930 fall injuries	Fall injuries involving playground equipment identified in the CHIRPP database

Table 1 Continued

Type of fall injury	First author, year	Design	Period	Country	Sampling frame	Data collection method	Risk factors	Type of analysis	Sample size	Outcome definition
Playground and playground equipment	Laforest, ¹⁹ 2001	Cross-sectional survey	Summer (1991 and 1995)	Canada	EDs of two children's hospitals in Montreal	ED injury surveillance databases and playground equipment checklist	Age, sex, supervision, playground use, equipment, type of surface, equipment height, g max	Multivariate	185 fall injuries	Fall injuries involving playground equipment identified in the CHIRPP database
Playground and playground equipment	Sacks, ²⁰ 1990	Cross-sectional survey	June 1987 and May 1988	US	Licensed child care centers in a single city	Interview of directors	Type of playground equipment	Univariate	100 pieces of equipment	Medically attended fall injuries involving playground equipment and reported by the directors of licensed day care centers

CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program; ED, emergency department; ICD9, International classification of diseases 9th edition.

Canada, given that models compliant with the regulations have not been produced.²² Baby walkers that comply with the American Society for Testing and Materials safety standard are for sale in small and medium-sized retail outlets in Canada. Other models, which are not compliant with the American Society for Testing and Materials standards, are being sold at flea markets and on street corners. Efforts to remove walkers from the marketplace also need to be considered, as used walkers are often passed to relatives or can be purchased at garage sales or second-hand stores.²²

In the US, baby walkers must comply with specific requirements regarding labeling and the prevention of mechanical injuries (eg, the pinching of fingers).²³ A safety standard that considers the risk of falls down stairs does exist, but adherence to this standard is voluntary. In Australia, the New South Wales Department of Fair Trading introduced a regulation on 1 September 2000 that all baby walkers sold in the State of New South Wales must comply with clauses of the US Baby Walker Standard, which specifies the regulation of labeling and information standards and stability performance standards for baby walkers. The Australian Commonwealth Consumer Affairs Division is considering the possibility of implementing the regulation nationwide.²³ In New Zealand, there has been a requirement since March 2002 that all baby walkers must comply with a mandatory product safety standard.²³

The studies that examined playground fall injuries identified the height of equipment and the nature of the undersurface as risk factors for injuries. These findings are supported by a recent review of articles (published from 1966 to 2000) on playground injuries in children, which showed a protective effect of the impact of absorbing surfaces on the overall injury rate (compared with surfaces such as tarmac, concrete or grass), and a relationship between height of fall and rate of injury.²⁴

The studies on risk factors on playgrounds and playground equipment support the adoption of, and adherence to, playground equipment standards. Standards for playgrounds have been developed both in Canada and internationally.²⁵ The Canadian Standards Association guidelines for design, installation and maintenance of playgrounds and equipment were most recently revised in 1998. These guidelines consider the type of impact-absorbing surfaces, barriers on step and high platforms, entrapment hazards, sharp edges, points or projections, and non-encroachment zones. A recent study showed a reduction in playground injury rates after removal of non-compliant playground equipment and replacement with Canadian Standards Association standard equipment.²⁶ In 2000, the US Access Board issued final accessibility guidelines for playgrounds under the Americans with Disabilities Act, entailing new construction and changes to playgrounds.²⁷ In 2004, the European Standards for Playground Equipment was published to harmonize existing European standards.²⁸

To our knowledge, this is the first systematic review on risk factors for unintentional fall injuries in children aged 0–6 years. Our findings indicate a need for more population-based case-control studies on contributing factors for fall injuries in young children on the basis of a determinants of health framework; studies to assess the value of pediatric fall injury rates as a community public health indicator; and evaluative studies on the effectiveness of environmental and policy decisions (eg, safe playgrounds, voluntary ban on walkers) on fall injury rates in young children. Lastly, although the burden of fall injuries is a global health problem, studies on risk factors for fall injuries in young children have been limited only to countries with a high income.

Table 2 Quality assessment of studies

Type of fall injury, first author, year	Representative sample	Response rate	Design	Controlled for confounders	Quality assessment
Population health, Shenassa, ⁷ 2004	Very likely	NA	Cross-sectional survey	Yes	Strong
Bunk beds, Selbst, ⁸ 1990	Not likely	NA	Population-based case-control	No	Weak-moderate
Height of falls, Parks, ⁹ 2004	Not likely	NA	Cross-sectional survey	No	Weak
Height of falls, Taratino, ¹⁰ 1999	Not likely	NA	Cross-sectional survey	No	Weak
Height of falls, Williams, ¹¹ 1991	Not likely	NA	Cross-sectional survey	No	Weak
Walkers, Fazen, ¹² 1982	Not likely	80–100%	Prospective cohort	No	Moderate
Walkers, Partington, ¹³ 1991	Not likely	NA	Cross-sectional survey	No	Weak
Walkers, Ridenour, ¹⁴ 1999	Very likely	NA	Cross-sectional survey	No	Moderate
Day care, Kopjar, ¹⁵ 1996	Very likely	NA	Population-based case-control	No	Moderate-strong
Day care, Rivara, ¹⁶ 1989	Somewhat likely	60–79%	Population-based case-control	No	Moderate-strong
Playground, Briss, ¹⁷ 1995	Very likely	80–100%	Cross-sectional survey	Yes	Moderate-strong
Playground, LaForest, ¹⁸ 2000	Somewhat likely	NA	Cross-sectional survey	Yes	Moderate-strong
Playground, Laforest, ¹⁹ 2001	Somewhat likely	NA	Cross-sectional survey	Yes	Moderate-strong
Playground, Sacks, ^{20,21} 1990	Somewhat likely	80–100%	Cross-sectional survey	No	Weak-moderate

NA, not applicable.

Design in descending order from strong to weak: cohort; case-control; cross-sectional survey.

IMPLICATIONS FOR PREVENTION

Informed public health decisions require valid and up-to-date information. Despite the burden of falls in young children, an exhaustive search of >40 years of research identified a dearth of studies examining the influence of individual-level and community-level factors on fall injury occurrence. Only one study used a determinants of health framework to assess the influence of individual-level and community-level factors on fall injury occurrence in young children. The remaining studies focused on products (bunk beds, walkers), settings (day care, home, playgrounds) and intentionality (whether short vertical falls can cause severe injuries in children). Therefore, the most appropriate use of the results from this comprehensive systematic review would be to encourage research on risk factors for fall injuries in young children.

In practice, knowledge of risk factors for fall injuries can assist injury practitioners, program developers and policy makers in determining appropriate interventions. Approaches may vary depending on whether risk factors are modifiable or fixed. Modifiable risk factors (eg, bunk beds, walkers, playgrounds, day care) describe targets for specific intervention, whereas fixed risk factors (eg, sex, age and socioeconomic status) aid in identifying populations in which to intervene. Although most studies in this review examined risk factors directly related to specific products or environments, fixed risk factors for fall injuries that were consistently found across studies included young age, male

sex and low socioeconomic status. The only population health study by Shenassa *et al* showed that young age and low socioeconomic status (at the household and community levels) increase the risk for fall injuries.

From a population health perspective, results from this review, based on a single study, suggest targeting interventions

Key points

- Consistent risk factors for fall injuries were young age, male sex and low socioeconomic status.
- Most studies examined risk factors related to specific products or environments (eg, bunk beds, walkers, playgrounds or day care).
- Results from a single population health study suggest targeting interventions to families with a low socioeconomic status in older communities with a low socioeconomic status.
- More population-based case-control studies on contributing factors; studies to assess the value of pediatric fall injury rates as a community public health indicator; and evaluative studies on the effectiveness of environmental and policy decisions are required.

Table 3 Study findings by type of fall injury examined

Type of fall injury, first author, year	Outcome	Comparison	Putative risk factors	n (%)	Association (p value)	Magnitude
Population health, Shenassa, ⁷ 2004	Medically attended injuries by ICD codes	Fall injury v no fall injury	<i>Individual level</i> Age of child <1 v 5–6 years 1–2 v 5–6 years 3–4 v 5–6 years Gender (male v female) <i>Community level</i> Percentage owner-occupied housing Percentage housing built before 1950 Concentrated poverty (low v high, middle) Concentrated poverty in African-American population Low v high Low v middle		<0.05 <0.05 ≥0.05 <0.05 <0.05 <0.05 ≥0.05 <0.05 <0.05	RR 2.13; 95% CI 1.94 to 2.34 RR 1.11; 95% CI 1.01 to 1.23 RR 0.97; 95% CI 0.88 to 1.07 RR 1.45; 95% CI 1.35 to 1.55 RR 0.94; 95% CI 0.90 to 0.99 RR 1.10; 95% CI 1.06 to 1.15 RR 1.92; 95% CI 1.55 to 2.36 RR 1.43; 95% CI 1.17 to 1.74
Bunk beds, Selbst, ⁸ 1990	Fall injuries related to bunk beds	Injuries (cases) v no injuries (controls) among children using bunk beds	<i>Child characteristics</i> Age of child (<2 v >2 years) Race (White v Black) Sex Payment (medical assistance v private insurance) Age of bed (>5 v ≤5 years) <i>Bunk bed environmental characteristics</i> Made of wood Stacked parallel No ladder Ladder at side of bed No side rails Carpeted floor	25 (37) v 10 (19) 30 (47) v 20 (37) 48 (80) v 35 (65) 26 (42) v 36 (67)	<0.05 ≥0.05 ≥0.05 <0.05 <0.05 ≥0.05 ≥0.05 ≥0.05 ≥0.05 ≥0.05 <0.05	RR 1.45; 95% CI 1.07 to 1.95 RR 2.64; 95% CI 1.18 to 5.89 RR 1.49; 95% CI 0.92 to 2.41 RR 0.60; 95% CI 0.43 to 0.84
Height of falls, Parks ⁹ 2004	Non-intentional head injuries from falls	Low (<1 m) v high (>1 m) fall injuries	<i>Low v high fall injuries</i> Age (0–3 v 4–6 years) Fracture Intracranial hemorrhage Extracranial Glasgow Outcome Scale	7 (18) v 17 (57) 6 (16) v 24 (71)	≥0.05 ≥0.05 <0.05 <0.05 ≥0.05	RR 0.41; 95% CI 0.22 to 0.79 RR 0.24; 95% CI 0.11 to 0.49
Height of falls, Taratino, ¹⁰ 1999	Short (<5 feet) vertical in-hospital fall	Significant injury v none or minor injury	<i>Major injury v minor or no injury</i> Age of child (0–4 v 5–10 months) Sex (male v female) Race (African-American v Caucasian) Insurance status (commercial v Medicaid) Mechanism (dropped by care taker v rolled or fell from something)	11 (44) v 23 (16)	≥0.05 ≥0.05 ≥0.05 ≥0.05 <0.05	RR 3.07; 95% CI 1.54 to 6.15
Height of falls, Williams, ¹¹ 1991	Witnessed free fall injury requiring hospital admission	Death v mild or severe v no injury	<i>Death v mild or severe v no injury</i> Height (≥10 v <10 feet)		≥0.05	
Walkers, Fazen, ¹² 1982	Parent-reported baby walker incident	Injury v no injury	Age of child Length of use of walker		≥0.05 ≥0.05	
Walkers, Partington, ¹³ 1991	Head trauma	Fracture v no fracture	<i>Stairway falls (fracture v without fracture)</i> Walker related v non-walker related		≥0.05	
Walkers, Ridenour, ¹⁴ 1999	Falls down stairs	Walker-aided v natural locomotion	<i>Age at highest risk for fall down the stairs</i> Walker-aided locomotion v natural locomotion	61 (24) v 11 (3)	<0.05	8 months v 12 months
Day care, Kopjar, ¹⁵ 1996	Medically attended injuries by ICD codes	Day care v home care	(6 months–2 years) (3–6 years)	11 (8) v 166 (15)	<0.05 ≥0.05	RR 0.50; 95% CI 0.38 to 0.66 RR 0.99; 95% CI 0.73 to 1.33
Day care, Rivara, ¹⁶ 1989	Medically attended injuries by ICD codes	Day care v home care	Setting (day care v home care)		≥0.05	Setting (daycare v homecare)

Table 3 Continued

Type of fall injury, first author, year	Outcome	Comparison	Putative risk factors	n (%)	Association (p value)	Magnitude
Playground and playground equipment, Briss, ¹⁷ 1995	Fall injuries on a playground	Playground fall (injury v no injury)	Center size (large v small)	Not specified	<0.05	OR 4.7; 95% CI 2.2 to 10.0
			Center fee (high v low)	Not specified	≥0.05	
			Playground surface (optimal v non-optimal)		≥0.05	
Playground and playground equipment, LaForest, ¹⁸ 2000	Fall injuries involving playground equipment	Nature of fall injury (fracture or head injury v other) and severity of fall injury (AIS 2–3 v 1)	Height of tallest playground equipment (183 v ≤ 122 cm)		<0.05†	OR 3.1; 95% CI 1.4 to 6.9
			Nature of injury (fracture or head injury v other)*			
			Surface (grass v sand)		<0.05	OR 1.74; 95% CI 1.21 to 2.52
			Type (municipal, school, day care or residential)		≥0.05	
			Equipment type (climber, module, swing, slide or other)		≥0.05	
			Supervision (yes v no)		≥0.05	
			Age of child (5–9 years v 1–4 years)		<0.05	OR 1.99; 95% CI 1.47 to 2.74
			Sex (female v male)		≥0.05	
			Playground use (rarely v frequently)		≥0.05	
			Risk factors by severity of injury (AIS 2–3 v 1)*			
			Surface (grass v sand)		<0.05	OR 1.68; 95% CI 1.17 to 2.36
			Type (municipal, school, day care or residential)		≥0.05	
			Equipment type (climber, module, swing, slide or other)		≥0.05	
			Supervision (no v yes)		<0.05	OR 1.39; 95% CI 1.02 to 1.89
			Age of child (5–9 v 1–4 years)		<0.05	OR 1.94; 95% CI 1.43 to 2.63
			Sex (male v female)		≥0.05	
			Playground use		≥0.05	
Playground and playground equipment, Laforest, ¹⁹ 2001	Fall injuries involving playground equipment	Equipment involving an injury v all play equipment	Equipment†			
			Height (>2.0 v <1.5 m)		<0.05	OR 2.56; 95% CI 1.07 to 6.14
			Surface (recommended v non-recommended)		≥0.05	
			g max (> 200 v < 150 g)		<0.05	OR 3.03; 95% CI 1.45 to 6.35
			Equipment type (module v climber)		<0.05	OR 2.17; 95% CI 1.14 to 4.11
		Severity of injury (severe v minor)	Risk factors by severity of injury‡			
			Age (5–9 v 1–4 years)		≥0.05	
			Sex (male v female)		≥0.05	
			Supervision (yes v no)		≥0.05	
			Playground use		≥0.05	
			Equipment type (swing, climber, module or slide)		≥0.05	
			Surface (non-recommended v recommended)		<0.05	OR 2.26; 95% CI 1.05 to 4.87
			Height (1.5–2.0, >2.0 v <1.5 m)		≥0.05	
			g max (150–199, >200 v <150 g)		≥0.05	
Playground and playground equipment, Sacks, ^{20, 21} 1990	Fall injuries involving playground equipment	Height of climbing equipment (≥6 v <6 feet)	Height of climbing equipment		≥0.05	Height of climbing equipment (≥6 v <6 feet)

AIS, Abbreviated Injury Scale.

*Adjusted OR for type of surface, age, location of the accident, month, number of medical visits for an injury per year, playground's utilization.

†Adjusted or for playground characteristics (height, surface, g max, equipment type) and density of children in the playground area.

‡Adjusted or for surface, height, age, sex, mother tongue, number of medical visits for an injury per year and year of data collection.

to families with a low socioeconomic status in older communities with a low socioeconomic status to reduce fall injuries in young children. Population-based, case-control studies on contributing factors for fall injuries in young children using a determinants of health framework are needed.

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