BRIEF REPORT

Bunk bed-related injuries sustained by young children treated in emergency departments in the United States, 2001–2004, National Electronic Injury Surveillance System – All Injury Program

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Objective: To characterize children's bunk bed-related injuries.

Methods: Data are from the 2001–2004 National Electronic Injury Surveillance System – All Injury Program. Cases were defined as children aged 0–9 years treated for a non-fatal, unintentional injury related to a bunk bed.

Results: An estimated 23 000 children aged 0–9 years were treated annually in emergency departments for bunk bed fall-related injuries, including 14 600 children aged <6 years. Overall, 3.2% were hospitalized. The injuries sustained were largely fractures, lacerations, contusions and abrasions, and internal injuries, with 25.2% injured in a fall from the top bunk. The most commonly injured body region was the head and neck.

Conclusions: Strategies are needed to reduce the most serious injuries. Bunk beds should meet CPSC standards, and the youngest children should not sleep or play in the upper bunk or on ladders. Making care givers aware of the risks, and modifying the living environment are essential.

Free falls are a common source of pediatric head trauma.¹ Falls account for the highest costs in unintentional home injuries, and the product associated with the highest cost in home injuries in young children was a bed.² Most reports of bunk bed-related injuries come from outside the US and document serious injuries and the inherent risk of bunk beds, especially for very young children.^{3–7} As the main factors related to the extent of the injury in a fall are distance, the landing surface, and striking something, falling from the top bunk is of primary concern.

According to the US Consumer Product Safety Commission (CPSC), there were 91 reported bunk bed-related deaths between 1990 and 1999.⁸ These deaths were primarily related to entrapment and formed the basis for the mandatory standards for guardrails and openings to reduce the risk of injury from entrapment.⁹ According to these standards, bunk beds manufactured in or brought into the US after June 2000, must meet specifications for guardrails, bunk bed ends, openings, and cautionary labelling. For example, bunk bed guardrails must not be <5 inches above the mattress top. The label and safety tips provided by the CPSC recommend that children aged <6 years should not sleep in the upper bunk.¹⁰

To characterize children's nonfatal, unintentional bunk bed-related injuries in the US, case files for injured children were extracted from the National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP). This analysis focused on children aged 0–9 years, in part, because of the CPSC recommendation that the youngest children (<6 years)

should not sleep in the upper bunk of bunk beds. Younger children are more vulnerable in risky situations because their motor skills and balance are still developing and they have a limited capacity to assess risk hazards.¹¹

METHODS

Data comes from the 2001–2004 NEISS-AIP, a stratified probability sample of all hospitals in the US and its territories having at least six beds and providing 24-h emergency services. Data elements used in this analysis included age, body part injured, cause, diagnosis, disposition, sex, product involvement and a brief narrative. NEISS-AIP has been described in previously published reports.^{12–13} There were over 370 000 cases in the NEISS-AIP of children aged 0–9 years presenting for unintentional injuries.

Cases were defined as children aged 0–9 years treated at a NEISS-AIP hospital for a non-fatal, unintentional injury involving a bunk bed ($n = 2376$). All case narratives were reviewed. In all, nine cases were removed from the sample (final $n = 2367$); in three cases, the bunk bed was not directly related to the injury (eg, child sustained a cervical strain while playing a video game in bed); in four cases a sibling jumped from the top bunk and landed on the patient; and in two cases a toy was thrown from the top bunk and it landed on the patient. Cases were then coded according to whether the child fell from, fell onto, jumped off or was pushed or pulled off the bed. When the narrative gave enough details, cases were also coded as to whether the top bunk, bottom bunk or ladder were involved. These estimates represent the minimum number of cases, for example, top bunk was only coded if that was specified. When the narrative simply stated, "fell from bunk bed" we could not code top, bottom or ladder and these cases were left as unknown (60% of the cases). Cases were also coded according to whether or not the child hit another object during the descent. Estimates were weighted to provide national estimates and to account for the sampling design. Analyses were conducted with SPSS Complex Samples.

RESULTS

In the US from 2001 to 2004, an estimated 27 504 children aged 0–9 years were treated annually in emergency departments for unintentional injuries involving bunk beds. Most of these injuries were fall-related (83.9% or 23 080 children annually). A small percentage of the falls (0.7%; 95% CI 0.2 to 1.7) involved children being unintentionally pushed or pulled off the bunk bed and another 10.2% of the falls involved children jumping from the bed (95% CI 8.4 to 12.4). The non-fall-related

Abbreviations: CPSC, Consumer Product Safety Commission; NEISS-AIP, National Electronic Injury Surveillance System – All Injury Program

Figure 1 Estimated annual number of bunk bed-related fall injuries among children aged 0–9 years treated in emergency departments, overall and by sex and age, National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP), United States, 2001–2004.

cases (16.1%) were classified under impact injuries involving the bunk bed (“struck by/against”), such as running into the bed. Most injuries occurred at home (86%) and a few in school or public settings (2%). The remaining cases were coded as an unknown location (12%).

Figure 1 shows the estimated annual number of cases of bunk bed-related fall injuries. The number of cases was higher for children aged 2–6 years than for those aged 7–9 years. Overall, patients were more likely to be male (59.0%; 95% CI 55.3 to 62.6) than female (41.0%; 95% CI 37.4 to 44.7). By age, however, the difference between males and females was significant only for 4–8-year olds.

The injuries sustained in bunk bed-related falls were largely fractures (28.0%; 95% CI 24.8 to 31.6%), lacerations (22.8%; 95% CI 19.6 to 26.3%) and contusions/abrasions (21.3%; 95% CI 19.0 to 23.8%; table 1). Injured children aged 6–9 years were more likely to be treated for fractures (34.4%; 95% CI 28.8 to 40.4%) than younger children (24.4%; 95% CI 21.0 to 28.2%). Older injured children were also more likely to be treated for strains/sprains (10.2%; 95% CI 8.0 to 12.9%) than younger children (5.7%; 95% CI 4.2 to 7.7%). There were no significant differences between males and females with regard to the types of injuries sustained. Overall, 3.2% of the children injured in bunk bed-related falls were hospitalized (95% CI 2.3 to 4.5%); however, 8.7% of children who sustained a fracture in the fall were hospitalized (95% CI 6.1 to 12.1%). Injuries classified as internal were largely to the head region (eg, cerebral contusion or traumatic brain injury).

Overall, the most commonly injured body regions in bunk bed-related falls were the head and neck (51.1%; 95% CI 47.0 to

55.2) and arm and hand (27.1%; 95% CI 23.3 to 31.3; table 2). However, there was considerable variation in body region affected by age. Among children aged <1 year, 93.8% of the injuries were to the head. This percentage declined steadily with age, down to 27.6% of the injuries among children aged 9 years.

To examine injuries from a height more closely, we extracted cases that mentioned the top bunk in the narrative. Overall, 30.8% of all bunk bed-related injuries mentioned striking and falling in or from the top bunk (95% CI 24.3 to 38.0; table 3), accounting for 8400 cases annually. The percentage of all bunk bed-related injuries where the child was injured in a fall from the top bunk was 25.2% (95% CI 20.0 to 31.1), or 6 900 children annually. The percentage of children injured in falls from the top bunk was similar across ages—for example, 26.2% of children aged 1 year seen for a bunk bed-related injury reported falling off the top bunk compared with 25% of children aged 9 years. Children who fell from the top bunk were more likely to sustain internal injuries (19.1%; 95% CI 13.8 to 25.9) and less likely to sustain lacerations (16.8%; 95% CI 13.6 to 20.6) than other bunk bed-related falls or impacts (internal injuries 10.0%; 95% CI 7.2 to 13.6 and, lacerations 32.1%; 95% CI 28.6 to 35.8).

Thirty percent of the narratives mentioned that the child struck something in the fall. Most of these cases mentioned the floor generically (33.7%), or more specifically carpeting (10.6%) or hardwood (2.7%). Many children hit the bunk bed itself (20.6%), whereas 6.2% hit a dresser.

For the cases where children sustained an impact injury (“struck by/against”) involving the bunk bed (roughly 4400 children annually), very few were hospitalized (<1%). Children in this group were significantly more likely to be treated and released (99.7%; 95% CI 98.9 to 99.9) than children who fell off the bunk bed (95.5%; 95% CI 93.5 to 96.9). Most cases involved running into the bunk bed (88.8%; 95% CI 83.6 to 92.5). Annually, 8% (95% CI 5.0 to 12.7), or roughly 400 children, were struck by ceiling fans while on the top bunk. Injuries sustained by contact with the fan blades were largely lacerations to the head.

DISCUSSION

Results characterize the nature of bunk bed-related injuries among young children at the national level. In the US, >23 000 children aged 0–9 years are treated annually in emergency departments for bunk bed-related fall injuries, or roughly 63 children an hour. An estimated 14 600 of these children are aged <6 years. Also consistent with previous work, we found that a substantial proportion of children hit other objects during their fall.¹⁴

Table 1 Percentage of bunk bed-related fall injuries among children aged 0–9 years treated in emergency departments, by diagnosis, age group and sex, National Electronic Injury Surveillance System – All Injury Program, United States, 2001–2004

Diagnosis	Total percentage (95% CI)	Age group		Sex	
		0–5 years percentage (95% CI)	6–9 years percentage (95% CI)	Male percentage (95% CI)	Female percentage (95% CI)
Concussion	2.1 (1.2 to 3.4)	2.2 (1.1 to 4.5)	1.8*	2.5 (1.6 to 3.9)	1.5 (0.6 to 3.7)
Contusion/abrasion	21.3 (19.0 to 23.8)	21.7 (18.5 to 25.4)	20.5 (17.2 to 24.4)	21.1 (17.8 to 24.9)	21.6 (18.2 to 25.4)
Dental injury	0.6 (0.3 to 1.0)	0.4*	0.9*	0.4*	0.8*
Fracture	28.0 (24.8 to 31.6)	24.4 (21.0 to 28.2)	34.4 (28.8 to 40.4)	25.8 (21.8 to 30.1)	31.3 (27.6 to 35.3)
Hematoma	1.2 (0.5 to 2.6)	1.6 (0.7 to 3.4)	0.4*	1.3*	0.9*
Internal injury	13.7 (9.9 to 18.6)	16.4 (11.9 to 22.1)	9.1 (5.2 to 15.4)	14.5 (10.0 to 20.6)	12.5 (8.5 to 18.2)
Laceration	22.8 (19.6 to 26.3)	24.5 (20.6 to 29.0)	19.8 (16.7 to 23.3)	25.4 (21.6 to 29.6)	19.1 (15.8 to 22.9)
Strain/sprain	7.4 (6.1 to 8.8)	5.7 (4.2 to 7.7)	10.2 (8.0 to 12.9)	6.6 (4.8 to 9.0)	8.4 (6.1 to 11.5)
Other	2.0 (1.1 to 3.8)	1.9 (1.0 to 3.6)	2.1 (0.9 to 5.0)	1.4*	2.9 (1.5 to 5.4)

*Estimates may be unstable due to the small number of cases.

Table 2 Percentage of bunk bed-related fall injuries among children aged 0–9 years treated in emergency departments, by body part injured and age, National Electronic Injury Surveillance System–All Injury Program, United States, 2001–2004

Age (in years)	Body part injured			
	Head/neck percentage (95% CI)	Trunk percentage (95% CI)	Arm/hand percentage (95% CI)	Leg/foot percentage (95% CI)
<1	93.8 (78.3 to 98.5)		2.6*	3.6*
1	71.2 (61.8 to 79.0)	12.7*	9.2*	6.9 (3.3 to 13.7)
2	62.3 (54.9 to 69.1)	8.5*	19.0 (10.7 to 31.5)	10.2 (6.0 to 16.9)
3	55.2 (46.7 to 63.4)	10.4 (7.2 to 14.7)	22.0 (16.8 to 28.4)	12.4 (7.7 to 19.4)
4	50.0 (39.6 to 60.3)	11.7 (7.2 to 18.4)	28.3 (20.0 to 38.3)	10.1 (6.2 to 16.1)
5	56.3 (47.3 to 64.9)	5.8 (2.3 to 13.7)	19.1 (10.9 to 31.5)	18.8 (13.1 to 26.3)
6	44.6 (33.4 to 56.3)	10.3 (5.9 to 17.1)	32.1 (23.5 to 42.1)	13.1 (8.4 to 19.9)
7	40.6 (28.8 to 53.7)	12.0*	36.5 (25.2 to 49.5)	10.9 (6.4 to 18.2)
8	36.3 (24.8 to 49.6)	7.9*	46.1 (34.1 to 58.6)	9.7*
9	27.6 (19.5 to 37.4)	19.1 (12.5 to 27.9)	45.3 (32.7 to 58.5)	8.1*
Total	51.1 (47.0 to 55.2)	10.3 (8.4 to 12.6)	27.1 (23.3 to 31.3)	11.5 (9.5 to 13.9)

*Estimates may be unstable due to the small number of cases.

Limitations

Results of this study are subject to limitations. NEISS-AIP only includes injuries treated in hospital emergency departments and thus excludes those treated in physician offices, outpatient clinics or at home. Our results then are probably an undercount of the total injuries sustained. The comment lines in some records provided little circumstantial information, thus we could not code all records thoroughly (eg, the height of the fall). This limited our ability to propose specific intervention strategies. Most cases had to be classified as unknown (eg, "Patient fell from bunk bed and hit chin"). Cases were classified by what is included in the medical record based on the parent's or child's report. As has been robustly discussed in the literature, some intentional injuries may be reported as unintentional falls and thus misclassified.¹⁵ Finally, we were unable to estimate how many children sleep in, or otherwise have access to, bunk beds.

Overall, 3.2% of the children treated for injuries related to bunk beds required hospitalization, which is lower than other published work.^{4, 6, 7, 14} The injuries sustained were largely fractures, lacerations, contusions and abrasions, and internal injuries, which is consistent with other studies.^{3–7, 16} Similar to the findings of Selbst, *et al*¹⁴ (1990), the most commonly injured body region was the head and neck. In addition, younger children were more likely to have head and neck injuries than children aged 6–9 years. This probably reflects the lesser ability

of young children to avert or react in a fall, and to their higher head to body mass ratio.

Since manufacturing regulations became effective, it seems that the number of bunk bed-related injuries sustained by children is declining; however, with only 5 years of data after 2000, this trend has not reached statistical significance (see supplementary table A available online at <http://ip.bmjournals.com/supplemental>). As indicated above, the numbers of injured children, especially those aged <6 years is still alarming. In 1999, the CPSC estimated that there were 8 million bunk beds in household use with annual sales on the rise.⁸

Most injuries reported occurred at home. Recognizing that bunk beds may be seen as necessary in crowded sleeping quarters, strategies are needed to reduce the most serious injuries when these beds are used. Bunk beds should meet the mandatory CPSC standards (summary guidelines and recall notices can be found on <http://cpsc.gov>).¹⁰ Children aged <6 years should not sleep or play in the upper bunk or on the ladders. Given the estimated 13–17 years of useful life for bunk beds,⁸ parents should be wary about purchasing used bunk beds manufactured before 2001. Purchased bunk beds should not be changed so as to negate safety standards and homemade bunk beds or lofts should follow standards as well.

Making care givers aware of the risks and modifying the living environment appropriately, are essential prevention strategies.¹⁷ Close parental and care giver supervision is recommended in homes where bunk beds are used.¹⁸ Although our analysis was not able to show significant differences in the occurrence of injury by landing surface type, consideration should be given for placing bunk beds on forgiving surfaces such as padded carpeting. Narrative analyses

Table 3 Percentage of bunk bed-related injuries involving the top bunk among children aged 0–9 years treated in emergency departments, by age, National Electronic Injury Surveillance System – All Injury Program, United States, 2001–2004

Age (in years)	Top bunk involved percentage (95% CI)	Fell from top bunk percentage (95% CI)
<1	19.3*	19.3*
1	29.9 (21.1 to 40.5)	26.2 (17.8 to 36.7)
2	24.3 (17.6 to 32.7)	19.2 (14.2 to 25.5)
3	37.0 (26.3 to 49.2)	28.9 (19.3 to 41.0)
4	30.4 (21.4 to 41.2)	24.1 (16.9 to 33.2)
5	27.5 (21.2 to 34.9)	21.0 (16.1 to 27.0)
6	40.6 (29.6 to 52.8)	35.8 (26.0 to 46.9)
7	27.3 (18.4 to 38.5)	22.6 (15.1 to 32.4)
8	26.3 (20.4 to 33.3)	22.5 (16.6 to 29.7)
9	31.1 (19.5 to 46.1)	25.0 (14.7 to 39.1)
Total	30.8 (24.3 to 38.0)	25.2 (20.0 to 31.1)

*Estimates may be unstable due to the small number of cases.

Key points

- Over 23 000 children aged 0–9 years are treated annually in US emergency departments for bunk bed fall-related injuries.
- Many injuries occurred among children aged <6 years.
- Narrative analyses suggest that positioning bunk beds away from other items such as desks, dressers, windows and ceiling fans is prudent injury prevention planning.

suggest that positioning bunk beds away from other items such as desks, dressers, windows and ceiling fans is prudent.

Supplementary table A available online at <http://ip.bmjjournals.com/supplemental>

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