Cigarette Smoking and Changes in Respiratory Findings

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Standardized surveys of cardiorespiratory findings were conducted among male telephone company employees 40 to 59 years of age, and repeated five to six years later. Cigarette smokers had considerably more cough, phlegm, and chronic wheeze and slightly more nasal catarrh and breathlessness on exertion than nonsmokers. Pipe and cigar smokers had intermediate levels of these symptoms. Men who quit cigarette smoking between two surveys showed considerable improvement in cough and phlegm. Respiratory symptoms were most common among heavy smokers and among smokers of nonfilter cigarettes.

Forced expiratory volume decreased and sputum volume increased among all groups over the observation period. Both changes were least marked among men who quit smoking cigarettes and were most marked among those who continued to smoke cigarettes, especially the heavy smokers and those who used nonfilter cigarettes.

Numerous cross sectional studies have shown cigarette smoking to be associated with an increased prevalence of respiratory symptoms and a decrease in mean ventilatory function. Few have examined the relationship between changes in these respiratory findings and changes in smoking habits over time. Higgins and Oldham determined the indirect maximum breathing capacity of a sample of 351 men living in the Rhondda Fawr, Wales. Over a five-year period, smokers generally showed greater declines than nonsmokers. Among 905 men studied for at least four years, Fletcher reported that the rate of decline in forced expiratory volume (FEV₁) was greater among smokers than among nonsmokers. Similar findings were reported by Higgins et al, who examined 593 men in Stavely in 1967 and again in 1968. They found the rate of decline in FEV₁ among ex-smokers to be intermediate between that of smokers and nonsmokers. Vilhelmsen et al examined 313 Swedish men at 50 and again at 54 years of age. The rate of decline in FEV₁ was greatest among heavy smokers, intermediate among light smokers, and least among nonsmokers. The decline among the few persons who quit smoking in the interval was similar to that for nonsmokers.

Three small studies involving a total of 38 adult subjects reported improvement in respiratory symptoms and ventilatory function after cigarette smoking had been discontinued for periods ranging from three weeks to 18 months. Even among children, cessation of smoking appears to have measurable short-term benefits. Holland and Elliott found improvement in respiratory findings...
among schoolchildren who smoked when first examined but who had stopped smoking a year later.\textsuperscript{11}

The present study was originally designed to assess the relative prevalence of chronic bronchitis in the United Kingdom and in the United States.\textsuperscript{12} Repeating the initial examinations after a period of years has allowed a comparison of changes in respiratory findings among smokers, ex-smokers, and nonsmokers. The results confirm and extend those of previous workers, and add further weight to the belief that cigarette smoking causes impairment of respiratory function.

### Material and Methods

This series of standardized surveys of respiratory findings was begun in 1962.\textsuperscript{13} The subjects were men between the ages of 40 and 65 years, who worked for telephone companies in four geographic areas: Baltimore; southern Manhattan in New York city; Washington, DC; and rural areas of Westchester and Rockland counties, New York. At the time of initial examinations, all men were employed in the plant departments of the Chesapeake and Potomac Telephone Company or the New York Telephone Company. Most of them installed or repaired telephones, or constructed local telephone lines and facilities. Virtually all had graduated from high school and few had attended college.

The initial round of surveys was carried out in the Baltimore, Washington, and Westchester areas in April and May 1962, and in southern Manhattan in May 1963. Reexaminations in the first three areas were conducted in May 1967, five years later. The second round in Manhattan had to be postponed because of a strike in 1968. It was done in May 1969, six years after the initial survey.

Criteria for eligibility for the second round of surveys were the same as for the first, except that men who had left the plant department or...
### Table 3.—Prevalence in Percent of Specified Respiratory Symptoms in Each Round*

<table>
<thead>
<tr>
<th>Smoking Status</th>
<th>Cigarette Smokers</th>
<th>Total</th>
<th>Filter</th>
<th>to Filter</th>
<th>Non-filter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of men</td>
<td>(181)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning cough, winter</td>
<td>1st</td>
<td>7</td>
<td>18</td>
<td>34</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>10</td>
<td>20</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>Persistent cough</td>
<td>1st</td>
<td>7</td>
<td>22</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>10</td>
<td>16</td>
<td>13</td>
<td>41</td>
</tr>
<tr>
<td>Morning phlegm, winter</td>
<td>1st</td>
<td>13</td>
<td>33</td>
<td>34</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>14</td>
<td>24</td>
<td>17</td>
<td>46</td>
</tr>
<tr>
<td>Persistent phlegm</td>
<td>1st</td>
<td>13</td>
<td>26</td>
<td>36</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>13</td>
<td>20</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>Persistent cough and</td>
<td>1st</td>
<td>7</td>
<td>16</td>
<td>30</td>
<td>31</td>
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<tr>
<td>phlegm</td>
<td>2nd</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>34</td>
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<tr>
<td>Episodes of increased</td>
<td>1st</td>
<td>9</td>
<td>14</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>cough and phlegm</td>
<td>2nd</td>
<td>14</td>
<td>19</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Chest illness in past</td>
<td>1st</td>
<td>19</td>
<td>16</td>
<td>15</td>
<td>23</td>
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<tr>
<td>3 yr</td>
<td>2nd</td>
<td>14</td>
<td>23</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Chronic wheeze</td>
<td>1st</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Persistent nasal catarr</td>
<td>1st</td>
<td>15</td>
<td>12</td>
<td>26</td>
<td>28</td>
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<tr>
<td>or more</td>
<td>2nd</td>
<td>21</td>
<td>18</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>Breathlessness, grade</td>
<td>1st</td>
<td>31</td>
<td>37</td>
<td>41</td>
<td>42</td>
</tr>
<tr>
<td>or more</td>
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* Among men examined in both rounds by smoking status.
† Includes four who switched from filter to nonfilter cigarettes.

who had moved from the designated areas were invited to participate if they still worked for the telephone companies in the vicinity of the survey sites. Most losses from the original surveyed group occurred because men reached the mandatory retirement age of 65. Others had retired before 65 and some had died. A few refused to participate on the second occasion. Very few had stopped working for the telephone companies for reasons other than retirement or death.

The examinations at both rounds included the British Medical Research Council's standardized short questionnaire of respiratory symptoms, physical measurements, volume of sputum produced within one hour after arising, and forced expiratory volume in one second (FEV$_{1.0}$). Three apparently satisfactory determinations of FEV$_{1.0}$ were made and the average of the last two readings was recorded. Descriptions of these procedures have been given elsewhere. To insure that examinations at different times and places were performed as similarly as possible, procedures were highly standardized, training sessions were conducted before and during the surveys, and some of the examiners always participated in successive surveys.

Respiratory symptoms selected for analysis are listed below, together with the questions with which they were elicited and the corresponding number of the questions on the Medical Research Council's questionnaire:

**Morning cough in winter:**
1. Do you usually cough first thing in the morning in the winter?
2. **Persistent cough:**
5. (If Yes to any of questions 1 to 4) Do you cough like this on most days for as much as three months each year?
6. **Morning phlegm in winter:**
6. Do you usually bring up any phlegm from your chest first thing in the morning in the winter?
7. **Persistent phlegm:**
10. (If yes to any of questions 6 to 9) Do you bring up phlegm like this on most days for as much as three months each year?
8. **Persistent cough and phlegm:** (This is derived from the answers to questions regarding persistent cough and persistent phlegm.)
9. **Episodes of increased cough and phlegm:**
12. In the past three years, have you had a period of increased cough and phlegm lasting for three weeks or more?
10. **Chest illness in the previous three years:**
21. During the past three years, have you had any chest illness which has kept you off
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Fig 1.—Prevalence of respiratory symptoms related to smoking status among men examined in both rounds.

work, indoors, at home or in bed?

Chronic wheeze:

15. Does your chest ever sound wheezy or whistling?

15c. Do you get this most days or nights?

Persistent nasal catarrh:

20. Do you have this (stuffy nose or catarrh at the back of your nose) for as much as three months each year?

Breathlessness on exertion:

14a. Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill?

Probing questions are not shown. The results are shown as prevalence ratios for each round. In addition to respiratory symptoms, FEV₁,₀ and the volume of sputum produced in the first hour after arising were used to evaluate changes in respiratory status between surveys.

Results

A total of 670 men participated in both the first and second rounds. Their smoking classification at both rounds is shown in Table 1. Only 3 of 94 men started to smoke in this interval, and they smoked only pipes or cigars. Exsmokers increased from 105 to 168. However, a higher proportion of first-round pipe or cigar smokers (28%) stopped smoking than men who smoked cigarettes only (14%) or those who smoked cigarettes together with cigars or pipes (18%). Of the cigarette smokers who quit during this interval, about a fifth did so because of cough. Two fifths stopped for other medical reasons and the remainder quit for reasons apparently not related to their current health.

The most striking change was the decrease in smokers of nonfilter cigarettes. The number of men smoking filter cigarettes had increased slightly by the second round, largely because recruits from previous smokers of nonfilter cigarettes outnumbered losses to the ex-smoker category. Only four persons had switched from filter to nonfilter cigarettes. Thirteen cigarette smokers changed to pipes or cigars exclusively, while 28, or about 8%, of cigarette smokers also smoked cigars or pipes by the second round.

The analysis of the association of smoking habits with respiratory findings has been limited to four major groups. These groups, comprising 527 men, are shown in Table 2. There were 181 men who said they had not smoked in the interval between survey rounds. Of these, 91 had never smoked and 90 had stopped before the first round. They are combined because preliminary analysis showed essentially the same findings for each group. There were 49 who said at each round that they were smoking pipes or cigars only, 132 filter cigarettes only, and 73 nonfilter cigarettes only. There were 41 who said they smoked nonfilter cigarettes at the first round and filter cigarettes at the second, and four who switched from filter to nonfilter cigarettes. Cigarette smokers total 250 men.

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The median grams of tobacco smoked per day is also shown in Table 2. The differences between the groups were not marked. Pipe and cigar smokers tended to smoke slightly less than cigarette smokers, and increased their consumption during the period. Smokers of filter cigarettes showed no change in their tobacco consumption, while smokers of nonfilter cigarettes showed a slight decrease. Men who quit smoking cigarettes between rounds smoked a little less initially than men who continued to smoke.

The age distribution of each category of smoker was essentially the same, the average age ranging from 45.7 years for nonfilter cigarette smokers to 48.0 for nonsmokers.

The frequency of respiratory symptoms in both rounds is shown in Table 3 and Fig 1 to 4, according to smoking status. The prevalence of cough and phlegm, both winter morning and persistent, tended to be similar within each smoking status group. However, there were marked differences between groups. In each instance and for both rounds, the prevalence of cough and phlegm was lowest among nonsmokers and highest among cigarette smokers. With the exception of winter morning phlegm, the prevalence among men who smoked only pipes or cigars was about twice that for nonsmokers and about half that for cigarette smokers.

The most striking change in the prevalence of cough and phlegm was noted among persons who quit smoking during the study period. At the first round, their prevalence ratios were similar to those for men who continued to smoke cigarettes. By the second round, their ratios were almost as low as those for nonsmokers. The most marked improvement occurred among men who quit because of a troublesome cough.

The highest frequency of cough and phlegm and the greatest increase in these symptoms was noted among smokers of cigarettes without filters. By the second round, about 60% of the nonfilter cigarette smokers had some manifestation of cough or phlegm. The frequency of cough and phlegm among smokers of filter cigarettes was about three quarters that for nonfilter cigarette smokers. Men who switched from nonfilter to filter cigarettes tended to have cough and phlegm to the same degree as smokers of filter cigarettes.

The smoking status groups differed little with respect to episodes of increased cough and phlegm or disabling chest illnesses during the three years prior to each round. It is noteworthy that about one of every five men in this study had experienced a disabling chest illness during each of these periods. This is equivalent to an incidence rate of at least 6% to 7% per year. Men who quit smoking cigarettes showed a slight increase in disabling chest illnesses prior to the sec-
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ness increased among men who quit smoking cigarettes regardless of their reasons for quitting.

More objective and quantifiable indices than the preceding historical items are the mean FEV<sub>1.0</sub> and the mean volume of sputum produced in the first hour after arising. These values are shown for each smoking status group in Table 4 and Fig 5. The mean FEV<sub>1.0</sub> did not differ greatly among the groups. Pipe and cigar smokers and nonsmokers showed the highest values and cigarette smokers the lowest values. Non-filter cigarette smokers had the lowest values among cigarette smokers. However, the decrease between rounds among men smoking nonfilter cigarettes was similar to that for nonsmokers, while pipe and cigar smokers increased their slight advantage over nonsmokers by showing an even lower decrease. The smallest decrease was observed among men who quit smoking cigarettes.

The pattern for mean sputum volume among the smoking status groups resembled that for the historical items of cough and phlegm. Nonsmokers had the lowest and cigarette smokers the highest values. The smallest increases in mean volume were noted for nonsmokers and for persons who had quit smoking, while the largest increases occurred among smokers of nonfilter cigarettes.

Among the 250 men who smoked only cigarettes at both rounds, there were 96 who smoked less than 25 per day on both occasions. They were classified as moderate smokers. There were 94 heavy smokers, men who smoked 25 or more cigarettes on both occasions. Twenty-seven shifted from the moderate to the heavy category and 33 in the opposite direction. Respiratory findings were less favorable among consistently heavy smokers than among consistently moderate cigarette smokers. However, decreasing cigarette consumption from heavy to moderate was not associated with significant improvement, nor was increasing cigarette consumption associated with significant deterioration in respiratory findings.

Comment

The results of this study indicate that the symptoms of cough, phlegm, chronic wheeze, and nasal catarrh, and the findings of in-
increased sputum volume and diminished ventilatory function, are associated with cigarette smoking. This was true of both rounds of examinations, thus adding to a considerable body of cross sectional evidence.\textsuperscript{1,2} More important is the demonstration that persons who quit cigarette smoking did not show as much decline in quality of their respiratory findings as persons who continued to smoke. Indeed, they actually improved while most other groups became worse. Again, these findings agree with the longitudinal evidence of others.\textsuperscript{4,11}

Giving up cigarettes probably has more potential benefit than is indicated from these findings, which are limited to men actively employed in both rounds. Men who died in the interval between rounds or who retired because of illness do not enter into this analysis. Both events were more common among cigarette smokers. Among the group who had quit cigarette smoking, there were some who quit on their own accord and others who were advised to stop because of a medical diagnosis. The latter group showed the least improvement, presumably because irreversible damage had been done before they gave up smoking. Had they quit before a recognizable abnormality developed, they might have fared even better. As noted by others, the effect of health on smoking tends to confound studies of the effect of smoking on health.\textsuperscript{15}

The question naturally arises whether the observed associations of cigarette smoking with respiratory findings might indicate a cause-and-effect relationship. First, one may consider what else could cause the observed associations. Chance is always a possibility. Although very few of the individual differences in the findings between rounds of examinations were statistically significant at the usual levels of confidence, the internal consistency lends credence to the reality of the general pattern. Agreement with the findings of others increases the credibility.

Initial selection of subjects could also cause the observed associations if persons who are destined to have respiratory symptoms are concentrated among persons who smoke cigarettes. However, much potential variation among subjects is removed by the unusual degree of homogeneity of this group. All were men within the age range of 40 to 59 initially, mostly from the same ethnic groups, similarly educated and trained, and working at similar jobs for similar compensation. All were sufficiently healthy to have been at work at both rounds of surveys, five to six years apart.

Furthermore, in addition to initial prevalence of findings among the study subgroups, it is possible to look at changes in these findings over time without regard to their initial frequencies. These changes were most favorable for men who stopped smoking and least favorable for men who continued to smoke cigarettes. To explain these observations on the basis of selection of subjects requires a complicated hypothesis. Persons who can and do stop smoking must be assumed to be destined to do best while those who continue to smoke are generally destined to do worst with regard to frequency of and changes in respiratory findings. Occam's razor (the law of parsimony) suggests that the simplest and hence most acceptable hypothesis is that cigarette smoking causes a deterioration in respiratory symptoms over and above that associated with aging and its concomitant exposure to other respiratory insults.
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Finally, there is suggestive evidence on the possible health effects of cigarette filters. Although the observed differences in respiratory findings are not marked, smokers of filter cigarettes tended to fare better than those who smoked cigarettes without filters. Men who switched from nonfilter to filter cigarettes had less cough, phlegm, and sputum than men who continued to smoke nonfilter cigarettes; their experience with other respiratory findings was less favorable. But although filter cigarettes may not be as harmful in some respects as nonfilter ciga-

rettes, the benefits of filters were not nearly as great nor as uniform as those of quiting.

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References


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