Cigarette Use and the Narrowing Sex Differential in Mortality

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AFTER WIDENING FOR nearly 100 years, the sex differential in mortality has begun to narrow over the last decade or two in many high-income Western countries. A brief and general history of the sex differential in mortality begins in preindustrial societies, where few differences existed in male and female life expectancy in large part because of the poor conditions experienced by women during adolescence and young adulthood (Vallin 1991). By the 1880s in some early-industrializing countries and by World War I in most other industrializing countries, the female advantage began its steady growth (Stolnitz 1957). The upward trend in the female advantage accelerated during the 1950s and 1960s, with middle-aged males unexpectedly experiencing rising death rates from coronary heart disease and females at all ages and for nearly all causes experiencing falling death rates (Waldron 1995). After 1968, coronary heart disease mortality fell for men, though more slowly than for women (Wingard 1984), and higher rates of death involving traffic accidents and lung cancer among men further contributed to the continued growth in the sex differential (Lopez 1983). Only in the 1990s did it become apparent that this century-long trend toward an increasing female advantage in mortality had started to reverse.

Three studies first described the reversal. Waldron (1993: 458), in calculating changes in male and female cause-specific mortality from 1979 to 1987 for 23 developed countries, concluded that the "pervasive trend toward increasing sex mortality ratios observed in the mid-twentieth century was no longer evident in the 1980s." She found that higher rates of lung cancer among women contributed most clearly to the end of the pervasive trend toward a greater female advantage. Trovato and Lalu (1996) demonstrated that 12 industrialized countries experienced narrowing of the sex differential in life expectancy by the 1990s. The reversal in the trend toward a growing female advantage occurred most often in high-income, low-mortality countries with high rates of family change and convergence in gender behavior. Trovato and Lalu (1998) further described changes in the cause-specific sex differential for a smaller set of high-income countries. They attributed the more general reversal to changes that narrow male and female differences in mortality from heart disease, accidents, and lung cancer.

To illustrate the change with some simple figures, consider life expectancy at birth in the United States (U.S. Census Bureau 2000 and various years). From 1955 to 1975, male life expectancy rose from 66.5 to 68.7 years, while female life expectancy rose from 72.6 to 76.5 years. The gap thus expanded from 6.1 to 7.8 years. In contrast, by 1997 male life expectancy reached 73.6 and female life expectancy reached 79.4, and the gap fell from 7.8 to 5.8 years during the period 1975 to 1997. More than a short-term fluctuation, the reversal in the direction of change in the sex differential appears substantial and robust.

On the surface, this evidence provides support for a gender-equality thesis that posits harmful consequences of improvements in women's status for the sex differential in mortality. Because higher levels of income, power, and prestige among men traditionally coexisted and currently coexist with higher levels of mortality, the thesis suggests that movement toward social and economic equality between men and women will tend to equalize their mortality. The recent reversal in the direction of change in the differential seems to support this argument. If one marks the 1960s as the beginning of the most recent period of change in the status and roles of women, and recognizes that, for major causes of mortality in modern societies, there is a lag of several decades between the adoption of unhealthy behaviors or the experience of unhealthy living conditions and death, then the gender-equality thesis accurately predicts the narrowing of the sex differential in the 1980s and 1990s.

The gender-equality thesis receives almost no support in the scholarly community, however: demographers have neither presented this argument in the form of a developed theory nor offered systematic empirical evidence in its favor. Rather than being developed and argued for, it has been criticized repeatedly in a variety of settings (Johansson 1991; Nathanson 1984, 1995; Vallin 1995; Waldron 1993, 2000; Wingard 1984). Three among the criticisms call into question any association between improvements in the status of women and the reversal in the trend in the sex differential in mortality.

First, the gender-equality thesis fails to consider the changes in male behaviors and roles that affect, along with changes in female behaviors and roles, the sex differential (Trovato and Lalu 1998). Indeed, critics highlight the importance of harmful behaviors among men in understanding both the rise and the more recent decline in the differential. Lopez (1983: 119) argues that "males have adapted less well [than females] to the more comprehensive process of modernization with its attendant behavioral changes" and that "much of the increase in male excess mortality has resulted from the widespread adoption of hazardous life styles by men and the general mismanagement of health." Contrary to general claims about the positive association between high male status and elevated mortality, Nathanson and Lopez (1987) attribute the growth of the sex differential in mortality largely to the behavior of working-class men, who differ from middle-class men and all women in their higher mortality. More recently, declines in smoking among men have contributed to the improvements in their longevity (Waldron 1993). Yet, the gender-equality thesis says little about the causes of these changes in male mortality.

Second, even women with high education, high-prestige occupations, and high income—those who benefit most from women's improved opportunities—maintain a substantial longevity advantage over men (Waldron 1993). At the individual level, Rogers, Hummer, and Nam (2000) show that, even among employed men and women, male risks of death are 90 percent higher than female risks. Similarly, higher occupational status does not raise mortality among women (Passannante and Nathanson 1985; Waldron 2000). It appears instead that opportunities outside narrowly constricted limits of home and family may improve the well-being of women and lower their mortality (Moen, Dempster-McClain, and Williams 1989). At the aggregate level, national differences in labor force participation do not correspond to national differences in the sex differential in mortality (Pampel and Zimmer 1989).

Third, analyses of mortality from external causes have not found strong links between changes in mortality and women's status. Little evidence emerges for the gender-equality thesis in studies of drunk driving (Bergdahl 1999), accidents (Pampel 2001a), homicide victimization (Gartner, Baker, and Pampel 1990), and suicide (Girard 1993; Pampel 1998). These types of death result in part from the lifestyles, problems, and activities of daily living, such as travel, work, recreation, alcohol consumption, interpersonal conflict, and weak social ties (Rockett and Smith 1989). Compared to degenerative diseases common at the older ages, deaths from injuries respond more immediately to social circumstances, emerge as important at younger ages as well as older ages, and do not require decade-long lags to gauge the effects of changing gender roles. Yet, the effects of gender equality on these external causes of death appear weak, thus also casting doubt on claims that gender equality strongly influences sex differences in deaths from heart disease, vascular disease, and cancers that develop more slowly.

If evidence fails to support the gender-equality thesis and suggests that the association over time with the sex differential in mortality is spurious, the question remains as to what explains the recent reversal. This study demonstrates that sex differences in the timing of cigarette smoking adoption and cessation can explain both the widening of the gap seen in earlier decades and the narrowing of the gap in recent decades, but, importantly, have little to do with movement toward gender equality per se. Rather, cigarette use follows well-demonstrated patterns of diffusion from high-status groups to lower-status groups, and from men to women, that relate more closely to the persistence of gender inequality in modern societies than to movement toward equality. Further, the cigarette diffusion explanation avoids the weaknesses of the gender-equality thesis by (a) addressing changes in both male and female smoking-related mortality, (b) attributing no special harm to female employment, and (c) proving consistent with the literature on sex differentials in external causes of death.

The next sections review the literature on the contribution of tobacco use to the widening of the sex differential in mortality; attempt to determine what portion of the recent decline in the overall sex differential in mortality stems from tobacco use; present a cigarette diffusion argument that explains the timing of the reversal in sex differences in tobacco-induced mortality; and offer evidence in favor of the cigarette diffusion argument. In so doing, the article provides a plausible and empirically supported explanation of the recent narrowing of the sex differential that has implications for future sex differences in mortality.

The contribution of tobacco to the sex differential

Previous studies demonstrate the importance of tobacco use, after a lag of several decades, to the growth of the sex differential in mortality over the last century. Preston (1970) described excess male mortality at older ages in terms of increases over time in deaths that were higher than expected given the level of female deaths. Rejecting arguments that obesity, lack of exercise, occupational stress, and ingestion of dietary fats account for rising excess male mortality, Preston concluded that rising cigarette smoking among men during the twentieth century represents the most promising explanation. The conclusion explains trends in male heart disease and lung cancer—both associated with cigarette smoking—and fits international differences in cigarette smoking and excess male mortality. Using different data, Retherford (1975) reached much the same conclusion. He calculated that rising smoking among men relative to women in the United States accounts for 75 percent of the increase in the sex differential in mortality at ages 37–87 between the years 1910 and 1962.

Perhaps the strongest evidence in support of the contribution of tobacco use to the sex differential in mortality comes from Miller and Gerstein (1983). Using a sample of death certificates in Erie County, Pennsylvania, and eliminating deaths from traumatic causes (accidents, suicides, and homicides) and deaths to smokers, they found that life expectancies of males and females do not differ. They concluded that virtually all of the increase in the differential between male and female mortality results from the effects of smoking. Others found, in contrast, that women outlive men even among nonsmokers (Wingard 1982; Rogers, Hummer, and Nam 2000). Using data from 12 studies, Waldron (1986) estimated that, for all ages, smoking explains about one-half of the differential between men and women; even that figure may overstate the importance of smoking to the extent that it overlaps with other causes of death such as drinking. Still, even if not as dominant as suggested by Miller and Gerstein, cigarette smoking represents a major source of the differences in mortality between men and women.

The trends in smoking among men and women over the first two-thirds of the twentieth century certainly match the trend in the sex differential in mortality. In the United States, smoking among men rose and remained high until the mid-1960s—about the time of the 1964 Surgeon General's report on the risks of smoking. Female smoking during these same decades lagged well behind. In 1965, when rates of smoking among males equaled 52 percent, female smoking had reached only 34 percent (Department of Health and Human Services (DHHS) 2001: 36). Given that the harm inflicted by cigarette use accumulates for several decades before causing death, these differences in smoking among men and women up to the 1960s are matched by the widening of the sex differential in mortality up to the 1990s. Thus, lung cancer rates among men in the United States rose until the early 1990s, when they reached a level 2.43 times higher than female rates (based on calculations using figures from World Health Organization 1996 and various years).

If high rates of tobacco use by men relative to women largely explain the growth of the sex differential over most of the twentieth century, can changes in tobacco use by men and women explain the more recent reversal in the sex differential in mortality? Trends in cigarette use and lung cancer suggest that they can. By 1998, male smoking had declined to 26 percent, while female smoking had declined to 22 percent (DHHS 2001: 36–37). The narrowing of the gap to 4 percentage points indicates a major shift from the mid-1960s. Although men adopted smoking in large numbers earlier than women, they have more recently reduced smoking faster than women. Consistent with the trends in cigarette use, the most recent data show declining lung cancer rates among men in the United States since 1990, while lung cancer rates among women continued to rise. The ratio of male lung cancer rates to female lung cancer rates has consequently fallen from 2.43 to 2.04 between 1990 and 1996 (World Health Organization 1996 and various years). Just as high smoking among men relative to women contributed heavily to the growing sex differential in decades past, the rise in smoking among women relative to men more recently may be contributing to the narrowing of the differential.[1]

Description of trends in smoking and lung cancer proves insufficient, however, to identify the full harm of cigarette use and its contribution to the sex differential. Because most lung cancer deaths stem from cigarette use (Thun et al. 1995), the lung cancer mortality of men and women reflects the relative level of smoking in previous decades. Even so, identifying the full harm of cigarette use and the full influence it has on the sex differential in mortality requires attention to causes of death other than lung cancer. According to estimates of the US Surgeon General (DHHS 1989), only 28 percent of tobacco-related deaths involve lung cancer. According to a 40-year study of British doctors (Doll et al. 1994), smoking raises the rate of death from lung cancer by a factor of 14.9, but also raises the rate of death from other cancers by 1.5, respiratory diseases by 2.9, ischemic heart disease by 1.6, and all causes combined by 1.8 (also see Ravenholt 1990, for similar figures).[2] Even if lung cancer alone represents a modest part of the level or change in the sex differential in mortality, lung cancer plus those portions of deaths from other cancers, heart and vascular disease, and respiratory problems due to smoking likely contribute substantially to the differential and its change. A full accounting of the harm of tobacco use must include deaths from causes other than lung cancer, and an accurate estimate of the role of smoking in the sex differential in mortality should include male and female deaths from causes other than lung cancer.

Distinguishing between deaths for a variety of causes, some of which are related to smoking and some of which are not, suggests several simple, testable hypotheses. If smoking accounts for the reversal in the trend in sex differences in mortality, then: (1) deaths related to tobacco use should become more similar over time among men and women; (2) deaths unrelated to tobacco should show no such convergence; (3) countries having experienced the largest narrowing of the sex differential in mortality overall should also experience the largest narrowing of the sex differential in tobacco-related mortality; and (4) the narrowing of the sex differential in mortality overall should have little relationship to the sex differential for deaths unrelated to smoking. Comparisons over time and across countries of male and female deaths due and not due to tobacco use can thus help isolate the sources of the reversal in the mortality differential.

One study has already demonstrated the value of such an approach. Using data for Denmark, Finland, the Netherlands, Norway, and Sweden, Valkonen and van Poppel (1997) estimated that 40 percent of the total sex difference in life expectancy at age 35 in 1970–74 came from smoking. Because of the decline in smoking-attributed mortality among men relative to women, however, that share dropped in 1985–89 to about 30 percent of the total difference. These results need to be extended to a larger and more diverse set of countries and used to identify the contribution of gender equality and other social changes to the narrowing sex differential. They nonetheless confirm the importance of considering smoking-related deaths attributable to causes other than lung cancer.

Estimating tobacco-attributed mortality

A comprehensive set of data on the consequences of tobacco use for mortality from Peto et al. (1992, 1994) proves useful in testing claims about the importance of smoking for the narrowing sex differential in mortality. Using data for 44 countries from 1975 to 1995 and indirect estimation techniques, they calculated smoking-attributed deaths and other deaths by age and sex. The indirect estimates differ from other approaches to calculating smoking-attributed mortality (DHHS 1989; Brønnum-Hansen and Juel 2000; Valkonen and van Poppel 1997) in a crucial way: without direct measures of the prevalence of smoking for the extensive sample of countries, Peto et al. (1992, 1994) employed a general strategy based on the use of excess lung cancer rates in a population to infer the cumulative exposure to cigarette smoking and, ultimately, the proportion of deaths from other diseases due to smoking. To summarize the more specific details of this general approach, Sterling, Rosenbaum, and Weinkam (1993) list four steps in computing smoking-attributed deaths.

The first two steps estimate excess lung cancer due to smoking and, based on the excess, the proportion of smokers in the population. First, the method computes excess lung cancer deaths for each age group (from 35–39 to 75–79) and sex (males and females) as the difference between actual lung cancer deaths and lung cancer deaths expected from the rates among a nonsmoking population.[3] Because lung cancer rates fall to low levels in the absence of smoking, the difference between the observed lung cancer rate and the lung cancer rate expected for a nonsmoking population serves as an indicator of the cumulative exposure to smoking. Second, the method estimates the proportion of current smokers in each age and sex group by assuming that the observed lung cancer mortality rate results from a mixture of such deaths among never smokers and current smokers. The assumption implies that the total lung cancer death rate for any age and sex group equals the weighted sum of the rates of current smokers and never smokers, with the weights equal to the proportion of smokers and nonsmokers. The lung cancer death rates for current smokers and never smokers obtained from step one make it possible to solve for the unknown proportion of smokers.[4]

The next two steps estimate the excess smoking deaths from causes other than lung cancer. Third, the method calculates excess risk by cause of death (other than lung cancer) for each age and sex group from two pieces of information: the proportion of current smokers obtained in step two and the relative risk of current versus never smokers for each cause of death. The relative risks come from the American Cancer Society's prospective Cancer Prevention Study II of one million Americans aged 30 and older from 1982 to 1992. The large sample allows reliable estimation of the mortality of current smokers and never smokers by age, sex, and cause of death. The excess risk then equals the proportion of smokers times the relative risk (minus one) for each cause. However, some of the excess risk associated with smoking stems from confounding with other risk factors such as drinking, poverty, poor diet, hazardous occupations, and lack of exercise. To compensate for the problem of confounding, Peto et al. halved these estimates of excess risk for causes other than lung cancer.[5] Fourth, based on total deaths and the proportion of deaths attributed to smoking by the excess risk and the proportion of smokers, the method calculates the actual number of smoking-attributed deaths for each cause, age group, and sex. To obtain total deaths by age, sex, and cause, Peto et al. used data from the World Health Organization (1996 and various years). Summing over the causes provides the total numbers of smoking-attributed and other deaths, and population figures allow calculation of rates.

To obtain reliable and conservative estimates, Peto et al. set several additional rules for implementation of the procedure. First, they assumed that no deaths occur from tobacco for ages under 35, for cirrhosis of the liver, and for nonmedical causes such as suicide and accidents. Some early deaths from tobacco use certainly occur (perhaps even among infants of mothers who smoke), but the number is too small to estimate reliably. Smokers also have higher rates of death than nonsmokers from liver cirrhosis and nonmedical causes, but with a few exceptions (such as fires caused by cigarettes) the association is largely spurious. Second, in presenting the results, Peto et al. separated the figures for ages 35–69 from those for ages 70 and older. The results for ages 35–69 proved most useful because those who die of smoking-related causes after age 70 would likely soon die from nonsmoking causes, and because lung cancer rates—and therefore the estimates of smoking-attributed deaths—are less reliable in extreme old age. Third, they obtained estimates for 1975, 1985, and 1990 (the most recent data available at the time) and extrapolated estimates to 1995. Because the 1995 estimates are reasonably secure given the short period of extrapolation, they can be useful in following the trends in mortality.

Peto et al. thus presented mortality data for (1) males and females, (2) ages 0–34, 35–69, and 70 and older, (3) all deaths, smoking-attributed deaths, and other deaths, and (4) years 1975, 1985, 1990, and (by extrapolation) 1995. Debate exists, however, over the accuracy of the indirect estimates, with critics arguing that they overstate deaths due to tobacco in two ways (Sterling, Rosenbaum, and Weinkam 1993). One, the relative risks of cause-specific deaths for smokers and nonsmokers come from the Cancer Prevention Study II (CPS-II), which does not fully reflect a random sample of the US population. Over-representing affluent and highly educated volunteers, the study may have understated deaths among never smokers. Two, the method does not directly adjust with statistical controls for confounding with other harmful statuses and behaviors associated with both smoking and death, and therefore may overstate the harm of cigarette use.[6]

To counter these concerns about the possible overstatement of smoking-attributed mortality, Peto et al. halved their initial estimates of excess smoking risk. Although in some ways arbitrary and made intentionally large to conservatively estimate smoking-attributed mortality, the adjustment has some validity. It gives almost exactly the same number of smoking deaths as does the US Surgeon General (DHHS 1989) when combining national mortality rates in the United States with additional data on the prevalence of smoking (Peto et al. 1992). Other tests of validity similarly support the indirect method. Brønnum-Hansen and Juel (2000) found with Danish data that the indirect method gives results nearly identical with those of a method that uses retrospective information on smoking.[7] Valkonen and van Poppel (1997: 308) found with data on the Nordic countries and the Netherlands that the method of Peto et al. shows "a relatively close correspondence... [with results] obtained in prospective national studies." Others suggested that the method may in fact understate rather than, as argued by critics, overstate tobacco-attributed mortality. The use of CPS-II overstates smoking-attributed mortality by 19 percent, and confounding factors overstate smoking-attributed mortality by 2.5 percent (Malarcher et al. 2000; Thun, Apicella, and Henley 2000). Given these findings, it would seem that the 50 percent adjustment in excess risk made by Peto et al. errs on the side of caution in identifying the harm of smoking.[8]

For the purposes of this study, however, the *absolute* level or rate of smoking deaths has little importance. Instead, the study compares changes in smoking and nonsmoking deaths of women *relative* to men. If the percentage bias is similar for men and women, it will cancel out in making comparisons over time and across countries and, thus, to a large extent reflect real trends and cross-national patterns for sex differences in smoking-attributed mortality. Even should bias differ for men and women or across countries, the extent of the problem for such comparisons will be considerably smaller than that for estimates of the absolute levels of smoking-attributed deaths. Even given some limitations, then, Peto et al. provide suitable and useful data.

From their figures, I select for analysis the 21 high-income countries with populations exceeding one million. The countries selected are the United States, Canada, Japan, Australia, New Zealand, and, in Western Europe, Finland, Sweden, Norway, Denmark, the United Kingdom, Ireland, Germany, the Netherlands, Belgium, France, Austria, Switzerland, Spain, Portugal, Italy, and Greece.[9] As background for the analyses to follow, the Appendix lists selected values for each of the 21 countries in the two bracketing years, 1975 and 1995. Focusing on the key age group of 35–69, the Appendix shows total, smoking-attributed, and other mortality rates of males and females, and the difference between the smoking-attributed mortality rates of males and females. The analyses report averages of these country values (as well as those for other years and ages) in summarizing the trends in the sex differential in mortality.

These high-income countries comprise an appropriate sample because, unlike developing countries, some have recently experienced a widening and others a narrowing of the sex differential in mortality, and they have made substantial (if still incomplete) progress toward gender equality. Compared with developing countries, the developed countries have higher tobacco use by their populations, and, with lower mortality overall, have experienced more harm from tobacco in terms of premature mortality. While satisfying the conditions needed for the reversal of the sex differential in mortality, the high-income countries nonetheless exhibit considerable variation. They differ in the relative levels of male and female mortality (Trovato and Lalu 1998), progress toward gender equality (Singh 1998), and extent of smoking (Nicolaides-Bouman and Wald 1993).

Recent changes in sex differences in tobacco-attributed mortality

All countries combined

Using the data reported by Peto et al. (1994) for 21 countries, Table 1 presents the mean male death rates, female death rates, and logged ratio of

TABLE 1 Mean mortality rates for males and females and the logged ratio of males to females by year, age, and cause of death in 21 high-income countries

	Ages 0–34	Ages 35–69			Ages 70+		
	Total	Total	Smoking	Other	Total	Smoking	Other
Male							
1975	1.48	11.42	3.39	8.03	91.82	16.06	75.76
1985	1.10	9.24	2.92	6.33	84.56	17.10	67.46
1990	1.08	8.51	2.57	5.95	81.94	16.17	65.76
1995	1.09	7.61	2.22	5.39	74.66	14.89	59.76
% Δ	–26.57	–33.37	–34.54	–32.88	–18.69	–7.23	–21.12
Female							
1975	0.85	6.11	0.39	5.73	68.13	1.41	66.73
1985	0.57	4.88	0.54	4.34	62.04	2.74	59.31
1990	0.53	4.54	0.56	3.98	61.25	3.37	57.88
1995	0.50	4.04	0.56	3.49	56.04	3.88	52.17
% Δ	–40.96	–33.83	45.14	–39.14	–17.74	175.30	–21.81
Logged ratio							
1975	0.56	0.62	2.93	0.33	0.30	3.66	0.13
1985	0.65	0.64	2.30	0.37	0.31	2.53	0.13
1990	0.70	0.64	2.08	0.40	0.29	2.25	0.13
1995	0.75	0.64	1.94	0.43	0.29	2.07	0.14
% Δ	34.33	2.22	–33.96	30.24	–3.75	–43.39	7.47

% Δ = difference between the 1995 value and the 1975 value divided by the 1975 value (times 100); calculations are based on values expressed to more decimals than shown here, and discrepancies may result from rounding error.

male rates to female rates in 1975, 1985, 1990, and 1995 in three age groups (0–34, 35–69, 70 and older) for all deaths, smoking-attributed deaths, and other deaths. The logged ratio serves as a measure of the female advantage or the male excess in mortality.[10] Because no deaths to persons under age 35 are attributed to smoking, Table 1 lists only the total death rates for ages 0–34. At these ages, female death rates fall faster than male rates, and the logged ratio measure of the female advantage rises by 34 percent over the 20-year period. Absent the harm of smoking at these ages, the mortality of females improves substantially relative to males.

For those aged 35–69, male and female death rates for all causes change similarly. Total mortality rates for males and females fall by nearly the same percentage, and the female advantage rises only slightly (by 2 percent). However, the lack of change derives from counterbalancing forces: for smoking-attributed deaths, male rates fall, female rates rise, and the female advantage declines by 34 percent, while for nonsmoking deaths, female rates fall faster than male rates and the female advantage rises by 30 percent. Only for smoking-attributed deaths does the female advantage decline. Without the harm of cigarettes, the female advantage grows considerably.

Finally, for those over age 70, the female advantage declines slightly for all deaths and rises slightly for nonsmoking deaths. It falls dramatically for smoking-attributed deaths, but these constitute a small proportion of the total at the oldest ages and have less effect on total deaths than at younger ages. Even so, the results for the oldest ages demonstrate substantial worsening of the female advantage only for smoking-attributed deaths.

Differences across countries

As the results in Table 1 average the experiences of diverse countries, new insights come from making comparisons across countries that show widening or narrowing differentials. According to the hypotheses, smoking-attributed deaths should contribute most to the trends in countries with a narrowing differential. Of the 21 countries, six show rates of change in the male-to-female ratio for all deaths at ages 35–69 that are above 10 percent (i.e., widening of the difference in male and female rates), eight show little change in either direction, and seven show rates of change that are below minus 10 percent (i.e., narrowing of the difference in male and female rates). Over the period 1975–95, countries in the first group continue to show growth in the female advantage and have not reached the point of reversal, while countries in the last group exhibit a diminishing female advantage. Using the logged ratio measure of the sex differential, Table 2 presents the trends by type of death for these three groups of countries.

The first group of six countries—those that showed growth in the female advantage—consists of Japan and the Western and Southern European countries of France, Germany, Austria, Greece, and Spain. At ages

TABLE 2 Mean logged ratio of male to female mortality rates by year, age, and cause of death for 21 high-income countries with widening, stable, and narrowing logged ratios

	Ages 0–34	Ages 35–69			Ages 70+		
	Total	Total	Smoking	Other	Total	Smoking	Other
Widening (six countries)							
1975	0.51	0.59	3.43	0.33	0.24	3.89	0.09
1985	0.66	0.67	3.20	0.37	0.28	3.25	0.11
1990	0.72	0.72	3.00	0.41	0.27	3.02	0.11
1995	0.75	0.78	2.94	0.47	0.28	2.19	0.11
% Δ	46.93	32.65	–14.17	41.48	14.06	–25.07	28.08
Stable (eight countries)							
1975	0.59	0.66	3.13	0.34	0.31	3.74	0.14
1985	0.68	0.68	2.47	0.37	0.32	2.69	0.13
1990	0.73	0.67	2.33	0.40	0.30	2.43	0.12
1995	0.78	0.67	2.22	0.43	0.30	2.30	0.14
% Δ	32.03	0.55	–28.97	25.70	–5.55	–38.43	–2.45
Narrowing (seven countries)							
1975	0.56	0.61	2.27	0.32	0.33	3.39	0.15
1985	0.60	0.58	1.34	0.37	0.32	1.74	0.15
1990	0.65	0.53	1.01	0.39	0.30	1.38	0.15
1995	0.71	0.48	0.74	0.40	0.29	1.10	0.16
% Δ	27.25	–21.00	–67.52	25.73	–13.05	–67.59	7.88

% Δ = difference between the 1995 value and the 1975 value divided by the 1975 value (times 100); calculations are based on values expressed to more decimals than shown here, and discrepancies may result from rounding error. Widening = logged ratio for all causes at ages 35–69 rises by more than 10 percent; stable = logged ratio for all causes at ages 35–69 does not change by more than 10 percent; narrowing = logged ratio for all causes at ages 35–69 falls by more than 10 percent. For list of countries in each of the three groups see text.

35–69, the female advantage increases by 33 percent. Consistent with this increasing advantage, the logged ratio of smoking-attributed mortality declines by only 14 percent from 1975 to 1995, while the logged ratio for other mortality grows substantially.

The second group of countries (Canada, Finland, Australia, Ireland, Belgium, Switzerland, Portugal, and Italy) shows little change in the sex differential overall. When averaged across all eight countries, the logged ratio at ages 35–69 for all causes rises by less than one percent. However, for nonsmoking deaths, the female advantage rises by 26 percent. Only the worsening of the female advantage in smoking-attributed mortality by 29 percent keeps the overall logged ratio stable. The harm of smoking for women has become serious enough in these countries to counter the improvements in female mortality that occur for nonsmoking deaths.

The last group of countries (United States, New Zealand, United Kingdom, Netherlands, Denmark, Sweden, and Norway) shows a decline in the female advantage of 21 percent at ages 35–69. Smoking-attributed mortality accounts for this decline. The logged ratio for nonsmoking deaths actually increases by 26 percent, but is overwhelmed by the 68 percent decline in smoking-attributed deaths. Because the female advantage in nonsmoking mortality increases, the decline in the female advantage in smoking mortality explains the overall decline.

In comparing mortality at ages 35–69 for these three groups of countries, a simple point emerges: the differences in the trends for smoking-attributed mortality account for the differences in the overall change in the female advantage. Although all three groups of countries exhibit an increase in the female advantage for nonsmoking mortality, they differ in the change in smoking-attributed mortality. Those countries experiencing an increasing advantage overall show only a small decline in the female advantage in smoking-attributed mortality, while those countries experiencing an increasing disadvantage overall show much stronger movement toward convergence in male and female smoking-attributed mortality. Both the reversal of the trend in the sex differential in some countries and the continuing widening of the differential in others derive from trends in smoking-attributed deaths.

A similar, but somewhat weaker pattern emerges at older ages. When comparing the three groups of countries, the size of the decline in the female advantage in smoking-attributed mortality corresponds to the decline in the female advantage overall. At the oldest ages, however, the logged ratio for nonsmoking deaths fails to rise to the same degree as at younger ages.

These results support the claim that the narrowing sex differential in mortality found in some countries stems completely from smoking-attributed mortality at ages 35–69 and largely from smoking-attributed mortality at ages 70 and older. At younger ages, where smoking has no influence on mortality, countries show a widening rather than a narrowing differential. At ages 35–69, the female advantage in mortality continues to grow absent the influence of smoking. This indicates that the adoption of smoking by women over the past several decades explains the narrowing sex differences in mortality.

These results provide insights not available from the typical study of cause-specific mortality. Although lung cancer and respiratory disease clearly reflect smoking, and accidents and violence clearly do not reflect smoking, deaths from causes such as heart disease, vascular disease, and many cancers reflect a mix of smoking and nonsmoking deaths. Analysis of changes in the sex ratio for these latter causes of death does not reveal consistent trends (Waldron 2000) because they mix counterbalancing forces. Women's advantage in heart disease, for example, likely increases among nonsmokers, decreases among smokers, and changes inconsistently in the aggregate. Whereas analysis of mortality by cause fails to capture heterogeneity within such categories of death as heart disease, the analysis of smoking-attributed and other deaths offers substantial benefits in understanding the underlying sources of change in the sex differential.

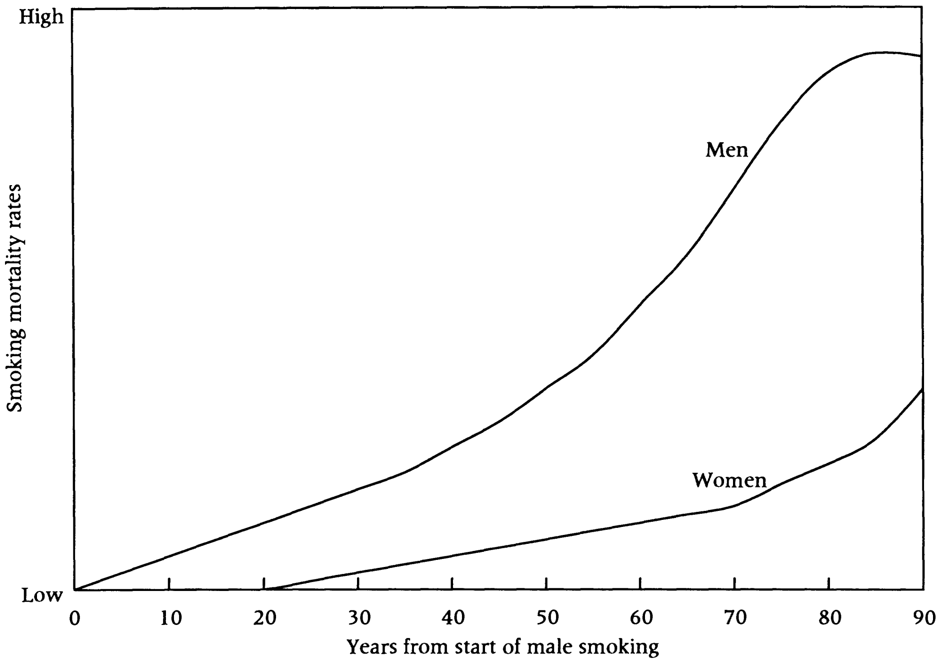
Cigarette-smoking diffusion and sex differences in mortality

An explanation of these trends in the sex differential in smoking-related mortality and their contribution to the overall sex differential in mortality must obviously focus on sex differences in smoking. An argument stemming largely from work in public health and epidemiology and focusing on the diffusion of cigarette use within populations has implications for sex differences in mortality (Borras et al. 2000; Cavelaars et al. 2000; Ferrence 1989; Lopez 1995; Molarius et al. 2001). This argument notes that, following the diffusion of cigarette use by several decades, smoking-attributed mortality spreads like an epidemic from relatively small parts of a population to other parts. In general terms, it rises slowly at first, accelerates to a peak, begins to abate, and falls to levels below the peak (Lopez, Collishaw, and Piha 1994).

The pattern occurs among both men and women, but because men in large numbers adopt cigarettes earlier than women, the male pattern precedes the female pattern by a decade or two (DHHS 2001: 135; Lopez 1995; Pampel 2001b). The *difference* in smoking-attributed mortality between men and women therefore depends on a more complex description of the epidemic. Because men are affected by the epidemic first, the differential initially grows. Later, as smoking mortality peaks among men and begins rising among women, the gap stops widening. Still later, as smoking mortality declines among men, it grows at a fast rate among women (just as it had earlier among men). Therefore, the gap begins to narrow. The lag in the process for women means, in short, that the more advanced the stage of the epidemic, the smaller the sex difference in mortality.

Figure 1, adapted from Lopez, Collishaw, and Piha (1994), depicts the changes in lung cancer mortality among men and women during the epidemic, but also fits changes in other smoking-related mortality. The horizontal axis represents time since the start of the process, the vertical axis represents rates of smoking mortality, and the two curves represent the patterns of change among men and women. Because the curve rises later for women than men, the gap grows during most of the temporal process. Eventually, the growth of the gap slows and reverses as male mortality levels off and declines, and as female mortality begins to rise at a faster pace. Many high-income countries have reached this stage and therefore exhibit narrowing sex differences in smoking-attributed mortality. Few have, however, passed the stages depicted in Figure 1 and entered a later stage where female rates peak and decline like male rates.

FIGURE 1 Temporal stylized pattern of smoking mortality, by sex



SOURCE: Adapted from Lopez, Collishaw, and Piha (1994).

In addition to varying over time, cigarette diffusion and the size of the sex differential in smoking-attributed mortality vary across countries. Because of a variety of historical, cultural, public policy, and commercial differences in the adoption and diffusion of cigarettes, countries differ in the timing of the smoking epidemic. For example, smoking emerged early in Great Britain and Ireland. By 1950, adults in Great Britain smoked on average 6.0 cigarettes per day, and adults in Ireland averaged 6.8 per day (Nicolaides-Bouman and Wald 1993). In contrast, smoking emerged later in Spain and France, which did not reach 6.0 cigarettes per day until 1973 and 1985, respectively. Because the epidemic began earlier and spread farther in countries with a long history of cigarette use, these countries should have a smaller sex differential in mortality.

Although thus far treated only as a descriptive device, the changes in smoking mortality among men and women reflect underlying status-based stages in the adoption, diffusion, and abatement of cigarette smoking. Complementing the literature on the epidemiology of smoking, a literature on diffusion of innovations establishes that high-status persons, who hold modern values supportive of innovation and nontraditionalism, adopt unfamiliar ideas and behaviors most quickly (Katz 1999; Rogers 1995; Strang and Soule 1998). The diffusion of the use of manufactured cigarettes, both a technological and cultural innovation (Griswold 1994), follows such a status-based pattern (Ferrence 1989). Once viewed as newly fashionable by elite groups who first adopted the habit (led, ironically, by physicians—see Lopez, Collishaw, and Piha 1994), cigarette smoking later lost that allure among high-status groups (again led by physicians) as middle and lower classes came to use tobacco disproportionately and as health concerns related to cigarette use became widely publicized. Smoking thus begins among elites, works it way down status hierarchies, and then abates first among high-status groups.

The status-based pattern of change has implications for comparing men and women: the less dominant position of women means their adoption of cigarettes follows that of men. In contrast to the gender-equality thesis, which treats female advancement as the source of convergence, this argument presupposes the existence of gender inequality as the source of sex differences in the timing of adoption and diffusion of cigarette use and, later, of smoking mortality. Even without movement toward gender equality, the subordinate position of women leads in the long term to similar rates of smoking and smoking mortality for men and women. If the similarity in smoking mortality between men and women stems largely from the stage of cigarette diffusion and the timing of its emergence in particular countries, then declining sex differences in smoking mortality may have little to do with rising gender equality.

In sum, these arguments explain the narrowing differential in male and female smoking mortality as the result of the timing of the adoption of cigarette use rather than gender equality. As cigarette diffusion and the smoking epidemic proceed, the gap in mortality between men and women rises, levels off, and declines. The influence of cigarette diffusion should also emerge in comparing countries that began the process at different time periods. If so, the simple passage of time since the start of cigarette diffusion can account for the current sex differential in smoking mortality and in overall mortality.

Testing the cigarette diffusion explanation

A simple way to evaluate the influence of cigarette diffusion and gender equality is to measure both characteristics for the 21 countries under study and then to examine the relationship between the measures and the sex differential in various types of mortality. Determining whether countries experiencing the greatest drop in the female advantage in mortality overall and in smoking-attributed mortality also have the longest history of cigarette smoking or the greatest gender equality will help identify the sources of change in the sex differential. The relationships appropriately focus on national differences because evidence for the importance of cigarette diffusion or gender equality requires more than the simple coincidence of trends. Indeed, because both cigarette diffusion and gender equality increase over time, it is hard to separate their influence on changes in mortality from one another with time-series data for one country. Cross-national data, in contrast, include independent variation in cigarette diffusion and gender equality that allows separation of the influence of the two variables and avoids reliance on often-spurious associations over time.

Measures

The country measure of the stage of cigarette diffusion relies on historical figures on cigarette consumption from Nicolaides-Bouman and Wald (1993). The consumption of cigarettes increases and decreases over time with diffusion, but when national comparisons are made, cigarette use may not reflect the stage of diffusion. Because of differences in prices, laws, and culture, some countries will peak at higher levels of smoking prevalence than others. Consequently, the same level of smoking could reflect an early stage in a high-smoking country and a peak stage in a low-smoking one. A better measure focuses on the timing of a country's movement through the diffusion of cigarette smoking. The earlier cigarette diffusion begins, the later or more advanced the current stage; conversely, the later the process begins, the earlier or less advanced the current stage. Using historical figures on cigarette smoking, a simple measure of the timing of the diffusion process is the number of years since cigarette consumption reached 50 percent of its eventual peak. As in Figure 1, a country that long ago passed the halfway point to the peak will since have reached a more advanced stage of diffusion, and a country that passed this point more recently will have advanced less far. In short, the longer the time span, the later the stage of diffusion.

Calculation of the measure proceeds as follows. Using yearly time-series on cigarette consumption per adult for each country dating back to the early part of the twentieth century (Nicolaides-Bouman and Wald 1993), I identify the peak value of cigarette use. I then identify the year cigarette consumption reached half the peak value and subtract that year from 1995. This procedure provides a measure of the years of cigarette diffusion. The Appendix lists the 1995 values of the measure for each country; to illustrate its meaning consider a few examples. In Great Britain, cigarette consumption peaked at 8.8 cigarettes per day per adult in 1995 and reached half that level, 4.4, in 1934. The interval between the two years is 61 years. In Spain, the halfway point occurred in 1962, and the interval between this year and the peak year of 1995 equals 33 years. Great Britain's longer history of cigarette smoking means it has reached a more advanced stage in the diffusion process than Spain. During this late stage of diffusion, declining smoking among men and rising smoking among women should lead to small sex differences in mortality. Countries such as Spain, in contrast, should exhibit relatively large differences in the smoking of men and women and in sex differences in smoking mortality—more so at older ages than younger ages.

Four aggregate indicators measure the level of equality in the work and family roles of men and women. The female labor force participation rate (Organisation for Economic Cooperation and Development 1996; International Labour Office 1996) reflects women's involvement in the paid economy. Because the countries do not report yearly data on age-specific rates, I must use the total female participation rate. Although the measure averages differences over the life course, it still exhibits substantial variation across countries and years. Crude marriage, divorce, and birth rates (United Nations 1996) also reflect changes in the family roles of women and men. I create a single measure or index that summarizes variation across countries and time in work and family roles by adding the four items.[11] To allow for the lagged effects of changes in gender roles on smoking mortality, I use the index for 1970 to predict mortality in 1995. The Appendix lists the 1970 values of the gender equality index for each country, which range from a low of –1.18 in Spain to a high of .82 in Sweden.

Correlations

Table 3 lists the bivariate correlations of the measures of cigarette diffusion and gender equality with the size of the female advantage in mortality at ages 35–

TABLE 3 Bivariate correlations of logged ratio of male to female mortality rates from all causes, from smoking, and from other causes at ages 35–69 with measures of cigarette diffusion and gender equality, in 21 high-income countries

	Bivariate correlation coefficients for	
	Cigarette diffusion	Gender equality
Total		
1995	–.54*	–.15
% Δ	–.62**	–.18
Smoking		
1995	–.65**	–.40
% Δ	–.62**	–.39
Other causes		
1995	.10	.27
% Δ	.09	.04

% Δ = difference between the 1995 value and the 1975 value divided by the 1975 value (times 100)
* $p < .05$; ** $p < .01$

FIGURE 2a Relationship between length of cigarette diffusion and logged ratio of male to female mortality rates in 1995 for all causes, ages 35–69 in 21 high-income countries

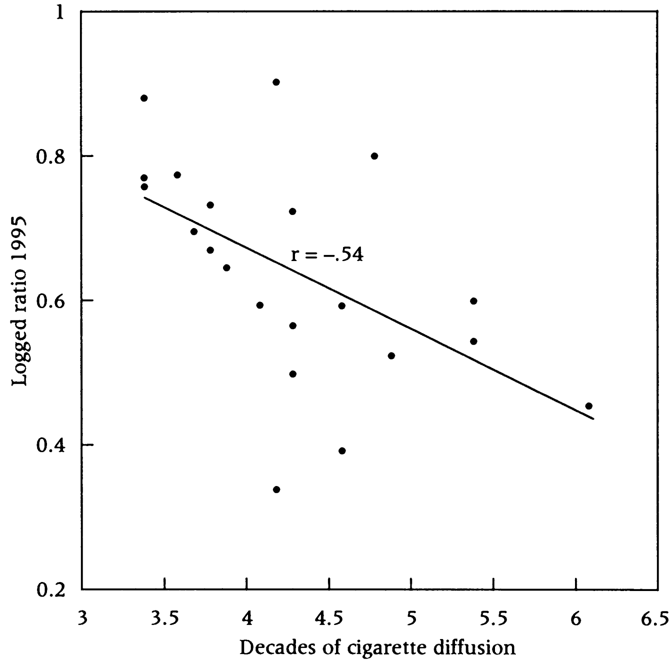
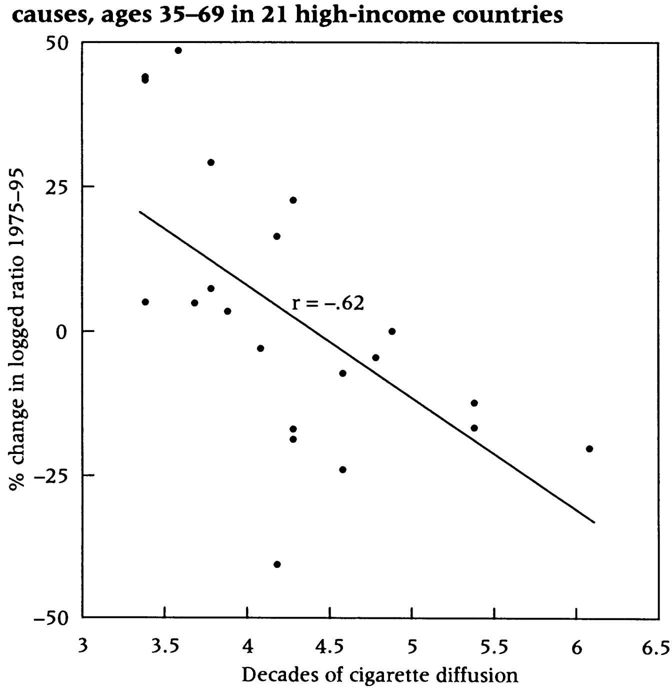


FIGURE 2b Relationship between length of cigarette diffusion and percent change in logged ratio of male to female mortality rates between 1975 and 1995 for all causes, ages 35–69 in 21 high-income countries



69 for all deaths, smoking-attributed deaths, and other deaths, and with the change in the female advantage from 1975 to 1995 for each type of death. The correlations for cigarette diffusion are strong, while those for gender equality are weak. The correlation of –.54, for instance, shows that the longer the diffusion of cigarette use, the lower the female advantage in mortality from all causes. Similarly, the correlation of –.62 shows that the longer the diffusion of cigarettes, the greater the decline in the female advantage. The correlations for cigarette diffusion and the measures of the sex differential in smoking-attributed mortality are similarly strong. Moreover, the correlations of cigarette diffusion with nonsmoking mortality are weak and insignificant. None of the correlations for gender equality reaches statistical significance or the size of the corresponding correlations for cigarette diffusion.

Figures 2a and 2b illustrate the relationships between years of cigarette diffusion and the level and change in sex differences in mortality from all causes at ages 35–69. Both figures reveal strong negative relationships. In Figure 2a, those countries plotted in the upper left (e.g., Portugal, Greece, Japan, and Switzerland) have a short history of smoking and a large female mortality advantage, while countries plotted in the lower right (e.g., Great Britain, United States, Norway, and Ireland) have a long history of smoking and a small female mortality advantage. In Figure 2b, decades of cigarette diffusion are closely related to the change in the sex differential, with a longer history leading to greater narrowing in the female advantage. The historical circumstances that led countries to begin widespread use of cigarettes in different decades eventually result in the diverse patterns of change in male and female mortality observed here.

Conclusion

The results presented here do not suggest that cigarette smoking fully accounts for the sex differential in mortality between males and females; rather, smoking fully explains the recent narrowing of the sex differential. For most of the twentieth century, cigarette smoking explains much of the widening of the sex differential in mortality. More recently, however, the female longevity advantage has fallen because of adoption of smoking by large numbers of women. Women continue to experience substantially lower mortality than men; and for causes of death unrelated to smoking, the female advantage continues to grow at most ages. The rising differential for nonsmoking mortality accords with claims that biological makeup (Rogers, Hummer, and Nam 2000; Waldron 1995; Wingard 1982) and many social behaviors besides nonsmoking, such as concern with health (Vallin 1995), networks of family, friends, and coworkers (Moen, Dempster-McClain, and Williams 1989), and avoidance of risky lifestyles (Lopez 1983), give women advantages in longevity. Yet, rising smoking among women counteracts these sources of the female advantage.

The finding that changes in male and female smoking narrow but do not eliminate the female advantage in mortality suggests that the advantage will persist into the future and perhaps even widen again once the effects of tobacco are equalized. According to the model of the mortality consequences of the diffusion of cigarette smoking depicted in Figure 1, the narrowing of the differential due to smoking-related causes will continue as the gap in smoking between men and women narrows. Eventually, however, male and female smoking will likely reach parity, and the increase in female smoking mortality will level off. At this point factors other than smoking may again dominate in affecting changes in the sex differential. Once sex differences in smoking reach parity, a substantial female advantage in mortality will reflect biological and social factors found to increase longevity of women more than men. Furthermore, projecting forward the continued improvement in nonsmoking mortality found here for 1975–95 suggests the female advantage in mortality will once again widen. This may show soonest in countries that already exhibit narrowing of the female advantage attributable to smoking-related causes. In countries that do not yet show the narrowing, the increasing harm of smoking to women may emerge later, and the reversal toward a growing female advantage may take longer to occur.

These projections apply largely to sex differences in premature mortality (i.e, under age 70). Estimates of the harm of smoking prove especially difficult at the oldest ages, and projections must allow for the possibility that the longevity of women will reach a ceiling that allows male longevity to catch up. Despite these qualifications, however, the importance of smoking to trends in male and female mortality, and the likelihood that current smoking patterns of women relative to men reflect a temporary stage in the process of cigarette diffusion, suggest that the narrowing sex differential in mortality will also be temporary.

Gender equality and sex role norms play little part in these projections. Rather than being a cause of changes in smoking, they may be seen as consistent with the patterns of cigarette-use diffusion. Waldron (1991: 990) argues that "historically, the trends towards increasing women's rights and sexual equality contributed to the increasing acceptance of women's smoking, but among contemporary women the relationship between smoking and attitudes toward women's rights and roles is inconsistent." In terms of diffusion, this suggests that restrictions on women's behavior in the early twentieth century contributed to the later diffusion of smoking among women than men. Otherwise, the weak correlations across countries between measures of gender roles and mortality suggest that the association over time between changes in gender roles and smoking is largely spurious. In making appropriate cross-national comparisons, the stage of cigarette diffusion rather than the level of gender equality emerges as crucial.

APPENDIX Mortality rates from smoking and other causes at ages 35–69, by sex, in 21 high-income countries, 1975

	Males				Females				
Countries	Total	Smoking	Other	%Smoking	Total	Smoking	Other	%Smoking	M minus F smoking
Australia	11.50	3.58	7.92	31.14	6.25	0.42	5.83	6.77	3.16
Austria	13.16	3.59	9.57	27.31	7.30	0.36	6.94	4.99	3.23
Belgium	12.62	5.15	7.47	40.82	6.77	0.20	6.58	2.92	4.95
Canada	10.73	3.26	7.47	30.39	5.67	0.58	5.09	10.19	2.68
Denmark	11.01	3.44	7.57	31.22	6.59	0.68	5.91	10.32	2.76
Finland	14.71	5.09	9.62	34.61	6.37	0.04	6.33	0.67	5.05
France	11.92	3.19	8.73	26.76	5.50	0.00	5.50	0.00	3.19
Germany	12.19	3.63	8.56	29.80	7.26	0.16	7.10	2.15	3.48
Greece	8.26	2.35	5.90	28.50	4.84	0.29	4.55	5.93	2.07
Ireland	13.19	4.43	8.76	33.57	7.83	1.38	6.45	17.64	3.05
Italy	11.17	3.59	7.59	32.09	5.66	0.14	5.51	2.55	3.44
Japan	7.77	0.89	6.88	11.43	4.62	0.14	4.48	3.07	0.75
Netherlands	10.12	4.40	5.72	43.49	5.13	0.04	5.09	0.71	4.36
New Zealand	11.88	3.86	8.02	32.48	6.74	0.91	5.83	13.50	2.95
Norway	10.62	1.89	8.73	17.81	5.37	0.11	5.26	2.09	1.78
Portugal	13.13	1.58	11.56	12.03	6.39	0.00	6.39	0.00	1.58
Spain	9.93	2.32	7.61	23.34	5.38	0.00	5.38	0.00	2.32
Sweden	10.32	1.56	8.76	15.13	5.60	0.16	5.44	2.92	1.40
Switzerland	9.59	3.15	6.43	32.89	4.94	0.08	4.87	1.57	3.08
UK	13.11	5.75	7.36	43.86	7.44	1.34	6.09	18.07	4.41
US	12.85	4.41	8.44	34.29	6.70	1.02	5.68	15.29	3.38
All countries	11.42	3.39	8.03	29.19	6.11	0.39	5.73	5.78	3.00

%Smoking = smoking mortality rate as a percent of the total mortality rate.
SOURCE: Peto et al. (1994).

APPENDIX (cont.) Mortality rates from smoking and other causes at ages 35–69, by sex, and indexes of the length of cigarette diffusion and of gender equality, in 21 high-income countries, 1995

Countries	Males Total	Males Smoking	Males Other	Males %Smoking	Females Total	Females Smoking	Females Other	Females %Smoking	M minus F smoking	Cigarette diffusion	Gender equality
Australia	5.91	1.48	4.43	25.03	3.27	0.50	2.77	15.40	0.97	41	–0.55
Austria	8.16	2.26	5.90	27.70	3.97	0.32	3.64	8.13	1.94	43	0.11
Belgium	7.54	2.90	4.64	38.47	3.96	0.29	3.67	7.34	2.61	39	–0.26
Canada	6.47	2.30	4.17	35.50	3.58	0.92	2.67	25.53	1.38	46	–0.24
Denmark	9.04	2.73	6.30	30.24	6.12	1.92	4.21	31.30	0.82	46	0.55
Finland	9.25	1.78	7.46	19.29	4.16	0.15	4.02	3.51	1.64	48	0.32
France	7.70	2.59	5.10	33.72	3.13	0.13	3.00	4.00	2.47	42	–0.21
Germany	9.31	2.94	6.37	31.59	4.77	0.42	4.36	8.70	2.53	38	0.18
Greece	7.36	2.48	4.89	33.62	3.42	0.15	3.27	4.40	2.33	34	–0.66
Ireland	7.54	2.01	5.53	26.70	4.48	0.90	3.58	20.12	1.11	49	–1.10
Italy	7.37	2.71	4.66	36.75	3.55	0.20	3.36	5.51	2.51	38	–0.52
Japan	6.10	1.09	5.01	17.87	2.82	0.11	2.71	4.04	0.98	36	–0.13
Netherlands	6.61	2.27	4.34	34.28	3.76	0.59	3.17	15.68	1.68	43	–0.81
New Zealand	6.66	1.75	4.91	26.25	4.76	1.05	3.71	22.02	0.70	42	–0.82
Norway	7.21	1.51	5.70	20.96	3.97	0.63	3.34	15.80	0.88	54	–0.33
Portugal	10.65	2.54	8.11	23.84	5.00	0.00	5.00	0.00	2.54	34	–0.84
Spain	8.01	2.89	5.11	36.13	3.33	0.00	3.33	0.00	2.89	33	–1.18
Sweden	6.18	0.96	5.22	15.55	3.76	0.47	3.29	12.58	0.49	43	0.82
Switzerland	6.66	1.99	4.67	29.85	3.33	0.26	3.07	7.91	1.72	37	0.17
UK	7.92	2.44	5.48	30.77	5.04	1.24	3.80	24.65	1.19	61	–0.15
US	8.13	2.93	5.19	36.07	4.73	1.49	3.24	31.41	1.45	54	–0.06
All countries	7.61	2.22	5.39	29.06	4.04	0.56	3.49	12.76	1.66	43	–0.27

NOTE: See text for explanation of indexes of cigarette diffusion and gender equality.
%Smoking = smoking mortality rate as a percent of the total mortality rate.
Gender equality values are for 1970, a lag of 25 years from 1995.
SOURCES: Peto et al. (1994) for mortality rates; author's calculations from figures in Nicolaides-Bouman and Wald (1993) for cigarette diffusion; and author's calculations from figures in Organisation for Economic Cooperation and Development (1996), International Labour Office (1996), and United Nations (1996) for gender equality.

Notes

I thank Richard Rogers for helpful comments on an earlier version.

1 The trends in other countries may differ from those in the United States, but they still indicate the strong association between changes in cigarette use and lung cancer rates. In Great Britain, for example, the female lung cancer mortality rate peaked in the early 1990s. Corresponding to this change, cigarette smoking among women in Great Britain peaked at 44 percent in 1966—decades earlier than in most other developed countries (Nicolaides-Bouman and Wald 1993: 441–442). Thus, even when female lung cancer rates have stopped rising, they still reflect changes in cigarette smoking.

2 The Surgeon General's Report (DHHS 1989) provides more detail on the harm of smoking. According to the report, the risks of lung cancer mortality among current smokers aged 35 and older relative to nonsmokers are 22.4 times higher for men and 11.9 times higher for women. In addition, the relative risks of mortality to smokers from bronchitis and emphysema are 9.7 (males 35+) and 10.5 (females 35+), from cerebrovascular disease 3.7 (males 35–69) and 4.8 (females 35–69), and from ischemic heart disease 2.8 (males 35–69) and 3.0 (females 35–69).

3 Peto et al. (1994: A.50) state: "Because lung cancer rates are particularly unreliable in extreme old age, the proportions of each disease category attributed to smoking will simply be taken to be the same at 80+ as at 75–79."

4 Lung cancer rates may, in some ways, better reflect the extent of cigarette use than survey questions about smoking habits. Self-reported cigarette use, although generally accurate at the time of a survey (DHHS 2001: 151–152), may not capture key details about an individual's lifetime exposure: age of initiation, periods of cessation, cigarettes per day, tar levels of cigarettes, and degree of inhalation. Lung cancer mortality, in contrast, responds to each of these dose-based factors and does not involve the same kind of error as self-reported cigarette use.

5 The method does not halve the number of smoking-attributed deaths, but halves the excess risk for causes other than lung cancer. Peto et al. (1994: A.49) note that halving does not greatly reduce the proportion of smoking-attributed deaths where smoking and lung cancer are common: "For example, whether the excess is 400% or 800%, the large majority (either 4/5 or 8/9, in this example) of all such deaths will still be attributed to tobacco. But where only a minority of deaths are attributable to tobacco, halving the percentage excess will almost halve the number attributed to tobacco."

6 Another criticism suggests that estimates of the relative risks of current smokers compared to never smokers ignore former smokers and differences among current smokers in the intensity of cigarette use. Although the method simplifies procedures by dividing the population into current and never smokers, the use of excess lung cancer deaths to estimate smoking prevalence also accounts for deaths among former smokers (Valkonen and van Poppel 1997: 308). By using lung cancer rates to reflect the smoking history of a group in terms of prevalence, duration, and intensity, the procedure allows for comparisons of countries that differ in the proportion of smokers and former smokers, and for the mix of heavy, moderate, and light smokers among current and former users. Although not measured directly, exposure to cigarette use of all types is reflected in the indirect estimates.

7 Specifically, their estimate of the proportion of deaths from selected causes in 1993 that are attributable to cigarette smoking is 33 percent for men, which differs little from the estimate of 35 percent according to the method of Peto et al. For women, the two estimates of 23 and 25 percent again reveal little difference.

8 However, Valkonen and van Poppel (1997) suggest that, although generally accurate, the method may overestimate rather than underestimate smoking-attributed mortality.

9 The formerly socialist countries of Eastern Europe also lag well behind the high-income countries in standard of living and life expectancy. Furthermore, their social and economic environments, particularly in relation to the social roles and policies in support of women, are so different as to require separate

study. Finally, the quality and completeness of data for some Eastern European countries do not match those for Western Europe.

10 A common measure of the sex differential simply divides one rate by the other. The ratio of male to female lung cancer rates would equal the proportional excess of the former over the latter. However, changing the denominator changes the implicit standard of comparison, can alter the scale of the ratio values, and makes results dependent on an arbitrary choice. Taking the log of the ratio, in contrast, eliminates the influence of choosing one denominator over the other; the log of the ratio of female rates to male rates gives the inverse of the log of the ratio of male rates to female rates. I use male rates in the numerator and female rates in the denominator, with high scores indicating excess male lung cancer and a female advantage. Note that, to avoid taking the logarithm of zero, I add a small constant of .01 to zero values (which occur for smoking mortality of women in just a few countries). Note also that, given the nonlinear transformation involved in taking logarithms, the mean of the logged ratios need not equal the logged ratio of the means for males and females. Table 1 reports the means across the 21 countries for male mortality rates, female mortality rates, and logged ratios of male to female mortality rates. The figures thus first compute the logged ratio for each country and then compute the mean, and may differ from figures that first compute the mean male and female mortality rates and then compute the log of the ratio of those means.

11 Before summing the items, I standardized them to have a mean of zero, a standard deviation of one, and both negative and positive values. The index thus also has both negative and positive values, with low values indicating gender inequality and high values indicating gender equality. Chronbach's alpha, a measure of reliability based on the internal consistency or inter-correlations among the four items, equals .728.

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