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Prevalence and associated factors for self-reported asthma in a Canadian population: The Canadian Community Health Survey, 2014

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ABSTRACT

Background: Asthma prevalence is increasing among adults, yet limited information regarding the association between adult asthma and environmental and personal exposures is available using large nationally representative population-based survey.

Objective: To determine the prevalence of asthma and associated factors for self-reported asthma in a Canadian population aged 12 years and older by using the Canadian Community Health Survey (CCHS) 2014 cross-sectional cohort.

Methods: We used data from the 2014 CCHS. Asthma as determined through self-reported health professional diagnosis. Information regarding covariates of importance, such as socio-economic status, life styles variables, was obtained. A weighted logistic regression analysis was performed with appropriate technique for clustering effects.

Results: Estimated self-reported asthma prevalence of 8.1% in the greater than 12 year old Canadian population was observed. We found that a substantial proportion of Canadians (aged 12 and older) reported having asthma and geographical differences and differences between specific provinces in asthma prevalence. Women had higher prevalence of asthma than men, but the relationship depended on age and body mass index. Interactions between household income and smoking status were observed to predict the probability of asthma.

Conclusions: Additional studies are needed to determine which factors influence the asthma prevalence between sex, body mass index as well as smoking status and household income and its interactions with each other.

BACKGROUND

Asthma is a major cause of disability, health resource utilization, and poor quality of life (1). It is considered the most common chronic disease among children and young adults and accounts for healthcare costs and loss of work productivity (2). Currently, asthma prevalence is approximately 10% globally (3). In Canada, it is estimated that over three million people currently have asthma. According to Statistics Canada, 8.3% of the population aged 12 and older have been diagnosed at some time as having asthma.(4) Asthma is a complex disease with multiple potential risk factors including genetic predisposition and environmental and behavioral causes, as well as significant gene-environment interactions. Such factors (5) may include age, sex, ethnicity, education, income, race, tobacco smoking, alcohol use, obesity, co-morbid conditions, unexplained temporal (6) and geographic variations (7), and/or interactions between these factors (5).

To our knowledge, only limited research has been conducted regarding the prevalence and characteristics of asthma in Canadian adults using a large data set. The aims of this study were to determine the prevalence of asthma and to identify determinants of asthma prevalence among a Canadian population aged 12 years and older by using the Canadian Community Health Survey (CCHS) 2014 cross-sectional cohort.

METHODS

Data source, study design and study population

This study consisted of secondary analysis of data obtained from the Canadian Community Health Survey (CCHS) conducted in 2014 (8). The CCHS is an ongoing multi-stage complex

survey undertaken by Statistics Canada that collects cross-sectional self-reported sociodemographic and health data on a nationally representative sample (98%) of the Canadian population aged 12 years and older.(8) A detailed description of the survey design and methodology appears elsewhere (8, 9). In brief, it was a cross-sectional study where respondents were selected using a multi-stage complex survey design with a 2-phase stratified sampling plan designed to ensure adequate representation from each Canadian Health Region. The survey had obtained information from 136 health regions covering all of the provinces and territories of Canada. Exclusions were people living on Crown lands, residents of Indian reserves, residents of health institutions, full time members of the Canadian Forces Bases, and some remote areas in Ontario and Quebec. Ethical approval for data collection was completed by Statistics Canada (Government of Canada). This analysis used the public use micro data file (PUMF) collected for 2014 (from January 2014 to December 2014) including 63522 people.

Operational definitions

Outcome variable of interest

The survey asks respondents to identify if they have any one of a list of chronic health conditions which are defined as “long-term conditions which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional.” The presence of asthma was based on “Do you have asthma?” As there is no gold standard in the diagnosis of asthma, questionnaire report of a doctor’s diagnosis of asthma is very frequently used in epidemiological studies. This method has reasonable levels of agreement with other methods of assessment and has been considered the method of choice for large epidemiologic studies (10).

Socio-demographic variables

Age, sex, ethnicity, marital status, educational attainment and income status were considered.

Age was classified into five groups (years): 12--14, 15-29, 30-49, 50-69 and greater than 70.

Ethnicity was self-selected by the individual and grouped into two categories according to cultural or racial background: white and visible minority (non-white).

Marital status included three categories: married or common-law or living together; single or never married; and widowed or divorced or separated.

Respondents' educational attainment were grouped into four categories: postsecondary degree/diploma; some postsecondary education; high school completed; and less than high school completed.

Annual household income consisted of five groups, increasing in \$20,000 increments beginning with zero ($\geq 80,000$; 60--79,999; 40--59,999; 20--39,999; No or $\leq 20,000$).

Location of residence

Location of residence was a nominal variable with six categories based on the sample size of the provinces: Atlantic (Nova Scotia, Newfoundland, New Brunswick, and Prince Edward Island); British Columbia; Prairies (Alberta, Saskatchewan, Manitoba); Territories (Yukon, Northwest Territories, Nunavut); Quebec; and Ontario. Ontario was the reference category.

Smoking exposures

Passive smoking: Exposure to passive smoking was assessed based on the question "Including both household members and regular visitors, does anyone smoke inside your home, every day or almost every day? A positive response indicated exposure to passive smoking.

Smoking status: The question to assess smoking status was: “At the present time do you smoke cigarettes daily, occasionally or not at all?” Based on this question, the variable had six categories: daily smoker, occasional smoker but former daily smoker, always an occasional smoker, former daily smoker, former occasional smoker, never smoked and not applicable. Smoking status was recoded further into three categories for analytical purposes. The three categories were current smoker, ex-smoker and non-smoker. The current smoker category was obtained by combining three categories: daily smoker, occasional smoker but former daily smoker and always an occasional smoker. Ex-smokers included former daily smokers and former occasional smokers. Non-smokers (reference category) included those who never smoked. Not applicable and not stated categories were coded as missing.

Body Mass Index (BMI)

Height and weight were self-reported. From this, BMI was calculated based on age range. For children aged 12 to 17, three categories including as “obese”, “overweight” or “neither obese nor overweight” was defined according to the age-and-sex specific BMI cut-off points as defined by Cole et al (11). The Cole cut-off points are based on pooled international data (Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States) for BMI and linked to the widely internationally accepted adult BMI cut-off points of 25 (overweight) and 30 (obese). Respondents who do not fall within the categories of “Obese” or “Overweight” (as defined by Cole et al.) have been classified by CCHS as “neither obese nor overweight.” This variable excludes respondents who are 18 years old or over. For adult respondents aged 18 and over (except pregnant women), BMI was calculated based on self-reported weight and height and

categorized into obese (BMI ≥ 30.0 kg/m²), overweight (BMI 25.0 kg/m² to 29.9 kg/m²) and normal-to-underweight (BMI <25.0 kg/m²).

Physical activity index (PAI)

A StatsCan-derived variable combining leisure time and transportation-physical activity based on estimated total daily energy expenditure variables (kcal/kg/day): active, moderately active, and inactive.

Type of drinker

This variable indicates the type of drinker the respondent is based on his/her drinking habits in the past 12 months.

Immigration status

The question of immigration status asked respondents to identify their immigration status only at the time during the first interview (Yes, No).

Household size was categorized in 5 groups (1 person, 2 person, 3 persons, 4 persons and 5 or more persons)

Statistical analysis

Statistical analyses were completed using SPSS version 24 (IBM Corporation, USA)(12) and STATA version 13 (StataCorp, USA)(13). An appropriate weight variable computed by Statistics Canada was used in all analyses to ensure that final estimates were representative of the Canadian population. The descriptive analysis included calculations of proportions for each of our independent variables (all categorical) for persons with and without asthma using a chi-squared test suitable for complex survey data to test whether each variable was distributed differently between those with and without asthma. Crude associations between each

independent variable and asthma were further assessed using bivariate logistic regression. In order to control for potential confounding, a multiple logistic regression model was developed. The Taylor linearization variance estimation (14) was used to estimate the robust standard errors of regression coefficients to account for clustering inherent in the study design of the cross-sectional multistage complex survey. Scientifically important two-way interactions were examined. The regression model was then fitted using purposeful selection informed by statistical significance, clinical importance, potential and observed confounding effects, and the calculated gamma values. Based on bivariate analysis, statistically significant variables with $p < 0.20$ become candidates for the multivariable model. All variables that were statistically significant ($p < 0.05$) were retained in the final multivariable model. The strength of association was quantified with the odds ratio (OR) and 95% confidence interval (CI).

RESULTS

Table 1 shows the demographic characteristics of the study population. The population in this study includes 73.4% participants reporting to be white and more female than male (50.7% vs. 49.3%). Majority of participants are at the age range of 30-49 years (30.7%); 50-69 years (31.5%) and 3.5% at the age range of 12-14 years. Estimated self-reported asthma prevalence of 8.1% in the greater than 12 year old Canadian population was observed (**Table 2**).

Table 3 presents the results of our descriptive and bivariate analysis. When comparing adults with and without asthma, all of the sociodemographic, lifestyle, and health characteristics we examined were significantly different between these groups at the levels. Those who reported themselves as “white” were more likely to have asthma compared to the visible minority (8.6% vs. 6.6%). Female were more likely to report asthma compared to men (9.2% vs. 7.0%). Among

age groups, 15-29 age group had the highest prevalence (10.2%) and 30-49 age group had the lowest (7.3%). Those who were obese were more likely to report asthma (11.1%) compared to those who were overweight or normal (7.3-7.4%). Respondents with lower levels of educational attainment and higher income levels were less likely to report having asthma. The Quebec region had the highest asthma prevalence compared to other regions (9.1%). The Atlantic regions, which included the province of PEI, Newfoundland and Labrador New Brunswick and Nova Scotia, and the region of Territories, had the lowest prevalence of asthma.

Table 4 presents multivariate model logistic regression results. It has been shown that being white was positively associated with the presence of asthma [OR = 1.24 (0.99-1.54)] compared to non-white and being widow increased the risk of asthma [aOR = 1.26 (1.06-1.48)]. More people living in a house (more than 5) significantly associated with the decreased risk of asthma [aOR = 0.71 (0.54-0.92)]. Further, interaction terms were added to the model. There was statistically significant interactions including sex * BMI ($p = 0.052$); sex * age ($p = 0.029$), and household income* smoking status ($p = 0.001$). Based on these significant interactions, we present a graph of predicted probability of asthma stratified by (i) sex and BMI; and (ii) sex and age in **Figure 1&2**. In general, female aged 15-69 years were 1.7 times more likely to be diagnosed with asthma compared with younger female less than 15 years old (**Figure 2**). Obese female were more likely to have asthma compared to the normal female [aOR = 1.29 (1.00-1.69; $p = 0.052$)] (**Figure 1**).

DISCUSSION

The aim of this study was to determine the prevalence of asthma and associated factors for self-reported asthma in a Canadian population aged 12 years and older by using the Canadian Community Health Survey 2014 cross-sectional population. We found that a substantial proportion of Canadians aged 12 and older reported having asthma (8.1%) and identified geographical differences and differences between specific provinces in asthma prevalence. Women had higher prevalence of asthma than men overall, but the relationship was dependent on age and body mass index. Interactions between household income and smoking status were observed to predict the probability of asthma.

The prevalence of asthma among adults varies globally. Recently, using the World Health Survey (WHS), To et al (2011) found that the prevalence of self-reported, doctor-diagnosed asthma among 178,215 individuals from 70 countries aged 18 to 45 years was 4.3% (15). In 2010, Sembajwe et al (16) analyzed the WHS data and reported variations in the prevalence of doctor-diagnosed asthma across world regions, relating them to national income. Subjects aged 18 to 99 years from 64 countries included in their study reported a 6% prevalence of doctor-diagnosed asthma, but there was a wide range of prevalence among the participating countries (from 1.8% in Vietnam to 32.8% in Australia) (16). Using nationally representative U.S. data from the 2012 National Health Interview Survey, Wang et al found that the prevalence of asthma determined by a positive response to the question “Has a doctor or health care professional ever told you had asthma?” was 12% (17). The major differences between their findings and ours may be attributed to differences in the study population included.

In our study, we found that in the age group of 12-14 years, boys are more likely than girls to have asthma (4.1% vs. 3.4%, respectively). However, this changed during early

adulthood (15-29 years old), in which females showed a higher prevalence of asthma compared with males (15.2% vs. 18.0%, respectively). This finding is in line with current findings determining differences in sex in association with asthma prevalence and risk. Using the large dataset from the Canadian National Population Health Survey, Ghosh et al found opposing trends in asthma prevalence between men and women (18). Similar to our results, several epidemiological studies have shown that childhood asthma is more prevalent in boys than girls (19, 20). However, during early adulthood, females begin to outnumber males in asthma prevalence (21-24). Although the mechanism is not completely understood, the higher prevalence of asthma in women has been related to their smaller airway caliber size(25, 26) and hormonal differences(27). Furthermore, we found that among those with asthma, 53.1% of women had asthma-related symptoms/attacks compared to 41.6% of men, and females were more likely than males to take medication (80.9% vs. 74.4%, respectively), which has been supported by previous work (28-30).

In the current study, we found that obese women were more likely to have asthma than obese men. Our finding is in agreement with a Canadian National Population Health Survey study in which researchers found that obesity may increase the incidence of asthma in women but not in men (31). Similar findings were also reported in the current study in the US. Using nationally representative U.S. data, the 2012 National Health Interview Survey, Wang et al (17) found that the prevalence of asthma, determined by a positive response to the question “Has a doctor or health care professional ever told you had asthma?”, was higher in women than in men, and the association between Class III obesity (defined as $BMI \geq 40$) and asthma was stronger in women than in men [OR = 2.11 (1.70-2.63) vs. 1.40 (1.01-1.96), $p < 0.05$]. Furthermore, other

studies have shown mixed results, including significant and similar association for both sexes (32), a stronger association among women than men(33), and no significant effect modification by sex (34). The mechanisms for such sex differences remain unclear (35) and controversial (17). It has been suggested that the stronger association between obesity and asthma in women than in men may be influenced by physiological (36) and hormone factors (37).

Strengths and Limitations

Our study has several strengths needed to be considered. First, we used a large, nationally representative study sample containing a wide range of information, which allowed us to examine socio-economic and lifestyle patterns associated with asthma risks. Second, the survey was administered using multi-staged random sampling in most of the sites, making the country-specific estimates representative of the whole population. Careful survey design, large sample size, and post-weighting based on Census and other Statistics Canada data ensure the survey is representative of the target population. The CCHS also experienced a relatively high participation rate, which has become rare in population-based studies in recent years. This reduces the potential bias and improves the generalizability of results.

Our study has several limitations. The main limitation of this study is the cross-sectional design, which precluded establishing temporal relationships or causality. The cross-sectional design did not permit us to draw conclusions regarding the direction of the observed associations, nor did it capture the clinical course and lifetime progression of asthma (including the onset of asthma and related symptoms). However, this national population cross-sectional cohort approach allowed us to capture not only new-onset or incident asthma but also those

people with existing and potentially longstanding asthma. Another limitation of the study was the reliance on self-reporting of health professional-diagnosed asthma. Misreported or underdiagnosed cases can result in misclassification. However, the validity of self-reported, health professional-diagnosed asthma questionnaires has been proven to be acceptable to study the risk factors of asthma in large population-based studies. Torén et al (38) concluded that “physician-diagnosed asthma” had a sensitivity of 64.3% and specificity of 94.3% compared with the definition of self-reported asthma. Pekkanen and Pearce (39) concluded that questionnaire surveys are cost effective and convenient. Third, no data were available on pulmonary function, methacholine challenge tests, or allergy skin-prick tests using the CCHS data. CCHS was not exclusively developed for asthma studies alone, but as a study of general health and chronic diseases. Thus, very limited information related to asthma was available. However, because it collects wide-ranging social, demographic, environmental, lifestyle and diet data, and as it is nationally representative, the CCHS provides a unique opportunity to draw descriptive conclusions about the social distribution and patterning of asthma risks.

CONCLUSION

We found that a substantial proportion of Canadians (aged 12 and older) reported having asthma (8.1%) and identified geographical differences and differences between specific provinces in asthma prevalence. Women had a higher prevalence of asthma than men overall, but the relationship depended on age and body mass index. Household income interacted with smoking status to predict the probability of asthma. Longitudinal studies and analysis are recommended, as is an intensive study about asthma in children and adults using objective measures or biomarkers to confirm the casual relationship between asthma and risk factors.

Declaration of interest

None of the authors have any known conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1. Demographic characteristics of the study population

Characteristics	Frequency (%) [*]	Missing (%)
Ethnicity		3.5
White	73.4	
Visible minority	24.2	
Sex		
Male	49.3	
Female	50.7	
Age group, years		
12-14	3.5	
15-29	22.9	
30-49	30.7	
50-69	31.5	
≥70	11.4	
Marital status		0.2
Married/common-law	57.5	
Widow/separated/divorced	12.2	
Single/never married	30.0	
Location of residence		
Ontario	38.8	
Quebec	23.3	

Territories, [‡]	0.3	
Prairies [§]	17.7	
Atlantic region	6.8	
British Columbia	13.2	
Educational attainment		1.6
Postsecondary degree/diploma	55.1	
Some postsecondary education	5.3	
High school completed	19.0	
Less than high school	19.0	
Household income/year, \$		0.1
≥80,000	42.8	
60--79,999	14.8	
40--59,999	17.7	
20--39,999	17.4	
No or ≤20,000	7.2	
Body Mass Index (BMI)		6.0
Neither nor overweight or obese	45.3	
Overweight	30.6	
Obese	18.1	
Immigrant status		3.6
No	72.6	

Yes	23.8	
Household size		0.1
1 person	14.3	
2 persons	33.9	
3 persons	18.4	
4 persons	19.3	
5 or more persons	14.0	
Physical activity index		2.0
Active	28.5	
Moderate active	24.2	
Inactive	45.4	
Smoking status		0.7
Never smoker	44.3	
Ex-smoker	37.0	
Current smoker	17.9	
Household smoking		
No	88.8	4.4
Yes	6.8	
Type of drinker		2.1
No drink last 12 months	23.8	
Occasional drinker	16.6	

Regular drinker	57.5	
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*Percentages weighted to the Canadian population

Table 2. Percentage* of self-reported asthma in Canada (≥ 12 years of age)

Demographic	Asthma, %	
	Yes	No
White	8.6	91.4
Visible minority	6.6	93.4
General Canadian population	8.1	91.9

*Percentages weighted to the Canadian population

Table 3. Sociodemographic and lifestyle characteristics of ≥ 12 year-old Canadian population with and without asthma

Characteristics	Self-reported asthma		Missing (%)	Unadjusted odds ratio	
	Yes (%)	No (%)		OR (95% CI)	P-value
Ethnicity			3.6		
White	8.6	91.4		1.32 (1.05-1.66)	0.018
Visible minority	6.6	93.4		1	
Sex			0.1		
Male	7.0	93.0		1	
Female	9.2	90.8		1.34 (1.19-1.52)	
Age group, years			0.1		<0.05
12-14	8.0	92.0		1	
15-29	10.2	89.8		1.29 (1.08-1.54)	0.006
30-49	7.3	92.7		0.90 (0.77-1.04)	0.176
50-69	7.4	92.6		0.91 (0.78-1.05)	0.215
≥ 70	8.2	91.8		1.02 (0.88-1.19)	0.742
Marital status			0.4		<0.001
Married/common-law	7.0	93.0			
Widow/separated/divorced	10.1	89.9		1.50 (1.24-1.81)	

Single/never married	9.5	90.5		1.39 (1.27-1.52)	
Location of residence			0.1		
Ontario	7.8	92.2		1	
Quebec	9.1	90.9		1.18 (0.93-1.50)	
Territories [‡]	6.9	93.1		0.88 (0.72-1.08)	
Prairies [§]	8.2	91.8		1.05 (0.87-1.28)	
Atlantic region	7.2	92.8		1.08 (0.89-1.31)	
British Columbia	8.4	91.6		0.92 (0.75-1.12)	
Educational attainment			1.7		
Postsecondary degree/diploma	7.7	92.4		1	
Some postsecondary education	8.9	91.1		1.19 (0.88-1.60)	0.237
High school completed	8.1	91.9		1.06 (0.90-1.25)	0.445
Less than high school	9.3	90.7		1.24 (1.11-1.40)	0.000
Household income/year, ^{\$}			0.2		<0.001
≥80,000	7.2	92.8		1	
60--79,999	7.0	93.0		0.97 (0.87-1.06)	
40--59,999	8.7	91.3		1.22 (1.08-1.37)	
20--39,999	9.1	90.0		1.29 (1.10-1.50)	
No or ≤20,000	12.0	88.0		1.74 (1.57-1.92)	
Body Mass Index (BMI)			6.1		<0.001
Neither nor overweight or	7.4	92.6		1	

obese					
Overweight	7.3	92.7		0.99 (0.89-1.11)	
Obese	11.1	88.9		1.56 (1.29-1.89)	
Immigrant status			3.7		<0.001
No	9.2	90.8		1	
Yes	4.9	95.1		0.51 (0.44-0.58)	
Household size			0.2		
1 person	9.8	90.2		1	
2 persons	8.1	91.9		0.81 (0.67-0.97)	
3 persons	8.4	91.6		0.83 (0.66-1.05)	
4 persons	8.2	91.8		0.81 (0.67-0.97)	
5 or more persons	5.9	94.1		0.57 (0.46-0.71)	
Physical activity index			2.1		
Active	7.8	92.2		1	
Moderate active	7.9	92.1		1.01 (0.86-1.20)	0.823
Inactive	8.4	91.6		1.08 (0.93-1.26)	0.295
Smoking status			0.8		
Never smoker	7.5	92.5		1	
Ex-smoker	8.5	91.5		1.14 (0.94-1.38)	0.160
Current smoker	9.0	91.0		1.21 (1.01-1.44)	0.031
Household smoking			4.5		0.02

No	7.9	92.1		1	
Yes	9.9	90.1		1.29 (1.04-1.59)	
Type of drinker					
No drink last 12 months	8.6	91.4		1	
Occasional drinker	8.9	91.1		1.04 (0.90-1.21)	0.50
Regular drinker	7.6	92.4		0.88 (0.76-1.01)	0.08

*Prevalence weighted to the Canadian Population

‡Northwest Territories, Yukon and Nunavut

§Alberta, Saskatchewan and Manitoba; Newfoundland and Labrador, Nova Scotia, New Brunswick and Prince Edward Island.

TABLE 4. Logistic regression analysis for the prevalence of self-reported asthma

Variables	Adjusted* odds ratio OR (95% CI)
Ethnicity	
White	1.24 (0.99-1.54)
Visible minority	1
Sex	
Male	1
Female	0.75 (0.46-1.21)
Age group, years	
12-14	1
15-29	0.86 (0.62-1.20)
30-49	0.60 (0.42-0.86)
50-69	0.51 (0.36-0.72)
≥70	0.62 (0.35-1.12)
Marital status	
Married/common-law	1
Widow/separated/divorced	1.26 (1.06-1.48)
Single/never married	1.14 (0.93-1.40)
Location of residence	
Ontario	1

Quebec	1.10 (1.02-1.19)
Territories [‡]	0.89 (0.61-1.30)
Prairies [§]	1.04 (0.97-1.11)
Atlantic region	0.95 (0.87-1.03)
British Columbia	0.97 (0.86-1.09)
Educational attainment	
Postsecondary degree/diploma	1
Some postsecondary education	0.93 (0.68-1.27)
High school completed	0.96 (0.81-1.13)
Less than high school	1.10 (0.93-1.30)
Household income/year, \$	
≥80,000	1
60--79,999	0.92 (0.78-1.27)
40--59,999	0.87 (0.71-1.08)
20--39,999	0.79 (0.63-0.99)
No or ≤20,000	1.20 (0.83-1.70)
Body Mass Index	
Neither overweight nor obese	-
Overweight	1.08 (0.85-1.37)
Obese	1.51 (1.14-2.00)
Household size	

1 person	1
2 persons	1.04 (0.89-1.23)
3 persons	1.01 (0.82-1.25)
4 persons	0.99 (0.80-1.23)
5 or more persons	0.71 (0.54-0.92)
Smoking status	
Never smoker	1
Ex-smoker	0.93 (0.77-1.13)
Current smoker	0.93 (0.77-1.13)
<i>Interactions</i>	
<i>Sex x BMI</i>	=0.052
<i>Sex x Age</i>	<0.05
<i>Household income x Smoking status</i>	<0.001

* Adjusted for all variables in the table

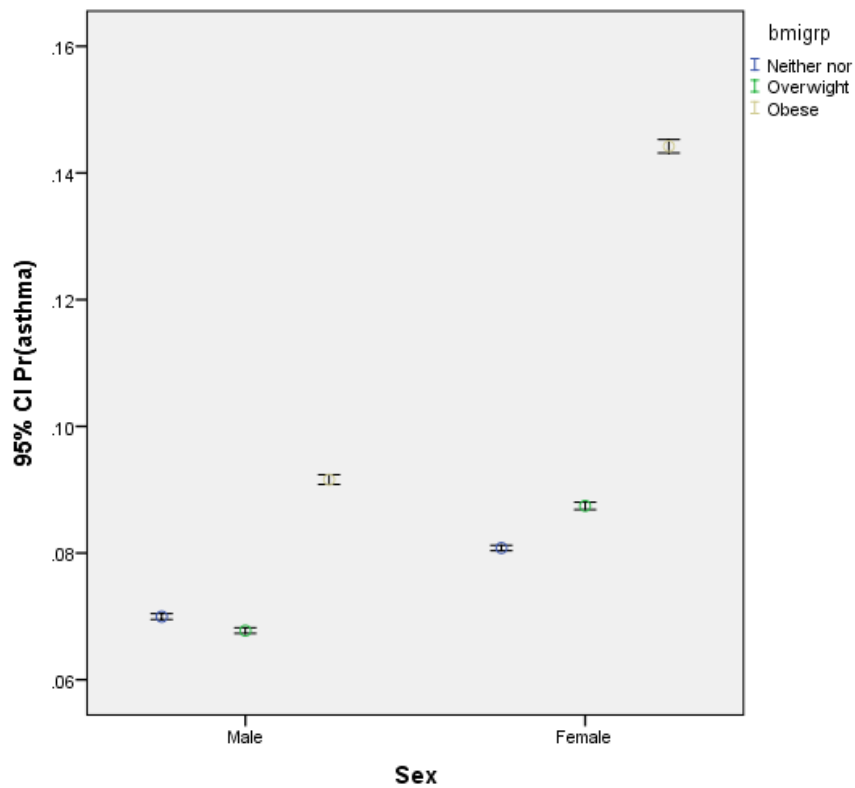


Figure 1. Probability of asthma stratified by sex and body mass index (BMI)

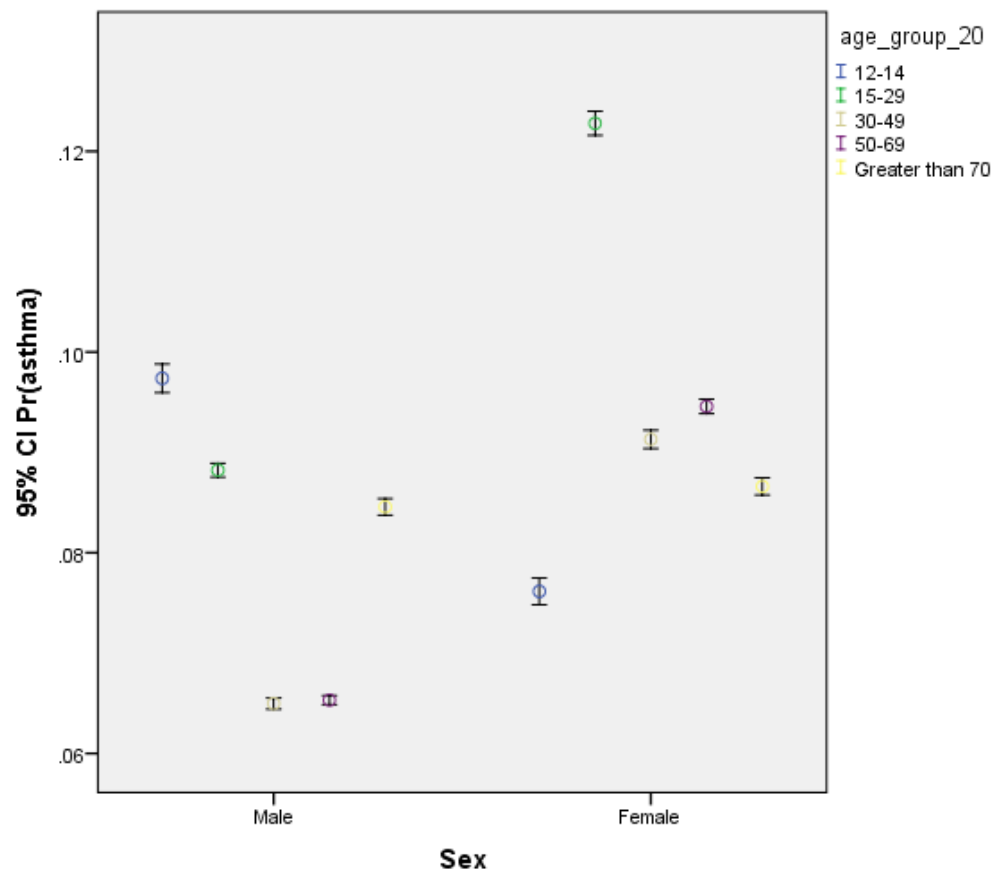


Figure2. Probability of asthma stratified by sex and age group