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Impact of Activity-Limiting Injuries based on the Canadian National Population Health Survey 1994-2006

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ABSTRACT

Objective: To examine the impact factors of activity-limiting injuries (ALI) on individuals and on the Canadian population; to detect short and long term impact after injuries in the Canadian National Population Health Survey (NPHS) from 1994 to 2006.

Design: This is a randomised longitudinal cohort study with biennial interview, which ranged from age, sex, education, marital status, income, residence, height and weight to self-perceived health status, health care utilization and medication use.

Setting: The study population was drawn from the NPHS with a random sample of 7,300 to 8,300 participants in both sexes over 20 years old from ten provinces and three territories in Canada.

Primary and secondary outcome measures: Logistic regression models were used to detect the potential impact of ALI on individuals and on Canadian population. The interviews two years before and two years after the ALI were compared to examine long-term effects, and the McNemar test option in SAS was used for the matched analysis.

Results: The immediate impact was pain, disability, disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor visits after ALI. Population impact included loss of productivity of 10% of the most productive and a considerable increase in health care access and cost. The odds ratios (ORs) for the 20-39 age group and males is more than for females for most years (OR, 2.2; 95% CI, 1.8-2.7 and OR, 1.4; 95% CI, 1.1-1.6). Individuals consuming nine or more alcoholic drinks per week have significantly differences (OR, 1.5; 95% CI, 1.3-1.8).

Conclusion: The findings from this study illustrated the immediate and long term impact of individuals and population level injuries in Canada. Injury control policies should aim to prevent the both the number of injuries fatalities as well as the consequences among survivors.

Summary Boxes:

What is already known on this subject?

1. Activity-limiting injuries (ALI) burden such as increased steadily prevalence, mortality and economic costs in Canada;
2. Showing increasing trends in obesity, limited activity, poor health status, medication use related to ALI;
3. Nature and types related to ALI;

What does this study add?

1. Potential associations between health care utilization and ALI before and after injury;
2. Hospital admission, Department emergency and medical doctors visits impacted on ALI;

3. The immediate individuals impact such as pain, disability, disruption of regular life. Long-term effects in patients were sequelae, chronic pain, stress and increased medical doctor visits after ALI. Population impact included loss of productivity of 10% of the most productive and a considerable increase in health care access and cost.
4. policies should aim to prevent both the number of injuries fatalities as well as the consequences among survivors.

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None to declare.

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Dr. Frank Mo, leader of the research project, and play the major role in research design, drafted the article and critical review, and advising for data analysis and results interpretation.
Dr. Ineke C. Neutel, contributed to data analysis, assisted in research design and data analysis, interpretation, and the report.
Dr. Howard Morrison, contributed to research consultation, provided critical review comments, and advising for data analysis and revised critically the article.
Mr. Doug Hopkins, assisted in research design, provided literature review and critical comments and signed final version of the manuscript.
Ms. Caroline Da Silva, participated in research design, provided critical review comments and signed final version of the manuscript.
Ms. Ying Jiang, contributed to research design, provided literature and critical review comments, and signed final version of the manuscript for submission.

INTRODUCTION

Injuries are a serious public health issue with a major impact on the lives of Canadians. They are leading causes of death and hospitalization, as well as of disability, loss of productivity and potential years of life lost (PYLL) [1]. Sequelaes from injuries can impact the quality of life for individuals and population levels, such as activity limitation, functional disability and pain as process influenced by a variety of social, psychological, and economic factors [2–5]. A rather complete analysis of injury in Canada was based on emergency department (ED) visits and hospitalisation admissions for all of Ontario province [6]. The analysis noted that one in four ED visits were injury-related, as were one in every 17 hospitalisations [6]. These data accentuate the importance of injuries to the health care system. Other studies have also demonstrated the increasing medical doctor (MD) contact, the use more medications for pain, more days in hospital, and more hours of home care services [6-8].

Several studies of traumatic disability have also focused on injuries resulting in hospitalization [9], types of injury [10-11], and serious head injuries [12]. Moreover, half of patients had some limitation in activity for two days or more due to injury, and patients treated in the clinic were somewhat more likely to have two or more days of limited activity than were patients treated in the ED [13].

Injuries are not only preventable, but the impact of injuries could also be lessened. In order to develop effective policies leading to prevention of injuries and reduced impact of injuries on society, information is needed about the influenced effects that individuals with injuries treated in the primary care setting and not requiring hospitalization frequently result in significant functional impairment and

to identify those injuries which, by virtue of their contribution to disability, would be targets for prevention programs.

The objectives of this study are to explore the immediate and longer term consequences of injury including physical, psychological, social and occupational functioning. This comprises a longitudinal population health study, which will measure the impact of injuries on individual's and population level health status and well-being due to activity-limiting injuries (ALI) in the NPHS from 1994 to 2006 in Canada.

METHODOLOGY

Study population

The source population for this study is the Canadian National Population Health Survey (NPHS), from1994/1995 (cycle 1) to 2006/2007 (cycle 7) with 17,276 of the respondents in the survey except for persons living on reserves or on Canadian Forces bases [6, 8]. The sample design is a multiple cluster [14]. The sampling frame for the first cycle (1994/5) originated with the Canadian Labour Force Survey (CLFS), a multi-stage, stratified sampling technique used for all provinces except Quebec for which a provincial sampling frame was used [14]. In the second cycle 1996-1997 the NPHS started using 17,276 of the respondents for a longitudinal component. For the 2000 cycle a few changes were made in the questionnaire including more detailed questions on health care use after the ALI.

Nearly all respondents were re-interviewed biennially by telephone except for individuals without telephone, for whom face to face interviews were used. Interviewers were instructed to follow

all reasonable strategies to trace people. Response rates were 83.6% from cycle one to cycle two-92.8%, cycle three-88.3%, cycle four-84.9%, cycle five-80.8%, cycle six-77.6%, and cycle seven-77.0%.

For the present study, interview cycles for 1996 to 2006 were used. Data were used from respondents who were willing to share their data for data analysis, and who completed all interviews to date and aschieved ages 20 and over. Since the source population, i.e. the total NPHS population, covered more ages than the study population, i.e. the population analysed for this study, it was possible to add younger persons from the source population to our study population after the cycle at which they reached age of 20 years old. Consequently, the study population changed somewhat over the years of the study, 1996 to 2006 allowing comparable cross-sectional analysis of populations with the same age range and age distribution.

Variables

The interview ranged from background questions (age, sex, education, marital status, income, residence, height and weight) to health-related questions (self-perceived health status, health care utilization and medication use). For this study the answers were dichotomized. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared [15]. A BMI of 30 and over was considered obese. Respondents were asked to rate their health as one of five categories: excellent, very good, good, fair or poor and for this study, the lower two categories were combined as poorer health and the top three as good health. Quartiles of total household income were calculated for the population and the lower two quartiles combined for the low income category to be compared to the top two as highest income category. A three-part physical activity index was calculated based on kilo-

calories per kilogram of body weight per day expended (KKD). Physically active is defined as energy expenditure of at least 3 KKD; moderately active corresponds to energy expenditure between 1.5 and 3 KKD; physically inactive is defined as less than 1.5 KKD. Medication use was elicited by the question: "In the past 30 days, did you take . . . ?' This was followed by a series of questions, such as "Did you take antidepressants?" "Did you take anything for pain?" A 'no' answer to the question "Are you usually free of pain and discomfort?" was taken as indication that the respondent often suffered pain.

The definition of injury in the NPHS data was "In the past 12 months, did you have any injuries serious enough to limit your normal activities?" If more than one, the following questions were to refer to the most serious one. A separate question asked respondents a general question about limitations in activity, "Because of a long-term physical or mental condition or a health problem, are you limited in the kind or amount of activity you can do: at home? at school? at work? in other activities?"

Data Analysis

For the statistical analysis, SAS version 9.2 (SAS Institute, Cary, NC, USA) was used. Logistic regression provided odds ratios (OR) with presence/absence of ALI as the dependent variable, adjusted for age (in single years) and sex. Since the data were collected as a statistical sample of the Canadian population, the 'weight' option was used in all SAS statistical analyses to make the results representative of the Canadian population from 1994 to 2006 in seven cycles of cross-sectional studies. Weights were provided by Statistics Canada according to their sampling procedures. In order to produce a meaningful estimate of the variance for the weighted results, the weights were adjusted using the formula: [average weight = (sample weight/sum of the sample weights) * sample size].

In order to determine the characteristics, life style and health status, medical attention and health care utilization as well as activity limitation and disability, which were impacted by ALI, all new injury cases, i.e., those who had not reported an injury in the previous interview were identified. For each new case, data from three cycles were selected, 1) the cycle before reporting, 2) the cycle of reporting, 3) the cycle after reporting. Data for the 1994 cycle were used only in this 'before and after' analysis. Only the first recorded ALI report per person was included. The McNemar test option in SAS was used for matched analysis.

RESULTS

The numbers of ALI in adult Canadians increased from 755 cases in 1996 to 1,006 in 2006 (not shown in table). The weighted prevalence of all ALI increased steadily from 10.5% in 1996 to 12.8% in 2006. The population is showing increasing trends in obesity, limited activity, poor health status, medication use, and potential injury sequelae, such as pain, stress and depression but declining trends in lower income and current smoking **(Table 1)**. The weighted percentages of medical doctor (MD) visits decreased form 29.8% to 25.3%, emergency department (ED) visits went from 34.0% to 28.8%, and hospital admission within 48 hours went from 6.5% to 4.9% from 2000-2006 for all ALI (**Table 2**). The rate of hospital admissions within 48 hours for adults aged 50+ years was higher than that of young aged (20-49) group. Rates of ALI for males were higher and increased more than for females. Furthermore, younger adults (20-49 yrs.) tended to have more ALI (12.2% to 14.0%) than the older (50+ yrs.) adults (8.6% to 9.8%) (**Table 3**).

The most frequent types of ALI were sprains and strains (42%), followed by fractures and dislocations (20%), and cuts, punctures and bites (10%) (T**able 4**). Only 3.3 to 5.0% of ALI were in the category of brain, internal and multiple injuries. Men tend to have more cuts, punctures and bites while women have more scrapes, bruises and blisters. Younger ages tend to have more sprains and strains and older ages more fractures and dislocations (**Table 4**). Logistic regression analysis indicated that younger age groups and male participants were more impacted by ALI, the OR for the 20-39 age group and males is more than for females for most years. Only a few of the other variables show associations with ALI - immigrants have consistently lower rates of ALI, while people consuming nine or more alcoholic drinks per week have significantly higher rates. (**Table 5**).

Attributes in the interview cycle before the ALI were compared with the rates in the interview year with the ALI and rates in the cycle after the ALI (T**able 6**). Some attributes showed higher rates for the cycle with the ALI compared to the previous one, i.e., two years earlier, and then continued the higher rate in the next cycle, i.e., two years after the ALI. This was true for limited activity, medical doctor (MD) visits, experiencing pain, medication use for pain, sedatives/ tranquillizers, and antidepressants for the patients with stress and depression (P<0.001) (**Table 6**).

DISCUSSION

Clearly, the impact of ALI can be found on several different levels. Immediate consequences were experienced by the more than 10% of the Canadian population who annually report an ALI, with rates increasing from 10.5% in 1996 to 12.8% in 2006. According to the definition of ALI as activity-

limiting injuries, all people with ALI experience a certain amount of disruption of their daily activities with the impact varying according to the type and severity of their injury and depending on their customary type of activity [16-19]. The most severe injury includes the 3-6% of ALI with brain, internal and multiple injuries. About 20% of ALI were fractures and dislocations, many of whom necessitate a period of altered activity. The elderly people are more likely to experience fractures than the younger age groups. The most common injuries are sprains and strains, the impact of which also varies a great deal depending on type and severity [20-21]. Groups most impacted by ALI were men and the younger ages, and thus more likely to have their busy schedules and possibly income, as well as that of their families disrupted. A widespread impact of injuries are on the workplace through absenteeism and on the family through the disruption of customary activities. Besides the impact of injuries on every day activities, there is also the impact on the health care system. About two thirds of people with ALI sought some kind of medical care in the year 2000. Evidence was presented showing that the impact of ALI might be even more far-reaching, as seen by the higher levels of medical care, and continued pain remaining two years after the ALI were reported.

Other research on injuries have used a variety of definition of injuries, based on different sources of information. Questions in the NPHS were able to put these other measures in perspective when compared to ALI. For example, some studies use hospital-based data [22], but the present study shows that only about 5% of ALI are admitted to hospital within the first 48 hours of the event. Assuming that all injuries that require hospitalization are within the activity-limiting rubric, it is clear that studies done on hospital data include only a small portion of important injuries [23]. However, the hospitalized injuries will be the more severe injuries which take a disproportional share of the health care cost and

disability [22]. Other studies have used ED visits as unit of measurement [6]. The present study showed less than one third of ALI went to an ED to obtain treatment. Again, the latter are the more severe injuries or those needing specialized treatment, e.g., casts on fractures, and thus have a greater impact on daily life and cost. Another source of data commonly used has been mortality data. Although deaths are definitely activity-limiting, obviously, none are included in this study. Mortality rates will also refer to a quite different range of injuries than ALI. For example, in an US study, firearm-related injuries were 22% of all injury deaths, second only to traffic accident related injuries, but firearms amounted to less than 1% for non-fatal injuries [8]. Thus, different measuring units for measuring injury rates will target different slices of the spectrum of injuries and provide different results. ALI are of special public health importance not sufficiently studied.

Another level of impact resulting from ALI would consist of impact onb the health care system. Approximately 60% of people with ALI obtain medical care of some type. Of these, approximately one third of persons with ALI went to ED to experience the often long wait before receiving treatment. Back at home the patient would not only experience the pain and disability of the ALI, but also the need to negotiate the health care system, such as making appointments with physicians, specialists, physiotherapists, etc., finding transportation, often needing someone to accompany them [24-27]. Even though the proportion of the population with ALI increased over the years 2000-2006, decreases were seen in use of primary care and the hospital ED visits as well as hospitalisation. This decrease in health care use could be an indication either of greater difficulty in accessing health care, or the ALI reported becoming less severe over the years. Berdahl found variation by ethnic group and sex, both in the reporting of work-related injuries and in the seeking of medical care and the change in ethnic

composition over the years could also be a factor in the NPHS data [28-30]. In any case, ALI are suffered by a large proportion of the population annually, and a majority of these seek medical treatment whether primary care, ED or hopsitla care . Some of these would need an ambulance for transportation. Clearly, this entails a large cost to the health care system and any prevention would not only improve quality of life of the putative victims but also would result in significantly lower health care costs.

Another type of impact would be long-term changes after the injury. The 'before and after' data available in the NPHS consisted of comparing the cross-sectional data from the interview cycle before the ALI with the data of the cycle reporting the ALI and with the next cycle after the ALI. While the interviews for each respondent could be linked for the 'before and after' cycles it was more difficult to determine which changes in attributes in the year of the ALI or subsequent years were sequelea of the ALI. For example, it might make sense that the increasing obesity for people with ALI be linked to after-effects, e.g. [31], due to inactivity resulting from the ALI but, in fact, similar changes are happening in the overall population. Given these caveats, we can note that no changes were found for smoking and little change in excessive alcohol use. Most likely to show long-term effects due to ALI were visits to medical doctors and ongoing pain. People with ALI showed increasing likelihood of visiting a MD at least five times during the year which continured for the subsequent cycle. Similarly pain increased in the cycle with the ALI and remained high over the years. Although this is weak evidence, it confirms work on long-term effects of other researchers [32-33] and again emphasizes the impact of ALI in the population.

Injuries have been found to lead to lost productivity, medical costs, compensation cost and

possibly long-term health problems and disability [34-36], which was confirmed by the present results for the Canadian population. Many injuries can be prevented and a better understanding of all aspects of injuries will lead to better ways of prevention or the minimizing of their effects. However, collaboration and cooperation is needed [37]. The European Union has committed itself to reducing number of traffic fatalities from 450,000 to 235,000 by 2010, which as Goule et al., point out, will require strong measures against use of alcohol [38-41], illicit and medicinal drugs before driving [42]. A difficulty is the multi-faceted aspect of injuries. For example, a fall may have many causes, such as unsafe working conditions or slippery stairs at home. Each of these would require different approaches to prevention. Similar diversities are found for most other types of injuries. With all difficulties inherent in devising effective interventions, prevention is still the best approach to lower the tremendous impact of ALI on the Canadian population.

The NPHS data have important strengths, such as its representativeness of the Canadian population and its longitudinal nature. Because of the longitudinal design, it was possible to identify new ALI, meaning no ALI in the previous interview, and compare risk factors before and after the event, as well as its consequences. The 'before and after' comparisons of the same person allowed for matched analysis at different times. Important also is the extensive and consistent information available on each respondent over the multiple cycles of the survey, such as type of ALI, and the medical care needed. Besides strengths, the NPHS also has limitations. In spite of the abundance of data available, further information is always desirable for particular uses of the data. One issue is the lack of distinction between intentional and unintentional injuries, another is the large time spans over which the information is available. Another issue is that of self-reported data. Part of self-reporting is recall of

events. Recall of having had ALI has been shown elsewhere to be less accurate with increasing time and is also likely to vary with severity of the injury [43-44]. Both of these would likely lead to an under-reporting of ALI. In spite of its limitations the NPHS gives an invaluable view of the level of serious injury in the Canadian adult population over a 12 year time period.

Another strength of these data is the use of ALI as a measurement of injury. There are various units of measurement in measuring rates of injury in a population. The unit of measurement used in the present study consists of the most serious ALI over the previous 12 months, excluding repetitive strains injuries. The use of ALI means the delimitation of a particular kind of injury in the spectrum of injuries as a concept meaningful to both respondent and researchers. In addition, it identifies a type of injury sufficiently severe to impact a person's regular routine.

CONCLUSION

The findings from this study quantified the immediate and long term impact of individuals and population level injuries in Canada. The immediate impact was pain, disability, and disruption of regular life. The two-thirds seeking medical care needed time, effort and know-how to negotiate the health care system, let alone transportation and other related help. Long-term effects in patients were chronic pain and increased medical doctor's visits remaining two years after the ALI. Population impact included loss of productivity of 10% of the most productive and a considerable increase in health care access and cost. This study also particularly contributes to injury prevention in social and psychological health services to help injured people make a better recovery and maintain the quality of life after injuries.

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Table 1: Weighted percentages of characteristics of ALI for which were impacted on the study population, NPHS, Canada, 1994-2006

Year	1996 wt%[1]	1998 wt%[1]	2000 wt%[1]	2002 wt%[1]	2004 wt%[1]	2006 wt%[1]
Total Number[2]	7,313	7,529	7,717	7,875	8,085	8,324
ALI (wt%)	10.5	10.9	11.4	12.6	12.6	12.8
Background variables						
Partner	71.0	69.3	68.2	66.2	65.7	64.7
Low income	40.0	34.2	27.9	26.0	23.5	19.8
Completed High School	89.6	89.9	89.3	84.7	84.5	84.5
Rural	17.9	20.5	21.0	20.6	19.9	22.0
Immigrant	17.5	17.3	16.8	16.2	16.1	15.7
Health related variables						
Current smoking	22.7	21.3	20.4	17.1	17.1	16.0
Inactive	58.3	52.9	56.1	48.3	51.0	45.9
Obese	18.4	21.2	23.0	24.3	25.0	26.4
9+ alcohol drinks/ week	11.0	11.6	11.9	11.8	11.6	14.8
Region of residence						
Atlantic	8.8	8.7	8.9	8.8	8.7	8.7
Quebec	25.5	25.6	25.9	26.0	26.1	25.9
Ontario	36.3	36.0	36.0	35.8	36.1	36.2
Prairies	17.0	17.3	17.1	17.4	17.3	17.4
BC	12.5	12.4	12.1	12.0	11.8	11.9
Outcome-related						
Ltd activity	17.3	17.8	17.98	22.9	24.5	26.6
Health status	33.6	33.2	38	41.2	42.3	43.5
5+ Medical Doctor visits /year	24.2	26.3	26.64	27.6	28.3	26.8
Pain	12.3	13.7	13.3	15.1	16.4	15.8
Stress	26.3	29.2	25.09	27.3	28.3	27.4
Depression	6.1	5.8	6.43	6.9	7.1	6.0
Medication use in last 30 years						
Pain medication	65.6	67.5	70.1	70.23	70.4	70.6
Tranquilizer/ sedative	5.1	5.3	6.8	8.12	8.2	10.0
Antidepressants	3.6	4.4	5.4	5.9	6.9	7.0

[1] wt%--Weighted percentages making rates representative of the Canadian population

[2] Number in study population

Table 2: Percent of persons with ALI for which were impacted on medical attention and health care resource utilization by age and sex groups, NPHS, Canada, 1994-2006*

Year		2000 wt%[1]	2002 wt%[1]	2004 wt%[1]	2006 wt%[1]
All	Number of ALI	865	932	913	1,005
	None	33.5	40.1	38.5	40.7
	Medical Doctor (MD) visits	29.8	27.1	27.3	25.3
	Emergency Department (ED) visits	34.0	28.5	31.0	28.8
	Hospital admission in 48 hours	6.5	5.4	5.5	4.9
	Other	2.7	4.3	3.1	5.2
	Any	66.6	60.0	61.5	59.3
Males	Number of ALI	394	460	463	482
	None	34.8	42.2	41.6	41.5
	MD visits	26.6	26.5	24.7	23.6
	ED visits	34.5	27.4	30.8	29.7
	Hospital admission in 48 hours	9.5	4.5	4.6	4.1
	Other	4.1	4.0	2.9	5.3
	Any	65.2	57.8	58.4	58.5
Females	Number of ALI	471	472	450	523
	None	32.3	37.6	34.8	39.7
	MD visits	32.6	27.7	30.5	27.3
	ED visits	33.6	29.9	31.3	27.8
	Hospital admission in 48 hours	4.0	6.4	6.6	5.7
	Other	1.5	4.7	3.4	5.1
	Any	67.7	62.4	65.2	60.2
Age 20-49	Number of ALI	588	601	564	590
	None	34.2	40.7	39.7	41.1
	MD visits	29.1	27.7	28.5	24.3
	ED visits	34.3	27.6	28.7	27.3
	Hospital admission in 48 hours	6.2	4.1	2.9	3.6
	Other	2.5	4.1	3.1	7.3
	Any	65.8	59.3	3.2	58.9
Age 50+	Number of ALI	277	331	349	415
	None	31.8	38.6	36.6	40.1
	MD visits	31.5	25.8	25.3	26.9
	ED visits	33.6	30.6	34.9	31.1
	Hospital admission in 48 hours	7.3	8.1	9.9	6.9
	Other	3.2	4.9	3.2	1.9
	Any	61.4	59.3	63.5	59.9

* Data on medical treatment was available only from 2000-2006
wt%[1] ---Weighted percentages making rates representative of the Canadian population

Table 3: Percentages for ALI for which were impacted by activity limitation per year, NPHS, Canada, 2000-2006*

Years	Injury status	2000 wt%[1]	2002 wt%[1]	2004 wt%[1]	2006 wt%[1]
All	None	85.5	84.0	84.0	82.2
	Activity limiting only	10.8	12.1	11.6	12.0
	Non-activity limiting	3.1	3.0	3.5	5.1
	Both	0.6	0.4	1.0	0.8
Males	None	84.9	82.0	82.2	80.1
	Activity limiting only	10.5	13.5	13.2	13.2
	Non-activity limiting	3.9	3.9	3.4	5.6
	Both	0.7	0.7	1.3	1.1
Females	None	86.0	85.8	85.7	84.1
	Activity limiting only	11.1	10.8	10.1	10.9
	Non-activity limiting	2.4	3.0	3.6	4.6
	Both	0.5	0.4	0.7	0.5
Ages	None	83.5	81.7	81.2	79.3
20-49	Activity limiting only	12.2	13.9	13.3	14.0
	Non-activity limiting	3.5	3.7	4.3	5.8
	Both	0.8	0.7	1.3	0.9
Ages	None	88.5	87.2	87.4	85.3
50+	Activity limiting	8.6	9.5	9.5	9.8
	Non-activity limiting	2.6	3.1	2.5	4.2
	Both	0.3	0.3	0.6	0.6

* Data on medical treatment was available only from 2000-2006

[1] wt%--Weighted percentages making rates representative of the Canadian population

Table 4: The pathology of ALI for which were impacted on patients' ED visits, admission and length of stay in hospital and consequence, NPHS, Canada, 1994-2006

	Interview cycles	**1996**	**1998**	**2000**	**2002**	**2004**	**2006**
N[2]	Number of ALI	755	786	865	931	911	1,006
	Patterns of ALI	[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%
ALL	Brain, internal, multiple	4.9	3.3	5.8	3.2	3.9	4.3
	Fractures/dislocation	20.6	21.2	19.9	20.3	22.2	24.9
	Burns	5.3	3.3	4.3	2.8	4.3	3.7
	Sprains, strains	42.0	42.3	42.4	47.3	42.8	42.2
	Cuts, punctures, bites	10.2	15.5	11.8	11.6	11.1	9.7
	Scrapes, bruises, blisters	7.7	6.9	7.8	4.8	7.1	6.3
	Other	9.3	7.5	8.0	10.0	8.6	8.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0
Males	Brain, internal, multiple	5.4	2.8	5.0	2.4	4.1	4.5
	Fractures/dislocation	21.3	21.5	21.5	20.3	21.0	26.1
	Burns	5.8	2.4	3.9	3.5	4.6	2.7
	Sprains, strains	39.6	42.6	40.5	47.2	41.7	39.8
	Cuts, punctures, bites	12.2	17.4	16.7	13.9	13.6	13.1
	Scrapes, bruises, blisters	6.2	5.2	5.7	4.4	6.2	5.8
	Other	9.5	8.1	6.7	8.3	8.8	8.0
Females	Brain, internal, multiple	4.3	3.9	6.4	3.8	3.6	4.2
	Fractures/dislocation	19.8	21.0	18.5	21.6	23.6	23.3
	Burns	4.5	4.1	4.7	3.6	4.0	4.8
	Sprains, strains	45.0	41.9	44.1	46.0	44.3	44.9
	Cuts, punctures, bites	7.8	13.3	7.7	9.1	7.9	6.0
	Scrapes, bruises, blisters	9.5	8.9	9.5	6.4	8.2	7.0
	Other	9.1	6.9	9.1	9.5	8.4	9.8
Age 20-49	Brain, internal, multiple	4.8	3.3	4.9	3.1	3.7	3.0
	Fractures/dislocation	17.4	19.8	22.5	17.4	18.2	22.9
	Burns	5.5	3.3	4.1	3.5	5.0	4.8
	Sprains, strains	43.8	47.2	42.8	51.3	50.9	46.3
	Cuts, punctures, bites	10.9	15.5	11.5	10.7	9.4	9.4
	Scrapes, bruises, blisters	8.5	5.0	7.5	4.5	4.4	4.6
	Other	9.1	5.9	6.7	9.5	8.4	9.0
Age 50+	Brain, internal, multiple	5.4	3.4	7.6	3.4	4.2	6.3
	Fractures/dislocation	30.8	24.9	13.8	26.4	29.0	27.9
	Burns	4.3	3.0	4.9	1.4	3.3	1.9
	Sprains, strains	36.2	30.2	41.7	39.0	29.1	35.8

Cuts, punctures, bites	8.1	15.2	12.5	13.4	13.7	10.3
Scrapes, bruises, blisters	5.1	11.7	8.5	5.4	11.7	9.1
Other	10.1	11.6	11.0	11.0	9.0	8.7

[1] wt%--Weighted percentages making rates representative of the Canadian population

[2] Number of ALI in study population

Table 5: Odds ratios (OR) and 95% confidence interval (C.I.) of ALI for which were impacted by life style and socioeconomic status, adjusted for sex and age, NPHS, Canada, 1994-2006

		1996		1998		2000		2002		2004		2006	
		OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
	M/F	1.4*	1.1 - 1.6	1.3*	1.1 - 1.6	0.9	0.8 - 1.1	1.3*	1.1 - 1.5	1.4*	1.2 - 1.6	1.3*	1.1 - 1.4
Age groups													
	20-39	2.1*	1.6 - 2.9	1.9*	1.5 - 2.4	1.8*	1.4 - 2.3	2.2*	1.8 - 2.7	1.8*	1.5 - 2.2	2.2*	1.8 - 2.6
	40-59	1.6*	1.1 - 2.1	1.4*	1.1 - 1.8	1.3	1.0 - 1.6	1.6*	1.3 - 2.0	1.3	1.0 - 1.5	1.5*	1.2 - 1.8
	60+ (reference)	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~
Background variables[2]													
Married/ Common-law	yes/no	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.9 - 1.2	0.9	0.7 - 1.0	0.9	0.8 - 1.0
income	low/high	1.1	0.9 - 1.3	1.0	0.9 - 1.3	1.2	1.0 - 1.4	0.9	0.8 - 1.1	1.1	0.9 - 1.3	1.2	1.0 - 1.4
Completed High School	yes/no	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.8 - 1.2	0.9	0.8 - 1.1	0.9	0.7 - 1.0	1.1	0.9 - 1.3
Rural	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	0.9	0.7 - 1.1	1.1	0.9 - 1.3	0.8	0.7 - 1.0	1.0	0.8 - 1.1
Non-English	yes/no	0.9	0.7 - 1.1	0.9	0.7 - 1.0	0.8	0.7 - 1.0	0.8	0.7 - 1.0	0.7	0.6 - 0.9	0.8	0.7 - 0.9
Immigrant	yes/no	0.6	0.5 - 0.8	0.7	0.6 - 0.9	0.8	0.6 - 1.0	0.8	0.6 - 1.0	0.7	0.5 - 0.8	0.7	0.6 - 0.9
Health related[3]													
Current smoking	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	1.2	1.0 - 1.5	1.2	1.0 - 1.5	0.9	0.8 - 1.1	0.9	0.7 - 1.1
Physical inactivity	yes/no	0.8	0.7 - 0.9	0.8	0.7 - 0.9	0.8	0.6 - 0.9	0.9	0.8 - 1.1	0.8	0.7 - 0.9	0.8	0.7 - 0.9
Obese	yes/no	1.2	1.0 - 1.5	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.9 - 1.2	1.1	0.9 - 1.3	1.0	0.8 - 1.1
Alcohol drink /week	9+/less	1.2	0.9 - 1.5	1.2	1.0 - 1.6	1.3	1.0 - 1.7	1.4*	1.2 - 1.8	1.2	1.0 - 1.5	1.5*	1.3 - 1.8
Alcohol 5+ at a time	weekly/less	1.3	1.0 - 1.5	1.4*	1.2 - 1.7	1.4*	1.2 - 1.7	1.2	1.0 - 1.5	1.3*	1.1 - 1.5	1.3*	1.1 - 1.5

1. For sex group, females are the reference group
2. For background variables comparison groups, the second listed group for binary variables is the reference group
3. For health-related comparison groups, the second listed group for binary variables is the reference group

* Means that there are statistically significant difference compared with control groups

Table 6: Persons with ALI for which were impacted on life style, socioeconomic status, and health care utilization before and after the injury, NPHS, Canada, 1994-2006

		Before % A	During % B	After % C	p value* A vs B	p value* B vs C	p value* A vs C	N**
Risky behaviours and socioeconomic status								
Income	low	36.3	32.1	28.5	<0.001	<0.001	<0.001	2,892
Obese	obese	17.8	19.7	22.4	0.005	<0.001	<0.001	1,780
Physical activity	inactive	50.4	47.1	48.1	0.001	0.197	0.343	3,044
Smoking	current	19.0	18.5	18.2	0.265	0.384	0.077	1,693
Alcohol drinking	9+/wk	9.6	10.7	11.2	0.048	0.535	0.349	3,548
Health-related issues								
Limited activity	yes	18.7	25.5	26.3	<0.001	0.221	<0.001	3,657
Health status	poor	33.1	36.3	39.6	<0.001	<0.001	<0.001	3,653
Medical Doctor visits	5+/year	26.5	34.0	29.8	<0.001	<0.001	<0.001	3,616
Pain	yes	13.7	16.8	17.3	<0.001	0.432	<0.001	3,657
Stress	yes	29.7	31.3	29.4	0.104	0.050	0.757	2,967
Medication use in past 30 days before interview								
Pain medication	yes	61.9	70.2	70.8	<0.001	0.489	<0.001	3,640
Sedatives /tranquiliser	yes	5.7	7.2	8.1	0.001	0.055	<0.001	3,639
Antidepressants	yes	4.2	5.9	6.2	<0.001	0.346	0.403	3,641

*P value calculated by McNemar's test

** N of persons making up the matched analysis for the before and after analysis

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2, 3
Introduction			**Page 4**
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			**Page 5**
Study design	4	Present key elements of study design early in the paper	Page 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5, 6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 5, 6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	Page 5, 6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 7
Bias	9	Describe any efforts to address potential sources of bias	Page 7
Study size	10	Explain how the study size was arrived at	Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 7, 8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 7, 8
		(*b*) Describe any methods used to examine subgroups and interactions	Page 7, 8
		(*c*) Explain how missing data were addressed	Page 7, 8
		(*d*) If applicable, explain how loss to follow-up was addressed	Page 7, 8
		(*e*) Describe any sensitivity analyses	Page 7, 8
Results			Page 8

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 5, 6
		(b) Indicate number of participants with missing data for each variable of interest	Page 5, 6
		(c) Summarise follow-up time (eg, average and total amount)	Page 5, 6
Outcome data	15*	Report numbers of outcome events or summary measures over time	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 8, 9
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			Page 9-13
Key results	18	Summarise key results with reference to study objectives	Page 9, 10, 11
Limitations			Page 12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 9-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Impact of Activity-Limiting Injuries based on the Canadian National Population Health Survey 1994-2006

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Impact of Activity-Limiting Injuries based on the Canadian National Population Health Survey 1994-2006

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ABSTRACT

Objective: To examine the prevalence and factors affecting activity-limiting injuries (ALI) on individuals and on the Canadian population; to estimate the short and long term impact on health status and well-being due to ALI in Canada from 1994 to 2006 using the Canadian National Population Health Survey (NPHS).

Design: The NPHS is a randomised longitudinal cohort study with biennial interviews, with information on age, sex, education, marital status, income, residence, height and weight to self-perceived health status, health care utilization and medication use in addition to ALI.

Setting: The study population was a random sample of male and female participants 20 years and older from ten provinces and three territories in Canada.

Primary and secondary outcome measures: Logistic regression models were used to assess the potential impact of ALI on individuals and on the Canadian population. The interviews two years before and two years after the ALI were compared to examine long-term effects, and the McNemar test option in SAS was used for the matched analysis.

Results: The immediate impacts of ALI were pain, disability, and disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor visits. Population impact included a considerable increase in health care access and cost. The odds ratios (ORs) for the 20-39 age group compared to those 60+ was OR, 2.2; 95% CI, 1.8-2.7, while the OR associated with being male was 1.4; 95% CI, 1.1-1.6. Individuals consuming nine or more alcoholic drinks per week were also significantly more likely to report an ALI (OR, 1.5; 95% CI, 1.3-1.8).

Conclusion: The findings from this study illustrated the immediate and long term impact of individuals and population level injuries in Canada. Injury control policies should aim to prevent the both the number of injuries fatalities as well as the consequences among survivors.

Summary Boxes:

What is already known on this subject?

1. Activity-limiting injuries (ALI) burden such as increased steadily prevalence, mortality and economic costs in Canada;
2. Showing increasing trends in obesity, limited activity, poor health status, medication use related to ALI;
3. Nature and types related to ALI;

What does this study add?

1. Potential associations between health care utilization and ALI before and after injury;
2. Hospital admission, Department emergency and medical doctors visits impacted on ALI;

3. The immediate individuals impact such as pain, disability, disruption of regular life. Long-term effects in patients were sequelae, chronic pain, and increased medical doctor visits after ALI. Population impact included loss of productivity and a considerable increase in health care access and cost.
4. policies should aim to prevent both the number of injuries fatalities as well as the consequences among survivors.

Competing Interest:
None to declare.

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Contributorship Statement:
Dr. Frank Mo, leader of the research project, and play the major role in research design, drafted the article and critical review, and advising for data analysis and results interpretation.
Dr. Ineke C. Neutel, contributed to data analysis, assisted in research design and data analysis, interpretation, and the report.
Dr. Howard Morrison, contributed to research consultation, provided critical review comments, and advising for data analysis and revised critically the article.
Mr. Doug Hopkins, assisted in research design, provided literature review and critical comments and signed final version of the manuscript.
Ms. Caroline Da Silva, participated in research design, provided critical review comments and signed final version of the manuscript.
Ms. Ying Jiang, contributed to research design, provided literature and critical review comments, and signed final version of the manuscript for submission.

INTRODUCTION

Injuries are a serious public health issue with a major impact on the lives of Canadians. They are leading causes of death and hospitalization, as well as of disability, loss of productivity and potential years of life lost (PYLL) [1-4]. Sequelae from injuries include activity limitation, functional disability and pain which in turn influence a variety of social, psychological, labour force, and economic factors [5-8]. An analysis of emergency department (ED) visits and hospitalisation admissions for Ontarionoted that one in four ED visits were injury-related, as were one in every 17 hospitalisations [9]. These data accentuated the importance of injuries to the health care system. Other studies have demonstrated the increasing medical doctor (MD) contacts, the use more medications for pain, more days in hospital, and more hours of home care services [9-11].

Several studies of traumatic disability have also focused on injuries resulting in hospitalization [12], types of injury [13-14], and serious head injuries [15]. One study reported that half of patients had some limitation in activity for two days or more due to injury, and patients treated in the clinic were somewhat more likely to have two or more days of limited activity than were patients treated in the ED [16].

Injuries are not only largely preventable, but the impact of injuries can usually be lessened. To develop effective policies leading to the prevention of injuries and to reduce the impact of injuries on society, information is needed about the influenced effects that individuals with injuries treated in the primary care setting and not requiring hospitalization frequently result in significant functional

impairment and to identify those injuries which, by virtue of their contribution to disability, would be targets for prevention programs.

The objectives of this study are to explore the immediate and longer term consequences of injury including physical, psychological, social and occupational functioning. This comprises a longitudinal population health study, which will measure the impact of injuries on individual's and population level health status and well-being due to activity-limiting injuries (ALI) in the NPHS from 1994 to 2006 in Canada.

METHODOLOGY

Study population

The source population for this study was the Canadian National Population Health Survey (NPHS), from1994/1995 (cycle 1) to 2006/2007 (cycle 7). The study population was designed to be representative of the Canadian population with the exception of persons living on Indian reserves or on Canadian Forces bases [9, 11]. The sample design was a multiple cluster [17], ideal for controlling costs when personal interviews are needed, as was the case for cycle 1 of the NPHS. To cover as much as possible of the Canadian population, separate components of the survey were also carried out in the Territories and in health care institutions. In the Territories, a simpler stratified design was used. As well, anticipating the creation of Nunavut, separate strata were formed for each of the future territories, Nunavut and NWT [17]. The sampling frame for the first cycle (1994/5) originated with the Canadian Labour Force Survey (CLFS), a multi-stage, stratified sampling technique used for all provinces except Quebec for which a provincial sampling frame was used [17]. From the 2000 cycle onward, additional

questions were added to the questionnaire, such as more detailed questions on health care use after the ALI, with the result that some analyses are restricted to data from 2000 to 2006

Nearly all respondents were re-interviewed biennially by telephone except for individuals without a telephone, for whom face to face interviews were used. Interviewers were instructed to follow all reasonable strategies to trace people. Response rates were 83.6% for cycle one, 92.8% for cycle two, 88.3% for cycle three, 84.9% for cycle four, 80.8% for cycle five, 77.6% for cycle six and 77.0% for cycle seven.

To look at ADIs resulting from new injuries, data for cycles from 1996 to 2006 were used; data for 1994 was only used for the "before and after" analysis (Table 6). Data were used from respondents who were willing to share their data for data analysis, who completed all interviews to date, and who achieved the age of 20 before 2006. Since the source population, i.e. the total NPHS population, covered more ages than the population analysed for this study, it was possible to add younger persons from the source population to our study population after the cycle at which they reached age of 20 years old. Consequently, the study population changed somewhat over the years of the study allowing comparable cross-sectional analysis of populations with the same age range and age distribution.

Variables

The interview ranged from background questions (age, sex, education, marital status, income, residence, height and weight) to health-related questions (self-perceived health status, health care utilization and medication use). Body mass index (BMI) was calculated as weight in kilograms divided

by height in meters squared [18]. A BMI of 30 or over was considered obese. Respondents were asked to rate their health as one of five categories: excellent, very good, good, fair or poor and for this study, the lower two categories were combined as poorer health and the top three as good health. Depression and stress were measured by the following questions: “have you had 2 weeks in a row during the past 12 months when you were sad, blue, or depressed?” and “During the past month, about how often did you feel: … so sad that nothing could cheer you up? ... nervous? ... restless or fidgety? ... hopeless?... worthless?”. A question about number of visits to any type of physician or medical specialist in the past year was dichotomized as: “five or more visits, versus fewer than five visits”. Alcohol consumption was based on a series of question on the number of drinks consumed each day of the past seven days before the interview. For this study, this was expressed as drinking nine or more drinks per week, versus drinking eight or less. In this study, “alcohol used 5+ at a time” was defined as "How often in the past week have you had 5 or more drinks on one occasion?". The variable “hospital treatment” was described as "Did you receive any medical attention for this injury from a health professional within 48 hours?" For example, doctor, hospital emergency room. Quartiles of total household income were calculated for the study population, with the lower two quartiles combined for the low income category to be compared to the top two as the high income category. A Physical activity index was calculated based on kilocalories per kilogram of body weight per day expended (KKD). Physically active was defined as energy expenditure of at least 3 KKD; and physically inactive was defined as less than 1.5 KKD. Medication use was elicited by the question: “In the past 30 days, did you take . . . ?’ This was followed by a series of questions, such as “Did you take antidepressants and or anti-stressants?” “Did you take anything for pain?” A 'no' answer to the question "Are you usually free of pain and discomfort?" was taken as indication that the respondent often suffered pain.

The definition of injury in the NPHS data was "In the past 12 months, did you have any injuries serious enough to limit your normal activities?" If more than one injury, the following questions were to refer to the most serious one. A separate question asked respondents a general question about limitations in activity, "Because of a long-term physical or mental condition or a health problem, have you limited in the kind or amount of activity you could do: at home? at school? at work? in other activities?". Otherwise, they should be defined as non-activity limiting.

Data Analysis

For the statistical analysis, SAS version 9.2 (SAS Institute, Cary, NC, USA) was used. Logistic regression was used to calculate odds ratios (OR) with the presence/absence of ALI as the dependent variable, adjusted for age (in single years) and sex. Since the data were collected as a statistical sample of the Canadian population, the 'weight' option was used in all SAS statistical analyses to make the results representative of the Canadian population from 1994 to 2006 in seven cycles of cross-sectional studies. Weights were provided by Statistics Canada according to their sampling procedures. In order to produce a meaningful estimate of the variance for the weighted results, the weights were adjusted using the formula: [average weight = (sample weight/sum of the sample weights) * sample size].

In order to determine the characteristics, life style and health status, medical attention and health care utilization as well as activity limitation and disability, which were impacted by ALI, all new injury cases, i.e., those who had not reported an injury in the previous interview were identified. For each new case, data from three cycles were selected, 1) the cycle before reporting, 2) the cycle of reporting, 3) the cycle after reporting. Data for the 1994 cycle were used only in this 'before and after' analysis. Only the first recorded ALI report per person was included. The McNemar test option in SAS was used for

matched analysis. This study approved by the research ethics committee of Health Canada.

RESULTS

The numbers of ALI in the study population increased from 755 cases in 1996 to 1,006 in 2006 .The weighted prevalence of all ALI increased steadily from 10.5% in 1996 to 12.8% in 2006. Those reporting ALI showed increasing trends in obesity, limited activity, poor health status, medication use, and potential injury sequelae, such as pain, stress and depression but declining trends in lower income and current smoking **(Table 1)**. The proportion of injuries which resulted in activity limitations were higher for males, and increased more over time than for females (**Table 2**). Furthermore, younger adults (20-49 yrs.) were more likely to report activity limiting injuries (12.2% to 14.0%) compared to older (50+ yrs.) adults (8.6% to 9.8%).Among respondents who reported a ALI, the weighted percentages who reported five or more visits to a medical doctor (MD) within the previous year decreased from 29.8% in 2000 to 25.3% in 2006, emergency department (ED) visits went from 34.0% to 28.8%, and hospital admission within 48 hours after the injury went from 6.5% to 4.9% (**Table 3**). The rate of hospital admissions within 48 hours for adults aged 50+ years was higher than that of young aged (20-49) group.

The most frequently reported injuries resulting in activity limitation were sprains and strains (42%), followed by fractures and dislocations (20%), and cuts, punctures and bites (10%) (T**able 4**). Only 3.3 to 5.0% of ALIs were in the category of brain, internal and multiple injuries. Men tended to have more cuts, punctures and bites while women had more scrapes, bruises and blisters. Younger ages tended to have more sprains and strains and older ages more fractures and dislocations.

Logistic regression analysis indicated that younger age groups and male participants were more impacted by ALI. Only a few of the other variables showed associations with ALI - immigrants had consistently lower rates of ALI, while people consumed nine or more alcoholic drinks per week had significantly higher rates (**Table 5**).

Attributes of persons with an ALI were compared in the cycles before and after their injury (**Table 6**). Most behavioural risk factors examined showed a pattern of an increase from the two years previous to the ALI to the time of the ALI to a further increase the two years after the ALI. A similar pattern was observed for health status and interactions with the health care system. (**Table 6**).

DISCUSSION

Based on NPHS data, more than 10% of the adult Canadian population annually experience an ALI, with the proportion increasing from 10.5% in 1996 to 12.8% in 2006. According to the definition of ALI as activity-limiting injuries, all people with ALI experienced a certain amount of disruption of their daily activities with the impact varying according to the type and severity of their injury and depending on their customary type of activity [19-22]. About 20% of ALIs were fractures and dislocations, many of whom necessitated a period of altered activity. Older people were more likely to report fractures than the younger age groups. The most common injuries were sprains and strains, the impact of which also varied a great deal depending on type and severity [23-24]. An important impact of injuries is on the workplace through absenteeism and on the family through the disruption of customary activities [25-26]. Besides the impact of injuries on every day activities, there was also the impact on the health care system [27]. In our data, in 2000, about two thirds of people with ALI sought

some kind of medical care. Evidence was presented showing that the impact of ALI might be even more far-reaching, as seen by the higher levels of medical care, and continued pain remaining two years after the ALI were reported.

Other research on injuries has used a variety of definition of injuries, based on different sources of information. Questions in the NPHS were able to put these other measures in perspective. For example, some studies used hospital-based data [28], but the present study showed that only about 5% of ALI were resulted in a hospital admission within the first 48 hours after the event. Assuming that all injuries that required hospitalization were within the activity-limiting rubric, it is clear that studies using only hospital data would include only a small portion of important injuries [29]. However, the hospitalized injuries will be the more severe injuries which are responsible for a disproportional share of the health care cost and disability [25]. Other studies have used ED visits as a unit of measurement [9]. The present study showed less than one third of ALI went to an ED to obtain treatment. Again, the latter were the more severe injuries or those needing specialized treatment, e.g., casts on fractures, and thus had a greater impact on daily life and cost. Another source of data commonly used has been mortality data. Although deaths are definitely activity-limiting, obviously, none were included in this study. Fatal injuries reflect a different range of injuries than those for ALI. For example, in an US study, firearm-related injuries were 22% of all injury deaths, second only to traffic accident related injuries, but firearms amounted to less than 1% for non-fatal injuries [11]. Thus, different measuring units for measuring injury rates will target different slices of the spectrum of injuries and provide different results. ALI are of special public health importance, but are not sufficiently studied.

Another level of impact resulting from ALI would consist of impact on the health care system. Approximately 60% of people with ALI obtained medical care of some type. Of these, approximately one third of persons with ALI went to ED to experience the often long wait before receiving treatment. Back at home the patient would not only experience the pain and disability of the ALI, but also the need to negotiate the health care system, such as making appointments with physicians, specialists, physiotherapists, etc., finding transportation, often needing someone to accompany them [30-33]. Even though the proportion of the population with ALI increased over the years 2000-2006, decreases were seen in use of primary care and the hospital ED visits as well as hospitalisation. This decrease in health care use could be an indication either of greater difficulty in accessing health care, or that the nature of ALIs has moderated over the years. Berdahl found variation by ethnic group and sex, both in the reporting of work-related injuries and in the seeking of medical care and the change in ethnic composition over the years could also be a factor in the NPHS data [34-36]. In any case, ALI are suffered by a large proportion of the population annually, and a majority of these seek medical treatment whether primary care, ED or hospital care. Clearly, this entails a large cost to the health care system and any prevention would not only improve quality of life of the putative victims but also would result in significantly lower health care costs.

Another type of impact would be long-term changes after the injury. The 'before and after' data available in the NPHS consisted of comparing the cross-sectional data from the interview cycle before the ALI with the data of the cycle reporting the ALI and with the next cycle after the ALI. While the interviews for each respondent could be linked for the 'before and after' cycles it was more difficult to determine which changes in attributes in the year of the ALI or subsequent years were sequelea of the

ALI. For example, it might make sense that the increasing obesity for people with ALI be linked to after-effects, e.g. [37], due to inactivity resulting from the ALI but, in fact, similar changes were happening in the overall population. Given these caveats, we can note that no changes were found for smoking and little change in excessive alcohol use. Most likely to show long-term effects due to ALI were visits to medical doctors and ongoing pain. People with ALI showed increasing likelihood of visiting a MD at least five times during the year which continued for the subsequent cycle. Similarly pain increased in the cycle with the ALI and remained high over the years. Although this is weak evidence, it confirms work on long-term effects of other researchers [38-39] and again emphasizes the impact of ALI in the population.

Injuries have been found to lead to lost productivity, medical costs, compensation costs and long-term health problems and disability [40-42], which was confirmed by the present results for the Canadian population. Many injuries can be prevented and a better understanding of all aspects of injuries will lead to better ways of prevention or the minimizing of their effects. However, collaboration and cooperation is needed [43]. The European Union has committed itself to reducing number of traffic fatalities from 45,000 to 25,000 by 2010, which as several reports point out, will require strong measures against use of alcohol [44-47] and illicit and medicinal drugs before driving [48]. A difficulty in injury prevention is the multi-faceted aspect of injuries. For example, a fall may have many causes, such as unsafe working conditions or slippery stairs at home. Each of these issues would require different approaches to prevention. Similar diversities are found for most other types of injuries. With all difficulties inherent in devising effective interventions, prevention is still the best approach to lower the tremendous impact of ALI on the Canadian population.

The NPHS data have important strengths, such as its representativeness of the Canadian population and its longitudinal nature. Because of the longitudinal design, it was possible to identify new ALI, meaning no ALI in the previous interview, and compare risk factors before and after the event, as well as its consequences. The 'before and after' comparisons of the same person allowed for matched analysis at different times. Important also is the extensive and consistent information available on each respondent over the multiple cycles of the survey, such as type of ALI, and the medical care needed. Besides strengths, the NPHS also has limitations. One issue is the lack of distinction between intentional and unintentional injuries. Another issue is that of self-reported data. Part of self-reporting is recall of events. Recall of having had an ALI has been shown elsewhere to be less accurate with increasing time and is also likely to vary with the severity of the injury [49-50]. Both of these would likely lead to an under-reporting of ALI. In spite of its limitations the NPHS gives an invaluable view of the level of serious injury in the Canadian adult population over a 12 year time period.

Another strength of these data is the use of ALI as a measurement of injury. There are various units of measurement in measuring rates of injury in a population. The unit of measurement used in the present study consists of the most serious ALI over the previous 12 months, excluding repetitive strains injuries. The use of ALI means the delimitation of a particular kind of injury in the spectrum of injuries as a concept meaningful to both respondent and researchers. In addition, it identifies a type of injury sufficiently severe to impact a person's regular routine.

CONCLUSION

The findings from this study quantified the immediate and long term impact of individuals and population level injuries in Canada. The immediate impact was pain, disability, and disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor's visits remaining two years after the ALI. Population impact included loss of productivity and a considerable increase in health care access and cost. This study also particularly contributes to injury prevention in social and psychological health services to help injured people make a better recovery and maintain the quality of life after injuries.

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Table 1: The estimated percent of adult Canadians reporting an activity limiting injury in the previous year based on NPHS data, 1996-2006

Year	1996	1998	2000	2002	2004	2006
All	10.5	10.9	11.4	12.6	12.6	12.8
Background variables						
Married/common law	71.0	69.3	68.2	66.2	65.7	64.7
Low income	40.0	34.2	27.9	26.0	23.5	19.8
Completed High School	89.6	89.9	89.3	84.7	84.5	84.5
Rural	17.9	20.5	21.0	20.6	19.9	22.0
Immigrant	17.5	17.3	16.8	16.2	16.1	15.7
Health related variables						
Current smoking	22.7	21.3	20.4	17.1	17.1	16.0
Inactive	58.3	52.9	56.1	48.3	51.0	45.9
Obese	18.4	21.2	23.0	24.3	25.0	26.4
9+ alcohol drinks/ week	11.0	11.6	11.9	11.8	11.6	14.8
Region of residence						
Atlantic	8.8	8.7	8.9	8.8	8.7	8.7
Quebec	25.5	25.6	25.9	26.0	26.1	25.9
Ontario	36.3	36.0	36.0	35.8	36.1	36.2
Prairies	17.0	17.3	17.1	17.4	17.3	17.4
BC	12.5	12.4	12.1	12.0	11.8	11.9
Outcome-related						
Limited activity	17.3	17.8	18.0	22.9	24.5	26.6
Poor health status	33.6	33.2	38.0	41.2	42.3	43.5
5+ Medical Doctor visits /year	24.2	26.3	26.6	27.6	28.3	26.8
Pain	12.3	13.7	13.3	15.1	16.4	15.8
Stress	26.3	29.2	25.1	27.3	28.3	27.4
Depression	6.1	5.8	6.4	6.9	7.1	6.0
Medication use in last 30 days						
Pain medication	65.6	67.5	70.1	70.2	70.4	70.6
Tranquilizer/ sedative	5.1	5.3	6.8	8.1	8.2	10.0
Antidepressants	3.6	4.4	5.4	5.9	6.9	7.0
Total Number[1]	7,313	7,529	7,717	7,875	8,085	8,324

[1] total number of survey respondents used to calculate weighted percentages representative of the Canadian population

Table 3: The percent of persons reporting specific health care use among those reporting an ALI by age group and sex, NPHS, Canada, 2000-2006*

Year		2000	2002	2004	2006
All	Number of ALI	865	932	913	1,005
	Medical Doctor (MD) visits (5+/year)	29.8	27.1	27.3	25.3
	Emergency Department (ED) visits	34.0	28.5	31.0	28.8
	Hospital admission in 48 hours	6.5	5.4	5.5	4.9
	Other	2.7	4.3	3.1	5.2
	Any	66.6	60.0	61.5	59.3
	None	33.5	40.1	38.5	40.7
Males	Number of ALI	394	460	463	482
	MD visits (5+/year)	26.6	26.5	24.7	23.6
	ED visits	34.5	27.4	30.8	29.7
	Hospital admission in 48 hours	9.5	4.5	4.6	4.1
	Other	4.1	4.0	2.9	5.3
	Any	65.2	57.8	58.4	58.5
	None	34.8	42.2	41.6	41.5
Females	Number of ALI	471	472	450	523
	MD visits (5+/year)	32.6	27.7	30.5	27.3
	ED visits	33.6	29.9	31.3	27.8
	Hospital admission in 48 hours	4.0	6.4	6.6	5.7
	Other	1.5	4.7	3.4	5.1
	Any	67.7	62.4	65.2	60.2
	None	32.3	37.6	34.8	39.7
Age 20-49	Number of ALI	588	601	564	590
	MD visits (5+/year)	29.1	27.7	28.5	24.3
	ED visits	34.3	27.6	28.7	27.3
	Hospital admission in 48 hours	6.2	4.1	2.9	3.6
	Other	2.5	4.1	3.1	7.3
	Any	65.8	59.3	3.2	58.9
	None	34.2	40.7	39.7	41.1
Age 50+	Number of ALI	277	331	349	415
	MD visits (5+/year)	31.5	25.8	25.3	26.9
	ED visits	33.6	30.6	34.9	31.1
	Hospital admission in 48 hours	7.3	8.1	9.9	6.9
	Other	3.2	4.9	3.2	1.9
	Any	61.4	59.3	63.5	59.9
	None	31.8	38.6	36.6	40.1

Table 2: Percentages for ALI for which were impacted by activity limitation per year, NPHS, Canada, 2000-2006

Years		2000	2002	2004	2006
	Injury status				
All	None	85.5	84.0	84.0	82.2
	Activity limiting (yes)	10.8	12.1	11.6	12.0
	Activity limiting (no)	3.1	3.0	3.5	5.1
	Both	0.6	0.4	1.0	0.8
Males	None	84.9	82.0	82.2	80.1
	Activity limiting (yes)	10.5	13.5	13.2	13.2
	Activity limiting(no)	3.9	3.9	3.4	5.6
	Both	0.7	0.7	1.3	1.1
Females	None	86.0	85.8	85.7	84.1
	Activity limiting (yes)	11.1	10.8	10.1	10.9
	Activity limiting(no)	2.4	3.0	3.6	4.6
	Both	0.5	0.4	0.7	0.5
Ages 20-49	None	83.5	81.7	81.2	79.3
	Activity limiting (yes)	12.2	13.9	13.3	14.0
	Activity limiting(no)	3.5	3.7	4.3	5.8
	Both	0.8	0.7	1.3	0.9
Ages 50+	None	88.5	87.2	87.4	85.3
	Activity limiting (yes)	8.6	9.5	9.5	9.8
	Activity limiting (no)	2.6	3.1	2.5	4.2
	Both	0.3	0.3	0.6	0.6

Table 4: The type of activity-limiting injury as a proportion of all activity-limiting injuries ALI NPHS, Canada, 1996-2006

	Interview cycles	1996	1998	2000	2002	2004	2006
N[2]	Number of ALI	755	786	865	931	911	1,006
		[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%
ALL	Brain, internal, multiple	4.9	3.3	5.8	3.2	3.9	4.3
	Fractures/dislocation	20.6	21.2	19.9	20.3	22.2	24.9
	Burns	5.3	3.3	4.3	2.8	4.3	3.7
	Sprains, strains	42.0	42.3	42.4	47.3	42.8	42.2
	Cuts, punctures, bites	10.2	15.5	11.8	11.6	11.1	9.7
	Scrapes, bruises, blisters	7.7	6.9	7.8	4.8	7.1	6.3
	Other	9.3	7.5	8.0	10.0	8.6	8.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0
Males	Brain, internal, multiple	5.4	2.8	5.0	2.4	4.1	4.5
	Fractures/dislocation	21.3	21.5	21.5	20.3	21.0	26.1
	Burns	5.8	2.4	3.9	3.5	4.6	2.7
	Sprains, strains	39.6	42.6	40.5	47.2	41.7	39.8
	Cuts, punctures, bites	12.2	17.4	16.7	13.9	13.6	13.1
	Scrapes, bruises, blisters	6.2	5.2	5.7	4.4	6.2	5.8
	Other	9.5	8.1	6.7	8.3	8.8	8.0
Females	Brain, internal, multiple	4.3	3.9	6.4	3.8	3.6	4.2
	Fractures/dislocation	19.8	21.0	18.5	21.6	23.6	23.3
	Burns	4.5	4.1	4.7	3.6	4.0	4.8
	Sprains, strains	45.0	41.9	44.1	46.0	44.3	44.9
	Cuts, punctures, bites	7.8	13.3	7.7	9.1	7.9	6.0
	Scrapes, bruises, blisters	9.5	8.9	9.5	6.4	8.2	7.0
	Other	9.1	6.9	9.1	9.5	8.4	9.8
Age 20-49	Brain, internal, multiple	4.8	3.3	4.9	3.1	3.7	3.0
	Fractures/dislocation	17.4	19.8	22.5	17.4	18.2	22.9
	Burns	5.5	3.3	4.1	3.5	5.0	4.8
	Sprains, strains	43.8	47.2	42.8	51.3	50.9	46.3
	Cuts, punctures, bites	10.9	15.5	11.5	10.7	9.4	9.4
	Scrapes, bruises, blisters	8.5	5.0	7.5	4.5	4.4	4.6
	Other	9.1	5.9	6.7	9.5	8.4	9.0
Age 50+	Brain, internal, multiple	5.4	3.4	7.6	3.4	4.2	6.3
	Fractures/dislocation	30.8	24.9	13.8	26.4	29.0	27.9
	Burns	4.3	3.0	4.9	1.4	3.3	1.9
	Sprains, strains	36.2	30.2	41.7	39.0	29.1	35.8

Cuts, punctures, bites	8.1	15.2	12.5	13.4	13.7	10.3
Scrapes, bruises, blisters	5.1	11.7	8.5	5.4	11.7	9.1
Other	10.1	11.6	11.0	11.0	9.0	8.7

[1] wt%--Weighted percentages making rates representative of the Canadian population
[2] Number of ALI in study population

Table 5: Odds ratios (OR) and 95% confidence interval (C.I.) of ALI by life style and socioeconomic status, adjusted for sex and age, NPHS, Canada, 1996-2006

		1996		1998		2000		2002		2004		2006	
		OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
	M/F	1.4*	1.1 - 1.6	1.3*	1.1 - 1.6	0.9	0.8 - 1.1	1.3*	1.1 - 1.5	1.4*	1.2 - 1.6	1.3*	1.1 - 1.4
Age groups													
	20-39	2.1*	1.6 - 2.9	1.9*	1.5 - 2.4	1.8*	1.4 - 2.3	2.2*	1.8 - 2.7	1.8*	1.5 - 2.2	2.2*	1.8 - 2.6
	40-59	1.6*	1.1 - 2.1	1.4*	1.1 - 1.8	1.3	1.0 - 1.6	1.6*	1.3 - 2.0	1.3	1.0 - 1.5	1.5*	1.2 - 1.8
	60+ (reference)	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~
Background variables[2]													
Married/ Common-law	yes/no	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.9 - 1.2	0.9	0.7 - 1.0	0.9	0.8 - 1.0
income	low/high	1.1	0.9 - 1.3	1.0	0.9 - 1.3	1.2	1.0 - 1.4	0.9	0.8 - 1.1	1.1	0.9 - 1.3	1.2	1.0 - 1.4
Completed High School	yes/no	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.8 - 1.2	0.9	0.8 - 1.1	0.9	0.7 - 1.0	1.1	0.9 - 1.3
Rural	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	0.9	0.7 - 1.1	1.1	0.9 - 1.3	0.8	0.7 - 1.0	1.0	0.8 - 1.1
Non-English	yes/no	0.9	0.7 - 1.1	0.9	0.7 - 1.0	0.8	0.7 - 1.0	0.8	0.7 - 1.0	0.7	0.6 - 0.9	0.8	0.7 - 0.9
Immigrant	yes/no	0.6*	0.5 - 0.8	0.7*	0.6 - 0.9	0.8	0.6 - 1.0	0.8	0.6 - 1.0	0.7*	0.5 - 0.8	0.7*	0.6 - 0.9
Health related[3]													
Current smoking	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	1.2	1.0 - 1.5	1.2	1.0 - 1.5	0.9	0.8 - 1.1	0.9	0.7 - 1.1
Physical inactivity	yes/no	0.8	0.7 - 0.9	0.8	0.7 - 0.9	0.8	0.6 - 0.9	0.9	0.8 - 1.1	0.8	0.7 - 0.9	0.8	0.7 - 0.9
Obese	yes/no	1.2	1.0 - 1.5	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.9 - 1.2	1.1	0.9 - 1.3	1.0	0.8 - 1.1
Alcohol drink /week	9+/less	1.2	0.9 - 1.5	1.2*	1.0 - 1.6	1.3*	1.0 - 1.7	1.4*	1.2 - 1.8	1.2	1.0 - 1.5	1.5*	1.3 - 1.8
Alcohol 5+ at a time	weekly/less	1.3*	1.0 - 1.5	1.4*	1.2 - 1.7	1.4*	1.2 - 1.7	1.2*	1.0 - 1.5	1.3*	1.1 - 1.5	1.3*	1.1 - 1.5

1. For sex group, females are the reference group
2. For background variables comparison groups, the second listed group for binary variables is the reference group
3. For health-related comparison groups, the second listed group for binary variables is the reference group

* Means that there are statistically significant difference compared with control groups

Table 6: life style, socioeconomic status, and health care utilization of persons with an activity limiting injury before and after the injury, NPHS, Canada, 1994-2006

		Before % A	During % B	After % C	p value* A vs B	p value* B vs C	p value* A vs C	N**
Risky behaviours and socioeconomic status								
Income	low	36.3	32.1	28.5	<0.001	<0.001	<0.001	2,892
Obese	obese	17.8	19.7	22.4	0.005	<0.001	<0.001	1,780
Physical activity	inactive	50.4	47.1	48.1	0.001	0.197	0.343	3,044
Smoking	current	19.0	18.5	18.2	0.265	0.384	0.077	1,693
Alcohol drinking	9+/week	9.6	10.7	11.2	0.048	0.535	0.349	3,548
Health-related issues								
Limited activity	yes	18.7	25.5	26.3	<0.001	0.221	<0.001	3,657
Health status	poor	33.1	36.3	39.6	<0.001	<0.001	<0.001	3,653
Medical Doctor visits	5+/year	26.5	34.0	29.8	<0.001	<0.001	<0.001	3,616
Pain	yes	13.7	16.8	17.3	<0.001	0.432	<0.001	3,657
Stress	yes	29.7	31.3	29.4	0.104	0.050	0.757	2,967
Medication use in past 30 days before interview								
Pain medication	yes	61.9	70.2	70.8	<0.001	0.489	<0.001	3,640
Sedatives /tranquiliser	yes	5.7	7.2	8.1	0.001	0.055	<0.001	3,639
Antidepressants	yes	4.2	5.9	6.2	<0.001	0.346	0.403	3,641

*P value calculated by McNemar's test

** N of persons making up the matched analysis for the before and after analysis

Impact of Activity-Limiting Injuries based on the Canadian National Population Health Survey 1994-2006

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KEYWORDS Activity limiting injury; impact factors, longitudinal health survey; epidemiology; injury prevention; Canada.

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Running title: Impact of Activity-Limiting Injury trends

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Manuscript: 3,496

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ABSTRACT

Objective: To examine the ~~impact~~prevalence and factors ~~of~~affecting activity-limiting injuries (ALI) on individuals and on the Canadian population; to ~~detect~~ estimate the short and long term impact ~~after injuries in~~on health status and well-being due to ALI in Canada from 1994 to 2006 using the Canadian National Population Health Survey (NPHS~~) from 1994 to 2006.~~).

~~**Methods**~~**Design:** The NPHS is a randomised longitudinal cohort study with biennial interviews, with information on age, sex, education, marital status, income, residence, height and weight to self-perceived health status, health care utilization and medication use in addition to ALI.

Setting: The study population was ~~drawn from the National Population Health Survey which was started from 1994 to 2006 with~~ a random sample of ~~17,276 people, who were re-interviewed biennially. The study population consisted of 7,300 to 8,300 people over~~male and female participants 20 years ~~old~~ and older from ten provinces and three territories in Canada.

Primary and secondary outcome measures: Logistic regression ~~model was~~models were used to ~~detect~~assess the potential impact of ALI on individuals and on the Canadian population. The interviews two years before and two years after the ALI were compared to examine long-term effects, and the McNemar test option in SAS was used for the matched analysis.

Results: The immediate ~~impact was~~impacts of an ALI were pain, disability, and disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor visits ~~after ALI~~. Population impact included ~~loss of productivity of 10% of the most productive and~~ a considerable increase in health care access and cost. The odds ratios (ORs) for the 20-39 age group ~~and males is more than for females for most years (~~compared to those 60+ was OR, 2.2; 95% CI, 1.8-2.7 ~~and~~), while the OR~~,~~ associated with being male was 1.4; 95% CI, 1.1-1.6). Individuals consuming nine or more alcoholic drinks per week ~~have~~were also significantly ~~differences~~more likely to report an ALI (OR, 1.5; 95% CI, 1.3-1.8).

Conclusion: The findings from this study illustrated the immediate and long term impact of individuals and population level injuries in Canada. Injury control policies should aim to prevent the both the number of injuries fatalities as well as the consequences among survivors.

~~**KEYWORDS** Activity limiting injury; impact factors, longitudinal health survey; epidemiology; injury prevention; Canada.~~

~~**Word count:**~~

~~Abstract: 265~~

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Summary Boxes:

What is already known on this subject?

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1. Activity-limiting injuries (ALI) burden such as increased steadily prevalence, mortality and economic costs in Canada;
2. Showing increasing trends in obesity, limited activity, poor health status, medication use related to ALI;
3. Nature and types related to ALI;

What does this study add?

1. Potential associations between health care utilization and ALI before and after injury;
2. Hospital admission, Department emergency and medical doctors visits impacted on ALI;
3. The immediate individuals impact such as pain, disability, disruption of regular life. Long-term effects in patients were sequelae, chronic pain, ~~stress~~ and increased medical doctor visits after ALI. Population impact included loss of productivity ~~of 10% of the most productive~~ and a considerable increase in health care access and cost.
4. policies should aim to prevent both the number of injuries fatalities as well as the consequences among survivors.

Competing Interest:
None to declare.

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Contributorship Statement:
Dr. Frank Mo, leader of the research project, and play the major role in research design, drafted the article and critical review, and advising for data analysis and results interpretation.
Dr. Ineke C. Neutel, contributed to data analysis, assisted in research design and data analysis, interpretation, and the report.
Dr. Howard Morrison, contributed to research consultation, provided critical review comments, and advising for data analysis and revised critically the article.
Mr. Doug Hopkins, assisted in research design, provided literature review and critical comments and signed final version of the manuscript.
Ms. Caroline Da Silva, participated in research design, provided critical review comments and signed final version of the manuscript.
Ms. Ying Jiang, contributed to research design, provided literature and critical review comments, and signed final version of the manuscript for submission.

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INTRODUCTION

Injuries are a serious public health issue with a major impact on the lives of Canadians. They are leading causes of death and hospitalization, as well as of disability, loss of productivity and potential years of life lost (PYLL) [1~~]. Sequelaes~~-4]. Sequelae from injuries ~~can impact the quality of life for individuals and population levels, such as~~include activity limitation, functional disability and pain ~~as process influenced by~~which in turn influence a variety of social, psychological, labour force, and economic factors [~~2 5~~]. ~~A rather complete~~-8]. An analysis of ~~injury in Canada was based on~~ emergency department (ED) visits and hospitalisation admissions for ~~all of Ontario province [6]. The analysis noted~~Ontarionoted that one in four ED visits were injury-related, as were one in every 17 hospitalisations [~~6~~9]. These data ~~accentuate~~accentuated the importance of injuries to the health care system. Other studies have ~~also~~ demonstrated the increasing medical doctor (MD) ~~contact~~contacts, the use more medications for pain, more days in hospital, and more hours of home care services [~~6-8~~9-11].

Several studies of traumatic disability have also focused on injuries resulting in hospitalization [~~9~~12], types of injury [~~10-11~~13-14], and serious head injuries [~~12]. Moreover,~~15]. One study reported that half of patients had some limitation in activity for two days or more due to injury, and patients

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treated in the clinic were somewhat more likely to have two or more days of limited activity than were patients treated in the ED [~~13~~16].

Injuries are not only largely preventable, but the impact of injuries ~~could also~~can usually be lessened. ~~In order to~~To develop effective policies leading to the prevention of injuries and ~~reduced~~to reduce the impact of injuries on society, information is needed about the influenced effects that individuals with injuries treated in the primary care setting and not requiring hospitalization frequently result in significant functional impairment and to identify those injuries which, by virtue of their contribution to disability, would be targets for prevention programs.

The objectives of this study are to explore the immediate and longer term consequences of injury including physical, psychological, social and occupational functioning. This comprises a longitudinal population health study, which will measure the impact of injuries on individual's and population level health status and well-being due to activity-limiting injuries (ALI) in the NPHS from 1994 to 2006 in Canada.

~~METHODS~~

METHODOLOGY

Study population

The source population for this study ~~is~~was the Canadian National Population Health Survey (NPHS), from1994/1995 (cycle 1) to 2006/2007 (cycle 7~~) with 17,276~~). The study population was designed to be representative of the ~~respondents in~~Canadian population with the ~~survey except~~

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~~for~~exception of persons living on Indian reserves or on Canadian Forces bases [~~6, 8~~9, 11]. The sample design ~~is~~was a multiple cluster [~~14]. 17~~], ideal for controlling costs when personal interviews are needed, as was the case for cycle 1 of the NPHS. To cover as much as possible of the Canadian population, separate components of the survey were also carried out in the Territories and in health care institutions. In the Territories, a simpler stratified design was used. As well, anticipating the creation of Nunavut, separate strata were formed for each of the future territories, Nunavut and NWT [17]. The sampling frame for the first cycle (1994/5) originated with the Canadian Labour Force Survey (CLFS), a multi-stage, stratified sampling technique used for all provinces except Quebec for which a provincial sampling frame was used [~~14]. In the second cycle 1996-1997 the NPHS started using~~17~~,276 of the respondents for a longitudinal component. For~~]. From the 2000 cycle ~~a few changes~~ onward, additional questions were ~~made in~~added to the questionnaire ~~including~~, such as more detailed questions on health care use after the ALI~~-~~, with the result that some analyses are restricted to data from 2000 to 2006

Nearly all respondents were re-interviewed biennially by telephone except for individuals without a telephone, for whom face to face interviews were used. Interviewers were instructed to follow all reasonable strategies to trace people. Response rates were 83.6% ~~from~~for cycle one~~ to~~, 92.8% for cycle two~~ 92.8%,~~, 88.3% for cycle three~~ 88.3%,~~, 84.9% for cycle four~~ 84.9%,~~, 80.8% for cycle five~~ 80.8%,~~, 77.6% for cycle six~~ 77.6%,~~ and 77.0% for cycle seven~~ 77.0%.~~

~~For the present study, interview~~ To look at ADIs resulting from new injuries, data for cycles ~~for~~from 1996 to 2006 were used~~-~~; data for 1994 was only used for the "before and after" analysis (Table

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6). Data were used from respondents who were willing to share their data for data analysis, ~~and~~ who completed all interviews to date, and ~~aschieved ages~~who achieved the age of 20 ~~and over~~before 2006. Since the source population, i.e. the total NPHS population, covered more ages than ~~the study population, i.e.~~ the population analysed for this study, it was possible to add younger persons from the source population to our study population after the cycle at which they reached age of 20 years old. Consequently, the study population changed somewhat over the years of the study~~, 1996 to 2006~~ allowing comparable cross-sectional analysis of populations with the same age range and age distribution.

Variables

The interview ranged from background questions (age, sex, education, marital status, income, residence, height and weight) to health-related questions (self-perceived health status, health care utilization and medication use). ~~For this study the answers were dichotomized.~~ Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared [~~15~~18]. A BMI of 30 ~~and~~or over was considered obese. Respondents were asked to rate their health as one of five categories: excellent, very good, good, fair or poor and for this study, the lower two categories were combined as poorer health and the top three as good health. Depression and stress were measured by the following questions: "have you had 2 weeks in a row during the past 12 months when you were sad, blue, or depressed?" and "During the past month, about how often did you feel: … so sad that nothing could cheer you up? ... nervous? ... restless or fidgety? ... hopeless?... worthless?". A question about number of visits to any type of physician or medical specialist in the past year was dichotomized as: "five or more visits, versus fewer than five visits". Alcohol consumption was based on a series of question on the

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number of drinks consumed each day of the past seven days before the interview. For this study, this was expressed as drinking nine or more drinks per week, versus drinking eight or less. In this study, "alcohol used 5+ at a time" was defined as "How often in the past week have you had 5 or more drinks on one occasion?". The variable "hospital treatment" was described as "Did you receive any medical attention for this injury from a health professional within 48 hours?" For example, doctor, hospital emergency room. Quartiles of total household income were calculated for the study population ~~and~~, with the lower two quartiles combined for the low income category to be compared to the top two as ~~highest~~the high income category. ~~A three part physical~~ A Physical activity index was calculated based on ~~kilo calories~~kilocalories per kilogram of body weight per day expended (KKD). Physically active ~~is~~was defined as energy expenditure of at least 3 KKD; ~~moderately active corresponds to energy expenditure between 1.5 and 3 KKD;~~and physically inactive ~~is~~was defined as less than 1.5 KKD. Medication use was elicited by the question: "In the past 30 days, did you take . . . ?' This was followed by a series of questions, such as "Did you take antidepressants~~?"~~ and or anti-stressants?" "Did you take anything for pain?" A 'no' answer to the question "Are you usually free of pain and discomfort?" was taken as indication that the respondent often suffered pain.

The definition of injury in the NPHS data was "In the past 12 months, did you have any injuries serious enough to limit your normal activities?" If more than one injury, the following questions were to refer to the most serious one. A separate question asked respondents a general question about limitations in activity, "Because of a long-term physical or mental condition or a health problem, ~~are~~have you limited in the kind or amount of activity you ~~can~~could do: at home? at school? at work? in other activities~~?"~~?". Otherwise, they should be defined as non-activity limiting.

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Data Analysis

For the statistical analysis, SAS version 9.2 (SAS Institute, Cary, NC, USA) was used. Logistic regression ~~provided~~was used to calculate odds ratios (OR) with the presence/absence of ALI as the dependent variable, adjusted for age (in single years) and sex. Since the data were collected as a statistical sample of the Canadian population, the 'weight' option was used in all SAS statistical analyses to make the results representative of the Canadian population from 1994 to 2006 in seven cycles of cross-sectional studies. Weights were provided by Statistics Canada according to their sampling procedures. In order to produce a meaningful estimate of the variance for the weighted results, the weights were adjusted using the formula: [average weight = (sample weight/sum of the sample weights) * sample size].

In order to determine the characteristics, life style and health status, medical attention and health care utilization as well as activity limitation and disability, which were impacted by ALI, all new injury cases, i.e., those who had not reported an injury in the previous interview were identified. For each new case, data from three cycles were selected, 1) the cycle before reporting, 2) the cycle of reporting, 3) the cycle after reporting. Data for the 1994 cycle were used only in this 'before and after' analysis. Only the first recorded ALI report per person was included. The McNemar test option in SAS was used for matched analysis. This study approved by the research ethics committee of Health Canada.

RESULTS

The numbers of ALI in ~~adult Canadians~~ the study population increased from 755 cases in 1996 to 1,006 in 2006 ~~(not shown in table).~~ . The weighted prevalence of all ALI increased steadily from 10.5%

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in 1996 to 12.8% in 2006. ~~The population is showing~~Those reporting ALI showed increasing trends in obesity, limited activity, poor health status, medication use, and potential injury sequelae, such as pain, stress and depression but declining trends in lower income and current smoking **(Table 1)**. The proportion of injuries which resulted in activity limitations were higher for males, and increased more over time than for females (Table 2) s. Furthermore, younger adults (20-49 yrs.) were more likely to report activity limiting injuries (12.2% to 14.0%) compared to older (50+ yrs.) adults (8.6% to 9.8%).Among respondents who reported a ALI, the weighted percentages ~~of~~ who reported five or more visits to a medical doctor (MD) ~~visits~~ within the previous year decreased ~~form~~from 29.8% in 2000 to 25.3~~%,~~% in 2006, emergency department (ED) visits went from 34.0% to 28.8%, and hospital admission within 48 hours after the injury went from 6.5% to 4.9% ~~from 2000-2006 for all ALI~~ (**Table ~~2~~3**). The rate of hospital admissions within 48 hours for adults aged 50+ years was higher than that of young aged (20-49) group. ~~Rates of ALI for males were higher and increased more than for females. Furthermore, younger adults (20-49 yrs.) tended to have more ALI (12.2% to 14.0%) than the older (50+ yrs.) adults (8.6% to 9.8%) (**Table 3**).~~

The most ~~frequent types of ALI~~frequently reported injuries resulting in activity limitation were sprains and strains (42%), followed by fractures and dislocations (20%), and cuts, punctures and bites (10%) (T**able 4**). Only 3.3 to 5.0% of ~~ALI~~ALIs were in the category of brain, internal and multiple injuries. Men ~~tend~~tended to have more cuts, punctures and bites while women ~~have~~had more scrapes, bruises and blisters. Younger ages ~~tend~~tended to have more sprains and strains and older ages more fractures and dislocations ~~(**Table 4**).~~ .

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Logistic regression analysis indicated that younger age groups and male participants were more impacted by ALI~~, the OR for the 20-39 age group and males is more than for females for most years.~~. Only a few of the other variables ~~show~~showed associations with ALI - immigrants ~~have~~had consistently lower rates of ALI, while people ~~consuming~~consumed nine or more alcoholic drinks per week ~~have~~had significantly higher rates~~.~~ (**Table 5**).

Attributes ~~in the interview cycle before the~~ of persons with an ALI were compared ~~with the rates~~ in the ~~interview year with the ALI~~cycles before and ~~rates in the cycle~~ after ~~the ALI~~their injury (**Table 6**). ~~Some attributes~~Most behavioural risk factors examined showed ~~higher rates for the cycle with the ALI compared to the previous one, i.e.,~~ a pattern of an increase from the two years ~~earlier, and then continued~~previous to the ~~higher rate in~~ALI to the ~~next cycle, i.e.,~~time of the ALI to a further increase the two years after the ALI. ~~This~~A similar pattern was ~~true for limited activity, medical doctor (MD) visits, experiencing pain, medication use for pain, sedatives/ tranquillizers, and antidepressants for the patients with stress and depression (P<0.001)~~observed for health status and interactions with the health care system. (**Table 6**).

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DISCUSSION

~~Clearly, the impact of ALI can be found~~Based on ~~several different levels. Immediate consequences were experienced by the~~ NPHS data, more than 10% of the adult Canadian population ~~who~~ annually ~~report~~experience an ALI, with ~~rates~~the proportion increasing from 10.5% in 1996 to 12.8% in 2006. According to the definition of ALI as activity-limiting injuries, all people with ALI ~~experience~~experienced a certain amount of disruption of their daily activities with the impact varying

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according to the type and severity of their injury and depending on their customary type of activity [~~16-19~~]. ~~The most severe injury includes the 3-6% of ALI with brain, internal and multiple injuries.~~ 22]. About 20% of ~~ALI~~ALIs were fractures and dislocations, many of whom ~~necessitate~~necessitated a period of altered activity. ~~The elderly~~Older people ~~are~~were more likely to ~~experience~~report fractures than the younger age groups. The most common injuries ~~are~~were sprains and strains, the impact of which also ~~varies~~varied a great deal depending on type and severity [~~20-21]. Groups most impacted by ALI were men and the younger ages, and thus more likely to have their busy schedules and possibly income, as well as that of their families disrupted. A widespread~~23-24]. An important impact of injuries is on the workplace through absenteeism and on the family through the disruption of customary activities. [25-26]. Besides the impact of injuries on every day activities, there ~~is~~was also the impact on the health care system. ~~About~~ [27]. In our data, in 2000, about two thirds of people with ALI sought some kind of medical care ~~in the year 2000~~. Evidence was presented showing that the impact of ALI might be even more far-reaching, as seen by the higher levels of medical care, and continued pain remaining two years after the ALI were reported.

Other ~~researches~~research on injuries ~~have~~has used a variety of definition of injuries, based on different sources of information. Questions in the NPHS were able to put these other measures in perspective ~~when compared to ALI~~. For example, some studies ~~use~~used hospital-based data [~~22~~28], but the present study ~~shows~~showed that only about 5% of ALI ~~are admitted to~~ were resulted in a hospital admission within the first 48 hours ~~of~~after the event. Assuming that all injuries that ~~require~~required hospitalization ~~are~~were within the activity-limiting rubric, it is clear that studies ~~done on~~using only hospital data would include only a small portion of important injuries [~~23~~29]. However, the hospitalized

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injuries will be the more severe injuries which ~~take~~are responsible for a disproportional share of the health care cost and disability [~~22~~25]. Other studies have used ED visits as a unit of measurement [~~6~~9]. The present study showed less than one third of ALI went to an ED to obtain treatment. Again, the latter ~~are~~were the more severe injuries or those needing specialized treatment, e.g., casts on fractures, and thus ~~have~~had a greater impact on daily life and cost. Another source of data commonly used has been mortality data. Although deaths are definitely activity-limiting, obviously, none ~~are~~were included in this study. ~~Mortality rates will also refer to a quite~~Fatal injuries reflect a different range of injuries than those for ALI. For example, in an US study, firearm-related injuries were 22% of all injury deaths, second only to traffic accident related injuries, but firearms amounted to less than 1% for non-fatal injuries [~~8~~11]. Thus, different measuring units for measuring injury rates will target different slices of the spectrum of injuries and provide different results. ALI are of special public health importance, but are not sufficiently studied.

Another level of impact resulting from ALI would consist of impact ~~on~~on the health care system. Approximately 60% of people with ALI ~~obtain~~obtained medical care of some type. Of these, approximately one third of persons with ALI went to ED to experience the often long wait before receiving treatment. Back at home the patient would not only experience the pain and disability of the ALI, but also the need to negotiate the health care system, such as making appointments with physicians, specialists, physiotherapists, etc., finding transportation, often needing someone to accompany them [~~24-27~~30-33]. Even though the proportion of the population with ALI increased over the years 2000-2006, decreases were seen in use of primary care and the hospital ED visits as well as hospitalisation. This decrease in health care use could be an indication either of greater difficulty in

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accessing health care, or that the ~~ALI reported becoming less severe~~nature of ALIs has moderated over the years. Berdahl found variation by ethnic group and sex, both in the reporting of work-related injuries and in the seeking of medical care and the change in ethnic composition over the years could also be a factor in the NPHS data [~~28-30~~34-36]. In any case, ALI are suffered by a large proportion of the population annually, and a majority of these seek medical treatment whether primary care, ED or hospital care. ~~Some of these would need an ambulance for transportation.~~ Clearly, this entails a large cost to the health care system and any prevention would not only improve quality of life of the putative victims but also would result in significantly lower health care costs.

Another type of impact would be long-term changes after the injury. The 'before and after' data available in the NPHS consisted of comparing the cross-sectional data from the interview cycle before the ALI with the data of the cycle reporting the ALI and with the next cycle after the ALI. While the interviews for each respondent could be linked for the 'before and after' cycles it was more difficult to determine which changes in attributes in the year of the ALI or subsequent years were sequelea of the ALI. For example, it might make sense that the increasing obesity for people with ALI be linked to after-effects, e.g. [~~31~~37], due to inactivity resulting from the ALI but, in fact, similar changes ~~are~~were happening in the overall population. Given these caveats, we can note that no changes were found for smoking and little change in excessive alcohol use. Most likely to show long-term effects due to ALI were visits to medical doctors and ongoing pain. People with ALI showed increasing likelihood of visiting a MD at least five times during the year which ~~continued~~continued for the subsequent cycle. Similarly pain increased in the cycle with the ALI and remained high over the years. Although this is weak evidence, it confirms work on long-term effects of other researchers [~~32-33~~38-39] and again

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emphasizes the impact of ALI in the population.

Injuries have been found to lead to lost productivity, medical costs, compensation ~~cost~~costs and ~~possibly~~ long-term health problems and disability [~~34-36~~40-42], which was confirmed by the present results for the Canadian population. Many injuries can be prevented and a better understanding of all aspects of injuries will lead to better ways of prevention or the minimizing of their effects. However, collaboration and cooperation is needed [~~37~~43]. The European Union has committed itself to reducing number of traffic fatalities from ~~450~~45,000 to ~~235~~25,000 by 2010, which as ~~Goule et al.,~~several reports, point out, will require strong measures against use of alcohol [~~38-41],~~44-47] and illicit and medicinal drugs before driving [~~42~~48]. A difficulty in injury prevention is the multi-faceted aspect of injuries. For example, a fall may have many causes, such as unsafe working conditions or slippery stairs at home. Each of these issues would require different approaches to prevention. Similar diversities are found for most other types of injuries. With all difficulties inherent in devising effective interventions, prevention is still the best approach to lower the tremendous impact of ALI on the Canadian population.

The NPHS data have important strengths, such as its representativeness of the Canadian population and its longitudinal nature. Because of the longitudinal design, it was possible to identify new ALI, meaning no ALI in the previous interview, and compare risk factors before and after the event, as well as its consequences. The 'before and after' comparisons of the same person allowed for matched analysis at different times. Important also is the extensive and consistent information available on each respondent over the multiple cycles of the survey, such as type of ALI, and the medical care needed. Besides strengths, the NPHS also has limitations. ~~In spite of the abundance of data available, further~~

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~~information is always desirable for particular uses of the data.~~ One issue is the lack of distinction between intentional and unintentional injuries~~, another is the large time spans over which the information is available~~. Another issue is that of self-reported data. Part of self-reporting is recall of events. Recall of having had an ALI has been shown elsewhere to be less accurate with increasing time and is also likely to vary with the severity of the injury [~~43-44~~49-50]. Both of these would likely lead to an under-reporting of ALI. In spite of its limitations the NPHS gives an invaluable view of the level of serious injury in the Canadian adult population over a 12 year time period.

Another strength of these data is the use of ALI as a measurement of injury. There are various units of measurement in measuring rates of injury in a population. The unit of measurement used in the present study consists of the most serious ALI over the previous 12 months, excluding repetitive strains injuries. The use of ALI means the delimitation of a particular kind of injury in the spectrum of injuries as a concept meaningful to both respondent and researchers. In addition, it identifies a type of injury sufficiently severe to impact a person's regular routine.

CONCLUSION

The findings from this study quantified the immediate and long term impact of individuals and population level injuries in Canada. The immediate impact was pain, disability, and disruption of regular life. ~~The two-thirds seeking medical care needed time, effort and know-how to negotiate the health care system, let alone transportation and other related help.~~ Long-term effects in patients were chronic pain and increased medical doctor's visits remaining two years after the ALI. Population impact included loss of productivity ~~of 10% of the most productive~~ and a considerable increase in health care access and

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cost. This study also particularly contributes to injury prevention in social and psychological health services to help injured people make a better recovery and maintain the quality of life after injuries.

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Table 1: ~~Weighted percentages~~The estimated percent of ~~characteristics of ALI for which were impacted~~adult Canadians reporting an activity limiting injury in the previous year based on ~~the study population, NPHS, Canada, 1994~~ data, 1996-2006

Year	1996	1998	2000	2002	2004	2006
	~~wt%~~[1]	~~wt%~~[1]	~~wt%~~[1]	~~wt%~~[1]	~~wt%~~[1]	~~wt%~~[1]
~~Total Number~~[2]	~~7,313~~	~~7,529~~	~~7,717~~	~~7,875~~	~~8,085~~	~~8,324~~
~~ALI (wt%)~~All	10.5	10.9	11.4	12.6	12.6	12.8
Background variables						
~~Partner~~Married/common law	71.0	69.3	68.2	66.2	65.7	64.7
Low income	40.0	34.2	27.9	26.0	23.5	19.8
Completed High School	89.6	89.9	89.3	84.7	84.5	84.5
Rural	17.9	20.5	21.0	20.6	19.9	22.0
Immigrant	17.5	17.3	16.8	16.2	16.1	15.7
Health related variables						
Current smoking	22.7	21.3	20.4	17.1	17.1	16.0
Inactive	58.3	52.9	56.1	48.3	51.0	45.9
Obese	18.4	21.2	23.0	24.3	25.0	26.4
9+ alcohol drinks/ week	11.0	11.6	11.9	11.8	11.6	14.8
Region of residence						
Atlantic	8.8	8.7	8.9	8.8	8.7	8.7
Quebec	25.5	25.6	25.9	26.0	26.1	25.9
Ontario	36.3	36.0	36.0	35.8	36.1	36.2
Prairies	17.0	17.3	17.1	17.4	17.3	17.4
BC	12.5	12.4	12.1	12.0	11.8	11.9
Outcome-related						
~~Ltd~~Limited activity	17.3	17.8	~~17.98~~18.0	22.9	24.5	26.6
~~Health~~Poor health status	33.6	33.2	38.0	41.2	42.3	43.5
5+ Medical Doctor visits /year	24.2	26.3	26.~~64~~6	27.6	28.3	26.8
Pain	12.3	13.7	13.3	15.1	16.4	15.8
Stress	26.3	29.2	25.~~09~~1	27.3	28.3	27.4
Depression	6.1	5.8	6.~~43~~4	6.9	7.1	6.0
Medication use in last 30 ~~years~~days						
Pain medication	65.6	67.5	70.1	70.~~23~~2	70.4	70.6
Tranquilizer/ sedative	5.1	5.3	6.8	8.~~12~~1	8.2	10.0
Antidepressants	3.6	4.4	5.4	5.9	6.9	7.0

[1] ~~wt% - Weighted percentages~~

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~~making rates representative of the Canadian population~~

~~[2] Number in study population~~

Total Number[1]	7,313	7,529	7,717	7,875	8,085	8,324

[1] total number of survey respondents used to calculate weighted percentages representative of the Canadian population

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Table ~~2: Percent~~3: The percent of persons ~~with ALI for which were impacted on medical attention and~~reporting specific health care ~~resource utilization~~ use among those reporting an ALI by age group and sex ~~groups~~, NPHS, Canada, ~~1994~~2000-2006*

Year		2000 ~~wt%~~‡	2002 ~~wt%~~‡	2004 ~~wt%~~‡	2006 ~~wt%~~‡
All	Number of ALI	865	932	913	1,005
-	~~None~~	~~33.5~~	~~40.1~~	~~38.5~~	~~40.7~~
	Medical Doctor (MD) visits (5+/year)	29.8	27.1	27.3	25.3
	Emergency Department (ED) visits	34.0	28.5	31.0	28.8
	Hospital admission in 48 hours	6.5	5.4	5.5	4.9
	Other	2.7	4.3	3.1	5.2
	Any	66.6	60.0	61.5	59.3
	None	33.5	40.1	38.5	40.7
Males	Number of ALI	394	460	463	482
	~~None~~	~~34.8~~	~~42.2~~	~~41.6~~	~~41.5~~
	MD visits (5+/year)	26.6	26.5	24.7	23.6
	ED visits	34.5	27.4	30.8	29.7
	Hospital admission in 48 hours	9.5	4.5	4.6	4.1
	Other	4.1	4.0	2.9	5.3
	Any	65.2	57.8	58.4	58.5
	None	34.8	42.2	41.6	41.5
Females	Number of ALI	471	472	450	523
	~~None~~	~~32.3~~	~~37.6~~	~~34.8~~	~~39.7~~
	MD visits (5+/year)	32.6	27.7	30.5	27.3
	ED visits	33.6	29.9	31.3	27.8
	Hospital admission in 48 hours	4.0	6.4	6.6	5.7
	Other	1.5	4.7	3.4	5.1
	Any	67.7	62.4	65.2	60.2
	None	32.3	37.6	34.8	39.7
Age 20-49	Number of ALI	588	601	564	590
	~~None~~	~~34.2~~	~~40.7~~	~~39.7~~	~~41.1~~
	MD visits (5+/year)	29.1	27.7	28.5	24.3
	ED visits	34.3	27.6	28.7	27.3
	Hospital admission in 48 hours	6.2	4.1	2.9	3.6
	Other	2.5	4.1	3.1	7.3
	Any	65.8	59.3	3.2	58.9
	None	34.2	40.7	39.7	41.1
Age 50+	Number of ALI	277	331	349	415
	~~None~~	~~31.8~~	~~38.6~~	~~36.6~~	~~40.1~~
	MD visits (5+/year)	31.5	25.8	25.3	26.9
	ED visits	33.6	30.6	34.9	31.1

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	Hospital admission in 48 hours	7.3	8.1	9.9	6.9
	Other	3.2	4.9	3.2	1.9
	Any	61.4	59.3	63.5	59.9
		31.8	38.6	36.6	
	None				~~* Data on medical treatment was available only from 2000-2006~~ ~~wt%+ --- Weighted percentages making rates representative of the Canadian population~~40.1

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Table ~~3~~2: Percentages for ALI for which were impacted by activity limitation per year, NPHS, Canada, 2000-2006~~*~~

Years		2000	2002	2004	2006
	~~-~~Injury status	~~wt%~~[†]	~~wt%~~[†]	~~wt%~~[†]	~~wt%~~[†]
All	None	85.5	84.0	84.0	82.2
	Activity limiting ~~only~~(yes)	10.8	12.1	11.6	12.0
	~~Non-activity~~Activity limiting (no)	3.1	3.0	3.5	5.1
	Both	0.6	0.4	1.0	0.8
Males	None	84.9	82.0	82.2	80.1
	Activity limiting ~~only~~(yes)	10.5	13.5	13.2	13.2
	~~Non-activity~~Activity limiting(no)	3.9	3.9	3.4	5.6
	Both	0.7	0.7	1.3	1.1
Females	None	86.0	85.8	85.7	84.1
	Activity limiting ~~only~~(yes)	11.1	10.8	10.1	10.9
	~~Non-activity~~Activity limiting (no)	2.4	3.0	3.6	4.6
	Both	0.5	0.4	0.7	0.5
Ages 20-49 ~~**20-49**~~	None	83.5	81.7	81.2	79.3
	Activity limiting ~~only~~(yes)	12.2	13.9	13.3	14.0
	~~Non-activity~~Activity limiting(no)	3.5	3.7	4.3	5.8
	Both	0.8	0.7	1.3	0.9
Ages 50+ ~~**50+**~~	None	88.5	87.2	87.4	85.3
	Activity limiting (yes)	8.6	9.5	9.5	9.8
	~~Non-activity~~Activity limiting (no)	2.6	3.1	2.5	4.2
	Both	0.3	0.3	0.6	0.6

~~* Data on medical treatment was available only from 2000-2006~~

~~† wt% - Weighted percentages making rates representative of the Canadian population~~

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Table 4: The ~~pathology~~type of activity-limiting injury as a proportion of all activity-limiting injuries ALI ~~for which were impacted on patients' ED visits, admission and length of stay in hospital and consequence,~~ NPHS, Canada, ~~1994~~1996-2006

	Interview cycles	1996	1998	2000	2002	2004	2006
N[2]	Number of ALI	755	786	865	931	911	1,006
	~~Patterns of ALI~~	[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%
ALL	Brain, internal, multiple	4.9	3.3	5.8	3.2	3.9	4.3
	Fractures/dislocation	20.6	21.2	19.9	20.3	22.2	24.9
	Burns	5.3	3.3	4.3	2.8	4.3	3.7
	Sprains, strains	42.0	42.3	42.4	47.3	42.8	42.2
	Cuts, punctures, bites	10.2	15.5	11.8	11.6	11.1	9.7
	Scrapes, bruises, blisters	7.7	6.9	7.8	4.8	7.1	6.3
	Other	9.3	7.5	8.0	10.0	8.6	8.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0
Males	Brain, internal, multiple	5.4	2.8	5.0	2.4	4.1	4.5
	Fractures/dislocation	21.3	21.5	21.5	20.3	21.0	26.1
	Burns	5.8	2.4	3.9	3.5	4.6	2.7
	Sprains, strains	39.6	42.6	40.5	47.2	41.7	39.8
	Cuts, punctures, bites	12.2	17.4	16.7	13.9	13.6	13.1
	Scrapes, bruises, blisters	6.2	5.2	5.7	4.4	6.2	5.8
	Other	9.5	8.1	6.7	8.3	8.8	8.0
Females	Brain, internal, multiple	4.3	3.9	6.4	3.8	3.6	4.2
	Fractures/dislocation	19.8	21.0	18.5	21.6	23.6	23.3
	Burns	4.5	4.1	4.7	3.6	4.0	4.8
	Sprains, strains	45.0	41.9	44.1	46.0	44.3	44.9
	Cuts, punctures, bites	7.8	13.3	7.7	9.1	7.9	6.0
	Scrapes, bruises, blisters	9.5	8.9	9.5	6.4	8.2	7.0
	Other	9.1	6.9	9.1	9.5	8.4	9.8
Age 20-49	Brain, internal, multiple	4.8	3.3	4.9	3.1	3.7	3.0
	Fractures/dislocation	17.4	19.8	22.5	17.4	18.2	22.9
	Burns	5.5	3.3	4.1	3.5	5.0	4.8
	Sprains, strains	43.8	47.2	42.8	51.3	50.9	46.3
	Cuts, punctures, bites	10.9	15.5	11.5	10.7	9.4	9.4

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	Scrapes, bruises, blisters	8.5	5.0	7.5	4.5	4.4	4.6
	Other	9.1	5.9	6.7	9.5	8.4	9.0
Age 50+	Brain, internal, multiple	5.4	3.4	7.6	3.4	4.2	6.3
	Fractures/dislocation	30.8	24.9	13.8	26.4	29.0	27.9
	Burns	4.3	3.0	4.9	1.4	3.3	1.9
	Sprains, strains	36.2	30.2	41.7	39.0	29.1	35.8
	Cuts, punctures, bites	8.1	15.2	12.5	13.4	13.7	10.3
	Scrapes, bruises, blisters	5.1	11.7	8.5	5.4	11.7	9.1
	Other	10.1	11.6	11.0	11.0	9.0	8.7

[1] wt%--Weighted percentages making rates representative of the Canadian population
[2] Number of ALI in study population

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Table 5: Odds ratios (OR) and 95% confidence interval (C.I.) of ALI ~~for which were impacted~~ by life style and socioeconomic status, adjusted for sex and age, NPHS, Canada, ~~1994~~1996-2006

		1996		1998		2000		2002		2004		200	
		OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
	M/F	1.4*	1.1 - 1.6	1.3*	1.1 - 1.6	0.9	0.8 - 1.1	1.3*	1.1 - 1.5	1.4*	1.2 - 1.6	1.3*	1.1 - 1.4
Age groups													
	20-39	2.1*	1.6 - 2.9	1.9*	1.5 - 2.4	1.8*	1.4 - 2.3	2.2*	1.8 - 2.7	1.8*	1.5 - 2.2	2.2*	1.8 - 2.6
	40-59	1.6*	1.1 - 2.1	1.4*	1.1 - 1.8	1.3	1.0 - 1.6	1.6*	1.3 - 2.0	1.3	1.0 - 1.5	1.5*	1.2 - 1.8
	60+ (reference)	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~
Background variables[2]													
Married/ Common-law	yes/no	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.9 - 1.2	0.9	0.7 - 1.0	0.9	0.8 - 1.0
Income	low/high	1.1	0.9 - 1.3	1.0	0.9 - 1.3	1.2	1.0 - 1.4	0.9	0.8 - 1.1	1.1	0.9 - 1.3	1.2	1.0 - 1.4
Completed High School	yes/no	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.8 - 1.2	0.9	0.8 - 1.1	0.9	0.7 - 1.0	1.1	0.9 - 1.3
Rural	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	0.9	0.7 - 1.1	1.1	0.9 - 1.3	0.8	0.7 - 1.0	1.0	0.8 - 1.1
Non-English	yes/no	0.9	0.7 - 1.1	0.9	0.7 - 1.0	0.8	0.7 - 1.0	0.8	0.7 - 1.0	0.7	0.6 - 0.9	0.8	0.7 - 0.9
Immigrant	yes/no	0.6*	0.5 - 0.8	0.7*	0.6 - 0.9	0.8	0.6 - 1.0	0.8	0.6 - 1.0	0.7*	0.5 - 0.8	0.7*	0.6 - 0.9
Health related[3]													
Current smoking	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	1.2	1.0 - 1.5	1.2	1.0 - 1.5	0.9	0.8 - 1.1	0.9	0.7 - 1.1
Physical inactivity	yes/no	0.8	0.7 - 0.9	0.8	0.7 - 0.9	0.8	0.6 - 0.9	0.9	0.8 - 1.1	0.8	0.7 - 0.9	0.8	0.7 - 0.9
Obese	yes/no	1.2	1.0 - 1.5	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.9 - 1.2	1.1	0.9 - 1.3	1.0	0.8 - 1.1
Alcohol drink /week	9+/less	1.2	0.9 - 1.5	1.2*	1.0 - 1.6	1.3*	1.0 - 1.7	1.4*	1.2 - 1.8	1.2	1.0 - 1.5	1.5*	1.3 - 1.8
Alcohol 5+ at time	weekly/less	1.3*	1.0 - 1.5	1.4*	1.2 - 1.7	1.4*	1.2 - 1.7	1.2*	1.0 - 1.5	1.3*	1.1 - 1.5	1.3*	1.1 - 1.5

1. For sex group, females are the reference group
2. For background variables comparison groups, the second listed group for binary variables is the reference group
3. For health-related comparison groups, the second listed group for binary variables is the reference group

* Means that there are statistically significant difference compared with control groups

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Table 6: ~~Persons with ALI for which were impacted on~~ life style, socioeconomic status, and health care utilization of persons with an activity limiting injury before and after the injury, NPHS, Canada, 1994-2006

		Before % A	During % B	After % C	~~P~~p value* A vs B	B vs C	A vs C	N**
Risky behaviours and socioeconomic status								
Income	low	36.3	32.1	28.5	<0.001	<0.001	<0.001	2,892
Obese	obese	17.8	19.7	22.4	0.005	<0.001	<0.001	1,780
Physical activity	inactive	50.4	47.1	48.1	0.001	0.197	0.343	3,044
Smoking	current	19.0	18.5	18.2	0.265	0.384	0.077	1,693
Alcohol drinking	9+/wk	9.6	10.7	11.2	0.048	0.535	0.349	3,548
Health-related issues								
Limited activity	yes	18.7	25.5	26.3	<0.001	0.221	<0.001	3,657
Health status	poor	33.1	36.3	39.6	<0.001	<0.001	<0.001	3,653
Medical Doctor visits	5+/year	26.5	34.0	29.8	<0.001	<0.001	<0.001	3,616
Pain	yes	13.7	16.8	17.3	<0.001	0.432	<0.001	3,657
Stress	yes	29.7	31.3	29.4	0.104	0.050	0.757	2,967
Medication use in past 30 days before interview								
Pain medication	yes	61.9	70.2	70.8	<0.001	0.489	<0.001	3,640
Sedatives /tranquiliser	yes	5.7	7.2	8.1	0.001	0.055	<0.001	3,639
Antidepressants	yes	4.2	5.9	6.2	<0.001	0.346	0.403	3,641

*P value calculated by McNemar's test

** N of persons making up the matched analysis for the before and after analysis

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2, 3
Introduction			**Page 4**
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			**Page 5**
Study design	4	Present key elements of study design early in the paper	Page 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5, 6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 5, 6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	Page 5, 6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 7
Bias	9	Describe any efforts to address potential sources of bias	Page 7
Study size	10	Explain how the study size was arrived at	Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 7, 8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 7, 8
		(*b*) Describe any methods used to examine subgroups and interactions	Page 7, 8
		(*c*) Explain how missing data were addressed	Page 7, 8
		(*d*) If applicable, explain how loss to follow-up was addressed	Page 7, 8
		(*e*) Describe any sensitivity analyses	Page 7, 8
Results			Page 8

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 5, 6
		(b) Indicate number of participants with missing data for each variable of interest	Page 5, 6
		(c) Summarise follow-up time (eg, average and total amount)	Page 5, 6
Outcome data	15*	Report numbers of outcome events or summary measures over time	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 8, 9
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			Page 9-13
Key results	18	Summarise key results with reference to study objectives	Page 9, 10, 11
Limitations			Page 12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 9-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Impact of Activity-Limiting Injuries based on the Canadian National Population Health Survey 1994-2006

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Impact of Activity-Limiting Injuries based on the Canadian National Population Health Survey 1994-2006

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KEYWORDS Activity limiting injury; impact factors, longitudinal health survey; epidemiology; injury prevention; Canada.

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ABSTRACT

Objective: To examine the prevalence and factors affecting activity-limiting injuries (ALI) on individuals and on the Canadian population; to estimate the short and long term impact on health status and well-being due to ALI in Canada from 1994 to 2006 using the Canadian National Population Health Survey (NPHS).

Design: The NPHS is a randomised longitudinal cohort study with biennial interviews, with information on age, sex, education, marital status, income, residence, height and weight to self-perceived health status, health care utilization and medication use in addition to ALI.

Setting: The study population was a random sample of male and female participants 20 years and older from ten provinces and three territories in Canada.

Primary and secondary outcome measures: Logistic regression models were used to assess the potential impact of ALI on individuals and on the Canadian population. The interviews two years before and two years after the ALI were compared to examine long-term effects, and the McNemar test option in SAS was used for the matched analysis.

Results: The immediate impacts of ALI were pain, disability, and disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor visits. Population impact included a considerable increase in health care access and cost. The odds ratios (ORs) for the 20-39 age group compared to those 60+ was OR, 2.2; 95% CI, 1.8-2.7, while the OR associated with being male was 1.4; 95% CI, 1.1-1.6. Individuals consuming nine or more alcoholic drinks per week were also significantly more likely to report an ALI (OR, 1.5; 95% CI, 1.3-1.8).

Conclusion: The findings from this study illustrated the immediate and long term impact of individuals and population level injuries in Canada. Injury control policies should aim to prevent the both the number of injuries fatalities as well as the consequences among survivors.

Summary Boxes:

What is already known on this subject?

1. Activity-limiting injuries (ALI) burden such as increased steadily prevalence, mortality and economic costs in Canada;
2. Showing increasing trends in obesity, limited activity, poor health status, medication use related to ALI;
3. Nature and types related to ALI;

What does this study add?

1. Potential associations between health care utilization and ALI before and after injury;
2. Hospital admission, Department emergency and medical doctors visits impacted on ALI;

3. The immediate individuals impact such as pain, disability, disruption of regular life. Long-term effects in patients were sequelae, chronic pain, and increased medical doctor visits after ALI. Population impact included loss of productivity and a considerable increase in health care access and cost.
4. policies should aim to prevent both the number of injuries fatalities as well as the consequences among survivors.

Competing Interest:
None to declare.

Funding Statement:
This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Contributorship Statement:
Dr. Frank Mo, leader of the research project, and play the major role in research design, drafted the article and critical review, and advising for data analysis and results interpretation.
Dr. Ineke C. Neutel, contributed to data analysis, assisted in research design and data analysis, interpretation, and the report.
Dr. Howard Morrison, contributed to research consultation, provided critical review comments, and advising for data analysis and revised critically the article.
Mr. Doug Hopkins, assisted in research design, provided literature review and critical comments and signed final version of the manuscript.
Ms. Caroline Da Silva, participated in research design, provided critical review comments and signed final version of the manuscript.
Ms. Ying Jiang, contributed to research design, provided literature and critical review comments, and signed final version of the manuscript for submission.

INTRODUCTION

Injuries are a serious public health issue with a major impact on the lives of Canadians. They are leading causes of death and hospitalization, as well as of disability, loss of productivity and potential years of life lost (PYLL) [1-4]. Sequelae from injuries include activity limitation, functional disability and pain which in turn influence a variety of social, psychological, labour force, and economic factors [5-8]. An analysis of emergency department (ED) visits and hospitalisation admissions for Ontarionoted that one in four ED visits were injury-related, as were one in every 17 hospitalisations [9]. These data accentuated the importance of injuries to the health care system. Other studies have demonstrated the increasing medical doctor (MD) contacts, the use more medications for pain, more days in hospital, and more hours of home care services [9-11].

Several studies of traumatic disability have also focused on injuries resulting in hospitalization [12], types of injury [13-14], and serious head injuries [15]. One study reported that half of patients had some limitation in activity for two days or more due to injury, and patients treated in the clinic were somewhat more likely to have two or more days of limited activity than were patients treated in the ED [16].

Injuries are not only largely preventable, but the impact of injuries can usually be lessened. To develop effective policies leading to the prevention of injuries and to reduce the impact of injuries on society, information is needed about the influenced effects that individuals with injuries treated in the primary care setting and not requiring hospitalization frequently result in significant functional

impairment and to identify those injuries which, by virtue of their contribution to disability, would be targets for prevention programs.

The objectives of this study are to explore the immediate and longer term consequences of injury including physical, psychological, social and occupational functioning. This comprises a longitudinal population health study, which will measure the impact of injuries on individual's and population level health status and well-being due to activity-limiting injuries (ALI) in the NPHS from 1994 to 2006 in Canada.

METHODOLOGY

Study population

The source population for this study was the Canadian National Population Health Survey (NPHS), from1994/1995 (cycle 1) to 2006/2007 (cycle 7). The study population was designed to be representative of the Canadian population with the exception of persons living on Indian reserves or on Canadian Forces bases [9, 11]. The sample design was a multiple cluster [17], ideal for controlling costs when personal interviews are needed, as was the case for cycle 1 of the NPHS. To cover as much as possible of the Canadian population, separate components of the survey were also carried out in the Territories and in health care institutions. In the Territories, a simpler stratified design was used. As well, anticipating the creation of Nunavut, separate strata were formed for each of the future territories, Nunavut and NWT [17]. The sampling frame for the first cycle (1994/5) originated with the Canadian Labour Force Survey (CLFS), a multi-stage, stratified sampling technique used for all provinces except Quebec for which a provincial sampling frame was used [17]. From the 2000 cycle onward, additional

questions were added to the questionnaire, such as more detailed questions on health care use after the ALI, with the result that some analyses are restricted to data from 2000 to 2006

Nearly all respondents were re-interviewed biennially by telephone except for individuals without a telephone, for whom face to face interviews were used. Interviewers were instructed to follow all reasonable strategies to trace people. Response rates were 83.6% for cycle one, 92.8% for cycle two, 88.3% for cycle three, 84.9% for cycle four, 80.8% for cycle five, 77.6% for cycle six and 77.0% for cycle seven.

To look at ADIs resulting from new injuries, data for cycles from 1996 to 2006 were used; data for 1994 was only used for the "before and after" analysis (Table 6). Data were used from respondents who were willing to share their data for data analysis, who completed all interviews to date, and who achieved the age of 20 before 2006. Since the source population, i.e. the total NPHS population, covered more ages than the population analysed for this study, it was possible to add younger persons from the source population to our study population after the cycle at which they reached age of 20 years old. Consequently, the study population changed somewhat over the years of the study allowing comparable cross-sectional analysis of populations with the same age range and age distribution.

Variables

The interview ranged from background questions (age, sex, education, marital status, income, residence, height and weight) to health-related questions (self-perceived health status, health care utilization and medication use). Body mass index (BMI) was calculated as weight in kilograms divided

by height in meters squared [18]. A BMI of 30 or over was considered obese. Respondents were asked to rate their health as one of five categories: excellent, very good, good, fair or poor and for this study, the lower two categories were combined as poorer health and the top three as good health. Depression and stress were measured by the following questions: “have you had 2 weeks in a row during the past 12 months when you were sad, blue, or depressed?” and “During the past month, about how often did you feel: … so sad that nothing could cheer you up? ... nervous? ... restless or fidgety? ... hopeless?... worthless?”. A question about number of visits to any type of physician or medical specialist in the past year was dichotomized as: “five or more visits, versus fewer than five visits”. Alcohol consumption was based on a series of question on the number of drinks consumed each day of the past seven days before the interview. For this study, this was expressed as drinking nine or more drinks per week, versus drinking eight or less. In this study, “alcohol used 5+ at a time” was defined as "How often in the past week have you had 5 or more drinks on one occasion?". The variable “hospital treatment” was described as "Did you receive any medical attention for this injury from a health professional within 48 hours?" For example, doctor, hospital emergency room. Quartiles of total household income were calculated for the study population, with the lower two quartiles combined for the low income category to be compared to the top two as the high income category. A Physical activity index was calculated based on kilocalories per kilogram of body weight per day expended (KKD). Physically active was defined as energy expenditure of at least 3 KKD; and physically inactive was defined as less than 1.5 KKD. Medication use was elicited by the question: “In the past 30 days, did you take . . . ?’ This was followed by a series of questions, such as “Did you take antidepressants and or anti-stressants?” “Did you take anything for pain?” A 'no' answer to the question "Are you usually free of pain and discomfort?" was taken as indication that the respondent often suffered pain.

The definition of injury in the NPHS data was "In the past 12 months, did you have any injuries serious enough to limit your normal activities?" If more than one injury, the following questions were to refer to the most serious one. A separate question asked respondents a general question about limitations in activity, "Because of a long-term physical or mental condition or a health problem, have you limited in the kind or amount of activity you could do: at home? at school? at work? in other activities?". Otherwise, they should be defined as non-activity limiting.

Data Analysis

For the statistical analysis, SAS version 9.2 (SAS Institute, Cary, NC, USA) was used. Logistic regression was used to calculate odds ratios (OR) with the presence/absence of ALI as the dependent variable, adjusted for age (in single years) and sex. Since the data were collected as a statistical sample of the Canadian population, the 'weight' option was used in all SAS statistical analyses to make the results representative of the Canadian population from 1994 to 2006 in seven cycles of cross-sectional studies. Weights were provided by Statistics Canada according to their sampling procedures. In order to produce a meaningful estimate of the variance for the weighted results, the weights were adjusted using the formula: [average weight = (sample weight/sum of the sample weights) * sample size].

In order to determine the characteristics, life style and health status, medical attention and health care utilization as well as activity limitation and disability, which were impacted by ALI, all new injury cases, i.e., those who had not reported an injury in the previous interview were identified. For each new case, data from three cycles were selected, 1) the cycle before reporting, 2) the cycle of reporting, 3) the cycle after reporting. Data for the 1994 cycle were used only in this 'before and after' analysis. Only the first recorded ALI report per person was included. The McNemar test option in SAS was used for

matched analysis. This study approved by the research ethics committee of Health Canada.

RESULTS

The numbers of ALI in the study population increased from 755 cases in 1996 to 1,006 in 2006 .The weighted prevalence of all ALI increased steadily from 10.5% in 1996 to 12.8% in 2006. Those reporting ALI showed increasing trends in obesity, limited activity, poor health status, people who live in the rural areas and drank more than 9 drinks per week, medication use, and potential injury sequelae, such as pain, stress but declining trends in lower income, current smoking, and immigrants **(Table 1)**. The proportion of injuries which resulted in activity limitations were higher for males, and increased more over time than for females (**Table 2**). Furthermore, younger adults (20-49 yrs.) were more likely to report activity limiting injuries (12.2% to 14.0%) compared to older (50+ yrs.) adults (8.6% to 9.8%).Among respondents who reported a ALI, the weighted percentages who reported five or more visits to a medical doctor (MD) within the previous year decreased from 29.8% in 2000 to 25.3% in 2006, emergency department (ED) visits went from 34.0% to 28.8%, and hospital admission within 48 hours after the injury went from 6.5% to 4.9% (**Table 3**). The rate of hospital admissions within 48 hours for adults aged 50+ years was higher than that of young aged (20-49) group.

The most frequently reported injuries resulting in activity limitation were sprains and strains (42%), followed by fractures and dislocations (20%), and cuts, punctures and bites (10%) (T**able 4**). Only 3.3 to 5.0% of ALIs were in the category of brain, internal and multiple injuries. Men tended to have more cuts, punctures and bites while women had more scrapes, bruises and blisters. Younger ages tended to have more sprains and strains and older ages more fractures and dislocations.

Logistic regression analysis indicated that younger age groups and male participants were more impacted by ALI. Only a few of the other variables showed associations with ALI - immigrants had consistently lower rates of ALI, while people consumed nine or more alcoholic drinks per week had significantly higher rates (**Table 5**).

Attributes of persons with an ALI were compared in the cycles before and after their injury (**Table 6**). Most behavioural risk factors examined showed a pattern of an increase from the two years previous to the ALI to the time of the ALI to a further increase the two years after the ALI. A similar pattern was observed for health status and interactions with the health care system. (**Table 6**).

DISCUSSION

Based on NPHS data, more than 10% of the adult Canadian population annually experience an ALI, with the proportion increasing from 10.5% in 1996 to 12.8% in 2006. According to the definition of ALI as activity-limiting injuries, all people with ALI experienced a certain amount of disruption of their daily activities with the impact varying according to the type and severity of their injury and depending on their customary type of activity [19-22]. About 20% of ALIs were fractures and dislocations, many of whom necessitated a period of altered activity. Older people were more likely to report fractures than the younger age groups. The most common injuries were sprains and strains, the impact of which also varied a great deal depending on type and severity [23-24]. An important impact of injuries is on the workplace through absenteeism and on the family through the disruption of customary activities [25-26]. Besides the impact of injuries on every day activities, there was also the

impact on the health care system [27]. In our data, in 2000, about two thirds of people with ALI sought some kind of medical care. Evidence was presented showing that the impact of ALI might be even more far-reaching, as seen by the higher levels of medical care, and continued pain remaining two years after the ALI were reported.

Other research on injuries has used a variety of definition of injuries, based on different sources of information. Questions in the NPHS were able to put these other measures in perspective. For example, some studies used hospital-based data [28], but the present study showed that only about 5% of ALI were resulted in a hospital admission within the first 48 hours after the event. Assuming that all injuries that required hospitalization were within the activity-limiting rubric, it is clear that studies using only hospital data would include only a small portion of important injuries [29]. However, the hospitalized injuries will be the more severe injuries which are responsible for a disproportional share of the health care cost and disability [25]. Other studies have used ED visits as a unit of measurement [9]. The present study showed less than one third of ALI went to an ED to obtain treatment. Again, the latter were the more severe injuries or those needing specialized treatment, e.g., casts on fractures, and thus had a greater impact on daily life and cost. Another source of data commonly used has been mortality data. Although deaths are definitely activity-limiting, obviously, none were included in this study. Fatal injuries reflect a different range of injuries than those for ALI. For example, in an US study, firearm-related injuries were 22% of all injury deaths, second only to traffic accident related injuries, but firearms amounted to less than 1% for non-fatal injuries [11]. Thus, different measuring units for measuring injury rates will target different slices of the spectrum of injuries and provide different results. ALI are of special public health importance, but are not sufficiently studied.

Another level of impact resulting from ALI would consist of impact on the health care system. Approximately 60% of people with ALI obtained medical care of some type. Of these, approximately one third of persons with ALI went to ED to experience the often long wait before receiving treatment. Back at home the patient would not only experience the pain and disability of the ALI, but also the need to negotiate the health care system, such as making appointments with physicians, specialists, physiotherapists, etc., finding transportation, often needing someone to accompany them [30-33]. Even though the proportion of the population with ALI increased over the years 2000-2006, decreases were seen in use of primary care and the hospital ED visits as well as hospitalisation. This decrease in health care use could be an indication either of greater difficulty in accessing health care, or that the nature of ALIs has moderated over the years. Berdahl found variation by ethnic group and sex, both in the reporting of work-related injuries and in the seeking of medical care and the change in ethnic composition over the years could also be a factor in the NPHS data [34-36]. In any case, ALI are suffered by a large proportion of the population annually, and a majority of these seek medical treatment whether primary care, ED or hospital care. Clearly, this entails a large cost to the health care system and any prevention would not only improve quality of life of the putative victims but also would result in significantly lower health care costs.

Another type of impact would be long-term changes after the injury. The 'before and after' data available in the NPHS consisted of comparing the cross-sectional data from the interview cycle before the ALI with the data of the cycle reporting the ALI and with the next cycle after the ALI. While the interviews for each respondent could be linked for the 'before and after' cycles it was more difficult to

determine which changes in attributes in the year of the ALI or subsequent years were sequelea of the ALI. For example, it might make sense that the increasing obesity for people with ALI be linked to after-effects, e.g. [37], due to inactivity resulting from the ALI but, in fact, similar changes were happening in the overall population. Given these caveats, we can note that no changes were found for smoking and little change in excessive alcohol use. Most likely to show long-term effects due to ALI were visits to medical doctors and ongoing pain. People with ALI showed increasing likelihood of visiting a MD at least five times during the year which continued for the subsequent cycle. Similarly pain increased in the cycle with the ALI and remained high over the years. Although this is weak evidence, it confirms work on long-term effects of other researchers [38-39] and again emphasizes the impact of ALI in the population.

Injuries have been found to lead to lost productivity, medical costs, compensation costs and long-term health problems and disability [40-42], which was confirmed by the present results for the Canadian population. Many injuries can be prevented and a better understanding of all aspects of injuries will lead to better ways of prevention or the minimizing of their effects. However, collaboration and cooperation is needed [43]. The European Union has committed itself to reducing number of traffic fatalities from 45,000 to 25,000 by 2010, which as several reports point out, will require strong measures against use of alcohol [44-47] and illicit and medicinal drugs before driving [48]. A difficulty in injury prevention is the multi-faceted aspect of injuries. For example, a fall may have many causes, such as unsafe working conditions or slippery stairs at home. Each of these issues would require different approaches to prevention. Similar diversities are found for most other types of injuries. With all difficulties inherent in devising effective interventions, prevention is still the best approach to lower the

tremendous impact of ALI on the Canadian population.

The NPHS data have important strengths, such as its representativeness of the Canadian population and its longitudinal nature. Because of the longitudinal design, it was possible to identify new ALI, meaning no ALI in the previous interview, and compare risk factors before and after the event, as well as its consequences. The 'before and after' comparisons of the same person allowed for matched analysis at different times. Important also is the extensive and consistent information available on each respondent over the multiple cycles of the survey, such as type of ALI, and the medical care needed. Besides strengths, the NPHS also has limitations. One issue is the lack of distinction between intentional and unintentional injuries. Another issue is that of self-reported data. Part of self-reporting is recall of events. Recall of having had an ALI has been shown elsewhere to be less accurate with increasing time and is also likely to vary with the severity of the injury [49-50]. Both of these would likely lead to an under-reporting of ALI. In spite of its limitations the NPHS gives an invaluable view of the level of serious injury in the Canadian adult population over a 12 year time period.

Another strength of these data is the use of ALI as a measurement of injury. There are various units of measurement in measuring rates of injury in a population. The unit of measurement used in the present study consists of the most serious ALI over the previous 12 months, excluding repetitive strains injuries. The use of ALI means the delimitation of a particular kind of injury in the spectrum of injuries as a concept meaningful to both respondent and researchers. In addition, it identifies a type of injury sufficiently severe to impact a person's regular routine.

CONCLUSION

The findings from this study quantified the immediate and long term impact of individuals and population level injuries in Canada. The immediate impact was pain, disability, and disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor's visits remaining two years after the ALI. Population impact included loss of productivity and a considerable increase in health care access and cost. This study also particularly contributes to injury prevention in social and psychological health services to help injured people make a better recovery and maintain the quality of life after injuries.

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Table 1: The percent and univariate analyses of the characteristics related to adult Canadians reporting an activity limiting injury in the NPHS data, 1996-2006*

Year	1996	1998	2000	2002	2004	2006	2006/ 1996	P-value
All	10.5	10.9	11.4	12.6	12.6	12.8	1.22	0.048
Background variables								
Married/common law	71.0	69.3	68.2	66.2	65.7	64.7	0.91	0.063
Low income	40.0	34.2	27.9	26.0	23.5	19.8	0.50	0.039
Completed High School	89.6	89.9	89.3	84.7	84.5	84.5	0.94	0.068
Rural	17.9	20.5	21.0	20.6	19.9	22.0	1.23	0.041
Immigrant	17.5	17.3	16.8	16.2	16.1	15.7	0.90	0.081
Health related variables								
Current smoking	22.7	21.3	20.4	17.1	17.1	16.0	0.70	0.153
Inactive	58.3	52.9	56.1	48.3	51.0	45.9	0.79	0.098
Obese	18.4	21.2	23.0	24.3	25.0	26.4	1.43	0.001
9+ alcohol drinks/ week	11.0	11.6	11.9	11.8	11.6	14.8	1.35	0.001
Region of residence								
Atlantic	8.8	8.7	8.9	8.8	8.7	8.7	0.99	0.086
Quebec	25.5	25.6	25.9	26.0	26.1	25.9	1.01	0.078
Ontario	36.3	36.0	36.0	35.8	36.1	36.2	1.00	0.101
Prairies	17.0	17.3	17.1	17.4	17.3	17.4	1.02	0.098
BC	12.5	12.4	12.1	12.0	11.8	11.9	0.95	0.156
Outcome-related								
Limited activity	17.3	17.8	18.0	22.9	24.5	26.6	1.54	0.001
Poor health status	33.6	33.2	38.0	41.2	42.3	43.5	1.29	0.035
5+ Medical Doctor visits /year	24.2	26.3	26.6	27.6	28.3	26.8	1.11	0.056
Pain	12.3	13.7	13.3	15.1	16.4	15.8	1.28	0.039
Stress	26.3	29.2	25.1	27.3	28.3	27.4	1.04	0.083
Depression	6.1	5.8	6.4	6.9	7.1	6.0	0.98	0.158
Medication use in last 30 days								
Pain medication	65.6	67.5	70.1	70.2	70.4	70.6	1.08	0.096
Tranquilizer/ sedative	5.1	5.3	6.8	8.1	8.2	10.0	1.96	0.001
Antidepressants	3.6	4.4	5.4	5.9	6.9	7.0	1.94	0.001
Total Number[1]	7,313	7,529		7,717	7,875	8,085	8,324	

*Univariate analysis was used to compare the trend of ALI between 1996 and 2006 in the different characteristics; P value <0.05 means a significant difference between study and control groups.

[1] total number of survey respondents used to calculate weighted percentages representative of the Canadian population

Table 2: Percentages for ALI for which were impacted by activity limitation per year, NPHS, Canada, 2000-2006

Years		2000	2002	2004	2006
	Injury status				
All	None	85.5	84.0	84.0	82.2
	Activity limiting (yes)	10.8	12.1	11.6	12.0
	Activity limiting (no)	3.1	3.0	3.5	5.1
	Both	0.6	0.4	1.0	0.8
Males	None	84.9	82.0	82.2	80.1
	Activity limiting (yes)	10.5	13.5	13.2	13.2
	Activity limiting(no)	3.9	3.9	3.4	5.6
	Both	0.7	0.7	1.3	1.1
Females	None	86.0	85.8	85.7	84.1
	Activity limiting (yes)	11.1	10.8	10.1	10.9
	Activity limiting(no)	2.4	3.0	3.6	4.6
	Both	0.5	0.4	0.7	0.5
Ages 20-49	None	83.5	81.7	81.2	79.3
	Activity limiting (yes)	12.2	13.9	13.3	14.0
	Activity limiting(no)	3.5	3.7	4.3	5.8
	Both	0.8	0.7	1.3	0.9
Ages 50+	None	88.5	87.2	87.4	85.3
	Activity limiting (yes)	8.6	9.5	9.5	9.8
	Activity limiting (no)	2.6	3.1	2.5	4.2
	Both	0.3	0.3	0.6	0.6

Table 3: The percent of persons reporting specific health care use among those reporting an ALI by age group and sex, NPHS, Canada, 2000-2006*

Year		2000	2002	2004	2006
All	Number of ALI	865	932	913	1,005
	Medical Doctor (MD) visits (5+/year)	29.8	27.1	27.3	25.3
	Emergency Department (ED) visits	34.0	28.5	31.0	28.8
	Hospital admission in 48 hours	6.5	5.4	5.5	4.9
	Other	2.7	4.3	3.1	5.2
	Any	66.6	60.0	61.5	59.3
	None	33.5	40.1	38.5	40.7
Males	Number of ALI	394	460	463	482
	MD visits (5+/year)	26.6	26.5	24.7	23.6
	ED visits	34.5	27.4	30.8	29.7
	Hospital admission in 48 hours	9.5	4.5	4.6	4.1
	Other	4.1	4.0	2.9	5.3
	Any	65.2	57.8	58.4	58.5
	None	34.8	42.2	41.6	41.5
Females	Number of ALI	471	472	450	523
	MD visits (5+/year)	32.6	27.7	30.5	27.3
	ED visits	33.6	29.9	31.3	27.8
	Hospital admission in 48 hours	4.0	6.4	6.6	5.7
	Other	1.5	4.7	3.4	5.1
	Any	67.7	62.4	65.2	60.2
	None	32.3	37.6	34.8	39.7
Age 20-49	Number of ALI	588	601	564	590
	MD visits (5+/year)	29.1	27.7	28.5	24.3
	ED visits	34.3	27.6	28.7	27.3
	Hospital admission in 48 hours	6.2	4.1	2.9	3.6
	Other	2.5	4.1	3.1	7.3
	Any	65.8	59.3	3.2	58.9
	None	34.2	40.7	39.7	41.1
Age 50+	Number of ALI	277	331	349	415
	MD visits (5+/year)	31.5	25.8	25.3	26.9
	ED visits	33.6	30.6	34.9	31.1
	Hospital admission in 48 hours	7.3	8.1	9.9	6.9
	Other	3.2	4.9	3.2	1.9
	Any	61.4	59.3	63.5	59.9
	None	31.8	38.6	36.6	40.1

Table 4: The type of activity-limiting injury as a proportion of all activity-limiting injuries ALI NPHS, Canada, 1996-2006

	Interview cycles	1996	1998	2000	2002	2004	2006
N[2]	Number of ALI	755	786	865	931	911	1,006
		[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%
ALL	Brain, internal, multiple	4.9	3.3	5.8	3.2	3.9	4.3
	Fractures/dislocation	20.6	21.2	19.9	20.3	22.2	24.9
	Burns	5.3	3.3	4.3	2.8	4.3	3.7
	Sprains, strains	42.0	42.3	42.4	47.3	42.8	42.2
	Cuts, punctures, bites	10.2	15.5	11.8	11.6	11.1	9.7
	Scrapes, bruises, blisters	7.7	6.9	7.8	4.8	7.1	6.3
	Other	9.3	7.5	8.0	10.0	8.6	8.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0
Males	Brain, internal, multiple	5.4	2.8	5.0	2.4	4.1	4.5
	Fractures/dislocation	21.3	21.5	21.5	20.3	21.0	26.1
	Burns	5.8	2.4	3.9	3.5	4.6	2.7
	Sprains, strains	39.6	42.6	40.5	47.2	41.7	39.8
	Cuts, punctures, bites	12.2	17.4	16.7	13.9	13.6	13.1
	Scrapes, bruises, blisters	6.2	5.2	5.7	4.4	6.2	5.8
	Other	9.5	8.1	6.7	8.3	8.8	8.0
Females	Brain, internal, multiple	4.3	3.9	6.4	3.8	3.6	4.2
	Fractures/dislocation	19.8	21.0	18.5	21.6	23.6	23.3
	Burns	4.5	4.1	4.7	3.6	4.0	4.8
	Sprains, strains	45.0	41.9	44.1	46.0	44.3	44.9
	Cuts, punctures, bites	7.8	13.3	7.7	9.1	7.9	6.0
	Scrapes, bruises, blisters	9.5	8.9	9.5	6.4	8.2	7.0
	Other	9.1	6.9	9.1	9.5	8.4	9.8
Age 20-49	Brain, internal, multiple	4.8	3.3	4.9	3.1	3.7	3.0
	Fractures/dislocation	17.4	19.8	22.5	17.4	18.2	22.9
	Burns	5.5	3.3	4.1	3.5	5.0	4.8
	Sprains, strains	43.8	47.2	42.8	51.3	50.9	46.3
	Cuts, punctures, bites	10.9	15.5	11.5	10.7	9.4	9.4
	Scrapes, bruises, blisters	8.5	5.0	7.5	4.5	4.4	4.6
	Other	9.1	5.9	6.7	9.5	8.4	9.0
Age 50+	Brain, internal, multiple	5.4	3.4	7.6	3.4	4.2	6.3
	Fractures/dislocation	30.8	24.9	13.8	26.4	29.0	27.9
	Burns	4.3	3.0	4.9	1.4	3.3	1.9
	Sprains, strains	36.2	30.2	41.7	39.0	29.1	35.8

Cuts, punctures, bites	8.1	15.2	12.5	13.4	13.7	10.3
Scrapes, bruises, blisters	5.1	11.7	8.5	5.4	11.7	9.1
Other	10.1	11.6	11.0	11.0	9.0	8.7

[1] wt%--Weighted percentages making rates representative of the Canadian population

[2] Number of ALI in study population

Table 5: Odds ratios (OR) and 95% confidence interval (C.I.) of ALI by life style and socioeconomic status, adjusted for sex and age, NPHS, Canada, 1996-2006

		1996		1998		2000		2002		2004		2006	
		OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
	M/F	1.4*	1.1 - 1.6	1.3*	1.1 - 1.6	0.9	0.8 - 1.1	1.3*	1.1 - 1.5	1.4*	1.2 - 1.6	1.3*	1.1 - 1.4
Age groups													
	20-39	2.1*	1.6 - 2.9	1.9*	1.5 - 2.4	1.8*	1.4 - 2.3	2.2*	1.8 - 2.7	1.8*	1.5 - 2.2	2.2*	1.8 - 2.6
	40-59	1.6*	1.1 - 2.1	1.4*	1.1 - 1.8	1.3	1.0 - 1.6	1.6*	1.3 - 2.0	1.3	1.0 - 1.5	1.5*	1.2 - 1.8
	60+ (reference)	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~
Background variables[2]													
Married/ Common-law	yes/no	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.9 - 1.2	0.9	0.7 - 1.0	0.9	0.8 - 1.0
income	low/high	1.1	0.9 - 1.3	1.0	0.9 - 1.3	1.2	1.0 - 1.4	0.9	0.8 - 1.1	1.1	0.9 - 1.3	1.2	1.0 - 1.4
Completed High School	yes/no	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.8 - 1.2	0.9	0.8 - 1.1	0.9	0.7 - 1.0	1.1	0.9 - 1.3
Rural	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	0.9	0.7 - 1.1	1.1	0.9 - 1.3	0.8	0.7 - 1.0	1.0	0.8 - 1.1
Non-English	yes/no	0.9	0.7 - 1.1	0.9	0.7 - 1.0	0.8	0.7 - 1.0	0.8	0.7 - 1.0	0.7	0.6 - 0.9	0.8	0.7 - 0.9
Immigrant	yes/no	0.6*	0.5 - 0.8	0.7*	0.6 - 0.9	0.8	0.6 - 1.0	0.8	0.6 - 1.0	0.7*	0.5 - 0.8	0.7*	0.6 - 0.9
Health related[3]													
Current smoking	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	1.2	1.0 - 1.5	1.2	1.0 - 1.5	0.9	0.8 - 1.1	0.9	0.7 - 1.1
Physical inactivity	yes/no	0.8	0.7 - 0.9	0.8	0.7 - 0.9	0.8	0.6 - 0.9	0.9	0.8 - 1.1	0.8	0.7 - 0.9	0.8	0.7 - 0.9
Obese	yes/no	1.2	1.0 - 1.5	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.9 - 1.2	1.1	0.9 - 1.3	1.0	0.8 - 1.1
Alcohol drink /week	9+/less	1.2	0.9 - 1.5	1.2*	1.0 - 1.6	1.3*	1.0 - 1.7	1.4*	1.2 - 1.8	1.2	1.0 - 1.5	1.5*	1.3 - 1.8
Alcohol 5+ at a time	weekly/less	1.3*	1.0 - 1.5	1.4*	1.2 - 1.7	1.4*	1.2 - 1.7	1.2*	1.0 - 1.5	1.3*	1.1 - 1.5	1.3*	1.1 - 1.5

1. For sex group, females are the reference group
2. For background variables comparison groups, the second listed group for binary variables is the reference group
3. For health-related comparison groups, the second listed group for binary variables is the reference group

* Means that there are statistically significant difference compared with control groups

Table 6: life style, socioeconomic status, and health care utilization of persons with an activity limiting injury before and after the injury, NPHS, Canada, 1994-2006

		Before % A	During % B	After % C	p value* A vs B	p value* B vs C	p value* A vs C	N**
Risky behaviours and socioeconomic status								
Income	low	36.3	32.1	28.5	<0.001	<0.001	<0.001	2,892
Obese	obese	17.8	19.7	22.4	0.005	<0.001	<0.001	1,780
Physical activity	inactive	50.4	47.1	48.1	0.001	0.197	0.343	3,044
Smoking	current	19.0	18.5	18.2	0.265	0.384	0.077	1,693
Alcohol drinking	9+/week	9.6	10.7	11.2	0.048	0.535	0.349	3,548
Health-related issues								
Limited activity	yes	18.7	25.5	26.3	<0.001	0.221	<0.001	3,657
Health status	poor	33.1	36.3	39.6	<0.001	<0.001	<0.001	3,653
Medical Doctor visits	5+/year	26.5	34.0	29.8	<0.001	<0.001	<0.001	3,616
Pain	yes	13.7	16.8	17.3	<0.001	0.432	<0.001	3,657
Stress	yes	29.7	31.3	29.4	0.104	0.050	0.757	2,967
Medication use in past 30 days before interview								
Pain medication	yes	61.9	70.2	70.8	<0.001	0.489	<0.001	3,640
Sedatives /tranquiliser	yes	5.7	7.2	8.1	0.001	0.055	<0.001	3,639
Antidepressants	yes	4.2	5.9	6.2	<0.001	0.346	0.403	3,641

*P value calculated by McNemar's test

** N of persons making up the matched analysis for the before and after analysis

Impact of Activity-Limiting Injuries based on the Canadian National Population Health Survey 1994-2006

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ABSTRACT

Objective: To examine the prevalence and factors affecting activity-limiting injuries (ALI) on individuals and on the Canadian population; to estimate the short and long term impact on health status and well-being due to ALI in Canada from 1994 to 2006 using the Canadian National Population Health Survey (NPHS).

Design: The NPHS is a randomised longitudinal cohort study with biennial interviews, with information on age, sex, education, marital status, income, residence, height and weight to self-perceived health status, health care utilization and medication use in addition to ALI.

Setting: The study population was a random sample of male and female participants 20 years and older from ten provinces and three territories in Canada.

Primary and secondary outcome measures: Logistic regression models were used to assess the potential impact of ALI on individuals and on the Canadian population. The interviews two years before and two years after the ALI were compared to examine long-term effects, and the McNemar test option in SAS was used for the matched analysis.

Results: The immediate impacts of ALI were pain, disability, and disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor visits. Population impact included a considerable increase in health care access and cost. The odds ratios (ORs) for the 20-39 age group compared to those 60+ was OR, 2.2; 95% CI, 1.8-2.7, while the OR associated with being male was 1.4; 95% CI, 1.1-1.6. Individuals consuming nine or more alcoholic drinks per week were also significantly more likely to report an ALI (OR, 1.5; 95% CI, 1.3-1.8).

Conclusion: The findings from this study illustrated the immediate and long term impact of individuals and population level injuries in Canada. Injury control policies should aim to prevent the both the number of injuries fatalities as well as the consequences among survivors.

Summary Boxes:

What is already known on this subject?

1. Activity-limiting injuries (ALI) burden such as increased steadily prevalence, mortality and economic costs in Canada;
2. Showing increasing trends in obesity, limited activity, poor health status, medication use related to ALI;
3. Nature and types related to ALI;

What does this study add?

1. Potential associations between health care utilization and ALI before and after injury;
2. Hospital admission, Department emergency and medical doctors visits impacted on ALI;

3. The immediate individuals impact such as pain, disability, disruption of regular life. Long-term effects in patients were sequelae, chronic pain, and increased medical doctor visits after ALI. Population impact included loss of productivity and a considerable increase in health care access and cost.
4. policies should aim to prevent both the number of injuries fatalities as well as the consequences among survivors.

Competing Interest:
None to declare.

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Contributorship Statement:
Dr. Frank Mo, leader of the research project, and play the major role in research design, drafted the article and critical review, and advising for data analysis and results interpretation.
Dr. Ineke C. Neutel, contributed to data analysis, assisted in research design and data analysis, interpretation, and the report.
Dr. Howard Morrison, contributed to research consultation, provided critical review comments, and advising for data analysis and revised critically the article.
Mr. Doug Hopkins, assisted in research design, provided literature review and critical comments and signed final version of the manuscript.
Ms. Caroline Da Silva, participated in research design, provided critical review comments and signed final version of the manuscript.
Ms. Ying Jiang, contributed to research design, provided literature and critical review comments, and signed final version of the manuscript for submission.

INTRODUCTION

Injuries are a serious public health issue with a major impact on the lives of Canadians. They are leading causes of death and hospitalization, as well as of disability, loss of productivity and potential years of life lost (PYLL) [1-4]. Sequelae from injuries include activity limitation, functional disability and pain which in turn influence a variety of social, psychological, labour force, and economic factors [5-8]. An analysis of emergency department (ED) visits and hospitalisation admissions for Ontarionoted that one in four ED visits were injury-related, as were one in every 17 hospitalisations [9]. These data accentuated the importance of injuries to the health care system. Other studies have demonstrated the increasing medical doctor (MD) contacts, the use more medications for pain, more days in hospital, and more hours of home care services [9-11].

Several studies of traumatic disability have also focused on injuries resulting in hospitalization [12], types of injury [13-14], and serious head injuries [15]. One study reported that half of patients had some limitation in activity for two days or more due to injury, and patients treated in the clinic were somewhat more likely to have two or more days of limited activity than were patients treated in the ED [16].

Injuries are not only largely preventable, but the impact of injuries can usually be lessened. To develop effective policies leading to the prevention of injuries and to reduce the impact of injuries on society, information is needed about the influenced effects that individuals with injuries treated in the primary care setting and not requiring hospitalization frequently result in significant functional

impairment and to identify those injuries which, by virtue of their contribution to disability, would be targets for prevention programs.

The objectives of this study are to explore the immediate and longer term consequences of injury including physical, psychological, social and occupational functioning. This comprises a longitudinal population health study, which will measure the impact of injuries on individual's and population level health status and well-being due to activity-limiting injuries (ALI) in the NPHS from 1994 to 2006 in Canada.

METHODOLOGY

Study population

The source population for this study was the Canadian National Population Health Survey (NPHS), from1994/1995 (cycle 1) to 2006/2007 (cycle 7). The study population was designed to be representative of the Canadian population with the exception of persons living on Indian reserves or on Canadian Forces bases [9, 11]. The sample design was a multiple cluster [17], ideal for controlling costs when personal interviews are needed, as was the case for cycle 1 of the NPHS. To cover as much as possible of the Canadian population, separate components of the survey were also carried out in the Territories and in health care institutions. In the Territories, a simpler stratified design was used. As well, anticipating the creation of Nunavut, separate strata were formed for each of the future territories, Nunavut and NWT [17]. The sampling frame for the first cycle (1994/5) originated with the Canadian Labour Force Survey (CLFS), a multi-stage, stratified sampling technique used for all provinces except Quebec for which a provincial sampling frame was used [17]. From the 2000 cycle onward, additional

questions were added to the questionnaire, such as more detailed questions on health care use after the ALI, with the result that some analyses are restricted to data from 2000 to 2006

Nearly all respondents were re-interviewed biennially by telephone except for individuals without a telephone, for whom face to face interviews were used. Interviewers were instructed to follow all reasonable strategies to trace people. Response rates were 83.6% for cycle one, 92.8% for cycle two, 88.3% for cycle three, 84.9% for cycle four, 80.8% for cycle five, 77.6% for cycle six and 77.0% for cycle seven.

To look at ADIs resulting from new injuries, data for cycles from 1996 to 2006 were used; data for 1994 was only used for the "before and after" analysis (Table 6). Data were used from respondents who were willing to share their data for data analysis, who completed all interviews to date, and who achieved the age of 20 before 2006. Since the source population, i.e. the total NPHS population, covered more ages than the population analysed for this study, it was possible to add younger persons from the source population to our study population after the cycle at which they reached age of 20 years old. Consequently, the study population changed somewhat over the years of the study allowing comparable cross-sectional analysis of populations with the same age range and age distribution.

Variables

The interview ranged from background questions (age, sex, education, marital status, income, residence, height and weight) to health-related questions (self-perceived health status, health care utilization and medication use). Body mass index (BMI) was calculated as weight in kilograms divided

by height in meters squared [18]. A BMI of 30 or over was considered obese. Respondents were asked to rate their health as one of five categories: excellent, very good, good, fair or poor and for this study, the lower two categories were combined as poorer health and the top three as good health. Depression and stress were measured by the following questions: “have you had 2 weeks in a row during the past 12 months when you were sad, blue, or depressed?” and “During the past month, about how often did you feel: … so sad that nothing could cheer you up? ... nervous? ... restless or fidgety? ... hopeless?... worthless?”. A question about number of visits to any type of physician or medical specialist in the past year was dichotomized as: “five or more visits, versus fewer than five visits”. Alcohol consumption was based on a series of question on the number of drinks consumed each day of the past seven days before the interview. For this study, this was expressed as drinking nine or more drinks per week, versus drinking eight or less. In this study, “alcohol used 5+ at a time” was defined as "How often in the past week have you had 5 or more drinks on one occasion?". The variable “hospital treatment” was described as "Did you receive any medical attention for this injury from a health professional within 48 hours?" For example, doctor, hospital emergency room. Quartiles of total household income were calculated for the study population, with the lower two quartiles combined for the low income category to be compared to the top two as the high income category. A Physical activity index was calculated based on kilocalories per kilogram of body weight per day expended (KKD). Physically active was defined as energy expenditure of at least 3 KKD; and physically inactive was defined as less than 1.5 KKD. Medication use was elicited by the question: “In the past 30 days, did you take . . . ?’ This was followed by a series of questions, such as “Did you take antidepressants and or anti-stressants?” “Did you take anything for pain?” A 'no' answer to the question "Are you usually free of pain and discomfort?" was taken as indication that the respondent often suffered pain.

The definition of injury in the NPHS data was "In the past 12 months, did you have any injuries serious enough to limit your normal activities?" If more than one injury, the following questions were to refer to the most serious one. A separate question asked respondents a general question about limitations in activity, "Because of a long-term physical or mental condition or a health problem, have you limited in the kind or amount of activity you could do: at home? at school? at work? in other activities?". Otherwise, they should be defined as non-activity limiting.

Data Analysis

For the statistical analysis, SAS version 9.2 (SAS Institute, Cary, NC, USA) was used. Logistic regression was used to calculate odds ratios (OR) with the presence/absence of ALI as the dependent variable, adjusted for age (in single years) and sex. Since the data were collected as a statistical sample of the Canadian population, the 'weight' option was used in all SAS statistical analyses to make the results representative of the Canadian population from 1994 to 2006 in seven cycles of cross-sectional studies. Weights were provided by Statistics Canada according to their sampling procedures. In order to produce a meaningful estimate of the variance for the weighted results, the weights were adjusted using the formula: [average weight = (sample weight/sum of the sample weights) * sample size].

In order to determine the characteristics, life style and health status, medical attention and health care utilization as well as activity limitation and disability, which were impacted by ALI, all new injury cases, i.e., those who had not reported an injury in the previous interview were identified. For each new case, data from three cycles were selected, 1) the cycle before reporting, 2) the cycle of reporting, 3) the cycle after reporting. Data for the 1994 cycle were used only in this 'before and after' analysis. Only the first recorded ALI report per person was included. The McNemar test option in SAS was used for

matched analysis. This study approved by the research ethics committee of Health Canada.

RESULTS

The numbers of ALI in the study population increased from 755 cases in 1996 to 1,006 in 2006 .The weighted prevalence of all ALI increased steadily from 10.5% in 1996 to 12.8% in 2006. Those reporting ALI showed increasing trends in obesity, limited activity, poor health status, people who live in the rural areas and drank more than 9 drinks per week, medication use, and potential injury sequelae, such as pain, stress ~~and depression~~ but declining trends in lower income, ~~and~~ current smoking, and immigrants **(Table 1)**. The proportion of injuries which resulted in activity limitations were higher for males, and increased more over time than for females (**Table 2**). Furthermore, younger adults (20-49 yrs.) were more likely to report activity limiting injuries (12.2% to 14.0%) compared to older (50+ yrs.) adults (8.6% to 9.8%).Among respondents who reported a ALI, the weighted percentages who reported five or more visits to a medical doctor (MD) within the previous year decreased from 29.8% in 2000 to 25.3% in 2006, emergency department (ED) visits went from 34.0% to 28.8%, and hospital admission within 48 hours after the injury went from 6.5% to 4.9% (**Table 3**). The rate of hospital admissions within 48 hours for adults aged 50+ years was higher than that of young aged (20-49) group.

The most frequently reported injuries resulting in activity limitation were sprains and strains (42%), followed by fractures and dislocations (20%), and cuts, punctures and bites (10%) (T**able 4**). Only 3.3 to 5.0% of ALIs were in the category of brain, internal and multiple injuries. Men tended to have more cuts, punctures and bites while women had more scrapes, bruises and blisters. Younger ages tended to have more sprains and strains and older ages more fractures and dislocations.

Logistic regression analysis indicated that younger age groups and male participants were more impacted by ALI. Only a few of the other variables showed associations with ALI - immigrants had consistently lower rates of ALI, while people consumed nine or more alcoholic drinks per week had significantly higher rates (**Table 5**).

Attributes of persons with an ALI were compared in the cycles before and after their injury (**Table 6**). Most behavioural risk factors examined showed a pattern of an increase from the two years previous to the ALI to the time of the ALI to a further increase the two years after the ALI. A similar pattern was observed for health status and interactions with the health care system. (**Table 6**).

DISCUSSION

Based on NPHS data, more than 10% of the adult Canadian population annually experience an ALI, with the proportion increasing from 10.5% in 1996 to 12.8% in 2006. According to the definition of ALI as activity-limiting injuries, all people with ALI experienced a certain amount of disruption of their daily activities with the impact varying according to the type and severity of their injury and depending on their customary type of activity [19-22]. About 20% of ALIs were fractures and dislocations, many of whom necessitated a period of altered activity. Older people were more likely to report fractures than the younger age groups. The most common injuries were sprains and strains, the impact of which also varied a great deal depending on type and severity [23-24]. An important impact of injuries is on the workplace through absenteeism and on the family through the disruption of customary activities [25-26]. Besides the impact of injuries on every day activities, there was also the

impact on the health care system [27]. In our data, in 2000, about two thirds of people with ALI sought some kind of medical care. Evidence was presented showing that the impact of ALI might be even more far-reaching, as seen by the higher levels of medical care, and continued pain remaining two years after the ALI were reported.

Other research on injuries has used a variety of definition of injuries, based on different sources of information. Questions in the NPHS were able to put these other measures in perspective. For example, some studies used hospital-based data [28], but the present study showed that only about 5% of ALI were resulted in a hospital admission within the first 48 hours after the event. Assuming that all injuries that required hospitalization were within the activity-limiting rubric, it is clear that studies using only hospital data would include only a small portion of important injuries [29]. However, the hospitalized injuries will be the more severe injuries which are responsible for a disproportional share of the health care cost and disability [25]. Other studies have used ED visits as a unit of measurement [9]. The present study showed less than one third of ALI went to an ED to obtain treatment. Again, the latter were the more severe injuries or those needing specialized treatment, e.g., casts on fractures, and thus had a greater impact on daily life and cost. Another source of data commonly used has been mortality data. Although deaths are definitely activity-limiting, obviously, none were included in this study. Fatal injuries reflect a different range of injuries than those for ALI. For example, in an US study, firearm-related injuries were 22% of all injury deaths, second only to traffic accident related injuries, but firearms amounted to less than 1% for non-fatal injuries [11]. Thus, different measuring units for measuring injury rates will target different slices of the spectrum of injuries and provide different results. ALI are of special public health importance, but are not sufficiently studied.

Another level of impact resulting from ALI would consist of impact on the health care system. Approximately 60% of people with ALI obtained medical care of some type. Of these, approximately one third of persons with ALI went to ED to experience the often long wait before receiving treatment. Back at home the patient would not only experience the pain and disability of the ALI, but also the need to negotiate the health care system, such as making appointments with physicians, specialists, physiotherapists, etc., finding transportation, often needing someone to accompany them [30-33]. Even though the proportion of the population with ALI increased over the years 2000-2006, decreases were seen in use of primary care and the hospital ED visits as well as hospitalisation. This decrease in health care use could be an indication either of greater difficulty in accessing health care, or that the nature of ALIs has moderated over the years. Berdahl found variation by ethnic group and sex, both in the reporting of work-related injuries and in the seeking of medical care and the change in ethnic composition over the years could also be a factor in the NPHS data [34-36]. In any case, ALI are suffered by a large proportion of the population annually, and a majority of these seek medical treatment whether primary care, ED or hospital care. Clearly, this entails a large cost to the health care system and any prevention would not only improve quality of life of the putative victims but also would result in significantly lower health care costs.

Another type of impact would be long-term changes after the injury. The 'before and after' data available in the NPHS consisted of comparing the cross-sectional data from the interview cycle before the ALI with the data of the cycle reporting the ALI and with the next cycle after the ALI. While the interviews for each respondent could be linked for the 'before and after' cycles it was more difficult to

determine which changes in attributes in the year of the ALI or subsequent years were sequelea of the ALI. For example, it might make sense that the increasing obesity for people with ALI be linked to after-effects, e.g. [37], due to inactivity resulting from the ALI but, in fact, similar changes were happening in the overall population. Given these caveats, we can note that no changes were found for smoking and little change in excessive alcohol use. Most likely to show long-term effects due to ALI were visits to medical doctors and ongoing pain. People with ALI showed increasing likelihood of visiting a MD at least five times during the year which continued for the subsequent cycle. Similarly pain increased in the cycle with the ALI and remained high over the years. Although this is weak evidence, it confirms work on long-term effects of other researchers [38-39] and again emphasizes the impact of ALI in the population.

Injuries have been found to lead to lost productivity, medical costs, compensation costs and long-term health problems and disability [40-42], which was confirmed by the present results for the Canadian population. Many injuries can be prevented and a better understanding of all aspects of injuries will lead to better ways of prevention or the minimizing of their effects. However, collaboration and cooperation is needed [43]. The European Union has committed itself to reducing number of traffic fatalities from 45,000 to 25,000 by 2010, which as several reports point out, will require strong measures against use of alcohol [44-47] and illicit and medicinal drugs before driving [48]. A difficulty in injury prevention is the multi-faceted aspect of injuries. For example, a fall may have many causes, such as unsafe working conditions or slippery stairs at home. Each of these issues would require different approaches to prevention. Similar diversities are found for most other types of injuries. With all difficulties inherent in devising effective interventions, prevention is still the best approach to lower the

tremendous impact of ALI on the Canadian population.

The NPHS data have important strengths, such as its representativeness of the Canadian population and its longitudinal nature. Because of the longitudinal design, it was possible to identify new ALI, meaning no ALI in the previous interview, and compare risk factors before and after the event, as well as its consequences. The 'before and after' comparisons of the same person allowed for matched analysis at different times. Important also is the extensive and consistent information available on each respondent over the multiple cycles of the survey, such as type of ALI, and the medical care needed. Besides strengths, the NPHS also has limitations. One issue is the lack of distinction between intentional and unintentional injuries. Another issue is that of self-reported data. Part of self-reporting is recall of events. Recall of having had an ALI has been shown elsewhere to be less accurate with increasing time and is also likely to vary with the severity of the injury [49-50]. Both of these would likely lead to an under-reporting of ALI. In spite of its limitations the NPHS gives an invaluable view of the level of serious injury in the Canadian adult population over a 12 year time period.

Another strength of these data is the use of ALI as a measurement of injury. There are various units of measurement in measuring rates of injury in a population. The unit of measurement used in the present study consists of the most serious ALI over the previous 12 months, excluding repetitive strains injuries. The use of ALI means the delimitation of a particular kind of injury in the spectrum of injuries as a concept meaningful to both respondent and researchers. In addition, it identifies a type of injury sufficiently severe to impact a person's regular routine.

CONCLUSION

The findings from this study quantified the immediate and long term impact of individuals and population level injuries in Canada. The immediate impact was pain, disability, and disruption of regular life. Long-term effects in patients were chronic pain and increased medical doctor's visits remaining two years after the ALI. Population impact included loss of productivity and a considerable increase in health care access and cost. This study also particularly contributes to injury prevention in social and psychological health services to help injured people make a better recovery and maintain the quality of life after injuries.

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Table 1: The ~~estimated~~ percent and univariate analyses of the characteristics related to adult Canadians reporting an activity limiting injury in the ~~previous year based on~~ NPHS data, 1996-2006*

Year	1996	1998	2000	2002	2004	2006	2006/ 1996	P-value
All	10.5	10.9	11.4	12.6	12.6	12.8	1.22	0.048
Background variables								
Married/common law	71.0	69.3	68.2	66.2	65.7	64.7	0.91	0.063
Low income	40.0	34.2	27.9	26.0	23.5	19.8	0.50	0.039
Completed High School	89.6	89.9	89.3	84.7	84.5	84.5	0.94	0.068
Rural	17.9	20.5	21.0	20.6	19.9	22.0	1.23	0.041
Immigrant	17.5	17.3	16.8	16.2	16.1	15.7	0.90	0.081
Health related variables								
Current smoking	22.7	21.3	20.4	17.1	17.1	16.0	0.70	0.153
Inactive	58.3	52.9	56.1	48.3	51.0	45.9	0.79	0.098
Obese	18.4	21.2	23.0	24.3	25.0	26.4	1.43	0.001
9+ alcohol drinks/ week	11.0	11.6	11.9	11.8	11.6	14.8	1.35	0.001
Region of residence								
Atlantic	8.8	8.7	8.9	8.8	8.7	8.7	0.99	0.086
Quebec	25.5	25.6	25.9	26.0	26.1	25.9	1.01	0.078
Ontario	36.3	36.0	36.0	35.8	36.1	36.2	1.00	0.101
Prairies	17.0	17.3	17.1	17.4	17.3	17.4	1.02	0.098
BC	12.5	12.4	12.1	12.0	11.8	11.9	0.95	0.156
Outcome-related								
Limited activity	17.3	17.8	18.0	22.9	24.5	26.6	1.54	0.001
Poor health status	33.6	33.2	38.0	41.2	42.3	43.5	1.29	0.035
5+ Medical Doctor visits /year	24.2	26.3	26.6	27.6	28.3	26.8	1.11	0.056
Pain	12.3	13.7	13.3	15.1	16.4	15.8	1.28	0.039
Stress	26.3	29.2	25.1	27.3	28.3	27.4	1.04	0.083
Depression	6.1	5.8	6.4	6.9	7.1	6.0	0.98	0.158
Medication use in last 30 days								
Pain medication	65.6	67.5	70.1	70.2	70.4	70.6	1.08	0.096
Tranquilizer/ sedative	5.1	5.3	6.8	8.1	8.2	10.0	1.96	0.001
Antidepressants	3.6	4.4	5.4	5.9	6.9	7.0	1.94	0.001
Total Number[1]	7,313	7,529		7,717	7,875	8,085	8,324	

*Univariate analysis was used to compare the trend of ALI between 1996 and 2006 in the different characteristics : P value <0.05 means a significant difference between study and control groups.

[1] total number of survey respondents used to calculate weighted percentages representative of the Canadian population

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Table 3: The percent of persons reporting specific health care use among those reporting an ALI by age group and sex, NPHS, Canada, 2000-2006*

Year	-	2000	2002	2004	2006
All	Number of ALI	865	932	913	1,005
-	Medical Doctor (MD) visits (5+/year)	29.8	27.1	27.3	25.3
-	Emergency Department (ED) visits	34.0	28.5	31.0	28.8
-	Hospital admission in 48 hours	6.5	5.4	5.5	4.9
-	Other	2.7	4.3	3.1	5.2
-	Any	66.6	60.0	61.5	59.3
	None	33.5	40.1	38.5	40.7
Males	Number of ALI	394	460	463	482
	MD visits (5+/year)	26.6	26.5	24.7	23.6
	ED visits	34.5	27.4	30.8	29.7
	Hospital admission in 48 hours	9.5	4.5	4.6	4.1
	Other	4.1	4.0	2.9	5.3
	Any	65.2	57.8	58.4	58.5
	None	34.8	42.2	41.6	41.5
Females	Number of ALI	471	472	450	523
	MD visits (5+/year)	32.6	27.7	30.5	27.3
	ED visits	33.6	29.9	31.3	27.8
	Hospital admission in 48 hours	4.0	6.4	6.6	5.7
	Other	1.5	4.7	3.4	5.1
	Any	67.7	62.4	65.2	60.2
	None	32.3	37.6	34.8	39.7
Age 20-49	Number of ALI	588	601	564	590
-	MD visits (5+/year)	29.1	27.7	28.5	24.3
-	ED visits	34.3	27.6	28.7	27.3
-	Hospital admission in 48 hours	6.2	4.1	2.9	3.6
-	Other	2.5	4.1	3.1	7.3
-	Any	65.8	59.3	3.2	58.9
	None	34.2	40.7	39.7	41.1
Age 50+	Number of ALI	277	331	349	415
-	MD visits (5+/year)	31.5	25.8	25.3	26.9
-	ED visits	33.6	30.6	34.9	31.1
-	Hospital admission in 48 hours	7.3	8.1	9.9	6.9
-	Other	3.2	4.9	3.2	1.9
	Any	61.4	59.3	63.5	59.9
	None	31.8	38.6	36.6	40.1

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Table 2: Percentages for ALI for which were impacted by activity limitation per year, NPHS, Canada, 2000-2006

Years		2000	2002	2004	2006
	Injury status				
All	None	85.5	84.0	84.0	82.2
	Activity limiting (yes)	10.8	12.1	11.6	12.0
	Activity limiting (no)	3.1	3.0	3.5	5.1
	Both	0.6	0.4	1.0	0.8
Males	None	84.9	82.0	82.2	80.1
	Activity limiting (yes)	10.5	13.5	13.2	13.2
	Activity limiting(no)	3.9	3.9	3.4	5.6
	Both	0.7	0.7	1.3	1.1
Females	None	86.0	85.8	85.7	84.1
	Activity limiting (yes)	11.1	10.8	10.1	10.9
	Activity limiting(no)	2.4	3.0	3.6	4.6
	Both	0.5	0.4	0.7	0.5
Ages 20-49	None	83.5	81.7	81.2	79.3
	Activity limiting (yes)	12.2	13.9	13.3	14.0
	Activity limiting(no)	3.5	3.7	4.3	5.8
	Both	0.8	0.7	1.3	0.9
Ages 50+	None	88.5	87.2	87.4	85.3
	Activity limiting (yes)	8.6	9.5	9.5	9.8
	Activity limiting (no)	2.6	3.1	2.5	4.2
	Both	0.3	0.3	0.6	0.6

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	Other	3.2	4.9	3.2	1.9
	Any	61.4	59.3	63.5	59.9
	None	31.8	38.6	36.6	40.1

Table 4: The type of activity-limiting injury as a proportion of all activity-limiting injuries ALI NPHS, Canada, 1996-2006

	Interview cycles	1996	1998	2000	2002	2004	2006
N[2]	Number of ALI	755	786	865	931	911	1,006
		[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%	[1]wt%
ALL	Brain, internal, multiple	4.9	3.3	5.8	3.2	3.9	4.3
	Fractures/dislocation	20.6	21.2	19.9	20.3	22.2	24.9
	Burns	5.3	3.3	4.3	2.8	4.3	3.7
	Sprains, strains	42.0	42.3	42.4	47.3	42.8	42.2
	Cuts, punctures, bites	10.2	15.5	11.8	11.6	11.1	9.7
	Scrapes, bruises, blisters	7.7	6.9	7.8	4.8	7.1	6.3
	Other	9.3	7.5	8.0	10.0	8.6	8.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0
Males	Brain, internal, multiple	5.4	2.8	5.0	2.4	4.1	4.5
	Fractures/dislocation	21.3	21.5	21.5	20.3	21.0	26.1
	Burns	5.8	2.4	3.9	3.5	4.6	2.7
	Sprains, strains	39.6	42.6	40.5	47.2	41.7	39.8
	Cuts, punctures, bites	12.2	17.4	16.7	13.9	13.6	13.1
	Scrapes, bruises, blisters	6.2	5.2	5.7	4.4	6.2	5.8
	Other	9.5	8.1	6.7	8.3	8.8	8.0
Females	Brain, internal, multiple	4.3	3.9	6.4	3.8	3.6	4.2
	Fractures/dislocation	19.8	21.0	18.5	21.6	23.6	23.3
	Burns	4.5	4.1	4.7	3.6	4.0	4.8
	Sprains, strains	45.0	41.9	44.1	46.0	44.3	44.9
	Cuts, punctures, bites	7.8	13.3	7.7	9.1	7.9	6.0
	Scrapes, bruises, blisters	9.5	8.9	9.5	6.4	8.2	7.0
	Other	9.1	6.9	9.1	9.5	8.4	9.8
Age 20-49	Brain, internal, multiple	4.8	3.3	4.9	3.1	3.7	3.0
	Fractures/dislocation	17.4	19.8	22.5	17.4	18.2	22.9
	Burns	5.5	3.3	4.1	3.5	5.0	4.8
	Sprains, strains	43.8	47.2	42.8	51.3	50.9	46.3
	Cuts, punctures, bites	10.9	15.5	11.5	10.7	9.4	9.4
	Scrapes, bruises, blisters	8.5	5.0	7.5	4.5	4.4	4.6
	Other	9.1	5.9	6.7	9.5	8.4	9.0

Age 50+	Brain, internal, multiple	5.4	3.4	7.6	3.4	4.2	6.3
	Fractures/dislocation	30.8	24.9	13.8	26.4	29.0	27.9
	Burns	4.3	3.0	4.9	1.4	3.3	1.9
	Sprains, strains	36.2	30.2	41.7	39.0	29.1	35.8
	Cuts, punctures, bites	8.1	15.2	12.5	13.4	13.7	10.3
	Scrapes, bruises, blisters	5.1	11.7	8.5	5.4	11.7	9.1
	Other	10.1	11.6	11.0	11.0	9.0	8.7

[1] wt%--Weighted percentages making rates representative of the Canadian population
[2] Number of ALI in study population

Table 5: Odds ratios (OR) and 95% confidence interval (C.I.) of ALI by life style and socioeconomic status, adjusted for sex and age, NPHS, Canada, 1996-2006

		1996		1998		2000		2002		2004		2006	
		OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
	M/F	1.4*	1.1 - 1.6	1.3*	1.1 - 1.6	0.9	0.8 - 1.1	1.3*	1.1 - 1.5	1.4*	1.2 - 1.6	1.3*	1.1 - 1.4
Age groups													
	20-39	2.1*	1.6 - 2.9	1.9*	1.5 - 2.4	1.8*	1.4 - 2.3	2.2*	1.8 - 2.7	1.8*	1.5 - 2.2	2.2*	1.8 - 2.6
	40-59	1.6*	1.1 - 2.1	1.4*	1.1 - 1.8	1.3	1.0 - 1.6	1.6*	1.3 - 2.0	1.3	1.0 - 1.5	1.5*	1.2 - 1.8
	60+ (reference)	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~	*1.0*	~
Background variables[2]													
Married/ Common-law	yes/no	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.8 - 1.2	1.0	0.9 - 1.2	0.9	0.7 - 1.0	0.9	0.8 - 1.0
Income	low/high	1.1	0.9 - 1.3	1.0	0.9 - 1.3	1.2	1.0 - 1.4	0.9	0.8 - 1.1	1.1	0.9 - 1.3	1.2	1.0 - 1.4
Completed High School	yes/no	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.8 - 1.2	0.9	0.8 - 1.1	0.9	0.7 - 1.0	1.1	0.9 - 1.3
Rural	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	0.9	0.7 - 1.1	1.1	0.9 - 1.3	0.8	0.7 - 1.0	1.0	0.8 - 1.1
Non-English	yes/no	0.9	0.7 - 1.1	0.9	0.7 - 1.0	0.8	0.7 - 1.0	0.8	0.7 - 1.0	0.7	0.6 - 0.9	0.8	0.7 - 0.9
Immigrant	yes/no	0.6*	0.5 - 0.8	0.7*	0.6 - 0.9	0.8	0.6 - 1.0	0.8	0.6 - 1.0	0.7*	0.5 - 0.8	0.7*	0.6 - 0.9
Health related[3]													
Current smoking	yes/no	1.1	0.9 - 1.4	1.1	0.9 - 1.3	1.2	1.0 - 1.5	1.2	1.0 - 1.5	0.9	0.8 - 1.1	0.9	0.7 - 1.1
Physical inactivity	yes/no	0.8	0.7 - 0.9	0.8	0.7 - 0.9	0.8	0.6 - 0.9	0.9	0.8 - 1.1	0.8	0.7 - 0.9	0.8	0.7 - 0.9
Obese	yes/no	1.2	1.0 - 1.5	1.2	1.0 - 1.5	1.1	0.9 - 1.3	1.0	0.9 - 1.2	1.1	0.9 - 1.3	1.0	0.8 - 1.1
Alcohol drink /week	9+/less	1.2	0.9 - 1.5	1.2*	1.0 - 1.6	1.3*	1.0 - 1.7	1.4*	1.2 - 1.8	1.2	1.0 - 1.5	1.5*	1.3 - 1.8
Alcohol 5+ at a time	weekly/less	1.3*	1.0 - 1.5	1.4*	1.2 - 1.7	1.4*	1.2 - 1.7	1.2*	1.0 - 1.5	1.3*	1.1 - 1.5	1.3*	1.1 - 1.5

1. For sex group, females are the reference group
2. For background variables comparison groups, the second listed group for binary variables is the reference group
3. For health-related comparison groups, the second listed group for binary variables is the reference group

* Means that there are statistically significant difference compared with control groups

Table 6: life style, socioeconomic status, and health care utilization of persons with an activity limiting injury before and after the injury, NPHS, Canada, 1994-2006

		Before % A	During % B	After % C	p value* A vs B	p value* B vs C	p value* A vs C	N**
Risky behaviours and socioeconomic status								
Income	low	36.3	32.1	28.5	<0.001	<0.001	<0.001	2,892
Obese	obese	17.8	19.7	22.4	0.005	<0.001	<0.001	1,780
Physical activity	inactive	50.4	47.1	48.1	0.001	0.197	0.343	3,044
Smoking	current	19.0	18.5	18.2	0.265	0.384	0.077	1,693
Alcohol drinking	9+/week	9.6	10.7	11.2	0.048	0.535	0.349	3,548
Health-related issues								
Limited activity	yes	18.7	25.5	26.3	<0.001	0.221	<0.001	3,657
Health status	poor	33.1	36.3	39.6	<0.001	<0.001	<0.001	3,653
Medical Doctor visits	5+/year	26.5	34.0	29.8	<0.001	<0.001	<0.001	3,616
Pain	yes	13.7	16.8	17.3	<0.001	0.432	<0.001	3,657
Stress	yes	29.7	31.3	29.4	0.104	0.050	0.757	2,967
Medication use in past 30 days before interview								
Pain medication	yes	61.9	70.2	70.8	<0.001	0.489	<0.001	3,640
Sedatives /tranquiliser	yes	5.7	7.2	8.1	0.001	0.055	<0.001	3,639
Antidepressants	yes	4.2	5.9	6.2	<0.001	0.346	0.403	3,641

*P value calculated by McNemar's test

** N of persons making up the matched analysis for the before and after analysis

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2, 3
Introduction			**Page 4**
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			**Page 5**
Study design	4	Present key elements of study design early in the paper	Page 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5, 6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 5, 6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	Page 5, 6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 7
Bias	9	Describe any efforts to address potential sources of bias	Page 7
Study size	10	Explain how the study size was arrived at	Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 7, 8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 7, 8
		(*b*) Describe any methods used to examine subgroups and interactions	Page 7, 8
		(*c*) Explain how missing data were addressed	Page 7, 8
		(*d*) If applicable, explain how loss to follow-up was addressed	Page 7, 8
		(*e*) Describe any sensitivity analyses	Page 7, 8
Results			Page 8

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 5, 6
		(b) Indicate number of participants with missing data for each variable of interest	Page 5, 6
		(c) Summarise follow-up time (eg, average and total amount)	Page 5, 6
Outcome data	15*	Report numbers of outcome events or summary measures over time	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 8, 9
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			Page 9-13
Key results	18	Summarise key results with reference to study objectives	Page 9, 10, 11
Limitations			Page 12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 9-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 3

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.