Characteristics of Adults Dying With COPD*

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Study objective: To describe factors associated with COPD deaths in the United States.

Design: Cross-sectional survey.


Methods: We compared the characteristics of adults ≥35 years of age who died with COPD (bronchitis, emphysema, chronic airway obstruction) with those dying without COPD listed on their death certificates.

Results: Of the estimated 225,700 adults who died with COPD in 1993, 16.7% had never smoked. People dying with COPD were more likely than those dying without COPD to be current smokers (odds ratio [OR], 6.5; 95% confidence interval [CI], 4.3 to 9.9) or former smokers (OR, 3.7; 95% CI, 2.5 to 5.3), have a history of asthma (OR, 5.0; 95% CI, 3.2 to 7.8), be underweight (OR, 4.5; 95% CI, 2.8 to 7.2), and be of the white race (OR, 3.1; 95% CI, 2.4 to 4.0), after controlling for age group and sex.

Conclusions: A significant proportion of COPD-related deaths occurs in never-smokers. Factors such as a history of asthma and being underweight are associated with COPD mortality and may provide additional opportunities for intervention. (CHEST 2002; 122:2003–2008)

Key words: asthma; mortality; obstructive lung disease; smoking

Abbreviations: CI = confidence interval; ICD-9 = International Classification of Diseases, Ninth Revision; OR = odds ratio

COPD is a syndrome defined by breathing-related symptoms and signs: chronic cough, expectoration, varying degrees of exertional dyspnea, and a significant and progressive reduction in expiratory airflow.1 Morbidity and mortality from COPD in the United States in 1996 cost an estimated $14.5 billion in direct medical-care expenditures; of this, $8.3 billion was for inpatient hospital care, $5.8 billion was for outpatient and emergency department services, and $0.4 billion was for nursing home and home health care.2

COPD ranks as the fourth-leading cause of death in the United States. The death rate for COPD has increased in recent years despite decreases in the death rates for the three other leading causes of death in the United States: diseases of the heart, malignant neoplasms, and cerebrovascular diseases.3,4 The increase in the death rate for COPD also contrasts with the decrease in the prevalence of cigarette smoking, the most important risk factor for COPD.1,4

In addition to smoking, other potential risk factors for COPD have been identified, such as asthma comorbidity,5 low socioeconomic living conditions,6 and cachexia, as measured by body mass index.7 However, there are gaps in our knowledge. For example, smoking is recognized as the most common risk factor for acquiring COPD, yet most people who smoke do not acquire COPD and some people who never smoke acquire COPD,8 suggesting that genetic9,10 and environmental factors also play an important role in the pathogenesis of COPD.

Clearly described factors associated with dying with COPD could be useful in identifying possible interventions to prevent such deaths. We assessed factors related to dying with COPD by analyzing a nationally representative sample of decedents, using the 1993 National Mortality Followback Survey. The 1993 National Mortality Followback Survey col-

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lected information that supplements data routinely collected on death certificates. The supplemental information included history of asthma, smoking, body weight, education, and income. We report the characteristics of adults dying with COPD in the United States in 1993.

**Materials and Methods**

**Sample**

The 1993 National Mortality Followback Survey, which became available in 1998, was initiated by the National Center for Health Statistics to provide information related to the mortality experience of the United States beyond that obtained through the vital registration of deaths. The National Mortality Followback Survey selected deaths from the 1993 Current Mortality Sample, a 10% systematic random sample of death certificates received by the vital statistics offices. Death certificates provided decedent demographic and socioeconomic information and the underlying and contributing causes of death. A total of 22,957 decedents were included in the survey, with oversampling of certain age groups and causes of death (e.g., homicide, suicide, accidental injury). Proxy respondents provided supplemental information on health conditions and potential risk behaviors, typically within 6 to 12 months of the subject’s death. Data from proxies were available for 19,003 decedents (83%). We included all decedents ≥35 years of age in our analysis (n = 12,803). Data on the decedents were weighted to reflect all 2.1-million deaths in US decedents in this age range for 1993.

**Definitions**

The cause or causes of death obtained from death records were coded according to the International Classification of Diseases, Ninth Revision (ICD-9). A decedent was classified as dying with COPD if any of the 20 diagnostic fields on individual death records listed any of the following ICD-9 codes: 490 (bronchitis, not specified as acute or chronic), 491 (chronic bronchitis), 492 (emphysema), and 496 (chronic airway obstruction). Asthma (ICD-9 code 493) was not included in our definition of COPD to explore the relation between a history of asthma and dying with COPD. We did not exclude subjects with asthma or bronchiectasis reported on their death certificate from our cases (these were listed as comorbid conditions on < 0.2% of the cases we studied).

The decedent’s smoking status at the time of death was obtained from proxy respondents. Smokers were defined as having smoked at least 100 cigarettes during their lifetimes. Smokers who were reported to have quit and never started again were classified as former smokers. Approximately 11.1% of all former smokers had reportedly quit smoking within the last year of life (14.7% of decedents with COPD and 10.5% of decedents without COPD). Cumulative cigarette smoking, expressed as cigarette pack-years, was calculated by dividing the number of cigarettes smoked daily by 20 and multiplying by the number of years the decedent smoked. Decedents were classified as ever having had asthma if the proxy respondent answered yes to the question, “Did the decedent have asthma at any time during his/her life?” Body weight was based on proxy responses to the question, “Was the decedent overweight, underweight, or just about right during most of his/her life?”

**Data Analysis**

Analyses, which were limited to decedents ≥35 years of age, used SAS statistical software (version 6.12; SAS Institute; Cary, NC); for weighted prevalence estimation and logistic regression, SUDAAN (Research Triangle Institute; Research Triangle Park, NC) was used. Backward stepwise logistic regression analyses examined multiple characteristics associated with dying with COPD and calculated odds ratios (ORs) and 95% confidence intervals (CIs). To assess differences by age group between people dying with COPD and those dying without COPD, we ran three separate models for each of the age groups of interest: 35 to 59 years, 60 to 74 years, and ≥75 years, controlling for sex and race. To examine risk factors by smoking status, we ran separate logistic regression models for each of the smoking status groups: current smokers, former smokers, and never-smokers, while controlling for age group, race, and sex.

**Results**

Most adult decedents ≥35 years of age in 1993 were white (87.7%), ≥75 years of age (54.9%), had a high school education or less (77.3%), lived in a metropolitan area (74.4%), had a family income of ≤$16,499 (56.4%), and had smoked (55.4%) [Table 1]. Approximately 10.6% of these death certificates listed COPD: 42.3% as the underlying cause of death, and 57.7% as a contributing cause of death. A lifetime history of asthma was reported for 6.5% of adult decedents. Among people dying with COPD, 18.5% were reported to have had asthma during their lifetime, yet <1% had asthma listed on the death certificate. Of all decedents with COPD, 16.7%, or an estimated 37,000 subjects, were never-smokers, including an estimated 12,900 subjects who had COPD listed as the underlying cause of death.

After controlling for age group, race, and sex, we found no association between dying with COPD, compared with dying from other conditions and family income, education, or metropolitan residence. Among all adults ≥35 years of age, dying with COPD was more likely to occur among current smokers (OR, 6.5; 95% CI, 4.3 to 9.9) and former smokers (OR, 3.7; 95% CI, 2.5 to 5.3) than among never-smokers (Table 2). Adults dying with COPD were more likely to be overweight (OR, 4.5; 95% CI, 2.8 to 7.2) or approximately the right weight (OR, 1.6; 95% CI, 1.1 to 2.2) than they were to be underweight, and were more likely than those dying without COPD to have a history of asthma (OR, 5.0; 95% CI, 3.2 to 7.8) and be white (OR, 3.1; 95% CI, 2.4 to 4.0). Smoking, a history of asthma, and race were significant in all age-specific models; however, the magnitude of the association differed among age categories.

Factors associated with dying with COPD varied by smoking status (Table 3). White race, underweight, and age ≥60 years were independently
Table 1—Characteristics of Sampled Adult Decedents ≥35 Years of Age by the Presence or Absence of COPD on the Death Certificate, United States, 1993*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>COPD</th>
<th>No COPD</th>
<th>Total Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>US decedents, No.</td>
<td>225,400</td>
<td>1,894,500</td>
<td>2,119,900</td>
</tr>
<tr>
<td>Survey sample size, No.</td>
<td>1,279</td>
<td>11,524</td>
<td>12,803</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>56.8 (2.5)</td>
<td>49.3 (0.4)</td>
<td>50.1 (0.2)</td>
</tr>
<tr>
<td>Female</td>
<td>43.2 (2.5)</td>
<td>50.7 (0.4)</td>
<td>49.9 (0.2)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>95.2 (0.5)</td>
<td>86.3 (0.3)</td>
<td>87.7 (0.2)</td>
</tr>
<tr>
<td>Other</td>
<td>4.8 (0.5)</td>
<td>13.2 (0.3)</td>
<td>12.3 (0.2)</td>
</tr>
<tr>
<td>Age group, yr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35–64</td>
<td>5.5 (1.4)</td>
<td>16.1 (0.7)</td>
<td>14.9 (0.7)</td>
</tr>
<tr>
<td>65–74</td>
<td>40.7 (2.7)</td>
<td>28.9 (1.0)</td>
<td>30.2 (0.9)</td>
</tr>
<tr>
<td>≥75</td>
<td>53.8 (2.7)</td>
<td>55.0 (1.1)</td>
<td>54.9 (1.0)</td>
</tr>
<tr>
<td>Family income, $</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;16,499</td>
<td>50.5 (3.3)</td>
<td>55.1 (1.4)</td>
<td>54.6 (1.3)</td>
</tr>
<tr>
<td>≥16,500</td>
<td>49.5 (3.3)</td>
<td>44.9 (1.4)</td>
<td>45.4 (1.3)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤12 yr</td>
<td>77.4 (2.6)</td>
<td>77.3 (1.0)</td>
<td>77.3 (1.0)</td>
</tr>
<tr>
<td>&gt;12 yr</td>
<td>22.6 (2.6)</td>
<td>22.7 (1.0)</td>
<td>22.7 (1.0)</td>
</tr>
<tr>
<td>Metropolitan residence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>71.5 (2.5)</td>
<td>74.7 (1.0)</td>
<td>74.4 (0.9)</td>
</tr>
<tr>
<td>No</td>
<td>28.5 (2.5)</td>
<td>25.3 (1.0)</td>
<td>25.6 (0.9)</td>
</tr>
<tr>
<td>Smoking status†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>36.1 (2.7)</td>
<td>18.7 (0.9)</td>
<td>20.6 (0.8)</td>
</tr>
<tr>
<td>Former</td>
<td>47.2 (2.8)</td>
<td>33.3 (1.1)</td>
<td>34.8 (1.0)</td>
</tr>
<tr>
<td>Never</td>
<td>16.7 (2.7)</td>
<td>48.0 (11.1)</td>
<td>44.6 (1.0)</td>
</tr>
<tr>
<td>Body weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>17.5 (2.1)</td>
<td>6.5 (0.5)</td>
<td>7.7 (1.0)</td>
</tr>
<tr>
<td>About right</td>
<td>64.3 (2.7)</td>
<td>65.1 (1.1)</td>
<td>65.0 (1.0)</td>
</tr>
<tr>
<td>Overweight</td>
<td>18.2 (2.2)</td>
<td>28.4 (1.0)</td>
<td>27.3 (1.0)</td>
</tr>
<tr>
<td>Ever had asthma</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18.5 (2.1)</td>
<td>5.0 (0.5)</td>
<td>6.5 (0.5)</td>
</tr>
<tr>
<td>No</td>
<td>81.5 (2.1)</td>
<td>95.0 (0.5)</td>
<td>93.5 (0.5)</td>
</tr>
<tr>
<td>Asthma listed on death certificate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.1 (0.1)</td>
<td>0.5 (0.1)</td>
<td>0.5 (0.1)</td>
</tr>
<tr>
<td>No</td>
<td>99.9 (0.1)</td>
<td>99.5 (0.1)</td>
<td>99.5 (0.1)</td>
</tr>
</tbody>
</table>

*Data are presented as number or weighted percentage (SE) unless otherwise indicated. COPD includes ICD-9 codes 490–491 (bronchitis), 492 (emphysema), and chronic airway obstruction (496), and can be the underlying or a contributing cause of death. The number and percentage of decedents are weighted estimates obtained from the National Center for Health Statistics, National Mortality Followback Survey, Provisional Data—Public Use Data File, 1993. Information about the decedent’s smoking status at the time of death was obtained from proxy respondents. Smokers were defined as having smoked at least 100 cigarettes during their lifetime. Smokers who were reported to have quit and never started again were classified as former smokers.

associated with dying with COPD. Among current smokers, those who smoked ≥46 pack-years were 3.1 times (95% CI, 1.6 to 5.8) more likely to die with COPD, and those who smoked 25 to 45 pack-years were 2.3 times (95% CI, 1.1 to 4.9) more likely to have died with COPD than were those who smoked 1 to 24 pack-years. Corresponding values among former smokers were ORs of 2.6 (95% CI, 1.5 to 4.5) and 1.4 (95% CI, 0.8 to 2.5), respectively. A history of asthma was associated with an increased risk for death with COPD among both never-smokers (OR, 13.9; 95% CI, 6.0 to 32.4) and former smokers (OR, 4.7; 95% CI, 2.7 to 8.3).

DISCUSSION

This nationally representative study is consistent with other research linking smoking with COPD. However, in addition to the strong association between smoking and dying with COPD, an estimated 37,000 adults died with COPD who had never smoked, including 12,900 for whom COPD was listed as the underlying cause of death. This somewhat surprising finding underscores the need to look beyond smoking to control morbidity and mortality related to COPD.

Another factor we found associated with dying with COPD was being underweight, a finding consistent with other studies of COPD mortality. Weight loss and muscle wasting in people with COPD adversely affects physical performance, and respiratory muscle function independent of airflow obstruction. Being underweight may also reflect malnutrition, and some studies suggest that oxidant- antioxidant imbalance may play a role in the pathogenesis of COPD. As would be expected, smoking was a significant predictor of COPD, although the very high OR for current and former smoking seen in 35- to 59-year-old decedents (Table 2) needs to be interpreted cautiously, in that the small number of never-smoking COPD decedents in this age group makes this estimate unstable.

An interesting but expected finding was the increased likelihood of having a history of asthma among people dying with COPD than among those dying from all other causes. Nearly one in five people dying with COPD had a lifetime history of asthma. The coexistence of asthma and COPD has been observed in other studies. Cohort studies have reported higher overall mortality and COPD death rates as well as shorter survival among people with asthma and COPD than among people with asthma but not COPD. Coexistence of a lifetime history of asthma and the presence of COPD on the death certificate raises questions. One possible explanation for the presence of COPD in decedents with a lifetime history of asthma is diagnostic misclassification. In their later stages, chronic obstructive bronchitis and asthmatic bronchitis may become indistinguishable. In addition, knowledge of the decedent’s smoking history could influence the designation of COPD as the primary cause of death.
There are several limitations associated with using death records. These include coding errors, ante-mortem diagnostic errors, inadvertent omissions, unavailability of medical records to the certifying physician, death record completion before autopsy, and misunderstanding of the certification process.

To avoid factors that contribute to asthma severity, and pharmacologic therapy directed at suppressing airway inflammation is not known.

A biologically plausible mechanism that could partially explain COPD-related mortality in never-smokers with asthma is the development of nonreversible airway obstruction. Our finding that COPD mortality in never-smokers increases with age supports this mechanism. The characteristic inflammation that occurs in asthma, even in mild-to-moderate cases, may lead to remodeling of the airway walls, and repeated inflammatory responses may lead to irreversible remodeling.

Whether airway remodeling can be prevented or modified by early diagnosis, avoidance of factors that contribute to asthma severity, and pharmacologic therapy directed at suppressing airway inflammation is not known.

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In addition to possible misclassification on the death certificates, some of the supplemental information collected from proxy respondents may have been misclassified. The accuracy of responses to the supplemental interview questions probably reflect how well the proxy respondent knew the decedent, especially regarding knowledge of the decedent’s smoking and body weight. Proxy responses regarding demographics, smoking history, and body weight and height are highly reliable; however, the nonresponse was 4 to 8% for more detailed smoking history information.

We decreased the potential for misclassifying COPD as the underlying cause of death by including all death records listing COPD. Inaccuracies in identifying the underlying cause of death have been reported when several disease processes are involved, however, the accuracy is improved for diseases of long duration and a well-characterized illness. Decedents whose death records listed COPD on the death certificate are more likely to have had more advanced disease because it was clinically significant, and most COPD is not diagnosed until severe symptoms or severe physiologic impairment is present, often after they have smoked at least 20 pack-years and typically during the fifth or sixth decade of life.

The long duration of COPD development provides the potential for preventive interventions. Clearly, smoking cessation/noninitiation remains the cornerstone of COPD mortality prevention efforts.
Former Smokers

Nevertheless, the large number of never-smokers who die with COPD each year provides additional evidence of a possible etiologic role for genetic, occupational and environmental factors, including environmental tobacco smoke, or undefined factors. The relation between asthma and COPD and the contribution of environmental exposures, muscle wasting, and nutritional status merits further investigation.

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