The Association between Risk Factors and Chronic Obstructive Pulmonary Disease in Canada: A Cross-sectional Study Using the 2014 Canadian Community Health Survey

Abstract

Background: The global prevalence of chronic obstructive pulmonary disease (COPD) is expected to increase and the disease is projected to be the third leading cause of death by the year 2020. The purpose of this study was to measure the prevalence and determine the risk factors for COPD in Canada. **Methods:** This is a cross-sectional study that uses data from a nationally generalizable survey, the Canadian Community Health Survey, 2014. There were 46,924 respondents aged 35 years or older. Uni- and multi-variate logistic regression analyses were conducted to determine the risk factors associated with COPD. **Results:** The overall prevalence of COPD in the surveyed population was 5.69%. Results from multivariate logistic regression showed that COPD was significantly higher among individuals who were 65 years or older (odds ratio [OR] =4.43; 95% confidence interval [CI]: 3.69–5.33), current smokers (OR = 5.13; 95% CI: 4.43–5.95), underweight or obese by body mass index ([OR = 1.81; 95% CI: 1.38–2.38] and [OR = 1.58; 95% CI: 1.41–1.77], respectively), with a total personal income of <$20,000 (OR = 3.67; 95% CI: 2.95–4.57,), and some postsecondary education (OR = 1.42; 95% CI: 1.14–1.76). Immigrants were less likely to have COPD compared to Canadian-born respondents (OR = 0.67; 95% CI: 0.57–0.79). **Conclusions:** COPD is a growing and serious public health issue in Canada. The risk factors identified in this study provide useful targets to health promotion and education initiatives, health-care providers, and public health organizations to decrease the prevalence of COPD.

Keywords: *Body mass index, Canada, chronic obstructive pulmonary disease, education, smoking, socioeconomic status*

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Introduction

Chronic obstructive pulmonary disease (COPD) is a nonreversible lung condition that includes both chronic bronchitis and emphysema.[1] Development of COPD is characterized by the progressive limitation of air passageways as well as pulmonary and systemic inflammation.[2,3] Symptoms of COPD include chronic cough, sputum production, and shortness of breath.[3] The global prevalence of COPD is projected to increase, becoming the third leading cause of death by the year 2020.[4] As of 2012, COPD was the fourth leading cause of mortality in Canada, which is comparable to the global statistics.[5] These projections suggest that the anticipated increase in the prevalence of COPD may cause further strain on the Canadian health-care systems.[5,6]

COPD is a multi-etiological disease, with several risk factors associated with its development. Health and lifestyle risk factors associated with COPD include smoking[7] and body mass index (BMI).[8] Among high-income countries (including Canada), approximately 73% of COPD cases are attributed to smoking.[7] When considering that 18%[9] of the Canadian population are classified as smokers, over six million Canadians are at an increased risk to develop COPD.[10] Another risk factor that has been strongly linked to COPD is BMI, particularly those in the obese and underweight categories.[8] In Canada, nearly 50% of adults are overweight or obese with the proportion increasing with age.[11,12] Additionally, 24% of Canadian adults over the age of 40 are underweight.[12] As a result, these findings suggest that a large proportion of the Canadian population is at risk to potentially develop COPD.

Some demographic risk factors for COPD include sex,[13] age,[2,3] cultural/racial

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origin,[14,15] and immigrant status.[16] The prevalence of COPD in women has increased in the recent years.[13] It has been suggested that this is due to certain behavioral factors, such as increased smoking or a gender bias in the diagnosis of COPD.[3,13] Increasing age has also been reported to be associated with COPD.[2,13] This is due to the observed pathophysiological changes in lung structure seen with older age, as well as increased survival of patients with COPD.[2] Initially, many studies reported a cultural/racial difference in COPD prevalence.[14,15] However, this association is often attributed to an underlying risk factor, such as socioeconomic status (SES).[14,15] Similarly to other chronic diseases, immigrant status is negatively associated with COPD, leaving the majority of the Canadian-born population at a higher risk of COPD.[16]

There is a strong, inverse relationship between SES and COPD.[17] Two indicators of SES are income[18] and education.[19] It is well documented that low SES is associated with COPD.[20-22] The literature suggests that lower income populations are at a higher risk of developing COPD.[18] Likewise, lower education has been associated with deteriorating lung function[19] and increased severity of COPD.[15,23]

The primary purpose of this study was to identify risk factors and assess their association with COPD. We specifically examined the association between health and lifestyle characteristics (type of smoker and BMI), demographic factors (sex, age, culture/racial origin, and immigration status), and SES (income and level of education) with COPD.

Methods

Data source

The Canadian Community Health Survey (CCHS) is a cross-sectional, nationally generalizable survey completed annually, from January to December, in partnership with Statistics Canada.[24] The survey is inclusive of all Canadians over the age of 12 years with the exception of approximately 3% of the population: who live on reserves and other Aboriginal settlements, full-time members of the Canadian Forces, the institutionalized population, and persons in the Quebec health regions of Région du Nunavik and Région des Terres-Cries-de-la-Baie-James.[24] Data are collected through a multistage sample strategy, the details of which are described by Statistics Canada[24] and have been presented elsewhere.[25] The CCHS is a self-reported questionnaire for the collection of information related to health status, health-care utilization, and health determinants for the Canadian population.[24]

Study population for analysis

This study used data from the 2014 CCHS Public Use Microdata File, and our target population was individuals aged 35 years and older (*n* = 46,924). This population

was chosen to be consistent with previous statistics[26] and because COPD is reported in the literature to mainly affect older individuals.[2,3]

Outcome variable

The outcome variable was self-reported COPD status, based on the following question: "Do you have chronic bronchitis, emphysema, or COPD?"[24] Only individuals who answered either "yes" or "no" were included in the study.

Independent variables

Health and lifestyle (type of smoker and BMI), demographic (sex, age, cultural/racial origin, immigrant status, and province), and SES (income and education) were the independent variables explored in this study.

Statistical analysis

Statistical analysis was made by SAS version 9.4 (SAS Institute Inc., Cary, North Carolina, USA). The type of smoker variable was categorized into three levels: current smoker, former smoker, and never smokers. The age variable was re-categorized into three levels on the basis of recommendations made in the COPD literature: 35–49, 50–65, and 65 years old and older.[27] Crosstabs were conducted measuring the prevalence of COPD by the way of each risk factor.

Univariate analysis was conducted to analyze the unconditional association between each independent variable and COPD status. To be included in multivariable modeling, $P \leq 0.25$ was considered statistically significant.

Multicollinearity was assessed examining the variance inflation factor with a value >2.5, indicating the presence of multicollinearity. Multivariable logistic regression modeling was conducted using the independent variables identified as being statistically significant from the univariate analysis. $P \leq 0.05$ was used to ascertain statistical significance. Manual backward selection was used for model building. A change in regression coefficient of 20% or more ($\Delta\beta \geq 20\%$) was used to determine whether variables were confounders. Upon completion of the main-effects model, interactions were assessed based on clinical and statistical considerations.

Results

Descriptive statistics

The prevalence and descriptive statistics of COPD in our study population are summarized in Table 1. The overall prevalence of COPD (*n* = 46,924) was 5.69%. COPD by the way of health and lifestyle variables had the following results: current smokers (10.82%) had the highest proportion of COPD compared to former and never smokers; individuals classified as underweight (10.77%) and obese (7.27%) by BMI had a higher prevalence of COPD compared with individuals with normal BMI and

Table 1: Descriptive characteristics of chronic obstructive pulmonary disease among Canadians (Canadian Community Health Survey, 2014)

Outcome variable	Percentage		Total
COPD (*n*=46,924)			
With COPD	5.69		2668
Without COPD	94.31		44,256

Independent variables	With COPD	Without COPD	Total
Health and lifestyle risk factors			
Type of smoker (*n*=46,452)			
Current smoker	10.82	89.18	8301
Former smoker	5.90	94.10	23,407
Never smoked	2.42	97.58	14,744
BMI class (*n*=44,244)			
Underweight	10.77	89.23	771
Normal weight	4.98	95.02	16,391
Overweight	4.82	95.18	16,445
Obese	7.27	92.73	10,637
Demographic characteristics			
Sex (*n*=46,924)			
Male	5.36	94.64	20,462
Female	5.94	94.06	26,462
Age (years, *n*=46,924)			
35-49	1.80	98.20	10,328
50-64	5.32	94.68	17,168
65+	8.07	91.93	19,428
Culture or racial origin (*n*=45,195)			
White	5.79	94.21	40,183
Visible minority	4.63	95.37	5012
Immigration status (*n*=45,306)			
Yes	3.46	96.54	7114
No	6.08	93.92	38,192
Province of residence (*n*=46,924)			
Newfoundland and Labrador	5.48	94.52	1534
PEI	6.70	93.30	776
Nova Scotia	7.84	92.16	2053
New Brunswick	5.75	94.25	1913
Quebec	5.47	94.53	8553
Ontario	6.24	93.76	15,515
Manitoba	4.10	95.90	2730
Saskatchewan	5.80	94.20	2708
Alberta	5.13	94.87	4252
British Columbia	4.88	95.12	5922
Yukon/NWT/Nunavut	5.06	94.94	968
Socioeconomic status indicators			
Total personal income (*n*=40,923)			
No income	4.50	95.50	645
<$20,000	10.48	89.52	9636
$20,000-$39,999	5.98	94.02	12,413
$40,000-$59,999	3.83	96.17	8038
$60,000-$79,999	2.78	97.22	4453
$80,000 or more	1.80	98.20	5738
Highest level of education (*n*=46,134)			

Contd...

Table 1: Contd...

Independent variables	With COPD	Without COPD	Total
Less than secondary graduation	9.82	90.18	9364
Secondary graduation	5.33	94.67	9197
Some postsecondary education	7.37	92.63	1587
Postsecondary certification	4.19	95.81	25,986

COPD=Chronic obstructive pulmonary disease, BMI=Body mass index, PEI=Prince Edward Island, NWT=Northwest Territory

overweight BMI. The prevalence of COPD by different demographic variables was as follows: females (5.94%) had a higher prevalence of COPD compared to males (5.36%); when looking at age, individuals aged 65 years old and older (8.07%) had the highest rates of COPD; individuals reporting a White cultural/racial origin had higher rates of COPD (5.79%) compared to visible minorities (4.63%); immigrants had lower rates of COPD (3.46%) compared to Canadian-born respondents (6.08%); and individuals residing in Nova Scotia reported the highest rates of COPD (7.84%) from all the provinces. The prevalence of COPD by socioeconomic indicators was as follows: individuals reporting an annual income of <$20,000 (10.48%) had the highest rates of COPD, and when considering education, those with less than secondary school graduation had the highest rates of COPD (9.82%).

Univariate analysis

A summary of the univariate analysis is presented in Table 2. All the risk factors were statistically significant ($P \leq 0.25$). Univariate analysis of health and lifestyle variables found that current smokers were 4.38 (95% confidence interval [CI]: 3.34–5.75) times more likely to report COPD compared to those who had never smoked; individuals who were characterized as underweight according to their BMI were 2.18 (95% CI: 1.42–3.34) times more likely of having COPD compared to those who were normal weight. When looking at the association between COPD and demographic variables, males were 15% less likely to have COPD than females (odds ratio [OR] =0.85; 95% CI: 0.72–0.99); adults aged 65 years and older were 5.25 (95% CI: 3.80–7.25) times more likely to have COPD compared to those who were 35–49 years old; visible minorities were 54% less likely to have COPD compared to Whites (OR = 0.46; 95% CI: 0.32–0.65); immigrants were 54% less likely to have COPD compared to Canadian-born respondents (OR = 0.47; 95% CI: 0.35–0.63); and there was no statistically significant difference in COPD when comparing the provinces and territories with the province of Saskatchewan. When examining SES, individuals with an annual income of <$20,000 were 8.47 (95% CI: 5.73–12.50) times more likely of having COPD compared to those who made an income of $80,000 or more; those with less than secondary school graduation were 3.57 (95% CI: 3.03–4.22) times more likely to have COPD than those with postsecondary certification.

Table 2: Univariate analysis of chronic obstructive pulmonary disease among Canadians (Canadian Community Health Survey, 2014)

Variables	OR (95% CI: Lower–upper)	*P* (α=0.25)
Health and lifestyle risk factors		
Type of smoker (reference: never smoker)		
Current	4.38 (3.34-5.75)	<0.0001
Former	2.14 (1.64-2.78)	
BMI class (reference: normal weight)		
Underweight	2.18 (1.42-3.34)	<0.001
Overweight	0.97 (0.79-1.19)	
Obese	1.57 (1.27-1.93)	
Demographic characteristics		
Sex (reference: female)		
Male	0.85 (0.72-0.99)	0.0396
Age (years, reference: 35-49)		
50-64	3.03 (2.16-4.24)	<0.0001
65+	5.25 (3.80-7.25)	
Culture or racial origin (reference: white)		
Visible minority	0.46 (0.32-0.65)	<0.0001
Immigration status (reference: No)		
Yes	0.47 (0.35-0.63)	<0.0001
Province of residence (reference: Saskatchewan)		
Newfoundland and Labrador	0.81 (0.54-1.21)	0.0221
PEI	1.20 (0.72-2.01)	
Nova Scotia	1.24 (0.88-1.77)	
New Brunswick	1.10 (0.71-1.69)	
Quebec	0.93 (0.69-1.27)	
Ontario	0.78 (0.58-1.04)	
Manitoba	0.74 (0.41-1.32)	
Alberta	0.79 (0.54-1.16)	
British Columbia	0.73 (0.50-1.08)	
Yukon/NWT/Nuna	0.991 (0.59-1.67)	
Socioeconomic status indicators		
Total personal income (reference: $80,000 or more)		
No income	3.11 (1.67-5.81)	<0.0001
<$20,000	8.47 (5.74-12.50)	
$20,000-$39,999	3.99 (2.70-5.88)	
$40,000-$59,999	2.28 (1.49-3.48)	
$60,000-$79,999	1.68 (1.04-2.73)	
Highest level of education (reference: postsecondary certification)		
Less than secondary graduation	3.58 (3.03-4.22)	<0.0001
Secondary graduation	1.67 (1.31-2.14)	
Some postsecondary education	2.72 (1.65-4.49)	

CI=Confidence interval, BMI=Body mass index, PEI=Prince Edward Island, NWT=Northwest Territory, OR=Odds ratio

Multivariate analysis

A summary of the multivariate logistic regression analysis is presented in Table 3. Results from our study found that adults aged 65 years or older had 4.43 (95% CI: 3.69–5.33) times greater odds of reporting COPD compared to 35–49 year olds, immigrants were less likely to have COPD compared to Canadian-born respondents (OR = 0.67; 95% CI: 0.57–0.79), individuals with an income of <$20,000 were more likely to have COPD compared to those with an income of $80,000 or more (OR = 3.67; 95% CI: 2.95–4.57), and those with less than secondary school graduation were more likely to have COPD compared to individuals with postsecondary certification (OR = 1.25; 95% CI: 1.12–1.41). Current smokers were more likely to report COPD compared to never smokers (OR: 5.13; 95% CI: 4.43–5.95); individuals who were classified as obese by BMI (OR = 1.58; 95% CI: 1.41–1.77) or underweight (OR = 1.81; 95% CI: 1.38–2.38) were more likely to have COPD compared to individuals with a normal BMI. Sex and geography were removed because they were not significant nor confounders ($P > 0.05$), while the culture/racial origin variable remained as a confounder.

Discussion

The present study identified the prevalence of COPD and its associated risk factors among Canadians aged 35 years old and older. It furthers our understanding and provides insight about the intricate relationship between certain risk factors and COPD. As the median age of the Canadian population is expected to increase, the burden due to COPD is projected to rise. Results from our study can help inform health-care practitioners/organizations and lead to the more effective allocation and use of health-care resources to better address COPD.

Our study found that current smokers are five times more likely (OR = 5.13; 95% CI: 4.43–5.95) to have COPD compared to never smokers. The prevalence of COPD among current smokers is 10.82% compared to never smokers at 2.42%. This finding is similar to the prevalence of COPD reported in other Canadian studies.[28-29] Although the number of Canadian smokers is decreasing, it is worthy to note that 80% of the individuals who have COPD in Canada have smoked at some point in their life.[29] Former smokers, who constitute an increasing subpopulation in Canada due to anti-smoking public health efforts, may still be at increased odds of developing COPD compared to never smokers and may not be aware of it. Health practitioners should be informed of the increased odds of COPD among former smokers to diagnose and treat this disease in its earlier form and more manageable stages.

Our study identified trends in the association between COPD and age. As people age, there is an increased prevalence of COPD.[2] Results from our study indicate that an individual aged 65 years or older is more likely to

Table 3: Logistic Regression Analysis of Characteristics of COPD

Variables	Odds ratio (95% CI: Lower, Upper)	*P* (α=0.05)
Health and Lifestyle Risk Factors		
Type of Smoker		
Reference: Never Smoker		
Current	5.13 (4.43, 5.95)	<0.0001
Former	2.23 (1.94, 2.56)	
BMI Class		
Reference: Normal Weight		
Underweight	1.81 (1.38, 2.38)	<0.0001
Overweight	1.00 (0.89, 1.12)	
Obese	1.58 (1.41, 1.77)	
Demographic characteristics		
Age		
Reference: 35-49		
50-64	2.76 (2.30, 3.30)	<0.0001
65+	4.43 (3.69, 5.33)	
Culture or Racial Origin		
Reference: White		
Visible Minority	1.00 (0.85, 1.19)	0.0662
Immigration Status		
Reference: No		
Yes	0.67 (0.57, 0.79)	0.0296
Socioeconomic Status Indicators		
Total Personal Income		
Reference: $80,000 or more		
No Income	2.44 (1.58, 3.78)	<0.0001
<$20,000	3.67 (2.95, 4.57)	
$20,000 - $39,999	2.18 (1.75, 2.71)	
$40,000 - $59,999	1.63 (1.29, 2.06)	
$60,000 - $79,999	1.35 (1.03, 1.77)	
Highest Level of Education		
Reference: Post-secondary certification		
Less than secondary graduation	1.25 (1.12, 1.41)	<0.0001
Secondary graduation	0.98 (0.86, 1.11)	
Some post-secondary education	1.42 (1.14, 1.76)	

have COPD compared to an individual aged 35–49 years old (OR = 4.43; 95% CI: 3.69–5.33). These findings are consistent with those reported in the literature[2,5] and with the natural history of most chronic diseases.[30] In many high-income countries, chronic diseases pose a significant burden on their health-care systems.[31] In Canada, the direct (drug, physician care, and hospital care) and indirect (mortality) costs due to COPD were estimated to be 1.26 billion during 2008.[32] Therefore, training physicians to look for early signs of COPD, when it is more manageable, may help reduce the financial burden of this disease.

While examining SES variables, our study found that, as income decreases, the odds of COPD increase. Other studies have reported similar trends.[14,33] A proposed mechanism for this finding may be that individuals with lower incomes have decreased access to health care in comparison to those with higher incomes, despite having a greater need.[14,34] This implication may cause a delay in the diagnosis of COPD, leading to poorer prognosis, and an increased prevalence and mortality among this disadvantaged population.[34] It is important for health-care services to target those in lower SES conditions and provide sufficient services to reduce the burden of COPD.

Consistent with other literature reports, our study found the prevalence of COPD to be highest in those who had the lowest level of education among the Canadian population.[14] Individuals with postsecondary certification or university degrees have decreased odds of COPD compared to those who did not complete secondary school or had some postsecondary education. However, the strength of the association between lower education and COPD was much weaker than the association between lower income and COPD. This was a surprising finding as it contradicts other literature in which the level of education is reported to be a stronger indicator of SES than both income and occupation.[19,35]

In our study, we found that obese individuals are 1.58 times (95% CI: 1.41–1.77) more likely to have COPD compared to individuals with normal BMI. As both COPD and the health consequences of obesity are sources of poor lung function, it is not surprising that obesity is associated with COPD.[36] Additionally, poor lung function due to COPD may lead to difficulties participating in physical activity, which in turn may contribute to obesity,[37] and therefore, increase morbidity outcomes in a cascading fashion. Our findings also demonstrate that underweight individuals are 1.81 (95% CI: 1.38–2.38) times more likely to have COPD than individuals with normal BMI. This finding may be partially explained by the link between smoking and nutrition deprivation. Individuals who smoke normally have suppressed appetites or increased metabolism, which may lead to lower BMI.[38] This hypothesis is supported in several studies that report individuals at extreme ends of BMI are at a greater risk of developing COPD than normal-weight individuals.[29,39,40] On the basis of the findings in our study, we are led to believe that examining the direct relationship between obesity and the development of COPD is an interesting avenue to research and could help improve preventive care. Thus, it is recommended to incorporate "years with COPD" question/variable in future cross-sectional studies and/or conduct longitudinal studies on this important topic.

Finally, our study found that immigration status is a protective factor against COPD. A possible explanation for this is the healthy immigrant effect. It is hypothesized that immigrants tend to have better health and lower rates of morbidity and mortality from chronic diseases than Canadian-born individuals.[41] This hypothesis may apply to rates of COPD as well, which is consistent with the findings of our study. The majority of Canadian immigrants are younger, healthier, and better educated as opposed to older, less healthy, and poorly educated individuals who are less likely to immigrate.[41]

Strengths and limitations

The present study analyzed recent data (2014) and provides additional support and a greater understanding of the significance of certain risk factors and COPD. In addition, the CCHS is a national survey that has a high sample size, resulting in greater generalizability of our findings to the Canadian population. A possible limitation is the unreliability that accompanies self-reported data. This may have caused underreporting of the prevalence of COPD in our study as there is evidence to suggest that self-reported COPD rates are usually lower than those confirmed by clinical diagnosis.[28]

Conclusions

The results of this study identify an array of risk factors that cause certain Canadian subpopulations to be at an increased risk of COPD. Significant risk factors include smoking, BMI, immigrant status, education, and income. These risk factors may be targeted by health promotion and education initiatives to decrease the prevalence of COPD. As the Canadian population continues to age, health-care providers and public health organizations (including governmental agencies) need to collaborate to effectively address the growing and serious public health issue posed by COPD in Canada.

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