Cough and Phlegm Are Important Predictors of Health Status in Smokers Without COPD*

Yvonne F. Heijdra, MD, PhD; Victor M. Pinto-Plata, MD; Lawrence A. Kenney, MD, FCCP; John Rassulo; and Bartolome R. Celli, MD, FCCP

Study objectives: The health-related quality of life of smokers without COPD and that of ex-smokers has not been defined. If abnormal, the role of small airways disease and that of cough and phlegm have never been evaluated. Therefore, the aim of the study was to explore whether the differences in quality of life between smokers and ex-smokers could be explained by cough and phlegm, differences in pulmonary function tests, or exercise capacity.

Design: Observational, prospective.

Setting: Pulmonary and Critical Care Division, COPD Center at St. Elizabeth’s Medical Center.

Population: In 36 smokers, 21 ex-smokers (stopped smoking for > 20 years), 19 never-smokers with normal FVC and FEV1 values, and 41 patients with COPD (FEV1 38 ± 11% predicted [mean ± SD]), the St. George’s Respiratory Questionnaire (SGRQ), pulmonary function tests, and a 6-min walk distance (6MWD) were performed.

Results: The total SGRQ scores were worse in current smokers (15 ± 15) than in ex-smokers (6 ± 4) or never-smokers (4 ± 3) [p < 0.05]. As expected, the worst score was seen in COPD (50 ± 15). After correcting for cough and phlegm, the difference in SGRQ scores between smokers and ex-smokers disappeared. In current and ex-smokers, the SGRQ score was associated with the exposure to pack-years smoking history (r = 0.45, p < 0.01, and r = 0.83, p < 0.0001, respectively) but independent of lung function or exercise parameters (6MWD).

Conclusions: In smokers without COPD, the abnormal SGRQ score is due to the noxious effect of cigarette smoke, resulting in cough and phlegm, independent of its physiologic effects.

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Key words: cough; quality of life; smoking; sputum

Abbreviations: DLco = diffusion capacity of the lung for carbon monoxide; FEF25–75 = forced expiratory flow, midexpiratory phase; FEF50 = forced expiratory flow at 50% of vital capacity; 6MWD = 6-min walk distance; SGRQ = St. George’s Respiratory Questionnaire

The health-related quality of life scores in smokers and ex-smokers or never-smokers have only been studied twice1,2 using the generic Short Form-36.3 In both studies, worse scores were seen in smokers than in ex-smokers or never-smokers. However, no attempts were made to explain the difference. There have been no studies using disease-specific quality of life instruments.

Since smokers can have normal spirometry findings but may have mucus hypersecretion,4 a reduced diffusion capacity of the lung for carbon monoxide (DLCO),5 or peripheral airway obstruction,6,7 the differences between smokers and ex-smokers or never-smokers could be explained by cough and phlegm, differences in pulmonary function tests, or exercise capacity. This prospective study evaluated the quality-of-life scores measured with the St. George’s Respiratory Questionnaire (SGRQ),8 lung function, and the functional capacity in smokers and ex-smokers with normal FVC and FEV1 values, and compared them with the values obtained in patients with COPD.

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Materials and Methods

Subjects

One hundred seventeen subjects (66 men and 51 women) were studied. 36 subjects were smokers, 21 were ex-smokers, 19 were never-smokers, and 41 had COPD. They are all participants in a cohort longitudinal study of patients with COPD and appropriate control subjects. The study was approved by the Institutional Review Board at St. Elizabeth’s Medical Center. All subjects signed the informed consent. Smokers were defined as subjects who were still active smokers. Ex-smokers were subjects who had not smoked for the past 20 years, and never-smokers were subjects who never smoked a cigarette. Smokers, ex-smokers, and never-smokers were recruited by advertisement. Inclusion criteria were: FEV1 and/or FEV1/FVC > 70% predicted value, age > 55 years, and the ability to complete the SGRQ. Exclusion criteria were myocardial infarction within 6 months, ventilator dependency, malignancy, congestive heart failure, hepatic cirrhosis, end-stage renal disease, orthopedic conditions precluding performance of the 6-min walk distance (6MWD), and a history of psychiatric or neurologic illness that interfered with participation in the study. All subjects were free of any disease thought to cause death within 5 years of initiation of the study, and were in a clinically stable state for at least 6 months prior to inclusion.

COPD was defined using standards of the American Thoracic Society.9 Inclusion criteria were age > 55 years, FEV1 < 55% predicted, stable disease on medical treatment, and the ability to understand and complete the SGRQ. They were recruited from our outpatient pulmonary clinic. The exclusion criteria were the same as mentioned earlier.

Measurements

Pulmonary Function Testing: Spirometry was performed with a dry seal spirometer (Vmax; SensorMedics; Yorba Linda, CA) calibrated according to American Thoracic Society recommendations.10 Functional residual capacity was measured in a body plethysmograph as described by Dubois et al11 in COPD patients and by N2 uptake in the normal spirometry groups.

Health-Related Quality of Life: A prepublished, translated, and validated version of the original SGRQ was used.8,12 The questionnaire contains 50 questions and is divided in three sections (symptoms, activity, impact). The symptom component consists of eight items that assess the frequency over the last year of such symptoms as coughing, sputum production, dyspnea, and wheezing, as well as the numbers of attacks. Responses to the symptom items are selected from four or five possible levels of frequency or occurrence. The 16 items of the impact component identify physical activities that induce breathlessness (eg, getting washed, walking up a flight of stairs) or that affect breathlessness (eg, taking a long time to get washed because of breathlessness). The 26 items of the impact component broadly assess the impact of the disease on different aspects of social and emotional functions, such as employment, self-efficacy, medication use, and expectations for health (eg, cough hurts, cough is embarrassing in public; medication interferes with life). The items of the activity and impact components are scored in a true/false format. A detailed description of the questionnaire has been published by Barr et al.12 Each section of the questionnaire is scored separately with a range from 0 to 100%. Zero indicates no impairment of life quality. A summary score utilizing responses to all items is the total SGRQ, also ranging from 0 to 100%. The SGRQ scores are calculated using weights attached to each item in the questionnaire.13

To see if the difference in quality-of-life scores between smokers and ex-smokers and never-smokers is caused by sputum production and cough, the first two questions of the SGRQ, which address those items, were scored separately. The first question was, “How much cough did you have over the last year?” The second question was, “How much phlegm or sputum did you bring up over the last year?” The five possible answers for these questions were as follows: (1) not at all, (2) only with chest infections, (3) a few days a month, (4) several days a week, and (5) most days a week. They were scored from 0 (not at all) to 4 (most days a week) on both questions, and the scores were added together to provide a value that ranged from 0 to 8. The SGRQ scores were analyzed between smokers, ex-smokers, and never-smokers with the same score on cough and phlegm production. The correlation between the added cough and sputum score and the impact SGRQ score was calculated.

6MWD: The subjects were asked to cover as much distance as possible in 6 min.14 At each 30-s interval, they are given a standard encouragement, “You are doing well.” The highest 6MWD value was used, which was the result of two tests separated by 20 min completed in a 50-m corridor. With oxygen desaturation < 88%, oxygen was added up to 5 L/min to keep oxygen saturation > 88% in the subsequent walks.

Statistical Analysis

Data are expressed as mean ± SD. Differences among the groups were evaluated using analysis of variance. The t test for independent samples was used to test differences between groups. Pearson correlation coefficients or, if not normally distributed, Spearman correlation coefficients were calculated between the different items of the SGRQ and the FEV1, the 6MWD, the number of smoking pack-years, the DLCO, the forced expiratory flows, and the total cough and sputum score. A p value < 0.05 was considered significant. For all analyses, Statistica software (StatSoft; Tulsa, OK) was used.

Results

General Characteristics

The characteristics of smokers, ex-smokers, never-smokers, and COPD patients are shown in Table 1. The age in the smoker group was slightly lower than in the other three groups. The four groups had the same anthropometric values.

Pulmonary Function

The pulmonary function test results are shown in Table 1. The smokers, ex-smokers, and never-smokers had similar FVC and static lung volumes. However, the DLCO was lower in current smokers (89 ± 16% predicted). The FEV1 percent predicted, although normal, was lower in ex-smokers (83 ± 12% predicted) compared to never-smokers (93 ± 16% predicted). The FEV1/FVC, however, was exactly the same and normal in smokers, ex-smokers, and never-smokers. The forced expiratory flow, midexpiratory phase (FEF25–75) percent predicted, and the forced expiratory flow at 50% of vital capacity (FEF50) percent predicted values were lower in ex-smokers compared to never-smokers. As expected, the patients with COPD were obstructed...
had increased static lung volumes, and had decreased Dlco. Only 4 of the 41 patients with COPD were current smokers.

SGRQ

The symptom, impact, and total SGRQ scores were significantly higher in smokers than in ex-

![Figure 1. SGRQ scores for symptoms (top left, A), activity (bottom left, B), impact (top right, C), and total (bottom right, D) in COPD patients, smokers, ex-smokers, and never-smokers. There were significant differences between smokers and ex-smokers in symptom, impact, and total scores. The scores were significantly higher for patients with COPD. *p < 0.05; **p < 0.001.](http://publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21977/)
cough and phlegm score (Table 2). The correlation between the phlegm and cough score and the impact SGRQ score was 0.64 ($p < 0.0001$; Fig 2). The impact score was used because it was different among those groups, correlations were evaluated among those parameters and the different items of the SGRQ in smokers, ex-smokers, and never-smokers separately and also taken as one group. However, no significant correlations were found. In contrast, there were high correlations between the SGRQ scores and the number of pack-years in smokers and even higher correlations in ex-smokers (Table 3). The correlation between the total cough and phlegm score and the amount of pack-years in smokers and ex-smokers was 0.49 ($p < 0.001$).

In COPD patients, significant correlations were found between SGRQ scores and FEV$_1$ and 6MWD. No correlations were found between SGRQ scores and the amount of smoking pack-years.

### TABLE 2—Comparison of the Total SGRQ Scores in Smokers, Ex-Smokers, and Never-Smokers With the Same Cough and Phlegm Score*

<table>
<thead>
<tr>
<th>Cough and Phlegm Score</th>
<th>Smokers (n = 36)</th>
<th>Ex-Smokers (n = 17)</th>
<th>Never-Smokers (n = 17)</th>
<th>p Value, ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4 ± 1 (4)</td>
<td>4 ± 4 (6)</td>
<td>3 ± 3 (7)</td>
<td>0.79</td>
</tr>
<tr>
<td>1</td>
<td>3 ± 3 (3)</td>
<td>5 ± 10 (2)</td>
<td>1 (1)</td>
<td>0.62</td>
</tr>
<tr>
<td>2</td>
<td>7 ± 6 (8)</td>
<td>5 ± 4 (6)</td>
<td>5 ± 4 (6)</td>
<td>0.74</td>
</tr>
<tr>
<td>4</td>
<td>21 ± 7 (4)</td>
<td>11 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>28 ± 5 (2)</td>
<td>6 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>21 ± 15 (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>13 (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>33 ± 17 (7)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Data are presented as mean ± SD (No. of subjects) or mean (No. of subjects). ANOVA = analysis of variance.

### Correlations

In smokers, ex-smokers, and never-smokers, no correlations were seen between SGRQ items and FEV$_1$ percent predicted and 6MWD (Table 3). Because the FEV$_1$, DLCO, FEF$_{25-75}$, and the FEF$_{50}$ (all expressed as percentage of predicted) were different among those groups, correlations were evaluated among those parameters and the different items of the SGRQ in smokers, ex-smokers, and never-smokers separately and also taken as one group. However, no significant correlations were found. In contrast, there were high correlations between the SGRQ scores and the number of pack-years in smokers and even higher correlations in ex-smokers (Table 3). The correlation between the total cough and phlegm score and the amount of pack-years in smokers and ex-smokers was 0.49 ($p < 0.001$).

In COPD patients, significant correlations were found between SGRQ scores and FEV$_1$ and 6MWD. No correlations were found between SGRQ scores and the amount of smoking pack-years.

### Discussion

The present study had several important findings. First, the health status measured with the disease-specific SGRQ was worse in current smokers vs ex-smokers and never-smokers. Second, in current and ex-smokers, the intensity of overall exposure to cigarettes (number of pack-years) was associated with worse health status independent of lung function. This is due to the presence and intensity of

![Figure 2](http://publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21977/ on 06/17/2017)
cough and sputum production. Third, exercise capacity, as represented by the 6MWD, was the same in smokers, ex-smokers, and never-smokers, and therefore cannot explain the differences in SGRQ scores. Fourth, the SGRQ scores did not differ between never-smokers and ex-smokers even though the latter had lower FEV₁ percent predicted, FEF_{25-75} percent predicted, and FEF_{25-75} percent predicted, minimizing the role of physiologic changes as the cause of worse quality of life in smokers. The first important finding in this study is that the health status of smokers was worse than that of ex-smokers and never-smokers in spite of normal FVC and FEV₁ values. In addition, we found that ex-smokers and never-smokers had the same SGRQ scores, a finding that underscores the benefit of smoking cessation independent of changes in lung function. To our knowledge, neither the SGRQ nor any other disease-specific questionnaire has been used to evaluate health status in smokers, ex-smokers, and never-smokers. Interestingly, smokers had worse scores than ex-smokers and never-smokers in spite of normal FVC and FEV₁ values. The largest difference was seen in the symptom score, with lesser difference in the impact and activity scores. Although no disease-specific questionnaire has been used, there are data utilizing generic health-related quality of life instruments. Wilson et al. reported significant differences in mean Short Form-36 health status scores between never-smokers, ex-smokers, and current smokers, but they did not compare it with COPD. In another study, 1,500 ex-smokers (having stopped for at least 5 years) were sent the Short Form-36, Euroqol, and a set of condition-specific and sociodemographic questions. This study showed that ex-smokers reported less respiratory symptoms and a better health-related quality of life than current smokers. However, there was no attempt to identify the reasons for these differences. It is appealing to speculate that the reason is the prevalence of a lower FEF_{25-75}, FEV₁ percent predicted, and DLco in smokers. However, this is not the case because the health status was similar between never-smokers and ex-smokers even though the later also had lower FEV₁ percent predicted and FEF_{25-75}. Furthermore, the fact that the differences in SGRQ scores among smokers, ex-smokers, and never-smokers are not due to the physiologic impairment caused by cigarette smoking is also supported by the 6MWD findings, which were identical for the three groups.

The best explanation for the observed differences in SGRQ scores between smokers and nonsmokers is derived from a careful analysis of the different components of the questionnaire. As shown in Figure 1, the main difference between groups occurred in the symptom component. Further analyses indicate that this was due to the presence and intensity of cough and phlegm production (Fig 2). After normalizing for cough and sputum production, there were no differences in scores among the three groups. Our findings also indicate that small airways dysfunction has very little impact on health status unless associated with cough and phlegm. Interestingly, Jones and coworkers also observed that patients with COPD manifested worse health status if they had cough and phlegm production. However, the association of these symptoms and the degree of physiologic impairment was not explored.

It could be argued that the reason why the SGRQ scores of smokers are worse than those of nonsmokers is the presence of comorbidity induced by cigarette use. However, we observed no difference in comorbidity in the three groups (Table 4). As ex-

<table>
<thead>
<tr>
<th>Variables</th>
<th>Symptom</th>
<th>Activity</th>
<th>Impact</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smokers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV₁</td>
<td>-0.32</td>
<td>-0.25</td>
<td>-0.21</td>
<td>-0.28</td>
</tr>
<tr>
<td>6MWD</td>
<td>-0.03</td>
<td>-0.05</td>
<td>-0.08</td>
<td>-0.06</td>
</tr>
<tr>
<td>Pack-years</td>
<td>0.47†</td>
<td>0.39†</td>
<td>0.40†</td>
<td>0.45†</td>
</tr>
<tr>
<td>Ex-smokers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV₁</td>
<td>0.06</td>
<td>-0.11</td>
<td>-0.29</td>
<td>0.03</td>
</tr>
<tr>
<td>6MWD</td>
<td>-0.20</td>
<td>-0.34</td>
<td>-0.30</td>
<td>-0.25</td>
</tr>
<tr>
<td>Pack-years</td>
<td>0.45</td>
<td>0.71‡</td>
<td>0.34</td>
<td>0.53‡</td>
</tr>
<tr>
<td>Never-smokers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV₁</td>
<td>0.02</td>
<td>0.09</td>
<td>-0.43</td>
<td>-0.05</td>
</tr>
<tr>
<td>6MWD</td>
<td>0.52</td>
<td>-0.13</td>
<td>0.19</td>
<td>0.28</td>
</tr>
<tr>
<td>COPD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV₁</td>
<td>-0.23</td>
<td>-0.57‡</td>
<td>-0.16</td>
<td>-0.34‡</td>
</tr>
<tr>
<td>6MWD</td>
<td>-0.06</td>
<td>-0.37‡</td>
<td>0.05</td>
<td>-0.12</td>
</tr>
<tr>
<td>Pack-years</td>
<td>0.05</td>
<td>-0.16</td>
<td>-0.02</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

*Correlation coefficients were calculated between symptom, activity, impact and total scores, and FEV₁, 6MWD, and pack-years. This was done in smokers, ex-smokers, never-smokers, and patients with COPD separately.

†p < 0.05.
‡p < 0.01.
§p < 0.001.

Table 4—Comorbidity in Smokers, Ex-Smokers, and Never-Smokers

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>Smokers</th>
<th>Ex-smokers</th>
<th>Never-smokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Arthritis</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>5</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Coronary artery bypass grafting</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Arthritis</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Claudication</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Data are presented as No.
pected, the health status score was worst in the patients with COPD and was within the range reported in the literature. Similarly, the average 6MWD in our COPD group was 370 m, which equals the distance seen in other studies. We also correlated SGRQ scores in these groups with FEV1, DLCO, and forced expiratory flow values, which were different among these groups, but again no correlations were found. Therefore, it seemed that factors other than simple pulmonary function are responsible for the differences in quality of life among smokers, ex-smokers, and never-smokers. This statement is further supported by the high correlation observed between the SGRQ items and the amount of pack-years in smokers and ex-smokers. It would appear that once cough and phlegm develop in patients exposed to cigarette smoke, the health status worsens and that the relation is proportional to the intensity and length of exposure, as was supported by the correlation between the amount of smoking pack-years and the total cough and phlegm score. Interestingly, smoking cessation results in improvement of health status independent of improvement of lung function. We believe that this is important, and that it should be added to the list of benefits associated with smoking cessation.

One possible limitation of our study is that the smokers were, on average, 4 years younger than the other groups. Lung function parameters would have been lower after correcting for age. However, this would have made the difference in DLCO between smokers and ex-smokers even bigger. In addition, it would not have affected the other lung function parameters because they are in general a little higher in the smoker group.

This study shows for the first time that cough and sputum production negatively affects health status independent of lung physiology and systemic function. It also suggests that smoking cessation is important not only because it improves lung function but because it may improve health status by helping decrease cough and sputum production.

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