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The relationship between chronic conditions and absenteeism and associated costs in Canada ¹

By Wei Zhang, PhD,² Christopher McLeod, PhD, Mieke Koehoorn, PhD

¹ Appendix

² Correspondence to Centre for Health Evaluation and Outcome Sciences, 588-1081 Burrard Street, Vancouver, BC V6Z 1Y6. Canada. [E-mail: wzhang@cheos.ubc.ca]

Predicted and incremental number of absent workdays

The negative binomial regression is expressed as follows

$$\ln(\text{absent workdays}) = b_0 + d_1C_1 + d_2C_2 + \cdots + d_{16}C_{16} + b_1X_1 + b_2X_2 + \cdots + b_nX_n$$

where C_s are the dummy variables for the 16 chronic conditions, X_s are the confounders.

The predicted number of absent workdays can be estimated as follows:

$$\widehat{\text{absent workdays}} = \exp(b_0 + d_1C_1 + d_2C_2 + \cdots + d_{16}C_{16} + b_1X_1 + b_2X_2 + \cdots + b_nX_n)$$

where d_s and b_s are the coefficients estimated from the regression model for the 16 chronic conditions and the confounders, respectively. C_s and X_s can be assigned any fixed values depending on whose absent workdays we are interested in.

Marginal effects at the mean

Taking asthma (C_1) as the example, the steps are as follows:

1. Predicted absent workdays for employees with asthma, holding other chronic conditions

and confounders at their means ($P_{\text{asthma}} = \exp(b_0 + \mathbf{d_1} \cdot \mathbf{1} + d_2C_2 + \cdots + d_{16}C_{16} +$

$b_1X_1 + b_2X_2 + \cdots + b_nX_n)$, where the estimated coefficients, d_s and b_s , are shown in

Table A1 and the mean values for other C s and X s can be found in Table 1 in the main manuscript.

2. Predicted absent workdays for employees without asthma, holding other chronic conditions and confounders at their means ($P_{\text{no_asthma}} = \exp(b_0 + \mathbf{d_1} \cdot \mathbf{0} + d_2 C_2 + \dots + d_{16} C_{16} + b_1 X_1 + b_2 X_2 + \dots + b_n X_n)$), where the estimated coefficients, d s and b s, are shown in Table A1 and the mean values for other C s and X s can be found in Table 1 in the main manuscript.
3. Incremental absent workdays per employee for asthma, holding other chronic conditions and confounders at their means = $P_{\text{asthma}} - P_{\text{no_asthma}}$

Employees with one condition only compared with employees without any conditions

Taking asthma (C_1) as the example, the steps are as follows:

1. Predicted absent workdays for employees with asthma but no other conditions, holding confounders at their means ($P_{\text{asthma_only}} = \exp(b_0 + \mathbf{d_1} \cdot \mathbf{1} + d_2 \cdot 0 + \dots + d_{16} \cdot 0 + b_1 X_1 + b_2 X_2 + \dots + b_n X_n)$), where the estimated coefficients, d s and b s, are shown in Table A1, other C s are equal to 0, X s are equal to their means shown in Table 1 in the main manuscript.
2. Predicted absent workdays for employees without any conditions, holding other chronic conditions and confounders at their means ($P_{\text{no_conditions}} = \exp(b_0 + \mathbf{d_1} \cdot \mathbf{0} + d_2 \cdot 0 + \dots + d_{16} \cdot 0 + b_1 X_1 + b_2 X_2 + \dots + b_n X_n)$), where the estimated coefficients, d s and b s, are shown in Table A1, all C s are equal to 0, X s are equal to their means shown in Table 1 in the main manuscript.

3. Incremental absent workdays per employee for asthma among those with no other chronic conditions, holding confounders at their means = $P_{\text{asthma_only}} - P_{\text{no_conditions}}$

Table A2 shows the results comparing predicted number of absent workdays among employees with the focal condition only with those without any chronic conditions and the corresponding incremental productivity loss per employee.

Employees with multiple conditions compared with employees without any conditions

Taking asthma (C_1) and Fibromyalgia (C_2) as the example, the steps are as follows:

1. Predicted absent workdays for employees with asthma and Fibromyalgia but no other conditions, holding confounders at their means ($P_{\text{asthma\&Fibrom_only}}$) = $\exp(b_0 + \mathbf{d_1} \cdot \mathbf{1} + \mathbf{d_2} \cdot \mathbf{1} + \dots + d_{16} \cdot 0 + b_1X_1 + b_2X_2 + \dots + b_nX_n)$, where the estimated coefficients, ds and bs , are shown in Table A1, other Cs are equal to 0, Xs are equal to their means shown in Table 1 in the main manuscript.
2. Predicted absent workdays for employees without any conditions, holding other chronic conditions and confounders at their means ($P_{\text{no_conditions}}$) = $\exp(b_0 + \mathbf{d_1} \cdot \mathbf{0} + \mathbf{d_2} \cdot \mathbf{0} + \dots + d_{16} \cdot 0 + b_1X_1 + b_2X_2 + \dots + b_nX_n)$, where the estimated coefficients, ds and bs , are shown in Table A1, all Cs are equal to 0, Xs are equal to their means shown in Table 1 in the main manuscript.
3. Incremental absent workdays per employee for asthma and Fibromyalgia among those with no other chronic conditions, holding confounders at their means = $P_{\text{asthma\&Fibrom_only}} - P_{\text{no_conditions}}$

Subgroup analysis

The same analysis was also conducted among the study population aged from 25 to 65 years.

The sub-sample was 23,608 representing 12,828,836 employed Canadians aged between 25 and 65 years. The corresponding results are shown in Tables A3-A6. The average number of absent workdays due to health problems was 1.39 days in 3 months. Eight conditions were significantly associated with increased number of absent workdays (Table A4). 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 (\$576 million), mood disorders (\$287 million) and migraine (\$198 million) accounted for the largest incremental productivity loss (Table A6).

Table A1. Coefficients of covariates in the Negative Binomial regression model for study population aged 15-75 years and sub-group aged 25-65 years.

Variables	Age 15-75	Age 25-65
Intercept	-0.003	-0.163
Age	-0.009	-0.013
Female	0.228	0.246
Married or common-law	-0.171	-0.201
Living alone	0.037	0.039
White	0.337	0.390
Log of household income	-0.022	0.005
Education		
< Secondary school graduation	Reference	Reference
Secondary school graduation	0.020	0.057
Some post-secondary	-0.095	-0.044
Post-secondary graduation	-0.021	0.005
BMI classification		
Normal or underweight	Reference	Reference
Overweight	0.029	0.006
Obesity	0.220	0.166
Type of smokers		
Current and former daily smoker	0.097	0.052
Current occasional smoker	0.013	-0.103
Former daily smoker	-0.011	-0.036
Former occasional smoker	-0.141	-0.187
Never smoked	Reference	Reference
Type of drinker		
Regular drinker	-0.302	-0.352
Occasional drinker	-0.266	-0.305
Not a drinker	Reference	Reference
Leisure and transportation physical activity		
Active	Reference	Reference
Moderately active	0.166	0.239
Inactive	0.118	0.151
Occupation		
Management	Reference	Reference
Business, finance and administrative	0.219	0.286
Natural and applied sciences and related	0.308	0.395
Health	0.321	0.440
Social science, education, government service and religion	-0.007	0.062
Art, culture, recreation and sport	0.257	0.406
Sales and service	0.078	0.237

Trades, transport and equipment operators	0.222	0.285
Primary industry	0.226	0.421
Processing, manufacturing and utilities	0.455	0.544
Self-perceived work stress		
Not at all stressful	Reference	Reference
Not very stressful	-0.061	-0.093
A bit stressful	0.078	0.060
Quite a bit stressful	0.172	0.123
Extremely stressful	0.671	0.655
Chronic conditions		
Asthma	0.268	0.283
Fibromyalgia	-0.062	0.002
Arthritis	0.238	0.298
Back problems	0.545	0.564
Diabetes	0.326	0.273
COPD	0.358	0.359
Migraine	0.382	0.356
Heart disease	0.548	0.692
Cancer	0.487	0.343
Intestinal/stomach ulcers	0.486	0.549
Urinary incontinence	0.244	-0.182
Multiple chemical sensitivities	0.312	0.215
Anxiety disorders	0.113	0.097
Mood disorders	0.737	0.778
Bowel disorders	0.545	0.570
Chronic fatigue syndrome	0.427	0.159

Table A2. Incremental number of absent workdays due to any health problems and productivity losses in a 3-month period.

Variables	Predicted absent days for the condition per employee^a	Predicted absent days for no conditions per employee^a	Incremental days per employee^a	Incremental productivity loss per employee^b (2010\$)
Asthma	1.07	0.82	0.25	77.37
Fibromyalgia	0.77	0.82	-0.05	-15.47
Arthritis	1.04	0.82	0.22	68.09
Back problems	1.41	0.82	0.59	182.59
Diabetes	1.13	0.82	0.31	95.94
COPD	1.17	0.82	0.35	108.32
Migraine	1.20	0.82	0.38	117.60
Heart disease	1.41	0.82	0.59	182.59
Cancer	1.33	0.82	0.51	157.83
Intestinal/stomach ulcers	1.33	0.82	0.51	157.83
Urinary incontinence	1.04	0.82	0.22	68.09
Multiple chemical sensitivities	1.12	0.82	0.30	92.84
Anxiety disorders	0.92	0.82	0.10	30.95
Mood disorders	1.71	0.82	0.89	275.44
Bowel disorders	1.41	0.82	0.59	182.59
Chronic fatigue syndrome	1.25	0.82	0.43	133.08

^a Predicted number of absent days for a specific focal condition and no other conditions and that for no 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; ^b calculated as incremental days per employee \times a hourly wage $\$24.33 \times 8$ hours per day $\times (1 + \text{wage multiplier } 0.44 + \text{employee benefit } 0.15)$; ^c calculated as weighted number of employees with the specific focal condition \times incremental productivity loss per employee.

Table A3. Study sample characteristics, CCHS 2010 survey for employed respondents aged 15 to 75

years.

Variables	Weighted %	Weighted mean	SE
Absent from work (yes vs. no)	27.8		
Number of absent workdays			
for all health reasons		1.39	0.06
for chronic diseases		0.46	0.05
for injuries		0.21	0.02
for infectious diseases		0.36	0.01
for other health problems		0.37	0.04
Age (years)		43.84	0.09
Female	45.3		
Married or common-law	73.0		
Living alone	13.7		
White	79.4		
Household income (\$)		90,651.00	899.34
Log of household income		11.19	0.01
Education			
< Secondary school graduation	7.2		
Secondary school graduation	15.5		
Some post-secondary	5.6		
Post-secondary graduation	71.8		
BMI classification			
Normal or underweight	43.9		
Overweight	37.1		
Obesity	19.0		
Type of smokers			
Current and former daily smoker	18.0		
Current occasional smoker	5.0		
Former daily smoker	22.9		
Former occasional smoker	17.1		
Never smoked	37.0		
Type of drinker			
Regular drinker	72.3		
Occasional drinker	13.6		
Not a drinker	14.1		
Leisure and transportation physical activity			
Active	27.4		
Moderately active	26.6		
Inactive	46.0		
Occupation			
Management	10.2		
Business, finance and administrative	20.1		
Natural and applied sciences and related	8.2		
Health	7.2		
Social science, education, government service and religion	9.4		
Art, culture, recreation and sport	3.2		
Sales and service	19.4		

Trades, transport and equipment operators	15.3
Primary industry	2.9
Processing, manufacturing and utilities	4.2
Self-perceived work stress	
Not at all stressful	7.7
Not very stressful	17.4
A bit stressful	42.9
Quite a bit stressful	26.5
Extremely stressful	5.6
Chronic conditions	
Asthma	7.2
Fibromyalgia	1.3
Arthritis	10.7
Back problems	18.8
Diabetes	4.5
COPD	1.8
Migraine	10.6
Heart disease	2.2
Cancer	3.7
Intestinal/stomach ulcers	2.6
Urinary incontinence	1.4
Multiple chemical sensitivities	2.6
Anxiety disorders	4.0
Mood disorders	5.7
Bowel disorders	4.1
Chronic fatigue syndrome	0.9
Number of chronic conditions	
0	53.2
1	26.3
2	12.2
3	4.7
4	2.1
5	0.9
6+	0.6

CCHS: Canadian Community Health Survey; SE: standard errors estimated by the balanced repeated replication method using 500 bootstrapped weights; BMI: body mass index; COPD: chronic obstructive pulmonary disease

Table A4. Ratio of expected counts of absent workdays due to any health problems using a negative binomial regression.

Variables	Unadjusted ratio	95% CI	Adjusted ratio	95% CI
Asthma	1.42	1.10-1.84 ^a	1.33	1.03-1.71 ^a
Fibromyalgia	1.10	0.72-1.66	1.00	0.65-1.54
Arthritis	1.29	1.05-1.59 ^a	1.35	1.06-1.70 ^a
Back problems	1.67	1.36-2.05 ^a	1.76	1.46-2.12 ^a
Diabetes	1.24	0.94-1.64	1.31	0.96-1.80
COPD	1.39	0.97-1.99	1.43	0.99-2.07
Migraine	1.74	1.13-2.68 ^a	1.43	1.06-1.93 ^a
Heart disease	1.86	1.23-2.82 ^a	2.00	1.32-3.02 ^a
Cancer	1.22	0.96-1.54	1.41	1.09-1.82 ^a
Intestinal/stomach ulcers	1.77	0.83-3.79	1.73	0.86-3.48
Urinary incontinence	0.87	0.61-1.24	0.83	0.58-1.19
Multiple chemical sensitivities	1.27	0.86-1.87	1.24	0.86-1.79
Anxiety disorders	1.19	0.91-1.55	1.10	0.84-1.45
Mood disorders	2.57	1.87-3.54 ^a	2.18	1.61-2.95 ^a
Bowel disorders	1.77	1.18-2.63 ^a	1.77	1.17-2.67 ^a
Chronic fatigue syndrome	1.27	0.80-2.01	1.17	0.73-1.88

CI: confidence interval; COPD: chronic obstructive pulmonary disease; ^a The CI that does not cover 1.

Table A5. Ratio of expected counts of absent workdays due to chronic conditions and other health reasons, respectively, using a negative binomial regression.

Variables	Adjusted ratio due to chronic conditions	95% CI	Adjusted ratio due to other health reasons	95% CI
Asthma	1.00	0.62-1.61	1.46	1.12-1.90 ^a
Fibromyalgia	2.27	0.84-6.16	0.75	0.43-1.30
Arthritis	3.16	1.79-5.56 ^a	0.97	0.78-1.21
Back problems	3.79	2.47-5.82 ^a	1.53	1.28-1.83 ^a
Diabetes	1.54	0.80-2.94	1.16	0.80-1.68
COPD	3.80	1.37-10.53 ^a	1.53	0.99-2.37
Migraine	2.55	1.26-5.17 ^a	1.17	0.96-1.42
Heart disease	4.72	1.95-11.39 ^a	1.38	0.91-2.10
Cancer	2.66	1.55-4.57 ^a	1.07	0.80-1.42
Intestinal/stomach ulcers	5.68	0.70-46.06	1.02	0.72-1.46
Urinary incontinence	0.65	0.28-1.51	1.02	0.66-1.56
Multiple chemical sensitivities	0.68	0.35-1.32	1.59	1.03-2.47 ^a
Anxiety disorders	1.13	0.60-2.16	1.08	0.80-1.45
Mood disorders	2.79	1.71-4.54 ^a	2.11	1.51-2.95 ^a
Bowel disorders	3.24	1.58-6.67 ^a	1.56	0.97-2.53
Chronic fatigue syndrome	1.23	0.50-3.06	1.20	0.61-2.35

CI: confidence interval; COPD: chronic obstructive pulmonary disease; ^a The CI that does not cover 1.

Table A6. Incremental number of absent workdays due to any health problems and productivity losses in a 3-month period.

Variables	Predicted absent days for the condition per employee^a	Predicted absent days without the condition per employee^a	Incremental days per employee^a	Incremental productivity loss per employee^b (2010\$)	Incremental productivity loss in population^c (millions of 2010\$)
Asthma	1.47	1.11	0.36	111.41	103.354
Fibromyalgia	1.13	1.13	0.00	0.00	0.000
Arthritis	1.48	1.10	0.38	117.60	160.664
Back problems	1.79	1.02	0.77	238.30	575.956
Diabetes	1.47	1.12	0.35	108.32	62.339
COPD	1.61	1.12	0.49	151.64	35.064
Migraine	1.56	1.09	0.47	145.45	197.968
Heart disease	2.23	1.11	1.11	343.52	96.909
Cancer	1.57	1.12	0.46	142.36	67.472
Intestinal/stomach ulcers	1.93	1.12	0.82	253.77	83.664
Urinary incontinence	0.95	1.13	-0.19	-58.80	-10.212
Multiple chemical sensitivities	1.40	1.13	0.27	83.56	27.797
Anxiety disorders	1.24	1.13	0.12	37.14	19.256
Mood disorders	2.36	1.08	1.27	393.04	286.569
Bowel disorders	1.96	1.11	0.85	263.06	137.529
Chronic fatigue syndrome	1.33	1.13	0.19	58.80	6.683

^a Predicted number of absent days for employees with a specific focal condition with probability of having other conditions and that for employees 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; ^b calculated as incremental days per employee \times a hourly wage \$24.33 \times 8 hours per day \times (1 + wage multiplier 0.44 + employee benefit 0.15); ^c calculated as weighted number of employees with the specific focal condition \times incremental productivity loss per employee.

Table A7. Comparing population characteristics between study population and the Labour Force Survey.

	Study population (%)	LFS (%) ^a
Age		
15-24	14.8	14.4
25-54	67.6	68.1
55 and over	17.6	17.5
Female	45.4	47.5
Education		
< Secondary school graduation	9.2	10.3
Secondary school graduation/Some post-secondary	24.5	27.3
Post-secondary graduation	66.3	62.0
Working status		
Full-time	82.7	80.7
Part-time	16.8	19.3
Occupation		
Management	9.0	8.8
Business, finance and administrative	18.9	18.2
Natural and applied sciences and related	7.5	7.3
Health	6.8	6.5
Social science, education, government service and religion	8.7	9.4
Art, culture, recreation and sport	3.4	3.2
Sales and service	23.7	24.1
Trades, transport and equipment operators	15.1	14.9
Primary industry	3.1	3.0
Processing, manufacturing and utilities	3.9	4.6
Province		
Newfoundland and Labrador	1.3	1.3
Prince Edward Island	0.5	0.4
Nova Scotia	2.9	2.6
New Brunswick	2.1	2.1
Quebec	22.9	23.1
Ontario	38.8	38.9
Manitoba	3.6	3.6
Saskatchewan	3.1	3.1
Alberta	11.9	11.8
British Columbia	12.7	13.2

LFS: Labour Force Survey

^a Wannell T, Usalcas J. Labour Force Survey: 2011 year-end review [Internet]. Ottawa: Statistics Canada; 2012 Mar. Report No.: Catalogue no. 75-001-X. Available from: <http://www.statcan.gc.ca/pub/75-001-x/2012002/article/11639-eng.htm>.