

RESEARCH PAPER

Health consequences of smoking 1–4 cigarettes per day

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Objectives: To determine the risk in men and women smoking 1–4 cigarettes per day of dying from specified smoking related diseases and from any cause.

Design: Prospective study.

Setting: Oslo city and three counties in Norway.

Participants: 23 521 men and 19 201 women, aged 35–49 years, screened for cardiovascular disease risk factors in the mid 1970s and followed throughout 2002.

Outcomes: Absolute mortality and relative risks adjusted for confounding variables, of dying from ischaemic heart disease, all cancer, lung cancer, and from all causes.

Results: Adjusted relative risk (95% confidence interval) in smokers of 1–4 cigarettes per day, with never smokers as reference, of dying from ischaemic heart disease was 2.74 (2.07 to 3.61) in men and 2.94 (1.75 to 4.95) in women. The corresponding figures for all cancer were 1.08 (0.78 to 1.49) and 1.14 (0.84 to 1.55), for lung cancer 2.79 (0.94 to 8.28) and 5.03 (1.81 to 13.98), and for any cause 1.57 (1.33 to 1.85) and 1.47 (1.19 to 1.82).

Conclusions: In both sexes, smoking 1–4 cigarettes per day was associated with a significantly higher risk of dying from ischaemic heart disease and from all causes, and from lung cancer in women. Smoking control policymakers and health educators should emphasise more strongly that light smokers also endanger their health.

Is there a threshold value for daily cigarette consumption that must be exceeded before serious health consequences occur?

Numerous population studies have reported on a strong dose–response relationship between cigarette consumption and severe diseases. In most studies, however, the lowest consumption group was set at 1–9 or 1–15 cigarettes per day. One may argue that smokers in these groups clustered close to the upper limit of this consumption span, and that a threshold value might be found on a lower level.

Only a few prospective studies have reported on the health consequences of smoking fewer than five cigarettes per day.^{1–3}

Our aim was to determine the risk in men and women smoking 1–4 cigarettes per day of dying from specified smoking related diseases and from any cause. We report on a Norwegian population of 23 521 men and 19 201 women, aged 35–49 years, who in the mid 1970s were screened for cardiovascular disease risk factors and followed throughout 2002 for deaths from ischaemic heart disease, all cancer, lung cancer, and from all causes.

METHODS

Participants

From 1972 to 1978 screening examinations for cardiovascular disease were undertaken in the Norwegian capital, Oslo, and in three Norwegian counties with a mainly rural settlement. In Oslo, all male residents aged 40–49 years were invited, and a 7% random sample of male residents aged 20–39.⁴ In the counties, all male and female residents aged 35–49 years were invited, and a 10% random sample of all residents aged 20–34.⁵

The screening programmes in the four areas included a questionnaire related to cardiovascular diseases. Height, weight, and blood pressure were measured according to an identical protocol. A non-fasting blood sample was drawn and serum analysed at the same laboratory for total

cholesterol, triglycerides, and glucose. Details on the screening programme have been given elsewhere.^{4–5}

A more extensive report on this study population after 13 years of observation with relevance to smoking and mortality has been reported previously.⁶

We will present pooled data for the age group 35–49 in the Oslo study and the County study. In Oslo the attendance was 65%, in the counties 91%.

Exclusions

The following groups were excluded:

- Men and women with a history of myocardial infarction, angina pectoris, stroke, diabetes, atherosclerosis of the legs, treatment for hypertension, use of glyceryl trinitrate (nitroglycerine), and symptoms indicative of angina pectoris or atherosclerosis obliterans. These exclusions applied to 10.2% of the attending men and 10.2% of the attending women, leaving 36 759 men and 21 960 women.
- Ex-smokers and men smoking a pipe. The very few women who smoked a pipe and the very few men and women who smoked cigars are disregarded. As a result, a further 13 238 men and 2759 women were excluded.

Hence, 23 521 men and 19 201 women were left as participants for analysis. At the time of screening, they did not report a history related to cardiovascular disease or diabetes, or symptoms indicative of angina pectoris or atherosclerosis obliterans. They were daily smokers of cigarettes only, or had never smoked daily.

Categories of daily cigarette consumption

In Oslo, the participants stated their daily cigarette consumption by ticking one of the preset categories in the questionnaire: 1–4, 5–9, 10–14, 15–19, 20–24, 25+ cigarettes. In the counties, the attending persons reported the actual number of cigarettes per day in a special box in the

questionnaire. Here, they were allowed to give a range, such as 10–15 cigarettes.

At the examination site, the nurses checked carefully the questionnaire together with the attendees. In all areas, factory made and hand rolled cigarettes had to be counted together. The nurses were instructed that one pack of tobacco for hand rolling (50 g) was equal to 50 cigarettes.

In our analyses, we transferred the consumption reported by people in the counties to one of the categories used in the Oslo questionnaire. For those who gave a range we used the highest figure—for example, 10–15 cigarettes were categorised as 15–19, and 9–14 cigarettes as 10–14.

End points

We carried out a mortality follow up by linking our records with the national register of causes of death, using the 11 digit personal identification number as record linkage. Each person accrued person years from the day of screening attendance until date of death, date of emigration, or 31 December 2002.

In addition to deaths from all causes, we studied deaths from:

- ischaemic heart disease (ICD-8 and ICD-9: 410-414; ICD-10: I20-I25)
- all cancer (ICD-8: 140-209; ICD-9: 140-208; ICD-10: C00-C97)
- lung cancer (ICD-8 and ICD-9: 161-162; ICD-10: C32-C34).

New screening in the three counties

In the three counties, a new examination was carried out around 10 years after the baseline screening.

Eligible persons aged 35–49 years at the first screening were re-invited; for 40.1% of the men and 68.6% of the women who were subject to analysis from the first screening

we have information on cigarette consumption 10 years after (10 231 men and 13 171 women). The lower male response was mainly due to the lack of re-examination in Oslo. For never smokers and smokers of 1–4 cigarettes at baseline we shall give their reported consumption category 10 years later.

Statistical methods

Relative risks adjusted for confounders were estimated with the Cox proportional hazards model.

Two sets of adjustments were made:

- Adjustments for age
- Adjustments for age, systolic blood pressure, total serum cholesterol, serum triglycerides, physical activity during leisure, body mass index, and body height.

Also, we ran Cox models with attained age as time variable. The relative risk estimates were similar, less than 2% difference from the relative risk estimates presented. The proportional hazards assumption was assessed by visual inspection of the plot of log minus log survival against log of time.

RESULTS

Table 1 shows baseline characteristics of the participants. In both sexes the duration of smoking increases by the number of cigarettes smoked daily; smokers of 1–4 cigarettes per day (below named “light smokers”), however, have a distinctly shorter history of smoking than participants with heavier cigarette consumption. In both sexes there is an increase in serum total cholesterol and serum triglycerides by cigarette consumption, while there is a decrease in physical activity during leisure. For the other variables there are only small and inconsistent differences.

Table 2 gives the number of participants and number of person years by cigarette consumption, and deaths from any cause, ischaemic heart disease, all cancer, and lung cancer. In

Table 1 Baseline characteristics of 23521 male and 19201 female participants.* Mean values, by cigarette consumption recorded at screening†

	Number of cigarettes smoked daily						
	0	1–4	5–9	10–14	15–19	20–24	25+
Males							
Age (years)	42.3	43.5	43.2	43.0	42.6	42.6	42.4
Duration of smoking (years)		18.7	21.6	22.7	22.8	23.3	23.9
Systolic BP (mm Hg)	134.9	134.8	135.2	135.2	135.4	135.2	135.2
Diastolic BP (mm Hg)	85.6	84.9	84.2	84.1	84.1	85.0	85.5
Total serum cholesterol (mmol/l)	6.65	6.67	6.97	7.04	7.04	7.14	7.13
Serum triglycerides (mmol/l)	2.16	2.28	3.31	2.36	2.39	2.46	2.44
Serum glucose (mmol/l)	5.79	5.77	5.78	5.81	5.82	5.80	5.82
Physical activity leisure‡	2.22	2.13	2.09	2.04	1.97	1.91	1.79
Physical activity work‡	2.20	2.17	2.43	2.39	2.27	2.23	2.15
BMI (kg/m ²)	24.9	24.7	24.5	24.5	24.6	24.9	25.2
Height (cm)	176.4	176.3	175.0	175.4	175.9	175.9	176.4
Females							
Age (years)	42.2	42.3	42.0	41.5	41.4	41.5	41.0
Duration of smoking (years)		12.5	16.3	18.3	19.5	19.5	20.1
Systolic BP (mm Hg)	132.0	129.3	130.0	129.0	128.9	128.6	128.7
Diastolic BP (mm Hg)	81.4	80.1	80.0	79.5	79.7	80.5	81.4
Total serum cholesterol (mmol/l)	6.63	6.74	6.88	6.92	6.95	6.99	7.00
Serum triglycerides (mmol/l)	1.55	1.64	1.74	1.76	1.76	1.84	1.91
Serum glucose (mmol/l)	5.76	5.69	5.71	5.65	5.69	5.71	5.65
Physical activity leisure‡	1.91	1.93	1.89	1.85	1.77	1.74	1.75
Physical activity work‡	2.22	2.18	2.12	2.10	2.01	2.03	2.08
BMI (kg/m ²)	25.0	24.7	24.0	23.7	23.7	23.7	24.5
Height (cm)	162.5	162.7	162.1	162.6	162.8	163.5	163.0

*Participants not reporting cardiovascular disease, diabetes or treatment for hypertension, nor symptoms of angina pectoris and atherosclerosis obliterans.

†Number of participants within the consumption groups (see table 2).

‡Physical activity during leisure and at work was graded 1–4, with 4 as the heaviest activity. BMI, body mass index; BP, blood pressure.

Table 2 Number of participants and person years; deaths from all causes, ischaemic heart disease, all cancer, and lung cancer, number and per 100000 person years, by number of cigarettes recorded at screening. 23521 male and 19201 female participants aged 35–49*

	Number of cigarettes smoked daily						
	0	1–4	5–9	10–14	15–19	20–24	25+
Males							
Number of participants	8308	627	2526	4941	3401	2599	1119
Number of person years	219699	16367	63464	122128	82836	61967	26310
All causes							
Number of deaths	1248	161	760	1697	1245	1084	499
Per 100000 person years	568	984	1198	1390	1503	1749	1897
Ischaemic heart disease							
Number of deaths	287	63	233	521	406	311	128
Per 100000 person years	131	385	367	427	490	502	487
All cancer							
Number of deaths	446	40	226	525	392	349	171
Per 100000 person years	203	244	356	430	473	563	650
Lung cancer							
Number of deaths	17	4	61	168	126	146	70
Per 100000 person years	8	24	96	138	152	236	266
Females							
Number of participants	11077	796	2759	3005	1008	477	79
Number of person years	288178	20537	70509	76158	25196	11720	2036
All causes							
Number of deaths	956	98	427	530	222	113	16
Per 100000 person years	332	477	606	696	881	964	786
Ischaemic heart disease							
Number of deaths	85	17	72	79	36	13	2
Per 100000 person years	29	83	102	104	143	111	98
All cancer							
Number of deaths	579	46	197	264	100	58	9
Per 100000 person years	201	224	279	347	397	495	442
Lung cancer							
Number of deaths	14	5	43	65	33	14	3
Per 100000 person years	5	24	61	85	131	119	147

*Participants not reporting cardiovascular disease, diabetes, or treatment for hypertension, nor symptoms of angina pectoris and atherosclerosis obliterans.

both sexes and all mortality groups, light smokers have higher death rates than never smokers, the death rates increasing with increasing cigarette consumption. Women have lower death rates than men in all mortality and consumption groups, the difference being most pronounced for ischaemic heart disease. Heavy smoking women, however, have higher death rates than never smoking men.

Table 3 displays adjusted relative risks of death with never smokers as reference, and with the two sets of adjustments described in the section on statistical methods. Within the various consumption groups there are only minor and inconsistent differences between the two sets of risk figures.

Light smokers have a significantly higher relative risk of dying from any cause, for both sexes about 1.5 times higher than in never smokers. The same applies for relative risk of dying from ischaemic heart disease—for both sexes, close to three times higher. The highest relative excess rate in light smokers is seen for lung cancer in women with a relative risk of 5.03 (95% confidence interval 1.81 to 13.98). The corresponding male relative risk is 2.79, but with a confidence interval encompassing 1.0.

In both sexes and in all consumption groups, relative risk for ischaemic heart disease is far higher than for all cancer and for deaths from any cause, with the steepest increase from 0 to 1–4 cigarettes per day.

On the whole, women have higher relative risks than men of dying from ischaemic heart disease and lung cancer, but one should keep in mind that the absolute risk is higher in men than in women in all consumption categories.

For all mortality groups, there is a significant increasing trend in relative risk by cigarette consumption, with the exception of ischaemic heart disease in women.

As light smokers clearly had a shorter history of smoking than the other consumption groups (table 1), we ran a separate analysis for smokers in order to elucidate the impact of this factor upon future mortality.

Table 4 presents the relative risks related to five years of smoking. This table, and table 1, show that if duration of smoking in the light smokers had been of the same length as for persons in other consumption groups, their relative risk would have been even higher than that reported in table 3, ranging from about 7% for ischaemic heart disease to about 47% for lung cancer in women.

Table 5 shows participants who at the first screening reported to be never-smokers, or to smoke 1–4 cigarettes daily, and who turned up for examination 10 years later.

Of the never-smokers at baseline, 7% of the men and 5% of the women had changed category 10 years later; 2% of both sexes had started to smoke. Of the light smokers at baseline, 24% of the men and 20% of the women stated unchanged daily cigarette consumption 10 years later. Higher cigarette consumption was registered for 26% of the male and 41% of the female light smokers, while 48% of the men and 39% of the women had become ex-smokers or stated that they had never smoked cigarettes daily. A few men had switched to pipe/cigars. A dominant fraction of the light smokers with increased consumption had moved only to the category 5–9 cigarettes per day.

DISCUSSION

Principal findings

In men and women smoking 1–4 cigarettes per day, there was a distinct increase in risk of death from ischaemic heart disease and from all causes. For ischaemic heart disease, the

Table 3 Adjusted relative risk (RR, 95% confidence intervals) of death from all causes, ischaemic heart disease, all cancer, and lung cancer, by number of cigarettes daily recorded at screening, with never smokers as reference. 23521 male and 19201 female participants aged 35–49*

	Number of cigarettes smoked daily						Test for trend, P
	1–4	5–9	10–14	15–19	20–24	25+	
Males							
All causes							
RR†	1.56 (1.33 to 1.84)	2.03 (1.85 to 2.22)	2.47 (2.29 to 2.65)	2.78 (2.57 to 3.00)	3.35 (3.09 to 3.64)	3.71 (3.34 to 4.11)	<0.001
RR‡	1.57 (1.33 to 1.85)	1.94 (1.77 to 2.12)	2.36 (2.19 to 2.55)	2.66 (2.46 to 2.88)	3.19 (2.93 to 3.46)	3.42 (3.07 to 3.81)	<0.001
Ischaemic heart disease							
RR†	2.65 (2.02 to 3.48)	2.67 (2.24 to 3.17)	3.24 (2.81 to 3.74)	3.89 (3.34 to 4.52)	4.10 (3.49 to 4.82)	4.07 (3.31 to 5.02)	<0.001
RR‡	2.74 (2.07 to 3.61)	2.47 (2.06 to 2.94)	3.09 (2.67 to 3.58)	3.70 (3.17 to 4.31)	3.75 (3.18 to 4.42)	3.60 (2.91 to 4.46)	<0.001
All cancer							
RR†	1.09 (0.79 to 1.50)	1.69 (1.44 to 1.98)	2.14 (1.88 to 2.42)	2.45 (2.14 to 2.81)	3.03 (2.63 to 3.49)	3.57 (2.99 to 4.26)	<0.001
RR‡	1.08 (0.78 to 1.49)	1.63 (1.38 to 1.92)	2.05 (1.81 to 2.34)	2.37 (2.06 to 2.72)	2.93 (2.54 to 3.38)	3.41 (2.85 to 4.09)	<0.001
Lung cancer							
RR†	2.84 (0.96 to 8.45)	11.94 (6.97 to 20.44)	17.98 (10.92 to 29.61)	20.77 (12.52 to 34.47)	33.48 (20.76 to 55.33)	38.64 (22.74 to 65.65)	<0.001
RR‡	2.79 (0.94 to 8.28)	11.30 (6.59 to 19.39)	16.73 (10.14 to 27.60)	19.36 (11.65 to 32.18)	31.69 (19.14 to 52.47)	36.22 (21.23 to 61.81)	<0.001
Females							
All causes							
RR†	1.44 (1.17 to 1.77)	1.90 (1.70 to 2.13)	2.31 (2.08 to 2.57)	3.01 (2.60 to 3.48)	3.29 (2.71 to 4.00)	2.67 (1.63 to 4.38)	<0.001
RR‡	1.47 (1.19 to 1.82)	1.90 (1.69 to 2.14)	2.29 (2.01 to 2.56)	2.97 (2.55 to 3.45)	3.14 (2.56 to 3.84)	2.61 (1.59 to 4.28)	<0.001
Ischaemic heart disease							
RR†	2.81 (1.67 to 4.72)	3.69 (2.69 to 5.05)	4.03 (2.97 to 5.48)	5.80 (3.92 to 8.57)	4.51 (2.52 to 8.10)	3.89 (0.96 to 15.81)	0.064
RR‡	2.94 (1.75 to 4.95)	3.55 (2.57 to 4.89)	3.78 (2.75 to 5.18)	5.28 (3.50 to 7.97)	4.25 (2.35 to 7.68)	3.53 (0.87 to 14.40)	0.114
All cancer							
RR†	1.11 (0.82 to 1.50)	1.44 (1.22 to 1.69)	1.87 (1.61 to 2.16)	2.18 (1.76 to 2.70)	2.73 (2.08 to 3.57)	2.44 (1.26 to 4.72)	<0.001
RR‡	1.14 (0.84 to 1.55)	1.44 (1.22 to 1.71)	1.85 (1.59 to 2.16)	2.22 (1.79 to 2.76)	2.47 (1.86 to 3.29)	2.43 (1.26 to 4.71)	<0.001
Lung cancer							
RR†	5.02 (1.81 to 13.93)	13.06 (7.14 to 23.87)	19.19 (10.76 to 34.21)	30.37 (16.24 to 56.81)	27.68 (13.18 to 58.11)	34.02 (9.77 to 118.44)	<0.001
RR‡	5.03 (1.81 to 13.98)	11.85 (6.43 to 21.84)	17.62 (9.80 to 31.66)	28.83 (15.28 to 54.38)	23.85 (11.10 to 51.25)	31.95 (9.12 to 111.96)	<0.001

*Participants not reporting cardiovascular disease, diabetes, or treatment for hypertension, nor symptoms of angina pectoris and atherosclerosis obliterans.

†Adjusted for age.

‡Adjusted for age, systolic blood pressure, total serum cholesterol, serum triglycerides, physical activity during leisure, body mass index, and height.

Table 4 Relative risk (95% confidence interval) of death from all causes, ischaemic heart disease, all cancer, and lung cancer, per five years of smoking estimated from Cox proportional hazards regression, adjusted for age and number of cigarettes*

	Males	Females
All causes	1.09 (1.06 to 1.12)	1.12 (1.08 to 1.18)
Ischaemic heart disease	1.07 (1.02 to 1.12)	1.07 (0.96 to 1.19)
All cancer	1.14 (1.09 to 1.20)	1.13 (1.06 to 1.21)
Lung cancer	1.29 (1.18 to 1.41)	1.47 (1.26 to 1.71)

*Participants not reporting cardiovascular disease, diabetes, or treatment for hypertension, nor symptoms of angina pectoris and atherosclerosis obliterans.

steepest increase was in both sexes between 0 and 1–4 cigarettes per day. Above this level, the slope was less pronounced.

For all disease groups and cigarette consumption levels, women had distinctly lower deaths rates than men; for ischaemic heart disease women's risks related to never smokers, however, were clearly higher than in men. The same applies to risk for lung cancer in women smoking fewer than 20 cigarettes per day.

It may be argued that the participants' smoking habits could have changed essentially since the screening took place. For example, analyses of results from the first screening indicate a steady increase in consumption during the first 10–20 years after starting to smoke.⁷ This may well have been the case, since the light smokers in this study had a shorter history of smoking than the other consumption groups. On the other hand, the light smokers may represent previous heavier smokers who have cut down on consumption.

Some participants who were never smokers at baseline reported 10 years later that they were smokers, and this biases the relative risk estimate towards the null. On the other hand, a large proportion of light smokers had changed smoking category, but almost as many had quit smoking as had increased their consumption. The result of these changes is hard to quantify. It may even differ for the specific causes, as the dose-response relationship varies between them. In all, we see no strong reason to believe that the relative risk estimates for light smokers are substantially biased.

Strengths and weaknesses of the study

The strength of the study is that it includes large numbers of both men and women who were examined according to standardised procedures and have been observed for more than two decades. The number of person years is 592 771 for men and 494 334 for women. We also have information on

smoking habits 10 years later for more than half of the participants. Furthermore, the follow up is complete.

One weakness of the study is that we have registered only deaths from ischaemic heart disease, and not incidence, as many other studies have. Mortality is the result of incidence and case fatality. In the Finnmark study (part of the County study), it was found that smoking (yes, no) was a predictor of case fatality.⁸ From the same study it was reported that smoking (yes, no) was related to incidence of myocardial infarction.⁹ No dose-response relationship was given, however, so we cannot be sure whether light smoking has an effect on both incidence and case fatality of myocardial disease. For lung cancer, on the other hand, estimates of mortality will be close to those of incidence, as the five year relative survival rate is less than 10%.¹⁰

Relation to other studies

The results confirm and strengthen observations in three prospective studies that have dealt with health consequences of light smoking. In these studies risks in light smokers were related to never smokers after adjustment for confounders that had been registered at screening.

- In Göteborg, 7495 men aged 47–55 years from the multifactor primary prevention trial were screened in 1970–73 and followed for 11.8 years. All surviving men who still lived in Göteborg were invited to a second screening in 1973–77 and followed for 7.1 years. In men smoking 1–4 cigarettes per day at the first screening, adjusted odds ratio for fatal and non-fatal myocardial infarction was 2.8, and for deaths from all causes it was 2.0. In men with stable smoking habits at both screenings, the corresponding adjusted odds ratios were 4.6 and 3.4. For myocardial infarction, there was no dose-response relationship with regard to increasing cigarette consumption. The risk of light smokers' dying from cancer was not increased significantly.¹
- Data from the US nurses' health study were based on 12 years' follow up (1976 through 1988). Information on smoking habits was updated every two years by a mailed questionnaire. A total of 117 006 women aged 30–55 years in 1976 were included. Adjusted relative risk for women smoking 1–4 cigarettes per day at baseline was 1.94 for fatal and non-fatal myocardial infarction. Relative risk increased with increasing cigarette consumption.²
- In the Copenhagen City heart study, 6505 women and 5644 men aged 30 and more underwent cardiovascular disease screening in 1976–78, and were followed for almost 22 years. Adjusted relative risk for women smoking and inhaling 3–5 cigarettes per day at baseline was 2.14 for fatal and non-fatal myocardial infarction, and 1.86 for all cause mortality. In corresponding males the increase was

Table 5 Smoking habits 10 years after baseline screening in persons who attended both examinations. 3774 men and 7591 women reporting at baseline never to have smoked, and 224 men and 552 women reporting at baseline a consumption of 1–4 cigarettes per day. Number of persons, age 35–49 at baseline*

Category at baseline	Categories of smoking 10 years after baseline screening										
	Never smoked	Ex-smokers	1–4 cigs	5–9 cigs	10–14 cigs	15–19 cigs	20–24 cigs	25+ cigs	Pipe only	Pipe + cigars	Total number of persons
Males											
Never smoked	3523	177	18	16	14	9	3	2	7	5	3774
1–4 cigs	15	93	53	44	13	2	0	0	3	1	224
Females											
Never smoked	7239	163	58	69	42	10	8	2	0	0	7591
1–4 cigs	71	144	113	179	38	2	3	2	0	0	552

*Participants not reporting cardiovascular disease, diabetes, or treatment for hypertension, nor symptoms of angina pectoris and atherosclerosis obliterans.

What this paper adds

Three prospective studies have shown that light smoking significantly increases the risk of fatal and non-fatal myocardial infarction; two of them also found increased risk of dying from any cause (in the third study, this end point was not taken up). One of these studies included men only, one women only, and one both sexes. In the last mentioned study, significant increased risk was not found in light smoking men.

This study included both men and women. In both sexes, smoking 1–4 cigarettes per day was associated with a significantly higher risk of dying from ischaemic heart disease and from all causes (both sexes), and in women, from lung cancer.

not significant. In women, relative risks of myocardial infarction and for all cause mortality increased further among inhalers, and among non-inhalers from 6–9 cigarettes and above. In men who inhaled, risks of myocardial infarction and for all cause mortality were significantly increased with a consumption of 6–9 cigarettes per day, and increased further above this level. After five years, 11 094 subjects were re-examined. Using the updated smoking habits did not affect the risk estimates.³

The adjusted relative risks we have reported for light smokers are within the same order of magnitude as in the three studies referred to above. As in our study, the Copenhagen City heart study found that relative risk was higher in women than in men. The same observation had previously been reported from the Finnmark study.⁹

Possible implications for policymakers

Over the years, both governmental and non-governmental Norwegian health education agencies have underlined that *all* daily cigarette consumption is dangerous to health. This view has been attacked by the Norwegian tobacco industry, which in 1973 claimed: "To our knowledge, no scientific investigations have shown clearly that a consumption of a few cigarettes daily is causing a significant health risk in healthy people. Also, in all probability there are some threshold values that must be exceeded before any health risk occur."¹¹ Undoubtedly, a similar view has been widespread in the general population. Since 1972, Statistics Norway has monitored annually the smoking habits of representative samples of the adult Norwegian population. Up to 1995 one of the standard questions was "How many cigarettes do you yourself think that you could smoke per day without harming your health?" In 1990–92, one third of the total sample answered that a few cigarettes a day are not harmful to health; of those who smoked daily, 40%.¹²

The results from this and other studies imply that smoking control policymakers and health educators should emphasise

more strongly that light smokers are also endangering their health.

Conclusions

In both sexes, smoking 1–4 cigarettes per day was significantly associated with higher risk of dying from ischaemic heart disease and from all causes, and from lung cancer in women. Accordingly, five cigarettes per day is not a threshold value for daily cigarette consumption that must be exceeded before serious health consequences occur.

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Competing interests: KB has been involved in national and international tobacco control. AT none declared.

KB participated in designing the County Study and was administratively responsible for the screening part. AT carried out the data extract and analyses. KB and AT drafted the paper.

*In 2002, this institute became an integrated part of the Norwegian Institute of Public Health

REFERENCES

- 1 Rosengren A, Wilhelmsen L, Wedel H. Coronary heart disease, cancer and mortality in middle-aged light smokers. *J Int Med* 1992;**231**:357–62.
- 2 Karachi I, Colditz GA, Stampfer MJ, *et al*. Smoking cessation and time course of decreased risks of coronary heart disease in middle-aged women. *Arch Intern Med* 1994;**154**:169–75.
- 3 Prescott E, Scharling H, Osler M, *et al*. Importance of light smoking and inhalation habits on risk of myocardial infarction and all cause mortality. A 22 year follow up of 12149 men and women in the Copenhagen City heart study. *J Epidemiol Community Health* 2002;**56**:702–6.
- 4 Leren P, Askevold E-M, Foss OP, *et al*. The Oslo study. Cardiovascular disease in middle-aged and young Oslo men. *Acta Med Scand* 1975;(suppl 588).
- 5 Bjartveit K, Foss OP, Gjervig T, *et al*. The cardiovascular disease study in Norwegian counties. Background and organization. *Acta Med Scand* 1979;(suppl 634).
- 6 Tverdal A, Thelle D, Stensvold I, *et al*. Mortality in relation to smoking history: 13 years' follow-up of 68,000 Norwegian men and women 35–49 years. *J Clin Epidemiol* 1993;**46**:475–87.
- 7 Bjartveit K, Foss OP, Gjervig T. The cardiovascular disease study in Norwegian counties. Results from first screening. *Acta Med Scand* 1983;(suppl 675).
- 8 Njølstad I, Arnesen E. Preinfarction blood pressure and smoking are determinants for a fatal outcome of myocardial infarction. A prospective analysis from the Finnmark Study. *Arch Intern Med* 1998;**158**:1326–32.
- 9 Njølstad I, Arnesen E, Lund-Larsen PG. Smoking, serum lipids, blood pressure, and sex difference in myocardial infarction. A 12-year follow-up of the Finnmark study. *Circulation* 1996;**93**:450–6.
- 10 Cancer Registry of Norway. *Cancer in Norway 2001*. Oslo: Cancer Registry of Norway, 2004.
- 11 Bogstad B. Rapport om tobakksindustriens høringsforslag til lover og forskrifter. In: Tobakksindustriens estatingsansvar. [Report on submissions by the (Norwegian) tobacco industry in relation to laws and regulations. In: Tort Liability for the Norwegian Tobacco Industry]. Norges offentlige utredninger 2000:16. Oslo: Statens forvaltningstjeneste. Informasjonstjeneste, 2000:599–606.
- 12 Statens tobakkskaderåd. Opp i røyk? Hvem, hva, hvor mye. Om tobakksbruk i Norge 1992. [Up in smoke? Who, what, how much. On tobacco use in Norway 1992]. Oslo: Statens tobakkskaderåd, 1993.

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