QUANTITATIVE RESEARCH

Socio-economic Inequities in Children’s Injury Rates: Has the Gradient Changed Over Time?

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ABSTRACT

Introduction: Changing socio-economic gradients in adult health over time have been documented, but little research has investigated temporal changes in child health gradients. Childhood hospitalizations for injury have fallen over the last two decades; whether the socio-economic gradient in childhood injury has changed is unknown.

Methods: Population-based hospital discharge data were used to calculate rates of hospitalization for injury from 1986/87 through 2005/06 for all children under 20 years of age in Manitoba (average yearly number of hospitalizations = 326,357). Information on socio-economic status (SES) came from area-level census data and was assigned by residential postal codes. Generalized linear models with generalized estimating equations were employed to describe the relation between SES and injury rates and whether this relation changed over time. All-cause injuries were examined as well as injuries for motor vehicle collisions (MVCs), other vehicle injuries, self-inflicted injuries, assault, poisoning, injuries caused by machinery, sports injuries and falls.

Results: Injury hospitalizations for children decreased steadily over the study period, from 1.07% to 0.51%. SES significantly predicted injury hospitalizations (p<0.0001), children with lower SES showing higher rates. A significant SES by year interaction (p<0.0001) indicated that the SES gradient for injury hospitalizations increased over time. Analysis by type of injury found a significant SES by year interaction for MVCs, self-inflicted injuries and falls; for MVCs and self-inflicted injuries the pattern (increasing SES gradient) was similar to that of hospitalization for all-cause injury. The pattern for falls was inconsistent.

Conclusion: Despite the overall drop in injury hospitalizations over time, the SES gradient in hospitalized injury rates has increased.

Key words: Injury; socioeconomic status; gradient; inequities; hospitalization

Socio-economic status (SES) is strongly related to health, lower SES being associated with both higher mortality and morbidity. The relation between health and SES is generally referred to as a “socio-economic gradient”;1 emphasizing the idea that the change in outcomes is gradual and occurs across the full range of SES. It is not just the case that individuals living in poverty have poorer outcomes when compared with individuals not living in poverty but, rather, that each increase in SES is associated with an increase in positive outcomes.

There has been considerable interest in the research literature on investigating changing SES gradients in health over time;2,7 however, most of this research has focused on adult populations. The few studies that have examined changes in SES gradients in children have produced mixed results: a study of childhood injury deaths in Great Britain found an increase in socio-economic disparity between 1981 and 1991,8 a study of all-cause child mortality in New Zealand found an increase in relative but not absolute disparity across income groups between 1981-84 and 1996-99;9 and a study from Australia examining changes between 1985-87 and 1995-97 found increases in all-cause mortality disparities among males 0-25 years old but decreases in all-cause mortality disparities among females in the same age range.10

The World Health Organization (WHO) report on health equity has called for the elimination of the socio-economic gradient in health outcomes within a generation,11 and in response to the report the Canadian Public Health Association has made a commitment to, among other things, helping develop a process to measure changes in the social gradient.12 The purpose of the current study was to measure changes in the socio-economic gradient for hospitalizations for childhood injury over a 20-year period in Manitoba. The results can be used not only to measure progress in reducing disparities in the past but also to provide an example of how disparities in health status can be monitored over time.

METHODS

Population and data sources
This study examined all hospitalizations for injuries that occurred from April 1, 1986, through March 31, 2006, to children under 20 years of age who were residents of Manitoba, Canada. The yearly number of hospitalizations ranged from 316,591 to 335,737, with an annual average of 326,357.

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Conflict of Interest: None to declare.
Data on inpatient hospitalizations came from de-identified population-based administrative databases housed in the Manitoba Centre for Health Policy’s Data Repository. Counts of injury hospitalizations were taken from hospital discharge abstracts, and population counts came from a population registry of those registered for universal health care services, representing 99% of the Manitoba child population. Information on SES was developed from area-level Canada census information. All linkages across datasets were made using anonymized identifiers.

**Variable definition**

Hospitalized injuries were defined as hospital discharges with an external cause of injury code (ICD-9-CM E-codes for 1985/86-2003/04; ICD-10 V, W, X and Y codes for 2004/05-2005/06). All-cause injuries were examined as well as the following types: motor vehicle collisions (MVCs), other vehicle injuries, self-inflicted injuries, assault, poisoning, injuries caused by machinery, sports injuries and falls. The specific codes used are available from the authors on request.

The main independent variable was SES, which was defined using a composite score based on census information from dissemination area (about 400-700 people), assigned according to each child’s residential postal code. The information consisted of level of education, unemployment, lone-parent status and female labour force participation. Because SES remained stable for 86.3% of the dissemination areas over the study period and the 2001 census had improved data quality, the SES score was based on the 2001 census but assigned to the study population from 1986/87 through 2005/06. SES composite scores were grouped into 10 classes whose median values ranged from -1.66 (highest SES) to 3.76 (lowest SES). Covariates included age (grouped into 0-4, 5-9, 10-14 and 15-19 years), sex and geographic region (Winnipeg, North Manitoba and South Manitoba), all taken from the population registry.

**Analysis**

Crude annual rates of hospitalization for injury were calculated over a 20-year period. Generalized linear models with generalized estimating equations (GEE) to account for the correlated nature of the data were employed to describe the relation between SES and injury rates and whether this relation changed over time. SES was entered into the models as a continuous measure. To reduce variability in yearly injury counts, which was a particular concern when analyzing by injury type, fiscal years were grouped into five groups of four years each. Other variables entered into the models were age, sex and geographic region. Interactions between each of the variables and SES were assessed. Model fit was assessed prior to applying GEE, using deviance to degrees of freedom ratio.

**RESULTS**

The percentage of Manitoba children hospitalized for injury decreased steadily over the study period, from 1.07% to 0.51%; decreases were observed in all SES groups (Figure 1). The deviance to degrees of freedom ratio for the regression model for all-cause injury hospitalizations was 1.10, indicating a good fit. A model run without interaction terms revealed that SES was a significant predictor of injury hospitalizations (p<0.0001), children with lower SES having higher rates of injury hospitalization. The model with the interaction terms entered revealed a significant SES by year interaction (p<0.0001), indicating that the SES gradient for injury hospitalizations changed over the study period (Table 1). Contrast estimates indicated that the effect of SES on injury increased over time: with every decrease in SES (indicated by an increase in the composite SES score) the relative risk (RR) of injury increased by 1.18 (confidence interval [CI]=1.16, 1.20) in 1986/87-1989/90, whereas this increase in RR was 1.28 (CI=1.25, 1.31) in 2002/03-2005/06. Other significant interactions indicated that the SES gradient was steeper for females than for males (RR of injury increased by 1.26 for every decrease in SES for females, whereas RR increased by only 1.19 for males) and steeper for the youngest (RR = 1.26 for 0-4 years) and oldest (RR = 1.25 for 15-19 years) age groups than for the middle age groups (RR = 1.19 for 5-9 years, RR = 1.20 for 10-14 years). Relative risks and 95% CIs for the all-cause injury hospitalization model are shown in Table 2.

Analysis by type of injury found a significant SES by year interaction only for MVCs, self-inflicted injuries and falls (SES by year interaction terms were not significant for other injury types).
interaction for each was p<0.05). For MVCs and self-inflicted injuries, the pattern of the SES by year interaction was similar to that of all-cause injury hospitalizations, indicating an increasing gradient over time. For falls, there was no clear pattern for the SES gradient. For MVCs, in 1986/87-1989/90 the RR for hospitalized injury was 1.13; the RR was 1.20 in 2002/03-2005/06. For self-inflicted injuries, in 1986/87-1989/90 the RR for hospitalized injury was 1.38; in 2002/03-2005/06 the RR was 1.44. For falls, the significant SES by year interaction appears to have been driven by an increased gradient in the middle of the time period, with similar RRs in the beginning and end of the study period (RR= 1.12 for 1986/87-1989/90, RR=1.10 for 2002/03-2005/06). Relative risks and 95% CIs for the SES by year interactions for these three injury types are shown in Table 3.

### DISCUSSION

There has been a steady and substantial decrease in hospitalization rates for injury over the past two decades. In Manitoba, the rate among children 0 to 19 years dropped by over one half between 1986/87 and 2005/06. The decrease in serious injuries has not been shared equally among all children, however; children from lower SES groups had consistently higher rates of hospitalized injuries over time compared with children from higher SES groups and, despite a decrease in injury rates for all SES groups, the socioeconomic gradient in childhood injuries actually widened during the study period.

Other research confirms the drop in childhood injury rates in Canada and the US over the last two decades, but little research has examined changes in the socioeconomic gradient for injury rates, and the few studies that have done so focused on injury mortality. To our knowledge, this is the first study to examine changes in the gradient for injury hospitalizations. While injury mortality is certainly important to study, rates of hospitalization for injury in childhood are over 25 times higher than rates of death from injury and so need to be considered when attempting to determine whether socio-economic gradients in childhood injuries have changed over time.

Why have injury hospitalizations in childhood declined so much over the past 20 years? Heinin et al. suggest that along with advances in technology and changes in health care utilization and resources, some of the observed decrease in the US may be due to public and private sector programs developed to prevent serious injuries. Examples of such injury prevention activities in Canada that may have contributed to the decline in childhood injuries include promotion of seat belt use, child safety seats and air bags in automobiles; improved road safety; graduated licensing programs; promotion of safety equipment in the home, such as baby gates and smoke detectors; safer playground equipment; promotion of bicycle helmet use and water safety; and suicide prevention programs.

However, injury prevention activities appear to have had a less pronounced impact on childhood injury hospitalizations in lower than in higher SES groups. Organizations focusing on the health and safety of children in Canada have called for a National Injury Prevention Strategy for Children and Youth as a means of further reducing childhood injuries. If the federal government implements such a strategy, it will be essential to integrate reduction in injury disparities as a key element in this strategy. Several studies suggest that reducing disparities in childhood injury may mean that some programs need to be targeted specifically at low income and other disadvantaged groups. On the other hand, Kendrick et al. found that reducing the cost and barriers to installation of safety equipment for targeted disadvantaged groups did not necessarily reduce disparities in use of this equipment. Furthermore, targeting injury prevention at disadvantaged groups ignores the graded association across all income levels; middle SES groups would thus be missed by targeted efforts. The recent WHO report and those who focus on increasing health equity would argue that the elimination of the social gradient in childhood injury will require addressing the broader determinants of injury, including the inequitable distribution of social resources.

### Table 3. Relative Risks (RR) and Confidence Intervals (CIs) for Type of Injury Hospitalization, Manitoba Children, 1986/87-2005/06, by SES by Year Interactions

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>Year by SES Interaction</th>
<th>RR</th>
<th>95% CI</th>
</tr>
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<tbody>
<tr>
<td>MVCs</td>
<td>1986/87-1989/90</td>
<td>1.13</td>
<td>1.08, 1.19</td>
</tr>
<tr>
<td></td>
<td>1990/91-1993/94</td>
<td>1.17</td>
<td>1.11, 1.22</td>
</tr>
<tr>
<td></td>
<td>1994/95-1997/98</td>
<td>1.22</td>
<td>1.17, 1.29</td>
</tr>
<tr>
<td></td>
<td>1998/99-2001/02</td>
<td>1.11</td>
<td>1.05, 1.18</td>
</tr>
<tr>
<td></td>
<td>2002/03-2005/06</td>
<td>1.20</td>
<td>1.14, 1.27</td>
</tr>
<tr>
<td>Self-inflicted</td>
<td>1986/87-1989/90</td>
<td>1.38</td>
<td>1.30, 1.45</td>
</tr>
<tr>
<td></td>
<td>1990/91-1993/94</td>
<td>1.35</td>
<td>1.27, 1.43</td>
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<tr>
<td></td>
<td>1994/95-1997/98</td>
<td>1.45</td>
<td>1.39, 1.52</td>
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<tr>
<td></td>
<td>1998/99-2001/02</td>
<td>1.34</td>
<td>1.28, 1.40</td>
</tr>
<tr>
<td></td>
<td>2002/03-2005/06</td>
<td>1.44</td>
<td>1.36, 1.52</td>
</tr>
<tr>
<td>Falls</td>
<td>1986/87-1989/90</td>
<td>1.12</td>
<td>1.08, 1.15</td>
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<tr>
<td></td>
<td>1990/91-1993/94</td>
<td>1.11</td>
<td>1.08, 1.14</td>
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<td>1998/99-2001/02</td>
<td>1.15</td>
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<td></td>
<td>2002/03-2005/06</td>
<td>1.10</td>
<td>1.06, 1.15</td>
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</table>

MVC=motor vehicle collision
There are several limitations of the current study that warrant discussion. The relatively small number of hospitalizations for several of the specific types of injury may have limited our ability to detect changes in the gradient for these injury types. The three injury types in which we found significant gradient changes are the top three causes of hospitalization for injury, accounting for over 40% of such hospitalizations in childhood. Future studies using larger populations should be considered for examining gradient changes in less common types of injury.

During the course of the study period, the coding of hospitalized injuries shifted from ICD-9-CM to ICD-10. While this would not have affected the patterns observed in overall injury hospitalizations, it may have had an impact on the injury type analyses. Overall, all time trends for MVCs, self-inflicted injuries and falls may have been influenced by the coding changes, but there is no reason to expect that coding changes would affect SES groups differently, so the observed patterns of gradient changes were unlikely due to the ICD shift.

Our measure of SES was not an individual but, rather, an area-level measure, attributed to individual children, thus an ecologic fallacy is possible: that is, an incorrect conclusion that associations found for aggregate level data apply at the individual level. How-fallacy is possible: that is, an incorrect conclusion that associations expected that coding changes would affect SES groups differently, so have been influenced by the coding changes, but there is no reason to expect that coding changes would affect SES groups differently, so the observed patterns of gradient changes were unlikely due to the ICD shift.

Our measure of SES was not an individual but, rather, an area-level measure, attributed to individual children, thus an ecologic fallacy is possible: that is, an incorrect conclusion that associations found for aggregate level data apply at the individual level. However, area-level measures have been shown to closely approximate individual level SES, and studies have demonstrated that area-level deprivation is associated with childhood injury risk independent of individual-level SES.

CONCLUSION

The substantial reduction in hospitalizations for injury over time may provide evidence of the effectiveness of policies and programs aimed at injury prevention. However, the increasing SES gradient suggests that despite the gains from injury prevention efforts, inequalities in hospitalized injury rates have increased. A combination of universal and targeted prevention programs may reduce the inequalities in injury hospitalizations; the elimination of the SES gradient for childhood injuries will likely require attention to the broader determinants of health. The current study not only provides an account of how the gradient for childhood injuries has increased over the past two decades in Manitoba but also demonstrates how provincial databases can be used to measure progress on reducing disparities, one of the overarching recommendations of the WHO report.

REFERENCES