900,000 Days in Hospital:

The Annual Impact of Smoking, Alcohol, Diet and Physical Activity on Hospital Use in Ontario

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Ottawa Hospital Research Institute
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ICES

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About the Organizations Involved in this Report

About ICES

The Institute for Clinical Evaluative Sciences (ICES) is an independent, non-profit organization that produces knowledge to enhance the effectiveness of health care for Ontarians. Internationally recognized for its innovative use of population-based health information, ICES evidence supports health policy development and guides changes to the organization and delivery of health care services.

Key to ICES' work is its ability to link population based health information, at the patient level, in a way that ensures the privacy and confidentiality of personal health information. Linked databases reflecting 13 million of 34 million Canadians allows ICES researchers to follow patient populations through diagnosis and treatment and to evaluate outcomes.

ICES brings together the best and the brightest talent across Ontario. Many of its scientists are not only internationally recognized leaders in their fields but are also practicing clinicians who understand the grassroots of health care delivery, making the knowledge produced at ICES clinically focused and useful in changing practice. Other team members have statistical training, epidemiological backgrounds, project management or communications expertise. The variety of skill sets and educational backgrounds ensures a multi-disciplinary approach to issues and creates a real-world mosaic of perspectives that is vital to shaping Ontario's future health care system.

ICES receives core funding from the Ontario Ministry of Health and Long-Term Care. In addition, its scientists and staff compete for peer-reviewed grants from federal funding agencies, such as the Canadian Institutes of Health Research, and receive project-specific funds from provincial and national organizations. These combined sources enable ICES to have a large number of projects underway, covering a broad range of topics. The knowledge that arises from these efforts is always produced independent of funding bodies, which is critical to ICES' success as Ontario's objective, credible source of evidence guiding health care.

About OHRI

The Ottawa Hospital Research Institute (OHRI) is the research arm of The Ottawa Hospital and is an affiliated institute of the University of Ottawa, closely associated with the university's Faculties of Medicine and Health Sciences. OHRI includes more than 1,700 scientists, clinical investigators, graduate students, postdoctoral fellows and staff conducting research to improve the understanding, prevention, diagnosis and treatment of human disease.

List of Exhibits

Background

This is the first Canadian study to examine the collective impact of health behaviours on health care utilization.

About this Study

Smoking, unhealthy alcohol consumption, poor diet and physical inactivity play an important role in overall health. Previously, our research team at the Institute for Clinical Evaluative Sciences (ICES) and Public Health Ontario (PHO) examined the impact of these health behaviours on health and life expectancy. The *Seven More Years* report demonstrated that 60% of deaths are related to health behaviours.[1] Improving the health of Ontarians requires a strategy that results in improved health behaviours.

Ontario policy makers and public health practitioners are also interested in the potential impact of health behaviours on health care use—the focus of this report. This study is in response to requests[a] to provide insights into the health care system and economic impact of preventive strategies.

There have been a number of studies that have evaluated the impact of individual health behaviours such as smoking and alcohol on health care use,[2-7] and a few studies have evaluated the impact of a broader

a These requests are submitted through the Applied Health Research Question (AHRQ) initiative of the Ontario Ministry of Health and Long-Term Care by a health-system policy maker or care provider seeking research evidence that will inform planning, policy and program development for the benefit the entire Ontario health system.

range of health behaviours on health care utilization or costs.[8,9] However, our study is likely the largest to directly link people's healthy living to their hospital use. Furthermore, to our knowledge, this is the first Canadian study to examine the role of all health behaviours on health care use or costs.

Questions examined

1. **What is the use of hospital care for Ontarians who have healthy versus unhealthy living?**
   To answer this question, we examined how hospital use varied by people's behavioural risk factors. For example, we calculated the hospital use of Ontarians who smoke compared to Ontarians who have never smoked.

2. **How much hospital care is related to smoking, unhealthy alcohol consumption, poor diet and physical inactivity?**
   This question addresses the role of each behavioural risk on hospitalization in Ontario, including adjustment for other behaviours and risk factors that contribute to hospital use.

Measurements of hospital use

Our study examined a cohort of individuals who were surveyed between 2001 and 2005. We followed each individual for five years between 2001 and 2012 to examine his or her hospital use with two measures.

- **Hospital bed-days.** We combined the number of hospitalizations and lengths of hospital stay into a single measure of "hospital bed-days." People may be hospitalized once or multiple times. Even for a single illness, a person may be admitted and transferred to multiple hospitals; for example, a person can be admitted to a community hospital and then transferred to a regional or tertiary hospital for speciality services.

  To generate the number of bed-days, we counted hospitalizations at any publicly funded Ontario hospital for adults aged 20 to 79 years (representing 55% of all bed-days in Ontario in 2011). We excluded hospital admissions for pregnancy and birth. We also excluded hospital use in the last year of life because this care is used more frequently for palliation than for illness. Our preliminary analyses indicated that health behaviours had a weak association with hospital use in the last year of life; therefore, for technical reasons, we had challenges in attributing differences to health behaviour profiles. The final cohort represented 41% of hospital bed-days in Ontario in 2011.

- **Hospital costs.** To estimate the economic burden, we examined costs associated with hospital care in 2011, the most recent year for which data were available. Given the same restrictions used to generate hospital bed-days, our cohort represented 63% of hospital costs for Ontarians.

Methods

To our knowledge, this study represents the largest evaluation of health behaviours and hospital use ever performed.

Data Sources

We examined the relationship between behavioural risks and hospitalization using the Ontario sample of three population health surveys: the Canadian Community Health Survey (CCHS) cycles 1.1, 2.1 and 3.1, administered between 2001 and 2005. The CCHS is a cross-sectional survey conducted biennially by Statistics Canada that collects data on health determinants, health status and health care utilization. The survey employs a complex multistage sampling strategy to randomly select households in each health region. Individuals in each household are then randomly selected to participate in the survey. A weight is assigned to each respondent signifying the number of people the respondent represents in the target population. The target population includes individuals aged 12 years and older across Canada's 10 provinces and three territories (excluded are individuals living on Indian Reserves, institutional residents, full-time members of the Canadian Forces and residents of certain remote areas).

For our study, the three CCHS cycles were combined to generate a cohort of 99,413 unique Ontario respondents. Respondents were included if they were eligible for publicly funded health care from the Ontario Health Insurance Program (OHIP), were not pregnant, were between 20 and 79 years of

age in the second year of follow-up (start of the study) and had consented to share their survey responses and have them linked to their health and health care data. We also excluded respondents who died within the first year of follow-up. There were 79,477 respondents in the final study cohort. (See **Exhibits A-1** and **A-2** in the Appendix.)

Hospital and mortality data

The CCHS respondents were individually linked to the Canadian Institute for Health Information's Discharge Abstract Database (DAD) to obtain their hospital use between 2001 and 2012. The DAD captures all government-funded hospital care. The CCHS respondents were linked to vital statistics to identify all deaths between 2001 and 2013. Respondents were also linked to health insurance eligibility files and mortality records held at the Institute for Clinical Evaluative Sciences. All respondents were followed for up to seven years after the corresponding survey administration date and censored if they became OHIP ineligible before the end of the seven years.

Behavioural and other risk factors for hospitalization

Exhibits 1 and 2 show the health behaviours (smoking, alcohol consumption, diet and physical activity) and other risks that were examined for their association with hospital use. Other risks included age, sex, stress, sociodemographic factors (ethnicity, immigration status, individual and family income, education, marital status and neighbourhood deprivation), chronic conditions (self-reports of physician-diagnosed diabetes, coronary heart disease, cancer and hypertension), body mass index, mobility and rurality.

Hospital costs

To ensure that hospital costs reflected current estimates, we used the most recent data available that permitted ascertainment of the cohort study eligibility criteria (e.g., exclusion of costs within the last year of life). These data consisted of daily prorated hospital costs from January 1 to December 31, 2011. The daily prorated hospital cost was derived by multiplying the resource intensity weight associated with a hospitalization by the year-specific cost per weighted case and then dividing the result by the length of the stay.[10,11]

EXHIBIT 1 Definitions of behavioural health risks

Behaviour	Category*	Definition
Smoking		
	Heavy smoker	**Current smoker (≥1 pack/day)†**
	Light smoker	Current smoker (<1 pack/day)
	Former heavy smoker	Former smoker (≥1 pack/day)
	Former light smoker	Former smoker (<1 pack/day)
	Non-smoker	*Former occasional smoker or never smoker*
Alcohol		
	Heavy drinker	**Bingeing‡ or >24 (men) or >17 (women) drinks/week**
	Moderate drinker	≤24 (men) or ≤17 (women) drinks/week with no bingeing‡
	Current non-drinker	No alcohol consumption in the last 12 months
Diet		
	Very poor diet	**Index score 0 to <2**
	Fair diet	Index score 2 to <4
	Adequate diet	*Index score 4 to 10*
Physical activity		
	Inactive	**0 to <1.5 METs/day**
	Moderately active	1.5 to <3 METs/day
	Active	*≥3 METs/day*

*Highest risk levels are in boldface and lowest risk levels (reference group) are in italics.

†One pack contains 20 cigarettes.

‡Bingeing was defined as ≥5 drinks/day on any day in the previous week or weekly bingeing behaviour in the previous month.

Index score = the healthiness of a diet based on consumption of fruit and vegetables. Individuals start with 2 points and are given up to 8 additional points for each average daily serving of fruits and vegetables (maximum score = 10). Points are deducted for daily fruit juice servings exceeding 1 (-2 points), no carrot consumption (-2 points), or daily potato consumption exceeding 1 serving for males and 0.7 servings for females (-2 points). Scores that result in negative values after deductions are recoded to zero, resulting in a final range of 0 to 10 for the index.

MET = metabolic equivalent of task; a measure of calories burned by type, duration and frequency of physical activity

EXHIBIT 2 Baseline description of the study cohort, by sex, 2001 to 2005

Key messages

- Only 7.2% of Ontarians reported no health behaviour risks.
- The largest proportion of men (35%) reported two behavioural risks; the largest proportion of women (39%) reported one behavioural risk.

Characteristics	Men		Women	
	Sample size*	Represented population‡ (x 1,000)	Sample size*	Represented population‡ (x 1,000)
Ontario cohort	36,991	4,200 (100%)	42,486	4,220 (100%)
Age group (years)				
20 to 29	5,268	804 (19%)	6,058	746 (18%)
30 to 39	7,407	881(21%)	7,985	842 (20%)
40 to 49	7,873	1,010 (24%)	8,098	1,000 (24%)
50 to 59	6,785	728 (17%)	7,789	738 (17%)
60 to 69	5,522	470 (11%)	6,716	513 (12%)
70 to 79	4,136	311 (7%)	5,840	376 (9%)
Smoking				
Heavy smoker	4,485	422 (10%)	3,028	235 (6%)
Light smoker	6,136	735 (17%)	7,474	707 (17%)
Former heavy smoker	6,701	611 (15%)	3,912	306 (7%)
Former light smoker	5,673	621 (15%)	7,022	642 (15%)
Non-smoker	13,738	1,790 (43%)	20,771	2,310 (55%)
Missing	258	24 (1%)	279	24 (1%)
Alcohol				
Heavy drinker	7,728	804 (19%)	3,944	381 (9%)
Moderate drinker	20,037	2,350 (56%)	21,191	2,080 (49%)
Current non-drinker	8,662	988 (24%)	16,953	1,720 (41%)
Missing	564	65 (2%)	398	46 (1%)
Diet				
Very poor diet	4,986	556 (13%)	3,458	340 (8%)
Fair diet	9,704	1,050 (25%)	7,697	745 (18%)
Adequate diet	21,248	2,470 (59%)	30,589	3,060 (72%)
Missing	1,053	128 (3%)	742	78 (2%)
Physical activity				
Inactive	16,728	1,960 (47%)	21,623	2,250 (53%)
Moderately active	9,099	992 (24%)	11,087	1,030 (25%)
Active	9,943	1,080 (26%)	9,352	861 (20%)
Missing	21,623	2,250 (53%)	424	74 (2%)
Healthy behaviour†				
4 behavioural risks	2,065	200 (5%)	790	73 (2%)
3 behavioural risks	8,302	844 (20%)	6,201	545 (13%)
2 behavioural risks	12,979	1,470 (35%)	15,252	1,450 (34%)
1 behavioural risk	9,028	1,130 (27%)	15,151	1,630 (39%)
No behavioural risks	2,180	265 (6%)	3,511	340 (8%)
Missing	2,437	301 (7%)	1,581	184 (4%)
Body mass index				
≥30 (obese)	7,121	703 (17%)	7,505	640 (15%)
<30 (non-obese)	29,712	3,480 (83%)	33,792	3,460 (82%)
Missing	158	22 (1%)	1,189	123 (3%)

EXHIBIT 2 *continued*

Characteristics	Men		Women	
	Sample size*	Represented population‡ (x 1,000)	Sample size*	Represented population‡ (x 1,000)
Stress				
Quite a bit or extremely	8,162	1,000 (24%)	10,469	1,100 (26%)
Not stressed	28,776	3,200 (76%)	31,959	3,120 (74%)
Missing	53	7 (0.2%)	58	5 (0.1%)
Household income				
<$30,000	6,260	492 (12%)	11,016	705 (17%)
$30,000 to <$80,000	17,399	1,750 (42%)	18,404	1,740 (41%)
≥$80,000	11,155	1,560 (37%)	9,555	1,250 (30%)
Missing	2,177	400 (10%)	3,511	525 (12%)
Ethnicity				
Visible minority	3,804	831 (20%)	4,114	791 (19%)
White	33,110	3,360 (80%)	38,295	3,410 (81%)
Missing	77	14 (0.3%)	77	14 (0.3%)
Immigration status (years in Canada)				
<15	1,776	449 (11%)	1,996	465 (11%)
15 to <30	1,658	359 (9%)	1,756	320 (8%)
30 to <45	2,097	305 (7%)	2,382	330 (8%)
≥45 or native born	31,420	3,080 (73%)	36,312	3,090 (73%)
Missing	40	9 (0.2%)	40	11 (0.3%)
Marital status				
No cohabitating partner	13,111	1,310 (31%)	17,622	1,440 (34%)
Cohabitating partner	23,873	2,890 (69%)	24,844	2,780 (66%)
Missing	7	0.5 (0%)	20	2 (0%)
Education				
Less than high school completion	6,976	624 (15%)	8,215	662 (16%)
High school graduate	9,807	1,180 (28%)	12,139	1,240 (29%)
Postsecondary graduate	19,860	2,360 (56%)	21,858	2,280 (54%)
Missing	348	45 (1%)	274	34 (1%)
Heart disease				
Yes	2,722	228 (5%)	2,475	175 (4%)
No	3,4231	3,970 (95%)	39,966	4,040 (96%)
Missing	38	3 (0.1%)	45	3 (0.1%)
Stroke				
Yes	490	37 (1%)	506	38 (1%)
No	36,486	4,170 (99%)	41,955	4,180 (99%)
Missing	15	1 (0%)	25	1 (0%)
Cancer				
Yes	813	65 (2%)	892	69 (2%)
No	36,150	4,140 (98%)	41,556	4,150 (98%)
Missing	28	2 (0%)	38	3 (0.1%)

EXHIBIT 2 *continued*

Characteristics	Men		Women	
	Sample size*	Represented population‡ (x 1,000)	Sample size*	Represented population‡ (x 1,000)
Diabetes				
Yes	2,475	226 (5%)	2,424	194 (5%)
No	34,494	3,980 (95%)	40,040	4,020 (95%)
Missing	22	2 (0%)	22	2 (0%)
High blood pressure				
Yes	6,655	628 (15%)	8,350	661 (16%)
No	30,256	3,570 (85%)	34,097	3,560 (84%)
Missing	80	9 (0.2%)	39	4 (0.1%)
Mobility				
Needs help from others	1,976	183 (4%)	4,506	376 (9%)
Physically restricted	9,117	840 (20%)	9,279	801 (19%)
No restriction	25,863	3,180 (76%)	28,667	3,040 (72%)
Missing	35	4 (0.1%)	34	3 (0.1%)
Neighbourhood deprivation				
High	5,692	511 (12%)	7003	529 (13%)
Moderate	22,832	2,580 (61%)	26,301	2,590 (61%)
Low	769	91 (2%)	8,352	1,020 (24%)
Missing	7,698	1,020 (24%)	830	80 (2%)
Rurality				
Rural	8,200	489 (12%)	9,164	478 (11%)
Urban	28,791	3,720 (88%)	33,322	3,740 (89%)
Local Health Integration Network				
Erie St. Clair	2,763	217 (5%)	3,193	217 (5%)
South West	4,715	315 (7%)	5,394	318 (8%)
Waterloo Wellington	2,338	236 (6%)	2,614	231 (5%)
Hamilton Niagara Haldimand Brant	4,679	462 (11%)	5,450	467 (11%)
Central West	1,023	236 (6%)	1,038	223 (11%)
Mississauga Halton	1,828	359 (9%)	1,962	376 (5%)
Toronto Central	1,198	401 (10%)	1,327	387 (9%)
Central	2,169	527 (13%)	2,416	529 (13%)
Central East	3,460	486 (12%)	4,043	498 (12%)
South East	2,303	159 (4%)	2,768	165 (4%)
Champlain	3,484	396 (9%)	4,153	403 (10%)
North Simcoe Muskoka	1,528	139 (3%)	1,783	136 (3%)
North East	3,951	194 (5%)	4,678	196 (5%)
North West	1,544	76 (2%)	1,659	73 (2%)
Missing	8	1 (0%)	8	1 (0%)

*Data source: Canadian Community Health Survey (CCHS) 1.1, 2.1 and 3.1 (2001, 2003 and 2005).

‡Population estimated using the CCHS sampling weights.

†Healthy behaviour was defined using the health behaviour definitions in Exhibit 1, with the exception of healthy alcohol consumption, which was defined as either current non-drinker or moderate drinker.

Analyses

CCHS respondents were followed for their hospital use for discrete one-year intervals (365 days) over the seven-year follow-up period. For respondents who died within the follow-up period, we excluded all hospital use within the year prior to death. Bed-days from hospitalizations that extended across yearly follow-up periods were split with attribution to the appropriate annual follow-up period. Bed-days from pregnancy related hospitalizations were excluded from bed-day counts and deducted from corresponding lengths of follow-up. Analysis was restricted to follow-up years 2 to 6 where respondents were between 20 and 79 years of age.

Development of the multivariable risk models

We created multivariable models to identify the risk of hospitalization (measured by annual bed-days) related to health behaviours. When building the models, we sought to address three main considerations in attributing health behaviours to hospital care (**Exhibit A-3** in the Appendix):

- First, to appropriately adjust for other risks such as age and sociodemographic factors that were correlated with health behaviours.
- Second, to consider the role of "intermediate" risks such as body mass index, blood pressure and diseases which may be a consequence of health behaviour risks rather than independently associated with hospitalization. Care was needed when adding these risks to a multivariable model to ensure that they did not inappropriately attenuate the risk from health behaviours.
- Third, to consider pre-existing illness that may have resulted in health behaviour changes. For example, as people become ill and frail they may become less physically active. In such a situation, physical inactivity could be associated with increased hospital use, when excess hospital use was more appropriately associated with illness-associated inactivity. Other assumptions and study limitations are discussed later.

We used zero-inflated negative binomial models to test the significance of each potential risk factor on the associated number of hospital bed-days. Zero-inflated negative binomial models were selected due to over-dispersion (dispersion parameter significantly different from zero) and an excessive number of zero hospitalizations.[12] A zero-inflated negative binomial model has two components: the first is a logistic regression which essentially estimates the risk of having no bed-days, and the second is a negative binomial regression which estimates the expected number of days given the initial risk of having a bed-day. The two components cannot be separated; thus, the total burden of hospital bed-days was calculated as the combination of the two components.

We created models for men and women separately using a prespecified, stepwise approach that started with the most distal risk factor (age), followed by health behaviours, sociodemographic factors and proximal risk factors, such as blood pressure and disease status (**Exhibit A-3** in the Appendix). Additional risks were entered if the predicted and observed estimates demonstrated a greater than 20% difference and the subgroup had at least 5% of the observed exposure.

We considered several different geographic or ecologic variables as sociodemographic risks, including deprivation index, rurality and injury rate. Local Health Integration Networks (LHINs) were assessed as a calibrating variable rather than as a risk of hospitalization. This meant that we compared predicted to observed rates of hospitalization by LHIN to ensure close approximation, but we did not include the LHIN as a risk variable in the model. The final models were restricted to survey participants with completed responses for the variables of interest (N = 73,946; person-years = 352,217; bed-days = 160,082), except in cases where household income was missing. Due to the large number of missing responses (12%), a category of "missing household income" was assessed and subsequently collapsed with moderate household income, based on univariate analysis. This stepwise analysis resulted in six models for each sex (**Exhibits A-5** to **A-8** in the Appendix).

Estimating the burden attributable to health behaviours

The burden of hospital bed-days attributable to health behaviours was calculated separately for each behavioural risk as well as for the combination of risks using each of our six models (**Exhibit A-9** in the Appendix). Each burden calculation was performed in two steps using a risk factor–deleted approach. The first step calculated the expected hospital bed-days based on respondents' exposure to each of the behavioural risks and their socioeconomic and personal factors. A second step repeated the calculation after recoding each respondent's health behaviour to the counterfactual reference or "no exposure" category. For example, we first estimated the risk of hospital bed-days for current and former smokers, and then re-estimated their risk of hospital bed-days assuming they had never smoked. The difference between the two calculations created an estimate of the contribution of smoking to the risk of hospital bed-days.

Contemporary estimates of the burden attributable to health behaviours

More current attributions of bed-days and costs for the behavioural risks were calculated by taking the attributed percentages of bed-days from our original cohort using Model 3, and extrapolating onto a comparable 2011 cohort. The contemporary cohort was derived from the Discharge Abstract Database using hospital bed-days that occurred in the 2011 calendar year. To ensure that the cohort was comparable to our original study cohort, we restricted the analysis to OHIP-eligible individuals aged 20 to 79 years who did not have a pregnancy-related hospitalization in 2011 and had not been admitted to hospital from a long-term care facility that year. Bed-days that occurred within the last year of life were also excluded. We obtained an estimate of hospitalized bed-days for Ontarians in 2011. For each sex, the percentage of bed-days attributed to each and all of the four behavioural risks from our study cohort were multiplied by the total number of bed-days in the contemporary cohort. The summation of the sex-specific values provided current estimates of the total number of bed-days attributed to the four behavioural risks individually and combined.

The annual economic cost was estimated in a similar manner using hospital costs from the 2011 contemporary cohort. Daily prorated hospital costs from January 1 to December 31, 2011, were summed separately for each sex; costs within one year of death that fell within the calendar year of interest (2011) were excluded. This resulted in an estimate of 2011 hospital costs for Ontarians comparable to our study cohort. For each sex, the percentage of bed-days attributed to each behavioural risk from our study cohort was then multiplied by the total hospital cost in the contemporary cohort to provide more current estimates of the absolute cost attributed to behavioural risks. The summation of the sex-specific values provided current estimates of economic burdens for the behavioural risks.

Behavioural profiles

The multivariable risk model was applied to subgroups to create cumulative behavioural profiles of those aged 20 to 79 years. For specific subgroups (e.g., heavy smokers), we calculated a weighted estimate of bed-days for each age group and summed the results to provide age-specific cumulative estimates of bed-days. The average age of first hospitalization was estimated from the cumulative behavioural profiles by taking the age at which the profile surpassed four bed-days (i.e., the median length of stay for a hospitalization during the study period).

Sensitivity analysis

We performed two sets of sensitivity analyses. First, we assessed hospital use and burden estimates by considering progressively more adjustment with risk factors other than age, sex and health behaviours (Model 1), proximal risks such as body mass index (Model 2), sociodemographic factors (Model 3), mobility (Model 4), disease status (Model 5) and geography (Model 6). The estimate derived from Model 3 was assumed to be our most accurate and appropriate estimate of the attributable burden due to health behaviours. The estimates derived from Model 1 (simply age and behaviours) and Model 6 (the overadjusted model) were used in sensitivity testing and reported as upper and lower bounds of uncertainty.

Second, we assessed burden estimates from Model 3 under several additional scenarios: including the first year of follow-up, excluding high health care users (those whose follow-up years included more than 30 bed-days annually), and excluding people who needed help to perform basic tasks (**Exhibit A-10** in the Appendix).

Limitations and Interpretive Cautions

In general, our study approach underestimates the actual burden of hospital use attributable to the four health behaviours in Ontario. We note several limitations and cautions in interpreting the findings.

Limitations

Pregnant women, children and adolescents were excluded

This study excluded hospitalizations related to pregnancy. Pregnancy-related hospitalization is a healthy life event rather than illness potentially avoided. However, poor health behaviour is associated with complications during pregnancy and child-birth: even a small contribution to extended hospital care would likely result in a notable excess burden. Within our targeted age group of 20- to 79-year-olds, pregnant women represented 5.4% of hospital bed-days and 5.0% of hospital costs in 2011.

The study also excluded people younger than 20 years of age. That said, alcohol burden for younger people is a notable omission. Alcohol use is an important attribution of injury, suicide and other social burdens that occur disproportionately among young people. In 2011, 13% of hospital bed-days and 10% of hospital costs were attributed to individuals younger than age 20 years.

Elderly adults and recipients of long-term and end-of-life care were excluded

The elderly (those aged 80 and older) were excluded from our study because their reported health behaviours may not have been a valid representation of their past behaviour but rather a result of aging. In 2011, 32% of hospital bed-days and 14% of hospital costs were attributed to the elderly. Had our report included the elderly, and assuming the burden of their health behaviours was proportional to that of other age groups, the proportion of hospital bed-days attributable to the four behavioural risks would have increased by 78% and hospital costs would have increased by $2.3 billion.

We also excluded adults living in long-term care settings and adults hospitalized within the last year of life. While the majority of such hospitalizations would have occurred among those aged 80 and older, within our targeted age group of 20- to 79-year-olds, long-term care represented 5.2% of hospital bed-days (2.2% of hospital costs) and end-of-life care represented 2.5% of hospital bed-days (4.6% of hospital costs) in 2011.

Health risks were likely underreported

The study used self-reported exposure to health risks, which generally results in an underestimation of risk burden.[13-16] Survey respondents tend to over report what they perceive as healthy behaviour and underreport unhealthy behaviour. For example, the sum of self-reported alcohol consumption in Ontario is about half the volume of alcohol sold.[17] Reporting accuracy affects all risks explored in this study. Estimates of burden are mostly affected when people report they are in the healthiest category (e.g., non-smoker or moderate drinker) when they are actually in an unhealthy category.

Similarly, respondents were asked brief questions about risks that may not capture the full spectrum of behaviour. For example, the study's measure of physical activity considered only leisure-time activity; not included were active transportation (such as walking and bicycling to work), activity at work, or sedentary time (time spent sitting). Our measure of diet was based on fruit and vegetable consumption without specifically ascertaining the intake of sodium, trans fats, calories or other aspects of healthy and unhealthy eating.

Interpretive Cautions

Bed-days attributable to health behaviours

The study estimated hospital bed-days attributable to health behaviours. The "cause-deleted" approach calculated the need for hospital care if Ontarians were never exposed to health behaviour risks. If Ontarians' health behaviour were to begin improving today, the risk of hospitalization would soon start to decline—especially for smokers who become former smokers—but the full benefit on health and health care would likely take years to fully realize.[18,19] Furthermore, attribution to health care is best viewed as the need for hospitalization based on current resources and care, rather than actual decreases in use that could be expected if health behaviours improved. Improving health behaviours will result in less illness and poor health, which will reduce the demand for hospital care, but actual use is influenced by many additional factors including hospital budgetary restraints.

Selected behavioural health risks and the combined effect of multiple risks

The study examined four behavioural risks. Additional behavioural risks that were not examined include sexual health risks, drug misuse and unintentional injuries (e.g., unsafe driving). Also missing from our estimates was the burden attributed to second-hand exposure to health risks, such as hospitalization of passengers in motor vehicle collisions where the driver was alcohol impaired.

The estimate of hospital care attributable to a behavioural risk is subtracted from total hospital care to calculate how much less hospital care would occur if Ontarians were never exposed to the risk. Because these behaviours rarely occur in isolation (i.e., someone who smokes may also have a low level of physical activity and a poor diet), the number of hospital bed-days attributed to the individual health behaviours should not be combined, except when reported as estimates.

There is also the possibility that poor health behaviours are attributable to illness rather than the cause of it; for example, people can become less physically active after prolonged illness due to frailty and mobility limitations. If not considered and appropriately adjusted, hospital use may be inappropriately attributed to poor health behaviour rather than pre-existing illness, and the study findings may overestimate the burden attributed to health behaviours.

Findings

Hospital use attributed to smoking, poor diet, physical inactivity and unhealthy alcohol use was calculated using responses from 79,477 Ontarians surveyed between 2001 and 2005.

Hospital Use Attributed to Health Behaviours

In total, the study cohort yielded 175,857 person-years of follow-up and 67,526 hospital bed-days over five years (**Exhibit 3**). We observed increased hospitalization with all four behavioural risks (smoking, poor diet, physical inactivity and unhealthy alcohol use) in both sexes, except for unhealthy alcohol use among women. Smoking had the highest association with hospitalization. After adjusting for age, we found that current smokers had more than twice the number of hospital bed-days than people who had never smoked (**Exhibits 3** and **4**). For men, poor diet had the second highest association with hospitalization. For women, poor diet, no alcohol consumption and physical inactivity each resulted in approximately the same level of hospitalization. There was a consistent pattern of decreasing hospitalization with less exposure to smoking. People who reported heavy smoking (one or more packs per day) had the highest level of hospitalization followed by light smokers, former smokers and non-smokers. The three other risks (diet, alcohol use and physical activity) showed similar dose-response relationships. The dose-response relationship for the four health behaviours

was relatively consistent across age groups (**Exhibit A-4** in the Appendix).

There was a marked difference in the expected number of days in hospital depending on a person's health behavioural risks. Hospitalization for people with a healthy profile (i.e., non-smokers, moderate drinkers, those who had an adequate diet and those who were physically active) was a relatively uncommon occurrence with an average hospitalization of 16 days for men between the ages of 20 and 80 years and 15 days for women in that age group (**Exhibit 5**). People who were heavy smokers had considerably longer hospital stays: more than 63 days for men and 51 days for women. Exhibit 6 shows the average age at first hospitalization for Ontario adults with the unhealthiest risk exposure compared to those with healthy behaviour. On average, men with exposure to all four behaviour risks were hospitalized 25 years earlier than men with no health risks (at age 35 versus 60); for women, there was a 20-year difference (at age 38 versus 58).

Exhibit 7 presents the burden of hospitalization from health behaviours. For men, 36% of hospital use was attributed to health behaviour risks ; for women, 27%. Smoking had the largest burden of hospitalization for both men and women (22% and 12%, respectively). For women, physical activity had the second largest burden (13%). For men, diet and physical activity had similar burdens (7% and 11%, respectively). Exhibit 8 shows the costs of hospitalization from health behaviours. In 2011, the burden attributed to the four health behaviours was over $1.8 billion (approximately $1.1 billion for men and $0.8 billion for women). Exhibit 9 shows the attribution of behavioural risks on bed-days and costs by Local Health Integration Network. In general, the relationship between health behaviours and hospitalization followed a similar pattern that has been observed for other health outcomes, including the results from our *Seven More Years* study, which examined life expectancy and health-adjusted life expectancy.[1]

Hospitalization differs by socioeconomic position in Ontario (**Exhibit 10**). Ontarians with the lowest family income had hospital use that was 171% higher than Ontarians with the highest family income. More than half the difference in hospital use between social groups is not explained by health behaviours. As well, health behaviour is strongly influenced by a person's sociodemographic setting. Furthermore, a focus on equity is important for improving health behaviours.[20] There is a need to examine the broader social determinants of health to understand the impact of socioeconomic position on hospital use.

The attribution of hospital care considered how health behaviours were affected by multiple risk factors and by different methods of estimating hospitalization. Exhibit 7 shows a range attribution for health behaviours that reflects the adjustment for multiple risk. The process of risk factor adjustment is depicted in Exhibits A-1 and A-3 in the Appendix. Exhibits A-9 and A-10 in the Appendix show how each adjusted approach affected the burden estimate for each health behaviour. As we expected, the attribution of hospitalization to health behaviour risks decreased as we increased the number of risk factors adjusted for in each model. We found that smoking had the most robust burden estimate with the smallest attenuation of risk during different adjustments. The physical activity burden varied to a greater degree; when we considered people with chronic diseases (including cancer, heart disease and diabetes) and their level of mobility, the attribution of hospital care decreased considerably. The attenuation of the physical activity burden is, in part, a consequence of being ill and frail and therefore unable to maintain a high level of physical activity. As noted earlier, a limitation of our study is the inability to identify the mechanism of health behaviour (i.e., whether a person's poor health behaviour is attributable to illness or causes it).

The three scenarios from our sensitivity analysis demonstrate a result similar to our main analysis (**Exhibit A-10** in the Appendix). Including the first year of follow-up had little to no impact on the burden estimates for both men and women. Excluding high health care users demonstrated slightly attenuated burdens for men and women, while excluding people who needed help to perform basic tasks attenuated the burdens only for women.

Individuals can determine their own risk of hospitalization with a new calculator based on smoking, alcohol consumption, diet and physical activity, and other factors such as age and sex.

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EXHIBIT 3 Number of hospital bed-days and person-years of follow-up attributed to selected health behaviours for Ontario adults aged 20 to 79, by sex, in a five-year period from 2001 to 2012*

Key message

- For each health behaviour (smoking, alcohol consumption, diet and physical activity), there was a dose-response with hospital use—people with worse health behaviours had higher hospital use.

	Men (n = 36,991)				Women (n = 42,486)			
	Hospital bed-days	Person-years of follow-up	Age-adjusted rate‡ (95% CI)	Relative rate (95% CI)	Hospital bed-days	Person-years of follow-up	Age-adjusted rate‡ (95% CI)	Relative rate (95% CI)
Ontario	67,526	175,857	0.36 (0.36, 0.37)	-	80,050	201,995	0.35 (0.35, 0.35)	-
Smoking								
Heavy smoker	10,671	21,421	0.62 (0.61, 0.63)	2.49 (2.43, 2.55)	8,392	14,421	0.65 (0.63, 0.66)	2.14 (2.09, 2.19)
Light smoker	9,368	29,478	0.43 (0.42, 0.44)	1.72 (1.68, 1.76)	13,238	36,006	0.46 (0.45, 0.47)	1.52 (1.49, 1.55)
Former heavy smoker	19,247	30,858	0.35 (0.34, 0.36)	1.42 (1.37, 1.46)	11,016	18,302	0.47 (0.45, 0.48)	1.55 (1.50, 1.60)
Former light smoker	11,589	26,606	0.33 (0.32, 0.34)	1.31 (1.27, 1.35)	12,946	33,264	0.30 (0.30, 0.31)	1.00 (0.98, 1.02)
Non-smoker	15,917	66,328	0.25 (0.25, 0.25)	Ref.	33,668	98,741	0.30 (0.30, 0.31)	Ref.
Missing	733	1,165	-	-	791	1,262	-	-
Alcohol								
Heavy drinker	10,509	37,476	0.39 (0.38, 0.40)	1.42 (1.39, 1.45)	3,760	19,248	0.31 (0.30, 0.32)	1.14 (1.10, 1.18)
Moderate drinker	32,015	95,499	0.28 (0.27, 0.28)	Ref.	30,483	101,611	0.28 (0.27, 0.28)	Ref.
Current non-drinker	23,818	40,299	0.51 (0.50, 0.51)	1.84 (1.81, 1.87)	44,959	79,233	0.49 (0.49, 0.50)	1.79 (1.77, 1.82)
Missing	1,184	2,582	-	-	848	1,904	-	-
Diet								
Very poor diet	9,398	23,859	0.51 (0.50, 0.52)	1.81 (1.77, 1.84)	6,758	16,494	0.50 (0.49, 0.51)	1.54 (1.50, 1.57)
Fair diet	17,782	46,167	0.39 (0.38, 0.39)	1.37 (1.34, 1.39)	16,422	36,480	0.45 (0.45, 0.46)	1.40 (1.37, 1.42)
Adequate diet	36,491	101,088	0.28 (0.28, 0.29)	Ref.	53,965	145,724	0.32 (0.32, 0.33)	Ref.
Missing	3,855	4,742	-	-	2,905	3,296	-	-
Physical activity								
Inactive	34,958	79,182	0.40 (0.40, 0.41)	1.57 (1.54, 1.61)	49,086	101,681	0.44 (0.43, 0.44)	1.61 (1.58, 1.64)
Moderately active	14,996	43,436	0.30 (0.30, 0.31)	1.18 (1.16, 1.21)	16,896	53,304	0.28 (0.28, 0.29)	1.04 (1.01, 1.06)
Active	13,732	47,686	0.26 (0.25, 0.26)	Ref.	12,362	45,119	0.27 (0.27, 0.28)	Ref.
Missing	3,840	5,553	-	-	1,706	1,891	-	-

*Follow-up years two to six for respondents to the Canadian Community Health Surveys conducted in 2001, 2003 and 2005.

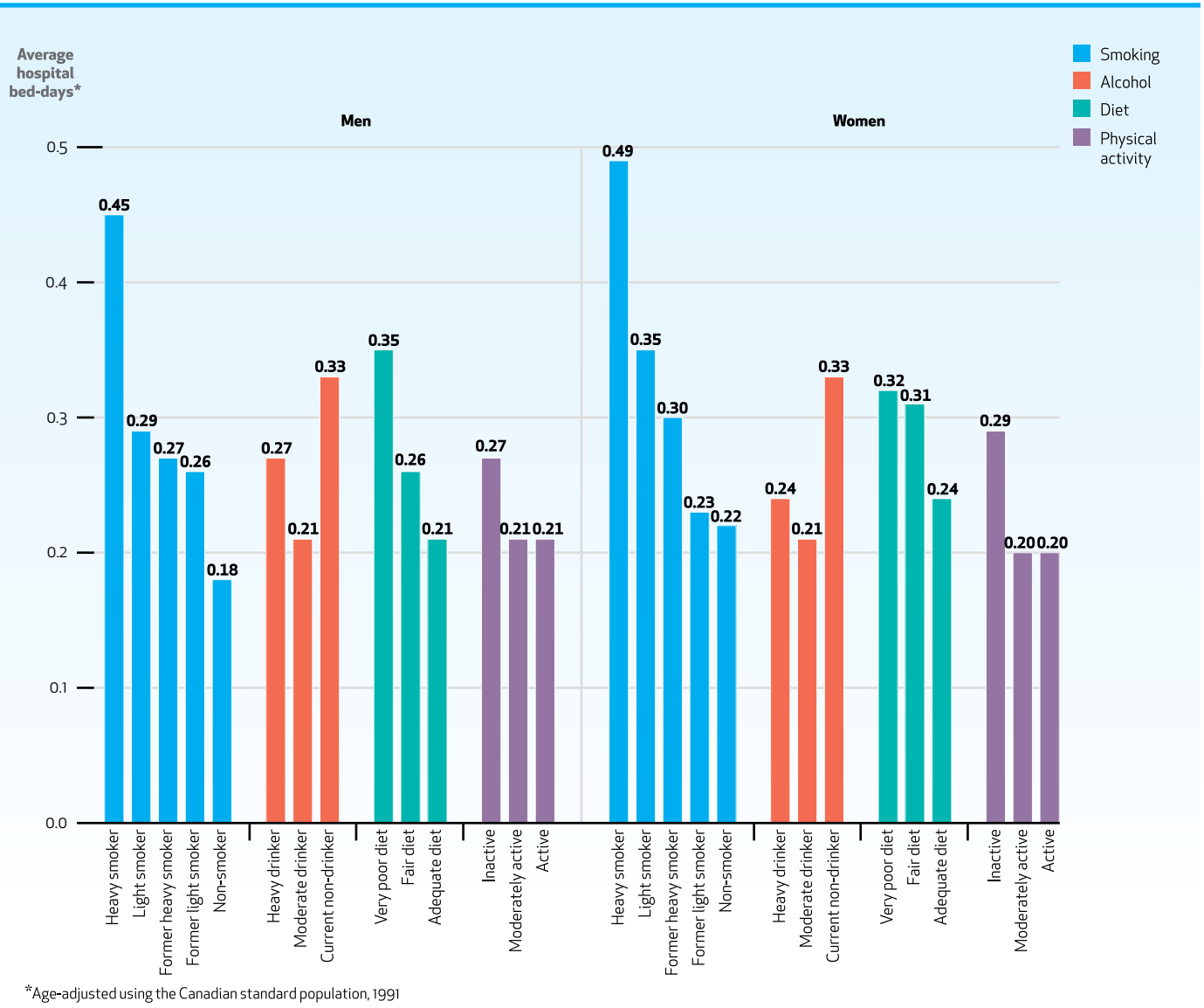
‡Number of hospital bed-days per person-year, age-adjusted using the 1991 Canadian standard population.

CI = confidence interval

EXHIBIT 4 Average number of hospital bed-days per year attributed to selected health behaviours for Ontario adults aged 20 to 79, by sex, 2001 to 2012

Key messages

- Among men, those who were current smokers had the highest annual number of hospital bed-days, followed by those with a poor diet.
- Among women, those who were current smokers had the highest annual number of hospital bed-days.
- Women who were current non-drinkers, had poor diets or were physically inactive had similar numbers of annual hospital bed-days.

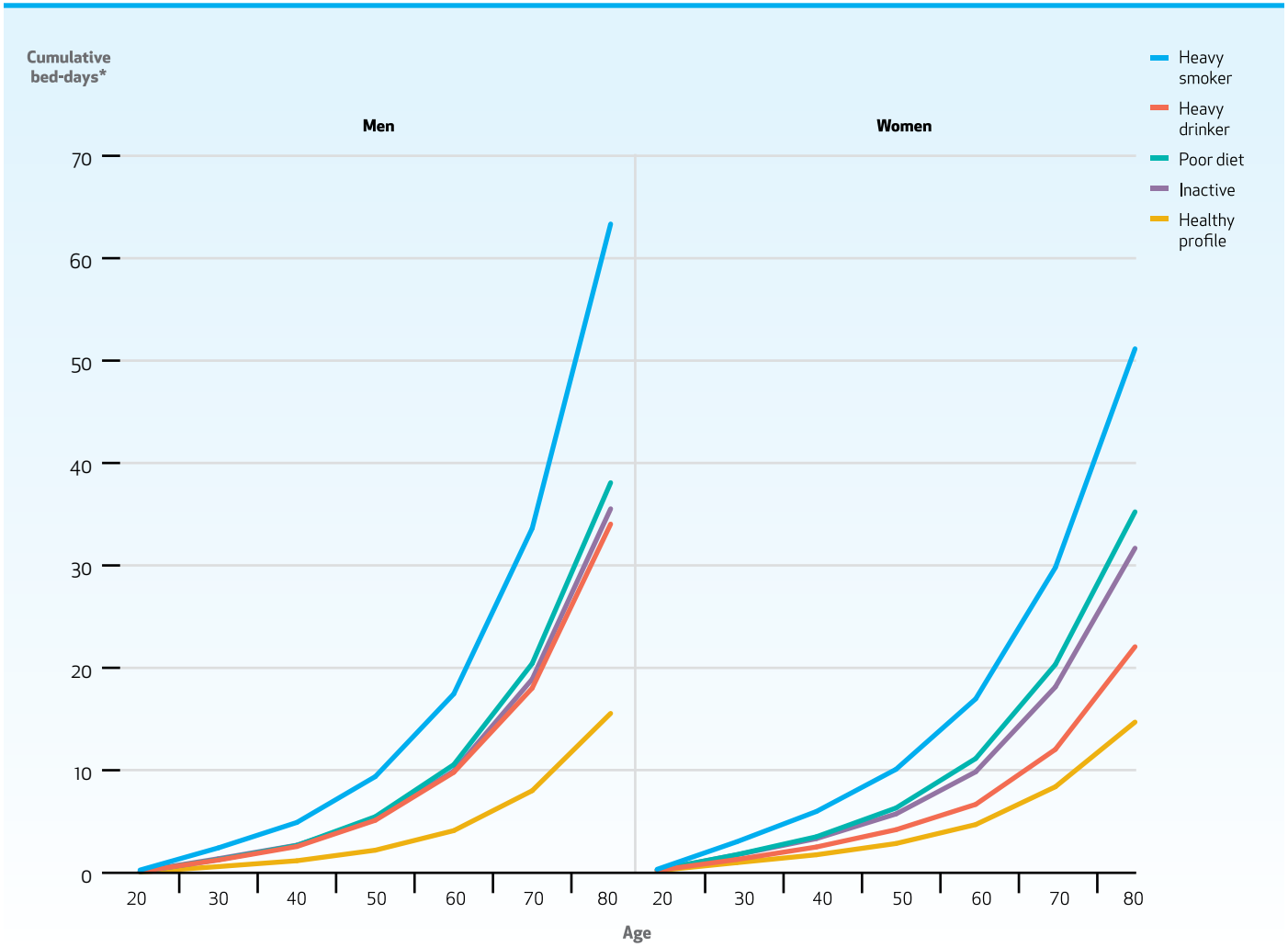


*Age-adjusted using the Canadian standard population, 1991

EXHIBIT 5 Cumulative number of hospital bed-days attributed to healthy versus unhealthy exposure to selected health behaviours for Ontario adults aged 20 to 79, by age and sex, 2001 to 2012

Key messages

- Ontario adults with a healthy profile (non-smoker, moderate drinker, adequate diet and physically active) had the lowest hospital use (16 bed-days for men and 15 bed-days for women, accumulated between ages 20 and 80).
- Heavy smokers had the highest hospital use (63 bed-days for men, 51 bed-days for women).

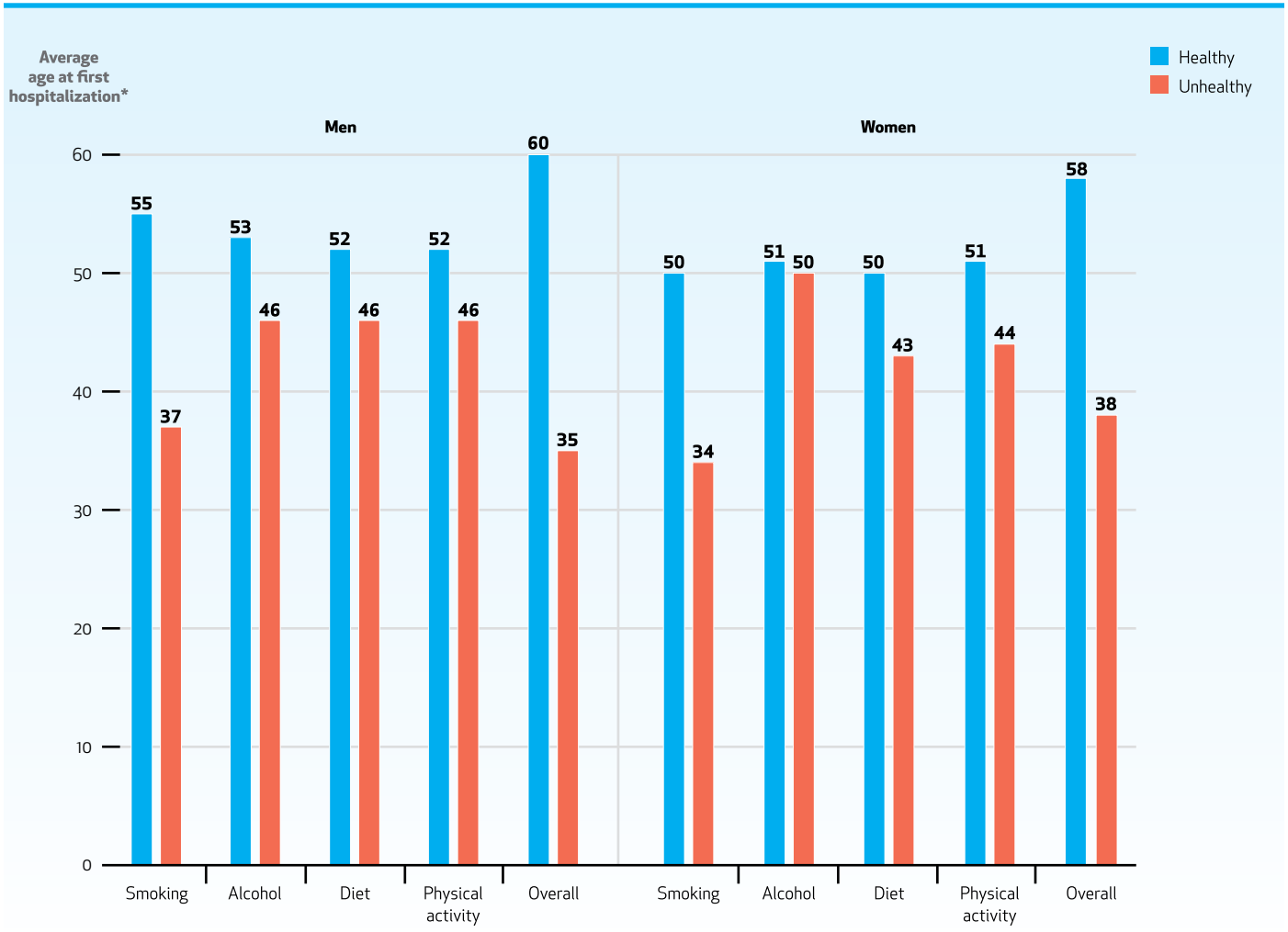


*The cumulative number of bed-days was calculated by estimating the number of bed-days by age and subgroup (e.g., heavy smokers) from the multivariable risk model and summing the results to provide age-specific cumulative estimates.

EXHIBIT 6 Average age at first hospitalization attributed to healthy versus unhealthy exposure to selected behaviours for Ontario adults aged 20 to 79, by sex, 2001 to 2012

Key message

- A 25-year gap existed between the average age at first hospitalization for men who had all four behavioural risks and men with none of the four risks; among women, this gap was 20 years.

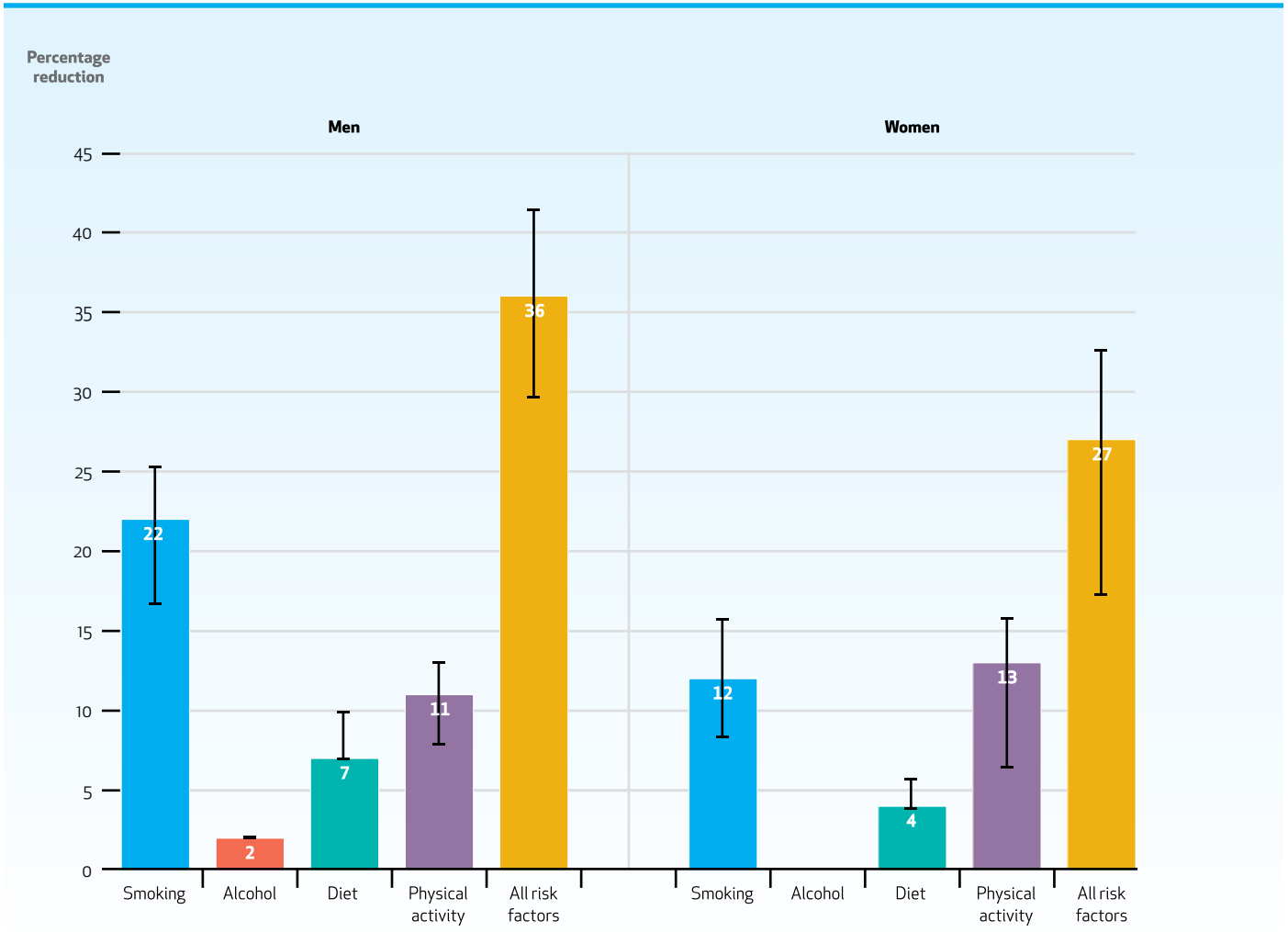


*The average age at first hospitalization was estimated from the cumulative behavioural profiles as the age at which the profile (e.g., heavy smoker) surpassed four bed-days (i.e., the median length of hospital stay during the study period).

EXHIBIT 7 Impact of eliminating selected health behavioural risks on hospital bed-days (percentage reduction)* for Ontario adults aged 20 to 79, by sex, 2001 to 2012

Key messages

- Smoking accounted for 22% of men's and 12% of women's hospital bed-days.
- Overall, physical activity accounted for 11% of men's and 13% of women's hospital bed-days.
- The four risk factors combined accounted for 36% of men's and 27% of women's hospital bed-days.



*Error bars represent high (Model 1) and low (Model 6) boundaries on the burden estimates.

EXHIBIT 8 Hospital bed-days and costs for Ontario adults aged 20 to 79, by health behaviour, 2011

Key message

- The burden of the four health behaviour risks equated to more than 900,000 hospital bed-days and more than $1.8 billion in hospital costs in 2011.

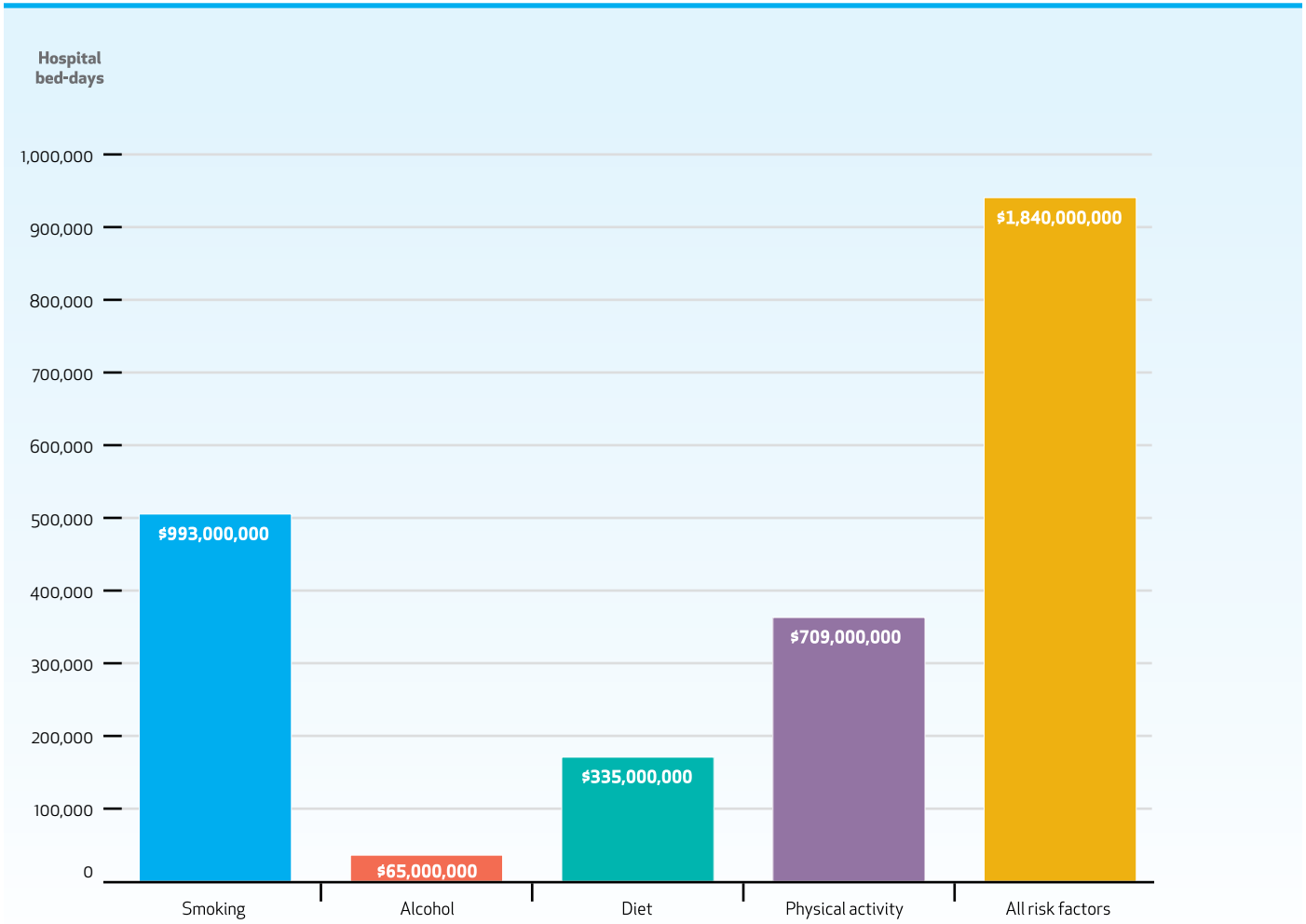


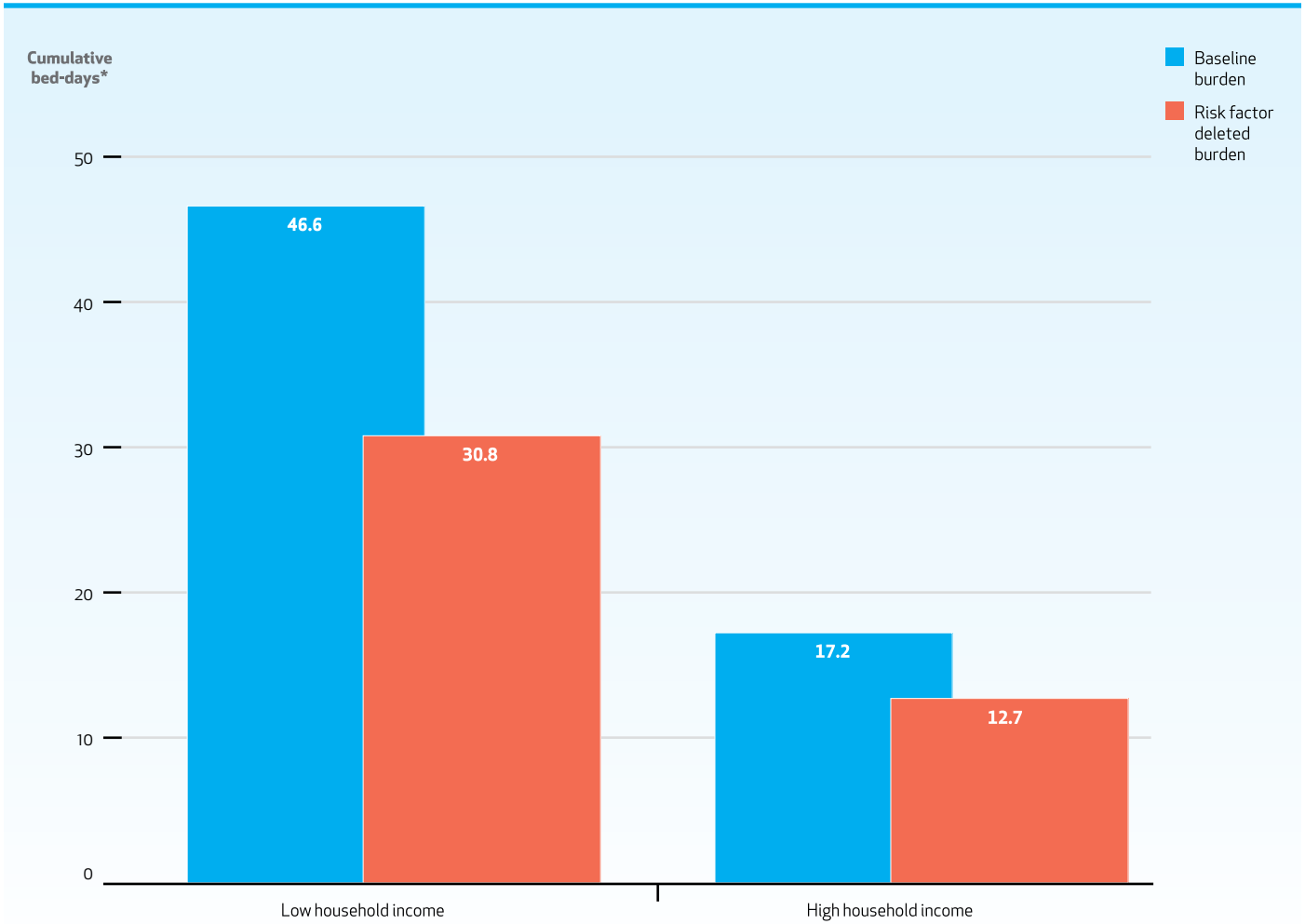
EXHIBIT 9 Attribution of risk behaviour, hospital bed-days and hospital costs to selected health behaviours for Ontario adults aged 20 to 79, by Local Health Integration Network, 2011

Local Health Integration Network	Smoking	Alcohol	Diet	Physical Activity	All Risk Factors
Risk behaviour attribution, %					
Erie St. Clair	18.7	1.3	6.3	12.5	33.6
South West	16.8	1.1	5.7	12.5	31.8
Waterloo Wellington	16.8	1.2	5.6	12.5	31.6
Hamilton Niagara Haldimand Brant	18.0	1.3	5.7	11.9	32.1
Central West	14.3	0.9	5.8	13.1	30.1
Mississauga Halton	14.7	0.8	5.4	12.8	29.8
Toronto Central	16.2	1.0	5.6	12.1	30.7
Central	14.8	0.9	5.4	12.3	29.6
Central East	15.9	0.9	5.1	12.6	30.5
South East	18.7	1.2	5.8	12.0	33.0
Champlain	18.0	1.1	6.3	11.7	32.4
North Simcoe Muskoka	19.9	1.4	6.1	11.2	33.6
North East	20.0	1.2	6.3	11.8	34.2
North West	19.2	1.5	5.7	10.6	32.4
Attributable bed-days, n					
Erie St. Clair	29,700	2,040	9,970	20,100	53,500
South West	38,100	2,330	12,900	28,700	72,100
Waterloo Wellington	23,900	1,760	7,970	17,900	45,100
Hamilton Niagara Haldimand Brant	64,300	4,400	20,200	43,400	116,000
Central West	22,300	1,380	9,100	20,500	47,100
Mississauga Halton	30,500	1,680	11,300	26,800	62,200
Toronto Central	39,500	2,310	13,700	29,700	74,900
Central	46,500	2,690	17,100	39,200	93,800
Central East	49,400	2,830	15,800	39,900	95,500
South East	24,100	1,510	7,480	15,500	42,500
Champlain	54,100	3,260	18,800	35,800	98,000
North Simcoe Muskoka	21,900	1,500	6,710	12,400	37,000
North East	42,700	2,550	13,500	25,300	73,100
North West	16,900	1,260	5,020	9,540	28,800
Attributable costs, $					
Erie St. Clair	60,900,000	4,340,000	20,400,000	40,200,000	109,000,000
South West	77,200,000	4,930,000	26,300,000	57,000,000	145,000,000
Waterloo Wellington	48,700,000	3,700,000	16,300,000	35,900,000	91,500,000
Hamilton Niagara Haldimand Brant	129,000,000	9,260,000	40,600,000	85,000,000	230,000,000
Central West	45,700,000	2,970,000	18,700,000	40,800,000	95,300,000
Mississauga Halton	59,600,000	3,410,000	21,800,000	50,900,000	120,000,000
Toronto Central	75,800,000	4,590,000	26,300,000	56,000,000	143,000,000
Central	92,300,000	5,580,000	33,700,000	75,600,000	184,000,000
Central East	98,900,000	5,950,000	31,600,000	78,300,000	190,000,000
South East	48,700,000	3,160,000	15,200,000	31,000,000	85,700,000
Champlain	101,000,000	6,430,000	35,400,000	65,800,000	183,000,000
North Simcoe Muskoka	44,400,000	3,210,000	13,700,000	24,800,000	74,900,000
North East	80,000,000	5,000,000	25,400,000	46,500,000	136,000,000
North West	30,500,000	2,350,000	9,070,000	16,900,000	51,700,000

EXHIBIT 10 Difference in cumulative hospital bed-days resulting from elimination of health behavioural risks for Ontario adults aged 20 to 79, by level of household income, 2001 to 2012

Key messages

- Adults with the lowest household income had 171% more hospital use than adults with the highest household income (46.6 bed-days versus 17.2 bed-days).
- Less than half of this gap can be attributed to health behaviours. After removing behavioural risks, the remaining gap was 30.8 bed-days for adults with low household income versus 12.7 bed-days for adults with high household income.



*The cumulative number of bed-days was calculated by estimating the number of bed-days by patient age and income group from the multivariable risk model and summing the results to provide age-standardized cumulative estimates.

Conclusion

This study suggests that a considerable reduction in hospital need in Ontario could be achieved through healthier living. We found that 36% of hospital use could be attributed to health behaviours; this equates to more than 900,000 hospital bed-days annually.

Reducing Demand for Hospital Care

This study confirms our previous analyses which showed that health behaviours are an important contribution to poor health.[1] Hospital care, for the most part, seeks to maintain or restore health to people with important illness or disability. This means that preventing hospital use can be equated with preventing health-limiting illness or disability.

In our previous study, we found that poor health behaviour was associated with increasingly higher mortality. In this study, we found the same relationship but with hospital care somewhat more concentrated in people with worse health behaviour. Improvements for people with the worst health behaviours, such as smoking, very poor diet and very limited physical activity, will have proportionately greater impact on hospital care than incremental improvements in the health behaviours of other people. We observed this relationship, in part, because people with the worst health behaviours have multiple hospital admissions and extended lengths of stay.

Ontario's public health strategy, *Make No Little Plans*, challenges us to consider improved health behaviours an imperative for government and society.[22] Furthermore, Ontario is adopting the IHI

Triple Aim framework to simultaneously pursue three dimensions of broader and linked goals: improving the patient experience of care; improving the health of populations; and reducing the per capita cost of health care.[23]

Our study further supports the preventive imperative and also strongly suggests that prevention can achieve at least two of the three Triple Aim goals: namely, improving population health while also constraining cost growth or demand. Patient experience can also be improved. People, including patients, commonly request improved preventive services.[24] As well, reducing demand for hospital care through prevention will allow hospitals to provide higher quality care.

Public health policy can often be implemented at a relatively lower cost and with fewer resources than large health behaviour–attributable hospital costs (more than $1.8 billion annually). This suggests that there is considerable potential for a reduction in hospital need that exceeds the cost of implementing healthy public policy. For example, at the time of writing, the Ontario government has introduced legislation that will require restaurants to post calorie information on their menus.[25] Given that our study finds that $355 million is spent annually on diet-attributable hospitalizations, it is quite possible that the cost of implementing this intervention will be far exceeded by the reduction in subsequent health care use, if labeling is successful in improving diets.

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Appendix

List of Exhibits

EXHIBIT A-1 Overview of study methods

CREATED A STUDY POPULATION	• Combined Canadian Community Health Surveys (CCHS 1.1, 2.1, 3.1). • Linked survey respondents to their hospital use for seven years of follow-up. • Examined hospitalization from year two. Excluded hospital care for obstetrics and for the last year of life.
EXAMINED THE RELATIONSHIP BETWEEN HEALTH BEHAVIOURS AND HEALTH OUTCOMES	• Created a multivariate model that examined health behaviour adjusting for sociodemographic and other risks. • Assessed model calibration: observed versus predicted hospital care across intermediate risks (e.g., body mass index) and distal risks (e.g., chronic disease) and adjusted if needed. • Used sensitivity testing to assess the robustness of burden estimates. Compared burden by excluding people who were frail or high health care users. Assessed burden in first year of follow-up.
ESTIMATED THE CONTRIBUTION OF HEALTH BEHAVIOURS TO HOSPITAL USE	• Considered health behaviours separately and combined. • Examined two outcomes: total bed-days and hospital costs.

EXHIBIT A-2 Creation of study cohort

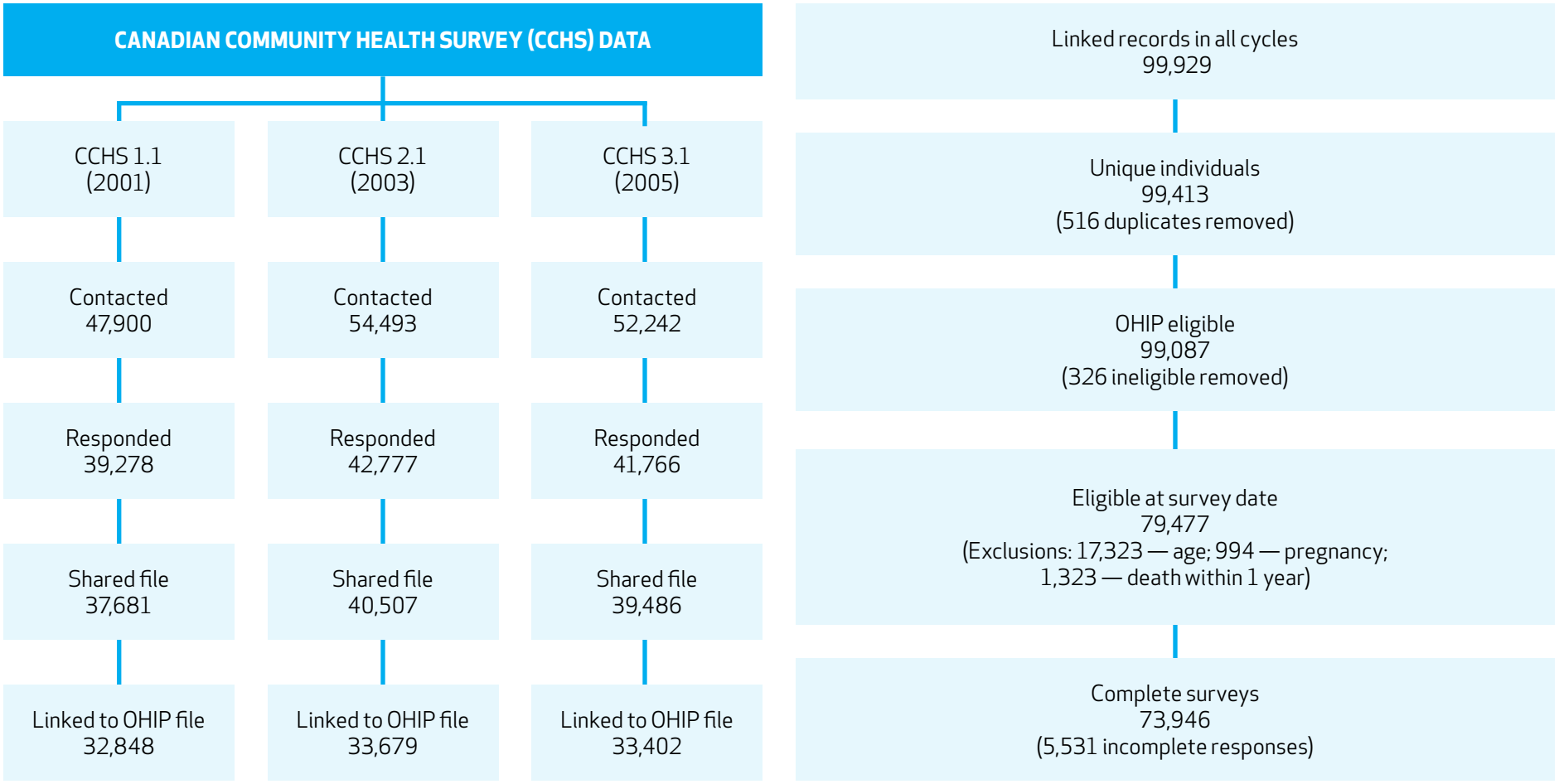


EXHIBIT A-3 Stepped approach to model building — consideration of factors leading to hospital use and costs

Key messages

- Behavioural risks are the focus of public health programs in Ontario.
- This report focuses on the attribution of behavioural risk factors to hospital use. Burden calculations were adjusted for background risk factors and body mass index (Model 3)

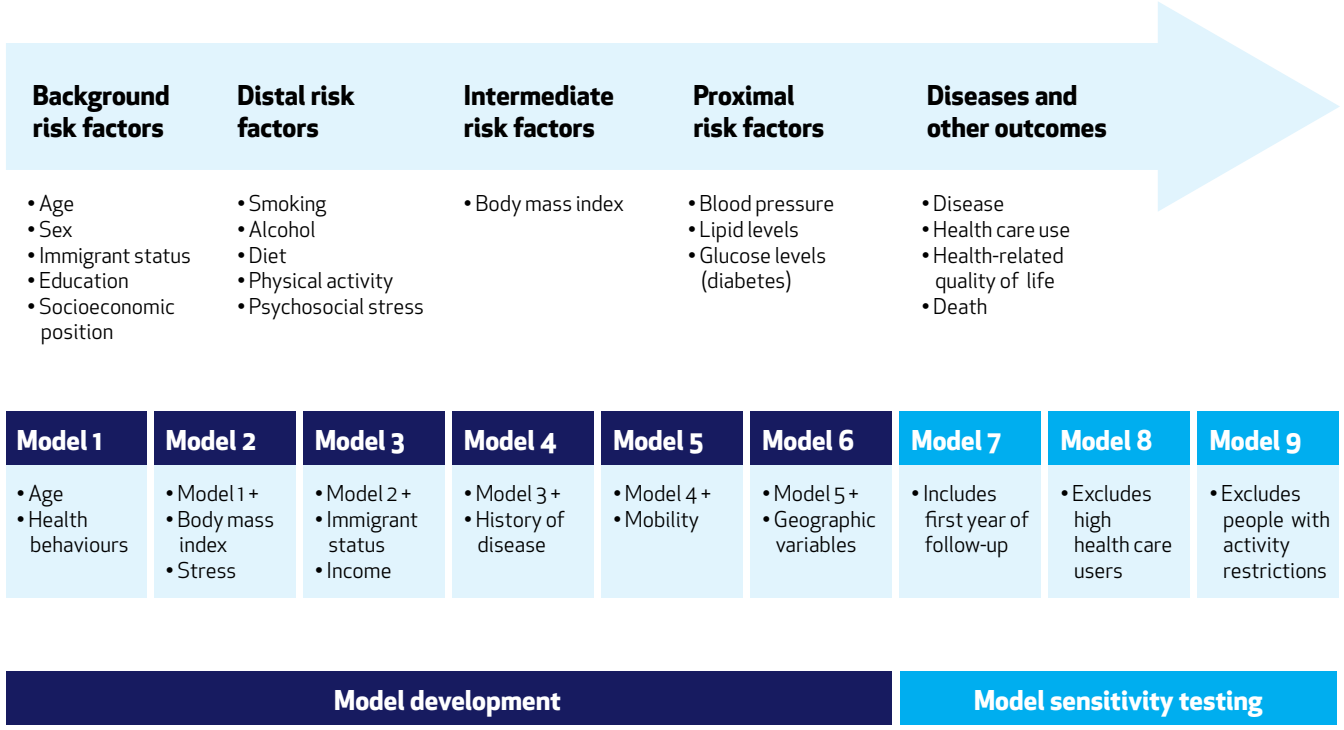


EXHIBIT A-4 Number of annual hospital bed-days attributed to smoking, alcohol, diet and physical activity, by patient age and sex (unadjusted analysis), in Ontario

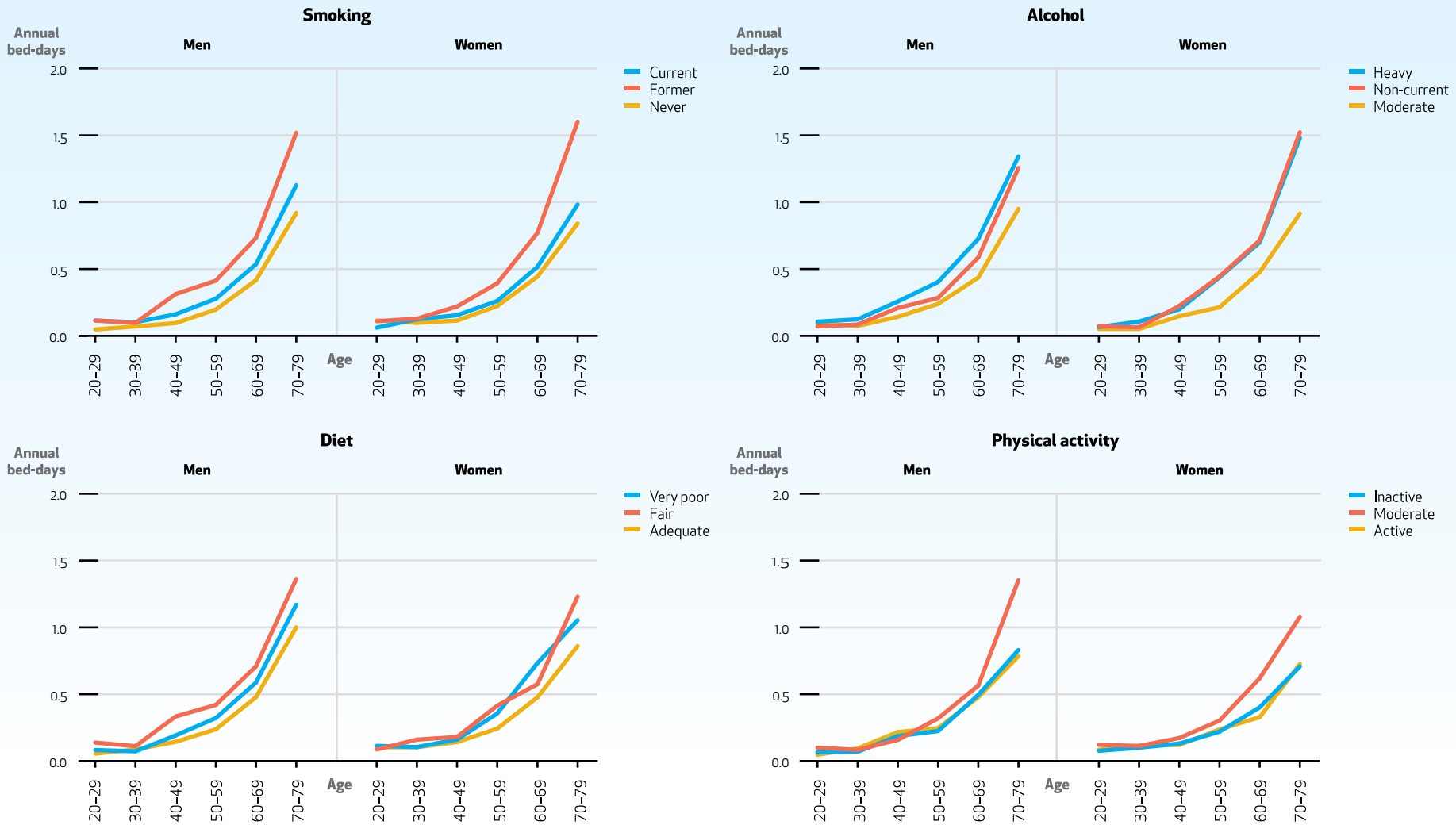


EXHIBIT A-5 Risk of hospitalization event — logistic regression component of the models for the male cohort

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Age group (years)						
75 to 79	8.96 (8.02, 10.0)	9.47 (8.48, 10.58)	8.62 (7.71, 9.65)	6.61 (5.88, 7.42)	5.94 (5.28, 6.68)	6.02 (5.36, 6.77)
70 to 74	7.31 (6.58, 8.13)	7.62 (6.84, 8.48)	7.01 (6.29, 7.82)	5.63 (5.03, 6.29)	5.22 (4.66, 5.84)	5.30 (4.73, 5.93)
65 to 69	5.75 (5.17, 6.40)	5.87 (5.27, 6.53)	5.58 (5.01, 6.22)	4.66 (4.17, 5.21)	4.35 (3.89, 4.86)	4.38 (3.92, 4.90)
60 to 64	4.19 (3.77, 4.66)	4.20 (3.78, 4.67)	4.11 (3.69, 4.57)	3.56 (3.19, 3.96)	3.30 (2.96, 3.68)	3.33 (2.98, 3.71)
55 to 59	3.01 (2.71, 3.35)	2.96 (2.66, 3.29)	2.95 (2.65, 3.28)	2.69 (2.41, 3.00)	2.53 (2.27, 2.83)	2.55 (2.29, 2.84)
50 to 54	2.15 (1.92, 2.42)	2.11 (1.88, 2.37)	2.14 (1.90, 2.40)	2.05 (1.82, 2.30)	1.92 (1.71, 2.16)	1.93 (1.72, 2.17)
40 to 49	1.39 (1.26, 1.54)	1.37 (1.24, 1.51)	1.39 (1.25, 1.53)	1.36 (1.23, 1.50)	1.33 (1.21, 1.48)	1.34 (1.22, 1.49)
20 to 39	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Smoking						
Heavy smoker	1.62 (1.49, 1.77)	1.63 (1.50, 1.78)	1.53 (1.41, 1.67)	1.51 (1.39, 1.65)	1.43 (1.31, 1.57)	1.43 (1.31, 1.56)
Light smoker	1.30 (1.19, 1.41)	1.31 (1.21, 1.43)	1.29 (1.18, 1.41)	1.26 (1.16, 1.38)	1.21 (1.11, 1.32)	1.21 (1.11, 1.32)
Former heavy smoker	1.47 (1.37, 1.58)	1.44 (1.34, 1.55)	1.41 (1.31, 1.51)	1.32 (1.23, 1.43)	1.29 (1.19, 1.39)	1.28 (1.18, 1.37)
Former light smoker	1.22 (1.12, 1.32)	1.22 (1.12, 1.32)	1.21 (1.11, 1.31)	1.18 (1.08, 1.28)	1.15 (1.06, 1.25)	1.14 (1.05, 1.23)
Non-smoker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Physical activity						
Inactive	1.10 (1.05, 1.16)	1.07 (1.02, 1.13)	1.07 (1.02, 1.13)	1.05 (1.00, 1.11)	1.01 (0.96, 1.07)	1.02 (0.97, 1.08)
Active	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Diet						
Poor diet (0 to <4)	1.06 (1.00, 1.12)	1.05 (1.00, 1.11)	1.03 (0.97, 1.08)	1.04 (0.98, 1.10)	1.04 (0.98, 1.10)	1.03 (0.98, 1.09)
Adequate diet (4 to 10)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol						
Heavy drinker	1.05 (0.97, 1.13)	1.05 (0.97, 1.13)	1.03 (0.95, 1.10)	1.03 (0.96, 1.11)	1.04 (0.96, 1.12)	1.03 (0.96, 1.11)
Current non-drinker	1.27 (1.19, 1.35)	1.25 (1.18, 1.33)	1.23 (1.16, 1.31)	1.18 (1.11, 1.25)	1.14 (1.07, 1.22)	1.14 (1.07, 1.21)
Moderate drinker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Body mass index						
≥30 (obese)		1.33 (1.25, 1.42)	1.31 (1.23, 1.40)	1.24 (1.16, 1.32)	1.19 (1.12, 1.27)	1.19 (1.11, 1.27)
<30 (non-obese)		Ref.	Ref.	Ref.	Ref.	Ref.
Stress						
Quite a bit or extremely		1.25 (1.17, 1.33)	1.26 (1.18, 1.34)	1.21 (1.13, 1.29)	1.14 (1.06, 1.22)	1.14 (1.07, 1.22)
Not stressed		Ref.	Ref.	Ref.	Ref.	Ref.
Income						
Low			1.27 (1.17, 1.38)	1.21 (1.11, 1.31)	1.1 (1.01, 1.20)	1.09 (1.00, 1.19)
Moderate or missing			1.11 (1.04, 1.19)	1.09 (1.02, 1.17)	1.06 (0.99, 1.14)	1.06 (0.99, 1.13)
High			Ref.	Ref.	Ref.	Ref.

EXHIBIT A-5 *continued*

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Immigration status (years in Canada)						
<15			0.63 (0.52, 0.77)	0.65 (0.53, 0.79)	0.69 (0.56, 0.84)	0.72 (0.59, 0.88)
15 to <30			0.73 (0.63, 0.85)	0.74 (0.63, 0.86)	0.76 (0.65, 0.89)	0.8 (0.68, 0.93)
30 to <45			0.86 (0.77, 0.96)	0.86 (0.77, 0.96)	0.88 (0.78, 0.98)	0.9 (0.81, 1.00)
≥45 or native born			Ref.	Ref.	Ref.	Ref.
Heart disease						
Yes				1.99 (1.84, 2.16)	1.83 (1.69, 1.99)	1.82 (1.68, 1.97)
No				Ref.	Ref.	Ref.
Stroke						
Yes				1.55 (1.30, 1.85)	1.35 (1.14, 1.61)	1.37 (1.15, 1.63)
No				Ref.	Ref.	Ref.
Cancer						
Yes				1.46 (1.27, 1.68)	1.38 (1.20, 1.58)	1.37 (1.20, 1.57)
No				Ref.	Ref.	Ref.
Diabetes						
Yes				1.45 (1.33, 1.58)	1.39 (1.28, 1.51)	1.39 (1.28, 1.52)
No				Ref.	Ref.	Ref.
Mobility						
Needs help from others					2.09 (1.89, 2.31)	2.08 (1.88, 2.30)
Restricted physically					1.46 (1.38, 1.55)	1.45 (1.37, 1.54)
No physical restriction					Ref.	Ref.
Deprivation						
Moderate or unknown						0.94 (0.88, 1.01)
High						0.97 (0.89, 1.07)
Missing						Ref.
Injury rate†						1.27 (1.16, 1.38)
Goodness of fit (AICc)*	112,711	112,562	112,341	111,739	111,277	111,200

†Local Health Integration Network rate of injury-related hospitalizations

*Akaike information criterion for finite sample sizes

EXHIBIT A-6 Hospital bed-days — negative binomial regression component of the models for the male cohort

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Age group (years)						
75 to 79	2.62 (2.26, 3.03)	2.63 (2.27, 3.05)	2.27 (1.95, 2.63)	2.20 (1.89, 2.57)	2.11 (1.81, 2.46)	2.08 (1.78, 2.42)
70 to 74	2.09 (1.81, 2.42)	2.11 (1.82, 2.44)	1.84 (1.59, 2.13)	1.80 (1.55, 2.10)	1.78 (1.53, 2.08)	1.74 (1.49, 2.02)
65 to 69	1.58 (1.37, 1.83)	1.59 (1.37, 1.84)	1.43 (1.23, 1.66)	1.40 (1.21, 1.63)	1.39 (1.20, 1.62)	1.37 (1.18, 1.59)
60 to 64	1.54 (1.32, 1.78)	1.54 (1.32, 1.78)	1.45 (1.25, 1.68)	1.44 (1.24, 1.67)	1.43 (1.23, 1.66)	1.38 (1.19, 1.60)
55 to 59	1.56 (1.34, 1.82)	1.56 (1.34, 1.82)	1.53 (1.31, 1.78)	1.52 (1.30, 1.77)	1.48 (1.27, 1.73)	1.42 (1.21, 1.65)
50 to 54	1.26 (1.07, 1.49)	1.26 (1.07, 1.48)	1.20 (1.02, 1.42)	1.19 (1.00, 1.40)	1.18 (1.00, 1.39)	1.14 (0.96, 1.34)
40 to 49	1.44 (1.24, 1.66)	1.43 (1.23, 1.65)	1.41 (1.22, 1.64)	1.44 (1.24, 1.67)	1.34 (1.15, 1.55)	1.30 (1.12, 1.51)
20 to 39	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Smoking						
Heavy smoker	1.59 (1.41, 1.80)	1.60 (1.41, 1.81)	1.50 (1.33, 1.70)	1.50 (1.32, 1.70)	1.48 (1.31, 1.67)	1.44 (1.28, 1.63)
Light smoker	1.27 (1.12, 1.43)	1.27 (1.12, 1.43)	1.13 (1.00, 1.28)	1.14 (1.01, 1.29)	1.14 (1.01, 1.29)	1.14 (1.01, 1.28)
Former heavy smoker	1.00 (0.91, 1.10)	1.00 (0.90, 1.10)	0.97 (0.88, 1.07)	0.95 (0.86, 1.04)	0.94 (0.86, 1.04)	0.94 (0.85, 1.04)
Former light smoker	1.06 (0.95, 1.19)	1.06 (0.95, 1.18)	1.03 (0.92, 1.15)	1.02 (0.92, 1.14)	1.02 (0.92, 1.14)	1.04 (0.94, 1.16)
Non-smoker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Physical activity						
Inactive	1.18 (1.10, 1.27)	1.18 (1.10, 1.27)	1.17 (1.09, 1.26)	1.16 (1.08, 1.25)	1.14 (1.06, 1.22)	1.14 (1.06, 1.22)
Active	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Diet						
Poor diet (0 to <4)	1.24 (1.15, 1.33)	1.23 (1.14, 1.33)	1.19 (1.10, 1.28)	1.20 (1.11, 1.29)	1.18 (1.09, 1.27)	1.17 (1.09, 1.26)
Adequate diet (4 to 10)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol						
Heavy drinker	1.12 (1.01, 1.24)	1.12 (1.01, 1.25)	1.14 (1.03, 1.26)	1.15 (1.04, 1.28)	1.15 (1.04, 1.27)	1.13 (1.02, 1.25)
Current non-drinker	1.40 (1.29, 1.52)	1.40 (1.29, 1.51)	1.27 (1.17, 1.38)	1.24 (1.14, 1.35)	1.19 (1.10, 1.30)	1.18 (1.09, 1.29)
Moderate drinker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Body mass index						
≥30 (obese)		1.04 (0.95, 1.13)	1.00 (0.92, 1.09)	0.97 (0.89, 1.06)	0.96 (0.88, 1.04)	0.95 (0.87, 1.03)
<30 (non-obese)		Ref.	Ref.	Ref.	Ref.	Ref.
Stress						
Quite a bit or extremely		1.04 (0.95, 1.14)	1.05 (0.96, 1.15)	1.04 (0.95, 1.14)	0.99 (0.91, 1.08)	0.99 (0.91, 1.09)
Not stressed		Ref.	Ref.	Ref.	Ref.	Ref.
Income						
Low			1.73 (1.54, 1.93)	1.68 (1.50, 1.89)	1.57 (1.40, 1.76)	1.43 (1.27, 1.61)
Moderate or missing			1.28 (1.16, 1.40)	1.27 (1.16, 1.40)	1.23 (1.11, 1.35)	1.16 (1.05, 1.27)
High			Ref.	Ref.	Ref.	Ref.

EXHIBIT A-6 *continued*

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Immigration status (years in Canada)						
<15			0.81 (0.61, 1.08)	0.83 (0.62, 1.11)	0.86 (0.64, 1.15)	0.91 (0.68, 1.21)
15 to <30			1.02 (0.82, 1.27)	1.03 (0.83, 1.29)	1.05 (0.84, 1.31)	1.08 (0.87, 1.35)
30 to <45			0.97 (0.84, 1.12)	0.96 (0.83, 1.12)	0.94 (0.81, 1.09)	0.98 (0.84, 1.13)
≥45 or native born			Ref.	Ref.	Ref.	Ref.
Heart disease						
Yes				0.96 (0.88, 1.06)	0.91 (0.83, 1.00)	0.92 (0.83, 1.01)
No				Ref.	Ref.	Ref.
Stroke						
Yes				1.24 (1.02, 1.50)	1.13 (0.93, 1.37)	1.10 (0.91, 1.34)
No				Ref.	Ref.	Ref.
Cancer						
Yes				1.10 (0.94, 1.30)	1.10 (0.94, 1.29)	1.08 (0.92, 1.27)
No				Ref.	Ref.	Ref.
Diabetes						
Yes				1.29 (1.16, 1.43)	1.28 (1.15, 1.42)	1.28 (1.16, 1.42)
No				Ref.	Ref.	Ref.
Mobility						
Needs help from others					1.61 (1.42, 1.82)	1.58 (1.40, 1.79)
Restricted physically					1.14 (1.05, 1.23)	1.14 (1.05, 1.23)
No physical restriction					Ref.	Ref.
Deprivation						
Moderate or unknown						1.19 (1.08, 1.31)
High						1.35 (1.19, 1.53)
Missing						Ref.
Injury rate†						1.20 (1.07, 1.34)
Goodness of fit (AICc)*	112,711	112,562	112,341	111,739	111,277	111,200

†Local Health Integration Network rate of injury-related hospitalizations

*Akaike information criterion for finite sample sizes

EXHIBIT A-7 Risk of hospitalization event — logistic regression component of the models for the female cohort

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Age group (years)						
75 to 79	3.61 (3.32, 3.92)	3.76 (3.46, 4.09)	3.26 (2.99, 3.55)	2.69 (2.47, 2.94)	2.31 (2.11, 2.52)	2.33 (2.13, 2.55)
70 to 74	2.67 (2.45, 2.90)	2.73 (2.51, 2.98)	2.42 (2.22, 2.64)	2.07 (1.89, 2.26)	1.84 (1.68, 2.01)	1.85 (1.69, 2.03)
65 to 69	2.12 (1.94, 2.31)	2.14 (1.96, 2.34)	1.94 (1.78, 2.12)	1.73 (1.58, 1.89)	1.57 (1.44, 1.72)	1.58 (1.45, 1.73)
60 to 64	1.76 (1.61, 1.92)	1.74 (1.59, 1.90)	1.65 (1.51, 1.81)	1.51 (1.38, 1.65)	1.36 (1.25, 1.49)	1.37 (1.25, 1.50)
55 to 59	1.39 (1.27, 1.52)	1.34 (1.23, 1.47)	1.31 (1.20, 1.44)	1.23 (1.12, 1.35)	1.12 (1.02, 1.23)	1.12 (1.02, 1.23)
50 to 54	1.17 (1.07, 1.29)	1.14 (1.03, 1.25)	1.16 (1.06, 1.28)	1.12 (1.02, 1.24)	1.04 (0.94, 1.14)	1.03 (0.94, 1.14)
40 to 49	0.92 (0.85, 1.00)	0.91 (0.83, 0.98)	0.93 (0.85, 1.01)	0.91 (0.84, 0.99)	0.88 (0.81, 0.95)	0.87 (0.81, 0.95)
20 to 39	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Smoking						
Heavy smoker	1.61 (1.48, 1.75)	1.58 (1.45, 1.72)	1.46 (1.34, 1.59)	1.44 (1.32, 1.57)	1.35 (1.24, 1.47)	1.33 (1.22, 1.45)
Light smoker	1.25 (1.17, 1.33)	1.26 (1.18, 1.35)	1.19 (1.11, 1.27)	1.17 (1.10, 1.25)	1.14 (1.07, 1.22)	1.13 (1.06, 1.21)
Former heavy smoker	1.37 (1.27, 1.48)	1.32 (1.22, 1.42)	1.28 (1.18, 1.37)	1.22 (1.13, 1.31)	1.18 (1.10, 1.27)	1.17 (1.09, 1.26)
Former light smoker	1.17 (1.09, 1.24)	1.16 (1.08, 1.23)	1.13 (1.06, 1.20)	1.10 (1.03, 1.18)	1.08 (1.02, 1.16)	1.08 (1.01, 1.15)
Non-smoker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Physical activity						
Inactive	1.14 (1.09, 1.19)	1.08 (1.03, 1.14)	1.09 (1.04, 1.14)	1.06 (1.01, 1.11)	1.03 (0.98, 1.08)	1.03 (0.98, 1.08)
Active	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Diet						
Poor diet (0 to <4)	1.08 (1.02, 1.14)	1.08 (1.02, 1.14)	1.04 (0.99, 1.1)	1.04 (0.99, 1.1)	1.03 (0.98, 1.09)	1.03 (0.98, 1.09)
Adequate diet (4 to 10)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol						
Heavy drinker	1.03 (0.93, 1.13)	1.03 (0.94, 1.13)	1.02 (0.92, 1.12)	1.02 (0.93, 1.12)	1.01 (0.92, 1.12)	1.01 (0.91, 1.11)
Current non-drinker	1.30 (1.24, 1.37)	1.25 (1.19, 1.31)	1.22 (1.16, 1.28)	1.18 (1.12, 1.24)	1.14 (1.08, 1.19)	1.13 (1.07, 1.19)
Moderate drinker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Body mass index						
≥30 (obese)		1.52 (1.44, 1.61)	1.48 (1.4, 1.56)	1.4 (1.32, 1.48)	1.3 (1.23, 1.37)	1.29 (1.22, 1.36)
<30 (non-obese)		Ref.	Ref.	Ref.	Ref.	Ref.
Self-perceived stress						
Quite a bit or extremely		1.22 (1.16, 1.29)	1.21 (1.15, 1.28)	1.19 (1.13, 1.25)	1.1 (1.04, 1.16)	1.1 (1.05, 1.17)
Not stressed		Ref.	Ref.	Ref.	Ref.	Ref.
Income						
Low			1.44 (1.33, 1.55)	1.38 (1.28, 1.49)	1.31 (1.21, 1.42)	1.25 (1.15, 1.35)
Moderate or missing			1.21 (1.13, 1.30)	1.21 (1.12, 1.29)	1.18 (1.10, 1.27)	1.15 (1.07, 1.24)
High			Ref.	Ref.	Ref.	Ref.

EXHIBIT A-7 *continued*

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Immigration status (years in Canada)						
<15			0.70 (0.60, 0.82)	0.71 (0.61, 0.84)	0.73 (0.62, 0.85)	0.78 (0.66, 0.91)
15 to <30			0.77 (0.68, 0.89)	0.78 (0.68, 0.89)	0.79 (0.69, 0.90)	0.84 (0.73, 0.96)
30 to <45			0.90 (0.82, 0.99)	0.91 (0.82, 1.00)	0.90 (0.82, 1.00)	0.95 (0.86, 1.05)
≥45 or native born			Ref.	Ref.	Ref.	Ref.
Heart disease						
Yes				1.76 (1.63, 1.90)	1.57 (1.45, 1.69)	1.56 (1.45, 1.69)
No				Ref.	Ref.	Ref.
Stroke						
Yes				1.93 (1.65, 2.25)	1.63 (1.40, 1.90)	1.63 (1.40, 1.90)
No				Ref.	Ref.	Ref.
Cancer						
Yes				1.64 (1.45, 1.86)	1.54 (1.36, 1.75)	1.55 (1.36, 1.75)
No				Ref.	Ref.	Ref.
Diabetes						
Yes				1.48 (1.37, 1.60)	1.39 (1.28, 1.50)	1.38 (1.28, 1.49)
No				Ref.	Ref.	Ref.
Mobility						
Needs help from others					2.04 (1.91, 2.18)	2.04 (1.91, 2.18)
Restricted physically					1.45 (1.38, 1.53)	1.45 (1.37, 1.53)
No physical restriction					Ref.	Ref.
Deprivation						
Moderate or unknown						1.04 (0.98, 1.11)
High						1.12 (1.03, 1.21)
Missing						Ref.
Injury rate†						1.36 (1.26, 1.46)
Goodness of fit (AICc)*	142,865	142,525	142,110	141,345	140,557	140,457

†Local Health Integration Network rate of injury-related hospitalizations

*Akaike information criterion for finite sample sizes

EXHIBIT A-8 Hospital bed-days — negative binomial regression component of the models for the female cohort

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Age group (years)						
75 to 79	3.59 (3.22, 4.00)	3.62 (3.25, 4.04)	3.22 (2.89, 3.60)	3.01 (2.70, 3.36)	2.94 (2.63, 3.28)	2.97 (2.66, 3.31)
70 to 74	2.95 (2.64, 3.31)	2.98 (2.66, 3.34)	2.67 (2.38, 2.99)	2.49 (2.22, 2.79)	2.47 (2.21, 2.77)	2.50 (2.23, 2.80)
65 to 69	2.87 (2.55, 3.22)	2.90 (2.57, 3.26)	2.77 (2.46, 3.12)	2.54 (2.26, 2.86)	2.47 (2.19, 2.77)	2.50 (2.22, 2.81)
60 to 64	2.24 (1.99, 2.53)	2.25 (2.00, 2.53)	2.16 (1.92, 2.43)	2.04 (1.81, 2.29)	1.99 (1.77, 2.24)	2.01 (1.79, 2.26)
55 to 59	1.86 (1.64, 2.11)	1.87 (1.65, 2.11)	1.92 (1.70, 2.18)	1.90 (1.67, 2.15)	1.82 (1.61, 2.06)	1.86 (1.65, 2.10)
50 to 54	1.93 (1.69, 2.21)	1.92 (1.68, 2.20)	1.89 (1.66, 2.15)	1.78 (1.56, 2.03)	1.72 (1.51, 1.96)	1.73 (1.52, 1.97)
40 to 49	1.56 (1.40, 1.75)	1.55 (1.39, 1.74)	1.59 (1.42, 1.78)	1.58 (1.41, 1.76)	1.50 (1.35, 1.68)	1.52 (1.36, 1.70)
20 to 39	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Smoking						
Heavy smoker	1.42 (1.27, 1.59)	1.40 (1.25, 1.57)	1.28 (1.14, 1.43)	1.26 (1.12, 1.41)	1.23 (1.10, 1.38)	1.22 (1.09, 1.36)
Light smoker	1.19 (1.09, 1.29)	1.18 (1.08, 1.29)	1.10 (1.01, 1.20)	1.10 (1.01, 1.20)	1.08 (0.99, 1.18)	1.08 (0.99, 1.18)
Former heavy smoker	1.24 (1.12, 1.37)	1.23 (1.11, 1.36)	1.19 (1.08, 1.31)	1.15 (1.05, 1.27)	1.13 (1.03, 1.25)	1.12 (1.02, 1.24)
Former light smoker	0.96 (0.88, 1.05)	0.96 (0.88, 1.05)	0.96 (0.88, 1.04)	0.95 (0.88, 1.04)	0.95 (0.87, 1.03)	0.94 (0.86, 1.02)
Non-smoker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Physical activity						
Inactive	1.19 (1.11, 1.26)	1.18 (1.11, 1.26)	1.17 (1.10, 1.25)	1.15 (1.08, 1.23)	1.08 (1.02, 1.15)	1.08 (1.02, 1.15)
Active	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Diet						
Poor	1.15 (1.07, 1.23)	1.14 (1.07, 1.22)	1.11 (1.04, 1.19)	1.11 (1.04, 1.19)	1.12 (1.05, 1.20)	1.11 (1.04, 1.19)
Adequate	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol						
Heavy drinker	0.89 (0.78, 1.01)	0.89 (0.78, 1.01)	0.87 (0.77, 0.99)	0.88 (0.78, 1.00)	0.89 (0.78, 1.00)	0.88 (0.78, 1.00)
Current non-drinker	1.33 (1.25, 1.42)	1.33 (1.24, 1.42)	1.24 (1.17, 1.33)	1.20 (1.12, 1.28)	1.15 (1.08, 1.23)	1.15 (1.08, 1.22)
Moderate drinker	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Body mass index						
≥30 (obese)		1.00 (0.93, 1.07)	0.94 (0.88, 1.01)	0.90 (0.83, 0.96)	0.87 (0.81, 0.93)	0.87 (0.81, 0.94)
<30 (non-obese)		Ref.	Ref.	Ref.	Ref.	Ref.
Stress						
Quite a bit or extremely		1.07 (1.00, 1.15)	1.06 (0.99, 1.14)	1.04 (0.97, 1.12)	1.01 (0.94, 1.08)	1.01 (0.94, 1.08)
Not stressed		Ref.	Ref.	Ref.	Ref.	Ref.
Income						
Low			1.61 (1.45, 1.78)	1.53 (1.38, 1.69)	1.43 (1.29, 1.58)	1.39 (1.25, 1.54)
Moderate or missing			1.09 (0.99, 1.19)	1.06 (0.97, 1.17)	1.03 (0.94, 1.13)	1.01 (0.92, 1.11)
High			Ref.	Ref.	Ref.	Ref.

EXHIBIT A-8 *continued*

	Model 1 Age and behaviours	Model 2 Add body mass index and stress	Model 3 Add socioeconomic status	Model 4 Add diseases	Model 5 Add mobility	Model 6 Add geography
Immigration status (years in Canada)						
<15			0.89 (0.72, 1.11)	0.92 (0.74, 1.15)	0.97 (0.78, 1.21)	0.95 (0.77, 1.18)
15 to <30			0.88 (0.74, 1.06)	0.91 (0.76, 1.09)	0.93 (0.78, 1.11)	0.93 (0.78, 1.11)
30 to <45			0.82 (0.72, 0.94)	0.83 (0.73, 0.95)	0.85 (0.74, 0.97)	0.84 (0.74, 0.96)
≥45 or native born			Ref.	Ref.	Ref.	Ref.
Heart disease						
Yes				1.12 (1.03, 1.23)	1.10 (1.00, 1.20)	1.10 (1.01, 1.21)
No				Ref.	Ref.	Ref.
Stroke						
Yes				1.30 (1.09, 1.55)	1.18 (0.99, 1.40)	1.18 (1.00, 1.41)
No				Ref.	Ref.	Ref.
Cancer						
Yes				1.00 (0.86, 1.17)	0.93 (0.80, 1.08)	0.93 (0.80, 1.08)
No				Ref.	Ref.	Ref.
Diabetes						
Yes				1.47 (1.34, 1.61)	1.41 (1.28, 1.55)	1.41 (1.29, 1.55)
No				Ref.	Ref.	Ref.
Mobility						
Needs help from others					1.53 (1.41, 1.67)	1.52 (1.39, 1.65)
Restricted physically					1.06 (0.98, 1.13)	1.05 (0.98, 1.13)
No physical restriction					Ref.	Ref.
Deprivation						
Moderate or unknown						1.21 (1.11, 1.32)
High						1.11 (1.00, 1.23)
Missing						Ref.
Injury rate†						0.97 (0.88, 1.07)
Goodness of fit (AICc)*	142,865	142,525	142,110	141,345	140,557	140,457

†Local Health Integration Network rate of injury-related hospitalizations

*Akaike information criterion for finite sample sizes

EXHIBIT A-9 Impact of eliminating behavioural risks on hospital bed-days (percentage reduction), comparison of models for the male and female cohorts

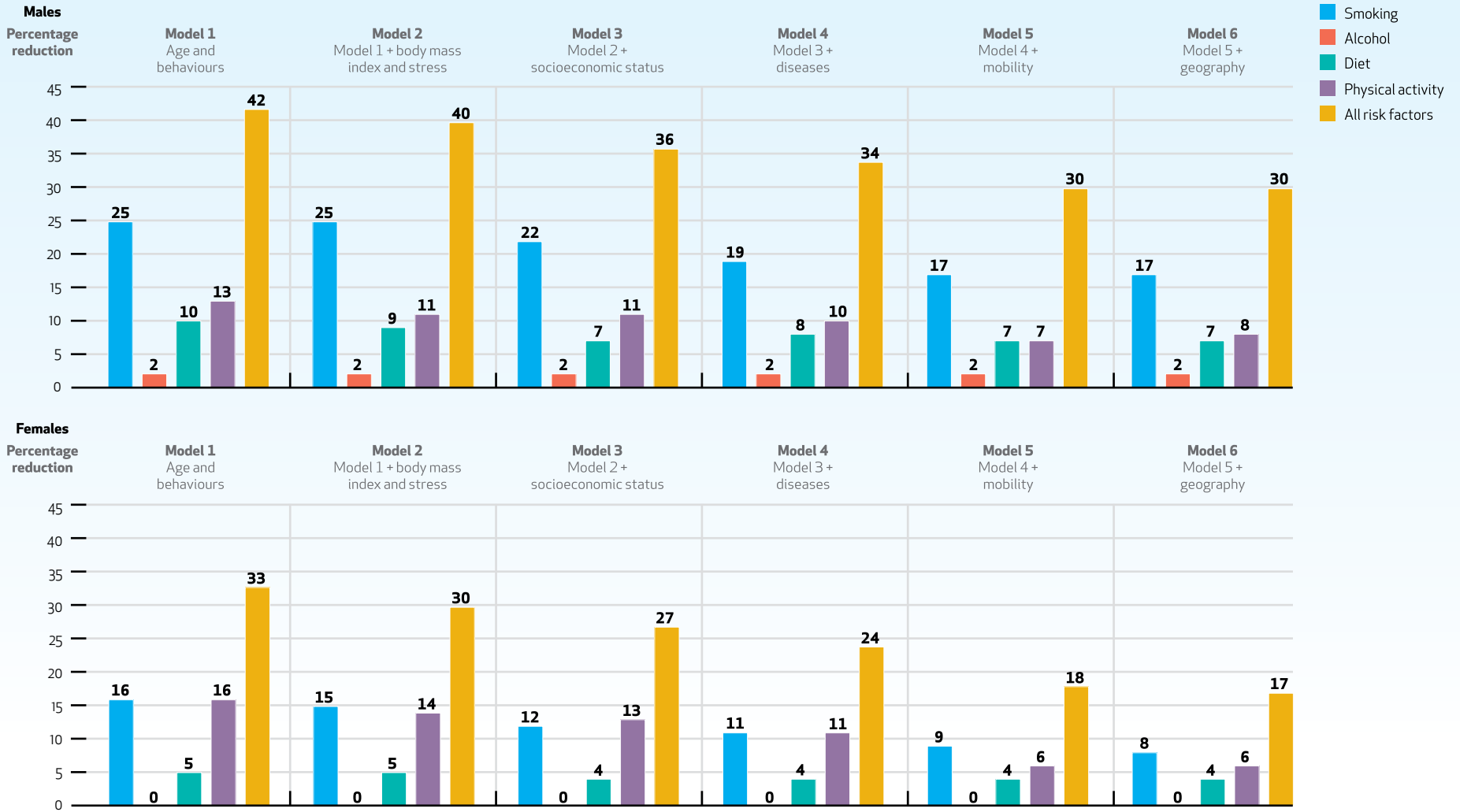
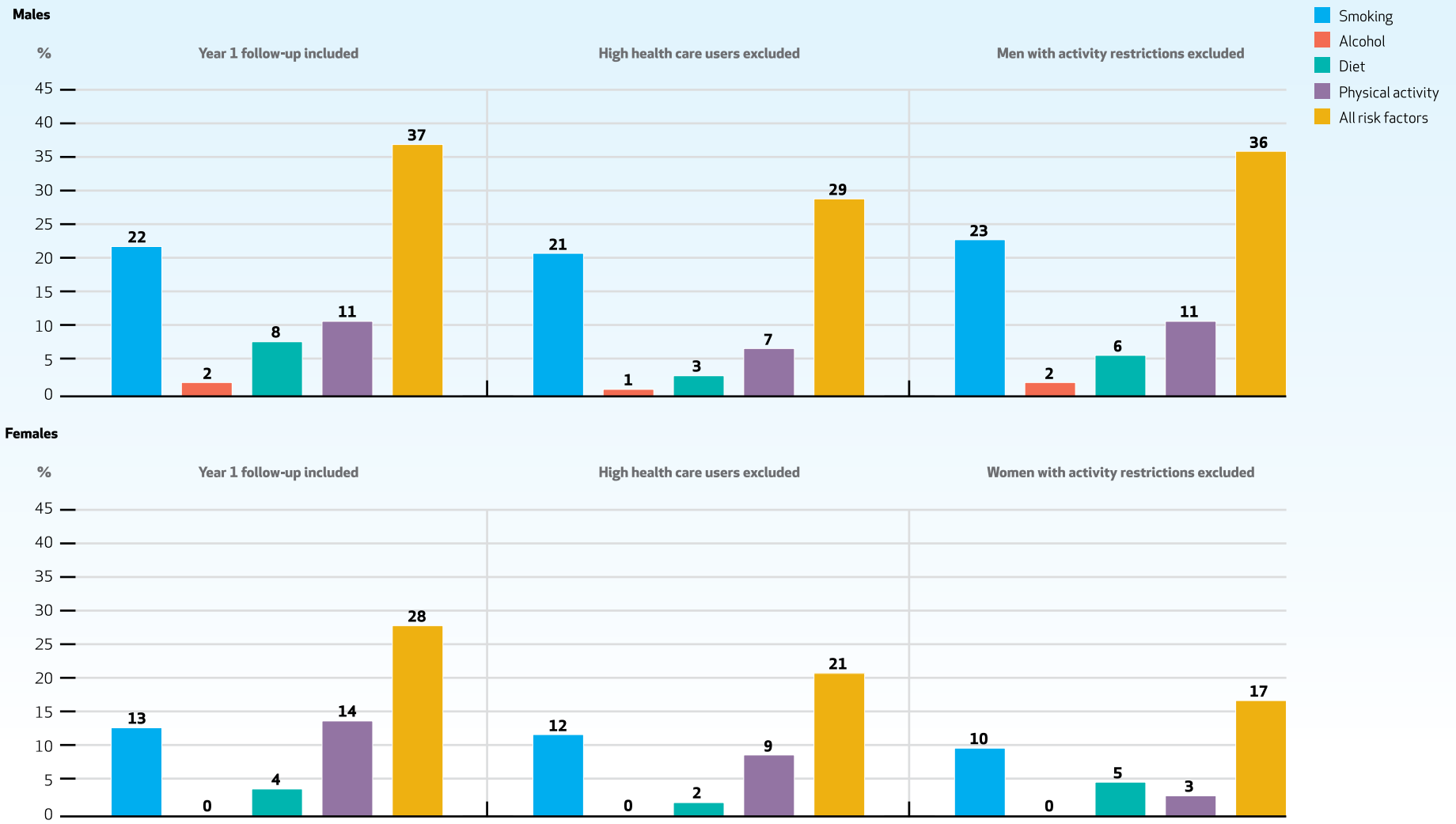


EXHIBIT A-10 Sensitivity analysis models for the male and female cohorts



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