

Ethnic Differences in the Epidemiological Characteristics of Severe Trauma Due to Falls from Heights among Children in Northern Israel

Naomi Bar-Joseph MSc^{1,2}, Gad Rennert MD^{2,3}, Ada Tamir PhD^{2,3}, Liora Ore MD² and Gad Bar-Joseph MD^{1,3}

¹Pediatric Intensive Care Unit, Meyer Children's Hospital, Rambam Medical Center, Haifa, Israel

²Department of Community Medicine and Epidemiology, Carmel Medical Center, Haifa, Israel

³Affiliated to Rappaport Faculty of Medicine, Technion-Israel Institute of Technology, Haifa, Israel

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Abstract

Background: In the western world, trauma is the leading cause of disability and mortality in the 1–39 years age group. Road accidents constitute the most frequent cause of mortality among children older than 1 year and falls from heights are the most frequent cause of injuries requiring hospitalization.

Objectives: To analyze the epidemiology and characteristics of severe pediatric trauma due to falls from a height in northern Israel. This analysis should aid in planning an effective intervention plan.

Methods: This observational study included all patients aged 0–14 who died or were admitted to an intensive care unit in northern Israel following a fall from a height. Demographic and clinical data were collected retrospectively for 3 years and prospectively for 1 year.

Results: A total of 188 children were severely injured or died following such a fall, with an annual rate of 11.4 per 100,000 children. Over 85% of severe injuries due to falls occurred among non-Jewish children, with an incidence rate 6.36 times higher than among Jewish children (20.17 and 3.17 per 100,000 children, respectively). In the non-Jewish sector 93.7% of the falls occurred at or around the child's home, mainly from staircases, balconies and roofs.

Conclusions: A very high incidence of severe trauma due to domestic falls from a height was found among non-Jewish children in northern Israel. Domestic falls represent an important epidemiological problem in the non-Jewish pediatric sector, and an effective prevention plan should include measures to modify parents' attitudes towards safety issues and the creation of a safe domestic environment.

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Trauma is the leading cause of death and permanent disability among children and young adults in the western world [1,2]. While road accidents constitute the most frequent cause of mortality among children older than 1 year, falls from heights are the most frequent cause of injuries requiring hospitalization [2,3].

The pediatric population in northern Israel comprises roughly 50% Jewish and 50% non-Jewish (mostly Moslems and Druze) children. Previous studies indicated a higher incidence of pediatric trauma due to falls in the non-Jewish compared to the Jewish population in northern Israel [4-8]. Rambam Medical Center, a level I trauma center for northern Israel, admits approximately 640 children following falls per year. A significant number of these children are admitted to its Pediatric Intensive Care Unit due to severe trauma.

The objective of the present study was to analyze the epi-

demology, scope and characteristics of severe pediatric trauma due to falls in this region. The findings of this analysis should contribute to the development of a comprehensive and effective intervention plan.

Subjects and Methods

This observational population-based study included all children aged 0–14 in northern Israel who sustained severe trauma following falling from a height during a 4 year period. "Severe trauma" was functionally defined as trauma resulting in the victim's death or requiring admission to an intensive care unit. Demographic and clinical data were collected retrospectively for 1995–97 and prospectively for 1998.

"Fall from height" was defined as a fall from one level to another, corresponding to ICD-9-E Codes 880-884. Intentional falls and falls from a moving vehicle were excluded.

Data collection

Data were collected retrospectively for children injured between 1 November 1994 and 31 October 1997, and prospectively between 1 November 1997 and 31 October 1998. We reviewed the medical records of all three ICUs in northern Israel eligible for admitting pediatric trauma cases. These included the pediatric ICU at the Rambam Medical Center and the general ICUs at HaEmek Medical Center in Afula and the Western Galilee Hospital in Nahariya. Extracted data included demographics, accident details and clinical variables. The prospective arm of the study included, in addition, an interview with the child's caretakers to better characterize the circumstances of the event.

Data regarding children who died at the scene or who were dead on arrival were obtained from death certificates at the Ministry of Health. The data recorded in death certificates are limited to age, gender, home address, religion, date of death, and basic details on the type of accident.

Data collection for this study was approved by the Ethics Committee of the Rambam Medical Center.

Statistical analysis

The denominator data for calculating incidence rates were extracted from the annual reports of the Israel Central Bureau of

ICU = intensive care unit

Statistics (1996–1999). Relative risk and 95% confidence interval were calculated. Chi-square test was used to compare incidence rates and distributions of the categorical variables between the different ethnic groups. Student's *t*-test was used to compare means of continuous variables and the Mann-Whitney test to compare ordinal variables. Chi-square for goodness of fit was used to examine equal frequencies between days/seasons. A *P* value < 0.05 was considered statistically significant. Statistical calculations were performed using the SPSS software, Version 9, USA.

Results

During the 4 years of the study, the 0–14 year old population in northern Israel consisted of approximately 412,000 children, 51.6% of whom were Jewish and 48.4% non-Jewish. During the study period 188 children sustained “severe trauma” due to falls from heights. Incidence and mortality rates were significantly higher in the non-Jewish compared to the Jewish population: the relative risk of a non-Jewish child to sustain severe trauma due to a fall was 6.36 (95%CI = 2.7–13.6) compared to that of a Jewish child [Table 1].

Demographic and ethnic characteristics

The male:female ratio for all severely injured children due to a fall was 1.76. Median age was 3.0 years; 54.2% of severe injuries occurred in children 2–4 years old, with a sharp decline in the incidence rates beyond 6 years of age.

The general incidence rate of severe trauma due to falls in the 0–4 year age group was fivefold higher compared to that in the 5–14 year age group (CI 3.47–7.23) [Table 2]. The risk of a 0–4 year old non-Jewish child to sustain severe trauma due to a fall was 7.87-fold higher compared to his or her Jewish counterpart (CI 4.42–14.27), while in the 5–14 year old age group the relative risk was 3.3-fold higher (CI 1.73– 6.67).

The non-Jewish population in northern Israel comprises three ethnic groups – Moslems (including Bedouins), Druze and Christians. The highest incidence of severe trauma due to falls was found among Druze (23.3, CI 16.4–30.2) and Moslems (21.3, CI 18.0–24.5). The annual incidence rate in the Christian population was almost 50% lower (12.5, CI 7.0–18.0).

Temporal characteristics

The exact time of the fall was available for the 51 prospectively surveyed cases. A distinct peak was observed in the late afternoon/early evening hours: 55% of all falls occurred between 16:00 and 19:00. No differences in the time of the fall were found between the 0–4 and the 5–14 year old groups.

For the entire study population, falls were distributed evenly over the 7 days of the week, with a slightly higher incidence on Saturday. This was due to a significantly higher rate among Jewish children, in whom 53% of all severe injuries due to falls occurred on Friday and Saturday – the two weekend days in Israel (*P* < 0.01 by the chi-square test for goodness of fit). This relatively high incidence relates to the fact that trauma due

Table 1. Annual incidence and mortality rates of severe trauma due to falls from height in the Jewish and non-Jewish pediatric population in northern Israel

| | All children | | Non-Jewish | | Jewish | | Relative risk (95%CI) Non-Jews/Jews |
|-----------|--------------|-------|------------|-------|--------|-------|--|
| | N | Rate* | N | Rate* | N | Rate* | |
| Incidence | 188 | 11.4 | 161 | 20.17 | 27 | 3.17 | 6.36 (4.16–9.77) |
| Mortality | 8 | 0.48 | 6 | 0.75 | 2 | 0.24 | 3.12 (0.59–22.85) |

* Annual rate/100,000 children (age 0–14 years)

Table 2. Annual incidence rates of severe trauma due to falls from height by age group and population sector

| Age group (yrs) | Total | | Non-Jewish | | Jewish | |
|-----------------|-------|--------------|------------|--------------|--------|--------------|
| | N | Annual rate* | N | Annual rate* | N | Annual rate* |
| | | | | | | |
| 0–4 | 138 | 22.8 | 124 | 38.73 | 14 | 4.92 |
| 5–14 | 50 | 4.8 | 37 | 7.74 | 13 | 2.29 |
| Total | 188 | 11.4 | 161 | 20.2 | 27 | 3.2 |

* Annual rate/100,000 children in the relevant age group

Table 3. Distribution of severe trauma due to falls from height by population sector and type of residence

| | N | Annual rate* (95%CI) |
|-----------------|-----|----------------------|
| | | |
| Non-Jewish | | |
| Rural residence | 143 | 22.0 (18.9–25.0) |
| Urban residence | 17 | 11.6 (7.0–16.2) |
| Jewish | | |
| Rural residence | 9 | 3.3 (1.5–5.2) |
| Urban residence | 18 | 3.1 (1.9–4.3) |

* Annual rate/100,000 children in the relevant population and type of residence groups

to falls in the Jewish population was mainly associated with recreational activities.

The majority (67%) of all falls occurred in the six spring and summer months (April to September), compared to the expected 50% (*P* < 0.0001 by chi-square test for goodness of fit).

Location of event

Of all severe trauma due to falls, 76.5% (143/188) occurred among non-Jewish children living in rural dwellings [Table 3]. The incidence rate for this population was approximately twofold higher than that of the non-Jewish population living in urban residences and over sevenfold higher than that of the Jewish population living in either rural or urban residences.

Details of the specific site of fall were available in 125 of the 188 cases (66.5%). Among non-Jewish children, 90% of severe trauma due to falls occurred in or around the child's home or in a neighboring house. Generally, almost one-third of the severe injuries were due to vertical falls from a staircase; only a few cases were associated with rolling down the stairs [Figure 1]. All staircase vertical falls occurred in the non-Jewish population, in which they comprised 40% of all cases. One-quarter of severe

CI = confidence interval

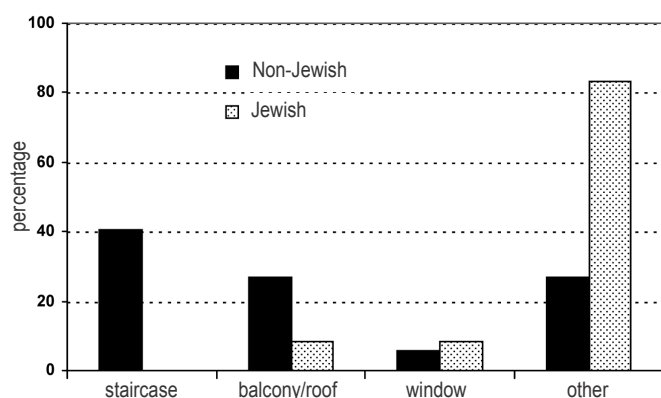


Figure 1. Distribution of severe trauma due to falls from height by location of the fall

injuries were due to falls from a balcony or a roof – almost all in the non-Jewish population. In 71% of falls from a staircase, roof or balcony, no railing – or only a very low one – had been installed. In 70% of the cases the falling child hit a hard surface (a concrete or tiled floor).

The specific sites of falls in the Jewish population were diverse: children fell from furniture, from the hands of a caretaker, or during play and recreational activities.

All six non-Jewish children who died fell in their homes. Five of them were 1–1.5 years old and one boy was 4 years old. One of the two Jewish children who died fell from a high cliff on a field trip; no information was available regarding the second fatal case.

Data on the falling height, as estimated by the child's caretaker, were available in 150 of the 188 cases. Almost 80% of the children sustained severe trauma following a fall from 4 meters or less.

Discussion

The classical “pyramid of injuries” starts with injuries not requiring medical attention, followed by injuries treated at the community level, injuries treated in the emergency room, those requiring hospitalization, and fatal injuries at the apex of the pyramid [2]. In this study we added another level: namely, injuries requiring admission to an intensive care unit. Like the rest of the pyramid levels, this is a functional definition and does not take into account other injury severity parameters, such as the Injury Severity Score or the Pediatric Trauma Score. Obviously, severity of injuries, acute and residual morbidity, mortality risk and resource utilization of patients at this level differ markedly from those of patients admitted to a regular hospital ward. In this analysis we combined under “severe trauma” the two upper levels of the pyramid: namely, cases admitted to an ICU and fatal cases.

The objective of this study was to describe the epidemiology of severe pediatric trauma due to falls in northern Israel, a region characterized by approximately equal Jewish and non-Jewish pediatric populations. Our analysis demonstrated a very high incidence of severe trauma due to falls in the non-Jewish pediatric population – mainly Moslems and Druze – in rural areas in northern Israel. These children fell in their homes, most

frequently from unprotected staircases, roofs or balconies. Several previous reports [4-8] also suggested that domestic falls represent a significant public health problem in the non-Jewish pediatric population in the region.

While most western world epidemiological studies on pediatric falls concerned urban populations – traditionally associated with a high incidence of trauma due to falls – our study analyzed the entire pediatric population of northern Israel and found a much higher incidence in the rural population.

The annual incidence of severe trauma due to falls was 11.4/100,000 in the 0–14 year age group. No similar data could be found in the literature for comparison. The case-fatality rate in our study was 4.25%, while rates of 0.7–2.8% were reported from the United States and Canada [9-12]. The markedly higher case-fatality rate in our study is due to a selection bias, as our denominator consisted of severely injured children while others reported case-fatality rates for hospitalized children in general. Similar to other reports, we found that the majority of falls occurred in the 0–4 age group [9,10,13,14].

Forty percent of the non-Jewish children sustained severe injuries by falling vertically from (mostly unprotected) stairways, and only 6% fell from windows. This finding contrasts with other reports that the majority of pediatric injuries due to vertical falls occurred after falls from windows, balconies and roofs, and only a small minority were due to falls from stairways [9-11,13,14]. The much smaller number of severe injuries due to falls in the Jewish population was mainly associated with recreational activities; only two children fell from balconies and two from windows.

Ethnic differences in the epidemiology of pediatric injuries were only rarely addressed [15-18]. Ethnic aspects cannot be easily differentiated from socioeconomic aspects, and a low socioeconomic status is a well-documented risk factor for severe accidental (as well as intentional) trauma in children [19-22]. Our data are insufficient to determine whether the socioeconomic status of the Jewish and non-Jewish families of our patient population differs. Based on national indicators, such as unemployment rates and housing density, the socioeconomic status of the non-Jewish sector is somewhat lower than that of the Jewish sector [23]. Although such differences may contribute to the problem, we do not believe they account for the grim picture documented in the non-Jewish pediatric population.

Based on interviews with parents of injured children, discussions with health care personnel and municipality officials, as well as inspections of some of the accident locations, we believe that the reasons for this ‘fall mini-epidemic’ in northern Israel are multifactorial, combining topographic, socioeconomic and cultural factors rooted in the traditional way of living of the rural non-Jewish population.

The great majority of the non-Jewish population lives in village communities in stand-alone houses; apartment blocks are non-existent. We found that villages with the highest rates of falls are located in the higher, steeper Galilee mountains. Construction in this terrain requires high stabilizing posts that result in elevated house levels. Often, these houses are enlargements of the original small house, which has become over the years a three

or flour-story building housing several generations of the family. Due to the "add-on" nature of the construction, the access to the higher apartments is often by external stairways. These houses are often built with limited resources that are exhausted before safety rails have been installed. Proper safety rails on staircases and balconies, and barriers preventing free access to flat roofs are basic requirements of the Building Code Regulations in Israel. These regulations are apparently not strictly adhered to in the non-Jewish municipalities. Safety attitudes in general seem to be less deeply rooted in the non-Jewish population in Israel as compared to the Jewish population. For example, recent data of the Israel Central Bureau of Statistics indicate that non-Jewish drivers constituted 11.7% of all drivers' license holders in Israel, yet they were involved in 26% of all "severe" and fatal accidents [24]. In 2002, 69% of all children killed in road accidents were non-Jewish [25]. Data from our study (not presented here) indicate that the relative risk of a non-Jewish child to sustain severe trauma due to a road accident was twofold higher than that of a Jewish child. A recent comprehensive research by the Ministry of Transportation [24] found an "absolute" lack of road safety behavior in the non-Jewish pediatric age group: small children were unaware of the dangers imposed by driving vehicles, older children did not take precautions while crossing a road, did not choose a safe crossing point, and were often mistaken in choosing the correct timing for crossing. Parental supervision of children playing near the road was markedly insufficient [24].

Clearly, domestic falls in the non-Jewish pediatric population constitute a major public health issue in northern Israel. Since major trauma occurred mainly following falls from unprotected staircases, roofs and balconies, most of them can be easily prevented. Evidently, no similar falls were recorded in the Jewish population. An effective, comprehensive prevention plan should include measures to modify parents' attitudes to safety issues, strict enforcement of the existing Building Code Regulations, and allocation of resources to create and improve public playgrounds and recreational facilities, which are presently scarce in the non-Jewish sector. While road accidents receive considerable public exposure, interest and resource allocation, falls from heights seem to be a far less appealing issue. A major objective of our research was to highlight this neglected problem and provide the scientific basis for future prevention plans. In fact, since the completion of this research and presentation of its findings in national forums, several local prevention plans were initiated and are now in progress. Despite that however, a recent publication [8] found that the number of admissions to the pediatric ICU at the Rambam Medical Center did not decrease in 2002–2004.

References

- Allshouse MJ, Rouse T, Eichelberger MR. Childhood injury: a current perspective. *Pediatr Emerg Care* 1993;9:159–64.
- Rivara FP, Grossman DC, Cummings P. Injury prevention [Review]. *N Engl J Med* 1997;337:543–8.
- Rivara FP, Calonge N, Thompson RS. Population-based study of unintentional injury incidence and impact during childhood. *Am J Public Health* 1989;79:990–4.
- Levi L, Linn S, Revach M, Feinsod M. Head trauma in northern Israel: incidence and types. *Neuroepidemiology* 1990;9:278–84.
- Levi L, Guilburd JN, Linn S, Feinsod M. The association between skull fracture, intracranial pathology and outcome in pediatric head injury. *Br J Neurosurg* 1991;5:617–25.
- Shavit I, Bar-Joseph G, Shehadeh N, Faraggi D, Jan V, Revach M. Hospitalizations due to falls in Jewish and Arab children in northern Israel. *Eur J Epidemiol* 2000;16:47–52.
- Levi L, Istitih A, Geva H, et al. Head injuries from falls in children of two ethnic groups. *Harefuah* 1995;129:9–12 (Hebrew).
- Shavit I, Tal-Or E. Hospitalizations due to falls in the childhood population of northern Israel: a comparison between the years 1993–5 and 2002–2004. *Harefuah* 2006;145:269–71 (Hebrew).
- Mosenthal AC, Livingston DH, Elcavage J, Merritt S, Stucker S. Falls: epidemiology and strategies for prevention. *J Trauma* 1995;38:753–6.
- Lehman D, Schonfeld N. Falls from heights: a problem not just in the northeast. *Pediatrics* 1993;92:121–4.
- Lallier M, Bouchard S, St-Vil D, Dupont J, Tucci M. Falls from heights among children: a retrospective review. *J Pediatr Surg* 1999;34:1060–3.
- Chadwick DL, Chin S, Salerno C, Landsverk J, Kitchen L. Deaths from falls in children: how far is fatal? *J Trauma* 1991;31:1353–5.
- Musemeche CA, Barthel M, Cosentino C, Reynolds M. Pediatric falls from heights. *J Trauma* 1991;31:1347–9.
- Barlow B, Niemirska M, Gandhi RP, Leblanc W. Ten years of experience with falls from a height in children. *J Pediatr Surg* 1983;18:509–11.
- Overpeck MD, Jones DH, Trumble AC, Scheidt PC, Bijur PE. Socioeconomic and racial/ethnic factors affecting non-fatal medically attended injury rates in US children. *Inj Prev* 1997;3:272–6.
- Matteucci RM, Holbrook TL, Hoyt DB, Molgaard C. Trauma among Hispanic children: a population-based study in a regionalized system of trauma care. *Am J Public Health* 1995;85:1005–8.
- Emmanuel S. Epidemiology of injuries in Singapore. *Ann Acad Med Singapore* 1991;20:190–5.
- Sceats J, Gillies J. Paediatric attendance at Waikato Hospital accident and emergency department, 1980–86. *N Z Med J* 1989;102:467–9.
- Nersesian WS, Petit MR, Shaper R, et al. Childhood death and poverty: a study of all childhood deaths in Maine, 1976 to 1980. *Pediatrics* 1985;75:41–50.
- Durkin MS, Olsen S, Barlow B, Virella A, Connolly ES. The epidemiology of urban pediatric neurological trauma: evaluation of, and implications for, injury prevention programs. *Neurosurgery* 1998;42:300–9.
- Durkin MS, Davidson LL, Kuhn L, O'Connor P, Barlow B. Low-income neighborhoods and the risk of severe pediatric injury: a small-area analysis in northern Manhattan. *Am J Public Health* 1994;84:587–92.
- Mayer M, LeClere FB. Injury prevention measures in households with children in the United States, 1990. National Center for Health Statistics, Advance Data 1994;250:1–14.
- Statistical Report of Israel. Annual Report. Jerusalem: Central Bureau of Statistics, 1998.
- Characteristics and causes of road accidents in the non-Jewish sector (Hebrew). National Road Safety Authority, Israel Ministry of Transportation, Available from URL: <http://bd.mot.gov.il>
- Road Accidents with Casualties, General Summaries. Jerusalem: Central Bureau of Statistics, 2002.

Correspondence: Dr. G. Bar-Joseph, Pediatric Intensive Care Unit, Rambam Medical Center, P.O. Box 9602 Haifa, Israel .
Phone: (972-4) 854-2855/935
Fax: (972-4) 854-2864
email: g_barjoseph@rambam.health.gov.il