The effect of smoking and occupation on changes in respiratory symptoms in middle-aged Danish men

J. Vestbo**, K.M. Knudsen**, F.V. Rasmussen***.


ABSTRACT: A group of 1404 middle-aged men from Aalborg who were examined in 1974 with interview and lung function tests were re-examined in 1985 using a postal questionnaire. Of the 1404 men, 1045 could be classified into well-defined occupational categories using information up to 1974. Of these men, 791 were alive at the time of the questionnaire survey. Questions on lung symptoms, occupation and smoking habits since the 1974 study were included in the follow-up survey; the response rate was 88%. Age and main occupation until 1974 were significantly related to the development of severe breathlessness from 1974 to 1985. After controlling for age, both cement workers and blue collar workers were considerably more likely to develop severe breathlessness than white collar workers: odds ratios (ORs) 2.51 (95% confidence interval 1.04-6.7) and 2.35 (1.02-5.42), respectively. Although weakened, these relationships remained after further controlling for forced expiratory volume in one second (FEV1) in 1974. Present smoking habit was an important determinant for the presence of cough, both in men with and without cough in 1974, yielding ORs of approximately 3 when comparing with lifetime nonsmokers. Cement workers tended to have cough in 1985 more frequently than white collar workers, OR = 2.09 (0.89-4.89) for men without cough in 1974 and OR = 2.60 (1.04-6.51) for men with cough in 1974.


Over the last two decades several papers have described the relationship between smoking, occupational exposure to dust and respiratory disease [1-8]. It has been claimed that the effects of exposure to dust were of a different kind and probably less harmful than those of smoking [9, 10]. The topic remains controversial. Whereas most people in the field of respiratory epidemiology seem to settle on a balanced attitude, as expressed in a recent review by Bechlake [11], others continue to downgrade the effects of dust [12]. Most often the effects of dust and smoking on lung function and respiratory symptoms have been examined in cross-sectional surveys, and relatively little has been published regarding the effect of long-term occupational exposures on later development of respiratory symptoms.

The aim of this study was to examine the effect of smoking habits and long-term occupational exposure to dust, in particular cement dust, on changes in respiratory symptoms, i.e. breathlessness and cough.

Material and methods

Initial survey

The population was sampled in 1974 from all men living in the city of Aalborg. The population was selected using stratified sampling. Firstly, all men who had worked at least 1 yr at an Aalborg Portland Cement factory were selected. Secondly, a 6.6% random sample of the remaining population was selected. A total of 1404 men were examined in 1974 using lung function tests and interview, including the British Medical Research Council (BMRC) questionnaire [13]. All men were interviewed by the same physician strictly following the BMRC guidelines [14]. Also, information on smoking habits and occupation was obtained. The main results of this cross-sectional survey have been published earlier [15].

In follow-up analyses, men who could not be categorized according to occupation and men with varied rural occupations until 1974 were excluded. As
explained in an earlier study [16] this restriction resulted in a group of 1045 men representing 3 occupational categories: cement workers (277 men) selected from the cement factory sample; other blue collar workers (574 men) and white collar workers (194 men), both selected from the random sample. All men had spent at least half of their working life in the occupational category in which they were placed. Other blue collar workers and white collar workers made up 89% of the random sample and were considered to be representative of an urban male middle-aged population.

Follow-up

On 27 October 1985, 791 men were alive, 1 man was lost to follow-up. In early November 1985 a questionnaire including the BMRC questionnaire and questions on smoking habits, occupation and housing conditions since 1974 was sent to all 791 men. Two reminders were sent to initial non-responders. The overall response rate was 88%; 91% for the cement workers and 85 and 95% for the blue collar workers and white collar workers, respectively. In this study, 2 levels of breathlessness were examined. We defined breathlessness as "shortness of breath when walking with other people of your own age on level ground" and severe breathlessness as "the need to stop for breath when walking at your own pace on level ground". Cough was considered to be present if the subject answered affirmatively to either of the BMRC questions on cough with no requirement to duration.

Four factors of importance to lung disease besides age were considered to have an effect on respiratory symptoms; smoking habits in 1974 and 1985, main occupation until 1974, obesity in 1974, and number of years with central heating until 1974. Regarding smoking, the men were divided into 4 categories in both 1974 and 1985; heavy smokers smoking more than 10 g of tobacco daily, light smokers smoking 10 g or less, ex-smokers, with no limit to the length of the abstinence period, lifetime nonsmokers. No information on the effect of smoking on respiratory symptoms was lost in our study using this classification instead of a cumulative measure of lifelong tobacco consumption. Obesity was defined as body mass index (BMI = weight/height²) > 30 kg/m².

Statistical methods

When comparing discrete and continuous variables from the 1974 survey in subgroups of the cohort, chi squared test and t-test were used.

Breathlessness, severe breathlessness and cough were used as response variables in the main statistical analyses. Using multivariate logistic regression analysis [17] we have analysed the probability of presence of respiratory symptoms in 1985 as a function of the corresponding respiratory symptom in 1974 and occupation, smoking habits in 1974 and 1985, age, obesity in 1974 and number of years in housing with central heating up to 1974.

Results

Information on smoking habits, respiratory symptoms and FEV₁ in 1974 is shown in table 1 for the whole cohort and for each of the three occupational categories. Cement workers and blue collar workers had both higher prevalences of respiratory symptoms and lower FEV₁ than white collar workers whereas their smoking habits did not differ significantly. In the follow-up period, 62 cement workers (22%), 148 blue collar workers (26%) and 43 white collar workers (22%) died; 1 white collar worker was lost to follow-up. Table 2 shows similar information as that in table 1 for questionnaire responders in 1985, non-responders in 1985 and non-survivors. Marked differences in all shown characteristics are found when comparing non-survivors and survivors. In contrast to this, only smoking histories differed significantly when comparing responders and non-responders; this was due to marked differences between responding and non-responding blue collar workers whereas it was not present among cement workers and white collar workers. FEV₁ was slightly lower for non-responders than for responders; the difference was only borderline significant, p=0.04 for FEV₁, in litres and p=0.09 for FEV₁ in % predicted.

Prevalences of respiratory symptoms and smoking habits in 1985 for the whole cohort and for each of the 3 occupational categories are shown in table 3. Cement workers had significantly higher prevalences of cough, breathlessness and severe breathlessness than white collar workers whereas blue collar workers only had significantly more severe breathlessness than white collar workers. Only minor differences in smoking habits were found.

Of the 691 men who answered questions on breathlessness in both 1974 and 1985, 87 men reported breathlessness in 1974; of these, 36 men had severe breathlessness. For the 604 men without breathlessness in 1974, multivariate logistic regression analysis showed that none of the variables of interest were significantly related to the development of breathlessness. Concerning severe breathlessness an effect of age and occupation was found whereas smoking and obesity were not related to development of breathlessness. The risk of severe breathlessness increased with increasing age (p<0.05) after controlling for occupation. After controlling for age, both cement workers and blue collar workers were significantly more likely to develop severe breathlessness than white collar workers (p<0.05). Odds ratios (ORs) and 95% confidence intervals for both the analysis of breathlessness and severe breathlessness are shown in table 4. In order to examine whether the relationship between occupation and development of severe breathlessness was due to initial differences in lung function, the above analysis was repeated including height-standardized FEV₁, (FEV₁-ST) as a covariate. The relationship between occupation and development...
Table 1. - Characteristics of the whole cohort and the 3 occupational categories in 1974

<table>
<thead>
<tr>
<th></th>
<th>Total population</th>
<th>Cement workers</th>
<th>Other blue collar workers</th>
<th>White collar workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=1045</td>
<td>n=227</td>
<td>n=574</td>
<td>n=194</td>
</tr>
<tr>
<td>Frequencies %:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cough</td>
<td>28</td>
<td>33*</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Breathlessness</td>
<td>16</td>
<td>19**</td>
<td>18**</td>
<td>7</td>
</tr>
<tr>
<td>Severe breathlessness</td>
<td>7</td>
<td>9*</td>
<td>8*</td>
<td>3</td>
</tr>
<tr>
<td>Lifetime non-smokers</td>
<td>8</td>
<td>7</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Ex-smokers</td>
<td>20</td>
<td>19</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Light smokers</td>
<td>24</td>
<td>26</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Heavy smokers</td>
<td>48</td>
<td>48</td>
<td>49</td>
<td>48</td>
</tr>
<tr>
<td>Mean values:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age yrs</td>
<td>56</td>
<td>57*</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>FEV₁ l</td>
<td>2.98</td>
<td>2.87***</td>
<td>2.94***</td>
<td>3.22</td>
</tr>
<tr>
<td>FEV₁ % pred</td>
<td>86.4</td>
<td>84.6***</td>
<td>85.6***</td>
<td>91.0</td>
</tr>
</tbody>
</table>

*: p<0.05 when comparing with white collar workers; **: p<0.0005 when comparing with white collar workers; ***: p<0.001 when comparing with white collar workers. FEV₁: forced expiratory volume in one second.

Table 2. - Characteristics in 1974 for questionnaire responders in 1985, non-responders in 1985 and non-survivors.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=698</td>
<td>n=93</td>
<td>n=253</td>
</tr>
<tr>
<td>Frequencies %:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cough</td>
<td>25</td>
<td>32</td>
<td>33**</td>
</tr>
<tr>
<td>Breathlessness</td>
<td>13</td>
<td>16</td>
<td>27***</td>
</tr>
<tr>
<td>Severe breathlessness</td>
<td>5</td>
<td>9</td>
<td>13***</td>
</tr>
<tr>
<td>Lifetime non-smokers</td>
<td>10</td>
<td>8</td>
<td>5**</td>
</tr>
<tr>
<td>Ex-smokers</td>
<td>21</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Light smokers</td>
<td>25</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>Heavy smokers</td>
<td>44</td>
<td>56*</td>
<td>58****</td>
</tr>
<tr>
<td>Mean values:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age yrs</td>
<td>55</td>
<td>56</td>
<td>50****</td>
</tr>
<tr>
<td>FEV₁ l</td>
<td>3.08</td>
<td>2.91*</td>
<td>2.68****</td>
</tr>
<tr>
<td>FEV₁ % pred</td>
<td>88.4</td>
<td>84.7</td>
<td>80.9***</td>
</tr>
</tbody>
</table>

*: p<0.05 when comparing with responders; **: p<0.05 when comparing with all survivors; ***: p<0.0005 when comparing with all survivors; ****: p<0.005 when comparing with all survivors. FEV₁: forced expiratory volume in one second.

The risk of cough increased with increasing use of tobacco. Cement workers tended to have more cough in 1985 than white collar workers, separately using multivariate logistic regression analysis. Of the risk factors under study, only present smoking habits were significantly related to cough in both analyses (p<0.05 and p<0.001). After controlling for occupation the risk of cough increased with increasing use of tobacco. Cement workers tended to have more cough in 1985 than white collar workers.
Table 3. - Respiratory symptoms and smoking habits in 1985 for the whole cohort and the 3 occupational categories

<table>
<thead>
<tr>
<th></th>
<th>Total population</th>
<th>Cement workers</th>
<th>Other blue collar workers</th>
<th>White collar workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=698</td>
<td>n=195</td>
<td>n=360</td>
<td>n=143</td>
</tr>
<tr>
<td>Cough</td>
<td>24</td>
<td>30*</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>Breathlessness</td>
<td>21</td>
<td>27**</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Severe breathlessness</td>
<td>13</td>
<td>17*</td>
<td>13**</td>
<td>6</td>
</tr>
<tr>
<td>Lifetime nonsmokers</td>
<td>10</td>
<td>7</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Ex-smokers</td>
<td>40</td>
<td>40</td>
<td>38</td>
<td>44</td>
</tr>
<tr>
<td>Light smokers</td>
<td>24</td>
<td>30*</td>
<td>25*</td>
<td>13</td>
</tr>
<tr>
<td>Heavy smokers</td>
<td>26</td>
<td>23</td>
<td>27</td>
<td>30</td>
</tr>
</tbody>
</table>

*: p<0.01 when comparing with white collar workers; **: p<0.05 when comparing with white collar workers.

Table 4. - Variables of interest related to the development of breathlessness and severe breathlessness

<table>
<thead>
<tr>
<th>Variable</th>
<th>Breathlessness</th>
<th>Severe breathlessness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>95% Confidence interval</td>
</tr>
<tr>
<td>Age per 10 yrs</td>
<td>1.29</td>
<td>0.89-1.88</td>
</tr>
<tr>
<td>Cement workers*</td>
<td>1.46</td>
<td>0.75-2.85</td>
</tr>
<tr>
<td>Blue collar workers*</td>
<td>1.41</td>
<td>0.77-2.58</td>
</tr>
</tbody>
</table>

The analysis of breathlessness includes 604 men without breathlessness in 1974, of which 92 had breathlessness in 1985. The analysis of severe breathlessness includes 655 men without severe breathlessness in 1974, of which 66 had severe breathlessness in 1985. *: in comparison with white collar workers.

Table 5. - Variables of interest related to the presence of cough in 1985, depending on absence/presence of cough in 1974

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>95% Confidence interval</td>
</tr>
<tr>
<td>Cement workers*</td>
<td>2.09</td>
<td>0.89-4.89</td>
</tr>
<tr>
<td>Blue collar workers*</td>
<td>1.77</td>
<td>0.82-3.83</td>
</tr>
<tr>
<td>Ex-smokers in 1985**</td>
<td>1.07</td>
<td>0.54-2.11</td>
</tr>
<tr>
<td>Light smokers in 1985**</td>
<td>0.93</td>
<td>0.43-2.00</td>
</tr>
<tr>
<td>Heavy smokers in 1985**</td>
<td>3.15</td>
<td>1.52-6.32</td>
</tr>
</tbody>
</table>

The analysis of "cough in 1985 but not in 1974" includes 519 men without cough in 1974, of which 98 had cough in 1985. The analysis of "cough in 1985 and in 1974" includes 165 men with cough in 1974, of which 67 also had cough in 1985. *: in comparison with white collar workers; **: in comparison with lifetime nonsmokers.

ORs in both categories >2 and for men with cough in both 1974 and 1985, the effect was significant (p<0.05). The estimated ORs and 95% confidence intervals for smoking habits in 1985 and occupation on cough in 1985 for men with cough in 1974 and men without cough in 1974, respectively, are shown in table 5. It is noteworthy that among men with cough in 1974, men who stopped smoking were significantly less likely to cough in 1985 than lifetime nonsmokers.

Since 1974 a large number of the responders had retired. In 1985 79%, 69% and 56% of cement workers, blue collar workers and white collar workers had retired in contrast to 8%, 16% and 7%, respectively, in 1974.
Discussion

We have presented 2 main findings from this 11 yr follow-up. Firstly, our survey demonstrated an overwhelming effect of tobacco smoking on cough. This finding is in accordance with other studies of the effect of tobacco smoke on respiratory symptoms [18]. Secondly, both men who had been heavily exposed to cement dust and other blue collar workers developed significantly more severe breathlessness than white collar workers. Also, less severe breathlessness and cough was more frequent among cement workers and other blue collar workers than among white collar workers although the differences did not reach significance on a 5% level. These findings are in agreement with the results of the initial cross-sectional survey showing more breathlessness among cement workers and other blue collar workers when comparing with white collar workers [16].

Recently, Assons et al. [19] found twice as much dyspnoea among cement workers than among other blue collar workers not exposed to dust; apart from this study there is an obvious lack of satisfactory studies on the effects of cement dust [20]. Generally, exposure to cement dust does not seem to differ from exposure to other inert dusts [21]. In our study, cement workers have definitely been heavily exposed to cement dust [22]. The exposures of the blue collar workers are more uncertain. A considerable number of blue collar workers have been working at a large ship-yard in Aalborg and they have invariably been exposed to welding fumes, isolation material and considerable amounts of inert dust. At the same time, however, our white collar workers may differ from the general concept of white collar workers since they do not merely consist of office staff. They were categorized as white collar workers since their exposures to dust, physical exertion and temperature variability did not exceed that of an average shop assistant in Aalborg [15]. This may lead to underestimation of the effects of occupation. The effect of occupation on respiratory symptoms in this study, however, is in concurrence with recent studies in this field as summarized by Becklake [11, 23]. In both our own cohort [16] and in other epidemiological studies [24, 25], breathlessness has been a significant predictor of both overall mortality and respiratory disease mortality. This has been the case even after controlling for FEV, and indicates the importance of our findings.

In both the initial study and this follow-up we have used the BMRC questionnaire. It is a frequently used tool in respiratory epidemiology; it has been extensively validated [26-28] and its reproducibility is considered to be satisfactory. Nevertheless, Fletcher and Tinker [29] found a significant underreporting of dyspnoea in the self-administered questionnaire when comparing with interview. Underreporting could probably explain why the estimates of the effects of age and occupation on breathlessness are numerically smaller than those found in the 1974 cross-sectional survey [16].

The estimated ORs in our study must be considered to be conservative estimates. As in all follow-up studies of middle-aged populations, men were lost to follow-up, mainly due to the death of 253 men in the intervening period. Furthermore, our rather rigid occupational classification is almost bound to result in a “healthy worker effect” which will tend to dilute the effect of exposure to dust. Occupational exposure after the 1974 survey is considered to have relatively little effect on the 1985 data since a large number of men retired before 1985. A particularly large number of cement workers (71%), had retired in the intervening years in comparison with 53% and 49% for other blue collar workers and white collar workers, respectively. Finally, non-response bias could be at work in the present study and disturb our conclusions. Our response rate, however, is fairly high and when comparing characteristics in 1974 for later responders and non-responders, no alarming differences were found.

References

15. Rasmussen FV, Borchsenius L, Holstein B, Salvsteen P.


