Home safety measures and the risk of unintentional injury among young children: a multicentre case–control study

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Abstract

Background: Young children may sustain injuries when exposed to certain hazards in the home. To better understand the relation between several childproofing strategies and the risk of injuries to children in the home, we undertook a multicentre case–control study in which we compared hazards in the homes of children with and without injuries.

Methods: We conducted this case-control study using records from 5 pediatric hospital emergency departments for the 2-year period 1995–1996. The 351 case subjects were children aged 7 years and less who presented with injuries from falls, burns or scalds, ingestions or choking. The matched control subjects were children who presented during the same period with acute non-injury-related conditions. A home visitor, blinded to case-control status, assessed 19 injury hazards at the children's homes.

Results: Hazards found in the homes included baby walkers (21% of homes with infants), no functioning smoke alarm (17% of homes) and no fire extinguisher (51% of homes). Cases did not differ from controls in the mean proportion of home hazards. After controlling for siblings, maternal education and employment, we found that cases differed from controls for 5 hazards: the presence of a baby walker (odds ratio [OR] 9.0, 95% confidence interval [CI] 1.1–71.0), the presence of choking hazards within a child's reach (OR 2.0, 95% CI 1.0–3.7), no child-resistant lids in bathroom (OR 1.6, 95% CI 1.0–2.5), no smoke alarm (OR 3.2, 95% CI 1.4–7.7) and no functioning smoke alarm (OR 1.7, 95% CI 1.0–2.8).

Interpretation: Homes of children with injuries differed from those of children without injuries in the proportions of specific hazards for falls, choking, poisoning and burns, with a striking difference noted for the presence of a baby walker. In addition to counselling parents about specific hazards, clinicians should consider that the presence of some hazards may indicate an increased risk for home injuries beyond those directly related to the hazard found. Families with any home hazard may be candidates for interventions to childproof against other types of home hazards.

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Injuries cause almost half of all deaths among children aged 1–4 years.[1] Most home injuries involving children under 5 years old are caused by falls from heights, burns and scalds, and poisonings[2] and are presumed to be preventable through removal of particular hazards. Interventions designed to reduce home injuries have focused on removal of a particular hazard (e.g., reduction in hot water temperature) or on intensive broad educational strategies (e.g., "childproofing" a house). However, few studies have examined the relation between the presence of hazards and the risk of injuries upon which these interventions depend. Only a minority of randomized controlled trials (RCTs) conducted to date have supported the relation between reduction in home hazards and reduction in injuries. A systematic review of interventions to increase smoke detector use identified only 2 of 29 studies in which both smoke detector use and burn-related injuries were measured.[3] One RCT of health education interventions to childproof homes measured the number of injury hazards and injury rates but failed to show an impact on either measure.[4] Another trial of a childproofing education intervention did show statistically significant reductions in injury hazards, but it failed to show a reduction in injury rates, in part because of the study's insufficient power for the latter outcome.[5] A systematic review of 22 interventions designed to reduce home injuries called for more observational studies to better understand the relation between hazards and injuries. This would facilitate the design of more effective future interventions.[6]

A few observational studies have provided evidence for a direct relation between specific hazards and specific injuries. In one study, the introduction of child-resistant containers was associated with a reduction in the number of deaths caused by ingestion of prescription drugs.[7] An economic analysis presented evidence that 75% of childhood fire-related deaths could be prevented in homes with working smoke alarms, sprinkler systems, anti-scald devices, slow-burning cigarettes and childproof lighters.[8] Finally, findings of 3 observational studies provided evidence for an association between smoke detector use and reduced fire-related injuries.[9–11]

To better understand the relation between several childproofing strategies and the risk of injuries to children in the

home, we undertook a multicentre case–control study in which home visitors measured the presence of hazards for home injury. We wished to determine whether the households of children who sustained a home injury had a higher proportion of injury hazards than the households of children who had not sustained a home injury. A secondary objective was to assess whether homes of cases and controls differed with respect to individual hazards.

Methods

Participants were identified from 1995 to 1996 by daily screening of the emergency department logs of 5 Canadian children's hospitals: the IWK Health Centre in Halifax, the Montreal Children's Hospital and Hôpital Sainte-Justine in Montréal, the Children's Hospital of Eastern Ontario in Ottawa and the Winnipeg Children's Hospital. Cases were defined as children younger than 8 years who presented because of a fall, scald, burn, poisoning, ingestion or choking episode at home. Controls were matched to each case by sex and age (within 6 months) and consisted of children who presented to the same emergency department with a non-injury-related diagnosis (e.g., diarrhea or otitis media).

Almost all home visits were made within 1 month after the initial emergency department visit. Following a defined protocol and blinded to the subjects' case–control status, a home visitor collected demographic data and inspected the home for hazards associated with injuries to children. Hazards for falls were the presence of a baby walker, no device to prevent child opening basement door, no gates at stairs, no safety straps on diaper change table, bedroom windows that open easily and beyond 15 cm and living room windows that open easily and beyond 15 cm. Hazards for poisonings or ingestions were choking hazards within child's reach in bedroom or in living room, no child-resistant lids on bathroom bottles, no child-resistant lids on household cleaning supplies, easy access to bathroom beauty supplies or medications and easy access to household cleaning supplies. Hazards for burns or scalds were tap water temperature greater than 54°C in kitchen, cords dangling from kettle or appliances in kitchen, no stove guard to prevent child from grabbing pots, no smoke detector, no functioning smoke detector, no fire extinguisher and matches or lighters within child's reach. The proportion of injury hazards was calculated by dividing the actual number of hazards found in the home by the total number of potential hazards. Certain hazards were excluded when considered not relevant. Baby walkers were analyzed only for households with an infant less than 1 year of age. In households with no children under 3, the following hazards were ignored: no device to prevent child from opening basement door, no gates at stairs, no safety straps on diaper change tables and no objects within child's reach.

We assessed the difference in proportions of home hazards between cases and matched controls by using paired *t* tests. We assessed the relation between specific hazards and the odds of being a case or control by using univariable and multivariable conditional logistic regression analysis. We controlled for potential confounders, defined as variables that differed between cases and controls at $p < 0.1$, using a backward stepwise model. The least significant contributors to model fit were removed in sequence until the removal was insignificant according to the likelihood ratio test at a level of $p < 0.05$.

Assuming 80% power and a 5% 2-sided type 1 error rate, we derived a sample size of 342 case–control pairs to detect an odds ratio of 1.5 for a baseline hazard proportion of 80% and an odds ratio of 1.36 for a baseline proportion of 50%.[12] The study was approved by the Research Ethics Board of the Montreal Children's Hospital.

Table 1: Characteristics of children who presented with home injuries (cases) and children who presented with acute non-injury-related conditions (controls) to pediatric emergency departments

Characteristic	No. (%) of children* Cases *n = 346*	Controls *n = 346*	*p* value†
Sex, female	143/346 (41.3)	138/346 (39.9)	0.85
Age, yr			
≤ 1	160/322 (49.7)	158/329 (48.0)	
> 1 and ≤ 3	106/322 (32.9)	116/322 (36.0)	
> 3 and < 8	56/322 (17.4)	55/322 (17.1)	0.70
≥ 1 sibling	220/346 (63.6)	192/346 (55.5)	0.03
Mother's age, yr			
< 25 yr	35/346 (10.1)	46/344 (13.4)	
≥ 25 and < 35 yr	222/346 (64.2)	213/344 (61.9)	
≥ 35 yr	88/346 (25.4)	85/344 (24.7)	0.48
Mother's education < 12 yr	44/332 (13.2)	60/334 (18.0)	0.09
Either parent in labour or service sector	129/346 (37.3)	151/346 (43.6)	0.09
Father unemployed or house-parent	16/346 (4.6)	14/346 (4.0)	0.71

*Denominators differ because of missing data.
†Difference between cases and controls by conditional logistic regression analysis.

Results

We obtained data for 346 matched case–control pairs and eliminated 10 unmatched subjects. The characteristics of the case subjects were similar to those of the control subjects except for the proportion with 1 or more siblings (63.6% v. 55.5% respectively) (Table 1). The distribution of injuries was as follows: falls (50.4%), burns (22.8%), poisonings (16.0%) and chokings (10.8%). Of the 177 falls, 104 (58.8%) involved stairs, 7

(4.0%) involved baby walkers, 14 (7.9%) were from changing tables, and 1 (0.6%) was through an open window; the cause was not specified for 51 (28.8%). Of the 80 burn injuries, 8 were due to exposure to hot tap water (10.0%), 27 to hot liquids or solids (33.7%), 22 to hot surfaces (27.5%) and 2 to dwelling fires (2.5%); the cause was not specified for 21 (26.3%). Of the 56 poisonings, 25 (44.6%) were due to medications and 10 to household chemicals (17.9%); for 21 (37.5%) the cause was not specified. Of the 38 choking episodes, 11 (28.9%) involved coins and 27 (71.1%) had no cause specified. Baby walkers were present in 32.3% of the case homes with at least 1 child less than 1 year old, as compared with 9.4% of the control homes ($p = 0.003$). Families with 1 or more children under 3 years of age lacked safety locks to prevent basement doors being opened in 50% of homes and lacked safety gates at stairs in 40% of homes. There were no smoke detectors in 6% of the homes and, where detectors were present, 17% were not functional. As well, 54% of the homes lacked fire extinguishers. The temperature of kitchen tap water was greater than 54°C in 43% of the homes.

The mean number of injury hazards was 7.0 in the homes of the cases, compared with 6.6 in the homes of the controls ($p = 0.018$). The proportion of injury hazards, after accounting for the age of children, was 0.39 in the case homes and 0.37 in the control homes ($p = 0.09$). The hazards for which there was a significant difference in crude odds ratios between the cases and controls were choking hazards within child's reach in bedroom, no child-resistant lids on bathroom bottles and no smoke detector (Table 2). The presence of a baby walker and no functioning smoke detector did not reach statistical significance. The adjusted odds ratios for these 5 factors had roughly the same magnitude as the crude odds ratios, but the presence of a baby walker and no functioning smoke detectors were now significant factors (Table 3).

Interpretation

There was little difference in the overall proportion of home hazards between the cases and their matched controls. Therefore, our primary hypothesis — that the proportion of potential hazards would be higher in the homes of cases than in the homes of controls — was not supported. After controlling for potential confounders, we found that the homes of cases did differ significantly from the homes of

Table 2: Proportion of homes with injury hazards to which cases and controls were exposed

Hazard	No. of case-control pairs*	No. of cases	No. of controls	OR (95% CI)
Related to falls				
Presence of a baby walker†	31	10	3	4.50 (0.97-20.83)
No device to prevent child opening basement door‡	93	40	53	0.61 (0.35-1.08)
No gates at stairs‡	84	46	55	0.62 (0.33-1.19)
No safety straps on diaper change table‡	48	22	18	1.44 (0.62-3.38)
Bedroom windows open easily and beyond 15 cm	339	203	201	1.03 (0.75-1.40)
Living room windows open easily and beyond 15 cm	339	173	175	0.98 (0.72-1.32)
Related to poisoning or ingestion				
In bedroom, choking hazards within child's reach‡	233	35	18	2.50 (1.28-4.88)
In living room, choking hazards within child's reach‡	243	44	34	1.31 (0.81-2.12)
No child-resistant lids on bathroom bottles	308	106	74	1.70 (1.18-2.44)
No child-resistant lids on household cleaning supplies	284	154	153	1.02 (0.70-1.48)
Easy access to bathroom beauty supplies or medications	336	129	125	1.06 (0.76-1.47)
Easy access to household cleaning supplies	337	141	137	1.05 (0.77-1.45)
Related to burns or scalds				
In kitchen, tap water temperature higher than 54°C	338	140	154	0.85 (0.62-1.15)
In kitchen, kettle or appliances with dangling cords	251	9	14	0.64 (0.28-1.49)
No stove guard to prevent child from grabbing pots	345	340	339	1.20 (0.37-3.93)
No smoke detector	343	29	12	2.89 (1.35-6.16)
No functioning smoke detector	314	61	43	1.54 (0.99-2.39)
No fire extinguisher	340	185	183	1.02 (0.75-1.40)
Matches or lighters within child's reach	344	48	39	1.30 (0.81-2.09)

Note: OR = odds ratio, CI = confidence interval
*Numbers differ because certain hazards were excluded when not considered relevant in the household.
†Restricted to households that had a child < 1 years old.
‡Restricted to households that had a child < 3 years old.

controls with respect to 5 specific hazards across the injury domains of falls, burns, poisonings and ingestions. Homes of both cases and controls had concerning rates of hazards: 17% of the households lacked functioning smoke detectors, and 21% of homes with children less than 1 year old had baby walkers. Cases and controls differed the most with respect to baby walker use (adjusted odds ratio 9, albeit with a wide confidence interval). This difference could not be explained by level of maternal education or type of parental occupation. Baby walkers were banned in Canada in 2004; however, in response to a request from industry, the Minister of Health established a board to review this ban in June 2006.[13] Most homes had windows accessible to toddlers that could be opened beyond 15 cm, access to household supplies without child-resistant caps, no fire extinguisher and, in 98% of homes, no stovetop guards.

Our primary hypothesis implied that parents would, on average, be attentive to safety to the same extent regardless of the type of injury (e.g., parents who had safe practices with respect to falls were likely to have safe practices with respect to ingestions). If this were the case, a home hazard score or proportion (with implicit equal weights for all hazards) would be a reasonable way to quantify this, as used in 3 RCTs,[5,14,15] 1 cross-sectional survey[16] and 1 cohort study.[17] In the 2-year cohort study involving 2357 children aged 7 years or less, fitted and working smoke detectors, safe storage of sharp objects and use of stair gates predicted decreased hospital admissions for all injuries, but only smoke detectors predicted decreased emergency department visits.[17] This confirms our finding that individual hazards are associated with an increase in overall home injuries that cannot be explained by the individual mechanisms of injury associated with a hazard. This suggests that these associations are not a result of chance. The lack of a functional smoke detector was the sole factor associated with injuries in both this cohort[17] and in our study. Although this could be a chance association, it may reflect a higher level of home injury prevention among parents who are conscious of fire safety.

A particular strength of our study is the collection of data through observation during a home visit rather than reliance on a written or verbal report. Because 1 or more weeks elapsed since the emergency department visit, caregivers could have eliminated common hazards. However, they did not know the specific content of the survey and could not have removed most items, except by chance. The internal validity of this study should not have been threatened, since caregivers of cases and controls were likely to have similarly prepared for the home visit. Our sample size of 702 is insufficient to examine specific exposure–outcome relationships. For example, among the 80 cases with burns, smoke detectors could have played a potential mitigating role only for the 2 cases in which the burns were the result of a fire in the home. Although we excluded hospital admissions a priori because of lack of power, Kendrick and colleagues found substantially stronger associations between hazards and hospital admissions for injuries than for emergency department visits, which suggests a need for studies large enough to capture sufficient admissions to hospital.[17] Because we analyzed the 19 hazards separately, readers are cautioned that the probability of having more than one statistically significant association is greater than the nominal 5% level. We eschewed methods to adjust for multiple comparisons (e.g., the Bonferroni correction) since they assume statistical independence among the comparisons and tend to be too conservative.[18]

Table 3: Relation between specific hazards and odds of home injury*

Hazard	No. of case–control pairs	OR (95% CI)
Presence of a baby walker	29	9.00 (1.14–71.04)
In bedroom, choking hazards within child's reach	224	1.95 (1.03–3.70)
≥ 1 sibling		1.84 (1.23–2.77)
Mother has < 12 yr education		0.56 (0.33–0.97)
No child-resistant lids on bathroom bottles	206	1.63 (1.05–2.53)
≥ 1 sibling		1.89 (1.24–2.87)
Mother has < 12 yr education		0.55 (0.31–0.97)
No smoke detector	318	3.25 (1.37–7.71)
≥ 1 sibling		1.50 (1.08–2.09)
Parent in service or labour sector		0.68 (0.49–0.96)
No functioning smoke detector	293	1.69 (1.03–2.76)
≥ 1 siblings		1.52 (1.08–2.13)
Parent in service or labour sector		0.67 (0.47–0.96)

Note: OR = odds ratio, CI = confidence interval.
*Backwards stepwise logistic regression model in which the following potential confounders were controlled for: presence of siblings in the home, level of mother's education and parent participation in labour or service sector.

The homes of injured and noninjured children included in our study differed with respect to several hazards for falls, burns, poisonings and ingestions. These differences are too small to be incorporated into screening strategies aimed at identifying families at increased risk for home injuries. However, physicians should counsel for specific hazards supported by evidence of their effectiveness.[6] They should also advocate for the control of hazards that markedly increase the risk of serious injury, such as baby walkers. In addition, clinicians should consider that the presence of any hazard may indicate an increased risk for home injuries beyond those directly related to that specific hazard. Therefore, families with any home hazard may be candidates for interventions for other types of home hazards. Unfortunately, conflicting evidence prevents the clear endorsement

Box 1: Tips for physicians to help counsel patients on home safety

Physician counselling

- Physician counselling is evidence-based, but only for some safety measures
- Patients listen to physician advice about motor vehicle restraint systems, smoke detectors, safe storage of cleaning agents and hot water temperature
- Physicians should counsel patients about high-risk home hazards such as baby walkers despite absence of evidence for effectiveness of counselling

Home injury prevention checklists

- Rourke Baby Record: www.cfpc.ca/English/cfpc/programs/patient care/rourke baby
- Injury Prevention Program (TIPP): www.aap.org/family/tippmain.htm

of specific counselling interventions as found in, for example, the Rourke baby record,[19] or generalized interventions such as home visits focused on several hazards simultaneously (Box 1). Future research should focus on understanding factors that motivate caregivers to enact some safety practices and ignore others.

This article has been peer reviewed.

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