# RESEARCH REPORT

# Multilevel analysis of associations between socioeconomic status and injury among Canadian adolescents

## Kelly Simpson, Ian Janssen, Wendy M Craig, William Pickett

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authors' affiliations
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Correspondence to:
Dr I Janssen, School of
Physical and Health
Education, Queen's
University, 69 Union
Street, Kingston, Ontario,
Canada, K7L 3N6;
janssen@post.queensu.ca

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**Study objective:** To determine the contribution of individual and area level measures of socioeconomic status (SES) to the occurrence of various injury types among Canadian adolescents.
**Design and setting:** Cross sectional Canadian data were used from two sources: (1) the 2001/02 health behaviour in school aged children survey (individual level SES measures, injury measures), and (2) the 2001 Canada census of population (area level SES measures). Injury outcomes included: medically treated injury, injury hospitalisation, sport/recreational injury, and fighting injury. Multilevel logistic regression models were used to examine individual and area level SES measures as potential determinants of adolescent injury.
**Participants:** 7235 students in grades 6–10 from 170 schools across Canada.
**Main results:** Associations between SES and injury were identified for each injury outcome examined, although a clear direction of association was not present for the overall measure of medically treated injury. In general, lower SES was associated with increased risk for hospitalised and fighting injury. Higher SES was associated with increased risks for sport/recreational injury. Independent contributions of individual and area level measures of SES were seen for hospitalised and fighting injury.
**Conclusions:** Associations between SES and adolescent injury exist; however, the direction of these relations becomes more apparent with particular indicators of SES and when homogenous injury outcomes are evaluated.

S ocioeconomic status (SES) is generally recognised as an important predictor of various health conditions, although its influence on many specific aspects of the health of populations is not fully understood.[1–4] Injury is one area that is not well understood with respect to socioeconomic determinants. Injury is a leading acute health problem as shown by the magnitude and burden of the problem but the potential for primary prevention does exist.[5] [6] The identification of socioeconomic gradients in risk for injury through aetiological study may provide opportunities for the targeting of preventive interventions to high risk groups.

In 2002, Cubbin and Smith published a review of literature that examined the relations between SES and injury and found that associations varied according to type or cause of injury, level of analysis, population, and setting; especially for non-fatal injury.[7] Several of these studies examined the associations between SES and non-fatal injury; however, these relations remain unclear, particularly among adolescents.

Difficulties with the conceptualisation and measurement of injury and SES may explain some inconsistencies in past research. Previous aetiological studies differed with respect to their definition of injury and associations with SES varied according to cause, type, and severity of injury.[8] Hence, the examination of homogeneous injury outcomes such as sports and fighting injuries may aid in the understanding of these relations. SES can also be measured in a variety of ways such as describing features of the individual person or their family (for example, family wealth) or characteristics of the area in which they reside (for example, average income of a community). Simultaneous examination of associations between SES and injury at more than one level (for example, individual and area) has rarely been performed. The only existing studies that have presented such analyses include one study of adult injury fatalities in the USA,[9] and two

studies of injured preschool[10] and older children[11] who presented to an accident and emergency department in Norwich, UK. Each of these studies identified gradients in risk for injury with those in lower socioeconomic classes being the most vulnerable. Individual and neighbourhood SES characteristics were independently associated with injury. Unfortunately, none of the existing multilevel analyses have focused upon adolescent populations.

In light of this background, the purpose of this study was to determine the contribution of individual and area level measures of SES to the occurrence of various injury types among Canadian adolescents. Several individual and area level measures of SES and their associations with homogenous injury outcomes were considered in a series of multilevel analyses.

## METHODS

### Health behaviour in school aged children survey (HBSC)

HBSC is a collaborative cross national study facilitated by the World Health Organisation.[12] The study involved a classroom based health survey among adolescents in the participating countries. Here, we used an analysis of Canadian data from the 2001/02 HBSC survey. Students were sampled according to a standard protocol to reflect the distribution of adolescents in grades 6–10 (typically aged 11–16 years).[12] The survey instrument included questions about health behaviours, lifestyle factors, and demographic characteristics.[12] Information on individual level SES measures and injury outcomes were obtained from this survey. Ethics approval was obtained from the Queen's University general research ethics board, and subject consent was obtained at the school board, parent, and student level.

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**Abbreviations:** SES, socioeconomic status; HBSC, health behaviour in school aged children

The census of population is conducted every five years to provide information on the population of Canada, its provinces, and smaller geographical areas.[13] For each geographical area, data are available that describe demographic, social, and economic circumstances. Through a linkage of school postal codes, the 2001 census was used to provide SES measures for the areas in which schools were situated.

### SES exposure variables

Five individual level measures of SES were examined from the Canadian HBSC survey: (1) material wealth (family affluence scale); (2) poverty (hunger); (3) perceptions of local area safety; (4) perceptions of residential area; (5) perceived family wealth. These variables were developed, piloted for face validity, and implemented under direction of an HBSC focus group that was responsible for the conceptualisation of SES. These variables (deliberately) covered a range of standard SES constructs including material wealth, household income, education, deprivation, and social/environmental safety.[12]

PCensus (Tetrad Computer Applications, Bellingham, WA, version 2001) for MapPoint software (Microsoft Corporation, Redmond, WA, version 2002) was used to define the geographical area (5 km radius) surrounding each participating school. Four measures of area level SES were obtained form the Canadian census of population for these 5 km areas (in secondary sensitivity analyses we used a smaller concentric area (1 km compared with 5 km) around schools to define area level SES for students, with the idea that this would be less inclusive of residences for students that attended the schools. Findings showed that there were no differences between the area level exposures obtained with the two radii). Area level SES measures included: (1) % of lone parent families in the area; (2) % unemployment; (3) % of residents with less than a high school education; (4) average employment income in the area. These measures were used to infer the levels of SES in the areas served by the schools, a proxy for SES in the neighbourhoods of individual participants. For analytical purposes, the area level measures of SES were divided into quartiles.

### Injury outcome variables

Four self reported injury outcomes were examined from the Canadian HBSC survey. These included: (1) any medically treated injury seen by a doctor or nurse in the 12 months before survey; (2) injuries requiring an overnight stay in hospital; (3) injuries occurring while playing or training for a sport/recreational activity; (4) injuries occurring during a physical fight. Hospitalised injuries were chosen as they are probably representative of more serious forms of trauma. We chose to present sports injury and fighting injury as illustrative examples of homogenous outcomes. Based upon exploratory analyses, sports and recreation were the leading external causes of injury among Canadian adolescents. In addition, SES measures have been shown to be associated with both sports injuries and fighting injuries in past Canadian analyses.[14][15]

### Statistical analysis

Spearman correlation coefficients were used to compute the association between the individual level measures of SES while Pearson correlation coefficients were used to compute the association between the area level measures of SES. Associations between SES and injury were examined using multilevel logistic regression procedures that modelled individual students (level 1) nested within schools (level 2). Odds ratios and associated 95% confidence intervals were estimated. The highest level of SES was chosen as the referent category within each multilevel model. A two step approach to the multilevel analysis was used. Firstly, bivariate models were fitted for each SES exposure and injury outcome. The second step involved fitting multivariate multilevel multiple logistic regression models. SES exposure variables that significantly contributed ($p < 0.05$) to the models were included in multivariate analyses. Age and sex were forced into all models according to a priori assumptions about potential confounding. During the multilevel analysis, no complex level 2 variations (differing slopes between schools) were found for each SES exposure variable and the medically treated injury outcome. Simple level 2 variation (random intercepts) was therefore assumed for all outcome variables. The multilevel analysis was conducted using MLwiN software (Centre for Multi-level Modelling, Institute of Education, University of London, London, UK, version 1.1).

### RESULTS

#### Injuries

A total of 7235 students from 170 schools participated in the 2001/02 Canadian HBSC survey. More than half of the study population reported one or more medically treated injury by a doctor or nurse during the 12 months before survey (table 1).

| Table 1 | Description of injuries among adolescent study population | | |
|---|---|---|---|
| | **Number (%*)** | | |
| **Variable** | **Injured** | **Not injured** | |
| Medically treated injury | 3905 (54.3) | 3291 (45.7) | |
| By sex | | | |
| Female | 1935 (50.1) | 1925 (49.9) | |
| Male | 1970 (59.1) | 1366 (40.9) | |
| By age (in years) | | | |
| ⩽11 | 536 (50.6) | 523 (49.4) | |
| 12–15 | 3088 (55.1) | 2517 (44.9) | |
| ⩾16 | 281 (52.8) | 251 (47.2) | |
| Activity at time of medically treated injury | | | |
| Playing or training for sport/recreational activity | 1914 (58.4) | | |
| Walking/running | 298 (9.1) | | |
| Biking/cycling | 216 (6.6) | | |
| Skating | 210 (6.4) | | |
| Fighting | 115 (3.5) | | |
| Other | 527 (16.1) | | |
| | **Treated (% of injured)*** | **Not treated (% of injured)*** | |
| Injury treated in emergency department | 975 (25.0) | 2930 (75.0) | |
| Injury hospitalisation | 258 (6.6) | 3647 (93.4) | |

*Percentage obtained after omitting non-response and not applicable values.

**Table 2** Description of individual level socioeconomic status variables

| Individual level socioeconomic status variable | Number | % Total* |
|---|---|---|
| Family affluence scale | | |
| I Highest | 3446 | 50.2 |
| II Medium | 2701 | 39.3 |
| III Lowest | 722 | 10.5 |
| How often I go to bed or school hungry | | |
| I Never | 6116 | 84.9 |
| II Sometimes | 943 | 13.1 |
| III Often | 99 | 1.4 |
| IV Always | 50 | 0.7 |
| I feel safe in the area where I live | | |
| I Always | 4828 | 69.8 |
| II Most of the time | 1746 | 25.2 |
| III Sometimes | 270 | 3.9 |
| IV Rarely or never | 77 | 1.1 |
| Area I live in is a good place to live | | |
| I It's really good | 4188 | 60.5 |
| II It's good | 1708 | 24.7 |
| III It's OK | 830 | 12.0 |
| IV It's not very good | 114 | 1.6 |
| V It's not good at all | 82 | 1.2 |
| How well off my family is | | |
| I Very well off | 1744 | 25.9 |
| II Quite well off | 2082 | 30.9 |
| III Average | 2315 | 34.4 |
| IV Not very well off | 331 | 4.9 |
| V Not at all well off | 266 | 3.9 |

*Percentage obtained after omitting non-response and not applicable values.

Injuries were more common among males compared with females (59.1% versus 50.1%, p<0.001). Twenty five per cent of the medically treated injuries presented to an emergency department and 6.6% required overnight hospitalisation. Injuries most commonly occurred while the students were playing or training for a sport or recreational activity (58.4%).

## SES measures

Table 2 further describes the study population according to individual level measures of SES. The correlation coefficients between the five individual level SES variables were weak to modest, ranging from 0.06 (how often I go to bed or school hungry compared with family affluence scale) to 0.50 (area I live is a good place to live compared with I feel safe in the area where I live). With respect to area level measures of the 170 schools, the mean percentage of lone parent families for the geographical areas surrounding schools was 15.1% (range 0%–39.1%). The unemployment rate ranged from 2.5% to 51.6%, and the mean unemployment rate was 6.7%. The mean percentage of residents with less than a high school education was 27.9% (range 11.7%–61.3%). The average household income level ranged from $14 049–$53 745 (mean

**Table 3** Bivariate analyses of associations between individual level socioeconomic status variables and injury

| Individual level socioeconomic status variable* | Medically treated injury | | Injury hospitalisation | | Sport/recreational injury | | Fighting injury | |
|---|---|---|---|---|---|---|---|---|
| | OR | (95% CI) | OR | (95% CI) | OR | (95% CI) | OR | (95% CI) |
| Family affluence scale | | | | | | | | |
| I Highest | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II Medium | 0.77 | (0.69 to 0.85) | 0.89 | (0.68 to 1.18) | 0.76 | (0.68 to 0.86) | 1.02 | (0.67 to 1.55) |
| III Lowest | 0.58 | (0.49 to 0.69) | 1.08 | (0.71 to 1.64) | 0.50 | (0.41 to 0.62) | 2.40 | (1.46 to 3.95) |
| How often I go to bed or school hungry | | | | | | | | |
| I Never | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II Sometimes | 1.27 | (1.10 to 1.46) | 1.89 | (1.38 to 2.58) | 1.00 | (0.85 to 1.17) | 0.94 | (0.52 to 1.69) |
| III Often | 1.14 | (0.76 to 1.71) | 3.58 | (1.53 to 8.38) | 0.51 | (0.29 to 0.88) | 2.78 | (1.00 to 7.79) |
| IV Always | 2.09 | (1.11 to 3.92) | 3.53 | (1.35 to 9.23) | 0.74 | (0.35 to 1.56) | 9.61 | (3.74 to 24.72) |
| I feel safe in the area where I live | | | | | | | | |
| I Always | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II Most of the time | 1.18 | (1.06 to 1.32) | 0.87 | (0.64 to 1.20) | 1.00 | (0.88 to 1.14) | 1.67 | (1.10 to 2.54) |
| III Sometimes | 1.54 | (1.19 to 1.99) | 2.16 | (1.32 to 3.52) | 1.02 | (0.77 to 1.36) | 3.12 | (1.57 to 6.20) |
| IV Rarely or never | 2.44 | (1.46 to 4.05) | 3.07 | (1.43 to 6.63) | 0.95 | (0.54 to 1.68) | 12.59 | (5.81 to 27.31) |
| Area I live in is a good place to live | | | | | | | | |
| I It's really good | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II It's good | 1.15 | (1.02 to 1.29) | 0.87 | (0.62 to 1.20) | 0.99 | (0.87 to 1.13) | 1.26 | (0.77 to 2.05) |
| III It's OK | 1.10 | (0.95 to 1.29) | 1.60 | (1.12 to 2.27) | 0.81 | (0.67 to 0.97) | 2.30 | (1.37 to 3.86) |
| IV It's not very good | 1.49 | (1.01 to 2.21) | 1.56 | (0.66 to 3.66) | 0.87 | (0.56 to 1.35) | 8.98 | (4.46 to 18.08) |
| V It's not good at all | 2.10 | (1.29 to 3.43) | 2.70 | (1.21 to 6.05) | 0.83 | (0.47 to 1.47) | 13.05 | (6.04 to 28.20) |
| How well off my family is | | | | | | | | |
| I Very well off | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II Quite well off | 0.97 | (0.85 to 1.10) | 0.61 | (0.43 to 0.87) | 1.12 | (0.96 to 1.29) | 1.18 | (0.68 to 2.05) |
| III Average | 0.99 | (0.87 to 1.12) | 0.75 | (0.54 to 1.04) | 0.96 | (0.83 to 1.12) | 1.47 | (0.87 to 2.48) |
| IV Not very well off | 1.17 | (0.92 to 1.49) | 1.05 | (0.60 to 1.85) | 0.86 | (0.65 to 1.14) | 2.14 | (0.97 to 4.70) |
| V Not at all well off | 1.23 | (0.94 to 1.60) | 1.56 | (0.91 to 2.66) | 1.13 | (0.83 to 1.52) | 2.56 | (1.12 to 5.87) |

*Each variable examined individually.

**Table 4** Bivariate analyses of associations between area level socioeconomic status variables and injury

| Area level socioeconomic status variable* | Medically treated injury | | Injury hospitalisation | | Sport/recreational injury | | Fighting injury | |
|---|---|---|---|---|---|---|---|---|
| | OR | (95% CI) | OR | (95% CI) | OR | (95% CI) | OR | (95% CI) |
| Lone parent families | | | | | | | | |
| I Low (<12.5%) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II Medium (12.5%–15.1%) | 0.87 | (0.73 to 1.05) | 1.57 | (0.97 to 2.52) | 0.89 | (0.73 to 1.09) | 1.12 | (0.59 to 2.11) |
| III High (15.1%–17.7%) | 0.85 | (0.71 to 1.02) | 1.69 | (1.05 to 2.72) | 0.91 | (0.75 to 1.12) | 0.97 | (0.50 to 1.87) |
| IVVery high (>17.7%) | 0.82 | (0.69 to 0.98) | 2.16 | (1.38 to 3.40) | 0.85 | (0.70 to 1.04) | 1.11 | (0.59 to 2.07) |
| Unemployment rate | | | | | | | | |
| I Low (<5.5%) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II Medium (5.5%–6.7%) | 1.09 | (0.92 to 1.30) | 1.01 | (0.65 to 1.59) | 0.98 | (0.80 to 1.19) | 1.57 | (0.85 to 2.88) |
| III High (6.7%–9.0%) | 0.95 | (0.80 to 1.13) | 0.97 | (0.62 to 1.52) | 0.92 | (0.76 to 1.13) | 0.95 | (0.49 to 1.81) |
| IVVery high (>9.0%) | 0.98 | (0.82 to 1.17) | 1.35 | (0.88 to 2.07) | 0.81 | (0.66 to 0.99) | 1.11 | (0.59 to 2.11) |
| Less than high school education | | | | | | | | |
| I Low (<22.4%) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II Medium (22.4%–27.9%) | 0.94 | (0.79 to 1.12) | 1.56 | (1.00 to 2.43) | 0.86 | (0.71 to 1.04) | 0.74 | (0.39 to 1.41) |
| III High (27.9%–35.4%) | 0.93 | (0.78 to 1.11) | 1.33 | (0.84 to 2.10) | 0.80 | (0.65 to 0.97) | 0.92 | (0.50 to 1.71) |
| IVVery high (>35.4%) | 0.97 | (0.82 to 1.16) | 2.17 | (1.42 to 3.33) | 0.82 | (0.68 to 1.00) | 1.02 | (0.56 to 1.87) |
| Average employment income | | | | | | | | |
| I Very high (>$33442) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| II High ($28994–$33442) | 0.87 | (0.85 to 0.88) | 1.20 | (0.77 to 1.88) | 0.80 | (0.66 to 0.97) | 0.87 | (0.46 to 1.65) |
| III Medium ($25610–$28994) | 0.91 | (0.77 to 1.09) | 1.37 | (0.88 to 2.12) | 0.77 | (0.64 to 0.93) | 1.15 | (0.63 to 2.12) |
| IVLow (<$25610) | 0.94 | (0.78 to 1.12) | 1.64 | (1.06 to 2.53) | 0.90 | (0.74 to 1.09) | 0.98 | (0.52 to 1.86) |

\* Each variable examined individually.

roughly $30 000). The correlation coefficients between the four area level SES variables ranged from 0.20 (% lone parent families compared with % less than high school education) to −0.77 (average employment income compared with % less than high school education).

## Bivariate analyses of associations between SES and injury

### Medically treated injury

Several SES variables were associated with medically treated injury however the direction of these associations varied depending upon the measure under study. For the family affluence scale, decreased risk for medically treated injury was found with lower levels of family affluence (p<0.001 for trend; table 3). Three other individual level measures of SES

(poverty, perceptions of local area safety, and perceptions of residential area) were also associated with medically treated injury. For these variables, lower SES was associated with higher risk for medically treated injury (p<0.001 for trend), which is opposite to the results reported above for the family affluence scale. Two area level SES variables (lone parent families and average employment income) were associated with medically treated injury in a statistically significant manner (table 4).

### Injury hospitalisation

Evidence of a gradient between several measures of SES and injury hospitalisation was seen in that lower SES was associated with increased risk for hospitalisation (p<0.025 for trend). This relation was seen for three individual level

**Table 5** Multivariate analyses of associations between socioeconomic status variables and injury

| Socioeconomic status variable* | SES level* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | I (highest) | II | | III | | IV | | V (lowest) | | |
| | | OR† | (95% CI)† | OR† | (95% CI)† | OR† | (95% CI)† | OR† | (95% CI)† | |
| **Individual level variables** | | | | | | | | | | |
| Family affluence scale | | | | | | | | | | |
| Medically treated injury | 1.00 | 0.76 | (0.68 to 0.84) | 0.53 | (0.45 to 0.63) | | | | | |
| Sport/recreational injury | 1.00 | 0.77 | (0.68 to 0.86) | 0.50 | (0.40 to 0.62) | | | | | |
| How often I go to bed or school hungry | | | | | | | | | | |
| Medically treated injury | 1.00 | 1.29 | (1.11 to 1.50) | 1.05 | (0.69 to 1.58) | 1.71 | (0.90 to 3.26) | | | |
| Injury hospitalisation | 1.00 | 1.71 | (1.21 to 2.41) | 3.00 | (1.51 to 5.94) | 2.25 | (0.83 to 6.13) | | | |
| Sport/recreational injury | 1.00 | 1.04 | (0.88 to 1.23) | 0.53 | (0.30 to 0.94) | 0.72 | (0.34 to 1.54) | | | |
| Fighting injury | 1.00 | 0.90 | (0.50 to 1.64) | 1.79 | (0.62 to 5.22) | 4.46 | (1.56 to 12.81) | | | |
| I feel safe in the area where I live | | | | | | | | | | |
| Medically treated injury | 1.00 | 1.21 | (1.08 to 1.36) | 1.69 | (1.30 to 2.19) | 2.57 | (1.51 to 4.39) | | | |
| Injury hospitalisation | 1.00 | 0.93 | (0.67 to 1.29) | 1.90 | (1.13 to 3.21) | 2.37 | (1.04 to 5.40) | | | |
| Area I live in is a good place to live | | | | | | | | | | |
| Fighting injury | 1.00 | 1.23 | (0.75 to 2.01) | 2.21 | (1.31 to 3.74) | 8.01 | (3.93 to 16.32) | 9.12 | (4.01 to 20.78) | |
| How well off my family is | | | | | | | | | | |
| Injury hospitalisation | 1.00 | 0.62 | (0.44 to 0.89) | 0.71 | (0.51 to 1.01) | 0.85 | (0.47 to 1.54) | 1.12 | (0.63 to 1.98) | |
| **Area level variables** | | | | | | | | | | |
| Lone parent families | | | | | | | | | | |
| Injury hospitalisation | 1.00 | 1.48 | (0.94 to 2.34) | 1.64 | (1.04 to 2.61) | 1.64 | (1.05 to 2.56) | | | |
| Less than high school education | | | | | | | | | | |
| Injury hospitalisation | 1.00 | 1.31 | (0.83 to 2.06) | 1.19 | (0.75 to 1.90) | 2.11 | (1.36 to 3.28) | | | |
| Average employment income | | | | | | | | | | |
| Sport/recreational injury | 1.00 | 0.81 | (0.68 to 0.97) | 0.80 | (0.67 to 0.96) | 0.97 | (0.81 to 1.15) | | | |

*See tables 3 and 4 for definitions of levels for each socioeconomic status variable. †Simultaneously adjusted for age, sex, and other socioeconomic status variables associated with the specific injury outcome.

## What this paper adds

### What is already known on this subject?
The socioeconomic determinants of injury among adolescents remain unclear, which may be explained by difficulties in the conceptualisation of socioeconomic status and that most previous studies have not studied homogenous injury outcomes such as sports and fighting injuries.

### What does this study add?
In general, lower SES was associated with increased risk for hospitalised and fighting injury. Higher SES was associated with increased risk for sport/recreational injury. Independent contributions of individual and area level measures of SES were seen for hospitalised and fighting injury. This study was one of the first to examine these relations using this conceptual approach.

measures of SES (poverty, perceptions of local area safety, and perceptions of residential area) and three area level measures of SES (lone parent families, less than high school education, and average employment income in the geographical area surrounding the school).

### Sport/recreational injury
In general, higher SES was associated with higher risk for sport/recreational injury. This relation was seen for several individual and area level variables.

### Fighting injury
A gradient was seen for all of the individual level SES variables: lower SES was associated with a higher likelihood of fighting injury (p<0.01 for trend).

### Multivariate analyses of associations between SES and injury
Only the SES exposure variables that significantly contributed (p<0.05) to the bivariate models were included in multivariate analyses. Independent associations between individual level measures of SES and injury were identified for all four injury outcomes (table 5). The poverty measure was associated with each of the four injury outcomes such that the risks for medically treated injury, injury hospitalisation, and fighting injury were increased in those students who frequently went to bed or school hungry while the risk for sport/recreational injury was lower in those who frequently went to bed or school hungry. Evidence for a gradient between family affluence with medically treated and sport/recreational injury was found in that lower SES was associated with a decreased risk for injury. For the self perceived measure of neighbourhood safety, lower SES was associated with a higher risk of medically treated injury and injury hospitalisation. For the self perceived measure of the neighbourhood being a good place to live, lower SES was associated with higher risk for fighting injury. Finally, perceived family wealth was inversely related to injury hospitalisation.

With respect to the area level SES measures, independent associations with injury were seen for only two of the four injury outcomes. The percentage of lone parent families and the percentage of population with less than a high school education in the geographical area surrounding the school were associated with injury hospitalisation. The average income from employment in the school area was independently associated with sport/recreational injury.

The directions of the relations between SES and injury varied according to the injury outcome examined. For all medically treated injuries, socioeconomic variables were associated with medically treated injury in opposing ways. The directions of the relations were more obvious for specific types of injury. In general, low SES was associated with increased risk for injury hospitalisation and fighting injury whereas high SES was related to an increased risk for sport/recreational injury.

## DISCUSSION
This population based study of Canadian adolescents examined associations between various measures of SES and the occurrence of specific types of injury. The principal finding was that the direction of associations between SES and injury varied according to the SES measure and type of injury under study. The results illustrate the importance of examining a variety of socioeconomic indicators and homogenous injury types in aetiological studies of this kind.

A number of previous studies have examined associations between SES and injury among adolescents.[14–19] Results of these studies are inconsistent, which may be attributable to differences in the underlying study populations, injury patterns, and/or analytical methods. It is also plausible that these inconsistent findings are explained by the limited SES indicators and injury types examined as, in general, these analyses focused on only a single measure of SES and/or a single injury outcome. This study examined several indicators of SES and measures of injury and independent associations were found. However, the direction of the relations varied according to the injury outcome under study. Our findings showed that lower SES was associated with injuries of a more serious nature such as those requiring hospitalisation and fighting injury. Conversely, higher SES was associated with sport/recreation injury. These findings were consistent with other reports.[7 9 15 20] Heterogeneous outcomes such as "medically treated injuries" are less likely to lead to clear aetiological findings, whereas study of more homogenous outcomes are more revealing. In addition, examination of multiple measures of SES is helpful because associations may be overlooked if measures that assess various dimensions of SES are not considered.

Mechanisms relating specific SES measures and different types of injury seem to vary. Adolescents from lower socioeconomic families have less opportunity to participate in sport or recreational activities because of cost or access barriers; therefore these adolescents are less vulnerable to these types of injury.[21] Adverse neighbourhood characteristics, such as exposure to crime and violence, and family characteristics, such as amount of adult supervision and attitudes about hazards and risks, may play a part in fighting injury.[20 21] Future research of the social determinants of injury should focus on the underlying mechanisms responsible for the existence of risk disparities. In addition, there is a need for mechanistic studies that explore the factors that can modify SES-injury relations.

To our knowledge, this study was the first to examine associations between SES and adolescent injury using a multilevel analysis. The importance of considering both individual and area level measures was highlighted. For

## Policy implications

- Interventions to reduce the occurrence of sport/recreational injury in adolescents should focus on people with a higher socioeconomic status
- Interventions to reduce the occurrence of fighting injuries in adolescents should focus on people with a lower socioeconomic status.

example, area level SES measures were independently associated with the occurrence of hospitalised injuries and sport/recreational injuries but not other injury types.

One explanation as to why the area-level SES measures were not significant predictors of some types of injury was that these measures were substantially weaker than individual level SES variables because of less variability between higher level units compared with individuals.[22][23] Hence, area level measures were more likely to underestimate any true effects. It was also possible that certain SES measures were not relevant mechanistically for all types of injury. The area level measures used in this study were limited to available census variables. Some caution is therefore warranted with the interpretation of individual compared with area influences of SES. It was not possible to assess whether the census based measures were truly tapping into socioeconomic influences of these areas, or whether the census measures were assessing a feature that was not measured at the individual level.[24]

Several additional limitations warrant consideration. Firstly, because this was a cross sectional study, the temporal directions of the associations under study cannot be identified. Temporality was not an important concern here because it is unlikely that a student's SES was influenced by the occurrence of an injury in the past 12 months. Secondly, some students may have been absent from school when the survey was administered or they may not have provided appropriate parental consent to participate. This limitation may, for example, influence the type of injuries captured, as students who sustained a serious injury would be more likely to be away from school. Non-respondents may also be more likely to engage in high risk lifestyles, hence leading to less variability in the exposure profile among respondents and a resultant reduction in statistical power to detect relations because of this potential response bias. Information bias is a third potential limitation. For example, in the measurement of SES variables school addresses were used in the estimation of area level SES for individual students, which would not be appropriate if the students' residences are outside of this area. The nature of this misclassification bias was assumed to be non-differential by injury status as the probabilities of socioeconomic misclassification were probably similar for all groups and unrelated to injury. Finally, we also recognise the potential for systematic under or over-reporting of both exposures and outcomes by students, if the accuracy of self reports for injury varied according to reported levels of SES. Such differential errors could lead to inflation of the risk estimates obtained in our analysis.

In summary, this study examined associations between SES and injury among a Canadian adolescent population. Certain socioeconomic groups were identified as being vulnerable for particular forms of adolescent injury. Our findings show the importance of considering multiple measures of SES at both the individual and area levels, as well as a need to examine the social aetiology of homogenous types of injury at a very mechanistic level. As this study is the first multilevel analysis that has examined these associations in adolescent populations, replication of these analyses in different settings or contexts is also warranted.

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## Authors' affiliations

**K Simpson, I Janssen, W Pickett,** Department of Community Health and Epidemiology, Queen's University, Kingston, Canada
**K Simpson, W Pickett,** Department of Emergency Medicine, Queen's University
**I Janssen,** School of Physical and Health Education, Queen's University
**W M Craig,** Department of Psychology, Queen's University

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