Macpherson et al. BMC Public Health 2010, 10:542
http://www.biomedcentral.com/1471-2458/10/542

BMC Public Health

RESEARCH ARTICLE Open Access

Safety standards and socioeconomic disparities in school playground injuries: a retrospective cohort study

Alison K Macpherson[1*], Jennifer Jones[2], Linda Rothman[3], Colin Macarthur[3,4], Andrew W Howard[3]

Abstract

Background: Playground injuries are fairly common and can require hospitalization and or surgery. Previous research has suggested that compliance with guidelines or standards can reduce the incidence of such injuries, and that poorer children are at increased risk of playground injuries.

Objective: The objective of this study was to determine the association between playground injury and school socioeconomic status before and after the upgrading of playground equipment to meet CSA guidelines.

Methods: Injury data were collected from January 1998-December 1999 and January 2004 - June 2007 for 374 elementary schools in Toronto, Canada. The objective of this study was to investigate the effect of a program of playground assessment, upgrading, and replacement on school injury rates and socio-economic status. Injury rates were calculated for all injuries, injuries that did not occur on equipment, and injuries on play equipment. Poisson regression was performed to determine the relationship between injury rates and school socio-economic status.

Results: Prior to upgrading the equipment there was a significant relationship between socio-economic status and equipment-related injuries with children at poorer schools being at increased risk (Relative risk: 1.52 [95% CI = 1.24-1.86]). After unsafe equipment was upgraded, the relationship between injury and SES decreased and was no longer significant (RR 1.13 [95% CI = 0.95-1.32]).

Conclusions: Improvements in playground equipment can result in an environment in which students from schools in poorer neighbourhoods are no longer at increased risk of injuries on play equipment.

Background

Unintentional injuries are the leading cause of death and one of the leading causes of hospitalization for children over one year in Canada [1]. Sports and recreation injuries, including injuries on playgrounds, are a common cause of unintentional injury [2]. For example, over a one year period (2004-2005), 8,231 children 14 years of age and under in Ontario visited an emergency department because of a playground injury and of these, almost 6% required at least one night in hospital. More than half (58%) of those injured were between 5 and 9 years of age [3]. Previous studies have identified improving school playgrounds as a promising strategy to prevent these injuries [4,5]. Upgrading playground equipment may be one way to reduce the burden of playground injuries because injuries due to falls from equipment are more severe than other falls on the playground. One previous study reported that fractures from playground equipment falls are 3.9 times more likely to require hospitalization and or surgery than are fractures from standing height falls on the playground [6].

In general, childhood injuries vary by socioeconomic status (SES). Injury morbidity and mortality are strongly associated with factors such as poverty, single parenthood, low maternal education, poor housing, large family size and parental drug and alcohol abuse [7]. As SES declines, the risk of injury mortality increases [8-11] as does the rate of non-fatal injuries [12-17]. In some cases, this relationship may be linked to the environment in which children live. For example, children living in deprived neighborhoods have higher rates of injury

* Correspondence: alison3@yorku.ca
[1]York University, 4700 Keele Street, Toronto ON, Canada
Full list of author information is available at the end of the article

BioMed Central

© 2010 Macpherson et al; licensee BioMed Central Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/2.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

than children from more affluent areas [15]. A previous Canadian study found that children with the lowest SES had 1.37 times higher rates of recreation and play injuries, compared to children with the highest SES [13]. The prevalence of playground hazards has been found to be higher in poorer areas [18,19].

In the summer of 2000, a program was initiated by the Toronto District School Board to upgrade school playground equipment throughout the city to comply with new Canadian Standards Association (CSA) standards for playground equipment that address equipment height, surfacing of playgrounds, entrapment angles, and other safety issues. Equipment that was deemed to be the most unsafe (potential for falls from heights greater than 2 metres, potential for entrapment, or non-absorbent surfacing) was removed immediately. Equipment that was thought to be able to be repaired was retrofitted. Schools then had the opportunity to replace the equipment, or to leave the schoolyards without new equipment. Subsequent investigation showed that compliance with the playground standards was associated with a reduction in playground injuries [20]. The objective of this study was to determine the association between playground injury and school SES before and after the upgrading of playground equipment to meet CSA guidelines.

Methods

Study population

Data from 374 elementary schools in Toronto, Canada were included in the study. These schools had a population of approximately 145,000 students per year over the study period, which included January 1998 to December 1999 for the period prior to replacement, and January 2004 to June 2007 for the period subsequent to replacement. Children who attended private schools and religious schools were not included in either the numerator or the denominator. The schools ranged in size, with the smallest including 62 students, the largest 1600. The average school population was 388 students.

Study context

In 2000, the Toronto District School Board initiated a program of removal and replacement of playground equipment that did not comply with standards for playground equipment provided by the Canadian Standards Association. Much of the equipment was replaced by compliant equipment. The methodology is further described in previous research that suggested that the program was successful in reducing the risk of injury on school playgrounds [20].

Defining SES: The Learning Opportunity Index (LOI)

The Learning Opportunity Index is used to define school SES by the Toronto District School Board. The LOI is calculated using the social and demographic characteristics of the student population based on data collected by Statistics Canada from the Canadian census. Data included in the LOI include family income, proportion of single parent families, housing (detached, apartment buildings), parental education, neighborhood immigration, the number of students at the school who arrived in Canada in the past 5 years, and records of student mobility [21]. The score is a weighted average of the variables over the three previous years: 50% for the current year, and 25% each for the previous two years [21]. The LOI score is used to classify each school in the school board. LOI scores range from 0 (wealthiest) to 0.97 (poorest). The average score is 0.53 with a standard deviation of 0.27. Schools with the highest LOI score receive support from the Ministry of Education's Learning Opportunities Grant to help equalize learning opportunities [21].

We used the LOI scores for 2001 and 2005 because they included the best available data for the years of our study (1998 to 2007). According to the school board, there is very little variability in LOI scores within schools from year to year, as suggested by the reported correlation of 0.986 between 2003 and 2005 LOI scores [21].

Defining injuries within elementary schools

A database of incident reports from the Ontario School Board Insurance Exchange (OSBIE) was used to identify all injury events occurring in elementary schools (grades Junior Kindergarten to Grade 6 or 8) in the Toronto District School Board. Data were available for 20 months prior to the application of CSA standards, and 36 months subsequent to the application of CSA standards. The summer months of July and August were excluded because children in Canada do not attend school during these months. Information in the database is provided by school staff whenever an incident occurs on school property during school hours. The threshold for completing a report is "whenever medical or dental attention is required" and this includes injuries attended to by teachers or school staff as well as those in which the child went home or to a health facility. All students who were injured in the outdoor school area were included [e.g. the child was injured on the playground, field, or play equipment]. Injuries from the OSBIE data were analyzed in three ways: all outdoor injuries, outdoor non-equipment injuries, and injuries occurring on play equipment. Any injury in the OSBIE data that were coded or described as occurring on a slide, swing, climber, monkeybar, playscape, structure, or play equipment, were identified as "play equipment injuries", while injuries including playing soccer, running, or playing ball were classified as 'non-equipment injuries'.

Statistical analysis

Injury rates were calculated using student months (student population times the number of school months) prior to and subsequent to the application of CSA standards. Student populations from 2001 (the earliest year for which population information was available) were used as the denominator for injury rates for the period prior to application. Student populations from 2006 were used as the denominator for the period subsequent to the upgrading of playground equipment. Poisson regression was used to determine the relationship between the rate of playground injuries and LOI scores for both time periods. Statistical analyses were conducted using SAS version 9.1.

Ethical approval for the study was received from the research ethics review board at the Hospital for Sick Children, Toronto, Canada.

Results

Prior to the application of standards (January 1998-December 1999)

Prior to the application of the CSA standards a total of 5,378 injuries were reported by 364 schools. As shown in Table 1, the mean rate of all outdoor injuries was 2.04/1000 student months and ranged from 0.1 to 26.33. The mean rate of non-equipment injuries was 1.51/1000 (range from 0-26.43) and for equipment injuries was 0.50 (range from 0 to 4.82). The association between the school's LOI score and all playground injuries; both non-equipment and equipment are presented in Table 2. The relative risk of all outdoor injury with each unit increase in LOI score was 1.65 (1.50 -1.82). The corresponding rate for equipment-related injuries was 1.52 (1.24-1.86), indicating a socio-economic gradient for playground injuries.

Subsequent to Application of Standards (January 2004-June 2007)

A total of 8,380 injuries were reported by 374 elementary schools between January 2004 and June 2007. As shown in Table 1, the mean rate of total injuries occurring anywhere outside in the playground was 1.76/1000 student months (range 0.05 to 29.94). The mean rate of non-equipment injuries was 1.40/1000 student months (range from 0.00 - 5.26), and for playground equipment injures was 0.36 (range 0.00 - 26.43)

A significant relationship remained between a school's LOI score and the rate of total injuries, with a greater risk of injury in poorer schools. However, the association between SES and injuries that occurred on the play equipment subsequent to the upgrading of equipment was no longer statistically significant with a relative risk of 1.13 (95% CI 0.95-1.32).

Discussion

This study examined the relationship between socioeconomic status and outdoor injury rates in elementary school children. A significant relationship was found between low SES and playground injury rates. However, subsequent to the modification of the play equipment, the relationship between LOI score and injury on play equipment was not statistically significant. Further, after the playgrounds were modified, the injury rate for play equipment dropped across all schools.

The initial association between SES and all outdoor injuries is supported by previous research related to unintentional childhood injuries and SES [10-16]. However, that there was no significant relationship between the rate of playground injuries that occurred on play equipment and SES status in schools subsequent to the modification of playgrounds may provide important insight into mechanisms for preventing childhood injuries. The play equipment is a controlled environment, and had been modified to meet CSA standards across all the schools in the school board. Our results suggest that the program to improve the play equipment appears to have been successful in equalizing the risk of injury on equipment between schools with different SES scores. This result supports the concept that modification of the built environment is a successful strategy to reduce inequity in childhood injury [22].

In general, the relationship between SES and injury is not consistent across different types of injury. Sports and recreation injuries are more common in children from a higher SES, perhaps because they have increased access to facilities and resources to be able to participate

Table 1 Injury rates in Toronto District School Board schools prior to and subsequent to the replacement of unsafe play equipment

		Prior to replacement	Subsequent to replacement
All Outdoor Injuries	Number of injuries	5378	8380
	Injury rate per 1000 student months (range)	2.04 (0.1-26.3)	1.76 (0.1-29.9)
Non-equipment injuries*	Number of injuries	4013	6791
	Injury rate per 1000 student months (range)	1.51 (0-21.7)	1.40 (0-26.4)
Equipment-related injuries*	Number of injuries	1272	1589
	Injury rate per 1000 student months (range)	0.50 (0-4.8)	0.36 (0-5.36)

* 93 children were missing values for non-equipment or equipment injury

Table 2 Relative risk of playground injury as school SES decreases, prior to and subsequent to equipment replacement (Poisson regression)

	Prior to replacement (RR*, 95% CI)	Subsequent to replacement (RR, 95% CI)
All Outdoor Injuries	1.65 (1.50-1.82)	2.07 (1.91-2.24)
Non-equipment injuries	1.68 (1.50-1.89)	2.41 (2.20-2.64)
Equipment-related injuries	1.52 (1.24-1.86)	1.13 (0.95-1.32)

* interpretation of the relative risk: With each unit decrease in school SES as measured by the Learning Opportunities Index, the relative risk of injury increases. For equipment related injuries prior to replacement, the relative risk increases 1.52 times with each unit decrease in school SES.

in these types of activities [12,13,23-26]. For example, one study found that children of higher SES had a higher injury rate from drowning, because their families were more likely to have a swimming pool at their house than children of a lower SES [23]. Our results cannot be explained by differential access to recreational equipment and facilities since all of the schools had play equipment available that was required to meet the same safety standards. However, it is possible that play equipment at poorer schools was of poorer quality prior to the upgrading of equipment.

Another methodological concern related to a lack a socioeconomic gradient in non-fatal injuries has been explained by claiming that low SES individuals may not have equal access to care and therefore, some non-fatal injuries go unreported [26]. If individuals do not have access to health care, or cannot afford it, they may be less likely to be included in the data for minor and less severe injuries [27-29]. However, this is unlikely to explain our findings because reporting was done by school staff with no consideration of whether the injury was treated at a health facility. Further, schools have standardized guidelines related to the reporting of incidents.

Although the playground injury rate for all injuries decreased subsequent to the upgrading of equipment, a socioeconomic gradient for non-equipment injuries remained. Of particular concern is the increased socioeconomic disparity in non-equipment injuries. We hypothesize that the socioeconomic disparity in non equipment related injuries is explained by a difference across schools in playground environment outside the equipment area. Although the schools could not provide us with evidence related to differences between schools with different LOI scores, we believe that differences may be related to the availability of funds to upgrade the outdoor environment and the presence of adults on the playground. For example, schools in wealthier areas may have had the ability to raise funds to make improvements to fields, retaining walls, and other outdoor areas, whereas, poorer schools may have only upgraded the playground equipment. There may also be differences across schools in the presence of adults in the school yard. Parents in wealthier neighbourhoods may be more available to volunteer to oversee students during the midday break. These differences warrant further investigation.

There were several limitations to this study. First, the threshold for reporting injuries is fairly low and there may have been differential reporting of injuries between the schools. It is possible that there was a systematic tendency to report more superficial injuries in lower socioeconomic schools. However, all schools have the same guidelines for reporting an injury, so the variation by SES is not likely to be due to reporting differences. A second limitation is that the validity of the LOI score has not been extensively tested, although it is based on actual census data of the school catchment areas. Finally, it is difficult to determine whether changes in injury rates are a result of the intervention to upgrade playground equipment to a standard safety level throughout Toronto schools or whether other factors, such as increased teacher supervision, or differential exposure to playground equipment in schools with different SES contributed to the difference in injury rates. It is possible that children played less (or more) on equipment after it was replaced. Further studies in this area should include measures of exposure to play where possible.

A goal of the school board that participated in this study is to "identify and eliminate socio-economic class biases and barriers in Board policies guidelines, day-to-day operations, protocols, and practices" [30]. The results of this study suggest that one way to achieve this may be to equalize the risk of injury on playground equipment. The next injury prevention challenge for schools is to find methods to equalize the risk of injury in all areas of the playground. It will be important to identify appropriate strategies for reduction of non-equipment injuries. These strategies may include increased supervision, behavioral intervention programs, more structured activities, and changes to other aspects of the built environment. The school playground is an important learning environment for all children, and it is essential that children have equal opportunity for safe play in all school playgrounds.

Conclusion

Upgrading of school playground equipment to meet CSA standards reduces the socio-economic gradient for this common cause of childhood injury.

Acknowledgements
We acknowledge the ongoing contribution of the Toronto District School Board and the Ontario School Board Insurance Exchange.

Author details
[1]York University, 4700 Keele Street, Toronto ON, Canada. [2]McMaster University, 1280 Main Street, West Hamilton ON, Canada. [3]The Hospital for Sick Children, 555 University Avenue, Toronto ON, Canada. [4]Bloorview Kids Rehab, 150 Kilgour Road, Toronto ON, Canada.

Authors' contributions
AKM, AWH, CM, and LR designed the study. JJ, LR, and AKM analyzed the data. AKM and JJ drafted the initial article. All authors were involved in critical evaluation and editing of the manuscript, and read and approved the final version.

Competing interests
The authors declare that they have no competing interests.

Received: 4 December 2009 Accepted: 8 September 2010
Published: 8 September 2010

References

1. Health Canada: **Injury surveillance in Canada: Current realities, challenges.** 2003.
2. Canadian Institute for Health Information: **Over 8,500 playground injury-related ERvisits in Ontario, reports CIHI.** 2004.
3. Canadian Institute for Health Information: **23 children visit an Ontario ER daily due to playground injuries.** 2007.
4. Phelan KJ, Khoury J, Kalkwarf HJ, Lanphear BP: **Trends and patterns of playground injuries in United States children and adolescents [see comment].** *Ambulatory Pediatrics* 2001, **1(4)**:227-33.
5. Macarthur C, Hu X, Wesson DE, Parkin PC: **Risk factors for severe injuries associated with falls from playground equipment.** *Accid Anal Prev* 2000, **32(3)**:377-82.
6. Fiissell D, Pattison G, Howard A: **Severity of playground fractures: play equipment versus standing height falls.** *Inj Prev* 2005, **11**:337-339.
7. United Nations Children's Fund Innocenti Research Centre: **A League Table of Child Deaths by Injury in Rich Nations.** 2001, **2**:1-17.
8. Roberts I, Power C: **Does the decline in child injury mortality vary by social class? A comparison of class specific mortality in 1981 and 1991.** *BMJ* 1996, **313**:784-786.
9. Birken CS, Parkin PC, To T, Macarthur C: **Trends in rates of death from unintentional injury among Canadian children in urban areas: influence of socioeconomic status.** *CMAJ* 2006, **175(8)**:867-868.
10. Carey V, Vimpani G, Taylor R: **Childhood injury mortality in New South Wales: Geographical and socio-economic variations.** *J Paediatr Child Health* 1993, **29**:136-140.
11. Cubbin C, LeClere FB, Smith GS: **Socioeconomic status and injury mortality: individual and neighbourhood determinants.** *J Epidemiol Community Health* 2000, **54**:517-524.
12. Jolly DL, Moller JN, Volkmer RE: **The socio-economic context of child injury in Australia.** *J Paediatr Child Health* 1993, **29**:438-444.
13. Faelker T, Pickett W, Brison RJ: **Socioeconomic differences in childhood injury: a population based epidemiologic study in Ontario, Canada.** *Inj Prev* 2000, **6(203)**:208.
14. Suecoff SA, Avner JR, Chou KJ, Crain EF: **A comparison of New York City playground hazards in high- and low-income areas.** *Arch Pediatr & Adolescent Med* 1999, **153(4)**:363-6.
15. Cradock AL, Kawachi I, Colditz GA, Hannon C, Melly SJ, Wiecha JL, Gortmaker SL: **Playground safety and access in Boston neighborhoods.** *Am J Prev Med* 2005, **28(4)**:357-63.
16. Roberts I, Marshall R, Norton R, Borman B: **An area analysis of child injury morbidity in Auckland.** *J Paediatr Child Health* 1992, **28**:438-441.
17. 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(4)**:587-592.
18. Haynes R, Reading R, Gale S: **Household and neighbourhood risks for injury to 5-14 year old children.** *Soc Sci Med* 2003, **57**:625-636.
19. Laing GJ, Logan S: **Patterns of unintentional injury in childhood and their relation to socio-economic factors.** *Publ Health* 1999, **113**:291-294.
20. Howard AW, Macarthur C, Willan A, Rothman L, Moses-McKeag A, Macpherson AK: **The effect of safer playground equipment on playground injury rates among children.** *CMAJ* 2005, **172(11)**:1443.
21. Toronto District School Board. Part 1: **Elementary Learning Opportunities Index.** 2005 [http://www.tdsb.on.ca/wwwdocuments/about_us/external_research_application/docs/loi%202004-5.pdf], Accessed March/1, 2008.
22. Howard AW: **Child Safety and the Built Environment.** *CMAJ* 2009.
23. Nixon J, Pearn J: **An investigation of socio-demographic factors surrounding childhood drowning accidents.** *Soc Sci Med* 1978, **12**:387-390.
24. Ni H, Barnes P, Hardy AM: **Recreational injury and its relation to socioeconomic status among school aged children in the US.** *Inj Prev* 2002, **8**:60-65.
25. Simpson K, Janssen I, Craig WM, Pickett W: **Multilevel analysis of associations between socioeconomic status and injury among Canadian adolescents.** *J Epidemiol Community Health* 2005, **59**:1072-1077.
26. Langley J, Silva P, Williams S: **Socio-economic status and childhood injuries.** *Aust Paediatr J* 1983, **19**:237-240.
27. Cubbin C, LeClere FB, Smith GS: **Socioeconomic status and the occurrence of fatal and nonfatal injury in the United States.** *Am J Public Health* 2000, **90(1)**:70-77.
28. Williams JM, Currie CE, Wright P, Elton RA, Beattie TF: **Socioeconomic status and adolescent injuries.** *Soc Sci Med* 1996, **44(12)**:1881-1891.
29. Reading R, Langford IH, Haynes R, Lovett A: **Accidents to preschool children: comparing family and neighbourhood risk factors.** *Soc Sci Med* 1999, **48**:321-330.
30. Toronto District School Board: **Equity foundation statement and commitments to equity policy implementation.** 2000 [http://www.tdsb.on.ca/wwwdocuments/programs/Equity_in_Education/docs/Equity_Foundation_Statement.pdf], Accessed March/2, 2008.

Pre-publication history
The pre-publication history for this paper can be accessed here:
http://www.biomedcentral.com/1471-2458/10/542/prepub

doi:10.1186/1471-2458-10-542
Cite this article as: Macpherson *et al.*: Safety standards and socioeconomic disparities in school playground injuries: a retrospective cohort study. *BMC Public Health* 2010 **10**:542.

Submit your next manuscript to BioMed Central and take full advantage of:

- **Convenient online submission**
- **Thorough peer review**
- **No space constraints or color figure charges**
- **Immediate publication on acceptance**
- **Inclusion in PubMed, CAS, Scopus and Google Scholar**
- **Research which is freely available for redistribution**

Submit your manuscript at
www.biomedcentral.com/submit

BioMed Central