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Canada

Fall-related injuries among Canadian seniors, 2005–2013: an analysis of the Canadian Community Health Survey

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Abstract

Introduction: We describe the epidemiology and trends of fall-related injuries among Canadian seniors aged 65 years and older by sex and age, as well as the circumstances and consequences of their injuries.

Methods: We analyzed nationally representative data from the 2005, 2009/2010 and 2013 samples of the Canadian Community Health Survey to calculate the number and rates of fall-related injuries for each survey year. Where possible, we combined data from two or more samples to estimate the proportion of fall-related injuries by type of injury, part of body injured, type of activity and type of treatment.

Results: The rate of fall-related injuries among seniors increased from 49.4 to 58.8 per 1000 population between 2005 and 2013, during which the number of fall-related injuries increased by 54% overall. Women had consistently higher rates than men across all survey years, while rates increased with advancing age. The upward trend in fall-related injury rates was more prominent among women and younger age groups. The most common type of injury was broken or fractured bones (37%), and the shoulder or upper arm (16%) was the most commonly injured body part. Many fall-related injuries occurred while walking on a surface other than snow or ice (45%). Over 70% of seniors seeking treatment for their injuries visited a hospital emergency department.

Conclusion: Given the increase in both the number and rates of fall-related injuries over time, there is a need to continue monitoring trends and injury patterns associated with falls.

Keywords: *falls, unintentional injuries, seniors, Canada*

Key findings

- Between 2005 and 2013, the rate of fall-related injuries among Canadian seniors aged 65 years or older increased from 49.4 to 58.8 per 1000 population.
- Fall-related injuries are more common in women and in older age groups.
- A significant increase in the rate of fall-related injury between 2005 and 2013 was observed in women and in those aged less than 75 years.
- Fractures accounted for 37% of all injuries due to falls, highlighting the importance of bone health.
- More years of survey data are needed to assess longer-term trends of fall-related injuries among seniors.

Introduction

Each year, about one in three seniors experience at least one fall.[1-5] In 2008–2009, 20% of Canadians aged 65 years or older who were living in the community reported falling in the previous year.[6] This prevalence increased with age, from 17% among those aged 65 to 69 years to 27% among those aged 85 years or older.[6]

Falls are also the leading cause of injury-related hospitalizations among Canadian seniors.[7] They result in an average length of hospital stay of approximately 3 weeks, which is 75% longer than the average length of stay for all causes of hospitalization combined.[7] Fall-related injuries are associated with significant disability, reduced mobility and independence, higher likelihood of admission to a nursing home and increased risk of premature death.[8,9] Falls are responsible for 95% of hip fractures in older adults,[10] leading to death in more than 20% of cases.[11]

Even in the absence of injuries, falls may have long-term psychological consequences, such as depression, fear of falling and loss of confidence. These, in turn, lead to restriction in daily and social activities and, subsequently, declines in health and function and increased risk of future falls.[12-14]

In addition to increased morbidity and mortality, fall-related injuries pose an economic burden on the health care system.[15-18] In Canada, direct medical costs associated with falls among seniors were estimated at over $2 billion in 2004.[19] This figure is expected to rise substantially as the number of Canadians aged 65 years or older is projected to more than double, from 5 million (15%) in 2011[20] to nearly 11 million (25%) in 2036.[21]

In April 2014, the Public Health Agency of Canada released its second report on falls among seniors.[7] The report provided an

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overview of risk factors for falls and presented national estimates of fall-related injuries derived from survey, hospitalization and mortality data. Specifically, data from the Canadian Community Health Survey (CCHS) showed that the number of seniors self-reporting injuries due to falls increased from about 179 000 to 256 000 (43%) between 2003 and 2009/2010.[7] In addition, the rate of fall-related injuries was significantly higher in women than men across all survey years.[7] With data newly available from the 2013 CCHS, an updated analysis is warranted to describe the current state of fall-related injuries among Canadian seniors.

This study aims to (1) provide the most recent national estimates of the number and rates of self-reported fall-related injuries by sex and age and estimate trends between 2005 and 2013, (2) compare the distribution of key demographic characteristics between seniors with and without a fall-related injury, and (3) describe injury characteristics associated with falls, including the nature and circumstances of injury, as well as health care utilization following a fall-related injury.

Methods

Data source

We used nationally representative data from the CCHS for the years 2005, 2009/2010 (combined) and 2013. The CCHS is a cross-sectional survey that collects information on the health status, health care utilization and health determinants of the Canadian population. Using a multistage stratified design, the CCHS targeted individuals aged 12 years and older living in private dwellings across the 10 provinces and 3 territories of Canada. People living on Indian reserves or Crown lands, residents of institutions, full-time members of the Canadian Forces and residents of certain remote regions were excluded. Three sampling frames were used to select the sample of households, with 99% coming from an area frame or a list frame of telephone numbers and the remaining 1% from a random digit-dialling frame. All surveys were conducted using computer-assisted personal or telephone interviewing. The response rates for the 2005, 2009/2010 and 2013 CCHS were 78.9%, 72.3% and 66.8%, respectively. Since 2007, instead of a 1-year collection period with data released every 2 years, CCHS data have been collected continually and released annually (or biannually as a 2-year data file).

Our analyses did not include data from the 2007/2008 and 2011/2012 surveys as information on injuries was collected only in certain provinces or territories in those years (British Columbia and Nova Scotia in 2007/2008; Alberta and Northwest Territories in 2011/2012). Moreover, since data from the 2014 CCHS were still being collected at the time of our analyses, the most recent estimates were derived from the annual data file of 2013, which consisted of a smaller sample compared to the 2005 and 2009/2010 samples. A detailed description of the CCHS, including background and methodology, can be found elsewhere.[22-24]

We obtained study samples from the CCHS share files that contain records of all respondents who agreed to share their data with the Public Health Agency of Canada. This represented approximately 95% of the full sample for each survey year. Very small differences in the distribution of variables were observed between the share file and the master file containing the full CCHS sample.[24] For the purpose of this study, the samples were restricted to respondents aged 65 years or older ($n = 26\,188$ in 2005; $n = 28\,379$ in 2009/2010; $n = 17\,290$ in 2013).

Fall-related injury

The Injuries module of the CCHS included a question that asked respondents if they had sustained an injury serious enough to limit their normal activities (e.g. a broken bone, a bad cut, a burn or a sprain) in the previous year. Those who answered ''yes'' to the question ''In the past 12 months, were you injured?'' were asked about their most serious injury, including whether that injury was a result of a fall. Those who responded ''yes'' were identified as having a fall-related injury. Information on the type of injury, the part of the body injured, the type of activity associated with the fall and the type of treatment received within 48 hours of injury was collected using questions with a predefined list of responses.

Demographic characteristics

The demographic characteristics examined included

- sex;
- age (65–69, 70–74, 75–79, 80–84, 85–89, and $\geq$ 90 years);
- marital status (married/common-law, widowed, separated/divorced, and single/never married);
- highest level of education attained (less than secondary school graduation, secondary school graduation, some post-secondary, and post-secondary graduation) and
- household income ($<$ \$15 000, \$15 000–\$29 999, \$30 000–\$49 999, \$50 000–\$79 999, and $\geq$ \$80 000).

For ease of comparison, these variables were categorized according to the Public Health Agency of Canada's report.[7] Respondents with missing data (i.e. unknown or refused to answer) on each variable were included as a separate category, with the exception of household income, for which missing data ($\sim$ 20%) were imputed by Statistics Canada using a nearest neighbour imputation method.[25]

Statistical analyses

We used descriptive statistics to examine the distribution of demographic characteristics by fall-related injury status in each survey sample. The Rao-Scott chi-square test, which is the equivalent of a Pearson chi-square test adjusted for design effects of the survey,[26] was used to test differences in the distribution of characteristics between seniors with and without a fall-related injury. The frequency and prevalence rate (number of people reporting an injury due to a fall during the previous year, per 1000 population) of fall-related injuries were also determined for each survey sample, with further stratification by sex and age group. To examine trends over time, we

used z-tests to assess differences in rates between successive survey samples, as well as between the 2005 and 2013 samples. All tests were two-sided, and a p value of $< .05$ was considered statistically significant. Due to small numbers in some categories, data from at least two of the three survey samples were combined[27] to calculate the proportion of fall-related injuries by type of injury, part of body injured, type of activity, and type of treatment.

To account for the complex sampling design of the CCHS (e.g. adjustments for non-response, under-coverage and post-stratification) and to obtain estimates representative of the Canadian population, we used sampling weights in all the

TABLE 1
Demographic characteristics of seniors, ≥ 65 years, by fall-related injury status, Canada, CCHS 2005, 2009/2010, 2013

Characteristics	CCHS 2005				CCHS 2009/2010				CCHS 2013			
	Without a fall-related Injury		With a fall-related Injury		Without a fall-related Injury		With a fall-related Injury		Without a fall-related Injury		With a fall-related Injury	
	n	%	n	%	n	%	n	%	n	%	n	%
Total sample (unweighted)	24 809		1379		26 743		1636		16 303		987	
Total population (weighted)	3 734 171		194 135		4 198 003		256 011		4 797 658		299 769	
Sex*												
Male	1 686 873	45.2	61 034	31.4	1 918 788	45.7	93 090	36.4	2 231 422	46.5	99 435	33.2
Female	2 047 298	54.8	133 102	68.6	2 279 215	54.3	162 921	63.6	2 566 236	53.5	200 334	66.8
Age, years*												
65–69	1 162 501	31.1	49 181	25.3	1 415 712	33.7	74 185	29.0	1 672 895	34.9	98 187	32.8
70–74	987 761	26.5	41 277	21.3	1 005 525	24.0	47 348	18.5	1 165 446	24.3	68 557	22.9
75–79	768 719	20.6	46 186	23.8	841 906	20.1	55 126	21.5	907 011	18.9	47 693	15.9
80–84	519 888	13.9	29 353	15.1	570 275	13.6	36 653	14.3	613 432	12.8	44 021	14.7
85–89	225 167	6.0	20 099	10.4	273 249	6.5	32 484	12.7	320 060	6.7	30 437	10.2
≥ 90	70 134	1.9	8040	4.1[E]	91 336	2.2	10 215	4.0[E]	118 815	2.5	10 874	3.6[E]
Marital status*												
Married/common-law	2 334 287	62.5	100 592	51.8	2 670 783	63.6	143 006	55.9	3 112 314	64.9	160 737	53.6
Widowed	980 197	26.2	69 984	36.0	989 597	23.6	79 415	31.0	999 912	20.8	82 685	27.6
Separated/divorced	240 658	6.4	14 570	7.5	342 082	8.1	23 245	9.1	446 792	9.3	38 582	12.9
Single, never married	176 653	4.7	8907	4.6	185 020	4.4	10 344	4.0	232 313	4.8	17 766	5.9[E]
Not stated[a]	2376	0.1[E]	x	x	10 521	0.3[E]	0	0.0	x	x	0	0.0
Education												
< Secondary school graduation	1 522 865	40.8	76 403	39.4	1 433 432	34.1	76 714	30.0	1 476 635	30.8	89 869	30.0
Secondary school graduation	495 206	13.3	28 856	14.9	618 242	14.7	41 275	16.1	896 124	18.7	53 225	17.8
Some post-secondary	186 005	5.0	11 481	5.9	227 552	5.4	15 901	6.2	158 172	3.3	8962	3.0[E]
Post-secondary graduation	1 395 142	37.4	72 526	37.4	1 763 707	42.0	112 140	43.8	2 152 020	44.9	137 858	46.0
Not stated[a]	134 952	3.6	x	x	155 070	3.7	9981	3.9[E]	114 707	2.4	9855	3.3[E]
Household income, $[b]												
< 15 000	405 814	10.9	28 492	14.7	279 721	6.7	19 440	7.6	213 042	4.4	18 142	6.1[E]
15 000–29 999	1 243 428	33.3	60 838	31.3	1 114 828	26.6	66 769	26.1	1 239 972	25.8	82 199	27.4
30 000–49 999	1 031 015	27.6	50 514	26.0	1 237 856	29.5	74 692	29.2	1 310 159	27.3	79 782	26.6
50 000–79 999	691 384	18.5	34 917	18.0	916 035	21.8	55 819	21.8	1 109 802	23.1	75 191	25.1
≥ 80 000	362 531	9.7	19 375	10.0	649 564	15.5	39 291	15.3	924 683	19.3	44 455	14.8

Source: Canadian Community Health Survey (2005, 2009/2010, 2013), Statistics Canada.

Abbreviation: CCHS, Canadian Community Health Survey.

Notes: Unless otherwise specified, all estimates (numbers and percentages) were weighted using sampling weights provided by Statistics Canada. Due to rounding, numbers may not sum up to the total population and percentages may not sum up to 100%.

[a] "Not stated" includes all responses categorized as "don't know," "refusal," or "not stated".

[b] Missing data on household income were imputed using a nearest neighbour imputation method.[25]

[E] Estimate is associated with high sampling variability (i.e. coefficient of variation is between 16.6% and 33.3%) – interpret with caution.

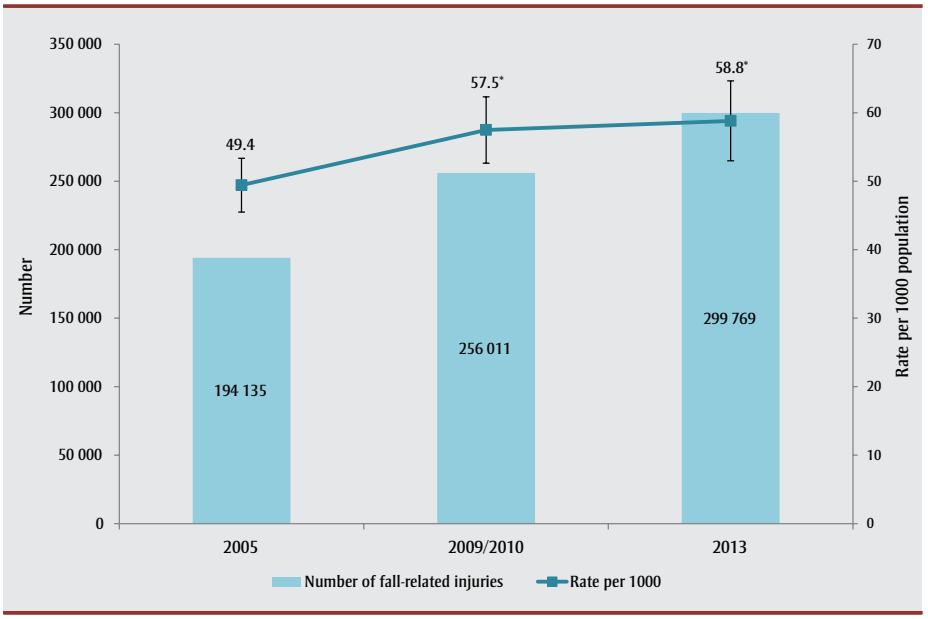
"x" indicates that the data do not meet standards for reportability due to extreme variability (coefficient of variation > 33.3%).

* Significant difference ($p < .05$) in the distribution of the characteristic between those with a fall-related injury and those without a fall-related injury for all 3 survey samples.

analyses.[24] Variance estimates, including 95% confidence intervals (CIs) and coefficients of variation (CVs), were calculated using the bootstrap technique and the BOOTVAR 3.2 program developed by Statistics Canada.[28] The bootstrap technique involves a repeated process of selecting simple random samples (n = 500) from the CCHS dataset, recalculating sampling weights for each selected subsample, and post-stratifying weights for each stratum to obtain the final bootstrap weights.[24,28] Estimates are reported according to Statistics Canada's sampling variability guidelines:[24] those with a CV between 16.6% and 33.3% are flagged to be interpreted with caution due to high sampling variability, while those with a CV greater than 33.3% are not reported due to extreme variability.

All analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, North Carolina, USA).

FIGURE 1
Numbers and rates of fall-related injuries, ≥ 65 years, Canada, CCHS 2005, 2009/2010, 2013



Source: Canadian Community Health Survey (2005, 2009/2010, 2013), Statistics Canada.
Abbreviation: CCHS, Canadian Community Health Survey.
Notes: Numbers and rates (per 1000 population) of fall-related injuries were calculated using sampling weights. Error bars represent 95% confidence intervals of rates of fall-related injuries, computed using the bootstrap technique.
* Significantly different from the 2005 estimate ($p < .05$) based on the z-test for proportions.

Results

The number of respondents aged 65 years or older in the 2005, 2009/2010 and 2013 CCHS samples were 26 188, 28 379 and 17 290, respectively. This represented a total population of community-dwelling Canadian seniors of about 3.9 million in 2005 and 5.1 million in 2013.

Table 1 shows the distribution of demographic characteristics among respondents with or without a fall-related injury in each of the three CCHS samples. For all survey years, fall-related injury status in the previous 12 months differed by sex, age and marital status ($p < .05$). Compared to those without a fall-related injury, seniors reporting a fall-related injury were more likely to be women, to be older and to be widowed and less likely to be married. We did not observe any statistically significant differences by education level or household income for any of the three samples.

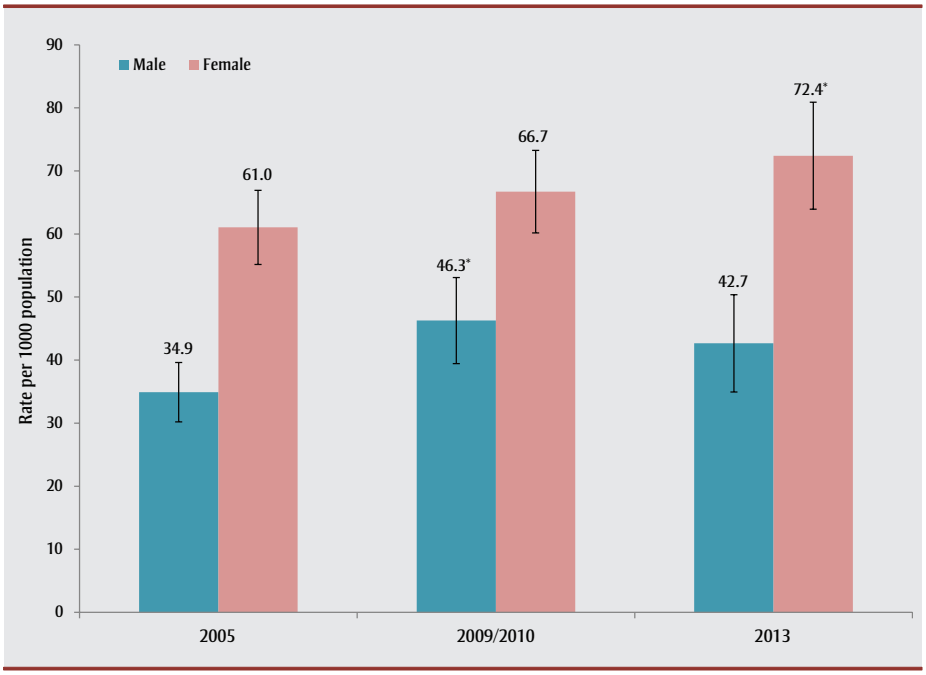
Rates and trends

Figure 1 shows the estimated numbers and rates of fall-related injuries among Canadian seniors across all survey years. In 2005, 194 135 Canadians aged 65 years or older reported being injured due to a fall in the previous 12 months. This number increased to 256 011 in 2009/2010 and 299 769 in 2013, with an overall increase of 54% from 2005 to 2013. A similar upward trend was observed in the rate of fall-related injuries, from 49.4 (95% CI: 45.5–53.3) per 1000 population in 2005 to 57.5 (95% CI: 52.6–62.3) per 1000 in 2009/2010 and 58.8 (95% CI: 53.0–64.6) per 1000 in 2013. Compared to 2005, the rate estimate was significantly higher in 2013 ($p = .01$). Of note, while the increase in rate between 2005 and 2009/2010 was statistically significant (8.1 per 1000, $p = .01$), the rate appeared to level off, with only a small and non-significant increase between 2009/2010 and 2013 (1.3 per 1000, $p = .72$).

Figure 2 shows rates of fall-related injuries by sex and survey year. Based on non-overlapping CIs, women had significantly higher rates of fall-related injuries than men across all survey years, with female-to-male ratios ranging from 1.4 to 1.7. Fall-related injury rates for women increased steadily from 61.0 (95% CI: 55.2–66.9) per 1000 in 2005 to 72.4 (95% CI: 63.9–80.9) per 1000 in 2013 ($p = .03$ for 2013 vs. 2005). On the other hand, whereas men experienced a marked increase between 2005 and 2009/2010, from 34.9 (95% CI: 30.2–39.6) per 1000 to 46.3 (95% CI: 39.5–53.1) per 1000 ($p = .007$), there was a small but non-significant decrease between 2009/2010 and 2013, to a rate of 42.7 (95% CI: 35.0–50.4) per 1000 in 2013. Unlike for women, the difference in rates between the 2005 and 2013 samples was not statistically significant for men ($p = .10$).

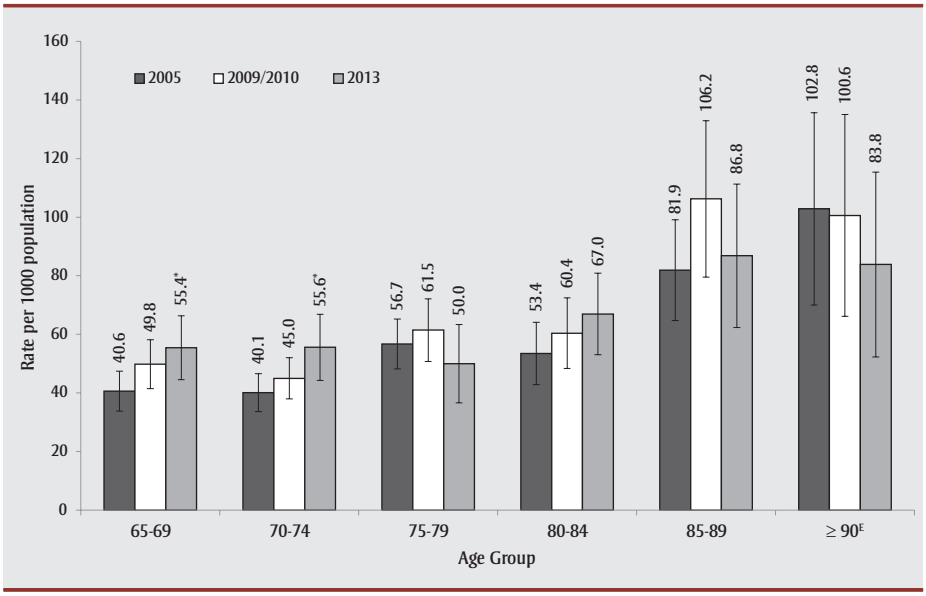
Figure 3 shows rates of fall-related injuries by 5-year age groups and survey year. In general, the rate of fall-related injuries increased with advancing age in all survey years, with a larger increase from the 80–84 to the 85–89 age group. From 2005 to 2013, a significant upward trend was seen among those aged 65–69 and 70–74 years ($p = .02$ for both), while a non-significant decline was noted in the oldest age group (i.e. ≥ 90 years). Moreover, in 2005, the rate of fall-related injuries among seniors aged 90 years or older was 2.5 times that among those aged 65 to 69 years (102.8 vs. 40.6 per 1000), but this ratio decreased to 2.0 in 2009/2010 (100.6 vs.

FIGURE 2
Rates of fall-related injuries by sex, ≥ 65 years, Canada, CCHS 2005, 2009/2010, 2013



Source: Canadian Community Health Survey (2005, 2009/2010, 2013), Statistics Canada.
Abbreviation: CCHS, Canadian Community Health Survey.
Notes: Rates of fall-related injuries were calculated per 1000 population using sampling weights. Error bars represent 95% confidence intervals computed using the bootstrap technique.
* Significantly different from the 2005 estimate ($p < .05$) based on the z-test for proportions.

FIGURE 3
Rates of fall-related injuries by age group, ≥ 65 years, Canada, CCHS 2005, 2009/2010, 2013



Source: Canadian Community Health Survey (2005, 2009/2010, 2013), Statistics Canada.
Abbreviation: CCHS, Canadian Community Health Survey.
Notes: Rates of fall-related injuries were calculated per 1000 population using sampling weights. Error bars represent 95% confidence intervals computed using the bootstrap technique.
E Estimates for the 2009/2010 and 2013 samples are associated with high sampling variability (i.e. coefficient of variation is between 16.6% and 33.3%) – interpret with caution.
* Significantly different from the 2005 estimate ($p < .05$) based on the z-test for proportions.

49.8 per 1000) and 1.5 in 2013 (83.8 vs. 55.4 per 1000).

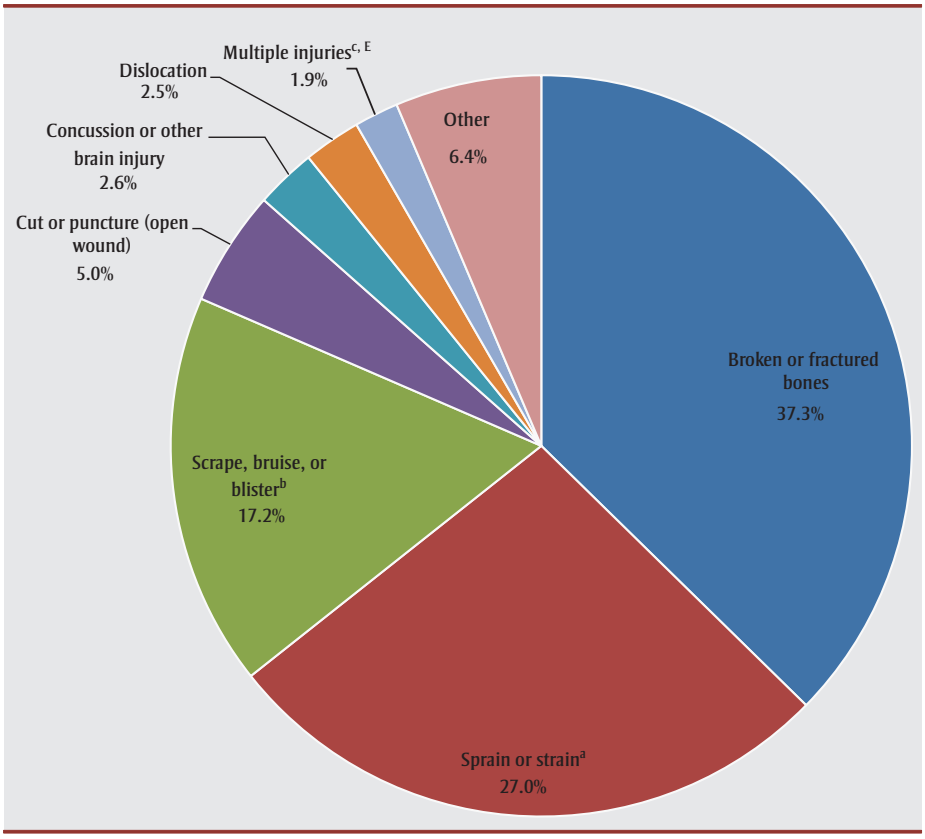
Injury characteristics

Based on combined data from the 2005, 2009/2010 and 2013 samples, Figures 4 and 5 show the proportion of fall-related injuries by type of injury and part of body injured, respectively. The majority of fall-related injuries involved broken or fractured bones (37%), sprains or strains (27%) and scrapes, bruises or blisters (17%). The body parts that were most frequently affected were shoulder or upper arm (16%), knee or lower leg (13%) and ankle or foot (11%). Although the wording in the 2009/2010 and 2013 questionnaires changed slightly from that in 2005 (e.g. the ''sprain or strain'' category was given more details in 2009/2010 and 2013: ''sprain or strain, including torn ligaments and muscles''), we did not observe any meaningful differences in proportions across survey years because of these changes (data not shown).

Figure 6 shows the proportion of fall-related injuries by type of activity associated with the fall using combined data from the 2009/2010 and 2013 samples (the 2005 sample was excluded due to differences in the categorization of activity types). The largest proportions of fall-related injuries resulted from slipping, tripping, stumbling or loss of balance while walking on a surface other than snow or ice (45%), while walking on snow or ice (16%) and while going up or down stairs or steps (12%). Others reported falling due to health problems (e.g. fainting, weakness, dizziness, hip/knee giving out, seizure) (7%), from furniture or while rising from furniture (e.g. bed, chair) (6%), while engaged in sport or physical exercise (5%) or from an elevated position (4%).

Of those seniors with a fall-related injury in the 2005 sample, 133 958 (69%) reported seeking medical attention from a health professional in the 48 hours following the injury. This number increased to 163 571 in 2009/2010 and 198 164 in 2013, although the proportions were slightly lower (64% in 2009/2010 and 66% in 2013). Based on combined data from the three survey years, the majority of those seeking treatment for a

FIGURE 4
Proportion of fall-related injuries by type of injury, ≥ 65 years, Canada, CCHS 2005, 2009/2010, 2013



Source: Canadian Community Health Survey (2005, 2009/2010 and 2013 combined), Statistics Canada.
Abbreviation: CCHS, Canadian Community Health Survey.
Note: There were slight wording changes for some categories in the 2009/2010 and 2013 questionnaires compared to 2005 (see below), but no meaningful differences were observed in the proportions of these categories across survey years.
[a] Stated as "sprain or strain" in 2005 and "sprain or strain (including torn ligaments and muscles)" in 2009/2010 and 2013.
[b] Stated as "scrape, bruise, blister" in 2005 and "scrape(s), bruise(s), blister(s) (including multiple minor injuries)" in 2009/2010 and 2013.
[c] Stated as "multiple injuries" in 2005 and "multiple serious injuries (excluding multiple minor injuries)" in 2009/2010 and 2013.
[E] Estimate is associated with high sampling variability (i.e. coefficient of variation is between 16.6% and 33.3%) – interpret with caution.

fall-related injury visited a hospital emergency department (71%), a doctor's office (15%), a clinic (6%) and a hospital outpatient clinic (5%). Less than 5% reported seeking medical treatment at a community health centre or at the site where the injury occurred. In addition, more than one-quarter of those who reported a medically attended fall-related injury were hospitalized overnight. Similar patterns were observed across all survey years (data not shown).

Discussion

Using population-based data from the 2005, 2009/2010 and 2013 CCHS, we provide an updated national profile of injuries resulting from falls among Canadians aged 65 years or older and examine trends over time.

From 2005 to 2013, the number of Canadian seniors who sustained a fall-related injury increased by over 50%, which corresponds to the demographic shift towards an older population.[21] Moreover, the increase in fall-related injury rates is consistent with that reported for the period 2003 to 2009/2010 in Canada[7] as well as with trends observed in the United States,[29,30] the Netherlands[31] and Australia.[32,33] Of note, while the majority of these studies were restricted to injuries treated in emergency departments or that required hospitalization, our study shows time trends of self-reported fall-related injuries regardless of whether medical treatment was sought.

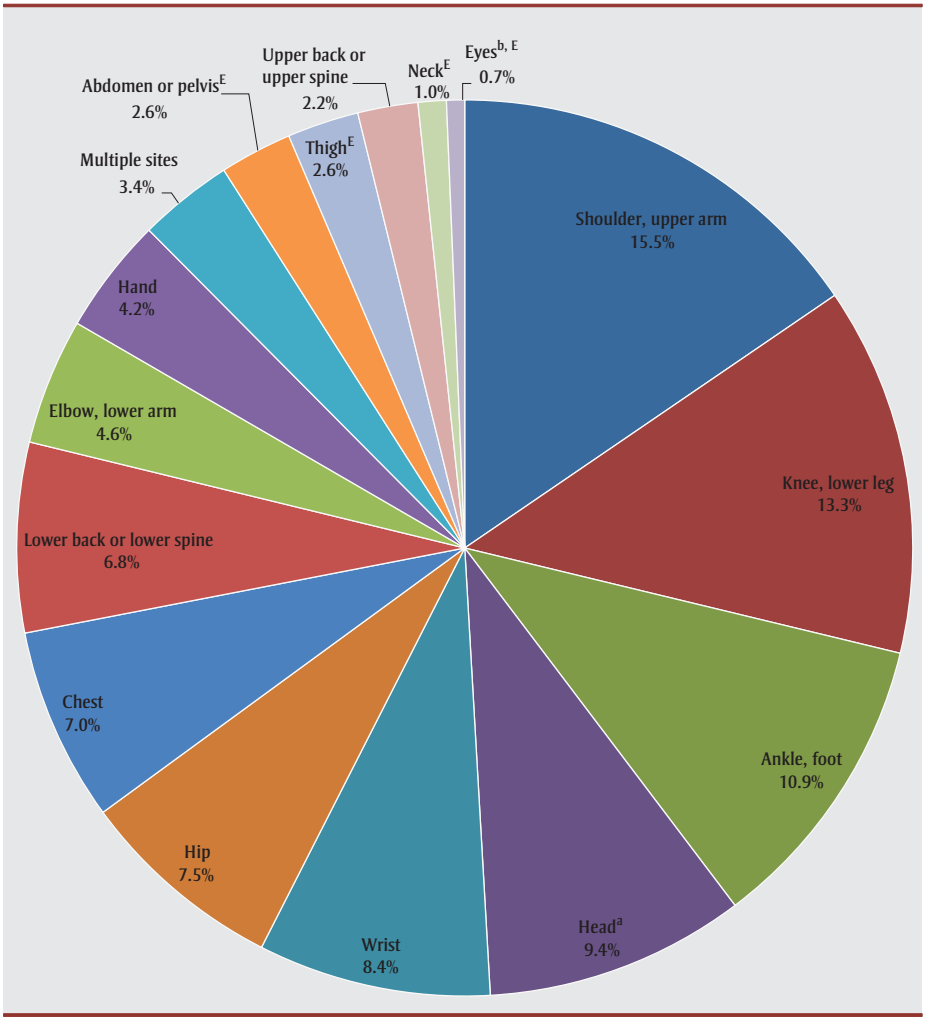
As with other studies,[29-36] we found significantly higher rates of fall-related injuries among older women compared to older men across all survey years. Loss of bone mineral density following menopause may predispose women to a higher risk of fracture.[37-39] The gender disparity in fall-related injury rates may also reflect differences between men and women in the strength of their lower extremities, chronic health conditions and lifestyle or behavioural factors.[40]

A study that used data from the CCHS – Healthy Aging survey showed that men and women have different sets of socio-demographic, lifestyle/behavioural and medical risk factors for falls.[41] For example, being widowed, separated or divorced, having a higher level of education and having an eye disorder were associated with elevated risk of falls in men, whereas older age, lower income, alcohol consumption, medication use and having diabetes, osteoporosis or a higher number of comorbid conditions increased the risk of falls in women.[41] Note that although women are at higher risk for falls and fall-related injuries, mortality rates from falls are higher among men,[7,42,43] who may be more severely injured due to the circumstances or events of their fall.[35]

While the rate of fall-related injuries increased steadily for women over time, we observed a peak among men in 2009/2010, followed by a small but non-significant decline in the most recent year, which may have partially accounted for the levelling off of the overall rate. This differs from the trends observed between 2003 and 2009/2010, during which there was a consistent increase in rates in both sexes.[7]

Although making direct comparisons is difficult due to differences in data sources and time periods examined, studies in other countries have shown either similar upward trends for both sexes[29,30] or a sharper increase in men than in women.[31-33] The reasons for the recent decline (or levelling off) that we observed among men are unclear and may be associated with changes in risk-taking behaviour and risk perception (e.g. taking extra caution when climbing

FIGURE 5
Proportion of fall-related injuries by part of body injured, ≥ 65 years, Canada, CCHS 2005, 2009/2010, 2013



Source: Canadian Community Health Survey (2005, 2009/2010 and 2013 combined), Statistics Canada.
Abbreviation: CCHS, Canadian Community Health Survey.
Note: Wording for some categories in the 2009/2010 and 2013 questionnaires changed from 2005 (see below), but no meaningful differences were observed in the proportions of these categories across survey years.
[a] Stated as "head (excluding eyes)" in 2005 and "head (including facial bones)" in 2009/2010 and 2013.
[b] Stated as "eyes" in 2005 and "eyes (excluding fracture of facial bones around the eye)" in 2009/2010 and 2013.
[E] Estimate is associated with high sampling variability (i.e. coefficient of variation is between 16.6% and 33.3%) – interpret with caution.

ladders and paying greater attention to surroundings while walking).[6,7,44] However, more years of data are needed to assess longer-term trends and to determine whether fall-related injury rates are truly decreasing for older men in Canada.

The increase in fall risk with age is well-documented[29-31,34-36] and can be attributed to age-induced declines in physical, sensory and cognitive function, as well as increases in comorbidities.[43,45] Moreover, our results indicate that, although older seniors (i.e. ≥ 85 years) continue to experience higher rates of fall-related injuries compared to younger seniors, the gap between the younger and the older age groups appears to be a closing over time. A possible explanation is that younger seniors have been leading more active lifestyles than in the past, spending more time pursuing activities that could increase their chances of falling.[29,46] However, the trends we observed most likely involved a complex interplay of fall risk factors, including age-related shifts in lifestyle and behaviour, health conditions and medication use.[47] In addition, recent declines in fall-related injury rates have also been reported in the older senior population (≥ 80 years) in Finland[48] and may reflect improvements in the functional ability and living environments of older seniors, although further assessment of trends is warranted. In contrast, studies in the USA[30] and Australia[33] have reported notably sharper increases in rates among older rather than younger age groups.

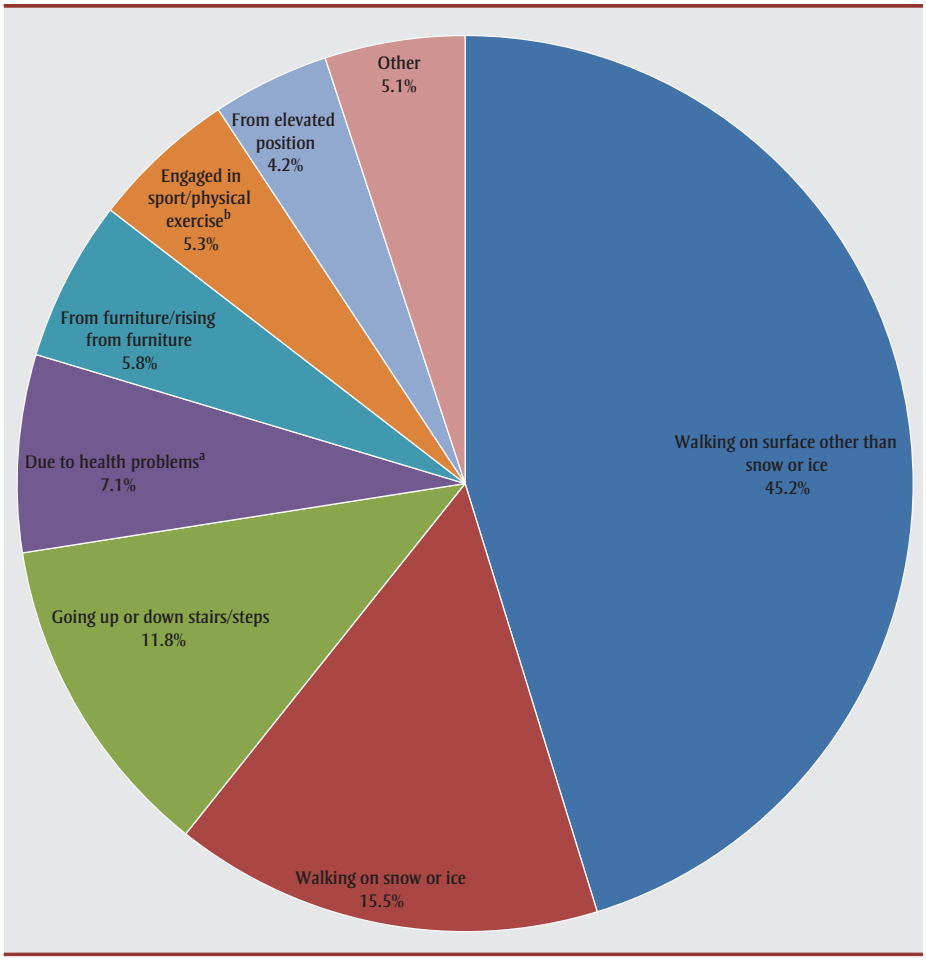
Our finding that fractures account for the greatest proportion of fall-related injuries is consistent with studies examining hospitalized[31,32] or emergency department–treated[35] fall-related injuries. It also suggests the importance of bone health in preventing fall-related fractures among seniors, especially given the high prevalence of osteoporosis in older women.[7,49] In addition, the circumstances surrounding fall-related injuries among seniors are similar to those reported in the USA,[36] as the majority involved slipping, tripping, stumbling or loss of balance while walking. However, of concern is the relatively large proportion of fall-related injuries among seniors that resulted from walking on ice or snow, highlighting the role of weather conditions in contributing to fall risk in Canada.[7,50] Our results also demonstrate the burden of fall-related injuries on the health care system. Specifically, over two-thirds of Canadian seniors who sustained fall-related injuries sought medical treatment, most commonly at a hospital emergency department. With an aging population, health care utilization resulting from fall-related injuries and associated costs are expected to increase substantially over the next decades.

Strengths and limitations

To our knowledge, this is the first peer-reviewed study that examines trends of self-reported fall-related injuries among Canadian seniors over time.

A major strength of this study is our use of a well-validated population-based survey, which provided a national picture of fall-related injuries representative of the entire community-dwelling senior population in Canada. Instead of restricting observations

FIGURE 6
Proportion of fall-related injuries by type of activity, ≥ 65 years, Canada, CCHS 2009/2010, 2013



Source: Canadian Community Health Survey (2009/2010 and 2013 combined), Statistics Canada.
Abbreviation: CCHS, Canadian Community Health Survey.
Note: Data from the 2005 CCHS sample were not included in the analysis due to differences in the categorization of activity types compared to the 2009/2010 and 2013 surveys.
[a] Examples include fainting, weakness, dizziness, hip/knee giving out and seizure.
[b] Includes skating, skiing and snowboarding.

only to injuries involving hospitalization or emergency department visits, our study shows estimates and trends for a wider spectrum of fall-related injuries.

Our study also has several limitations that should be taken into consideration when interpreting the findings. First, based on the way the questions were designed in the CCHS, data were only collected for the most serious injury experienced by the respondent during the previous year. In other words, falls resulting in less serious injuries compared to other causes of injuries (e.g. traffic collisions) occurring in the same time period would not have been captured, likely leading to underestimated numbers and rates of fall-related injuries. Similarly, the survey did not collect information on multiple falls experienced by the same individual.

Second, since the CCHS does not collect data annually on injuries from all provinces and territories of Canada, our examination of national trends is limited to only several data points (i.e. 2005, 2009/2010 and 2013). As a result, potential changes in trends during the gap periods may have been missed. Nevertheless, we demonstrated a generally increasing trend of fall-related injuries consistent with that reported previously.[7]

Third, due to the self-reported nature of the CCHS, our results may be subject to measurement bias and misclassification. For example, questions about injuries may be interpreted differently by different respondents. There may also be the issue of underreporting of falls due to social desirability bias (i.e. an unwillingness to admit falling) or difficulty recalling, particularly among an older population.[51]

Fourth, low response rates, particularly in the most recent survey year (i.e. 66.8% in 2013), could have resulted in limited generalizability of study findings. However, to minimize potential bias associated with total non-response (i.e. refusal to participate or inability to contact the selected household or individual), Statistics Canada has adjusted the survey weights by redistributing weights of non-responding households or people to responding households or people with similar characteristics (e.g. geographic information, collection period, time and number of contact attempts).[24]

Finally, our findings may only be generalized to a relatively healthy population of seniors living in the community and do not apply to residents of care facilities, who may have a distinct risk profile for falls and very different circumstances and outcomes of fall-related injuries compared to the general population.[52]

Conclusion

As in other developed nations, fall-related injuries among seniors in Canada have been increasing over the past decade. Recent data also suggest differences in trends by sex and age, with a sharper increase among women and among younger seniors. As our population is rapidly aging, it remains essential to monitor trends and patterns of fall-related injuries along with the associated burdens on the health care system.

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Evidence Brief

Trends and projections of obesity among Canadians

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Key messages

- Approximately 1 in 7 Canadian children and adolescents is obese.
- Obesity prevalence rates in Canadian children and adolescents have not changed significantly since 2007. These rates are projected to remain stable over the next two decades.
- Approximately 1 in 4 Canadian adults is obese.
- Obesity prevalence rates in Canadian adults are projected to continue to increase over the next two decades.
- The increase in obesity rates is projected to be greater in males than females across the lifespan.

Keywords: *obesity, epidemiology, body mass index, prevalence, health surveys, computer simulation, projections*

Background

The prevalence of obesity, defined as body mass index (BMI) of 30 kg/m^2 or higher for adults and as 2 standard deviations above the World Health Organization growth standard mean for children, has increased in many parts of the world.[1] Obese adults are at an increased risk of certain chronic conditions, including hypertension, type 2 diabetes, cardiovascular diseases and some cancers, and of premature death.[2,3] Obese children have increased cardiometabolic risk, including dyslipidemia, insulin resistance and elevated blood pressure.[4,5,6] Excess childhood body weight that continues into adulthood can affect quality of life, educational attainment and earnings over the lifecourse.[7,8]

The Public Health Agency of Canada has projected an annual direct health care cost (including physician, hospitalization and medication costs) of those categorized as obese in Canada in constant 2001 Canadian dollars. Calculated as $7.0 billion in 2011, this annual direct health care cost is projected to rise to $8.8 billion by 2021, based on simulated average direct health care costs, which are higher among the obese ($2,283) than the overweight ($1,726), the underweight ($1,298) and those at normal weight ($1,284).[9] Canadian estimates from 2006 and 2008 that used different methodologies place the annual economic burden (direct and indirect costs) of obesity between $4.6 billion and $7.1 billion.[10,11]

The purpose of this evidence brief is to show current Canadian obesity prevalence rates and estimates for the future using objectively measured height and weight to calculate BMI. The use of objectively measured height and weight to derive BMI is strongly recommended, especially for children and adolescents,[12] as self- or proxy-reported height and weight tend to underestimate actual weight and consequently BMI and obesity prevalence.[13,14]

Data sources

Before 2007, only a few national population-level surveys directly measured the height and weight of children and adolescents: the Canada Health Survey (age 0 and older) in 1978/1979; the Canada Fitness Survey (age 7 years and older) in 1981; the Campbell's Survey on Well-being in Canada (age 7 years or older) in 1988; and the Canadian Community Health Survey (CCHS), Cycle 2.2 Nutrition (age 2 years or older) in 2004. Since 2007, the Canadian Health Measures Survey (CHMS) has systematically collected objectively measured BMI; data collection through the CHMS occurs in two-year cycles.[15]

We generated projections of past, current and future BMI from 2001 through to 2031 using the **PO**pulation **H**ealth **M**icrosimulation model for childhood and adult BMI (POHEM-BMI).[16] POHEM-BMI is a continuous-time, Monte Carlo microsimulation model in which the basic unit of analysis is the individual. The dynamic simulation recreates the Canadian population at a given point in time through births, immigration and emigration, and ages it, one person at a time, until death. Life events such as smoking initiation and cessation, changes in physical activity and BMI, and incidence and progression of diseases affect the life trajectory and mortality of individual simulated people. POHEM-BMI integrates data distributions and equations derived from sources that include nationally representative cross-sectional and longitudinal surveys, and vital statistics and cancer registries.[9,16] In particular, multivariate regression equations estimated from the longitudinal National Population Health Surveys from 1994 to 2006 simulate the plausible dynamics of BMI, adjusting for self- and proxy-report bias. The POHEM-BMI model is auto-regressive and includes variables that have predictive power beyond that of the history of BMI, such as age, sex, physical activity and smoking status. POHEM-BMI projections assume that current

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behaviour patterns continue and nothing new is done to prevent obesity.

Obesity trends in Canadian children and adolescents

Obesity prevalence rates that used objectively measured BMI more than doubled in Canadian children and adolescents (aged under 18 years) between 1978/79 and 2004, from 6.3% (in 2 to 17 year olds) to 13.3% (in 6 to 17 year olds).[17] Obesity prevalence rates are higher in boys than in girls and higher in adolescents (12–17 years) than in younger children (6–11 years). Data from the 2007–2009, 2009–2011 and 2012–2013 cycles of CHMS suggest that obesity prevalence rates have stabilized between 11.6% and 14.3% (in 6 to 17 year olds). These observations are consistent with POHEM-BMI,[16] which projects that obesity among Canadian children aged 6 to 17 years will stabilize after 2013, resulting in 1 in 7 children being obese (Figure 1).

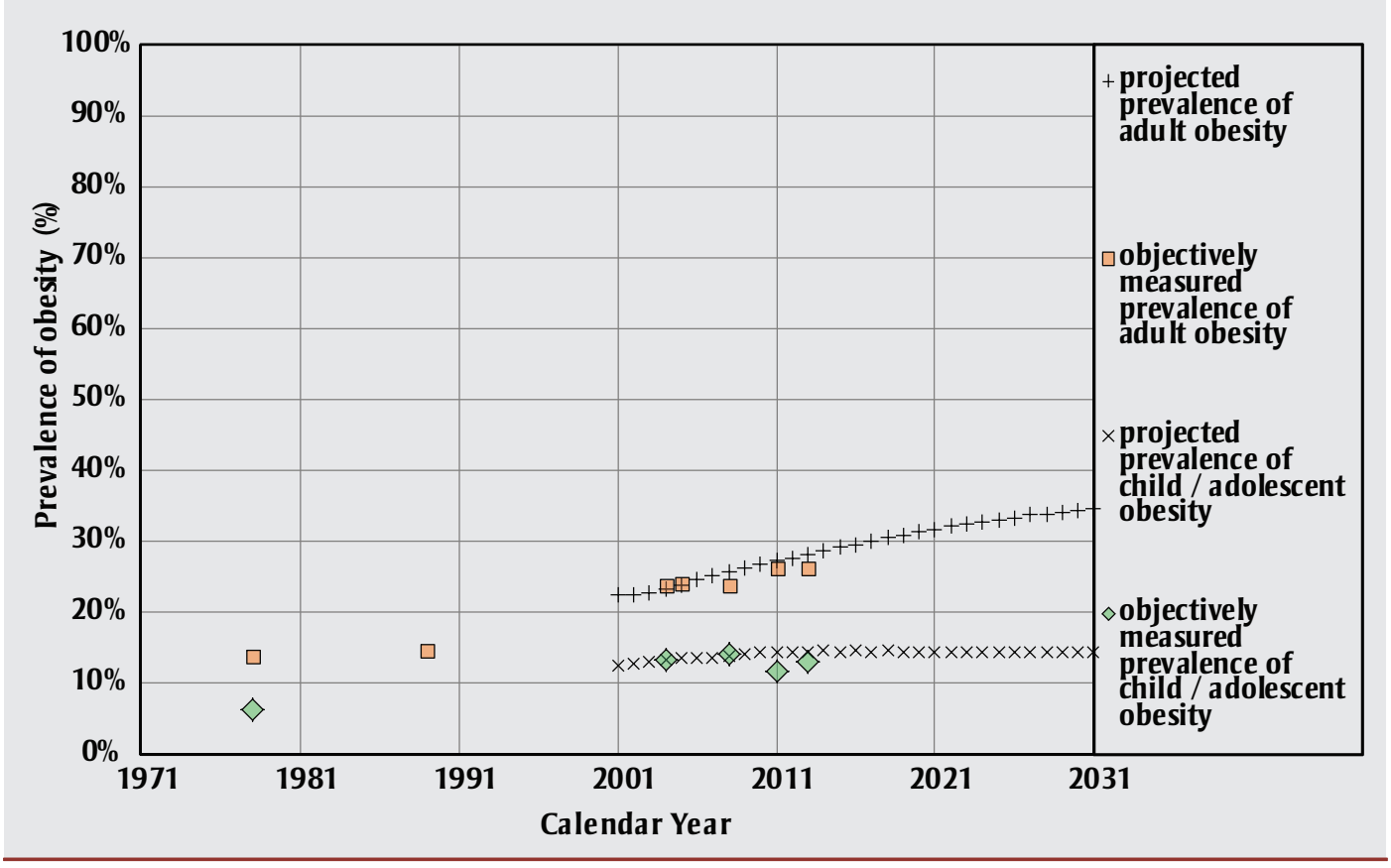
Obesity trends in Canadian adults (18+ years)

Obesity prevalence rates that used objectively measured BMI nearly doubled in Canadian adults between 1978/79 and 2004, from 13.8% to 23.1%.[11] Obesity prevalence rates among adults are lowest in early adulthood, increase in middle age and decline slightly in seniors. Data from the 2007–2009, 2009–2011 and 2012–2013 cycles of CHMS suggest adult obesity prevalence was between 23.9% and 26.4%, resulting in 1 in 4 adults being obese. Projections using POHEM-BMI suggest obesity among adults will rise over the next two decades (Figure 1), with the largest increase in adult men (Figure 2).

Conclusions

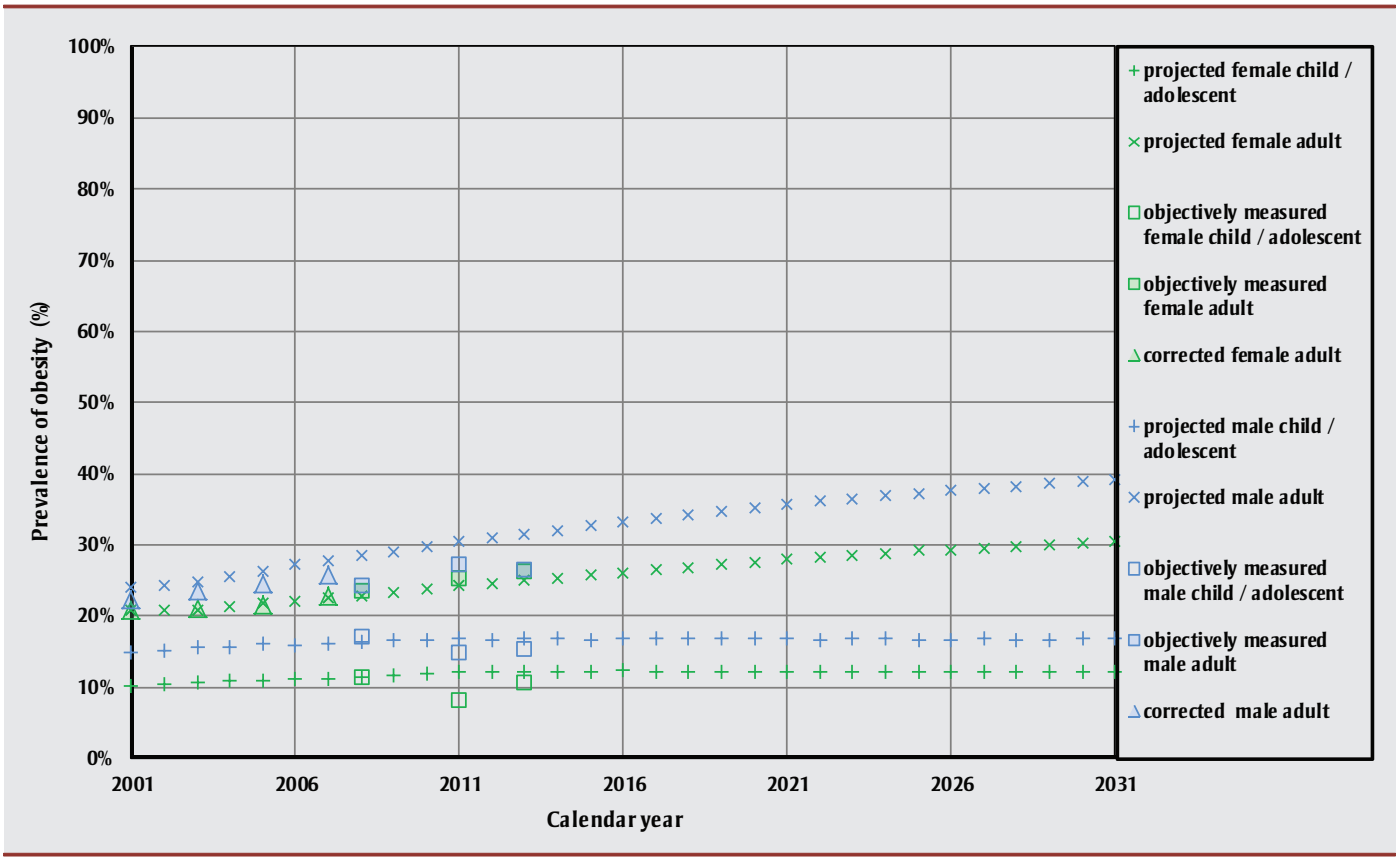
Our analysis of three recent cycles of the CHMS shows that obesity prevalence rates that use objectively measured BMI stabilized in children and adolescents but rose slightly in adults. Our microsimulation projections suggest that despite a stabilization in obesity prevalence among children and adolescents, if nothing new and effective is done to mitigate the trend among adults, objectively measured obesity will rise over the next two decades, affecting more than one in three Canadian adults by 2031. These projections from a validated population health microsimulation model[18] provide a realistic benchmark against which to compare new surveillance data to gauge shifts in the trend of obesity among Canadian children and adults.

FIGURE 1
Prevalence of obesity among Canadian children and adolescents and adults by calendar year



Notes: Projected prevalence using Population Health Model for body mass index (POHEM-BMI) Version 6.0.1.0, March 3, 2015.
Objectively measured prevalence from Canadian population health surveys (see Data Sources for details).
Children/adolescents encompass ages 6 to 17 years; adults encompass ages 18 to 79 years.

FIGURE 2
Prevalence of obesity among Canadian children and adolescents and adults by sex and calendar year



Notes: **Projected prevalence using Population Health Model for body mass index (POHEM-BMI) Version 6.0.1.0, March 3, 2015.**
Objectively measured prevalence from Canadian population health surveys (see Data Sources for details).
Children/adolescents encompass ages 6 to 17 years; adults encompass ages 18 to 79 years.

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Report Summary

Rio Political Declaration on Social Determinants of Health: A Snapshot of Canadian Actions 2015

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In 2012, Canada and other United Nations (UN) Member States endorsed the ''Rio Political Declaration on Social Determinants of Health'' (Rio Declaration),[1] a non-binding pledge which calls on World Health Organization (WHO) Member States to improve/influence the working and living conditions that affect health and well-being. The Rio Declaration sets out actions to address health inequities in five themes: to adopt better governance for health and development; to promote participation in policy making and implementation; to further reorient the health sector towards reducing health inequities; to strengthen global governance and collaboration; and to monitor and increase accountability.

Canada's commitment to the Rio Declaration

In 2013, following the endorsement of the Rio Declaration, the Government of Canada released a report to begin to document Canadian actions related to its five themes.[2] Building on this first report, and in anticipation of WHO reporting on Member State implementation of the Rio Declaration at the May 2015 World Health Assembly, the Government of Canada developed the report, *Rio Political Declaration on Social Determinants of Health: A Snapshot of Canadian Actions 2015*,[3] which showcases Canada's recent actions since 2013 contributing to the advancement of the five Rio Declaration themes. The report provides a current picture of the diverse spectrum of activities undertaken across levels of government and sectors to advance health equity and address social determinants of health in Canada, and intends to stimulate global and domestic exchange and uptake of promising practices to advance health equity.

Selection criteria for health equity initiatives and tools

Key Canadian developments across different levels of government and with civil society include further reorientation of the health sector towards reducing health inequities and initiatives to monitor progress and increase accountability. In all, 29 recent, diverse and multiple Canadian initiatives or tools demonstrating action across the Rio Declaration themes were profiled in the report.[3] The following selection criteria were developed and used to select the initiatives and tools:

- aligns with at least one or more of the five themes of the Rio Declaration
- was published in 2013 or after
- profiles Canadian action/showcases Canada's value added:
  - national, provincial/territorial and/or federal/provincial/territorial collaborative efforts
  - public, non-government organizations or private sector efforts
  - intersectoral partnership efforts
- may profile a compilation of Canadian experiences from different jurisdictions, including local level
- profiles proven, promising or innovative action (ideally, the initiative or tool should demonstrate the evidence base of evaluation results/its impact)
- profiles action and not position statements/recommended actions
- underwent an appropriate review, for example, a peer-review process, approval process or is informed by evaluation data
- is publicly accessible, i.e. posted on the internet (preferable)

Efforts were also made to profile a balance of upstream and downstream interventions improving health and advancing health equity; profile Aboriginal populations (First Nations, Métis, Inuit); apply a common definition of health equity*; and reflect Canada's commitment to gender equity.

Canadian health equity initiatives and tools

The highlights of each initiative or tool are summarized in the report, and source websites are provided. The initiatives profiled in Canada's 2015 report demonstrate actions to advance health equity and fall under the following groupings:

- To adopt better governance for health and development:
  - Applying health impact assessment
  - Working across sectors to reduce poverty, improve social protection, advance key determinants, such as housing

*Unless in the context of monitoring, where the term 'health inequalities' is applied.

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- To promote participation in policy-making and implementation:
  - Reforming government processes to increase openness of data, transparency and participation, and engaging citizens
  - Providing approaches to engage and empower Aboriginal peoples for self-governance
- To further reorient the health sector towards reducing health inequities:
  - Integrating equity, including gender-related considerations, into the design and delivery of programs and services
  - Providing capacity and tools to advance health equity
- To strengthen global governance and collaboration:
  - Providing financial contribution to countries and international organizations
  - Fostering North-South support in information sharing and technical expertise
- To monitor progress and increase accountability:
  - Strengthening monitoring systems and methods to report on health inequalities
  - Sharing evidence to inform policy and action

These initiatives can be of interest to provincial/territorial, regional and local authorities, as well as national governments and non-government organizations, academic organizations, and professional and civil society organizations working to advance the social determinants of health in Canada and internationally.

Canada will continue to explore opportunities to further advance the social determinants of health and health equity including the implementation of the 2014 resolution endorsed by Canada and other UN Member States: ''Contributing to social and economic development: sustainable actions across sectors to improve health and health equity.''[4] The resolution calls on Member States to take action on improvements in health and reduction of health inequity across various sectors and levels of government. It builds on and aligns with the Rio Declaration which calls for action across sectors for health and health equity.

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Other PHAC publications

Researchers from the Public Health Agency of Canada also contribute to work published in other journals. Look for the following articles published in 2014 and 2015:

Afifi TO, MacMillan HL, Taillieu T, Cheung K, Turner S, **Tonmyr L**, **Hovdestad W**. Relationship between child abuse exposure and reported contact with child protection organizations: results from the Canadian Community Health Survey. Child Abuse Neglect. 2015. [In press]

Brehaut JC, Carroll K, Elwyn G, Saginur R, Kimmelman J, Shojania K, Syrowatka A, **Nguyen T**, et al. Elements of informed consent and decision quality were poorly correlated in informed consent documents. J Clin Epidemiol. 2015. [In press]

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Nguyen V, Nguyen-Viet H, Pham-Duc P, Stephen C, McEwen SA. Identifying the impediments and enablers of ecohealth for a case study on health and environmental sanitation in Hà Nam, Vietnam. Infect Dis Poverty. 2014;3:36.

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Zinck JW, **De Groh M**, MacFarlane AJ. Genetic modifiers of folate, vitamin B-12, and homocysteine status in a cross-sectional study of the Canadian population. Am J Clin Nutr. 2015;101(6):1295-304.