

The Prevalence, Characteristics, and Impact of Chronic Obstructive Pulmonary Disease in North Carolina

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BACKGROUND Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality. We describe the prevalence, characteristics, and impact of COPD in North Carolina.

METHODS We determined the prevalence of self-reported COPD and characteristics of affected persons using data from the 2009 North Carolina Behavioral Risk Factor Surveillance System (BRFSS) survey. We also determined the number of persons with COPD in nursing homes and adult care or family care homes. We drew conclusions about the impact of COPD from data regarding mortality, hospitalizations, emergency department visits, prednisone use, and health impairment.

RESULTS The age-adjusted prevalence of COPD among BRFSS survey respondents was 5.6%, and about 10,000 adults in nursing homes, adult care homes, or family care homes had COPD; thus we estimate that nearly 408,000 adults in North Carolina had COPD in 2009. Rates of self-reported COPD were highest among elderly individuals, smokers, individuals with less education, and those with lower incomes. Mental and physical impairment were significantly worse in those with COPD, two-thirds of whom reported that dyspnea affected their quality of life. Prednisone use was reported by 27.4% of persons with COPD, 11.4% of respondents with COPD had been hospitalized for this condition within the preceding year, and COPD admissions accounted for 1.44% of all hospital charges. Asthma, heart disease, stroke, and diabetes mellitus were significantly more common in persons with COPD. In terms of mortality, COPD was the fourth leading cause of death ($n = 4,324$); 77% of COPD deaths were among persons who had no education beyond high school, and 53% of those who died were women. COPD was reported in 17.1% of deaths from all causes, 21% of deaths from asthma, 10.1% of deaths from lung cancer, and 6.7% of deaths from heart disease.

LIMITATIONS These data are based on population and health care database estimates and are approximations.

CONCLUSION COPD has substantial effects on the health of North Carolinians.

Chronic obstructive pulmonary disease (COPD) constitutes more than 95% of all cases of chronic lower respiratory disease, which in 2008 surpassed stroke to become the third leading cause of death in the United States [1]. Since the 1990s, substantial national and state-based efforts have targeted asthma, likely contributing to the stabilization or decrease in the numbers of emergency department (ED) visits, hospitalizations, and deaths due to that disease [2]. Similarly, greater efforts with regard to the prevention, recognition, and management of COPD are needed to decrease its growing impact.

In 2007 and 2009, COPD-related questions were incorporated into North Carolina's principal annual health survey, the Behavioral Risk Factor Surveillance System (BRFSS) survey, to help define the prevalence and impact of COPD in the state [3]. Although the BRFSS survey gives insight into the prevalence, patient characteristics, and impact of COPD from the patient's perspective, it lacks some very important measures—such as data regarding mortality, ED visits, and hospitalizations—and it does not survey institutionalized persons. The purpose of this paper is to describe the burden of COPD in North Carolina using various health-related databases.

Methods

We chose to estimate the burden of COPD in North

Carolina for the year 2009 because data for that year were available in the desired databases. This paper presents information from a variety of sources: data that we collected ourselves, our analysis of the 2009 BRFSS survey results, North Carolina vital statistics mortality data, and data from other published reports [4-8]. We estimated the total number of persons in North Carolina with COPD in 2009 by combining the age-adjusted prevalence of self-reported COPD among noninstitutionalized adults (using BRFSS data), the number of residents in nursing homes with a diagnosis of COPD [3], and the estimated number of adults with COPD living in adult care or family care homes [4].

The BRFSS survey is an annual telephone health survey that is conducted in each state and is coordinated by the Centers for Disease Control and Prevention (CDC). The survey includes more than 90 core questions that address chronic illnesses and health behaviors of noninstitutionalized adults [9]. In 2007 and 2009, the North Carolina

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COPD Task Force collaborated with the North Carolina State Center for Health Statistics to add a COPD prevalence question to the BRFSS survey; a module of 5 questions assessing the impact of COPD was also added. Two COPD-related questions from the 2007 North Carolina BRFSS survey were modified for the 2009 survey to better address hospitalizations and acute exacerbations of COPD. Table 1 shows these and other BRFSS questions that produced the information used in our analysis.

Using a script, trained interviewers collected BRFSS data using an independent, random-digit-dialed probability sample of noninstitutionalized persons in households contacted through landline telephones [9]. A separate interviewer validated selected questions in a random selection of 5% of completed surveys. In 2009, the North Carolina BRFSS oversampled 23 of the state's largest counties as well as Native American census tracts in 6 counties because of small sample size in these categories; the remainder of the sample was then apportioned to 3 regions of the state—Western, Piedmont, and Eastern. Response and cooperation rates for eligible households in North Carolina in 2009 were 62.50% and 80.48%, respectively [10]. The BRFSS has been approved as exempt research by the CDC's institutional review board.

Residents of nursing homes, adult care homes, and family care homes are excluded from the BRFSS survey, but most persons in these facilities are elderly, so we included these individuals in our estimate of the number of COPD patients. The number of COPD patients in North Carolina nursing homes in 2009 was obtained (using a diagnosis of COPD or emphysema) through the Centers for Medicare & Medicaid Services Minimum Data Sets (MDS) 2.0 Active Resident Information Report for the fourth quarter of 2009 [4].

Because there is not a similar database that can be used to estimate the number of COPD patients in adult care or family care homes in North Carolina, we used a 2009 report from the North Carolina Institute of Medicine (NCIOM) that estimated the number of these residents [5]. The vast majority of the estimated 28,500 such residents were older than 65 years. Thus we used a COPD prevalence of 10%, based on the BRFSS COPD data for that age group.

Finally, to estimate the overall number of persons with COPD in the state, we combined the number of persons from these 3 sources, using the BRFSS age-adjusted prevalence rate to calculate the number of persons with COPD among the estimated 7,102,917 adults living in North Carolina in 2009 [11]. Persons not included in our estimate of COPD prevalence were those living in correctional facilities, college dormitories, or military barracks. There were about 40,000 inmates in correctional facilities in North Carolina in 2009; more than 60% were aged 25–44 years and 90% were men [12], so they were unlikely to contribute significantly to the overall number of persons with COPD.

The number of acute care visits related to COPD in 2009 was calculated using hospitalization data from the North

Carolina Department of Health and Human Services [6], ED data collected by the North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) [7], and BRFSS data relating to survey questions about overnight hospital stays and prednisone use (Table 1). We considered the use of prednisone to be a surrogate marker for acute exacerbations of COPD. Prednisone is considered to be a standard of care for exacerbations requiring acute care visits, but it is also used long term by a small percentage of COPD patients.

To determine COPD-related deaths in relationship to

TABLE 1.
Questions on the 2009 Behavioral Risk Factor Surveillance System Survey That Produced Information Used in Our Analysis

Questions in the chronic obstructive pulmonary disease module

- Have you ever been told by a doctor or health professional that you have chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis?
- Have you ever been given a breathing test, which measures how much air you can breathe out through a tube, to diagnose your COPD, chronic bronchitis, or emphysema?
- Would you say that shortness of breath affects the quality of your life?
- Other than a routine visit, have you had to see a doctor in the past 12 months for symptoms related to shortness of breath, bronchitis, or other COPD, or emphysema flare?
- During the past 12 months, have you stayed in a hospital overnight because of shortness of breath, COPD, or emphysema flare?
- Prednisone is a medicine that helps people with breathing problems breathe easier. It is sometimes called Deltasone or Medrol. During the past 12 months, has a doctor ever prescribed prednisone for your breathing problems?

Core questions

- Would you say that in general your health is excellent, very good, good, or poor?
- 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?
- 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?
- Have you ever been told by a doctor that you have diabetes?
- Has a doctor, nurse, or other health professional ever told you that you had a heart attack, also called a myocardial infarction?
- Has a doctor, nurse, or other health professional ever told you that you had angina or coronary heart disease?
- Has a doctor, nurse, or other health professional ever told you that you had a stroke?
- Have you ever been told by a doctor, nurse, or other health professional that you had asthma?
- Do you still have asthma?
- Have you smoked at least 100 cigarettes in your entire life?
- Do you now smoke cigarettes every day, some days, or not at all?
- How long has it been since you last smoked cigarettes regularly?
- Have you ever been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?
- Have you ever been told by a doctor, nurse, or other health professional that you have some form of kidney disease?

Source: North Carolina 2009 Questionnaire Version 2, Behavioral Risk Factor Surveillance System, September–December 2009. North Carolina State Center for Health Statistics Web site. http://www.schs.state.nc.us/schs/brfss/pdf/BRFSSQ09_ver2.pdf. Accessed August 23, 2013.

selected mortalities, as well as primary versus secondary cause of death, we used the 2009 raw mortality data from the Vital Statistics Section of the North Carolina State Center for Health Statistics. COPD-related mortality was also determined from a report published by the Vital Statistics Section of the North Carolina State Center for Health Statistics [8]. We looked at the frequency of COPD as a primary cause of death (International Classification of Diseases, 10th Revision [ICD-10] mortality codes J420-J440) or as a secondary diagnosis when the primary cause of death was one of the following: all deaths; deaths due to heart disease (ICD-10 codes I20-I25); deaths due to cancers of the trachea, bronchus, or lung (ICD-10 codes C32-C34); or deaths due to asthma (ICD-10 codes J450-J460). Health impairment was determined based on responses to the BRFSS questions that asked how many days during the past 30 days a person's mental or physical health was not good and the question that asked about dyspnea affecting quality of life (in those with self-reported COPD only).

Descriptive statistics were used to report data for ED visits; hospitalizations; impact of dyspnea on quality of life; mortality; and number of persons in nursing homes, adult care homes, or family care homes. All BRFSS analyses were weighted using SAS-callable SUDAAN software, version 10 (Research Triangle Institute) to account for the complex sampling design. The prevalence of self-reported COPD among 2009 BRFSS survey respondents was age-adjusted to the 2000 US Census. To assess the association between COPD prevalence and respondent characteristics, we determined the prevalence ratio and 95% confidence interval (CI) for each association using a separate multivariate logistic regression model that included respiratory category, race/ethnicity, education level, income level, and smoking status. The relationship between health-related impairment and presence of COPD was assessed using chi-square analysis of the proportion of those reporting 14 or more days of poor physical health and the proportion of those reporting 14 or more days of poor mental health in the preceding month. The relative risk of prednisone use in the past 12 months among respondents with self-reported COPD was determined to assess the impact of other comorbidities on acute exacerbations of COPD. Among those with COPD, we calculated the risk of prednisone use for those with and without other chronic or comorbid diseases, such as cardiovascular disease (CVD). In this case, the numerator includes those with CVD who were prescribed prednisone versus those without CVD who were prescribed prednisone. *P*-values less than .05 were considered statistically significant.

Results

Of the 13,277 adults in North Carolina who were interviewed during the 2009 BRFSS survey, 12,165 respondents provided complete data. Based on the responses of those 12,165 adults, the age-adjusted prevalence of self-reported

COPD in the adult population of North Carolina was determined to be 5.6%. A large proportion (82.2%) of these persons with COPD indicated that they had been given a breathing test to diagnose their disease. Table 2 shows the geographic distribution of age-adjusted COPD prevalence by Area Health Education Center (AHEC) region.

Table 3 shows the characteristics of those BRFSS respondents with self-reported COPD—that is, those who answered yes to the question “Have you ever been told by a doctor or health professional that you have chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis?” The prevalence of COPD was not significantly different between women and men (6.1% versus 5.1%) or between whites and African Americans (5.5% versus 5.4%). There were significant differences ($P<.05$) in COPD prevalence between persons with more than a high school education compared with those who reported less than a high school education (4.2% versus 10.0%), between persons with annual household incomes less than \$15,000 compared with those whose incomes were greater than or equal to \$15,000 (11.7% versus 6.4%), between current smokers and never smokers (12.3% versus 2.6%), and between former smokers and never smokers (6.2% versus 2.6%).

Additional information about smoking was obtained but is not reported in Table 3. A positive history of tobacco use (an affirmative answer to the question “Have you smoked at least 100 cigarettes in your entire life?”) was reported by 71.4% of respondents with COPD, compared with 47.5% of those who did not have COPD. Also, current cigarette use was 20.3% among all respondents compared with 36.1% among those with COPD. Data from the Centers for Medicare & Medicaid Services [4] show that nearly 10% of nursing home residents were current smokers in 2009.

Tables 4 and 5 show 2 different aspects of the relationship between COPD and comorbidities. Table 4 shows the

TABLE 2.
Mean Age-Adjusted Prevalence of Self-Reported Chronic Obstructive Pulmonary Disease in North Carolina, by Area Health Education Center Region, 2009

AHEC region	Mean age-adjusted prevalence of self-reported COPD (%)
Southern Regional	6.8
Mountain	6.8
Eastern	6.4
Northwest	6.3
South East	6.1
Greensboro	5.5
Charlotte	5.3
Area L	4.3
Wake	4.0

Note. AHEC, Area Health Education Center; COPD, chronic obstructive pulmonary disease.

Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.

TABLE 3.
Age-Adjusted Prevalence and Multivariable-Adjusted
Prevalence Ratio of Self-Reported Chronic Obstructive
Pulmonary Disease Among Adults in North Carolina in 2009

Characteristic	COPD prevalence (95% CI)	Prevalence ratio ^a (95% CI)
Age in years		
18-44	2.9% (2.1-3.7)	1.0
45-54	6.7% (1.6-8.8)	2.2 (1.5-3.4) ^b
55-64	7.5% (6.2-8.8)	2.4 (1.7-3.6) ^b
65-74	9.8% (8.3-11.4)	3.1 (2.1-3.5) ^b
≥75	9.8% (7.9-11.7)	3.2 (2.2-3.7) ^b
Sex		
Male	5.1% (3.9-6.3)	1.0
Female	6.1% (5.3-6.9)	1.25 (0.91-1.71)
Race		
White	5.5% (4.7-6.1)	1.0
African American	5.4% (3.3-7.7)	0.93 (0.56-1.4)
Other	5.7% (3.5-8.5)	1.04 (0.47-1.46)
Educational level		
Some college or technical school	4.2% (3.5-4.9)	1.0
High school graduate	7.4% (5.6-9.2)	1.36 (0.57-1.89)
Less than high school graduate	10.0% (7.6-12.5)	1.52 (1.02-1.95) ^b
Annual household income		
≥\$15,000	6.4% (5.3-7.5)	1.0
<\$15,000	11.7% (9.3-14.1)	1.76 (1.2-2.43) ^b
Smoking status		
Never smoker	2.6% (1.9-3.3)	1.0
Former smoker	6.2% (4.4-8.0)	2.38 (1.66-3.41) ^b
Current smoker	12.3% (10.0-16.1)	4.99 (3.31-7.51) ^b

Note. CI, confidence interval; COPD, chronic obstructive pulmonary disease. Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.

^aMultivariate-adjusted prevalence ratios (PRs) were obtained from a multivariate logistic regression model that included age, sex, race/ethnicity, education, household income, and smoking status as covariates. The prevalence is only age-adjusted and was obtained with the direct method, using the 2000 US census population in North Carolina for age-standardization. The overall age-adjusted prevalence of COPD was 5.6%.

^bP<.05 compared with referent (PR = 1.0).

likelihood of concomitant chronic health conditions, and Table 5 shows the likelihood that a person with COPD and a particular comorbidity had received prednisone during the preceding year. Overall, CVD was more common in persons with COPD than in those who did not have COPD. Also, having either angina or coronary heart disease was associated with a higher likelihood of having received prednisone during the preceding year; however, no such association was found for myocardial infarction. Diabetes was more common in persons who had COPD than in those without COPD; however, prednisone was used less frequently by persons with COPD and diabetes.

Among the 36,626 residents in North Carolina nursing homes during the fourth quarter of 2009 [4], 19.7% had a diagnosis of COPD (n = 7,215); this rate was stable throughout 2009. According to a report from the NCIOM

[5], 28,500 persons lived in adult care or family care homes in 2009, and the majority of these individuals were 65 years of age or older. Therefore we estimated that there were 2,850 persons with COPD in these settings. Using an estimate that the adult population of North Carolina was 7,102,917 in 2009, and multiplying that figure by the prevalence of COPD found using data from the BRFSS survey, we estimated that there were 397,763 noninstitutionalized adults with COPD in 2009. There were an additional 7,215 persons with COPD residing in nursing homes, and we estimated that another 2,850 persons with COPD lived in adult care or family care homes. Together, these figures gave us a total estimate of nearly 408,000 adults in North Carolina who have been diagnosed with COPD.

The proportion of adults reporting that they had experienced 14 or more days of poor physical health during the preceding month was greater among persons who had COPD than among those who did not (45% versus 17%; *P*<.05). Similarly, the proportion of respondents who reported that they had experienced 14 or more days of poor mental health during the preceding month was greater among those with COPD than among those without (29% versus 14%; *P*<.05). Health impairment in persons with COPD was also evidenced by the fact that 66.3% (95% CI, 59.9-73.7) of persons with self-reported COPD indicated that dyspnea affected their quality of life.

Of 964,898 ED visits in 2009, COPD was the primary diagnosis (excluding patients with concomitant asthma) in 46,889 of these visits [7]. In addition, COPD was a secondary diagnosis for approximately 130,000 ED visits. COPD was listed as a disease for 4.1% of all ED visits. Charges were not reported for these ED visits. For the 20,586 hospitalizations in 2009 in which COPD was the primary diagnosis, the average length of stay was 4.4 days; total hospital charges were \$337,503,859 (for an average charge of \$16,397 per case), and this sum accounted for 1.44% of all hospital charges [6]. Of the 2009 BRFSS survey respondents with COPD, 11.4% reported that in the preceding 12 months they had stayed in the hospital for at least 1 night because of shortness of breath or an exacerbation of COPD. The BRFSS survey also included 2 other measures of acute exacerbations of COPD: use of prednisone in the preceding 12 months, which was reported by 27.4% of respondents with COPD; and a visit to a health care provider for either shortness of breath or an exacerbation of COPD in the preceding 12 months, which was reported by 43.2% of respondents with COPD.

In 2009 chronic lower respiratory diseases were the fourth leading cause of death in North Carolina, with 4,324 deaths; in comparison, there were 17,476 deaths from cancer, 17,133 deaths from CVD, and 4,391 deaths from stroke [8]. More than 95% of the deaths from chronic lower respiratory disease were caused by COPD. Among individuals for whom COPD was the primary cause of death, 77% had a high school education or less, 53% were women, 88% were white, 10.8% were African American, and 87% were

65 years of age or older. Of the 88 persons in North Carolina for whom asthma was the primary cause of death in 2009, 21% were reported to also have COPD. COPD was listed as a comorbidity in 727 (6.7%) of the 10,922 cases in which heart disease was the primary cause of death and in 548 (10.1%) of the 5,433 deaths due to cancers of the trachea, bronchus, or lung. COPD was a primary or secondary cause of death in 17.1% (13,008 of 76,250) of all deaths.

Discussion

We have provided a comprehensive estimate of the prevalence and burden of COPD in North Carolina in 2009. Until recently, there was a paucity of state-based data on COPD, and prior prevalence estimates were based on national cross-sectional studies [13, 14]. According to the 2009 BRFSS survey, about 1 in 18 adults in North Carolina reported having COPD; about one-third of them also reported that they continued to smoke, despite having a markedly impaired quality of life. Nearly 50% of adults in North Carolina reported a his-

tory of smoking, which puts them at risk for COPD. Our findings are consistent with those of national population-based studies in that the prevalence of COPD was highest among elderly individuals, smokers, persons with low socioeconomic status, and residents of nursing homes. The burden of the disease was evidenced by frequent exacerbations leading to numerous acute care visits, substantial impairment of health status, and rising mortality. In addition to being the fourth leading cause of death in North Carolina in 2009, COPD was present in 1 out of every 6 adults who died in the state. Comorbid chronic health conditions, particularly asthma and heart disease, were common in those with COPD, which certainly contributes to the burden of the disease.

Although North Carolina has a long and substantial tobacco history, the prevalence of COPD in the state in 2009 (5.6%) is similar to the prevalence of COPD found in national cross-sectional data [13, 14]. Geographically, the prevalence of COPD was fairly uniform across the state, except that rates were lower in the Wake AHEC region and (surprisingly) in the Area L AHEC region (Table 2). This pattern was also present in the 2007 BRFSS survey data for North Carolina. The 2011 BRFSS survey revealed a higher prevalence of COPD in North Carolina (6.5%) [15] than that found on the 2009 BRFSS survey. In 2011 the BRFSS survey method used in most states was modified to include cell phone numbers, and additional statistical weighting adjustments were made based on sex and socioeconomic status, leading to a higher overall prevalence of COPD and to a wider difference between men and women [15] compared with the prevalence and sex difference found using 2009 data. Of note, our analysis is the first estimate of COPD frequency to include persons in nursing homes, adult care homes, and family care homes.

Limited data have been published regarding COPD in residents of nursing homes, adult care homes, or family care homes. In 2009 nearly 20% of nursing home residents in North Carolina had a diagnosis of COPD, which is similar to the 21.5% prevalence reported in a recent study of skilled nursing homes nationwide [16]. According to that study, nearly 50% of cognitively impaired nursing home residents with COPD were being treated with short-acting beta-agonists alone, which likely indicates undertreatment. The use of long-acting bronchodilators and anti-inflammatory drugs has been shown to decrease the risk of COPD exacerbations [17]. The high prevalence of COPD and the possible underutilization of drug therapies for COPD in nursing homes warrants additional research in this population.

The BRFSS survey is a unique COPD surveillance tool for several reasons: a large number of adults are surveyed every year (more than 12,000 in North Carolina); the survey includes a wide range of demographic and health-related questions; information about health status is captured from the patient's perspective; and the survey is state-based. Responses to the 2009 BRFSS survey indicate that the typical person with COPD in North Carolina is 65 years of age or older, is a current or former smoker, has a low annual house-

TABLE 4.
Age-Adjusted Prevalence and Multivariate-Adjusted Prevalence Ratio of Self-Reported Chronic Obstructive Pulmonary Disease Among Adults with Comorbidities in North Carolina in 2009

Comorbid health condition	COPD prevalence (95% CI)	Prevalence ratio ^a (95% CI)
Any cardiovascular disease ^b		
Yes	18.1% (14.2-22.0)	2.15 (1.51-3.07) ^c
No	5.3% (4.1-6.5)	1.0
Ever diabetes mellitus		
Yes	23.4% (17.5-28.2)	1.68 (1.41-1.90) ^c
No	8.4% (8.0-8.4)	1.0
Arthritis ^d		
Yes	59.8% (58.4-61.1)	1.51 (1.39-1.74) ^c
No	28.9% (28.0-29.9)	1.0
Ever stroke		
Yes	7.4% (7.0-7.7)	1.79 (1.38-2.03) ^c
No	2.5% (2.1-2.9)	1.0
Current asthma		
Yes	41.6% (37.8-45.3)	4.12 (3.67-4.64) ^c
No	9.4% (8.7-10.0)	1.0
Obesity (BMI ≥ 30 kg/m ²)		
Yes	6.7% (5.6-6.2)	1.1 (0.7-1.3)
No	5.9% (5.2-6.5)	1.0

Note. BMI, body mass index; CI, confidence interval; COPD, chronic obstructive pulmonary disease.

Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.

^aMultivariate-adjusted prevalence ratio (PR) for each chronic disease was obtained from a multivariate logistic regression model that included age, race/ethnicity, education, and smoking status as covariates. The prevalence is only age-adjusted and was obtained with the direct method, using the 2000 US census population in North Carolina for age-standardization. The overall age-adjusted prevalence of COPD was 5.6%.

^bBased on responses to the questions in Table 1 about heart attack, angina, or coronary heart disease.

^c $P < .05$ compared with referent (PR = 1.0)

^dBased on responses to the question "Have you ever been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

TABLE 5.
Relative Risk of Prednisone Use by Adults in North Carolina with Self-Reported Chronic Obstructive Pulmonary Disease Who Have Comorbidities, 2009

Comorbid health condition	Relative risk of prednisone use (95% CI)
Arthritis	1.15 (0.89–1.48)
Diabetes mellitus	0.73 (0.47–1.11)
Myocardial infarction	1.0 (0.6–1.68)
Angina/coronary heart disease	1.86 (1.02–3.38) ^a
Stroke	1.28 (0.67–2.43)
Kidney disease	1.77 (0.77–4.07)
Current asthma	1.48 (1.08–2.03) ^a
3 or more of these comorbidities	1.44 (0.95–2.2)

Note. CI, confidence interval.

Source: Data are from the 2009 Behavioral Risk Factor Surveillance System survey.

^a $P < .05$.

hold income, has a high school education or less, and is likely to have comorbidities. Low socioeconomic status is known to be a risk factor for cigarette use; low income is therefore associated with a greater probability of developing tobacco-related diseases, including COPD [18]. Women may be more susceptible than men to the effects of tobacco smoke on lung function [19], which may partly explain why women are increasingly being affected by COPD. Notably, nearly 3% of persons in North Carolina aged 18–44 years who responded to the 2009 BRFSS survey reported that they had COPD; these individuals were likely responding to the chronic bronchitis component of the question used to determine the COPD prevalence (see Table 1). Although the prevalence of COPD was highest in elderly persons, it was substantial (6.7% or greater) in those aged 45–64 years, indicating a need for clinicians to consider the diagnosis in middle-aged persons.

The BRFSS survey also showed that comorbidities were more common in persons who had COPD than in those who did not. A different analysis of comorbidities in COPD using the 2009 North Carolina BRFSS data has also been reported [20]. Substantial research has shown a strong relationship between COPD and other diseases, particularly heart disease, lung cancer, and asthma [21, 22]. COPD is now considered to be a systemic disease related to the effects of impaired lung function and systemic inflammation. Thus, comorbidities such as heart disease, diabetes, cancer, and asthma are common [21, 22]. Obesity is no more frequent in persons with COPD than in those who do not have COPD, but obesity still plays an important role in the illness, because obese patients often have airflow restriction, obstructive sleep apnea, greater dyspnea associated with activities of daily living, and increased risk for CVD [23]. The higher incidence of diabetes in persons with COPD may be related to obesity and other factors [21, 22]. The higher likelihood of prednisone use in persons with concomitant asthma, angina, or coronary artery disease also indicates that COPD patients with

these comorbidities likely experience more severe and/or frequent acute exacerbations of COPD.

“Overlap syndrome” is a term used to describe persons who have both asthma and COPD [24–26]. The 2009 BRFSS data for North Carolina show that about 40% of respondents with COPD had overlap syndrome. The number of ED visits recorded by NC DETECT is an underestimate of the number of ED visits by COPD patients, because those with overlap syndrome were not included. There are multiple reasons why persons “develop” overlap syndrome: some smokers with asthma develop COPD; adults with obstructive lung disease who are frequent users of health care are likely to be seen by multiple providers and to receive both diagnoses; and persons with long-term severe asthma can develop clinical and other characteristics of COPD [26]. Notably, 1 out of 5 asthma deaths in North Carolina in 2009 had COPD listed as a contributory cause of death. Overlap syndrome is now recognized as one of the most important phenotypes of obstructive lung disease [24].

The BRFSS survey is unique because it provides the patient’s perspective on health impairment, which is not available through most other health care databases. Health impairment from COPD is the result of numerous factors, including dyspnea, deconditioning from inactivity, and the presence of comorbidities [27]. Physical impairment associated with COPD was indicated by the number of days on which respondents’ physical health had not been good, and by the frequency with which dyspnea affected respondents’ quality of life. Although the North Carolina BRFSS questionnaire for 2009 did not include a question about depression, respondents with COPD reported a greater number of days on which their mental health had not been good. Anxiety and depression are common in COPD and cause significant morbidity [23].

Health care utilization related to COPD was substantial, with high numbers of acute exacerbations of COPD, hospitalizations, ED visits, and nursing home stays. The BRFSS survey results showed that nearly half of respondents with COPD reported having visited a health care provider for worsening symptoms in the preceding 12 months, and 1 in 9 respondents with COPD reported at least 1 overnight stay in the hospital for shortness of breath. Studies have found that COPD is associated with an increase in hospital readmissions within 30 days of discharge [28, 29], which is a particularly important consideration today due to new Medicare quality initiatives. Up to 50% of health care costs for COPD are for care of acute exacerbations [30]. Interventions that can decrease the frequency of such exacerbations include smoking cessation, pulmonary rehabilitation, and optimization of drug therapies [17].

Unlike mortality rates for other leading causes of death in the United States—such as heart disease and stroke—mortality from COPD continues to rise [1]. In contrast, mortality from asthma appears to be declining nationally [2]. Chronic lower respiratory illness surpassed stroke to become the third

leading cause of death in the United States in 2008 [1], and it became the third leading cause of death in North Carolina in 2011 [31]. This may be related to better strategies for the prevention and treatment of stroke, as well as to increasing mortality from COPD, particularly among women. COPD was also present in many deaths, either as the primary cause of death, or as a contributing factor in deaths due to concomitant heart disease, asthma, or cancer of the respiratory tract.

Studies have shown that having both COPD and CVD is associated with a higher risk of mortality [29]. The 2009 North Carolina BRFSS survey responses showed that COPD patients with asthma, angina, or coronary artery disease were more likely to have acute exacerbations of COPD as measured by prednisone use; targeting these important patient phenotypes may help to decrease mortality.

Similarly, it has been documented that COPD, especially emphysema, is associated with an increased risk of lung cancer [32]. In addition, 90% of COPD deaths in North Carolina occurred among whites, while only 9% of deaths occurred among African Americans. This finding is noteworthy because the prevalence of tobacco use and COPD is similar in those 2 races in North Carolina, even considering that only about 20% of the adult population of the state is African American. North Carolina mortality data indicates that African Americans are more likely to die from other tobacco-related diseases, such as heart disease and cancers [8]; this warrants additional research.

One weakness of our analysis is the lack of spirometry testing to confirm the diagnosis of COPD in BRFSS survey respondents. In addition, we did not identify persons with undiagnosed COPD. (We recently completed a different study using BRFSS survey results to try to identify persons who are at risk for COPD based on symptoms and tobacco exposure.) We also did not attempt to report specific health care data using national ambulatory care surveillance tools or Medicare records for North Carolina. Because the basic statistics available for residents of adult care or family care homes are not robust, our estimate of COPD prevalence needs to be validated. We could have included more specific data for hospitalizations and ED visits, but the general data was adequate to describe their contribution to the burden of COPD in North Carolina.

Conclusion

The health care and economic burden of COPD in North Carolina is apparent in health care and population-based surveillance data. By all measures, COPD is one of the most important lung diseases in our state. COPD is preventable in about three-fourths of patients because of its relation to tobacco use. With improved interventions—including treatments to facilitate tobacco cessation, optimization of drug therapies, pulmonary rehabilitation, and screening of high-risk populations—there is substantial opportunity to decrease both the prevalence and impact of COPD. To do so, North Carolina needs to take a comprehensive approach

involving public health practitioners and health care providers, similar to the approach taken for asthma. **NCMJ**

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