Tar Yields of Cigarettes and Male Lung Cancer Risk 1,2

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ABSTRACT—Of 252 male lung cancer patients, 248 or 98% were cigarette smokers, significantly (P<.001) more than in the control group (526=64% of 839). In relation to the relative risks (RR) of never-smokers, the adjusted (for age, total years smoked, and average number of cigarettes smoked per day) lung cancer RR for smokers who had exclusively smoked cigarettes belonging to group II (15-24 mg tar/cigarette) was 10.4 (P<.001); for smokers who had exclusively smoked cigarettes belonging to group III (>24 mg tar/cigarette), it was 25.1 (P<.001). The respective RR of smokers who had mainly smoked cigarettes belonging to group I (<15 mg tar/cigarette), group II, or group III were 10.9 (P<.001), 20.6 (P<.001), and 36.7 (P<.001). After the differences in daily consumption were taken into account, the adjusted (for age and total years smoked) lung cancer RR for smokers who had consumed mainly cigarettes belonging to the various groups were the following: group II (11-20 cigarettes/day) compared to group III (11-20 cigarettes/day), RR=0.6 (P<.05); group II (>20 cigarettes/day) compared to group III (>20 cigarettes/day), RR=0.8; group II (>20 cigarettes/day) compared to group III (11-20 cigarettes/day), RR=1.3 (P<.001); group II (>20 cigarettes/day) compared to group III (<10 cigarettes/day), RR=7.8 (P<.001); and group II (11-20 cigarettes/day) compared to group III (<10 cigarettes/day), RR=2.5 (P<.001).—JNCI 1983; 71:435-437.

Over the last two decades a trend toward filter cigarettes was observed in Austria as well as in other countries. The market shares of filter-tipped brands increased in Austria from 8% in 1960 to 93% in 1977. At the same time tar and nicotine yields of cigarettes decreased considerably, the average tar yield decreasing by 55% (from 33.67 mg to 15.3 mg/cigarette) and the average nicotine yield decreasing by 63% (from 1.95 to 0.7 mg/cigarette) (Klus H: Personal communication).

It is of great importance to investigate whether this reduction in cigarette tar is linked to any changes in the lung cancer RR in men. This paper deals with the influence of tar yields of consumed cigarettes on male lung cancer risk in groups of cases and controls who had not been exposed to other inhaled toxic substances.

MATERIALS AND METHODS

In a nationwide case-control study (1, 2), performed in 15 centers in which lung cancer patients were treated, a total of 1,580 male patients (with histologically confirmed diagnoses of cancer) and 3,160 control persons were interviewed during 1976-80. This study was part of an international study; the protocol and questionnaire are described in detail in (3). The following criteria were used for choosing the control sample: matched by age (±5 yr) with the cases and absence of of a tobacco-related disease (defined as cancers of the lung, larynx, mouth, esophagus, bladder, pancreas, liver, or kidney; myocardial infarction; stroke; peripheral vascular disease or abdominal aortic aneurysm; chronic obstructive pulmonary disease; or gastric ulcer). In addition, patients with cirrhosis of the liver were excluded from the control group. Of the controls, 50% were patients who had been treated in the same hospital in which the lung cancer patient had been diagnosed and treated and 50% were controls who lived in the same neighborhood as the lung cancer patients. An analysis of the control group showed their comparability with the general population in regard to social class distribution (4).

The total sample of cases and controls was screened for persons having any inhalation risk relating to occupational exposure. This screening was done by use of the information about life-long occupational patterns. According to their occupational anamnesis, 252 patients (and 839 controls) free of occupational risk factors were selected for further analysis; 14 patients (81) were under 50 years of age, 72 (302) were between 51 and 60, 94 (271) were between 61 and 70, and 72 (185) were older than 70. This selection process was performed to exclude occupational risks, which could alter the results when lung cancer risks are analyzed in relation to the tar yields of cigarettes smoked.

For people with a history of cigarette smoking, the following detailed information was obtained on their cigarette consumption patterns: total duration of smoking, daily cigarette consumption, and years of smoking by brand.

The brands mentioned by the respondents were allocated to I of 3 groups (2) according to their tar yields (5). Group I comprised brands with a tar content of less than 15 mg/cigarette, group II consisted of brands with 15-24 mg tar, and group III was comprised of all brands with tar yields over 24 mg. The corresponding nicotine yields per cigarette were 0.18-0.89 mg for group I, 0.65-1.58 mg for group II, and 1.27-2.17 mg for group III.

The lung cancer RR (6), adjusted by age, total duration of smoking, and average daily consumption, compared to that of nonsmokers was calculated for smokers who smoked only brands of groups I, II, and III and for smokers who consumed mainly (at least two-thirds of their smoking career) brands of groups I, II, and III.

ABBREVIATION USED: RR=relative risk(s).

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### TABLE 1.—Male cigarette smokers—lung cancer RR adjusted for age, years of smoking habit, and average number of cigarettes smoked per day

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Never smoked</th>
<th>Group I, &lt;15 mg tar/cigarette</th>
<th>Group II, 15-24 mg tar/cigarette</th>
<th>Group III, &gt;24 mg tar/cigarette</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR</td>
<td>4 303</td>
<td>8 42</td>
<td>59 180</td>
<td></td>
</tr>
<tr>
<td>95% CL</td>
<td>1.0</td>
<td>10.4</td>
<td>25.1</td>
<td></td>
</tr>
<tr>
<td>x²</td>
<td></td>
<td>5.3-20.4</td>
<td>17.6-35.7</td>
<td></td>
</tr>
<tr>
<td>Risk reduction, %</td>
<td></td>
<td>39.94b</td>
<td>31.34b</td>
<td></td>
</tr>
</tbody>
</table>

Furthermore, the lung cancer RR (adjusted for age and total duration of smoking) were calculated for group II consumers and compared with those for group III consumers, with different daily consumptions being taken into account.

The 95% confidence intervals were calculated according to Miettinen’s method (7). The strata to adjust for age were under 50 years, 51-60, 61-70, and older than 70; the strata to adjust for total cigarette consumption were under 10 years, 11-20, 21-30, 31-40, and more than 40; and the strata to adjust for daily consumption were less than 10, 11-20, and more than 20 cigarettes. The category “smokers” comprises present smokers and ex-smokers (at least for 1 yr).

### RESULTS

Significantly more patients (248/252, 98%, $\chi^2$ 112.55; $P<.001$) were cigarette smokers than controls (536/839, 64%). Table 1 shows the lung cancer RR (adjusted by age, total duration of smoking, and daily consumption) of smokers smoking only or mainly group I, II, and III cigarettes compared to lung cancer risks of people who never consumed cigarettes.

The dose-response relationship is evident; the lung cancer RR increased significantly in relation to the tar yields of the cigarette brands. Compared to smokers only smoking extremely high-tar cigarettes (group III), those only smoking group II brands had a 59% lower RR, and those smoking these cigarettes most of the time but other cigarettes as well had a 44% lower RR. People who mostly consumed relatively low-tar cigarettes (group I) experienced a lung cancer RR 70% lower than that of group III smokers.

Table 2 shows the lung cancer RR (adjusted by age and total duration of smoking) of smokers who consumed predominantly group II brands compared to lung cancer risks of group III smokers and takes into account the variety of daily consumption. If group II smokers reported a high daily consumption, their RR was greater than the RR of group III smokers smoking less; when both groups smoked equal amounts of cigarettes, the lung cancer RR of group II smokers was lower.

### DISCUSSION

The dose-response relationship of lung cancer RR and tar yields of cigarettes (8-11) was confirmed. Compared to the smokers consuming group III cigarettes, smokers consuming group II and group I cigarettes experienced a reduced lung cancer RR. The percentages of the RR reduction are the same as those that we have found in female smokers (11). Results referring to group I cigarettes are based on small samples; their interpretation,
therefore, is rather difficult. Relatively low-tar cigarettes were not available in Austria before the mid-1960’s. As Hammond and co-workers (9) have done, we have shown that daily consumption is somewhat more important than tar yields as far as the lung cancer RR is concerned. When comparing group II smokers with group III smokers having identical daily consumption, we cannot derive mechanisms of compensation for tar.

To reach as many smokers (who cannot yet stop smoking) with products of the “less hazardous cigarette” type (12), various additional strategies are necessary. Upper limits for tar are among the most important ones; they have to be lowered continuously, leading to the elimination of group III and II brands. Further investigations should show where a feasible upper limit for group I is to be defined. Price policy is another important tool to support the desirable consumer’s trend; price increase and differential taxation are measures to be applied.

All these considerations must not interfere with the ultimate goal in lung cancer prevention, i.e., tobacco abstinence.

REFERENCES