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Among 16 chronic conditions, mood disorder, heart disease and bowel disorder were associated with the largest incremental number of absent workdays per employee. On the national scale, back problems (CAD$621 million), mood disorder (CAD$299 million) and migraine (CAD$245 million) account for the greatest productivity loss due to absenteeism in 3 months. Policy-makers and employers can set policy priorities accordingly.

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Key terms: absenteeism; arthritis; associated cost; back pain; Canada; chronic condition; chronic disease; cost of illness; migraine; mood disorder; productivity loss; sickness absence; working population

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The relationship between chronic conditions and absenteeism and associated costs in Canada

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Objectives This study aimed to measure and compare the relationship between chronic diseases and the number of absent workdays due to health problems and the associated costs among working Canadians.

Methods The study sample included respondents to the 2010 Canadian Community Health Survey between aged 15–75 years who reported employment in the past three months. Respondents reported their number of absent workdays due to health problems and chronic conditions. A negative binomial regression was used to estimate the incremental absent workdays associated with having a particular chronic condition (of 16 conditions), conditional on other chronic conditions and confounders. For each condition, we calculated the incremental number of absent workdays, the incremental productivity loss attributed to absenteeism per employee, and the overall productivity loss in the population.

Results The final sample consisted of 28 678 respondents representing 15 468 788 employed Canadians. The average number of absent workdays due to health problems was 1.35 days over a 3-month period. The three conditions with the greatest association with absent workdays were mood disorders, heart disease, and bowel disorders. They were associated with 1.17, 0.81, and 0.80 additional absent workdays, respectively, compared to workers without this condition, holding other conditions and confounders at their means. At the national working population level, back problems (CAD$621 million), mood disorders (CAD$299 million) and migraine (CAS$245 million) accounted for the largest incremental productivity loss.

Conclusions Chronic conditions, especially mood disorders and back problems, are associated with substantial work productivity loss. The study findings can help policy-makers and employers prioritize their programs and resources aimed at reducing absenteeism among the working population with chronic conditions.

Key terms arthritis; back pain; chronic disease; cost of illness; migraine; mood disorder; productivity loss; sickness absence; working population.

From a societal perspective, the economic burden of illness is estimated by both direct and indirect costs. Indirect costs are commonly referred to as productivity losses as a result of mortality, long-term disability, short-term absence from work (absenteeism), or reduced performance while working (presenteeism) (1, 2). The productivity losses due to a specific illness, such as arthritis, asthma or depression, are substantial and can be even greater than their direct costs (3, 4). Absenteeism has been found to account for a significant proportion of indirect costs (3, 4). According to the Labour Force Survey (LFS) of Statistics Canada, the average absent days per full-time worker in 2011 were 9.3 days, where 7.7 were due to illness or disability and 2.1 were due to personal and family responsibilities (5). The Conference Board of Canada estimated the cost of absenteeism to the Canadian economy to be CAD$16.6 billion in 2011 (6).

Policy-makers would benefit from evidence on comparative burden of different chronic conditions as this may inform the allocation of resources and the provision of programs with the aim of reducing the burden of chronic diseases, including mitigating work disability/

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absenteeism and improving work productivity. Evidence on lost productivity can also motivate employers to change work conditions and practices (employee benefits, support services and facilities) for workers with different health problems to further reduce work disability and retain workers with chronic conditions in the workforce.

Many studies have focused on measuring the number of absent workdays among people with one health condition (7–13). Due to different settings, populations, measures and methods, estimates of absent workdays and the associated productivity loss due to a health condition from different studies vary widely and may not be comparable. While there is research that has compared sickness absence workdays across different health conditions, very few studies have been able to assess the extent to which sickness absence could be attributed to certain chronic conditions (14–20). In 2010, the Canadian Community Health Survey (CCHS) "loss of productivity module" asked employed respondents to report the number of missed workdays due to health problems as well as their chronic conditions (21). This data enabled the current research to measure and compare the relationship between different chronic conditions and the number of absent workdays and then the consequent costs among working Canadians.

Methods

Study sample

The CCHS is an annual cross-sectional survey that collects information related to health status, healthcare utilization and health determinants for the Canadian population conducted by Statistics Canada. Data from the 2010 CCHS were collected from a population-based, representative sample of individuals aged ≥12 years, living in private occupied dwellings in the 117 health regions covering all provinces and territories in Canada (22). Individuals living on Indian Reserves and on Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of certain remote regions were excluded (22). The CCHS represents approximately 98% of the Canadian population aged ≥12 years (22). Internal and external validation was undertaken by Statistics Canada for data quality assurance purposes. Internal validation included measures to verify interviewer performance, comparison of estimates with previous survey years, and publication of a series of reports on the survey variables (22, 23). For external validation, Statistics Canada sent data to provincial and federal partners to identify any anomalies or concerns related to data quality (22, 23). The overall person-level response rate in 2010 was 88.6%. CCHS questions on sickness absence workdays were only asked of respondents aged 15–75 years and who reported employment in the past three months.

Measures

The outcome variable was defined as the total number of self-reported missed workdays in the prior three months due to any health problems. This represented the sum of missed workdays across four questions: "How many days of work have you missed because of a chronic condition", "How many days … because of an injury", "How many days … because of an infectious disease", and "How many days … because of another reason related to your own physical or mental health". The reported number of absent workdays could not be attributed to a specific chronic condition. Rather, the current analyses investigate the association of having a specific chronic condition with total health-related absent workdays.

The key explanatory variables were the presence of 16 different chronic conditions. In the CCHS, chronic conditions refer to "long-term conditions" expected to last or have been present ≥6 months and that have been diagnosed by a health professional. A total of 16 chronic conditions were considered: asthma; fibromyalgia; arthritis; back problems; migraine; chronic obstructive pulmonary disease (COPD) including chronic bronchitis and emphysema; diabetes; heart disease including stroke; cancer (previously and currently); intestinal or stomach ulcers; urinary incontinence; bowel disorders (including Crohn's disease, ulcerative colitis, irritable bowel syndrome or bowel incontinence); chronic fatigue syndrome; multiple chemical sensitivities; mood disorders including depression, bipolar disorder, mania or dysthymia; and anxiety disorders such as phobia, obsessive-compulsive disorder or panic disorder.

Characteristics associated with both absenteeism and the presence of chronic conditions were considered as potential confounders (24) as follows: (i) demographic characteristics including age as a continuous variable, sex (female versus male), race (white versus visible minority), marital status (currently married or common law versus windowed, divorced, separated or never married) and living arrangement (living alone versus living together); (ii) socioeconomic status (SES) including log transformed household income, and personal education attainment (<secondary school graduation, secondary school graduation, some post-secondary, post-secondary graduation); (iii) health and lifestyle factors including body mass index classification (underweight/normal weight (<25 kg/m^2), overweight (25–30 kg/m^2), obese (>30 kg/m^2)), type of smoker (never smoked, former occasional smoker, former daily smoker, current occa-

sional smoker, current daily smoker), type of drinker in the past 12 months (not a drinker, occasional drinker, regular drinker >once a month), and leisure and transportation physical activity using energy expenditure (active, moderately active, inactive); (iv) work-related characteristics including ten occupations classified by the Standard Occupation Classification of Statistics Canada (25) and self-perceived work stress (not at all stressful, not very stressful, a bit stressful, quite a bit stressful, extremely stressful).

Statistical analysis

The study sample included all subjects who were eligible for and had valid responses to the questions related to the number of absent workdays, 16 chronic conditions, and all the potential confounders. Negative binomial regression was used as the number of absent workdays has a highly skewed distribution with a lot of zeros. This regression is commonly used to model count outcome variables when the count outcome variables are over-dispersed. The unadjusted regression model was constructed by entering dummy variables representing the 16 chronic conditions simultaneously as the main explanatory variables for absent workdays. The adjusted regression model was then constructed by adding all the potential confounders into the unadjusted model.

The marginal impact on absent workdays associated with having a particular chronic condition, conditional on other chronic conditions and confounders was estimated from the negative binomial regression model. The coefficient of each chronic condition can be interpreted as the difference in the log of the expected count of absent workdays between workers with one chronic condition and those without such a condition after controlling other conditions and confounders. The exponential of the coefficient represents the ratio of the expected counts of absent workdays between the two groups. A ratio of 1.2 or 0.7, for example, indicates that absent workdays for workers with one condition is 20% more than or 30% less than those without this condition, respectively. If workers have multiple chronic conditions, the regression coefficients have an additive effect in the log scale and the ratios have a multiplicative effect.

As a sensitivity analysis, absent workdays due to chronic diseases only were modeled separately from absent workdays due to other health reasons (injuries, infectious diseases or other physical or mental health problems). The analysis was also repeated among the study sub-sample aged 25–65 years, excluding the youngest and oldest members of the workforce.

Sampling weights provided by Statistics Canada were used in all analyses. For each regression model, 500 bootstrapped weights (representing the 500 bootstrap replicates) provided by Statistics Canada were used to estimate standard errors and 95% confidence intervals (95% CI). All analyses will be performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Monetization of productivity loss due to absenteeism

For each chronic condition, a marginal effect at the mean was calculated based on the adjusted negative binomial regression model. The number of absent workdays in a 3-month time frame was first predicted from the adjusted regression model in the presence of a particular chronic condition, holding other chronic conditions and confounders at their means. The number of absent workdays for an employee without the particular chronic condition was then predicted, holding other chronic conditions and confounders at their means. The difference in the two predicted values is referred to as marginal effect at the mean, in other words the incremental number of absent workdays attributable to each particular chronic condition per employee. The detailed calculation steps are presented in the online Appendix for further reference (http://www.sjweh.fi/index.php?page=data-repository).

The marginal effects at the mean are a good (asymptotically valid) approximation of the average marginal effects (calculating the difference between the predicted absent workdays with and without a condition, all other variables being kept as is with each observation, and then taking the average of the difference among all study observations) (26, 27). The method we used to calculate the predicted and incremental number of absent workdays is more flexible because it can be done simply based on the estimated coefficients of the variables in the regression model without accessing individual-level data. In addition to the above marginal effects at the mean, absent workdays can be predicted for different scenarios by applying different fixed values to the covariates in the model, such as for workers with one condition only compared with workers with no conditions, or workers with multiple conditions compared with workers with no conditions (please see the online Appendix, http://www.sjweh.fi/index.php?page=data-repository).

The incremental productivity loss (CAD$) attributed to absenteeism per employee was calculated as the incremental number of absent workdays multiplied by the average hours per work day of eight hours and the average hourly wage of $24.33 for Canadian employees aged 25–54 years, reported by Statistics Canada in 2010 (28). An employee benefit (eg, employer pension contribution, workers compensation, employment insurance) multiplier of 15% of the wage was added (29). A wage multiplier of 1.44 that takes into account team production, time sensitivity of output, and the availability of perfect substitution, was also used to adjust the wage to represent the value of productivity loss (30, 31). No Canadian studies provide such a multiplier estimate. This multiplier

was taken from a US study by Nicholson et al, who used a random sample of firm managers (N=804) from 12 industries to estimate the additional productivity loss for absenteeism for any of the 57 job types they supervised (30). The overall productivity loss in the study sample was calculated by multiplying the weighted number of employees reporting the focal condition by the incremental productivity loss per employee.

Results

Study sample and characteristics

Figure 1 presents the flowchart of the final analysis sample. In total, there were 63 191 respondents to the CCHS 2010. Respondents were excluded as ineligible for age (N=9488 aged <15 or >75 years), proxy interviews (N=695), not employed in the past three months (N=20 224), missing responses to absent workdays (N=95), missing responses to chronic conditions (n=316) and missing responses to all potential confounders (N=3695). The final analytic sample of 28 678 respondents represented 15 468 788 employed Canadians aged between 15–75 years.

A total of 27.8% of the sample reported absent workdays in the past three months (table 1). The average number of absent workdays due to any health problems among the study sample was 1.35 days [standard error (SE) 0.05]. The average absent workdays due to chronic conditions was 0.42 (SE 0.04). Among those reporting at least one absent workday, the average was 4.86 days (SE 0.19) due to any health problems and 1.52 (SE 0.15) due to chronic conditions. Approximately 45% of the sample had at least one chronic condition. The three most prevalent chronic conditions in the study sample were back problems (17.5%), migraine (10.3%) and arthritis (9.8%). Chronic fatigue conditions (0.8%), fibromyalgia (1.1%) and urinary incontinence (1.3%) were the least prevalent.

Chronic conditions and absent workdays

In the unadjusted model (table 2), a total of 9 chronic conditions including asthma, arthritis, back problems, diabetes, migraine, heart disease, cancer, mood disorders and bowel disorders, were associated with a statistically significant (P<0.05) increase in absent workdays due to any health problems. Mood disorders, migraine, bowel disorders, back problems and heart disease were the five chronic conditions with the greatest association with absent workdays due to any health problems compared to not having these conditions.

In the final multivariable model adjusted for the potential confounding effects, one additional chronic condition of COPD was associated with a significant increase in absent workdays due to any health problems. In the adjusted model, the five conditions with the greatest association with absent workdays were mood disorders, heart disease, bowel disorders, back problems, and cancer. Keeping other conditions and confounders constant, absent workdays for workers with mood disorders were 2.1 times as many as those without this condition. The estimated coefficients from the regression model are shown in table A1 in the Appendix (http://www.sjweh.fi/index.php?page=data-repository).

In the sensitivity analysis modeling absent workdays for chronic conditions separately from absent workdays for other health reasons (table 3), heart disease, back problems, COPD, bowel disorders and mood disorders were the five conditions with the strongest association with absent workdays due to chronic conditions only. The conditions identified above in the final adjusted models for total absent workdays were also significantly associated with absent workdays due to chronic conditions only, with the exception of asthma and diabetes. Asthma was significantly associated with increased

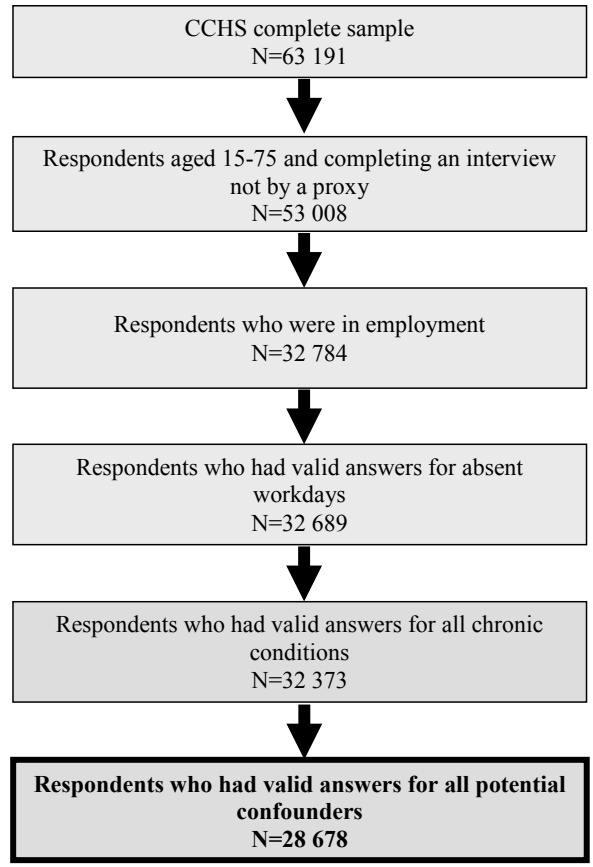

Figure 1. Flow chart of sample selection. [CCHS: Canadian Community Health Survey.]

Table 1. Study sample characteristics, CCHS 2010 survey for employed respondents aged 15 to 75 years. [CCHS=Canadian Community Health Survey; SE=standard error; BMI=body mass index; COPD=chronic obstructive pulmonary disease.]

Variables	% [a]	Mean [a]	SE [b]
Absent from work (yes versus no)	27.8		
Number of absent workdays (reasons)			
All health reasons		1.35	0.05
Chronic disease		0.42	0.04
Injuries		0.22	0.02
Infectious disease		0.37	0.01
Other health problems		0.34	0.03
Age (years)		40.94	0.10
Female	45.4		
Married or common-law	64.2		
Living alone	12.6		
White	79.5		
Household income ($)		88 757.00	783.89
Log of household income		11.15	0.01
Education			
<Secondary school graduation	9.2		
Secondary school graduation	16.4		
Some post-secondary	8.0		
Post-secondary graduation	66.3		
BMI classification			
Normal or underweight	47.9		
Overweight	34.6		
Obesity	17.6		
Type of smokers			
Current and former daily smoker	17.2		
Current occasional smoker	5.9		
Former daily smoker	20.6		
Former occasional smoker	16.9		
Never smoked	39.5		
Type of drinker			
Regular drinker	72.3		
Occasional drinker	13.8		
Not a drinker	13.9		
Leisure and transportation physical activity			
Active	29.5		
Moderately active	26.8		
Inactive	43.7		
Occupation			
Management	9.0		
Business, finance and administrative	18.9		
Natural & applied sciences & related	7.5		
Health	6.8		
Social science, education, government service and religion	8.7		
Art, culture, recreation and sport	3.4		
Sales and service	23.7		
Trades, transport & equipment operators	15.1		
Primary industry	3.1		
Processing, manufacturing & utilities	3.9		
Self-perceived work stress			
Not at all stressful	9.0		
Not very stressful	19.1		
A bit stressful	42.2		
Quite a bit stressful	24.6		
Extremely stressful	5.1		
Chronic conditions			
Asthma	7.6		
Fibromyalgia	1.1		
Arthritis	9.8		
Back problems	17.5		
Diabetes	4.0		
COPD	1.6		
Migraine	10.3		
Heart disease	2.2		
Cancer	3.5		
Intestinal/stomach ulcers	2.3		
Urinary incontinence	1.3		
Multiple chemical sensitivities	2.4		
Anxiety disorders	3.9		
Mood disorders	5.3		
Bowel disorders	3.8		
Chronic fatigue syndrome	0.8		
Number of chronic conditions			
0	55.2		
1	25.7		
2	11.5		
3	4.3		
4	2.0		
5	0.8		
6+	0.6		

[a] Weighted

[b] Estimated by the balanced repeated replication method using 500 bootstrapped weights

absent workdays due to other health reasons. Multiple chemical sensitivities was significantly associated with increased absent workdays due to health reasons other than chronic conditions. This emerged as a new finding relative to the findings presented above for total absent workdays.

Monetization of productivity loss

The estimates of the incremental number of absent workdays attributable to a particular chronic condition, holding all other variables including other chronic conditions and confounders at their means, are presented in table 4. Employees with mood disorders experienced the largest loss, with an additional 1.2 absent days per employee in three months compared with employees without mood disorders. This equates to CAD$362.1 per employee. On a population, workforce level, back problems, mood disorders, migraine, bowel disorders and arthritis accounted for the largest incremental productivity loss due to strong associations with absent workdays and high prevalence. This totaled CAD$621 million, CAD$299 million, CAD$245 million, CAD$144 million, and CAD$135 million in three months, respectively.

Table A2 in the Appendix (http://www.sjweh.fi/index.php?page=data-repository) presents the results comparing the predicted number of absent workdays among workers with a particular chronic condition only to those without any chronic conditions and the corresponding incremental productivity loss per employee. The incremental number of absent workdays and productivity loss per employee were smaller than those estimated from our main analysis.

Table 2. Ratio of expected counts of absent workdays due to any health problems using negative binomial regression. [R_{adj}=adjusted ratio; 95% CI=95% confidence interval; COPD=chronic obstructive pulmonary disease]

Variables	Ratio	95% CI	R_{adj}	95% CI
Asthma	1.39	1.11–1.73 [a]	1.31	1.05–1.62 [a]
Fibromyalgia	1.01	0.67–1.51	0.94	0.62–1.43
Arthritis	1.23	1.01–1.51[a]	1.27	1.01–1.59 [a]
Back problems	1.67	1.39–2.01[a]	1.72	1.46–2.04 [a]
Diabetes	1.34	1.01–1.78[a]	1.39	1.01–1.90 [a]
COPD	1.38	0.98–1.96	1.43	1.00–2.04 [a]
Migraine	1.74	1.20–2.52 [a]	1.46	1.11–1.92 [a]
Heart disease	1.65	1.12–2.42 [a]	1.73	1.19–2.50 [a]
Cancer	1.40	1.07–1.83 [a]	1.63	1.19–2.23 [a]
Intestinal/stomach ulcers	1.72	0.84–3.52	1.62	0.85–3.12
Urinary incontinence	1.25	0.80–1.96	1.28	0.77–2.10
Multiple chemical sensitivities	1.40	0.97–2.04	1.37	0.96–1.95
Anxiety disorders	1.21	0.95–1.55	1.12	0.87–1.43
Mood disorders	2.40	1.78–3.24 [a]	2.09	1.55–2.81 [a]
Bowel disorders	1.74	1.20–2.52 [a]	1.73	1.18–2.53 [a]
Chronic fatigue syndrome	1.70	0.96–3.01	1.53	0.88–2.67

[a] The 95% CI does not cover 1.

Table 3. Adjusted ratio (R_{adj}) of expected counts of absent workdays due to chronic conditions and other health reasons, respectively, using negative binomial regression. [95% CI=95% confidence interval; COPD=chronic obstructive pulmonary disease.]

Variables	R_{adj} [a]	95% CI	R_{adj} [b]	95% CI
Asthma	0.99	0.63–1.55	1.41	1.13–1.77 [c]
Fibromyalgia	2.06	0.81–5.26	0.72	0.41–1.25
Arthritis	2.56	1.56–4.22 [c]	0.95	0.77–1.19
Back problems	3.63	2.42–5.44 [c]	1.51	1.28–1.78 [c]
Diabetes	1.73	0.92–3.29	1.12	0.78–1.61
COPD	3.27	1.26–8.51 [c]	1.51	0.99–2.31
Migraine	2.67	1.36–5.23 [c]	1.22	1.03–1.45 [c]
Heart disease	3.90	1.86–8.18 [c]	1.17	0.79–1.74
Cancer	2.67	1.50–4.75 [c]	1.26	0.84–1.88
Intestinal/stomach ulcers	4.18	0.65–26.74	0.99	0.71–1.38
Urinary incontinence	1.29	0.48–3.50	1.30	0.83–2.05
Multiple chemical sensitivities	0.66	0.35–1.24	1.70	1.11–2.60 [c]
Anxiety disorders	1.22	0.64–2.33	1.08	0.83–1.41
Mood disorders	2.71	1.65–4.47 [c]	2.02	1.46–2.80 [c]
Bowel disorders	3.14	1.54–6.41 [c]	1.64	1.04–2.60 [c]
Chronic fatigue syndrome	1.20	0.50–2.89	1.46	0.74–2.85

[a] Due to chronic conditions.
[b] Due to other health reasons.
[c] The 95% CI that does not cover 1.

Subsample analysis

The results from the analysis of the sub-sample of workers aged 25–65 years were similar to study findings among the study sample aged 15–75 years (tables A3–6 in the Appendix, http://www.sjweh.fi/index.php?page=data-repository). The five conditions with the greatest association with absent workdays were mood disorders, heart disease, bowel disorders, back problems and migraine. On the national scale, back problems (CAD$576 million), mood disorders (CAD$287 million), and migraine (CAD$198 million) accounted for the largest incremental productivity loss.

Table 4. Incremental number of absent workdays due to any health problems and productivity losses in a 3-month period. [PD=predicted days; ID=incremental days; IPL=incremental productivity loss; COPD=chronic obstructive pulmonary disease.]

Variables	PD (with condition) [a]	PD (without condition) [a]	ID [a]	IPL [b] per employee (2010$)	IPL [c] in population (millions of 2010$)
Asthma	1.43	1.10	0.34	105.22	124.136
Fibromyalgia	1.05	1.12	-0.07	-21.66	-3.795
Arthritis	1.39	1.09	0.29	89.75	135.362
Back problems	1.76	1.02	0.74	229.01	621.070
Diabetes	1.53	1.11	0.43	133.08	82.818
COPD	1.59	1.11	0.48	148.55	36.566
Migraine	1.58	1.08	0.50	154.74	245.371
Heart disease	1.91	1.11	0.81	250.68	85.611
Cancer	1.79	1.10	0.69	213.54	115.092
Intestinal/stomach ulcers	1.80	1.11	0.69	213.54	76.953
Urinary incontinence	1.42	1.12	0.31	95.94	18.925
Multiple chemical sensitivities	1.52	1.11	0.41	126.89	46.557
Anxiety disorders	1.25	1.11	0.13	40.23	24.502
Mood disorders	2.25	1.08	1.17	362.09	298.795
Bowel disorders	1.89	1.10	0.80	247.58	143.937
Chronic fatigue syndrome	1.71	1.12	0.60	185.69	23.813

[a] Predicted number of absent days for an employee with a specific focal condition with probability of having other conditions and that for an employee without the focal condition but with probability of having other conditions were estimated from negative binomial regressions with all other covariates at their mean value and their difference is the incremental days for the focal condition per employee.
[b] Calculated as incremental days per employee × a hourly wage CAD$24.33 × 8 hours per day × (1 + wage multiplier 0.44 + employee benefit 0.15).
[c] Calculated as weighted number of employees with the specific focal condition in the study sample × incremental productivity loss per employee.

Representativeness

The study sample was a subsample of the CCHS survey representing respondents who were employed during the past three months. To examine the representativeness, we compared key labor force characteristics of the study sample to those obtained from the national, monthly LFS administered by Statistics Canada for the same study period, including age, sex, education, full- and part-time work status, occupational classification, and province of residence (32). This comparison showed that our study sample is comparable to the employed population working population on all key measures (table A7 in the Appendix, (http://www.sjweh.fi/index.php?page=data-repository) (32).

Discussion

This study is the first Canadian study examining the association between different chronic health conditions and absent workdays using representative, population-based survey data. We found that 10 of 16 chronic conditions (asthma, arthritis, back problems, diabetes, COPD, migraine, heart disease, cancer, mood disorders and bowel disorders) are significantly associated with increased absent workdays due to any health problems. Overall, mood disorders, heart disease, bowel disorders, back problems, and cancer were associated with the largest incremental absent workdays due to health problems at the worker level, while back problems, mood disorders, migraine, bowel disorders, and arthritis were associated with largest productivity losses at the national level. The results were consistent with the analysis limited to absent workdays attributable to chronic conditions only, except that asthma and multiple chemical sensitivities were associated with absent workdays due to other health reasons but not associated with absent workdays due to chronic conditions. These latter two findings may suggest that workers with asthma and multiple chemical sensitivities tend to attribute their work absence to the symptoms of these two conditions or other health issues instead of the chronic conditions themselves.

Mood disorder, back problems, and bowel disorders were identified as three of the five conditions with strongest associations with work absence at the employee level and productivity loss at the national level. The possible explanation is that these three conditions are very episodic conditions with longer-term trajectories (ie, chronic recurrent conditions) resulting in the need for more work days on a frequent basis to cope with.

It can be challenging to compare absent workdays across different studies as different health promotion, sick leave and work accommodation policies differ markedly across countries, industrial sectors and employers (33–35). Workplace accommodations have been found to be effective or even cost-effective in preventing long-term sick leave (33, 36). There is a lack of consensus about the type and structure of effective workplace accommodations for employees with chronic conditions such as musculoskeletal or mental disorders (33–35). In the literature, only a few studies measured the incremental associations of different chronic conditions with absent workdays or estimated the incremental productivity loss (17–20). Mood disorders or depression (17–20), cancer (17–19), COPD or bronchitis (17,19), and heart disease (17,18,20) have consistently been associated with the largest incremental productivity loss per employee. This is despite different definitions on absent workdays, settings [Canada versus the United States (17–19) and Netherlands (20)], and definitions and number of chronic conditions included.

Our study has several limitations. First, chronic conditions were based on self-report. While CCHS specified that a condition needs to have lasted ≥6 months and have been diagnosed by a health professional, the self-reported nature of the question could have biased the response. Studies that have examined the validity of self-reported chronic conditions through comparison to medical records or health administrative data have found that the agreement between self-report and medical records vary by chronic conditions and across studies (37–42). Overall, if a disease is easy to define, life-threatening, or persistent, there is a higher agreement between self-report and medical records (37, 40, 42). Self-reported diabetes, hypertension, stroke, cancer, and Parkinson's disease have high agreement with external data (37–42). Respiratory and musculoskeletal diseases and mental disorders have relatively lower agreement (38–42) and their prevalence tends to be underestimated by self-report (38, 42). This indicates that for some conditions, there may be differential misclassification.

Second, this study relies on one time point measurement of absent workdays over the previous three months. This may lead to an over- or underestimation of the association between chronic conditions and absenteeism, especially for chronic conditions with episodic symptoms or sensitive to seasonal influences such as asthma, arthritis, and fibromyalgia. However, self-reported recall for absent workdays in the previous three months is found to be better than recall for a previous year (43). Also, the CCHS is administered randomly throughout the year, so seasonal variations in symptoms associated with chronic conditions and associated work absences would be randomly distributed in the data.

Third, the CCHS did not ask for wage information. An average, hourly wage estimate was obtained from the LFS conducted by Statistics Canada. The hourly wage was selected for a Canadian employee aged 25–54 years because it corresponded to the average age of this study sample at 41 years old (table 1). We recognize that applying one hourly wage estimate may lead to biased cost estimates and a potential over estimation of costs for individuals with chronic conditions who perhaps do not have the same earning potential as that of their healthier counterparts. This may also be differential by type of conditions, whereby individuals with chronic conditions with long-term disability or episodic trajectories have less earning potential than individuals with chronic conditions that resolve or improve over time or with treatment.

Finally, the CCHS does not have a question asking workers if they attended work while their work productivity was affected by their chronic conditions. As a result, the current study was unable to investigate asso-

ciations between chronic conditions and presenteeism. Future studies are needed to compare the associations or effects of different chronic conditions on absenteeism and presenteeism simultaneously, a method suggested by literature (44–46).

In the current study, the human capital approach was used instead of the friction cost approach to calculate the costs. The friction cost approach allows for non-zero involuntary unemployment and estimates the productivity loss only for the "friction period" it takes to replace the absent worker plus the replacement costs such as recruitment and training costs (47). Currently there is no consensus on which method is preferable when estimating costs due to productivity losses (43, 47–49). The human capital approach was chosen as it is applicable to estimating productivity losses in a short duration where an employee might not be replaced or only replaced temporarily. Further, in the human capital approach, the costs can be directly estimated from the incremental absent workdays multiplied by the wage and benefit costs, and productivity multiplier. The cost estimates using the two approaches differ only among the cases that one absence is longer than the "friction period". We could not tell whether the reported number of absent workdays was a sum of multiple absences or from one long absence. Also, in Canada, a friction duration from 2–4.5 months has been used (3). Thus, we expect the impact of using a different approach would be small.

It is essential for the government, employers and employees to recognize that the workplace plays a key role in promoting health and well-being. The Conference Board of Canada has found that there are significant gaps in employer chronic disease management programs (50). The Board has provided employers with advice on how to create an effective workplace disability management program and how to more effectively manage absenteeism. Key components of an effective program are: (i) identification of the chronic conditions associated with absences; (ii) implementation of wellness initiatives specific to these conditions; and (iii) implementation of programs to help employees manage chronic health conditions (50, 51). Our study can help employers prioritize chronic conditions when implementing these initiatives and programs, as well as provide data to evaluate the potential cost savings.

In conclusion, chronic conditions, especially mood disorders, back problems and bowel disorders, are associated with substantial work productivity loss due to absenteeism. The study findings will help different stakeholders including policy makers and employers to assess the potential productivity impact of chronic disease prevention and management.

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