

# Mortality from smoking worldwide<sup>a</sup>

**Richard Peto\***, **Alan D Lopez†**, **Jillian Boreham\***, **Michael Thun§**,  
**Clarke Heath Jr§** and **Richard Doll\***

\*ICRF/MRC/BHF Clinical Trial Service Unit & Epidemiological Studies Unit, Harkness Building, Radcliffe Infirmary, Oxford, UK, †Tobacco or Health, World Health Organization, Geneva, Switzerland, §Epidemiology Unit, American Cancer Society, Atlanta, Georgia, USA

<sup>a</sup>Adapted from Peto *et al.* (1994)<sup>1</sup>

Estimates are made of the numbers and proportions of deaths attributable to smoking in 44 developed countries in 1990. In developed countries as a whole, tobacco was responsible for 24% of all male deaths and 7% of all female deaths, rising to over 40% in men in some former socialist economies and 17% in women in the USA. The average loss of life for all cigarette smokers was about 8 years and for those whose deaths were attributable to tobacco about 16 years. Trends in mortality attributable to tobacco differed between countries. In some the mortality in middle age (35–69 years) had decreased by half in men since 1965; in others it was continuing to increase. In women, the proportion was mostly increasing, almost universally in old age. Mortality not attributable to smoking decreased since 1955 in all OECD (Organization for European Collaboration and Development) countries, by up to 60% in men and more in women. No precise estimate can be made of the number of deaths attributable to smoking in undeveloped countries, but the prevalence of smoking suggests that it will be large. In the world as a whole, some 3 million deaths a year are estimated to be attributable to smoking, rising to 10 million a year in 30–40 years' time.

For the past few decades it has been widely known in developed countries that tobacco is dangerous; but it is still insufficiently widely known how large these dangers are. This is partly because of the failure to take account of the very long delay, perhaps lasting several decades, between starting to smoke and its full effect and partly because of the failure to recognize the very many different effects that smoking may have. Studies that would provide a direct estimate of the proportion of deaths in each country that is attributable to smoking might in principle be straightforward, but would in practice be extremely costly and time-consuming. It is possible, however, to provide estimates of the number of deaths attributable to smoking in developed countries by an indirect method, based on published vital statistics, and to estimate very roughly the

number that is likely to occur worldwide in the early part of the next century, based on the current smoking patterns of young people.

We have, therefore, provided, for those interested in public health, estimates of the proportion of deaths attributable to smoking in each of the major populations that are classed by the United Nations as 'developed' (including the 15 newly independent countries that constituted the former USSR), and rounded estimates of the numbers of deaths that may be expected worldwide in the next few decades, if smoking habits are unaltered. We also give, for the developed countries, the trends in the estimated death rates attributable to smoking and those that may be deduced for deaths due to other causes in the absence of tobacco. The data are presented in greater detail elsewhere<sup>1</sup>.

## Mortality in developed countries

### *Deaths attributable to smoking*

To estimate the number of deaths attributable to smoking in each country we have, first, compared the national lung cancer mortality rates with the rates that have been observed among US non-smokers and used the **absolute excess mortality** from lung cancer as an indication of the extent to which that population was being damaged by tobacco. This is justified, because in developed countries lung cancer is very closely related to smoking and so seldom caused by any other factor among non-smokers. Secondly, we used this lung cancer excess as a guide to the **fractions of the deaths** from other causes that could be attributed to tobacco, calibrating this relationship by epidemiological evidence from the massive cohort study of a million men and women carried out by the American Cancer Society in the 1980s<sup>2</sup>. Details of the method are described elsewhere<sup>3</sup>.

The number of premature deaths estimated in this way to occur as a result of smoking is enormous. In males, it amounted in 1990 to 24% of all deaths in all developed countries combined and 35% in middle age (defined for this purpose as 35–69 years of age). In females, the proportion amounted to 'only' 7% (or 12% at ages 35–69), but these proportions are increasing. Indeed, in the few countries where women have smoked cigarettes regularly for several decades, the proportion of female deaths that is attributed to tobacco is now approaching the male figure. In the US, for example, the proportions of the male and female deaths in 1990 that were attributed to tobacco are, respectively, 26 and 17%. Elsewhere, the number of female deaths now attributed to smoking is still relatively small, for few of the middle-aged or older women are regular cigarette smokers. In many countries (such as France, The

**Table 1** Number and percentage of deaths attributed to smoking in OECD developed countries in 1990

Country	Number of deaths in thousands (% in parentheses)					
	Males			Females		
	Aged (years)		All ages	Aged (years)		All ages
	35-69	70+		35-69	70+	
Australia	6.7 (28)	7.3 (21)	14.0 (22)	1.9 (15)	3.1 (8)	5.0 (9)
Austria	4.0 (28)	3.6 (16)	7.5 (20)	0.6 (7)	1.5 (4)	2.0 (5)
Belgium	7.9 (41)	8.6 (28)	16.5 (31)	0.7 (6)	0.6 (1)	1.2 (2)
Canada	13.5 (35)	14.1 (24)	27.6 (27)	5.0 (23)	7.0 (11)	12.1 (14)
Denmark	3.3 (32)	4.3 (22)	7.6 (25)	1.8 (27)	2.6 (11)	4.4 (15)
Finland	2.6 (25)	2.7 (21)	5.3 (21)	0.2 (5)	0.5 (3)	0.8 (3)
France	32.6 (32)	24.5 (16)	57.1 (21)	1.0 (2)	1.2 (1)	2.2 (1)
Germany	52.0 (32)	43.3 (18)	95.3 (22)	6.2 (7)	10.4 (3)	16.5 (3)
Greece	5.2 (33)	5.2 (17)	10.4 (21)	0.4 (5)	0.9 (3)	1.3 (3)
Ireland	1.7 (31)	2.5 (24)	4.2 (25)	0.7 (20)	1.6 (15)	2.3 (16)
Italy	37.8 (37)	34.9 (21)	72.7 (26)	2.7 (5)	7.4 (4)	10.1 (4)
Japan	26.8 (16)	41.5 (16)	68.3 (15)	3.6 (4)	15.4 (6)	19.0 (5)
Luxembourg	0.2 (34)	0.3 (25)	0.5 (27)	<0.1 (9)	<0.1 (1)	0.1 (3)
The Netherlands	8.6 (38)	13.0 (32)	21.6 (32)	1.4 (11)	1.3 (3)	2.7 (4)
New Zealand	1.4 (28)	1.7 (22)	3.1 (22)	0.7 (21)	0.8 (9)	1.4 (11)
Norway	1.4 (21)	1.9 (12)	3.4 (14)	0.4 (12)	0.6 (3)	1.0 (5)
Portugal	4.0 (21)	2.8 (9)	6.8 (13)	0.0 (0)	0.0 (0)	0.0 (0)
Spain	20.5 (33)	19.4 (19)	40.0 (23)	0.0 (0)	0.0 (0)	0.0 (0)
Sweden	2.1 (16)	3.2 (9)	5.3 (11)	0.7 (10)	1.3 (3)	2.0 (4)
Switzerland	3.1 (31)	3.7 (18)	6.8 (21)	0.3 (6)	0.9 (3)	1.2 (4)
UK	37.2 (35)	52.1 (27)	89.4 (28)	16.4 (24)	32.1 (13)	48.5 (15)
USA	150.0 (36)	136.2 (23)	286.3 (26)	72.7 (28)	102.1 (14)	174.9 (17)
All	423.5 (32)	427.8 (20)	851.3 (23)	117.7 (16)	191.6 (7)	309.3 (9)

Netherlands and Sweden), however, there have been large absolute increases in cigarette use by young women in the past few decades, foreshadowing large increases in female mortality from the habit early next century. Individual figures for the 22 developed countries participating in the Organization for Economic Collaboration and Development (OECD) are shown in Table 1 for two age groups and all ages in both sexes and similar data are shown for the 22 countries formerly with socialist economies (FSE) in Table 2. In both sets it is assumed that no death is caused by smoking under 35 years of age. In fact, a few are so caused, but the numbers are small and do not affect the overall percentages. The high proportions of premature deaths attributable to tobacco that are shown in the tables lead to the conclusion that the average loss of life for those killed by tobacco in developed countries in 1990 was about 16 years (17 years in the countries with former socialist economies and 14 years in the OECD countries). Since about half of all regular smokers in developed countries are eventually killed by the habit, teenagers or young adults who become regular cigarette

**Table 2** Number and percentage of deaths attributed to smoking in former socialist economies in 1990

Country	Number of deaths in thousands (% in parentheses)					
	Males			Females		
	Aged (years)		All ages	Aged (years)		All ages
	35-69	70+		35-69	70+	
Armenia	2.2 (38)	0.5 (13)	2.8 (23)	0.2 (6)	<0.1 (1)	0.3 (3)
Azerbaijan	2.7 (24)	0.5 (8)	3.1 (14)	0.0 (0)	0.0 (0)	0.0 (0)
Belarus	11.0 (39)	3.1 (16)	14.1 (26)	0.3 (2)	0.1 (<1)	0.4 (1)
Bulgaria	8.2 (30)	2.2 (7)	10.4 (17)	0.5 (3)	0.4 (1)	0.9 (2)
Czech Rep	13.3 (42)	6.1 (19)	19.4 (29)	1.4 (9)	1.5 (3)	2.9 (5)
Estonia	1.9 (38)	0.5 (15)	2.4 (26)	0.2 (6)	0.1 (2)	0.3 (3)
Georgia	2.8 (24)	0.7 (9)	3.5 (15)	0.1 (2)	<0.1 (<1)	0.1 (1)
Hungary	16.0 (41)	6.5 (19)	22.5 (29)	3.1 (14)	3.1 (7)	6.0 (9)
Kazakhstan	15.2 (43)	3.7 (22)	18.9 (28)	2.3 (12)	1.9 (6)	4.2 (7)
Kyrgyzstan	2.0 (28)	0.7 (17)	2.7 (17)	0.2 (4)	0.3 (5)	0.5 (4)
Latvia	3.3 (38)	1.0 (15)	4.3 (25)	0.3 (6)	0.3 (2)	0.6 (3)
Lithuania	3.8 (38)	1.4 (17)	5.2 (25)	0.2 (3)	0.4 (3)	0.6 (3)
Moldova (Rep)	3.5 (31)	0.7 (10)	4.3 (20)	0.3 (3)	0.3 (3)	0.6 (3)
Poland	44.6 (42)	15.3 (18)	59.9 (29)	5.1 (10)	4.4 (4)	9.5 (5)
Romania	19.6 (32)	4.2 (8)	23.8 (18)	2.2 (6)	0.8 (1)	2.9 (3)
Russian Fedn	191.9 (42)	48.6 (20)	240.5 (30)	16.4 (7)	19.3 (3)	35.7 (4)
Slovakia	5.8 (38)	1.9 (15)	7.7 (26)	0.3 (4)	0.4 (2)	0.7 (3)
Tajikistan	0.7 (14)	0.2 (6)	1.0 (5)	0.0 (0)	0.0 (0)	0.0 (0)
Turkmenistan	1.1 (22)	0.2 (6)	1.3 (9)	0.0 (0)	0.0 (0)	0.0 (0)
Ukraine	64.4 (40)	19.5 (17)	83.9 (28)	5.9 (6)	8.5 (4)	14.5 (4)
Uzbekistan	4.7 (20)	0.9 (5)	5.6 (8)	0.7 (5)	0.5 (2)	1.3 (2)
Yugoslavia (former)	19.4 (36)	6.3 (13)	25.7 (23)	2.0 (6)	1.6 (2)	3.6 (4)
<b>All</b>	<b>441.2 (39)</b>	<b>126.3 (17)</b>	<b>567.5 (26)</b>	<b>42.1 (7)</b>	<b>44.4 (3)</b>	<b>86.5 (4)</b>

smokers must be reducing their life expectancy by the substantial amount of about 8 years. An 8 year loss of life expectancy for cigarette smokers is also indicated by the most recent evidence from the 40 year study of smoking and death among British doctors<sup>4</sup>.

### Trends in mortality attributed to smoking and to other causes

Two further sets of estimates are of special interest. The first shows the trends over the whole of the second half of this century in the absolute death rates attributed to smoking in two age groups in each sex. To obtain these trends, estimates of the proportions of deaths attributable to smoking have been derived by the same method from the cause-specific mortality rates published for the years 1955, 1965, 1975, 1985 and 1990. For the purpose of predicting what is likely to happen in the future, the trends at ages 35-69 years are of greater interest, as the trends at

**Table 3** Trend in mortality attributed to smoking by sex and age: various populations

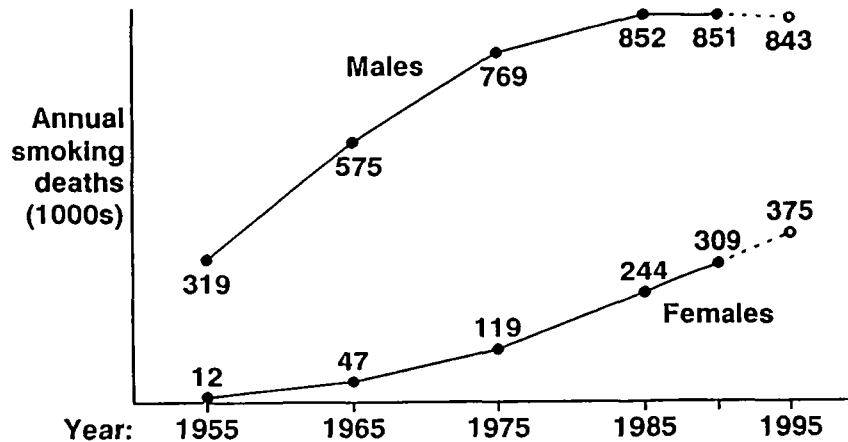
Population	Age (yrs)	Annual mortality attributable to smoking per 1000									
		Males					Females				
		1955	1965	1975	1985	1990	1955	1965	1975	1985	1990
Finland	35-69	6.53	7.50	6.11	4.65	3.35	0.15	0.00	0.05	0.31	0.24
Hungary	35-69	2.56	3.72	4.41	7.09	8.48	0.32	0.45	0.45	1.02	1.29
Ireland	35-69	2.73	4.20	4.80	4.58	3.59	0.66	0.77	1.46	1.44	1.30
Portugal	35-69	0.70	1.19	1.76	2.06	2.47	0.00	0.00	0.00	0.00	0.00
UK	35-69	6.51	7.32	6.22	4.78	3.79	0.55	0.96	1.35	1.60	1.53
US	35-69	3.27	4.75	4.91	4.36	4.13	0.06	0.39	1.08	1.66	1.78
OECD* countries	35-69	2.83	4.03	4.08	3.58	3.24	0.09	0.28	0.54	0.79	0.80
FSE* countries	35-69	3.61	4.47	5.49	7.07	7.31	0.26	0.32	0.42	0.54	0.55
Finland	70-79	12.60	19.42	20.02	19.15	15.55	0.00	0.00	0.23	1.15	1.29
Hungary	70-79	3.25	10.29	17.94	19.44	17.80	0.45	2.10	2.95	3.41	4.25
Ireland	70-79	2.03	7.56	15.67	19.85	18.13	0.00	1.63	3.99	7.61	7.38
Portugal	70-79	1.82	2.33	3.91	6.29	7.36	0.00	0.00	0.00	0.00	0.00
UK	70-79	13.13	21.60	26.40	22.78	18.90	0.93	1.91	3.63	5.85	6.35
US	70-79	3.98	8.90	13.51	14.61	14.48	0.00	0.20	1.58	4.52	6.06
OECD* countries	70-79	4.41	9.47	14.32	14.22	13.09	0.13	0.51	1.23	2.52	3.21
FSE* countries	70-79	6.05	8.87	12.37	15.36	15.35	0.33	0.46	1.05	1.64	2.02

\*Organization for Economic Collaboration and Development and Former Socialist Economy countries

older ages will be more dependent on changes that took place in the distant past and, in some countries, are also less reliable, because the causes of death will have been less fully investigated. Trends in both age groups and both sexes for selected countries and groups of countries are shown in Table 3. Those for the other countries studied are generally similar or less marked. In some, the mortality in men attributed to smoking has decreased substantially, notably in the UK and Finland, in both of which it has decreased by about half at ages 35-69 years since 1965 and by about a quarter at ages 70-79 years since 1975. In others, notably in Hungary and Portugal, the mortality attributed to smoking has increased throughout, or, in the older age group, to at least 1985. In women, small decreases in the younger age group have been seen in a few countries, notably in Ireland where the rate has decreased by over 10% since 1975, but the rate at older ages in countries where any substantial proportion of women has been smoking for more than two decades is almost universally continuing to increase. In OECD countries as a group, the trends have been similar to those in the US, except that there has been slightly more indication of a decrease in older men and a less marked increase in women, while the trends in the former socialist economy countries as a group have been broadly similar to those in Hungary.

Owing to the increasing size of the world population and the increasing proportion of old people, the increase in the number of deaths attributable to smoking is proportionately greater than the increase in the death rate attributable to it. The estimated increase in

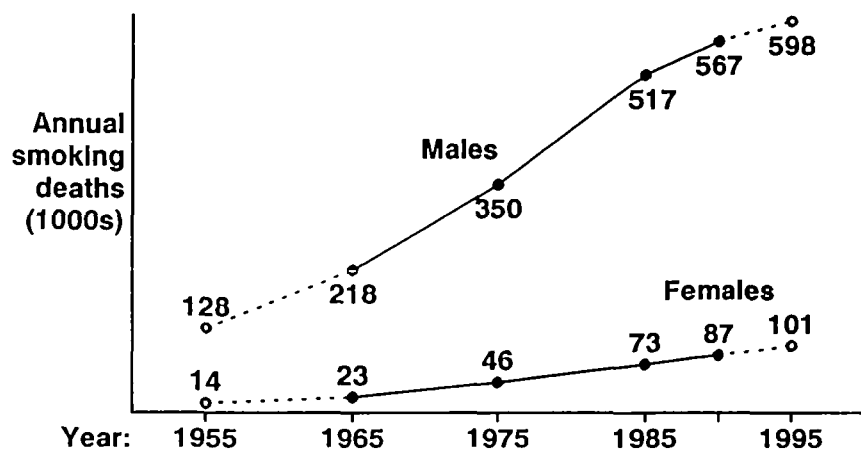
**Fig. 1** Smoking-attributed numbers of deaths per year (all ages) in Organization for Economic Collaboration and Development countries<sup>1,3</sup>



deaths is shown in Figures 1 and 2, which give the numbers for 6 years between 1955 and 1995 for each sex in, respectively, OECD and FSE countries, the last numbers (for 1995) having been derived by extrapolation of the trends in the sex and age-specific death rates between 1985 and 1990.

The second set of estimates shows the trends in mortality that remain when the death rates attributed to smoking are subtracted from the overall death rates. These indicate what the underlying patterns might have been in the absence of tobacco. The results are given in Table 4 for the eight populations for which the trends in mortality attributable to smoking were shown in Table 3. In the OECD countries, the mortality in both age groups decreased by over 40% in men and by over 50% in women. Similar decreases occurred with minor variation in all the

**Fig. 2** Smoking-attributed numbers of deaths per year (all ages) in Former Socialist Economy countries<sup>1,3</sup>



**Table 4** Trend in mortality not attributable to smoking by sex and age: various populations

Population	Age (yrs)	Annual mortality not attributable to smoking per 1000									
		Males					Females				
		1955	1965	1975	1985	1990	1955	1965	1975	1985	1990
Finland	35-69	13.24	11.99	11.21	9.50	9.30	9.84	8.82	6.65	4.99	4.75
Hungary	35-69	11.30	10.26	11.27	12.50	12.28	9.81	8.26	8.14	8.11	7.76
Ireland	35-69	11.75	10.07	9.51	8.38	7.90	10.12	8.06	6.88	5.59	5.01
Portugal	35-69	15.18	13.54	13.06	9.83	9.58	9.27	7.79	7.06	5.67	5.51
UK	35-69	9.34	8.23	7.98	7.34	6.93	8.33	7.01	6.13	5.22	4.73
US	35-69	12.92	11.97	9.57	7.62	7.06	9.16	8.25	6.10	4.84	4.40
OECD* countries	35-69	12.17	11.06	9.31	7.45	6.82	8.98	7.73	6.18	4.74	4.24
FSE* countries	35-69	14.05	10.64	11.67	11.92	11.48	10.00	7.56	7.74	7.94	7.50
Finland	70-79	82.48	73.79	61.73	55.50	50.85	71.79	69.45	48.65	38.68	35.31
Hungary	70-79	73.36	74.10	68.82	68.70	64.06	65.98	61.73	56.35	52.04	47.70
Ireland	70-79	80.54	68.83	62.49	60.45	52.77	70.77	56.73	48.49	38.53	33.19
Portugal	70-79	88.89	80.43	75.93	60.59	57.31	65.89	59.75	53.69	40.57	38.98
UK	70-79	75.22	62.44	56.00	49.86	45.66	57.45	48.78	41.99	34.67	30.58
US	70-79	67.48	63.35	53.59	44.85	40.29	50.74	44.72	35.95	28.94	25.55
OECD* countries	70-79	72.39	66.92	57.90	47.51	41.96	57.14	50.32	42.21	32.32	27.79
FSE* countries	70-79	69.47	60.42	61.69	68.13	62.35	53.43	48.15	48.42	51.28	46.73

\*Organization for Economic Collaboration and Development and Former Socialist Economy countries

constituent countries, except that in Japan the mortality in men decreased by about 60% (61 and 57% in the two age groups) and by about two thirds in women (69 and 63% in the two age groups). In the former socialist economy countries, in contrast, the reduction was small (between 10-25%) and occurred principally in the first 10 years (1955 to 1965).

Modern medicine and the social conditions that a developed country can provide have not yet reduced mortality in middle age anywhere to the same extent that they have done in youth. The figures presented here, however, provide encouraging evidence that, in the absence of smoking, the achievements in many countries have been greater than is commonly thought. Death in old age is inevitable, but death before old age is not. In previous centuries, 70 years used to be regarded as humanity's allotted span of life and only about one in five survived to such an age. Nowadays, however, for non-smokers in 'OECD' developed countries, the situation is reversed. In the absence of tobacco, only about one in five will die before 70, and the non-smoker death rates are still decreasing, offering the promise of a world where death before 70 is uncommon.

## Number of deaths attributable to smoking worldwide

In the present century, most of the deaths from smoking have been in developed populations, but next century the opposite will be true. The

annual number of deaths from smoking is still increasing in the developed populations, but it will be increasing even faster elsewhere. There has, over the past few decades, been a massive global increase in cigarette consumption, which will have its chief effects on mortality in the next century. Estimates are therefore needed not only of the current health effects of past smoking patterns, but of the far larger future health effects of current smoking patterns. These were discussed in 1989 by a WHO collaborative group<sup>5</sup>, the conclusions of which are summarised below.

Although more accurate information, particularly about the exact evolution of this epidemic, would still be very desirable, the order of magnitude of the current problem in developed countries has been reasonably reliably established. From Tables 1 and 2, the total number of deaths caused by tobacco was estimated to be over 1.8 million in 1990, so that, with allowance for an increased number of old people, tobacco must be expected to cause about 20 million deaths during the last decade of this century. At present most of these deaths from tobacco are male, but in many such countries female mortality from tobacco will eventually increase substantially as well, due to the large increases in female smoking over the past few decades.

For most developing countries the assessment of tobacco-attributable mortality is more difficult. Cigarette sales have increased substantially in recent years (much the largest absolute increase being in China), the male prevalence of smoking now exceeds 50% in many parts of the developing world (although the female prevalence is generally low), and chronic disease mortality rates are already high in many parts of Asia and Latin America. Overall, it was estimated that during the 1990s, the annual number of deaths from tobacco in the developing world would be about 1 million (including several hundreds of thousands in China, plus several hundreds of thousands in India and elsewhere), although this total is necessarily somewhat uncertain. When both developed and developing countries are taken together, tobacco is estimated to be responsible for an average of about 3 million deaths a year worldwide during the 1990s, with a range of uncertainty of perhaps 2–4 million.

At present there are 2.3 billion children and teenagers in the world and, on current smoking patterns, about 30–40% (i.e. about 0.8 billion) will be smokers in early adult life. A large recent prospective study in the US<sup>2,3</sup> indicated that, on average, persistent smokers have more than double the age-standardised death rates of lifelong non-smokers. If smoking caused a 2-fold excess at all ages it would eventually kill about half of all smokers. Not all the excess mortality associated with smoking is actually caused by smoking, however (although the greater part of it is), the mortality ratio beyond 75 years of age may be less than 2-fold, and the death rates from some unrelated causes (e.g. infectious diseases) are higher in developing countries than in the US. Consequently, the



proportion of persistent smokers eventually killed by the habit in developing countries will probably be somewhat less than the proportion of about one-half that is suggested by the North American study. Even if the proportion is 'only' about one-third, however, then about 250 million of these 800 million future smokers will be killed by the habit.

If, on current smoking patterns, 200–300 million of those born in a 20-year period (e.g. 1970 to 1990) will be killed by tobacco, then at some stage around the middle of the next century (when the majority of these deaths will occur) the average annual number of deaths from tobacco must be about 1/20th of this, or about 10–15 million, and at some earlier stage the average annual number of deaths from tobacco will, therefore, be about 10 million. The uncertainty is not whether, but when, the annual total will, on present smoking patterns, be about 10 million—perhaps in the 2020s, but perhaps not until the 2030s. If the epidemic grows as rapidly in other developing countries as it seems to be doing in China<sup>6</sup>, then the date might be earlier rather than later. Between 1978 and 1992, Chinese annual consumption of manufactured cigarettes increased from 500 billion to 1700 billion (about 30% of the world total) and cigarette tar levels were high; case-control studies in China have already shown large effects of prolonged smoking on the risk of lung cancer, and the 'background' death rates among non-smokers are already unusually high from diseases such as emphysema and cancer of the oesophagus (which suggests that among Chinese smokers the habit will cause particularly large hazards from these diseases). Indeed, the unpublished evidence from the nationwide 'spouse-control' study by Liu Boqi *et al.* of several hundred thousand Chinese deaths (plus the same number of controls) suggests that tobacco is already causing about half a million deaths a year in China, of which about half are due to chronic lung disease (Peto and Liu Boqi, personal communication).

If annual mortality from tobacco rises from about 3 million in the 1990s to about 10 million in the 2020s or early 2030s, then the average mortality over this 40-year period will be intermediate between 30–100 million per decade. Since most of those dying from smoking over the next 40 years (plus some of those dying from it more than 40 years hence) are already adults in 1990, about 200–300 million of today's 3 billion adults can be expected eventually to die from tobacco.

Combining the estimates for those now under 20 and for those now over 20 years of age, we estimate that, on present smoking patterns, about half a billion of the world's current population will eventually be killed by tobacco, and current experience in developed countries suggests that about half of them will be 35–69 years of age when killed. These predictions will be substantially wrong only if there are substantial changes in global smoking patterns.

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