Smoking and asthma in men and women with normal weight, overweight and obesity

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Abstract

Background: There is a complex interrelationship among smoking, body weight and asthma. It needs to be clarified if smoking is related to an increased risk of asthma after taking into account for relative body weight.

Objective: To examine the association between cigarette smoking and the prevalence of asthma in Canadian men and women with normal weight, overweight and obesity.

Methods: The analysis was based on data from 112,830 Canadians aged 18 years or more who participated in a national survey in 2007-2008. A questionnaire covered the information on prevalent asthma, smoking status, height, weight and other factors. Logistic regression analysis was used to determine the association between smoking and the prevalence of asthma stratified by sex and body mass index.

Results: The crude prevalence of asthma was 6.6% for men and 9.3% for women. After adjustment for covariates, the odds ratios (ORs) for current smoking associated with asthma was 1.20 (95% confidence interval [CI]: 1.01 - 1.43) for men with normal weight, 0.98 (95% CI: 0.81, 1.18) for overweight men and 1.02 (95% CI: 0.80 – 1.30) for obese men. For women, the corresponding adjusted odds ratios were 1.41 (95% CI: 1.23 – 1.62), 1.27 (95% CI: 1.05 – 1.54) and 1.28 (95% CI: 1.03 – 1.59), respectively.

Conclusion: Current smoking was significantly associated with prevalent asthma in all women regardless their relative body weight. In men however, the association was only observed in those with under or normal weight.

Key words: asthma; body mass index; national survey; sex; smoking

Introduction

Cigarette smoking is a major determinant of respiratory health. However, study results concerning its impact on asthma incidence and prevalence are widely inconsistent.[1] Some longitudinal studies have shown no association between smoking and the incidence of asthma,[2-4] while others have demonstrated that smoking increases the risk of asthma onset.[1 5-9] The association between active smoking and incident asthma was observed in men only in one study,[1] and in women only in some other studies.[6-8] There are also contradictory results for the association between smoking and asthma risk from case-control studies[10-12] and cross-sectional studies.[13 14] Case-control and cross-sectional study design cannot tell if smoking causes asthma or if asthma patients are less likely to start smoking or more likely to quit smoking. The temporality is not an important concern for prospective longitudinal studies while potential selections biases have been discussed.[15 16]

Obesity, which is likely to have a detrimental influence on asthma,[17] is closely related to smoking status. Smoking may reduce while smoking cessation may increase body weight.[18] The opposite may also be true that overweight/obese people tend to smoke more to lose weight[19] and not to quit smoking to avoid weight gain.[20 21] The complex interrelationship among smoking, body weight and asthma may explain, at least a part, the inconsistent results observed for the association between smoking and asthma from different study populations and is difficult to be sorted out in observational studies when sample size is not large. To minimize the potential impact of being overweight and obesity on the estimates for smoking and asthma association, we conducted an analysis

stratified by relative body weight based on data from a large scale Canadian national survey.

Material and methods

We used data from the Canadian Community Health Survey (CCHS) conducted by Statistics Canada in 2007 and 2008 (Canadian Community Health Survey - Annual Components. User guide. 2007-2008 microdata file. Statistics Canada, Health Statistics Division). The target population of the survey was household residents aged 12 years or more in all the ten provinces and three territories in Canada, excluding individuals living on Indian Reserves or Crown lands, clientele of institutions, full-time members of the Canadian Armed Forces and residents of certain remote regions. This survey used a multistage stratified sampling design and three sampling frames to select the sample of households: an area frame of the Canadian Labour Force Survey, a list frame of telephone numbers and a Random Digit Dialling (RDD) sampling frame. Overall, 131,061 (one per household) participated in the survey and the response rate was 76.4%. The survey included questions related to health status, health care utilization and health determinants.

The present study was based on data from 112,830 subjects 18 years of age or more who responded to questions about asthma and smoking status and provided information on height and weight. The survey asked about "long-term conditions" that had lasted or were expected to last six months or more and that had been diagnosed by a health professional. Respondents who answered the following question affirmatively were considered as having asthma: "Do you have asthma diagnosed by a health professional?"

Current smokers were respondents who reported smoking cigarettes every day at the time of the survey. Former smokers were those who reported smoking cigarettes daily in the past but were not smoking at the time of the survey. Otherwise, subjects were classified as nonsmokers. Body mass index (BMI) was calculated: BMI = weight (kg)/[height (m)]^2. Subjects were grouped into the following BMI categories: <25.0 (under or normal weight), 25.0-29.9 (overweight), ≥30.0 (obesity). Since the number of underweight was small especially for men, participants with under and normal weight were grouped into one category. Individuals were grouped into three household income categories based on household income distribution at national level (Canadian Community Health Survey - Annual Components. User guide. 2007-2008 microdata file. Statistics Canada, Health Statistics Division and Special Surveys Division). It is a distribution of Canadians in deciles (ten categories including approximately the same percentage of residents for each province) in the basis of the adjusted ratio of their total household income to the low income cut-off corresponding to their household and community size. This is a relative measure of each individual's household income to the household incomes of all other respondents. Based on this measure, subjects were grouped into three income categories: low (ratio ≤ 30%), middle (30 < ratio ≤ 70%) and high (ratio > 70%). For education level, subjects not proceeding beyond secondary school were classified into the lower education group. The higher education group included those admitted to college or university and those with a post-secondary school certificate or diploma. Other variables included in the analysis were age (18-29, 30-39, 40-49, 50-59, 60-69, ≥70), marital status (married or common law partner, single, separated or divorced or widowed), race (White, non-White), immigrant status (yes or

no), alcohol drinking (current drinker, former drinker, <1 time per week, 1+ times per week), and regular exercise (yes or no).

We calculated the prevalence of asthma according to smoking status overall and stratified by body mass index in men and women. Logistic regression analysis was used to examine the association between smoking status and asthma stratified by sex and body mass index after adjustment for covariates. Model parameters were estimated by using the method of maximum likelihood and were tested for significance by using the Wald statistic. The CCHS used a complex survey design. All the point estimates were weighted to the Canadian population and average design effect was taken into consideration in variance estimation in both simple and multivariate analyses.[13] All the statistical analyses were conducted by using the Statistical Analysis System (SAS) version 9.1 (SAS Institute, Inc., Cary, North Carolina).

Results

Having asthma diagnosed by a health professional was reported by 6.5% of men and 9.1% of women (weighted to the Canadian general population). The proportions of current smoking and former smoking were higher in men (21.0% and 28.3%) compared with women (16.2% and 22.4%). Among Canadian adults, 40.5% of men and 27.4% of women were overweight, and 18.1% of men and 16.0% of women were obese. Table 1 shows the prevalence of self-reported asthma according to age, smoking status and body mass index. There was an increased risk of asthma in young adults, smokers and obese individuals.

Figure 1 presents the prevalence of asthma associated with smoking status by sex and body mass index. For women, the data consistently demonstrated that the risk of

asthma was the highest in current smokers, the lowest in nonsmokers and in between for former smokers for all the categories of body mass index. For men, the difference was only significant for those with a body mass index of less than 25.0 kg/m^2 and there was no significant association between smoking status and asthma risk in overweight or obese individuals. Table 2 shows crude odds ratios and associated 95% confidence intervals for the association between smoking status and asthma stratified by sex and body mass index, and the association varied across sex and body mass index categories.

Logistic regression model was used to adjust for potential confounding factors including age, body mass index as a continuous variable, income, educational level, race, immigrant status, marital status, alcohol use and exercise. Overall, former smoking was significantly associated with prevalent asthma in both men [odds ratio (OR): 1.12; 95% confidence interval (CI): 1.01, 1.24] and women (OR: 1.18, 95% CI: 1.08, 1.30). The odds ratio for current smoking was 1.08 (95% CI: 0.96, 1.21) for men and 1.33 (95%: 1.21, 1.47) for women, suggesting a sex difference in the association between smoking and asthma. Table 3 shows the adjusted odds ratios and 95% confidence intervals for the association between smoking status and prevalent asthma further stratified by body mass index. For men and women with a body mass index of less than 25 kg/m^2, both current smoking and former smoking were significantly associated with an increased risk of asthma. In overweight and obese individuals, there was a significant association between current smoking and asthma in women but not in men and no significant association between former smoking and asthma in either men or women. No substantial change was observed when body mass index value was excluded from the models.

Discussion

Our data demonstrated that the association of current smoking with prevalent asthma was significantly stronger in women than in men. In women, this association was all significant across body mass index categories while in men it was significant only in those with a body mass index of less than 25 kg/m^2. Former smoking had a similar association with prevalent asthma in men and women and the influence of former smoking was significant among underweight or normal weight individuals but not among overweight or obese ones.

The relationships between smoking status and body weight, between smoking status and prevalent asthma, and between body weight and prevalent asthma can all be bidirectional. Smoking may reduce body weight and people with self-perceived overweight or obesity may try to loss weight by smoking cigarettes.[22] Smoking cessation may result in weight gain[23] and overweight and obese people may be less likely to stop smoking.[21] Smoking is likely to have a detrimental effect on asthma occurrence[1 5 6 9 10 24] but asthma patients may be more likely to stop smoking or less likely to initiate smoking.[25 26] Overweight and obesity increases the risk of asthma[17 27] while asthma patients may be more likely to have sedentary lifestyle and therefore gain more weight.[28] Sex often plays an important role for the possible bidirectional relationships.[1 6 13 25 29] This puzzle of the interrelationship among smoking status, body weight and asthma cannot be easily solved by observational studies. Even cohort design suffers some major selection biases such as "healthy worker effect" at baseline and during follow-up period.[15 16]

A very large representative sample size of this study allowed us to examine the relationship between smoking status and prevalent asthma across sex and body mass

index categories. The data suggest that smoking tends to have a stronger impact on asthma in women than in men, which is consistent with observations from several previous studies.[6-8 13] In Canada, women have a higher risk of asthma than men do, indicated by prevalence data,[13] incidence data[29] and hospital admission data.[30] Information bias may be one of possible reasons for sex difference in self-reporting asthma but primary diagnosis for hospital admission is provided by health professionals and therefore is less likely to be biased. The sex difference in susceptibility in response to cigarette smoking is likely to be true although the reasons for this remain to be investigated, which may include the differences in relative airway size, sex hormones and behavioral and lifestyle patterns between sexes.[29 30]

A significant relationship between cigarette smoking and prevalent asthma was also observed in men with a body mass index of less than 25 kg/m^2 but not in overweight and obese men. In addition to a direct effect on asthma occurrence, cigarette smoking may also indirectly influence and reduce the risk of asthma through weight loss. As the direct effect of smoking is relatively small in men, it may be neutralized by the beneficial effect of smoking-related weight loss for overweight or obese men. This hypothesis needs to be investigated in future studies.

Our data also demonstrated a positive association between former smoking and asthma risk in both men and women with under or normal weight. Former smoking may result in an increased risk of asthma. However, an interesting finding is that there was no such an association in overweight and obese men and women. If former smoking increases asthma risk, compounded with post-cessation weight gain, we would expect a stronger association between former smoking and asthma risk in overweight and obese

people. One possibility is that asthma patients with under or normal weight may be more likely to quit smoking while weight gain may be a barrier against quitting smoking for overweight and obese people.

There are some limitations for the study. Information bias is inevitable for self-reported data. For example, people tended to under-report their body weight especially for those with overweight or obesity, and to over-report their height,[31] which may result in a conservative estimate of an association with asthma. Asthma was based on a question if a person had the condition diagnosed by a health professional. A Canadian study demonstrated that asthma was over-diagnosed although the degree of the over-diagnosis was similar for obese and non-obese adults.[32] Some of those people might have chronic obstructive pulmonary disease.

Conclusions

Very large sample size is an important strength for this study, which allows us to determine the association between smoking status and asthma risk among population subgroups defined by sex and body mass index. Although cross-sectional design does not suggest a causal relationship, it would be hard to assume that asthma increases the proportion of current smoking. We therefore conclude that smoking increases the risk of asthma especially in women. A weaker direct detrimental effect of cigarette smoking and a possible indirect beneficial effect of smoking through weight loss may be a reason for the lack of association between current smoking and asthma in overweight and obese men. It warrants an investigation if overweight and obesity is a major barrier to smoking quit attempts and success for asthma patients.

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Table 1. Prevalence of self-reported asthma according to age, smoking status and body mass index by sex, the Canadian Community Health Survey 2007-08

	Men (n = 51609)			Women (n = 61221)		
	No.	Cases	%*	No.	Cases	%
Age (years)						
18-29	8198	727	8.4	8822	1051	11.0
30-39	8599	579	6.1	9203	856	8.7
40-49	9110	546	6.2	9523	870	8.9
50-59	9873	531	5.0	11684	1056	9.1
60-69	8206	505	5.9	9943	869	7.9
≥70	7623	535	7.2	12046	975	8.4
Smoking status						
Non-smoker	23497	1498	6.2	34798	2921	8.1
Former smoker	16823	1148	6.7	15629	1556	10.1
Smoker	11289	777	7.0	10794	1200	11.7
Body mass index (kg/m^2)						
<25.0	19698	1177	5.7	31507	2410	8.0
25.0-29.9	21271	1361	6.4	18082	1650	9.1
≥30.0	10640	885	8.5	11632	1617	13.3

* Weighted to the Canadian population.

Table 2. Unadjusted odds ratios (ORs) and 95% confidence intervals (95% CIs) for asthma in relation to smoking status by body mass index in men and women, the Canadian Community Health Survey 2007-08

	Body mass index (kg/m^2)					
	<25.0		25.0-29.9		≥30.0	
Smoking status	OR	95% CI	OR	95% CI	OR	95% CI
Men						
Non-smoker	1.00	Reference	1.00	Reference	1.00	Reference
Former smoker	1.12	0.94, 1.34	1.05	0.90, 1.22	0.96	0.79, 1.17
Smoker	1.27	1.07, 1.49	1.07	0.89, 1.29	1.08	0.85, 1.36
Women						
Non-smoker	1.00	Reference	1.00	Reference	1.00	Reference
Former smoker	1.35	1.19, 1.53	1.09	0.92, 1.28	1.15	0.96, 1.37
Smoker	1.55	1.36, 1.76	1.44	1.20, 1.72	1.40	1.14, 1.72

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Table 3. Adjusted* odds ratios (ORs) and 95% confidence intervals (95% CIs) for asthma in relation smoking status by body mass index in men and women, the Canadian Community Health Survey 2007-08

	Body mass index (kg/m^2)					
	<25.0		25.0-29.9		≥30.0	
Smoking status	OR	95% CI	OR	95% CI	OR	95% CI
Men						
Non-smoker	1.00	Reference	1.00	Reference	1.00	Reference
Former smoker	1.26	1.03, 1.53	1.07	0.91, 1.26	1.03	0.83, 1.29
Smoker	1.20	1.01, 1.43	0.98	0.81, 1.18	1.02	0.80, 1.30
Women						
Non-smoker	1.00	Reference	1.00	Reference	1.00	Reference
Former smoker	1.34	1.17, 1.54	1.03	0.86, 1.22	1.10	0.92, 1.33
Smoker	1.41	1.23, 1.62	1.27	1.05, 1.54	1.28	1.03, 1.59

* Adjusted for age, body mass index as a continuous variable in each BMI category, income, educational level, race, immigrant status, marital status, alcohol use and exercise.

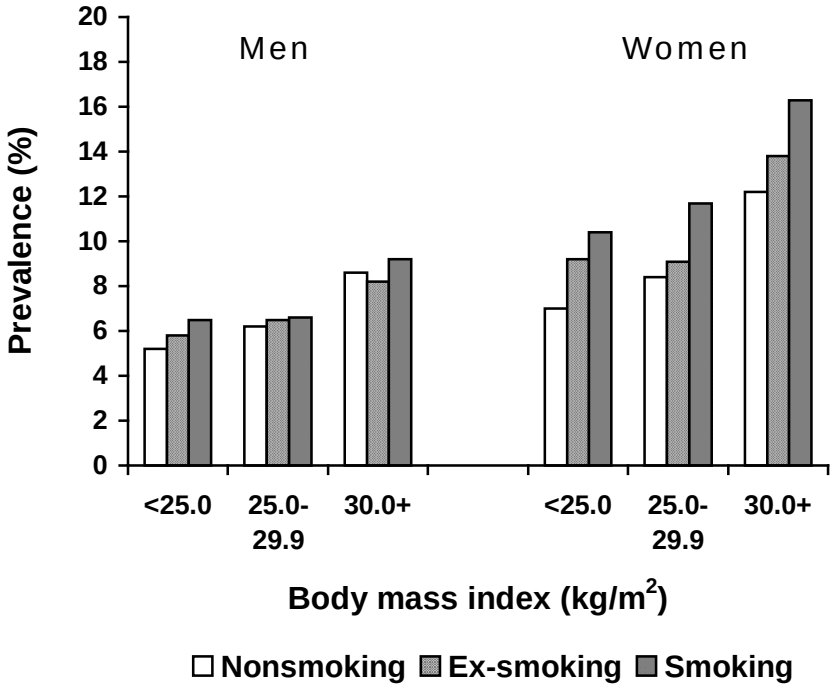

Figure 1. Prevalence of asthma associated with smoking status according to sex and body mass index