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A 28 year follow up of mortality among women who smoked during pregnancy

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Abstract

***Objective*—To investigate long term mortality among women who smoked during pregnancy and those who stopped smoking.**

***Design*—A follow up of a geographically defined cohort from 1966 through to 1993.**

***Subjects*—11 994 women in northern Finland expected to deliver in 1966, comprising 96% of all women giving birth in the area during that year. Smoking habits were recorded during pregnancy but not later.**

***Main outcome measure*—Mortality by cause (571 deaths).**

***Results*—The mortality ratio adjusted for age, place of residence, years of education and marital status was 2·3 (95% confidence interval 1·8 to 2·8) for the women who smoked during pregnancy and 1·6 (1·1 to 2·2) for those who stopped smoking before the second month of pregnancy, both compared with non-smokers. Among the smokers the relative mortality was higher for typical diseases related to tobacco intake, such as respiratory and oesophageal cancer and diseases of the cardiovascular and digestic organs and also for accidents and suicides.**

***Conclusion*—The risk of premature death seems to be higher in women who smoke during pregnancy than in other women who smoke. This may be explained either by the low proportion of those who stop later and the high proportion of heavy smokers or by other characteristics of these subjects that increase the risk.**

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Introduction

The consequences for the child of maternal smoking during pregnancy have been well documented,[1] but less interest has been directed towards the mothers' prognosis. We analyse here 28 year mortality data on a geographically defined population of women who smoke during pregnancy; many background variables were recorded prospectively.

Methods

Population—The cohort consisted of 12 055 pregnant women (13 of them delivering twice) in the two most northern provinces in Finland, Oulu and Lapland, whose expected dates of delivery fell in 1966 and when the pregnancy resulted in a birth. The cohort covered 96% of all deliveries in the region in 1966.[2] The

women were recruited to the cohort on their visit to an antenatal clinic at the seventh or eighth month of pregnancy.[2]

Follow up—Since 1967 every citizen in Finland has had a unique personal identification number provided by the Population Registration Centre. The identification number was traced for 11 994 mothers (99·5%) in the cohort. The records of the cohort were linked with the files of Statistics Finland to obtain dates and causes of death. The number of women recorded by the centre as having emigrated by 1994 was 614. Individual person years were calculated up to the date of death, emigration, or 31 December 1993 as appropriate.

Smoking—Smoking habits were recorded at the antenatal clinics by asking each woman whether she was a regular smoker (at least one cigarette a day) in the year before the index pregnancy, the daily consumption, and whether she had changed her habits during pregnancy and how. The cohort was divided into non-smokers; smokers before pregnancy—that is, those who smoked before pregnancy but had stopped by the end of the second month; smokers during pregnancy; and smoking not known. The possible changes in smoking habit after delivery were not ascertained.

Background variables—The following variables were included in the analyses as possible confounders: age at delivery, place of residence (urban or rural and province), education by years of schooling, and marital status at delivery and 14 years later. Data on all these variables were collected at the antenatal clinics[2] and by a family questionnaire in 1980.[3] The analyses were repeated by adding body mass index (weight (kg)/(height (m)^2)) as an explanatory variable.

Causes of death—The causes of death on the death certificates were coded according to the seventh, eighth, and ninth revisions of the *International Classification of Disease* (ICD) and are given below as in the ninth revision.[4] Only the underlying causes of death were used, and no attempt was made to revise the code. The causes were divided primarily into four groups: cardiovascular diseases (heart diseases, ICD 390-414, 420-429; cerebrovascular, ICD 430-438; and others, ICD 415-419, 439-459), cancer (ICD 140-208), accidental and violent deaths (ICD 800-999, E800-999), and all other causes. Cancer mortality was further divided into breast cancer (ICD 174); cancers related to tobacco intake—that is, cancers of the pharynx, oesophagus (ICD 148-150), and lung (ICD 162); and all others. In addition, a combined group of "lifestyle deaths" was formed by taking all other accidental and violent deaths except traffic accidents together with alcohol related diseases, such as alcohol dependence syndrome and alcoholic cardiomyopathy, gastritis, and liver disease (ICD 303, 4255, 5353, 5710-5713).

Statistical methods—Numbers of deaths, person years at risk, and mortality were calculated in the smoking categories stratified by age at delivery. Age standardised mortalities were calculated by drawing the weights from the age distribution of the whole cohort at delivery.[5] The Cox proportional hazards model[6] was fitted by the BMDP program 2L[7] to estimate the hazard ratio or relative mortality of the smokers compared with non-smokers with adjustment for the background factors above.

Results

Table I presents the distribution of the background variables in the smoking groups. Smoking was more common among young, thin, unmarried urban dwellers with fewer than nine years of schooling, and the smokers were also more likely to emigrate. Of those who continued smoking during the pregnancy, 1505 had previously smoked fewer than 10 cigarettes a day, and 301 had smoked at least 10 cigarettes. The mean number of cigarettes smoked a day after the second month of pregnancy was four in the former group and 13 in the latter. The mean number of cigarettes smoked a day by women who had given up by the end of the second month was five.

The number of deaths was 571, but the underlying cause was known for only 556 (table II); the 15 women with unknown cause were living outside Finland at the time. The age standardised all cause mortality among those who smoked during the pregnancy was 2·3 times the rate among the non-smokers, and among those who had smoked only before the pregnancy it was 1·5 times higher. The rate was 3·9 per 1000 person years among the heavy smokers (at least 10 cigarettes a day) and 3·3

TABLE I—*Distributions of certain background variables by smoking habits. Figures are numbers (percentages) of women*

Background variables	Non-smoker (n=9130)	Smoked before but not during pregnancy (n=781)	Smoked during pregnancy (n=1806)	Smoking not known (n=277)	Total (n=11994)
Age at delivery (years):					
14-24	2949 (32)	401 (51)	926 (51)	96 (35)	4372 (36)
25-29	2669 (29)	213 (27)	418 (23)	58 (21)	3358 (28)
30-34	1651 (18)	103 (13)	231 (13)	62 (22)	2047 (17)
35-49	1861 (20)	64 (8)	231 (13)	61 (22)	2217 (18)
Body mass index (kg/m^2) before pregnancy:					
<20	1005 (11)	114 (15)	315 (17)	23 (8)	1457 (12)
20-<25	5359 (59)	498 (64)	1053 (58)	123 (44)	7033 (59)
25-<30	1648 (18)	84 (11)	219 (12)	42 (15)	1993 (17)
≥30	356 (4)	18 (2)	40 (2)	5 (2)	419 (3)
Not known	762 (8)	67 (9)	179 (10)	84 (30)	1092 (9)
Province at delivery:					
Oulu	6170 (68)	504 (65)	1023 (57)	180 (65)	7877 (66)
Lapland	2960 (32)	277 (35)	783 (43)	97 (35)	4117 (34)
Place of residence at delivery:					
Urban	2722 (30)	379 (49)	779 (43)	93 (34)	3973 (33)
Rural	6408 (70)	402 (51)	1027 (57)	184 (66)	8021 (67)
Education:					
<5 Years	884 (10)	43 (6)	132 (7)	25 (9)	1084 (9)
5-8 Years	6469 (71)	573 (73)	1422 (79)	128 (46)	8592 (72)
>8 Years	1696 (19)	160 (20)	240 (13)	15 (5)	2111 (18)
Not known	81 (1)	5 (1)	12 (1)	109 (39)	207 (2)
Marital status at delivery:					
Married	8871 (97)	709 (91)	1637 (91)	248 (90)	11465 (96)
Unmarried, divorced, or widowed	248 (3)	69 (9)	169 (9)	27 (10)	513 (4)
Not known	11 (0)	3 (0)		2 (1)	16 (0)
Marital status 14 years later:					
Married	7875 (86)	620 (79)	1407 (78)	224 (81)	10126 (84)
Unmarried, divorced, or widowed	1255 (14)	161 (21)	399 (22)	53 (19)	1868 (16)
Emigration:					
Not emigrated	8750 (96)	727 (93)	1644 (91)	259 (93)	11380 (95)
Emigrated	380 (4)	54 (7)	162 (9)	18 (6)	614 (5)

TABLE II—*Number of deaths and age adjusted all cause mortality (SE) per 100 000 person years by smoking habit*

Mortality	Non-smokers	Smoked before but not during pregnancy	Smoked during pregnancy	Smoking not known	Total
No at risk	9130	781	1806	277	11 994
Person years	241 947	20 490	49 090	7287	315 814
Cause of death known	380	37	125	14	554
Cause not known	6	1	7	1	15
Total	386	38	132	15	571
Age adjusted mortality (SE)	154 (8)	226 (40)	354 (32)	177 (47)	181 (8)

TABLE III—*Cox proportional hazard analyses of mortality from various causes. Estimated hazard ratios (95% confidence interval) for smoking during and before pregnancy v non-smoking during both periods. Other variables included in model were age, place of residence, education, and marital status*

Causes of death (No of deaths)	Smoking before pregnancy only	Smoking during pregnancy
Cardiovascular diseases (185)	1·8 (1·0 to 3·4)	2·6 (1·9 to 3·8)
Cancer (218)	1·3 (0·7 to 2·3)	1·7 (1·2 to 2·5)
Accidents and violations (91)	1·4 (0·7 to 3·0)	2·0 (1·2 to 3·3)
Others (62)	2·0 (0·8 to 5·0)	2·8 (1·6 to 5·1)
All causes* (571)	1·6 (1·1 to 2·2)	2·3 (1·8 to 2·8)

*Cause of death not known for 15 cases.

among the light smokers. Because of the small number of heavy smokers and the small difference in the mortality the light and heavy smokers were pooled in the subsequent analyses..

The hazard ratios adjusted for age, place of residence, years of schooling, and marital status for the major groups of causes of death and that for total mortality were significantly increased among the women who smoked during pregnancy, varying from 1·7 to 2·8 across the disease groups (table III). Smoking before but not during the pregnancy predicted increased mortality, too, but with lower ratios. The deaths from cancer were further divided into breast cancer, tobacco related cancers, and others (table IV). As expected, the hazard ratio for tobacco related cancers was high: of the 12 cases of lung cancer eight occurred in women who had smoked during pregnancy, even though the latter formed only 15% of the cohort. No association of mortality from breast cancer with smoking was found.

When we subdivided the cardiovascular deaths the adjusted relative mortality from heart diseases (108 deaths) was 3·2 (95% confidence interval 2·0 to 4·9) and that from cerebrovascular diseases (69 deaths) 2·2 (1·3 to 3·9) for smoking during pregnancy. These figures were 2·1 (1·0 to 4·6) and 1·6 (0·6 to 4·2), respectively, for smoking only before pregnancy.

TABLE IV—*Cox proportional hazard analyses of mortality from cancer. Estimated hazard ratios (95% confidence interval) for smoking during and before pregnancy v non-smoking during both periods. Other variables included in model were age, place of residence, education, and marital status*

Causes of death (No of deaths)	Smoking before pregnancy	Smoking during pregnancy
Breast cancer (50)	0·4 (0·1 to 2·7)	0·9 (0·4 to 2·2)
Cancer of pharynx, oesophagus, trachea, bronchus, and lung (18)	0*	15·9 (5·8 to 44·0)
Other cancer (150)	1·7 (0·9 to 3·2)	1·3 (0·8 to 2·2)
All cancer (218)	1·3 (0·7 to 2·3)	1·7 (1·2 to 2·5)

*No deaths in this group.

TABLE V—*Age adjusted mortality from accidental and violent deaths per 100 000 person years by smoking habits (No of deaths in parentheses)*

Type of accident	Non-smoker	Smoked before but not during pregnancy	Smoked during pregnancy	Smoking not known	Total
Traffic accidents	9 (22)	–	8 (4)	–	8 (26)
Suicide	8 (20)	17 (4)	22 (10)	–	11 (34)
Poisoning	2 (4)	3 (1)	15 (6)	–	3 (11)
Others	5 (11)	12 (3)	11 (5)	18 (1)	7 (20)
Total	24 (56)	32 (8)	56 (25)	18 (1)	29 (91)

Deaths from accidents and violence were further divided into traffic accidents, suicides, poisonings, and others (table V). If it was not known whether death was inflicted on purpose the case was classified as unintentional poisoning, drowning, etc. The age adjusted mortality was considerably higher among those who smoked during pregnancy than among the non-smokers in each subcategory with the exception of traffic accidents, but the statistical precision of these figures is low.

A combined group of lifestyle deaths was formed which included all accidents except traffic accidents (65 deaths) and alcohol related diseases (11) which were placed under "other diseases" in the primary grouping. The adjusted hazard ratio for smoking during the pregnancy with respect to the lifestyle deaths was 3·5 (2·1 to 5·8) and that for smoking before the pregnancy 2·7 (1·3 to 5·6). Of the 51 deaths left in the group of other diseases, the women who smoked during pregnancy had a clear overrepresentation only in diseases of the digestive system, five of the 10 deaths occurring in them. Pulmonary diseases (13 deaths) were rare causes of death; only one woman who had smoked during the pregnancy died (of pneumonia).

Discussion

The smoking habits of this population were known only for the time of pregnancy and the previous year, but no information was available about possible cessation and commencement thereafter. In a similar cohort representing a parturient population in Great Britain in 1958 with a 40% prevalence of smoking the rate of taking up smoking in the next 15 years was 17% and that of cessation of smoking was also 17%.[8] The contrast in all cause mortality between those who had smoked during the pregnancy and the original non-smokers was clear with a relative risk of 2·3. Despite the probable overlapping among the groups with time, the risks for women who smoked during pregnancy were greater when compared with non-smokers than the corresponding risks for non-pregnant female smokers with regular records of smoking habits.[9-11] In a Norwegian 13 year follow up of non-parturient women the all cause mortality among the current daily smokers was 1·6 times that of the group who had never smoked: 1·3 for light smokers and 1·9 for heavy smokers.[9] In a 22 year follow up of female British doctors the age adjusted mortality among those who smoked 1-14 cigarettes a day was 0·9 times that of the group who had never smoked, while the corresponding figures were 1·5 for those smoking 15-24 cigarettes daily and 1·7 for those smoking more than 24 cigarettes.[10] In an American follow up of half a million women the mortality ratios for average smokers compared with non-smokers varied from 1·1 to 1·3, and the highest ratio, 2·0, was found for those aged 45-54 years who smoked over 40 cigarettes a day.[11]

The excess mortality among the smokers in our series was found in the disease groups traditionally considered to be related to tobacco intake, such as respiratory and oesophageal cancer, cardiovascular and cerebrovascular diseases, and diseases of the digestive organs. Diseases of the respiratory organs other than cancer were not overrepresented among the smokers, possibly because of the relatively young age of these subjects.

The association of smoking during the pregnancy with accidental deaths during the subsequent years was no less clear than that with traditional "tobacco related diseases" other than lung cancer. In a study of British male doctors accidents had a clear dose-response

Key messages

- Mortality among women who smoked when pregnant was 2·3 times that of non-smokers, the increase in risk being greater than among non-pregnant women who smoke
- In addition to causes of death related to tobacco intake excess mortality was also caused by accidents and suicides
- Health education about ill effects of tobacco or legal restrictions and controls on smoking behaviour will probably not alone lead to a cessation of smoking among women who smoke during pregnancy; they also need support to learn to cope more effectively with sources of stress in their lives
- Differences in lifestyle between smokers and non-smokers may also act as confounders which are difficult to control for when the health consequences of maternal smoking on the child are being evaluated

relation with smoking,[12] and the same was true in suicides in that series and in an American one.[13] Even though the association between deaths from accidents and suicides and smoking is a strong one and has dose-response characteristics, it is not usually regarded as a causal one but is attributed to one or more factors predisposing people to a mental state that increases both the prevalence of smoking and the risk of accidents and suicide.[12 13] We were able to control for several background variables as possible confounders, but there are a number of lifestyle factors which can be considered to be associated with both smoking and poor health and thereby with premature death from various causes, such as a risky occupation, unhealthy dietary habits, personal characteristics, attitudes to health, and stress of life, [14-16] which were not controlled for in this study. Thornton *et al* cast some doubt on the causal association between smoking and various causes of death; they reported that 27 out of 33 lifestyle factors generally considered to be associated with poor health were significantly more prevalent in heavy smokers than in subjects who had never smoked and that the prevalence of many of these factors increased with the amount smoked.[14]

The prevalence of smoking in our cohort was low, 15% compared with the figure of about 40% commonly found among parturient populations in Great Britain and the United States in the 1960s.[1] Smoking in women in Finland became common later than in many other countries and is still at a relatively low level, the prevalence being about 20% among those aged 15 to 64 years[17] compared with 30% in Great Britain.[18] Possibly when the prevalence is low, either as a result of effective health education or for more traditional reasons, those who start smoking may be more deviant in their behaviour than smokers in communities with a high prevalence of smoking. There was not as much health education against smoking in the mid-1960s as there is now, but smoking was clearly not associated with the idea of good motherhood according to traditional thinking. Therefore the smokers may have formed a subclass in each social or educational class or according to marital status, in which norm breaking and risk taking were more common, health consciousness less common, and life more stressful. When social status is measured only by years of education and marital status it obviously will leave quantitative residual confounding caused by the psychosocial aspects.[19]

The work by Graham focusing on women with young children in Britain in the 1990s highlights how cigarette smoking is linked with additional responsibilities for care and restricted access to material resources.[18] The results on the relation between stress of the social environment, smoking, and mortality studied in different states of the United States by a macrosocial approach suggested that a population that experiences more stressful events will smoke more heavily and has a higher smoking related mortality. The higher accidental and suicidal mortality in our cohort and in others[12 13] can be interpreted similarly.

Our results show that the women who smoked during pregnancy had a clearly increased risk of premature death relative to non-smokers, but they give us little opportunity to judge how much this was caused by smoking and how much by the different characteristics of those who smoked. This is of little importance from the point of view of preventive care, however, for if we simply attribute the ill effects mainly to smoking it may be said that this population has not benefited from health education about the ill effects of tobacco or the legal restrictions and controls on smoking behaviour and obviously will not do so in the future. A more effective form of prevention would be to prepare people to cope better with stress in their lives or to try to eliminate some of the stressful events or conditions that may be implicated both in smoking and in risk taking or other unhealthy behaviour.

It seems, too, that investigations into the health consequences of maternal smoking for the child entail more confounders than we can easily control for. In families where the mother is more often ill and is likely to die earlier, is less likely to take care of her own health, or may even show self destructive behaviour the differences in children's health and development, such as poorer school performance and retarded growth,[20-21] are not necessarily caused by maternal smoking as such but can just as well be accounted for by differences in maternal care.

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