



Published in final edited form as:

J Asthma. 2016 September ; 53(7): 720–731. doi:10.3109/02770903.2016.1154072.

Gender and Asthma-Chronic Obstructive Pulmonary Disease Overlap Syndrome

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Abstract

Objective—To assess relationships between obstructive lung diseases, respiratory symptoms, and comorbidities by gender.

Methods—Data from 12 594 adult respondents to the 2012 South Carolina Behavioral Risk Factor Surveillance System telephone survey were used. Five categories of chronic obstructive airway disease (OAD) were defined: former asthma only, current asthma only, chronic obstructive pulmonary disease (COPD) only, asthma-COPD overlap syndrome (ACOS), and none. Associations of these categories with respiratory symptoms (frequent productive cough, shortness of breath, and impaired physical activities due to breathing problems), overall health, and comorbidities were assessed using multivariable logistic regression for men and women.

Results—Overall, 16.2% of men and 18.7% of women reported a physician diagnosis of COPD and/or asthma. Former asthma only was higher among men than women (4.9% vs. 3.2%, t-test $p=0.008$). Current asthma only was more prevalent among women than men (7.2% vs. 4.7%, $p<0.001$), as was ACOS (4.0% vs. 2.2%, $p<0.001$). Having COPD only did not differ between

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women (4.3%) and men (4.4%). Adults with ACOS were most likely to report the 3 respiratory symptoms. COPD only and ACOS were associated with higher likelihoods of poor health and most comorbidities for men and women. Current asthma only was also associated with these outcomes among women, but not among men.

Conclusions—In this large population-based sample, women were more likely than men to report ACOS and current asthma, but not COPD alone. Gender differences were evident between the OAD groups in sociodemographic characteristics, respiratory symptoms, and comorbidities, as well as overall health.

Keywords

respiratory symptoms; health status; obstructive lung disease; comorbidities; health survey; tobacco history

Introduction

Chronic obstructive pulmonary disease (COPD) and lifetime asthma are diagnosed in approximately 6% and 13% of the US adult population, respectively [1,2]. Among adults with COPD, between 13% and 55% have been reported to also have asthma, termed asthma/COPD overlap syndrome (ACOS) [3–6]. According to new guidelines, this overlap syndrome is characterized by persistent airflow limitation with several features of both asthma and COPD [7,8]. Among published studies, persons labeled with this overlap syndrome are reported to experience more frequent healthcare utilization and severe impairment than persons with COPD [3,5,6,9–12] or asthma alone [6,11,12].

Gender differences have been reported for persons with asthma, COPD, and ACOS. The prevalence of asthma [13] and frequency of respiratory symptoms among those with asthma [14,15] are higher in women than men. Although historically males were more likely than females to develop COPD, this began to change in the middle of the twentieth century with a steady increase in COPD prevalence among women [1,16]. In the past decade, more women than men die annually from COPD in the United States [1]. Women appear to be susceptible to developing COPD earlier, exhibit greater bronchial reactivity, and experience poorer health status than men with the same tobacco exposure [17,18]. Some, but not all, studies have reported ACOS to be more common in women; however, no studies have primarily focused on the role of gender in ACOS as compared to asthma or COPD [6,10,11,19]. The aim of this analysis is to describe the sociodemographic characteristics of persons with asthma, COPD, and ACOS and compare the frequency of respiratory symptoms, health impairment, and comorbidities in relationship to gender in a state's general adult population.

Methods

Each year, state health departments collaborate with the Centers for Disease Control and Prevention to conduct the Behavioral Risk Factor Surveillance System (BRFSS) survey, a random digit-dialed telephone survey of non-institutionalized adults aged 18 years [20]. The core questionnaire with questions about chronic conditions, health behaviors, and sociodemographic and health characteristics is asked of all respondents, but states can also

add supplementary questions to their state questionnaire based on their priorities. In 2012, the South Carolina (SC) Department of Health and Environmental Control included a series of questions referred to as the COPD Risk Assessment module in collaboration with the North Carolina COPD Taskforce. These questions were primarily meant to identify respondents who might be at high risk of having COPD and included questions about respiratory symptoms and lifetime duration of smoking [21,22]. Response rates for BRFSS are calculated using standards set by the American Association of Public Opinion Research Response Rate Formula #4 [23]. The response rate is the number of respondents who completed the survey as a proportion of all eligible and likely-eligible persons. The response rate for SC in 2012 was 48.6%, which was higher than the median rate of 45.2% for all 50 states and DC. For detailed information see the 2012 BRFSS Summary Data Quality Report [24]. As a secondary data analysis, this study was exempt from review by an institutional review board.

Definition of variables

Obstructive airway disease (OAD) categories—All respondents were asked, “Have you ever been told by a doctor, nurse, or other health professional that you have chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis?” Individuals who responded “yes” were defined as having COPD, while those who responded “no” or “don’t know” were defined as not having COPD. All respondents were also asked if they had ever been told they had asthma (lifetime asthma). If they responded yes to this asthma question, they were also asked if they still had asthma (current asthma). An affirmative response to the first asthma question (lifetime asthma), but a response of “no” or “don’t know” to the second (current asthma) was defined as former asthma. An affirmative response to both asthma questions was defined as current asthma. Based on these responses, persons were categorized into OAD categories: neither (neither asthma nor COPD), former asthma only (former asthma, no COPD), current asthma only (current asthma, no COPD), COPD only (COPD, no asthma), and ACOS (both asthma (either former or current) and COPD). All respondents who reported COPD were also asked whether they had ever undergone a breathing test to diagnose their COPD, with 78.5% reporting having had a diagnostic test but no information on diagnostic findings were obtained.

Respiratory symptoms—Respondents were asked, “During the past 30 days, how often did you feel short of breath – would you say all of the time, most of the time, some of the time, a little of the time, or none of the time?” We defined frequent shortness of breath (SOB) as a response of most of the time or all of the time. Respondents were also asked, “How often do you cough up mucus or phlegm?” Possible responses to this question were every day, most days a week, a few days a month, only with occasional colds or chest infections, and never. Individuals who responded either most days or every day were defined as having frequent productive cough. Finally, respondents were asked, “Thinking about your physical activity during the last 12 months, do you agree slightly or strongly or disagree slightly or strongly with the following statement: I do less now than I used to because of my breathing problems.” Possible responses included agree strongly, agree slightly, neither agree or disagree, disagree slightly, and disagree strongly. If respondents agreed strongly or

slightly, they were characterized as agreeing that breathing problems limited their physical activity.

Non-respiratory chronic conditions and overall health—In addition to asthma and COPD, respondents were also asked whether they had been told by a healthcare professional that they had angina or coronary heart disease; diabetes; arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia; cancer (other than skin cancer); a depressive disorder, including depression, major depression, dysthymia, or minor depression; or a stroke. Respondents were also asked to rate their health as excellent, very good, good, fair, or poor. Frequent mental distress was defined as a response of ≥ 14 days to the question, “Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good.” Frequent physical distress was defined as a response of ≥ 14 days to the question, “Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good.”

Smoking status—All respondents were asked, “Have you smoked at least 100 cigarettes in your entire life?” Persons who responded “no” were categorized as never smokers. Persons who responded “yes” were further asked, “Do you now smoke cigarettes every day, some days, or not at all?” Persons who responded “not at all” were defined as former smokers with the remainder defined as current smokers. Current and former smokers were also asked, “Over your lifetime, how many years have you smoked tobacco products?” Smoking duration for this study was defined as smoked ≥ 10 years, smoked <10 years or unknown duration, and never smoked.

Other respondent characteristics—Socio-demographic characteristics included gender, age, race (white, black, or other/multiracial), and education (less than high school diploma; high school graduate or general equivalency diploma; or at least some college). Survey respondents’ body mass index (BMI) was calculated from their self-reported weight and height (weight [kg]/height [m²]) and used to categorize respondents as underweight (BMI <18.5 kg/m²), normal weight (BMI = 18.5–24.9 kg/m²), overweight (BMI = 25.0–29.9 kg/m²), and obese (BMI = ≥ 30.0 kg/m²).

Exclusions—In 2012, 12 795 SC adults were surveyed. Respondents were excluded if they were missing data on age (n=105), race (n=94), or COPD (n=2) (total excluded=201). The final sample size for data analysis included 12 594 adults (94% of adults).

Statistical analysis

All analyses were gender-specific and were conducted using SAS-callable SUDAAN (Release 11.0.0, Research Triangle Institute, NC) to account for the complex sampling design. First we examined the distribution of selected characteristics among study respondents. Then we assessed the unadjusted prevalence and 95% confidence interval (CI) of OADs for the total population and by age groups. We also assessed the age-adjusted prevalence of each OAD group by sociodemographic and other selected characteristics. T-tests were used to assess differences in prevalence between subgroups. We then examined

the association between OAD group and smoking status, smoking ≥ 10 years, being obese, and having each of the three respiratory symptoms. Using the ADJRR option on the PREDMARG statement in PROC RLOGIST, we assessed adjusted prevalences, prevalence ratios (PR), and 95% CI in models that adjusted for age, race, and education. The models for the respiratory symptoms also included smoking status and BMI category. In addition, PRED_EFF statements were used to conduct t-tests for model-adjusted prevalence differences between non-referent categories. Finally, we also assessed prevalence, PRs, and 95% CI for individual chronic diseases, ≥ 1 non-respiratory chronic disease, and physical and mental impairments by OAD group in separate multivariable logistic regression analyses that adjusted for age, race, education, BMI category, and smoking status. Statistical significance was defined at the $p < 0.05$ level.

Results

Compared with the men, women were slightly older and had higher percentages of black respondents and respondents with at least some college education. Women were more likely than men to have never smoked; to have a normal BMI or be obese; to report fair/poor health, frequent mental distress, and frequent physical distress; and to report having arthritis, cancer, depression, as well as at least one non-respiratory chronic condition. Women were also more likely than men to report frequent SOB. Men, on the other hand, were more likely than women to have smoked ≥ 10 years, be overweight, and have coronary heart disease. Overall, 16.2% of men and 18.7% of women reported a physician diagnosis of COPD and/or asthma. Former asthma only was higher among men than women (4.9% vs. 3.2%, $p = 0.008$). Current asthma only was more prevalent among women than men (7.2% vs. 4.7%, $p < 0.001$), as was ACOS (4.0% vs. 2.2%, $p < 0.001$). Having COPD only did not differ between women (4.3%) and men (4.4%) (Table 1). Among respondents with COPD and/or asthma, 13.9% of men and 21.2% of women had ACOS.

Women had a higher age-adjusted prevalence of any asthma (former asthma only, current asthma only, or ACOS; 14.5% vs. 12.0%, $p = 0.013$) and any COPD (COPD only or ACOS; 7.6% vs. 6.3%, $p = 0.050$) than men. Men had a higher age-adjusted prevalence of former asthma only (5.1% vs. 3.3%, $p = 0.008$), but women had a higher age-adjusted prevalence of current asthma only (7.4% vs. 4.8%, $p < 0.001$) and ACOS (3.8% vs. 2.1%, $p < 0.001$). The age-adjusted prevalence of COPD only did not differ between men and women (4.2% vs. 3.9%, $p = 0.508$). Increasing age was associated with lower prevalence of former asthma only and current asthma only and higher prevalence of COPD only and ACOS for both men and women (all linear trends $p < 0.05$). Among men, black respondents reported current asthma only more than white respondents (7.4% vs. 3.7%, $p = 0.003$). Among women however, there were no differences in any OAD prevalence between black and white respondents. Among both men and women, respondents with less than a high school education had a higher prevalence of current asthma only, COPD only, and ACOS than respondents with at least some college education ($p < 0.05$ for each comparison). Among both men and women, prevalence of COPD only was highest for current smokers and lowest for never smokers (men: 8.8% vs. 1.8%, $p < 0.001$; women: 10.4% vs. 1.8%, $p < 0.001$). ACOS prevalence was highest for current smokers and lowest for never smokers among women (7.5% vs. 2.1%, $p < 0.001$), but did not vary significantly by smoking status among men. Among men, the

prevalence of COPD only was higher for those who reported smoking ≥ 10 years (7.6%) than for never smokers (1.8%, $p < 0.001$) or those who smoked < 10 years (2.9%, $p < 0.001$), with no statistically significant difference between never smokers and those who smoked < 10 years. Among women, the prevalence of COPD only was higher for women who smoked < 10 years compared with never smokers (4.6% vs 1.8%, $p = 0.002$) and higher still for women who smoked ≥ 10 years (8.2% vs 4.6%, $p = 0.027$). The prevalence of ACOS, however, was only significantly higher for women who smoked ≥ 10 years (8.1% vs 3.7% for those who smoked < 10 years [$p = 0.002$] and 2.1% for never smokers [$p < 0.001$]). Among men, prevalence of current asthma only, COPD only, and ACOS varied by BMI. Men who were obese were more likely to have current asthma only and ACOS compared to men in the normal weight or overweight categories; however, numbers of underweight men were relatively small. The prevalence of COPD only was lower among overweight men compared with men who were normal weight (3.0% vs 5.7%, $p = 0.009$). Among women, BMI was only associated with ACOS prevalence, with women who were obese having a higher prevalence (5.9%) than women who were normal weight (2.1%, $p < 0.001$) or overweight (3.0%, $p = 0.001$) (Table 2).

Among men, the likelihood of current smoking was higher for those with COPD only (PR=2.1 [95% CI: 1.7–2.5]), but not those with ACOS, compared to men with no OAD. Women with COPD only (PR=2.4 [95% CI: 1.9–3.0] or ACOS (PR=2.0 [95% CI: 1.6–2.6]) were more likely to be current smokers than women with no OAD. Likelihood of former smoking did not vary by OAD category among men, but was higher among women with ACOS compared to those with no OAD (PR=1.2 [95% CI: 1.001–1.6]). Among both men and women, the likelihood of having smoked ≥ 10 years was higher for those who had COPD only (men: PR=1.8 [95% CI: 1.6–2.1]; women: PR=2.1 [95% CI: 1.8–2.5]) or ACOS (men: PR=1.6 [95% CI: 1.3–2.1]; women: PR=2.1 [95% CI: 1.7–2.5]) compared to those with no OAD. Among both men and women, the likelihood of obesity was higher for groups with current asthma only (men: PR=1.7 [95% CI: 1.4–2.1]; women: PR=1.2 [95% CI: 1.03–1.5]) or ACOS (men: PR=1.7 [95% CI: 1.3–2.3]; women: PR=1.6 [95% CI: 1.4–1.9]), but not former asthma only or COPD only, compared to the no OAD group. Among men, the likelihood of each respiratory symptom was higher for those in the COPD only (frequent productive cough: PR=3.5 [95% CI: 2.5–4.7]; frequent SOB: PR=6.4 [95% CI: 4.1–10.1]; limited physical activity: PR=3.5 [95% CI: 2.7–4.4]) and ACOS groups (frequent productive cough: PR=3.8 [95% CI: 2.7–5.5]; frequent SOB: PR=14.2 [95% CI: 9.2–22.1]; limited physical activity: PR=6.1 [95% CI: 4.6–8.1]) compared with those with no OAD. The difference was especially notable for frequent SOB. In addition, the likelihood of limited activity due to breathing problems was higher for those with current asthma only compared to those with no airway disease (PR=1.8 [95% CI: 1.2–2.8]). However, neither frequent productive cough nor frequent SOB was elevated for this group. The adjusted prevalence of each respiratory symptom was also higher for those with ACOS compared with current asthma alone (frequent productive cough: 34.9% vs 10.2%, $p < 0.001$; frequent SOB: 29.2% vs 2.5%, $p < 0.001$; limited physical activity: 67.1% vs 20.0%, $p < 0.001$). Compared to the COPD alone group, the prevalence of frequent SOB (29.2% vs 13.2%, $p = 0.002$) and limited physical activity (67.1% vs 38.0%, $p = 0.001$) was higher for those with ACOS. Among women, the likelihood of each respiratory symptom was higher in the current asthma only

(frequent productive cough: PR=2.9 [95% CI: 2.1–4.0]; frequent SOB: PR=6.0 [95% CI: 3.7–9.6]; limited physical activity: PR=3.7 [95% CI: 3.0–4.7]), COPD only (frequent productive cough: PR=3.9 [95% CI: 2.9–5.1]; frequent SOB: PR=4.7 [95% CI: 3.0–7.5]; limited physical activity: PR=4.0 [95% CI: 3.1–5.2]), and ACOS groups (frequent productive cough: PR=6.2 [95% CI: 4.8–8.0]; frequent SOB: PR=11.3 [95% CI: 7.6–16.9]; limited physical activity: PR=6.0 [95% CI: 5.0–7.2]) compared with the group with no airway disease. The adjusted prevalence of each respiratory symptom was also higher for those with ACOS compared with either current asthma alone (frequent productive cough: 38.0% vs 17.7%, $p<0.001$; frequent SOB: 26.9% vs 14.2%, $p=0.005$; limited physical activity: 55.9% vs 34.7%, $p<0.001$) or COPD alone (frequent productive cough: 38.0% vs 23.9%, $p=0.003$; frequent SOB: 26.9% vs 11.3%, $p<0.001$; limited physical activity: 55.9% vs 37.6%, $p=0.002$). As among the men, the association with airway disease was strongest for frequent SOB (Table 3).

Among men, current asthma only was not associated with increased likelihood of poor overall health or any chronic health condition compared with the group with neither airway disease. However, former asthma only was associated with a higher likelihood of diabetes (PR=1.5 [95% CI: 1.01–2.2]) and depression (PR=1.9 [95% CI: 1.2–3.0]). Men with COPD only had a higher likelihood of the three poor overall health measures (fair/poor health: PR=2.2 [95% CI: 1.7–2.8]; frequent mental distress: PR=2.3 [95% CI: 1.6–3.4]; frequent physical distress: PR=2.5 [95% CI: 1.8–3.3]) as well as coronary heart disease (CHD) (PR=2.8 [95% CI: 2.0–4.1]), arthritis (PR=1.7 [95% CI: 1.4–2.2]), cancer (PR=1.7 [95% CI: 1.2–2.6]), and depression (PR=2.2 [95% CI: 1.6–3.1]). Men with ACOS had a higher likelihood of the three poor overall health measures (fair/poor health: PR=3.3 [95% CI: 2.6–4.2]; frequent mental distress: PR=2.9 [95% CI: 1.9–4.5]; frequent physical distress: PR=4.7 [95% CI: 3.5–6.2]) and all chronic health conditions except cancer (PR ranged from 1.8 for diabetes to 3.4 for depression) compared with the group with no airway disease. In addition, compared to men with COPD only, men with ACOS reported a higher prevalence of fair/poor health (52.7% vs 34.5%, $p=0.008$), frequent physical distress (46.5% vs 24.6%, $p=0.001$), and at least one non-respiratory chronic disease (74.0% vs 55.7%, $p=0.024$). Among women, the current asthma only, COPD only, and ACOS groups had higher likelihoods of the three poor overall health measures compared to women with no OAD. Compared to women with no OAD, women with former asthma had a higher likelihood of cancer (PR=1.8 [95% CI: 1.03–3.1]) and depression (PR=1.6 [95% CI: 1.2–2.1]), but not of any of the poor overall health measures or other chronic health conditions. Women with current asthma only or COPD only had higher likelihood of all of the chronic health conditions except cancer, while those with ACOS had a higher likelihood of all of the chronic health conditions. Additionally, compared to women with current asthma only, those with ACOS had a higher prevalence of fair/poor health (48.4% vs 31.5%, $p=0.001$), frequent mental distress (28.6% vs 18.7%, $p=0.033$), frequent physical distress (34.9% vs 23.6%, $p=0.019$), cancer (18.2% vs 8.1%, $p=0.001$), depression (41.3% vs 28.3%, $p=0.010$), and at least one non-respiratory chronic disease (76.3% vs 60.6%, $p=0.004$). The PRs for ACOS were generally similar to those for COPD only; however, the adjusted prevalence of cancer was higher among women with ACOS compared to those with COPD only (18.2% vs 10.4%, $p=0.009$) (Table 4).

Discussion

We undertook an analysis of a state's health survey (2012 SC BRFSS) in more than 10,000 adults that included questions about socio-demographics, health behaviors, respiratory symptoms, major chronic diseases, and health impairment. Although the unadjusted prevalence of ACOS was low (2.2% in men and 4.0% in women) among adults in South Carolina, ACOS was reported by one of every six adults (13.9% in men and 21.2% in women) who had either COPD or asthma. Gender differences were evident between the four OAD groups in disease prevalence, socio-demographic characteristics, smoking history, and comorbidities as well as health status and impairment.

In our study, the prevalence of current asthma only (4.7% of men and 7.2% of women), COPD only (4.4% of men and 4.3% of women), and ACOS (2.2% of men and 4.0% of women) are consistent with most other studies. Among two US, one Asian, one Latin American, and two European cross-sectional studies, the prevalence of asthma only, COPD only, and ACOS ranged from 1.7–6.2%, 3.1–11.7%, and 1.8–2.7%, respectively [3,5,6,12,19]. This and other studies show that women are more likely than men to have ACOS [3,6,12,25]. In prevalence studies that did not evaluate ACOS, women were more likely than men to have current asthma [13] and COPD [1]. In our study, women were also more likely than men to report any asthma (represented in either asthma only group and the ACOS group) and COPD (represented in the COPD only and ACOS groups). An Italian study that included an ACOS group [6] reported that prevalence of ever asthma or COPD was not significantly different by gender, whereas the PLATINO study reported that 75% of the asthma only group was female [5]. Some studies reporting characteristics of patients with ACOS show a younger mean age compared to those with COPD alone [10,12,25], whereas others did not [3,26]. In the current study, women with ACOS were younger than those with COPD only (mean age 52.8 years vs. 58.4 years, $p < 0.01$), although there was no significant age difference for men. The prevalence of asthma and COPD, and likely other characteristics of these patient types, may be affected by whether individuals with ACOS are considered a separate group.

Why some patients with asthma or COPD go on to develop ACOS may be related to unique immunological responses, genetic predisposition, or other factors. Adults with asthma, even after adjusting for smoking history, are at a 12-fold higher risk of developing COPD than those without asthma [27]. This finding may explain why the prevalence of ACOS in our study was higher among women, who are also more likely to have asthma. A recent study evaluated whether expression of asthma-associated gene signatures (T helper type 2) were increased in COPD patients and found that higher scores were associated with worse lung function and more "asthma-like" features, but not with asthma history [28]. In a group of 3500 subjects who were part of the Genetic Epidemiology of COPD (COPDGene) study, several genetic variants associated with ACOS approached genome-wide significance, although the authors hypothesized that the study was underpowered for that portion of their analysis [10].

Prior studies have indicated that women are more susceptible than men to the effects of tobacco smoking [29–31]. In our study, men who smoked <10 years did not have a higher

prevalence of COPD only or ACOS than never smokers. However, compared to never smokers, women who smoked <10 years had a higher prevalence of COPD only, with an even higher prevalence for those who smoked 10 years. Of note, the prevalence of ACOS among those who smoked 10 years was more than double for women compared to men. When limiting our analyses to never smokers only, men and women had a similar prevalence of COPD only and ACOS.

A number of studies support that obesity and weight gain are a major risk factor for declines in lung function [32–34], respiratory symptoms [35,36], asthma [37], and COPD [35], although some studies have observed a lower risk for COPD, especially emphysema, with obesity [38,39]. In the current study, obesity was more common in the current asthma only and ACOS groups. With respect to gender, three studies observed that the association between FEV1 decline and obesity or weight gain were stronger for men than women [32–34]. Guerra et al. however observed an association between excess weight and asthma among women only [37]. We noted a slightly stronger association between obesity and current asthma only for men than women, but similar associations for the ACOS group.

Prior to our study, no other publication has described the frequency and type of respiratory symptoms in relationship to gender in a population that distinguished asthma, COPD, and ACOS. In our study, the most common respiratory symptom reported was limitation of physical activity due to breathing problems, followed by frequent productive cough, and then frequent SOB; the latter was reported more commonly by women. In other general adult population studies, women reported respiratory symptoms more often than men [40,41]. We observed that both men and women with COPD only were more likely than those without OAD to report respiratory symptoms, while the risk was even higher for those with ACOS. Current asthma only was associated with frequent productive cough and frequent SOB among women, but not among men. Although frequent SOB was not reported as often as the other respiratory symptoms among the respondents in our study, frequent SOB was very evident in ACOS (PR > 11) and COPD (PR > 4) compared to no OAD. Other groups have also shown greater risk of respiratory symptoms in ACOS than COPD [5,6] and asthma [6,42].

Other studies have reported that health impairment is more frequent and severe in patients with ACOS compared to other OAD [3,19,26]. We found that OADs increased the likelihood of poor health status and frequent mental and physical distress, but with some differences by gender. Among men, although the likelihood of each of these measures was significantly higher for the COPD only and ACOS groups than the no OAD group, only the likelihood of frequent physical distress was significantly higher for those with ACOS compared to COPD only. Among women, the likelihood of these three measures was higher for the current asthma only, COPD only, and ACOS groups compared to the no OAD group, but the likelihood of fair/poor health and frequent physical distress was comparable for the ACOS and COPD only groups.

Comorbidities have been reported to be more common in ACOS than COPD [19,25] and asthma [11,19]. It is known that COPD alone increases the risk of comorbidities [43,44]. We found that most non-respiratory comorbidities were more common in the COPD only and

ACOS groups than in persons with no OAD among both men and women. However in general, we found that the current asthma only group was similar to the no OAD group among men, but more similar to the COPD only and ACOS groups among women. Both men and women with ACOS or COPD only in our study reported higher rates of coronary heart disease compared to respondents with no OAD. An increased risk of coronary heart disease in COPD has been previously reported [45]. Systemic effects of airway inflammation may play a role in some non-pulmonary diseases such as coronary artery disease [45,46]. Compared to respondents with no OAD, men with COPD only and women with former asthma only or ACOS had a higher likelihood of cancer. In the only other study of ACOS reporting cancer history, there was no difference in rates of cancer between ACOS and COPD [25]. Due to the low prevalence of cancer in our sample and therefore unreliable estimates, we were not able to compare cancer prevalence in the COPD only and ACOS groups.

This study was subject to some limitations. First, this was a cross-sectional study; therefore we could not confirm causality in the relationships between OAD and the other variables in the study. Second, all the information on OAD and other chronic condition diagnoses was self-reported. There is evidence that similar questions asking about physician diagnoses of COPD, emphysema, and chronic bronchitis have high specificity and low sensitivity [47], which would result in misclassification of individuals with COPD as not having COPD. This would tend to bias estimates towards the null. Third, the study population is representative of non-institutionalized adults in South Carolina. Therefore, individuals with more severe OADs and other chronic conditions may reside in facilities that are not included in the survey.

Conclusion

Although there may never be a clear distinction between asthma, COPD, and ACOS in all patients, it is imperative to undertake research to better understand the phenotypic and genotypic characteristics of this population as well as the most effective interventions to minimize impact. In this study of more than 10 000 adults in South Carolina, ACOS was an important phenotype of OAD and compared to asthma or COPD alone sometimes exhibited the most substantial health impairment, respiratory symptoms, and a higher frequency of comorbidities. Gender differences were evident regarding the prevalence of the OAD groups, sociodemographic characteristics, smoking history, and comorbidities as well as health status and impairment. The principal difference was in the association of current asthma only with respiratory symptoms and comorbidities, with this group being more comparable to the no OAD group among men but with the COPD only and ACOS groups among women. Inclusion of an ACOS group has a significant impact on the reported characteristics of persons with asthma or COPD alone. This study provides useful information about the prevalence, patient characteristics, and respiratory symptoms in persons with asthma and/or COPD in relationship to gender in a US state's adult population. This type of data may assist in methodologies for clinical and population health research. Clearly, it is necessary to continue to re-evaluate the view of COPD and asthma as distinct diseases, and to consider circumstances where characteristics of both exist in the same patient, such as an asthmatic with significant smoking history or prolonged, excessive bronchial hyper-reactivity [48].

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Table 1
Distribution of selected characteristics of the adult study population aged 18 years, by gender: South Carolina Behavioral Risk Factor Surveillance System, 2012

Characteristic	Men			Women		
	n ^a	% ^b (95% CI)	n ^a	% ^b (95% CI)	p-value ^c	
Total	4,900	100.0	7,694	100.0		
Age (years)						
18-44	1,387	48.1 (46.1-50.1)	1,892	44.4 (42.8-46.0)	0.007	
45-64	1,914	34.3 (32.4-36.1)	2,985	34.4 (32.9-35.9)	0.914	
65	1,599	17.6 (16.5-18.9)	2,817	21.2 (20.2-22.3)	<0.001	
Mean age (SE)		46.1 (0.4)		48.1 (0.3)	<0.001	
Race						
White	3,472	68.5 (66.5-70.4)	4,991	67.3 (65.7-68.8)	0.349	
Black	1,195	25.1 (23.3-26.9)	2,421	27.6 (26.2-29.1)	0.034	
Other/multiracial	233	6.4 (5.3-7.8)	282	5.1 (4.3-6.1)	0.103	
Education						
Less than high school diploma	628	18.2 (16.5-20.2)	945	15.4 (14.1-16.9)	0.017	
High school graduate or GED	1,508	32.3 (30.4-34.3)	2,426	29.8 (28.3-31.3)	0.042	
At least some college	2,754	49.4 (47.4-51.5)	4,309	54.8 (53.1-56.4)	<0.001	
Smoking status						
Current smoker	1,009	26.3 (24.4-28.2)	1,137	19.3 (17.9-20.7)	<0.001	
Former smoker	1,769	29.3 (27.6-31.1)	1,896	22.4 (21.1-23.8)	<0.001	
Never smoker	2,023	44.4 (42.4-46.5)	4,517	58.4 (56.7-60.0)	<0.001	
Smoking duration						
Never smoker	2,023	44.9 (42.8-46.9)	4,517	58.6 (57.0-60.3)	<0.001	
Smoked <10 years or duration unknown	743	18.7 (17.0-20.5)	1,021	16.2 (14.9-17.6)	0.025	
Smoked 10 years	2,000	36.4 (34.5-38.4)	1,986	25.2 (23.8-26.6)	<0.001	
BMI category (kg/m ²)						
Underweight (<18.5)	51	1.1 (0.7-1.8)	140	1.9 (1.5-2.4)	0.042	
Normal weight (18.5-24.9)	1,277	28.8 (27.0-30.8)	2,418	35.5 (33.9-37.2)	<0.001	
Overweight (25.0-29.9)	2,086	39.9 (37.9-41.9)	2,225	29.4 (27.9-31.0)	<0.001	

Characteristic	Men		Women		p-value ^c
	n ^d	% ^b (95% CI)	n ^d	% ^b (95% CI)	
Obese (30.0)	1,440	30.1 (28.3–32.0)	2,423	33.2 (31.6–34.8)	0.014
Overall health					
Fair/poor health	1,055	17.7 (16.2–19.2)	1,814	20.0 (18.7–21.3)	0.019
Frequent mental distress ^d	471	10.9 (9.7–12.2)	1,000	15.3 (14.0–16.6)	<0.001
Frequent physical distress ^e	650	11.9 (10.7–13.2)	1,213	14.3 (13.2–15.5)	0.005
Non-respiratory chronic conditions					
Coronary heart disease	412	5.8 (5.1–6.7)	436	4.5 (3.8–5.2)	0.008
Diabetes	751	11.5 (10.4–12.7)	1,200	11.8 (10.8–12.8)	0.720
Arthritis	1,585	24.8 (23.2–26.4)	3,223	32.5 (31.1–34.0)	<0.001
Cancer (excluding skin cancer)	432	5.2 (4.5–5.9)	817	8.3 (7.5–9.1)	<0.001
Depression	655	12.9 (11.6–14.2)	1,662	22.8 (21.4–24.2)	<0.001
Stroke	254	3.7 (3.1–4.4)	397	3.7 (3.2–4.2)	0.941
Number of non-respiratory chronic conditions					
None	2,401	59.6 (57.7–61.5)	3,098	49.4 (47.7–51.1)	<0.001
1	1,400	23.9 (22.3–25.6)	2,389	27.7 (26.2–29.1)	<0.001
2	723	11.2 (10.1–12.4)	1,477	15.5 (14.4–16.6)	<0.001
3	274	4.0 (3.4–4.7)	531	5.4 (4.7–6.1)	0.003
4	98	1.3 (1.0–1.7)	187	2.1 (1.7–2.6)	0.009
Chronic obstructive airway disease					
None	4,187	83.8 (82.2–85.4)	6,262	81.3 (79.9–82.6)	0.015
Former asthma only	180	4.9 (3.9–6.0)	219	3.2 (2.6–3.9)	0.008
Current asthma only	171	4.7 (3.8–5.7)	471	7.2 (6.3–8.2)	<0.001
COPD only	248	4.4 (3.6–5.3)	387	4.3 (3.7–5.0)	0.915
Asthma-COPD overlap syndrome	114	2.2 (1.7–2.9)	355	4.0 (3.4–4.6)	<0.001
Respiratory symptoms					
Frequent productive cough ^f	538	10.9 (9.7–12.2)	712	9.5 (8.6–10.6)	0.108
Frequent SOB ^g	207	3.8 (3.1–4.6)	364	5.2 (4.4–6.1)	0.010
Breathing problems limited activity ^h	712	14.5 (13.1–16.0)	1,153	15.4 (14.2–16.7)	0.347

BMI - body mass index; CI - confidence interval; COPD - chronic obstructive pulmonary disease; GED - general equivalency diploma; SOB - shortness of breath

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^aUnweighted sample. Categories might not sum to survey total because of missing responses.

^bWeighted percentage.

^ct-test (men versus women).

^dFrequent mental distress: a response of 14 days to the question, “Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good.”

^eFrequent physical distress: a response of 14 days to the question, “Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good.”

^fDefined as a response of either most days or every day to the question “During the past 30 days, how often do you cough up mucus or phlegm?”

^gDefined as a response of either most of the time or all of the time to the question “During the past 30 days, how often do you feel short of breath?”

^hDefined as a response of agree slightly or agree strongly to the question, “How much do you agree or disagree with the following statement? ‘In the past year, I am not as physically active as I once was because of my breathing problems.’”

Unadjusted, age-specific, and age-adjusted^a prevalence of chronic obstructive airway disease categories among adults aged 18 years by gender and selected characteristics: South Carolina Behavioral Risk Factor Surveillance System, 2012

Table 2

Characteristic	N	Asthma-COPD overlap syndrome		
		Former asthma only % (95% CI)	Current asthma only % (95% CI)	COPD only % (95% CI)
MEN				
Total				
Unadjusted	4,900	4.9 (3.9–6.0)	4.7 (3.8–5.7)	4.4 (3.6–5.3)
Age-adjusted	4,900	5.1 (4.1–6.3)	4.8 (3.9–5.9)	4.2 (3.5–5.1)
Age (years)				
18–44	1,387	7.2 (5.5–9.4)	5.8 (4.4–7.7)	2.3 (1.4–3.6)
45–64	1,914	3.1 (2.2–4.4)	3.8 (2.8–5.3)	5.1 (4.0–6.6)
65	1,599	1.9 (1.1–3.3)	3.2 (2.1–4.7)	8.7 (6.6–11.4)
Race ^b				
White	3,472	4.7 (3.6–6.3)	3.7 (2.8–4.9)	4.6 (3.7–5.6)
Black	1,195	5.2 (3.5–7.5)	7.4 (5.5–10.0)	3.3 (2.0–5.5)
Other/multiracial	233	7.0 (3.7–12.9) [*]	5.1 (2.0–12.3) [*]	6.6 (2.6–15.5) [*]
Education ^d				
Less than high school diploma	628	7.1 (4.2–11.8)	8.0 (5.2–12.3)	7.1 (5.0–10.0)
High school graduate or GED	1,508	3.5 (2.4–5.1)	3.8 (2.6–5.5)	3.8 (2.9–4.9)
At least some college	2,754	5.4 (4.1–7.1)	4.3 (3.2–5.7)	3.4 (2.5–4.7)
Smoking status ^e				
Current smoker	1,009	6.1 (4.3–8.5)	5.2 (3.4–7.7)	8.8 (6.4–11.8)
Former smoker	1,769	4.4 (2.8–6.8)	4.4 (2.6–7.4)	3.4 (2.7–4.4)
Never smoker	2,023	4.7 (3.3–6.6)	4.8 (3.6–6.3)	1.8 (1.1–2.9)
Smoking duration ^d				
Never smoker	2,023	4.7 (3.3–6.6)	4.8 (3.6–6.3)	1.8 (1.1–2.9)
Smoked <10 years or duration unknown	743	6.1 (4.1–8.9)	5.3 (3.3–8.5)	2.9 (1.7–4.9)
Smoked 10 years	2,000	4.3 (2.8–6.5)	4.0 (2.6–6.2)	7.6 (5.9–9.7)

Characteristic	N	Former asthma only % (95% CI)	Current asthma only % (95% CI)	COPD only % (95% CI)	Asthma-COPD overlap syndrome % (95% CI)
BMI category (kg/m ²) ^d					
Underweight (<18.5)	51	15.4 (3.1–50.6)*	10.6 (2.5–34.9)*	5.8 (2.1–15.0)*	8.2 (3.0–20.2)*
Normal weight (18.5–24.9)	1,277	5.6 (3.9–8.0)	3.2 (2.1–4.8)	5.7 (4.2–7.8)	1.4 (0.8–2.4)
Overweight (25.0–29.9)	2,086	4.6 (3.2–6.7)	3.4 (2.4–4.7)	3.0 (2.1–4.3)	1.4 (0.9–2.1)
Obese (≥ 30.0)	1,440	4.4 (3.0–6.4)	8.0 (5.8–11.0)	4.9 (3.5–6.9)	3.5 (2.3–5.4)
WOMEN					
Total					
Unadjusted	7,694	3.2 (2.6–3.9)	7.2 (6.3–8.2)	4.3 (3.7–5.0)	4.0 (3.4–4.6)
Age-adjusted	7,694	3.3 (2.7–4.1)	7.4 (6.4–8.5)	3.9 (3.3–4.6)	3.8 (3.2–4.4)
Age (years)					
18–44	1,892	3.9 (2.8–5.3)	8.3 (6.8–10.1)	1.5 (0.8–2.6)	2.7 (1.9–3.8)
45–64	2,985	3.1 (2.3–4.2)	7.3 (5.8–9.1)	6.3 (5.1–7.8)	5.2 (4.3–6.4)
65	2,817	2.1 (1.5–2.9)	4.9 (3.8–6.2)	7.0 (5.8–8.5)	4.6 (3.7–5.7)
Race ^d					
White	4,991	3.0 (2.2–4.0)	7.2 (6.0–8.6)	4.1 (3.3–5.1)	3.6 (3.0–4.4)
Black	2,421	3.3 (2.4–4.5)	8.0 (6.3–10.0)	3.8 (2.8–5.2)	3.8 (2.8–5.0)
Other/multiracial	282	6.2 (3.0–12.4)*	9.5 (4.9–17.5)*	1.0 (0.4–2.5)*	5.7 (2.8–11.3)*
Education ^d					
Less than high school diploma	945	5.0 (2.5–9.8)*	13.0 (9.1–18.3)	8.4 (5.5–12.5)	7.3 (5.0–10.4)
High school graduate or GED	2,426	2.6 (1.7–4.0)	7.1 (5.6–9.0)	3.8 (2.9–5.0)	4.4 (3.3–5.9)
At least some college	4,309	3.3 (2.6–4.2)	6.3 (5.2–7.5)	2.7 (2.2–3.3)	2.7 (2.1–3.3)
Smoking status ^d					
Current smoker	1,137	3.8 (2.2–6.3)	7.1 (5.3–9.5)	10.4 (8.5–12.7)	7.5 (5.7–9.9)
Former smoker	1,896	3.1 (1.9–5.1)	6.7 (4.9–9.1)	4.9 (2.7–8.6)	4.2 (3.0–5.8)
Never smoker	4,517	3.3 (2.5–4.3)	7.6 (6.3–9.2)	1.8 (1.4–2.5)	2.1 (1.7–2.7)
Smoking duration ^d					
Never smoker	4,517	3.3 (2.5–4.3)	7.6 (6.3–9.2)	1.8 (1.4–2.5)	2.1 (1.7–2.7)
Smoked <10 years or duration unknown	1,021	3.5 (2.0–6.2)	8.8 (6.6–11.6)	4.6 (3.2–6.7)	3.7 (2.4–5.6)
Smoked ≥ 10 years	1,986	3.4 (2.1–5.5)	6.0 (4.4–8.1)	8.2 (5.9–11.2)	8.1 (6.1–10.7)

Characteristic	N	Former asthma only		Current asthma only		COPD only		Asthma-COPD overlap syndrome	
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	
BMI category (kg/m ²) ^d									
Underweight (<18.5)	140	1.1 (0.2–7.5)*	8.6 (3.7–18.4)*	5.7 (3.0–10.6)*	6.1 (2.6–13.6)*				
Normal weight (18.5–24.9)	2,418	3.5 (2.4–5.1)	6.2 (4.6–8.2)	3.5 (2.7–4.6)	2.1 (1.5–2.9)				
Overweight (25.0–29.9)	2,225	2.6 (1.5–4.5)	6.9 (5.2–9.1)	4.1 (2.7–6.2)	3.0 (2.1–4.3)				
Obese (≥ 30.0)	2,423	4.1 (2.9–5.6)	8.5 (6.9–10.5)	4.3 (3.4–5.5)	5.9 (4.6–7.5)				

BMI - body mass index; CI - confidence interval; COPD - chronic obstructive pulmonary disease

^d Age-adjusted to the projected 2000 U.S. population aged 18 years.

* Estimates may not be reliable. Relative standard error 0.3. Estimates not included in comparison tests.

Adjusted^a prevalence and adjusted prevalence ratio (PR) of smoking, obesity, and respiratory symptoms by chronic obstructive airway disease category and gender: South Carolina Behavioral Risk Factor Surveillance System, 2012

Table 3

Chronic obstructive airway disease	Men		Women	
	% (95% CI)	PR (95% CI)	% (95% CI)	PR (95% CI)
Current smoker				
Neither asthma nor COPD	24.6 (22.7–26.7)	1.0 (referent)	17.4 (15.9–19.0)	1.0 (referent)
Former asthma only	30.8 (22.0–41.4)	1.3 (0.9–1.7)	20.8 (13.8–30.2)	1.2 (0.8–1.8)
Current asthma only	25.6 (18.0–35.0)	1.0 (0.7–1.5)	17.4 (13.2–22.6)	1.0 (0.8–1.3)
COPD only	50.8 (41.8–59.7)	2.1 (1.7–2.5)	41.7 (32.9–51.1)	2.4 (1.9–3.0)
Asthma-COPD overlap syndrome	31.7 (20.5–45.5)	1.3 (0.9–1.9)	35.6 (28.6–43.2)	2.0 (1.6–2.6)
Former smoker				
Neither asthma nor COPD	29.3 (27.4–31.3)	1.0 (referent)	22.0 (20.5–23.5)	1.0 (referent)
Former asthma only	27.2 (19.8–36.2)	0.9 (0.7–1.3)	20.9 (14.7–28.9)	1.0 (0.7–1.3)
Current asthma only	28.8 (20.3–39.2)	1.0 (0.7–1.4)	21.5 (16.9–26.9)	1.0 (0.8–1.2)
COPD only	27.3 (21.5–34.0)	0.9 (0.7–1.2)	27.0 (20.5–34.7)	1.2 (0.9–1.6)
Asthma-COPD overlap syndrome	36.4 (25.7–48.7)	1.2 (0.9–1.7)	27.4 (22.0–33.5)	1.2 (1.001–1.6)
Smoked 10 years				
Neither asthma nor COPD	35.0 (32.9–37.1)	1.0 (referent)	23.1 (21.6–24.6)	1.0 (referent)
Former asthma only	33.4 (24.6–43.6)	1.0 (0.7–1.3)	24.3 (16.8–33.8)	1.1 (0.7–1.5)
Current asthma only	31.3 (22.9–41.2)	0.9 (0.7–1.2)	20.7 (16.2–26.0)	0.9 (0.7–1.1)
COPD only	63.1 (54.1–71.3)	1.8 (1.6–2.1)	48.9 (41.5–56.3)	2.1 (1.8–2.5)
Asthma-COPD overlap syndrome	56.8 (43.4–69.2)	1.6 (1.3–2.1)	47.7 (40.0–55.4)	2.1 (1.7–2.5)
Obese (BMI ≥30kg/m²)				
Neither asthma nor COPD	28.6 (26.7–30.7)	1.0 (referent)	31.5 (29.8–33.3)	1.0 (referent)
Former asthma only	27.3 (19.3–37.0)	1.0 (0.7–1.3)	37.9 (28.7–48.1)	1.2 (0.9–1.6)
Current asthma only	48.9 (38.6–59.3)	1.7 (1.4–2.1)	38.7 (32.3–45.4)	1.2 (1.03–1.5)
COPD only	32.4 (23.9–42.2)	1.1 (0.8–1.5)	35.9 (29.4–43.0)	1.1 (0.9–1.4)
Asthma-COPD overlap syndrome	48.9 (35.9–62.1)	1.7 (1.3–2.3)	51.1 (43.4–58.7)	1.6 (1.4–1.9)
Frequent productive cough^b				
Neither asthma nor COPD	9.1 (7.9–10.5)	1.0 (referent)	6.2 (5.3–7.2)	1.0 (referent)

Chronic obstructive airway disease	Men		Women	
	% (95% CI)	PR (95% CI)	% (95% CI)	PR (95% CI)
Former asthma only	5.2 (2.3–11.2)	0.6 (0.3–1.3)	8.1 (3.1–19.7)	1.3 (0.5–3.4)
Current asthma only	10.2 (5.7–17.8)	1.1 (0.6–2.0)	17.7 (13.1–23.5)	2.9 (2.1–4.0)
COPD only	31.5 (23.5–40.6)	3.5 (2.5–4.7)	23.9 (18.6–30.0)	3.9 (2.9–5.1)
Asthma-COPD overlap syndrome	34.9 (24.3–47.2)	3.8 (2.7–5.5)	38.0 (30.3–46.2)	6.2 (4.8–8.0)
Frequent SOB^c				
Neither asthma nor COPD	2.1 (1.5–2.8)	1.0 (referent)	2.4 (1.8–3.2)	1.0 (referent)
Former asthma only	3.2 (0.7–13.6)	1.5 (0.3–7.2)	3.0 (0.7–12.5)	1.3 (0.3–5.7)
Current asthma only	2.5 (0.9–6.3) *	1.2 (0.4–3.3)	14.2 (9.9–20.0)	6.0 (3.7–9.6)
COPD only	13.2 (9.3–18.6)	6.4 (4.1–10.1)	11.3 (7.7–16.2)	4.7 (3.0–7.5)
Asthma-COPD overlap syndrome	29.2 (20.6–39.7)	14.2 (9.2–22.1)	26.9 (20.0–35.3)	11.3 (7.6–16.9)
Breathing problems limited physical activity^d				
Neither asthma nor COPD	11.0 (9.5–12.5)	1.0 (referent)	9.4 (8.2–10.6)	1.0 (referent)
Former asthma only	11.8 (5.7–23.0)	1.1 (0.5–2.2)	13.4 (8.3–20.9)	1.4 (0.9–2.3)
Current asthma only	20.0 (13.2–29.1)	1.8 (1.2–2.8)	34.7 (28.5–41.5)	3.7 (3.0–4.7)
COPD only	38.0 (30.6–46.0)	3.5 (2.7–4.4)	37.6 (29.5–46.3)	4.0 (3.1–5.2)
Asthma-COPD overlap syndrome	67.1 (49.5–80.9)	6.1 (4.6–8.1)	55.9 (47.7–63.8)	6.0 (5.0–7.2)

BMI - body mass index; CI - confidence interval; COPD - chronic obstructive pulmonary disease; SOB - shortness of breath

^a Adjusted prevalence and prevalence ratio (PR) and 95% CI for the likelihood of each smoking category, obesity, and each respiratory symptom associated with a given chronic obstructive airway disease category were obtained from separate multivariable logistic regression models. Models for smoking categories and obesity included age, race, and education as covariates. Models for respiratory symptoms included age, race, education, smoking status, and BMI category as covariates. The referent for PRs was the group of respondents with no obstructive airway impairment.

^b Defined as a response of either most days or every day to the question "During the past 30 days, how often do you cough up mucus or phlegm?"

^c Defined as a response of either most of the time or all of the time to the question "During the past 30 days, how often do you feel short of breath?"

^d Defined as a response of agree slightly or agree strongly to the question, "How much do you agree or disagree with the following statement? 'In the past year, I am not as physically active as I once was because of my breathing problems.'"

* Estimates not reliable. Relative standard error 0.3.

Adjusted^a prevalence and adjusted prevalence ratio (PR) of poor overall health and chronic health conditions by chronic obstructive airway disease category and gender: South Carolina Behavioral Risk Factor Surveillance System, 2012

Table 4

Chronic obstructive airway disease	Men		Women	
	% (95% CI)	PR (95% CI)	% (95% CI)	PR (95% CI)
Self-reported fair/poor health				
Neither asthma nor COPD	15.9 (14.3–17.6)	1.0 (referent)	16.1 (14.8–17.5)	1.0 (referent)
Former asthma only	11.6 (7.4–17.8)	0.7 (0.5–1.2)	23.3 (14.9–34.5)	1.4 (0.9–2.2)
Current asthma only	13.6 (8.8–20.3)	0.9 (0.6–1.3)	31.5 (26.2–37.4)	2.0 (1.6–2.4)
COPD only	34.5 (26.9–43.0)	2.2 (1.7–2.8)	38.8 (31.5–46.8)	2.4 (2.0–3.0)
Asthma-COPD overlap syndrome	52.7 (41.6–63.7)	3.3 (2.6–4.2)	48.4 (40.6–56.2)	3.0 (2.5–3.6)
Frequent mental distress^b				
Neither asthma nor COPD	9.6 (8.3–11.0)	1.0 (referent)	12.9 (11.6–14.4)	1.0 (referent)
Former asthma only	10.7 (5.9–18.5)	1.1 (0.6–2.0)	19.3 (11.9–29.8)	1.5 (0.9–2.4)
Current asthma only	13.4 (7.5–22.9)	1.4 (0.8–2.5)	18.7 (14.0–24.5)	1.4 (1.1–2.0)
COPD only	22.2 (15.4–30.9)	2.3 (1.6–3.4)	34.1 (26.5–42.6)	2.6 (2.0–3.4)
Asthma-COPD overlap syndrome	27.5 (17.7–40.2)	2.9 (1.9–4.5)	28.6 (21.8–36.4)	2.2 (1.7–2.9)
Frequent physical distress^c				
Neither asthma nor COPD	9.9 (8.7–11.4)	1.0 (referent)	11.1 (9.9–12.3)	1.0 (referent)
Former asthma only	13.4 (7.8–22.1)	1.4 (0.8–2.3)	13.4 (7.0–24.2)*	1.2 (0.6–2.3)
Current asthma only	10.4 (6.0–17.2)	1.0 (0.6–1.8)	23.6 (18.3–29.8)	2.1 (1.6–2.8)
COPD only	24.6 (18.7–31.7)	2.5 (1.8–3.3)	34.5 (26.8–43.1)	3.1 (2.4–4.0)
Asthma-COPD overlap syndrome	46.5 (35.1–58.3)	4.7 (3.5–6.2)	34.9 (27.9–42.5)	3.2 (2.5–4.0)
Coronary heart disease				
Neither asthma nor COPD	5.0 (4.2–5.9)	1.0 (referent)	3.4 (2.8–4.1)	1.0 (referent)
Former asthma only	5.2 (2.5–10.7)*	1.0 (0.5–2.2)	3.3 (1.7–6.6)*	1.0 (0.5–2.0)
Current asthma only	2.3 (1.0–5.2)*	0.5 (0.2–1.1)	6.2 (3.6–10.6)	1.8 (1.04–3.3)
COPD only	14.2 (10.1–19.6)	2.8 (2.0–4.1)	9.8 (6.4–14.7)	2.9 (1.8–4.5)
Asthma-COPD overlap syndrome	16.6 (10.8–24.8)	3.3 (2.1–5.3)	11.1 (8.0–15.3)	3.3 (2.3–4.7)
Diabetes				

Chronic obstructive airway disease	Men		Women	
	% (95% CI)	PR (95% CI)	% (95% CI)	PR (95% CI)
Neither asthma nor COPD	10.9 (9.7–12.3)	1.0 (referent)	10.7 (9.6–11.8)	1.0 (referent)
Former asthma only	16.4 (11.1–23.7)	1.5 (1.01–2.2)	15.7 (10.1–23.5)	1.5 (1.0–2.3)
Current asthma only	7.3 (4.3–12.1)	0.7 (0.4–1.1)	16.7 (12.6–21.7)	1.6 (1.2–2.1)
COPD only	13.4 (9.5–18.6)	1.2 (0.9–1.7)	16.3 (12.0–21.8)	1.5 (1.1–2.1)
Asthma-COPD overlap syndrome	19.8 (13.2–28.6)	1.8 (1.2–2.7)	15.4 (11.4–20.4)	1.4 (1.1–2.0)
Arthritis				
Neither asthma nor COPD	23.4 (21.7–25.1)	1.0 (referent)	30.0 (28.4–31.6)	1.0 (referent)
Former asthma only	24.3 (18.1–31.8)	1.0 (0.8–1.4)	35.6 (25.9–46.6)	1.2 (0.9–1.6)
Current asthma only	23.1 (17.1–30.5)	1.0 (0.7–1.3)	45.2 (39.5–51.1)	1.5 (1.3–1.7)
COPD only	40.2 (32.0–49.0)	1.7 (1.4–2.2)	50.1 (43.2–57.0)	1.7 (1.4–1.9)
Asthma-COPD overlap syndrome	44.8 (31.2–59.2)	1.9 (1.4–2.7)	51.0 (43.4–58.5)	1.7 (1.5–2.0)
Cancer (excluding skin)				
Neither asthma nor COPD	5.1 (4.4–5.9)	1.0 (referent)	7.4 (6.6–8.3)	1.0 (referent)
Former asthma only	4.7 (2.0–10.6)*	0.9 (0.4–2.2)	13.2 (7.6–22.1)	1.8 (1.03–3.1)
Current asthma only	4.1 (2.1–7.8)*	0.8 (0.4–1.6)	8.1 (5.2–12.5)	1.1 (0.7–1.7)
COPD only	8.9 (6.1–13.0)	1.7 (1.2–2.6)	10.4 (7.3–14.4)	1.4 (1.0–2.0)
Asthma-COPD overlap syndrome	3.7 (1.6–8.6)*	0.7 (0.3–1.7)	18.2 (13.9–23.4)	2.5 (1.8–3.3)
Depression				
Neither asthma nor COPD	11.0 (9.7–12.3)	1.0 (referent)	19.9 (18.4–21.4)	1.0 (referent)
Former asthma only	20.5 (12.5–31.7)	1.9 (1.2–3.0)	31.3 (22.9–41.3)	1.6 (1.2–2.1)
Current asthma only	14.8 (9.1–23.3)	1.4 (0.8–2.2)	28.3 (23.0–34.3)	1.4 (1.2–1.8)
COPD only	24.4 (17.8–32.5)	2.2 (1.6–3.1)	42.2 (34.6–50.3)	2.1 (1.7–2.6)
Asthma-COPD overlap syndrome	36.8 (24.8–50.7)	3.4 (2.3–4.9)	41.3 (33.6–49.3)	2.1 (1.7–2.6)
Stroke				
Neither asthma nor COPD	3.4 (2.7–4.1)	1.0 (referent)	3.1 (2.6–3.7)	1.0 (referent)
Former asthma only	5.0 (2.2–11.0)*	1.5 (0.6–3.5)	3.0 (1.5–6.1)*	1.0 (0.5–2.0)
Current asthma only	4.0 (2.0–8.0)*	1.2 (0.6–2.5)	5.7 (3.5–9.3)	1.9 (1.1–3.1)
COPD only	4.7 (2.3–9.1)*	1.4 (0.7–2.8)	6.3 (4.2–9.5)	2.1 (1.3–3.3)
Asthma-COPD overlap syndrome	8.8 (4.6–16.5)*	2.6 (1.3–5.2)	7.8 (5.0–11.9)	2.5 (1.6–4.1)

	Men		Women	
	% (95% CI)	PR (95% CI)	% (95% CI)	PR (95% CI)
Chronic obstructive airway disease				
1 non-respiratory chronic disease				
Neither asthma nor COPD	38.5 (36.4–40.5)	1.0 (referent)	47.6 (45.7–49.5)	1.0 (referent)
Former asthma only	48.9 (39.0–58.8)	1.3 (1.03–1.6)	63.1 (52.2–72.8)	1.3 (1.1–1.6)
Current asthma only	40.9 (32.8–49.5)	1.1 (0.9–1.3)	60.6 (54.5–66.5)	1.3 (1.1–1.4)
COPD only	55.7 (45.5–65.5)	1.4 (1.2–1.7)	78.9 (71.6–84.7)	1.7 (1.5–1.8)
Asthma-COPD overlap syndrome	74.0 (59.9–84.4)	1.9 (1.6–2.3)	76.3 (66.3–84.0)	1.6 (1.4–1.8)

BMI - body mass index; CI - confidence interval; COPD - chronic obstructive pulmonary disease

^a Adjusted prevalence and prevalence ratio (PR) and 95% CI for the likelihood of each condition associated with a given chronic obstructive airway disease category were obtained from separate multivariable logistic regression models that included age, race, education, BMI category, and smoking status as covariates. The referent for all PRs was the group of respondents with no obstructive airway impairment.

^b Frequent mental distress: a response of 14 days to the question, “Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good.”

^c Frequent physical distress: a response of 14 days to the question, “Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good.”

* Estimates not reliable. Relative standard error 0.3.