

Cigarette smoking: an epidemiological overview

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The detailed mortality and morbidity statistics on smoking tend to conceal the overall impact of the habit on health. About 3 million people die each year from smoking in economically developed countries, half of them before the age of 70. Cancers of eight sites are recognized as being caused by smoking—lung cancer almost entirely and the others (upper respiratory, bladder, pancreas, oesophagus, stomach, kidney, leukaemia) to a substantial extent. Six other potentially fatal diseases are also judged to be caused by smoking: respiratory heart disease, chronic obstructive lung disease, stroke, pneumonia, aortic aneurysm and ischaemic heart disease, the most common cause of death in economically developed countries. Non-fatal diseases, such as peripheral vascular disease, cataracts, hip fracture, and periodontal disease, which cause appreciable disability, cost and inconvenience are also caused by smoking. In pregnancy, smoking increases the risk of limb reduction defects, spontaneous abortion, ectopic pregnancy, and low birth weight. While there are some diseases for which smoking shows a protective effect, the 'benefits' of these are negligible in relation to the illness and premature mortality caused by smoking. About 20% of all deaths in developed countries are caused by smoking; an enormous human cost which can be completely avoided.

Worldwide, about 3 million people currently die each year from smoking, half of them before the age of 70¹—an enormous human cost. What is so unusual is the social and political acceptability of this lethal habit. The tobacco industry is probably responsible for more premature deaths and illness than any other organized commercial enterprise, exceeding the destructive impact of the arms and illicit drugs industries.

There are about 1 billion smokers in the world today, one-third of whom live in China. Table 1 shows the average number of manufactured cigarettes consumed per day per adult for 22 developed countries². Smoking increased between 1945 and 1965 in all the countries, and from 1965 to 1985 it did not decline substantially in any of the countries and continued to increase in many. In 1985, 1650 billion cigarettes were sold in the countries listed in Table 1—double the figure in 1955. Since 1985, there has been a decline in consumption in a few countries. In the UK, for example, the total number of cigarettes sold declined from 98 billion in

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Table 1 Number of manufactured cigarettes consumed per day per adult (age 15 years or over) in 22 economically developed countries

	1945	1965 (relative to 1945)	1985 (relative to 1965)
Australia	1.6	7.3 (4.5)	6.3 (0.9)
Austria	1.3	5.3 (4.1)	6.9 (1.3)
Belgium	1.1	5.4 (4.9)	5.4 (1.0)
Canada	4.5	9.0 (2.0)	8.1 (0.9)
Denmark	1.1	4.1 (3.7)	5.1 (1.2)
Finland	2.1	5.4 (2.6)	4.7 (0.9)
France	1.2	4.1 (3.4)	6.0 (1.5)
Germany	0.7 [†]	5.8 (8.3)	6.4 (1.1)
Greece	2.3	5.3 (2.3)	9.7 (1.8)
Ireland	4.3	7.4 (1.7)	6.8 (0.9)
Israel	—	5.4 [#] (—)	6.4 (1.2)
Italy	1.8	4.2 (2.3)	6.3 (1.5)
Japan	0.9	6.4 (7.1)	9.0 (1.4)
The Netherlands	1.3 [‡]	5.6 (4.3)	3.8 (0.7)
New Zealand	2.7	6.3 (2.3)	6.3 (1.0)
Norway	0.6	1.4 (2.3)	1.9 (1.4)
Portugal	1.2	3.2 (2.7)	4.8 (1.5)
Spain	1.3	4.8 (3.7)	7.4 (1.5)
Sweden	1.3	3.7 (2.8)	4.5 (1.2)
Switzerland	3.2	8.5 (2.7)	8.1 (0.9)
UK	7.1	7.4 (1.0)	5.9 (0.8)
USA	7.0	10.5 (1.5)	8.7 (0.8)

[†]1948

[‡]1946

[#]1967

Data taken from reference 2.

1985 to just over 93 billion in 1992/93³. Consumption figures for economically developing countries are not readily available, but the increase in consumption of cigarettes in many of these countries has been substantial over the past 30 years. For example, in China about 700 cigarettes per adult were consumed in 1970. This increased dramatically to about 2000 per year in 1990/92 (A Lopez, personal communication).

This brief epidemiological overview covers the health effects of active cigarette smoking on the smoker and in pregnancy. In February 1985, the International Agency for Research on Cancer, part of the World Health Organization, convened a workshop which reported on tobacco smoking⁴. Since that report, new evidence has reinforced conclusions about diseases that were judged at that time to be caused by smoking. New evidence has also identified additional diseases caused by smoking (see *Cancers weakly related to smoking* in this issue).

In this chapter, we first examine *fatal* diseases that are positively associated with smoking, classifying them according to the extent to which the difference in incidence (or mortality) between smokers and non-smokers is a causal effect of smoking (Tables 2 and 3). We use three

Table 2 Fatal diseases positively associated with smoking—study of male British doctors⁵

Disease	Standardised mortality per 100,000 men/year		Relative risk (b/a)	Absolute excess risk per 100,000 men/year (b-a)	Attributable proportion [†] (%)
	Life-long non-smoker (a)	Current cigarette smoker (b)			
(i) Increased risk largely or entirely caused by smoking					
Cancer of:					
Lung	14	209	15.0	195	81
Upper respiratory sites	1	24	24.0	23	87
Bladder	13	30	2.3	17	28
Pancreas	16	35	2.2	19	26
Ischaemic heart disease	572	892	1.6	320	15
Respiratory heart disease	0	10	—	10	100
Aortic aneurysm	15	62	4.1	47	48
Chronic obstructive lung disease	10	127	12.7	117	78
(ii) Increased risk partly caused by smoking					
Cancer of:					
Oesophagus	4	30	7.5	26	66
Stomach	26	43	1.7	17	17
Kidney	9	13	2.1	4	25
Leukaemia	4	7	1.8	3	19
Stroke	152	203	1.3	51	8
Pneumonia	71	138	1.9	67	21
(iii) Increased risk due to confounding					
Cirrhosis of liver	6	32	5.3	26	—
Cancer of liver	7	11	1.6	4	—
Suicide	23	37	1.6	14	—
Poisoning	7	19	2.7	12	—
All diseases excluding those in category (iii)	907	1823	2.0	916	23
All diseases excluding those in categories (ii) & (iii)	612	1324	2.2	712	26

Results taken from reference 5.

[†]The proportion of all deaths from the specified disease attributable to smoking, assuming 30% of the population are current smokers and that all the excess risk in smokers is due to smoking. In Group (ii) the actual proportions will be somewhat less than those specified.

categories: (i) increased risk largely or entirely due to smoking; (ii) increased risk partly due to smoking; and (iii) increased risk due to confounding. We then consider non-fatal diseases under the first of these three categories (Table 4), disorders in pregnancy (Table 5), and finally diseases negatively associated with smoking (Table 6).

The International Agency for Research on Cancer (IARC) Report assessed the evidence on confounding and assigned the smoking related diseases to one of these three categories. For some smoking related diseases, such as lung cancer and peripheral vascular disease, the excess incidence or mortality is almost entirely caused by smoking. For most diseases, part of the association is likely to be attributable to confounding, as smoking is correlated with a number of dietary and other factors that also cause disease. In Table 2, for example, alcohol is

Table 3 Fatal diseases positively associated with smoking—American Cancer Society (CPSII). Men and women aged 35 years or more

		Standardised mortality per 100,000/year [#]		Relative risk	Absolute excess risk per 100,000 per year	Attributable proportion [†] (%)
		Life-long non-smoker	Current cigarette smoker			
(i) Increased risk largely or entirely caused by smoking						
Cancer of:						
Lung	M	24	537	22.4	513	87
	F	18	213	11.9	195	77
Upper respiratory sites	M	1	27	24.5	26	89
	F	2	10	5.6	8	58
Bladder and other urinary organs	M	18	53	2.9	35	36
	F	8	21	2.6	13	32
Pancreas	M	18	38	2.1	20	25
	F	16	37	2.3	21	29
Ischaemic heart disease	M	500	970	1.9	470	22
	F	386	688	1.8	302	19
Aortic aneurysm [‡]	M	24	98	4.1	74	48
	F	11	52	4.6	41	52
Chronic obstructive pulmonary disease	M	39	378	9.7	339	72
	F	21	216	10.5	195	74
(ii) Increased risk partly caused by smoking						
Cancer of:						
Oesophagus	M	9	68	7.6	59	66
	F	4	41	10.3	37	74
Kidney	M	8	23	3.0	15	37
	F	6	8	1.4	2	11
Cerebrovascular lesions	M	147	328	2.2	181	27
	F	236	434	1.8	198	20
(iii) Increased risk due to confounding						
Cancer of cervix						
	F	8	18	2.1	10	—
All diseases excluding those in category (iii)	M	788	2520	3.2	1732	40
	F	708	1720	2.4	1012	30
All diseases excluding those in categories (ii) or (iii)	M	588	2010	3.4	1422	42
	F	438	1179	2.7	741	34

Relative risks taken from the American Cancer Study (CPSII)[‡].

[#]Calculated using the published relative risk, the mortality in the population aged ≥ 35 years[#] and assuming that 30% of the population are current smokers.

[†]The proportion of all deaths from the specified disease attributable to smoking, assuming 30% of the population are current smokers and that all the excess risk in smokers is due to smoking. In Group (ii) the actual proportions will be somewhat less than those specified.

[‡]Taken from American Cancer Society (CPSII)[‡].

also a cause of stroke and oesophageal cancer, and smokers, on average, drink more alcohol than non-smokers. Alcohol also predisposes to falls and hip fracture (Table 4), as does lack of exercise, and smokers may on average exercise less. For diseases in which confounding plays a role, the effect of smoking and a confounding factor, such as alcohol, often tends to act synergistically so that those who do not smoke avoid most of the excess risk.

Table 4 Non-fatal diseases positively associated with smoking

Disorder	Incidence per 100,000/year [†]		Relative risk	Absolute excess risk per 100,000/year	Attributable proportion [†] (%)	Reference
	Life-long non-smoker	Current smoker				
(i) Increased risk largely or entirely caused by smoking						
Peripheral vascular disease (age 45–74 years)	150	300	2.0	150	23	11
(ii) Increased risk partly caused by smoking						
Cataracts (men aged 40–84 years)	247	543	2.2	296	26	12
Crohn's disease	5	15	2.1	10	25	13
Gastric ulcer (aged 20–61 years, Norway)	60	201	3.4	141	42	14
Duodenal ulcer (aged 20–61 years, Norway)	61	250	4.1	189	48	14
Hip fracture (aged ≥ 65 years)	453	587	1.3	134	8	15
Periodontitis (aged 19–40 years)[Prevalence]	22,500	67,000	3.0	44,500	38	16

[†]The proportion of all deaths attributable to smoking, assuming 30% of the population are current smokers and that all the excess risk in smokers is due to smoking. In Group (ii) the actual proportion will be somewhat less than those specified.

Fatal diseases

Table 2, based on data on male British doctors⁵, shows the mortality in cigarette smokers and life-long non-smokers. The relative risk and the absolute excess risk in cigarette smokers is given for each disease, together with the attributable proportion—the proportion of all deaths for each specified disease that is due to smoking. Cancers of eight sites (considering upper respiratory cancers [lip, tongue, mouth, pharynx and larynx] as one site) are recognized as being caused by smoking. The increased risks of cancer of the bladder and cancer of the pancreas are now considered to be largely due to smoking⁶. Six other diseases are judged to be caused by smoking, including ischaemic heart disease, the most common cause of death in economically developed countries. Smoking is responsible for much of the disease specified in categories (i) and (ii), for example, over 75% of deaths from lung cancer and chronic obstructive lung disease. Smoking causes more deaths from ischaemic heart disease than any other disease; about 35% of all the excess deaths for the diseases specified in Table 2 (320/916) per 100,000. Overall, the death rate in cigarette smokers from all the specified diseases is double that in life-long non-smokers.

Table 3 is similar to Table 2 but based on the American Cancer Society study of over 1 million men and women aged 35 years and over⁷. The results are similar to those from the British Doctors' study, although the relative risk for stroke is larger (2.2 compared with 1.3), probably because the men in the Doctors' study were older and the relative risk of stroke decreases in older men. The table shows that, for most diseases,

Table 5 Disorders in pregnancy positively associated with smoking

Disorder	Incidence per 100,000/year [†]		Relative risk	Absolute excess risk per 100,000/year	Attributable proportion [†] (%)	Reference
	Life-long non-smoker	Current smoker				
Congenital limb reduction defects (births)	41	87	2.10	46	25	17
Spontaneous abortion	13,838	17,712	1.28	3874	8	18
Ectopic pregnancy [#]	441	971	2.20	530	26	19

[†]The proportion of all deaths attributable to smoking, assuming 30% of the population are current smokers and that all the excess risk in smokers is due to smoking. The actual proportion will be somewhat less than those specified if not all excess is due to smoking.

[#]It is uncertain how much of the association is causal; at least part of it is likely to be due to confounding.

the relative risk in women is similar to that in men. The relative risk for cervical cancer is 2.1 but the increase in risk may be largely due to confounding⁹; number of sexual partners is associated with the risk of cervical cancer and there is a strong relationship between the number of partners and current smoking¹⁰ (see also the chapter *Cancers weakly related to smoking* by R Doll in this issue).

Non-fatal diseases

Table 4, based on various sources, is similar to Tables 2 and 3 but relates to diseases associated with smoking that are not usually fatal. Some diseases, such as peripheral vascular disease, are recognised to be caused by smoking, but others, such as cataracts, which cause appreciable disability, are less recognised. The relative risk of hip fracture in smokers compared with non-smokers is modest (1.3) but the frequency of the disorder means that smoking accounts for many cases. Periodontal disease is the major cause of teeth loss in adults, affecting nearly a quarter of non-smokers. The risk in smokers is substantial (relative risk of 3) and smoking accounts for about 40% of all periodontitis in communities in which about one-third of adults smoke. Some of this increase in risk may be due to confounding, for example, smokers brushing their teeth infrequently, but it is likely that a major part of the association is causal.

Disorders in pregnancy

Table 5 shows three disorders positively associated with smoking. A rare but serious hazard is congenital limb reduction defects in which part or all of a limb can fail to develop; the risk with maternal smoking is double

Table 6 Diseases negatively associated with smoking

Disease	Incidence (or deaths) per 100,000/year		Relative risk	Reference
	Non-smoker	Current (or ever) smoker		
Parkinson's (deaths)	8	4	0.50	21
Ulcerative colitis	16	13	0.70	13
Alzheimer's (aged over 65 years)	8286	5667	0.70	22
Endometrial cancer (women over 60 years)	230	110	0.50	23
Pre-eclampsia (births)	507	331	0.65	24
Down's syndrome (births)	147	90	0.60	25
Uterine fibroids (women aged 25–39)	3473	2430	0.70	26
Vomiting during pregnancy (hyperemesis gravidarum)	864	517	0.60	26

that in non-smokers. Spontaneous abortion occurs in about 15–20% of all pregnancies and although the proportion attributable to smoking is modest (28% increase) it accounts for almost 4000 cases per 100,000 women who smoke. The risk of having an ectopic pregnancy is double that in smokers—as many as a quarter of cases may be caused by smoking if all the excess is causal.

It has also been demonstrated that babies of smoking mothers weigh, on average, 150–250 g less at birth¹⁸. The association has been shown to be causal since randomised trials of smoking cessation in pregnancy have shown that birth weight can be increased¹⁸. Smoking is an important hazard in pregnancy.

Diseases less common in smokers

Table 6 summarises diseases that show a negative association with smoking. Much of the evidence is summarised in Wald and Baron²⁰ (see also the chapter *Protective effects of tobacco* by J Baron in this issue). There is a remarkable consistency in the data on smoking and Parkinsonism²¹—smokers have about half the risk of non-smokers. Most of the reduction is probably causal; there are no grounds for concluding that bias or confounding explains the association and there is a plausible pharmacological explanation for the association; nicotine stimulates dopamine release, which can ameliorate the disease. Smoking also reduces the risk of endometrial cancer—probably because of the anti-oestrogenic effect of smoking²³, smokers again having about half the risk of non-smokers. The position on Alzheimer's disease is uncertain. The summary relative risk from eight case-control studies (0.78) and one

cohort study (0.70) are not very different from unity, so bias or confounding could be an explanation, and even chance cannot be totally excluded.

Smoking probably has a protective effect on ulcerative colitis¹³, which contrasts with the increased risk of Crohn's disease (Table 4). The effect is consistent, though modest in size; the relative risk in case-control studies is about 0.5 and in two cohort studies it is about 0.7. The latter estimate is cited in Table 6. It is not widely recognised that the birth prevalence of Down's syndrome is lower in women who smoke than in non-smokers; relative risk 0.60, 95% CI 0.44–0.81 (based on a review of five studies²⁵ and supplemented by a further unpublished study provided as a personal communication by G Palomaki). The most likely explanation is that smoking increases the risk of miscarriage and this has a disproportionate effect in Down's syndrome pregnancies compared with unaffected pregnancies.

Taken as a whole, the 'benefits' arising from the protective biological effects of smoking are quantitatively much smaller and considerably less serious than illness and premature mortality caused by smoking.

Conclusion

The detailed mortality and morbidity statistics on smoking tend to conceal the overall impact of the habit on health. In Britain, for example, about one-third of adults smoke and half of these smokers will die of the habit, over one-third before the age of 65 years. In 1995, the total number of deaths attributed to smoking is estimated as 150,000 in the UK, over half a million in the USA, and in all developed countries about 2 million²⁷. About 20% of all deaths in these countries are smoking-induced. The overall morbidity is more difficult to quantify but many millions of people will suffer illness and disability due to smoking. While the trend in cigarette consumption in some countries such as the UK is downward, this is not so in many countries. In every continent of the world, the public health impact of cigarette smoking is immense — a pandemic that is completely avoidable.

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