School Injuries and Preventive Policies and Programs

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ABSTRACT

Background: Injuries are a major source of morbidity and mortality throughout childhood and many occur on school premises. Differences in policies, programs and practises at the level of school boards or individual schools may account for some of the differences in injury rates among schools.

Methods: We used data from the Montreal Children's Hospital to identify children injured at school. By telephone interview, we identified the school attended and calculated injury rates per school for the study year. A questionnaire to principals identified practises and programs. The two data sets were merged and the data analyzed using cross tabulations and logistic regression.

Results: Nearly one third of the 310 injured children required admission or follow up. Most involved falls, boys, 10-14 year olds, and sports. The variables associated with higher rates of injuries were: school board (English), proximity to hospital, wood gym flooring, gym use during breaks, presence of a playing field, frequent checks of field surface, and the presence of an injury prevention program. Using logistic regression, after controlling for all other variables in the model, only school board and distance to hospital remained significant.

Conclusion: These findings provide little support for the notion that school policies influence injury rates. If anything, they suggest that the reverse may be true; i.e., that injury rates help stimulate schools to take certain preventive actions. An alternative explanation is that many of the differences observed among schools simply reflect differences in the extent to which their pupils are exposed to the risk of injury because of, for example, the availability of sports facilities.

La traduction du résumé se trouve à la fin de l'article.

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Many injuries involving children occur on school premises. Injuries from bullying or school bus crashes are familiar, but many other types of school injuries are equally important and preventable.[1-4] They are also costly. "Each year, 3.7 million children suffer a substantial injury at school, resulting in an estimated $3.2 billion in medical spending…."[5] Miller and Spicer conclude that data on school injury causes are greatly needed, and this view is underscored by Spicer et al. who show how data can be used to build partnerships for school-based prevention programs.[6]

Although some injuries occurring at schools are ones over which the school has little control, most are related directly or indirectly to factors amenable to school policies or practices. The school is an environment in which situational or structural changes are reasonably easy to introduce.[7-9] Some such changes lie within the purview of principals, others are school board responsibilities, and still others may be influenced by parent groups.[10] Recently, the CDC has issued Guidelines to prevent both unintentional injuries and violence at schools.[11] Additionally, many programs aimed at specific injuries, such as bullying,[12,13] seatbelt use,[14] or suicide,[15] use schools as their preferred venue. Thus, the school is a promising site for injury prevention in children.

This hospital-based case-control study aimed to determine whether school characteristics were related to the incidence of injuries in schools on the Island of Montreal.

METHODS

We used data from parents of ER visitors seen at the Montreal Children's Hospital (MCH) as reported on CHIRPP forms.[16] (A second children's hospital serving a larger part of the French community was not included due to insufficient resources). The Research Ethics Board of the Montreal Children's Hospital reviewed and approved this protocol. Injuries were selected if the locale was recorded as "school" or if the injury occurred during school hours or during after-school activities under the aegis of the school, but not during travel to or from school. Parents who did not withhold consent to further contact on the CHIRPP form were tele-

phoned to obtain additional information about the injury and the name of the school. These data were collected for the 1998-1999 school year. For the main study, private schools and those off-island were excluded because they were not administered by any single school board. However, because CHIRPP data were available for children visiting the ER from these schools, clinical and demographic data are shown in Table I for purposes of comparison and to provide an estimate of the generalizability of our findings.

In 2000, a 15-item questionnaire was mailed to the principals of all 444 public schools. This questionnaire addressed specific social, structural, and situational characteristics of the school that may be related to injury occurrence and that were assumed to be modifiable by the principal or school board. Principals at 302 of the 444 schools (68%) responded (Figure 1). A Deprivation Score based on several census-based indicators of poverty was used to examine the socio-economic status (SES) of the census tract in which the school was located.[17,18]

ANALYSIS

Using student enrolment figures as denominators, injury rates per 1000 students were calculated for each school and divided by the median of all schools with injuries (3.79) into low and high injury-rate schools. Although using the median rate of the schools with injuries as the cut-off between low and high injury-rate schools was arbitrary, this method was chosen to provide a roughly equal number of schools in the low and high groups. This yielded three groups for the 302 schools with completed questionnaires: none (191 schools), low (59 schools, 0.1-3.8 per 1000), and high (52 schools, >3.8 per 1000) (Figure 1). For schools whose principals did not reply, the corresponding figures were none (109), low (13), and high (20). The response rate was significantly higher among schools with injuries than among those without injuries (77% vs. 64%, p=0.005).

As noted above, 444 schools were contacted and 302 principals completed the questionnaire. The main study attempted to link these responses to information from the CHIRPP forms of children attending these schools. As shown in Figure 1, there were 310 children from on-island public

TABLE I

Demographic and Clinical Characteristics of Students with Injuries by School Group (%) (CHIRPP Sample Only)

	Montreal Island Students		Off-Island & Private School Students		χ^2 P value
Age (years)	N (310)	%	N (180)	%	NS
5-9	97	31	54	30	
10-14	174	57	97	53	
15-19	38	12	29	16	
Sex					NS
Male	202	65	108	60	
Female	108	35	72	40	
Area					0.001
Schoolyard	131	42	62	34	
Gymnasium	109	35	64	35	
Other	41	14	40	22	
Not specified	27	9	16	9	
Context					NS
Sports, organized	35	11	39	22	
Sports, informal	112	36	50	28	
Playing	87	28	47	26	
Walking, running	44	14	27	15	
Other/not specified	32	10	17	9	
Mechanism					NS
Man-made surfaces	27	9	13	7	
Floor	39	13	23	13	
Ball	38	12	22	12	
Ice, snow, frost	39	13	14	8	
Other child (unintentional injury)	24	8	14	8	
Victim (intentional injury)	46	15	27	15	
Other/not specified	97	31	67	37	
Body part					NS
Face	29	9	21	12	
Head	57	18	21	12	
Hand	63	20	43	24	
Knee	19	6	3	2	
Ankle	42	14	35	19	
Other/not specified	100	32	57	32	
Nature of injury					NS
Superficial	34	11	25	14	
Open wound	27	9	16	9	
Fracture	67	22	46	26	
Sprain/strain	111	36	60	33	
Minor head injury	41	13	16	9	
Other/not specified	30	10	17	9	
Disposition					NS
Advice only	51	17	28	16	
Treated	165	54	99	55	
Admitted	91	29	53	29	

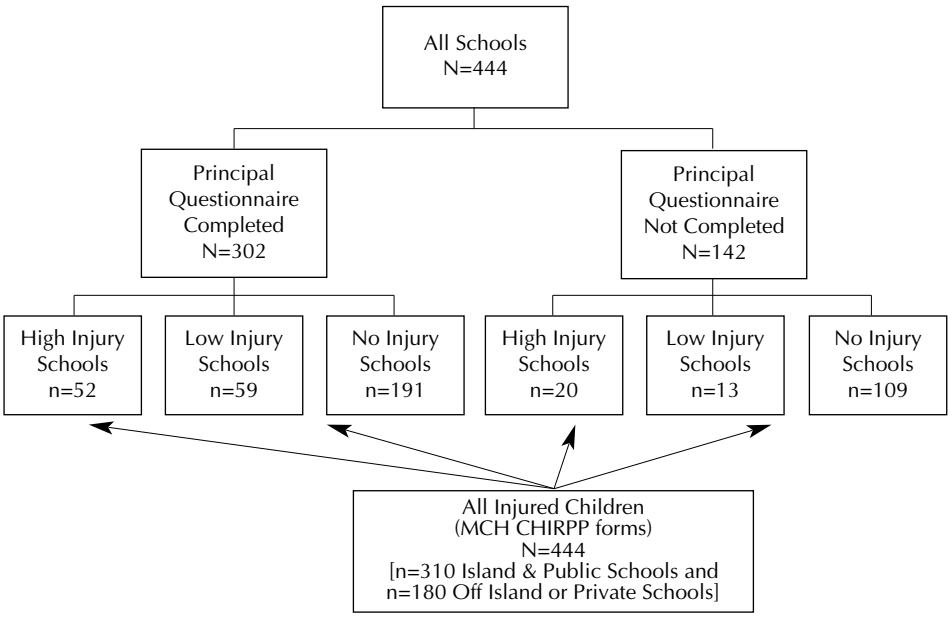

Figure 1. Flow chart showing relations between school (principal) information and hospital (injured child) information.

TABLE II
Characteristics of Schools with No versus Low, High and Any Injury Rates

Risk Factors	No Injury Schools			No Injury Schools vs. Low Injury Schools				No Injury Schools vs. High Injury Schools				No Injury Schools vs. Any Injury Schools			
	No.	Total	%	No.	Total	%	χ^2	P (2-tailed)	No.	Total	%	χ^2	P (2-tailed)	No.	Total	%	χ^2	P (2-tailed)
Injury prevention program (no)	143	173	82.66	36	50	72.00	2.80	0.10	31	44	70.45	3.20	0.08	67	94	71.3	4.7	0.04
Anti-violence program (no)	18	178	10.11	5	50	10.00	0.03	1.00	6	51	11.76	0.11	0.79	11	105	10.5	0.01	1
Supervision (low)	25	182	13.74	6	56	10.71	0.13	0.72	6	51	11.76	3.10	0.21	12	107	11.2	1.7	0.42
Wet floor notices (rarely)	87	177	49.15	28	56	50.00	0.12	0.94	29	48	60.42	3.70	0.26	57	104	54.8	0.93	0.63
Salt icy (not always)	16	177	9.04	6	56	10.71	0.31	0.86	6	50	12.00	0.57	0.75	12	106	11.3	0.63	0.73
Playground (yes)	41	172	23.84	15	54	27.78	0.16	0.69	13	47	27.66	0.29	0.59	28	101	27.7	0.5	0.47
Playground surface (poor)	53	174	30.46	18	49	36.73	0.69	0.48	16	45	35.56	0.43	0.59	34	94	36.2	0.91	0.34
School yard checks (rare)	10	174	5.75	4	56	7.14	1.10	0.77	3	50	6.00	2.80	0.41	7	106	6.6	0.55	0.91
Playing field (yes)	42	171	24.56	23	49	46.94	9.10	0.00	20	45	44.44	6.80	0.01	43	94	45.7	12.5	0.001
Check field surface (rarely)	19	45	42.22	11	26	42.31	0.00	0.99	3	23	13.04	4.66	0.03	14	53	26.6	12	0.007
Gym (yes)	174	180	96.67	52	54	96.30	0.01	1	50	50	100	1.01	0.34	102	104	98.1	0.45	0.71
Gym during breaks (yes)	34	174	19.54	22	52	42.31	9.95	0.00	16	50	32.00	2.80	0.09	38	104	36.5	10.9	0.004
Gym flooring (not wood)	74	124	59.68	19	46	41.30	5.10	0.07	11	40	27.50	12.90	0.00	30	86	34.9	12.5	0.002
Deprivation factor (high)	99	288	34.38	24	72	33.33	0.08	0.96	23	69	33.33	0.34	0.84	47	141	33.3	0.09	0.96
School <2km from hospital	4	300	1.30	2	72	2.8	0.76	0.33	7	72	9.72	14.2	0.001	9	144	6.25	8.3	0.0006
School board (French)	234	300	78	46	72	63.9	6.2	0.01	25	72	34.7	51.4	0.001	71	144	49.3	37.5	0.000

TABLE III
Multivariable Logistic Regression: Backward stepwise likelihood ratios. All Variables Entered in the Model (Summary Statistics)

Variables	Number	Percent
School board		
English	139	31.3
French	305	68.7
Deprivation score (SES)		
Low (high SES)	141	31.2
Medium	142	32.0
High (low SES)	146	32.9
Distance to Hospital (<2km)		
< 2km (~1 mile)	13	2.9
≥ 2km	431	97.0
Injury prevention program		
Yes	57	21.3
No	210	78.7
Anti-violence program		
Yes	254	89.8
No	29	10.2
Supervision		
Low	37	12.8
Medium	188	65.1
High	64	22.1
School has gym		
Yes	276	97.2
No	8	2.8
Play in gym during breaks		
Yes	72	26.4
No	204	73.6
Check school yard		
Often	189	70.3
Occasionally	63	23.4
Rarely	17	6.3
Number of Sports		
Few (0-3)	314	70.7
Many (4+)	130	29.3
Salt icy		
Almost always	255	90.1
Sometimes	20	7.1
Almost never	8	2.8
Wet floor notices		
Almost always	87	31.0
Sometimes	50	17.8
Almost never	144	51.2

schools and 180 from private or off-island schools. Thus, the main analysis involves 302 schools for which injury rates could be calculated. However, the denominators shown in Table II varied depending on the questions asked.

Chi-square tests were used to examine the effect of each exposure variable on injury rate group (none, low, and high). We also used backward stepwise logistic regression to examine relationships with the proportion of injuries in each school after adjustment for other possible risk factors. All analyses were conducted using SPSS for Windows, version 11.

RESULTS

310 children with injuries at school (as defined) had completed CHIRPP forms at the MCH ER. These injuries occurred in 111 schools yielding rates of injuries per school from 1 to 29.4 per 1000 students. (These rates assume similar days of attendance and may include more than one injury per student.) All other schools in the sample (300) had no children with injuries reported at this hospital.

To estimate the extent to which our sample using only on-island schools could be generalized, we compared several sociodemographic and clinical characteristics with off-island public and private schools, and found only one significant difference (Table I). We also ran these analyses excluding schools within 2 km of the hospital with the same results, although distance from hospital is an important consideration when studying visits for many medical conditions. The mean injury rate for nearby schools (<2 km) was 6.3% compared with 1.6% for more distant schools (p=0.006).

Over one half (57%) were ages 10-14 and 65% were boys (Table I). Most injuries occurred in the school yard (42%) and over half (54%) required treatment or follow up. A majority involved fractures or sprains (58%) and one third (36%) were injured during informal sports or recreational activities. Notably, 18% were head injuries. When these patterns were compared to injuries to children attending private schools (128) or off-island schools (52), the only significant differences were those related to the area where the injury occurred.

The mean injury rate of the 111 schools with injuries whose principals responded was 4.7 per 1000 students, whereas at the 33 schools that did not respond, the rate was 6.5 per 1000 students. Response rates by language-grouped boards also did not differ significantly.

Because few differences were found between the low and high injury-rate groups on most variables (Table II), these categories were combined and the main analysis compared schools with no injuries and those with one or more. As shown in Table II, only 6 variables showed significant differences between schools with and without injuries: the school board, distance from hospital, gym flooring and gym use during breaks, the presence of a playing field, and having a formal injury prevention program.

The final component used a case control design, with cases being schools with one or more injuries and controls those with none. We conducted a backward stepwise logistic regression analysis to identify pre-

dictors of schools with injuries (Table III). The predictor or exposure variables included some that represented socio-demographic features (e.g., deprivation), some that were structural (e.g., flooring), and some that reflected policies (e.g., frequency checking playing field, reported supervision procedures, and formal injury prevention program). As shown in Table IV, once confounders are controlled using backward stepwise logistic regression, only two measures remained predictive of schools with and without injuries: school board, and distance from hospital. However, this analysis was limited to the 90 cases for which there were no missing responses to any variable.

TABLE IV

Odds Ratios of Significant Variables in Final Model Used to Predict Schools With and Without Injuries

	Odds Ratio	P Value	95% CI	
			Lower	Upper
School board	0.197	0.000	0.11	0.37
Distance to hospital (<2km)	0.090	0.034	0.01	0.83
Injury prevention program	0.537	0.09	0.26	1.10
Constant	2706.5			

DISCUSSION

Our findings fail to provide strong support for the postulate that school policies influence safety. At best, they focus attention on some specific associations, e.g., among deprivation, supervision, playground surfacing and injury frequency at school. Parts of this relationship have been described previously,[19] but this is the first report to do so based on merged hospital and school data. The postulate seems reasonable. It assumes that principals or school boards have the ability to take steps to improve the safety of their pupils. The steps range from having formal injury prevention or violence prevention programs, to activities like posting notices when floors are slippery. However, the surprising finding is how few such measures were associated with reduced injury rates, and in some instances the expected relationship was actually reversed. In particular, we found an opposite relationship with the presence of a formal injury prevention program. Some variables such as the language of the board and the distance between school and hospital had highly significant relationships with schools with injuries, while other such variables, such as SES, were borderline.

The age and sex distribution of the injured children is what one would expect, as is the finding that most injuries occur in the gym or playground, most often during sports. The fact that many injuries involve the head and many are fractures, with a total of nearly one third requiring admission or follow up, indicates that many of the injuries are potentially serious.

Other significant results in the univariate analyses reflect exposure. Schools with playing fields have more injuries because many such fields are difficult to supervise. Furthermore, schools with fields are likely to offer more sports programs, and both organized and informal sports have been associated with injuries in many studies.[20-22]

Some of the unexpected ('reverse') findings may be explained if it is assumed that the occurrence of injuries was a stimulus for action rather than the fact that the action was protective, as we had implicitly postulated. For example, we expected lower SES schools to have higher injury rates but the reverse was found, perhaps because higher SES schools have more facilities that increase exposure to risk.

In the case of the strong relationship with the language division between school boards, we suspected selection bias because more children from English school board schools are seen at the MCH rather than at another predominantly French hospital. Although a larger proportion of schools in the French school board had high deprivation (low SES) scores, deprivation alone was not significantly related to the injury rates. The significant relationship with schools located within one mile (2 km) from the MCH may reflect the greater use of the ER by nearby schools and not a real difference in rates. However, this relationship may be confounded by SES (deprivation) because, in general, schools close to city center hospitals tend to be in lower SES census tracts, although, as noted above, SES was not a significant correlate. It is also possible that the two school boards had fundamentally different policies and philosophies not reflected in any of the other variables we measured.

It was encouraging to note the number of schools that reported having an anti-violence/anti-bullying policy, but disappointing that so few had a formal injury prevention program. Violence in schools in Canada may not have reached the same levels as it has recently in the US[23] and concerns about bullying have prompted various initiatives.[11-13]

The large percentage of schools without a prevention program raises several questions. It is possible that between the time the schools answered the questionnaires and the period for which the injury rates were calculated, formal programs may have been instituted. It is also possible that the programs are ineffective or that they are only instituted by schools with high injury rates. However, the main result – that there are few, if any, modifiable social or structural elements in the school that are related to injury occurrence – is disappointing. This conclusion may, however, be premature because of limitations in the way the study was conducted.

LIMITATIONS

The most important limitation arises from the cross-sectional design which makes it difficult to tease out causal directions. A second problem is that using CHIRPP data alone to identify school injury rates is likely to be inaccurate because not all injured children are seen at children's hospitals and not all parents of those seen at the participating hospitals complete forms. The most likely consequence is underestimation, but this should not result in systematic differences with respect to associations with the risk factors examined. As noted, one of the most important may be a selection bias reflecting the more 'English' clientele of the hospital studied.

Another limitation arises from using reports to describe safety measures.[24,25] We would have preferred systematic observations of each of the safety elements based on school visits. Using responses to a questionnaire to assess safety measures may be biased or a very rough approximation of reality. For example, principals may be inclined to exaggerate the precautions they routinely take. Related to this are possible differences between responding and non-responding schools if those who did not

respond had rates higher or lower than expected. Both assumptions are equally plausible: a disinclination to participate because of possible embarrassment, or conversely, for schools with low rates, because there seemed little sense that a problem pertained to their school.

Ideally, Bonferroni or some other correction should be made because of the large number of statistical tests performed. This was judged to be unnecessary because so few findings were statistically significant. Had such a correction been applied, however, the number of significant results would undoubtedly have been even fewer.

Finally, it must be acknowledged that the questionnaire's validity and reliability was not established. Ideally, validation would entail direct observations, but this would have been very costly. Test-retest reliability might have been feasible, but as with observations to establish validity, posed the risk of reduced response rate. In the end, the nature of the questions appeared sufficiently straightforward as to justify these omissions.

CONCLUSION

We are forced to conclude that the school as a social unit may not be as powerful a force for injury prevention as we and other investigators assumed it to be. As they stand, however, these results provide little encouragement that prevention of these injuries in the school may be influenced by teachers, principals, or school boards. Nonetheless, the postulate is so compelling, that a larger, more complex study may be needed to properly examine these relationships.

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RÉSUMÉ

Contexte : Les blessures sont une cause majeure de morbidité et de mortalité chez les enfants, et elles ont souvent lieu à l'école. Les différences dans les consignes, les programmes et les procédures des commissions scolaires ou des écoles pourraient peut-être expliquer au moins une partie des écarts dans les taux de blessure par école.

Méthode : Nous avons utilisé les données de l'Hôpital Sainte-Justine de Montréal pour répertorier les enfants blessés à l'école. À l'aide d'une entrevue téléphonique, nous avons identifié l'école fréquentée, puis calculé le taux de blessures par école pour l'année scolaire en question. Un questionnaire envoyé aux directeurs d'écoles nous a aidés à répertorier les consignes et les programmes utilisés. Les deux ensembles de données ont ensuite été regroupés, et les données analysées par recoupement et par régression logistique.

Résultats : Près du tiers des 310 enfants blessés ont dû être hospitalisés ou suivis. La plupart des blessures étaient liées aux chutes, au fait d'être un garçon, au fait d'avoir entre 10 et 14 ans et à la pratique des sports. Les variables liées à des taux de blessures plus élevés étaient : la commission scolaire (anglaise), la proximité de l'hôpital, un plancher de gymnase en bois, l'utilisation du gymnase durant les récréations, la présence d'un terrain de jeu, la fréquence élevée des vérifications du terrain de jeu et la présence d'un programme de prévention des blessures. Après l'application du modèle de régression logistique, et compte tenu de toutes les autres variables du modèle, les seuls liens significatifs qui ont subsisté étaient la commission scolaire et la proximité de l'hôpital.

Conclusion : Ces résultats ne permettent pas d'affirmer que les consignes scolaires ont une influence sur les taux de blessures. Ils suggèrent plutôt l'inverse, soit que des taux de blessure élevés poussent les écoles à prendre des mesures préventives. Il est possible également que bon nombre des écarts observés d'une école à l'autre tiennent uniquement à la mesure dans laquelle les élèves sont exposés à un risque de blessure, par exemple s'ils ont accès à des installations sportives.