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The contribution of a history of heavy smoking to Scotland's mortality disadvantage

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Abstract

Scotland has a lower life expectancy than any country in Western Europe or North America, and this disadvantage is concentrated above age 50. According to the Human Mortality Database, life expectancy at age 50 has been lower in Scotland than in any other developed country since 1980. Relative to 15 developed countries that we have chosen for comparison, Scotland's life expectancy in 2009 at age 50 was lower by an average of 2.5 years for women and 1.6 years for men. We estimate that Scottish women lost 3.6 years of life expectancy at age 50 as a result of smoking, compared to 1.4 years for the comparison countries. The equivalent figures among men are 3.1 and 2.1 years. These differences are large enough for the history of heavy smoking in Scotland to account both for most of the shortfall in life expectancy for both sexes and for the country's unusually narrow sex differences in life expectancy.

Keywords

mortality; lung cancer; tobacco; smoking; Scotland; geographic variation

Although mortality in Scotland and other developed countries steadily declined over the last century, a widening gap in life expectancy between Scotland and other high-longevity countries emerged around 1950 and accelerated after 1980 (McCartney et al. 2012a; McCartney et al. 2012b). In this paper we document and briefly review explanations of Scotland's poor performance in the improvement of life expectancy compared with other countries. We report the results of applying two methods to estimate the contribution of deaths attributable to a history of heavy smoking to Scotland's shortfall in life expectancy compared with a set of other high-income countries.

Background

Scotland's life expectancy in international perspective

To demonstrate that Scottish mortality falls below international standards for developed countries, we chose two comparison groups with high-quality mortality data. One group consisted of other English-speaking countries: England and Wales, Ireland, the United States, Canada, Australia, and New Zealand. The second group was European: two countries

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from northern Europe (Sweden and Finland), two countries from central Europe (Austria and Switzerland), two countries from southern Europe (Italy and Portugal), and two countries from western Europe (France and Belgium). A non-western developed country, Japan, was added to the set of countries when we made the broadest aggregate comparison. We relied primarily on data from the Human Mortality Database, a source of high-quality historical and contemporary data on mortality.

Table 1 shows the value of life expectancy in 2009 for Scotland and the three sets of comparison countries. For females, Scottish life expectancy at birth in 2009 is 2.82 years below the mean for the other countries, and for males it is 2.24 years lower. The Scottish disadvantage appears in relation to all sets of comparison countries.

The bulk of Scotland's mortality disadvantage occurs above age 50 years. According to the 2009 Scottish life tables (Human Mortality Database 2014), 96.3 per cent of female births and 93.3 per cent of male births reach age 50. Compared to the mean of the 15 countries, the Scottish shortfall of 2.51 years in female life expectancy at age 50 accounts for about 85 per cent $[(0.95)2.51/2.82]$ of the shortfall of 2.82 years in life expectancy at birth (Table 1). Among men, the equivalent figure is 66 per cent. Figure 1 shows the trend since 1950 in life expectancy at age 50 in the countries being compared. It shows that Scottish women and men were near the bottom of rankings in 1950 and that they were always at the bottom after 1980. In fact, from 1980 onwards, life expectancy at age 50 was lower in Scotland than in any other developed country (Human Mortality Database 2014).

Next to Scotland, the lowest life expectancy at birth for both females and males in Table 1 is that of the United States. The poor standing of the US in life expectancy was the subject of a major National Research Council study that produced 13 background papers (Crimmins, et al. 2010) and a long synthesis report (Crimmins et al. 2011). The report concluded that the single leading reason for the relatively low life expectancy of the US at age 50 was its history of very heavy cigarette smoking, and that this accounted for 78 per cent of the US shortfall relative to comparison countries for women and 41 per cent of the shortfall for men (Crimmins et al. 2011).

It is not surprising that differences in smoking patterns contribute to international differences in mortality because tobacco use is the primary cause of preventable mortality in the developed world (Ezzati et al. 2002). The 1964 US Surgeon General's report (Surgeon General's Advisory Committee on Smoking and Health 1964) decisively linked smoking to the development of lung cancer, and subsequent evidence confirmed that smokers were at increased risk of chronic obstructed lung disease, heart disease, stroke, chronic respiratory diseases, and various other cancers and circulatory diseases (Doll et al. 2004; Doll et al. 1994). The 2014 US Surgeon General's report (US Department of Health and Human Services 2014) estimates that 21 million deaths in the United States were attributed to tobacco use between 1964 and 2014, of which 24 per cent were caused by lung cancer.

Explanations of Scotland's exceptionally high mortality

Explanations of Scotland's historic mortality disadvantage have focused not on smoking but on several other causes. A recent paper reviewed hypotheses offered to explain Scotland's

mortality disadvantage relative to the rest of Western Europe, distinguishing between the 1950–80 period and the period since 1980 (McCartney et al. 2012a). Seventeen hypotheses were identified in a comprehensive literature search, and each was evaluated using the Bradford-Hill criteria for causality among observational data (Hill 1965).

The review suggests that the most plausible explanation for Scotland's mortality gap within the UK between 1950 and 1980 is relative deprivation. In 1989, Carstairs and Morris developed a much-cited measure of social deprivation in the United Kingdom using four census indicators: overcrowding, unemployment among men, low social class, and not having a car (Carstairs and Morris 1989). Applying this measure to area-level data on wards and post-code sectors from the 1981 UK censuses, the authors accounted for approximately 60 per cent of Scotland's excess age-standardized and sex-standardized mortality relative to England and Wales.

The McCartney review argues that the explanatory power of socioeconomic deprivation, using the Carstairs or alternate measures of deprivation, declined after 1980 (Hanlon et al. 2005; Hanlon et al. 2001; Walsh, Taulbut and Hanlon 2010). Hanlon et al. calculated the Carstairs and Morris area-level deprivation scores using the 1981, 1991, and 2001 censuses in Scotland and England and Wales (Hanlon et al. 2005). Whereas in 1981 the Carstairs and Morris index accounted for 60 per cent of Scotland's excess mortality, the index could account for less than half of Scotland's excess mortality in 1991 and 2001. In fact, relative to England and Wales, Scotland became less deprived during the period, yet simultaneously experienced a widening mortality disparity (Hanlon et al. 2005). Following common practice, the authors refer to this unexplained excess in Scottish mortality as the 'Scottish effect'.

In light of available data, the McCartney review further evaluates, and cautiously discounts hypotheses that suggest that the Scottish mortality gap after 1980 could be explained by migration, health systems, or health-related behaviour. The migration hypothesis posits that the country's higher mortality could be explained by the emigration of a higher proportion of healthy individuals from Scotland than from other Western European regions. But the limited literature on the subject shows that Scottish migrants display mortality profiles in their country of destination that are similar to those of non-migrants remaining in Scotland, particularly in death rates from lung cancer and ischemic heart disease (Connolly et al. 2011; Popham et al. 2010).

Though too little evidence is available for a full evaluation of the role of health systems in Scotland's mortality disparity, the McCartney review suggests that differentials in health systems' performance were not responsible. Self-reported use of health services in the General Household Survey of 1982 suggest that differences in use were minimal and insignificant between Scotland, England, and Wales (Haynes 1991). Since devolution of the United Kingdom in 1999, the Scottish Parliament and Government have been responsible for most areas of domestic policy, including the health system. During this period, Scotland spent a higher proportion of its national budget on healthcare than England, Wales, or Northern Ireland (Connolly et al. 2010; Sutherland and Coyle 2009). According to the OECD Regional Database (Directorate of Public Governance and Territorial Development

2014), the number of physicians per head in Scotland was at the median of the 16 countries under review in 2010 (data not available for Finland).

Finally, the health-behaviour hypothesis posits that poorer health behaviour in Scotland may have driven observed mortality differentials. This hypothesis has received little attention, although a comparison of 2003 Health Surveys in Scotland and England provides little basis for the belief that behavioral differences account for Scotland's divergence from England (McCartney et al. 2012a; Shelton 2009). One study, which was focused on people at younger ages, suggests that illicit drug use may account for up to a third of Scotland's mortality disadvantage relative to England between 2002 and 2005 (Bloor et al. 2008).

Smoking in Scotland

Smoking prevalence in the United Kingdom has historically been higher than in other OECD countries, particularly among women (Appendix Figure 1). With few exceptions, women in the United Kingdom reported the highest prevalence of cigarette smoking over a 50-year period from 1960 (42.0 per cent) to 2009 (20.7 per cent) (Appendix Figure 1(a),) (Directorate of Public Governance and Territorial Development 2014).

Within the United Kingdom, several sources that permit comparisons of smoking levels in different countries routinely show Scotland to have the highest prevalence of smoking and the highest consumption of cigarettes per adult. The 2003 Health Surveys in Scotland and England found that 29 per cent of adult Scottish men were current smokers, compared to 27 per cent in England; the figures for women were 28 per cent and 24 per cent (Shelton 2009). The General Lifestyle Survey collects individual-level information on smoking status by country within the United Kingdom. It shows that between 1978 and 2009, the annual prevalence of cigarette smoking among men and women aged 16+ years was highest in Scotland. Among 2010 adult current smokers, Scottish men and women smoked an average of 14.8 and 13.1 cigarettes per day (Gray and Leyland 2013), respectively, compared to 13.3 and 12.1 cigarettes per day in England (Eastwood 2012).

The influence of smoking on mortality depends on a number of the characteristics of the practice, including its duration, intensity, age at initiation, years since quitting, nicotine content, and how deeply the smoker inhales. These are not readily captured in a single indicator. An alternative indicator is the death rate from lung cancer. In those developed countries with high rates of smoking, 90 per cent of deaths from lung cancer have been attributed to smoking, in the sense that they would not have occurred if no one had smoked (Peto et al. 1992). On this indicator, Scotland's history of heavy smoking has left a vivid mark. Figure 2 shows that Scotland's death rate from lung cancer at ages 50 and above, age-standardized to the European standard population, has been significantly higher than comparison countries for women since 1970. For men, Scotland has had the first or second highest lung cancer mortality since 1960, sometimes exchanging places with Belgium in these positions.

Methods for calculating smoking-attributable mortality

To circumvent the limitations of survey-based estimates of the mortality effects of smoking, Peto et al. (1992) developed a widely documented indirect method (hereafter called

the Peto-Lopez method) to estimate smoking-attributable mortality at the population level. The Peto-Lopez method uses lung cancer mortality rates as a proxy for the cumulative impact on mortality of smoking over the life-course (Peto et al. 1992). The accuracy of lung cancer death coding on death certificates is high, and as noted, approximately 90 per cent of deaths from this disease are directly attributable to the impact of smoking in countries with high rates of smoking (Peto et al. 1992). The Peto-Lopez method combines population-level rates of death from lung cancer with the cause-specific relative risk of mortality between non-smokers and smokers. It assumes that, in the absence of smoking, the set of age/sex-specific death rates for lung cancer would be those recorded in the largest prospective cohort study of the mortality hazards of smoking, the Cancer Prevention Study II (CPS-II). This study is a US-based longitudinal study of approximately 1.2 million individuals followed from 1982 to 1988 (Thun et al. 1997). The CPS-II allowed for the calculations of the relative risks of cause-specific mortality between smokers and nonsmokers. The logic of the Peto-Lopez method is to map 'excess' lung cancer death rates onto an estimate of the prevalence of smoking in a population, and then to use the estimated prevalence to estimate the proportion of deaths from other specific causes that are attributable to smoking. The number of deaths attributable to smoking is the sum across causes of death of the cause-specific attributable deaths.

An alternative indirect method, hereafter called the PGW method, was developed by Crimmins et al. (2010) and Preston et al. (2010b). This method also uses lung- cancer death rates as an indicator of the cumulative damage caused by smoking but does not use the relative risks from the CPS-II, which may not be generalizable to all populations (Preston et al. 2010a). The PGW method relies instead solely on the macro-level statistical relationship between age-specific mortality rates for lung cancer and age-specific mortality rates for all other causes of death combined. Preston et al. estimated the parameters of this relationship using annual data for the period 1950 to 2007 for 21 high-income countries. The data set contained 9.9 billion person-years of exposure and 285 million deaths. Estimates of the smoking-mortality relations were made separately for the two sexes and 5-year age groups, controlling period effects, country effects, and interactions between the two. The analyses presented in this paper used the PGW method (Preston et al. 2010b) to estimate smoking-attributable mortality indirectly. We show that results using the Peto-Lopez method are extremely close to those using the PGW method.

Oza et al. (Oza et al. 2011) examine time-patterns of relative mortality risks of smokers for various causes of death. Relative to the lag between smoking behaviour and death for lung cancer, they found the lag structure to be longer for chronic obstructive pulmonary disease (COPD) and shorter for cardiovascular diseases. Using the Peto and Lopez method, the estimated number of deaths attributable to smoking differed by only 1.7 per cent when cause-specific lag structures were incorporated compared to when they were not. Thus, it appears that the pattern of lung cancer lags is sufficiently similar to that for the aggregate of other causes of death that serious distortions do not arise from assuming that they are, on average, the same.

Data and methods

Our study used the following data from the Human Mortality Database (HMD) (HMD 2014) for the period 1955–2009: annual all-cause death counts by sex in 5-year age intervals from 50–54 to 85+; population-exposure estimates; and life-tables by sex and 5-year age group. Annual death counts by cause of death, sex, and 5-year age group were taken from the World Health Organization Mortality Database for the period 1955–2009 (Mathers 2014). The International Classification of Diseases, Injuries, and Causes of Death was used. For each year-country-sex-age group, the distribution of lung cancer deaths was calculated from the World Health Organization Mortality Database. This distribution was applied to the all-cause death counts from the Human Mortality Database to determine lung cancer deaths and death rates. For the application of the Peto-Lopez method, the cause-specific death counts in the WHO Mortality Database were used to distribute deaths in the HMD by cause.

Attributable-risk calculation in the PGW method

In the PGW method, the fraction of lung cancer deaths attributable to smoking at a particular age is calculated as follows:

$$A_L = \frac{M_L - M'_L}{M_L}$$

where M_L is the observed death rate from lung cancer and M'_L is the age- and sex-specific lung cancer death rate among non-smokers in CPS-II (Thun et al. 1997). The fraction of deaths attributed to smoking from all causes of deaths other than lung cancer uses the model coefficients produced by Preston et al. (2010b). The fraction of not-lung-cancer deaths is calculated as follows:

$$A_O = 1 - e^{\beta'_L (M_L - M'_L)}$$

where β'_L is the model coefficient of lung cancer mortality.

The fraction of all deaths that is attributable to smoking is calculated as a weighted average of deaths attributable to lung cancer and not-lung-cancer deaths:

$$A = \frac{A_L D_L + A_O D_O}{D}$$

where D_L , D_O , and D are deaths attributable to lung cancer, to not-lung-cancer causes, and total deaths, respectively.

Age-specific death rates following the removal of smoking-attributable mortality are calculated as:

$$m_i^{-s} = m_i (1 - A_i)$$

for each age group $i=50-54, 55-59, \dots, 80-84, 85+$.

Sex-specific life tables are created using standard methods (Wilmoth et al. 2007) in STATA 13.1 by the use of death counts and exposure counts for each age, country, sex, and period. Age-specific mortality rates are created before and after the removal of smoking-attributable mortality.

Results

Smoking-attributable mortality above age 50, by sex and country, 1955–2009

Table 2 shows the estimated proportion of deaths attributable to smoking obtained by applying the PGW method to data from Scotland and comparison countries in 1955, 1980, and 2009. In 2009, Scottish women have a higher percentage of deaths attributable to smoking (28 per cent) than any other country; the mean percentage for other countries is only 11 per cent. Other English-speaking countries have a higher attributable fraction (18 per cent) than European countries (6 per cent). The high smoking-attributable fraction in Scotland is long-standing; Scottish women had the highest fraction, 10 per cent, in 1980.

The story for men is similar but less dramatic. Scotland has the second-highest fraction of deaths attributable to smoking in 2009, just behind Belgium (26 per cent vs. 25 per cent). The mean for all comparison countries is 18 per cent. So the Scottish excess in fractions attributable to smoking is smaller for men than for women, in accordance with the narrower gap in Scottish life expectancy for men shown in Table 1. The relatively high smoking-attributable fraction of deaths for Scottish men was also present in 1955 (16 per cent vs. a mean of 8 per cent for comparison countries) and 1980 (33 per cent vs. 20 per cent). Reflecting the ebbing of the smoking epidemic among them, men in most countries, including Scotland, had a higher fraction of deaths attributable to smoking in 1980 than in 2009.

Also shown in Table 2 are the 2009 estimates made using the Peto-Lopez method. This method too shows Scotland to have the highest smoking-attributable fraction of deaths of any country. The two series track one another very closely, with a correlation coefficient between them of 0.97 for women and 0.95 for men. Furthermore, the mean of the two series for the 15 comparison countries is identical for women (0.11) and nearly identical for men (0.19 vs. 0.18). Clearly, both series similar yield the same conclusions about the importance of smoking for the Scottish shortfall in life expectancy.

Effect on life expectancy

Table 3 shows the impact of removing deaths attributable to smoking on the life expectancy at age 50 for each country in 2009. Smoking-attributable mortality reduces the life expectancy at age 50 by a full 3.10 years for Scottish men in 2009, compared to a mean of 2.14 years for comparison countries. Of the initial gap of 1.69 years between Scotland and comparison countries before the removal of smoking-attributable deaths, only 0.74 years remains after their removal. Thus, smoking accounts for 56 per cent $[1 - (0.74/1.69)]$ of Scottish men's shortfall in life expectancy compared to the mean of comparison countries.

Once smoking-related deaths are removed, Scottish men have nearly the same life expectancy (32.09 years) as the mean of European countries (32.30).

Among Scottish women, smoking-attributable mortality reduces life expectancy at age 50 by 3.59 years in 2009, compared to 1.37 years for the mean of women in comparison countries. The removal of smoking-related deaths reduces the original gap between Scotland and the mean of comparison countries to 0.45 years, compared to the original gap of 2.67 years. So smoking accounts for about 83 per cent of the difference in women's life expectancy between Scotland and the mean of comparison countries. When the comparison is restricted to other English-speaking countries, smoking accounts for 64 per cent of the gap. This figure is lower because women in other English-speaking countries were themselves heavy smokers, losing an average of 2.19 years of life expectancy compared to only 0.74 years for European countries.

Scottish women lost more years of life expectancy to smoking than Scottish men in 2009, 3.59 years compared to 3.10 years. One consequence is that the sex difference in life expectancy in Scotland is a relatively low 3.41 years, compared to a mean of 4.39 years in comparison countries. Once smoking-related deaths are removed, Scotland's gap in life expectancy between the sexes rises to 3.90 years, similar to the gap of 3.62 years for comparison countries. So smoking is primarily responsible for the anomalously low sex difference in life expectancy in Scotland.

More generally, smoking patterns are disturbing the international pattern of differences in life expectancy between women and men. Among European comparison countries, men lost 1.96 years to smoking compared to only 0.74 years for women. In contrast, English-speaking countries had roughly equal losses to smoking for men and women: women lost an average of 2.19 years compared to 2.28 years for men. The correlation between men's and women's life expectancy among the 16 countries in 2009 was 0.68 before the removal of smoking deaths and 0.85 after their removal. Men's and women's life expectancies were more closely aligned after the removal of the exceptionally heavy impact of smoking on the life expectancy of English-speaking women.

In order to provide more temporal depth, Figure 3(a) shows the contribution of smoking to the difference in women's life expectancy at age 50 between England and Wales and Scotland annually between 1950 and 2009. The differences in life expectancy are calculated both before and after the removal of smoking-attributable deaths. A third-degree polynomial is fit to the two series. Before the removal of smoking-attributable deaths, the Scottish deficit in life expectancy grows slowly over time. The removal of smoking mortality, however, reduces the mortality gap, from about 1.5 years in 1950 to less than 0.5 years from 2000 to 2009.

Figure 3(b) is the corresponding figure for men. Before allowance for smoking, the disparity in life expectancy for men worsens over time in Scotland relative to England and Wales. The removal of smoking, however, largely eliminates this widening divergence and holds the Scottish disparity for men relatively constant over the period.

Smoking has little effect for either sex on the gap in life expectancy between England and Wales and Scotland in the 1950s. But its influence strengthens thereafter, especially among women after 1980. By 2010, the difference in life expectancy at age 50 is reduced to only 1.03 years for men and 0.56 years for women after the removal of smoking-attributable mortality, compared to actual differences of 1.78 and 1.76 years.

Discussion

The foregoing analysis finds strong evidence that smoking-attributable mortality is the primary driver of Scotland's large and widening mortality disadvantage relative to other developed countries. Smoking-attributable mortality in Scotland reduces life expectancy at age 50 in 2009 by a full 3.59 years for women and 3.10 years for men. The reduction for women is higher than in any of 15 comparison countries, in which smoking reduces life expectancy by an average of 1.37 years. For men, only Belgium lost more years of life to smoking than Scotland. Smoking had an especially strong influence on women's mortality in Scotland after 1980.

The indirect estimation method used here has several limitations. One is that the model coefficients taken from Preston et al. (2010b) rely on the statistical association between lung cancer mortality and smoking. In populations where conditions other than smoking may contribute heavily to lung cancer mortality, the assumption that lung cancer mortality represents the cumulative impact from smoking on mortality may not be valid. Other contributors to lung cancer mortality include exposure to heavy pollution and such behavioural practices as indoor coal burning. Among Asians living in Asia, for example, the incidence of and mortality from lung cancer are significantly higher among nonsmokers than among their European counterparts (Thun et al. 2008). In historically heavy-smoking populations such as the United Kingdom, however, smoking is the primary contributor to lung cancer mortality (Ezzati and Lopez 2003).

Two possible sources of bias in the estimates should be borne in mind. One is differences between the samples of non-smokers used. The expected rates of death from lung cancer among non-smokers used in the PGW method are drawn from the CPS-II study, which is of a US population of predominantly middle-class, college-educated white persons (Thun et al. 1997). In contrast, the rates for non-smokers presented by (Thun et al. 2008) using the CPS-II are similar to those reported in other samples (Doll et al. 1994; Enstrom 1979). Another possible source of bias is differences in the classification of lung cancer death rates across countries, though the accuracy of lung cancer classification remains consistently high in industrialized countries (Percy et al. 1981).

The reasons for Scotland's higher prevalence of smoking, lung cancer mortality, and years of life sacrificed to smoking remain uncertain. There is nothing in government policy on tobacco use that might account for heavy smoking in Scotland relative to the rest of Great Britain. Before devolution in 1999 and the formation of the Scottish Parliament, England, Wales, and Scotland were subject to the same policy. By 1930, Great Britain had the highest rate of lung cancer mortality in the world according to the Royal College of Physicians Action on Smoking and Health (ASH) council (Action on Smoking and Health 2014). The

rising recognition of Britain's smoking epidemic led the British Parliament to introduce a massive 43 per cent tax on tobacco cigarettes in 1947. Parliament banned cigarette advertisements on television in 1965, and on radio in 1978. Upon devolution in 1999, the Scottish Parliament took a relatively stronger stance than England and Wales in legislation on smoke-free areas. In 2006, Scotland became the first United Kingdom country to ban smoking in all enclosed public spaces and workplaces.

Heavy smoking in Scotland is not inconsistent with the country being relatively deprived socioeconomically: deprivation may lead to smoking, which may then function as the 'proximate' cause of disease. That would be consistent with the widespread observations that, within developed countries, including Scotland, people of lower education or income are more likely to smoke than those without these disadvantages (Huisman et al. 2005). The 2003 Health Survey in Scotland (Bromley et al. 2003) found that, among men, 15 per cent in the highest household income quintile smoked cigarettes compared with 51 per cent in the lowest quintile. The corresponding figures for women were 13 per cent and 45 per cent.

Scotland has reduced or eliminated its economic disadvantages relative to England and Wales, but not its longevity disadvantage. As we noted earlier, the 'Scottish effect' refers to the increasing inability of relative deprivation to account for the poor ranking of Scottish longevity within the United Kingdom after 1980. Identifying smoking as the principal reason for the shortfall in Scottish longevity may help account for this anomaly. Because of the long lag between smoking behaviour and its mortality consequences, smoking-attributable deaths in any particular period reflect smoking behaviour over many previous decades. In the case of smoking, the past casts a long shadow.

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Figure 1.

(a) Trends in life expectancy at age 50, $e(50)$, among high-longevity countries, females 1950–2009. (b) Trends in life expectancy at age 50, $e(50)$, among high-longevity countries, men 1950–2009

Source: Human Mortality Database (accessed November 2014).

Figure 2.

(a) Lung cancer death rates at ages 50 and above by country, women 1950–2009. (b) Lung cancer death rates at age 50 and above by country, men 1950–2009. *Note:* Age-standardized death rates per 100,000 person-years using the European Standard Population.

Source: Human Mortality Database (accessed November 2014) and the World Health Organization Mortality Database (accessed November 2014)

Figure 3.

(a) Differences in life expectancy at age 50, $e(50)$, before and after the removal of smoking-attributable mortality, Scotland vs. England and Wales, 1950–2009, women. (b) Differences in life expectancy at age 50, $e(50)$, before and after the removal of smoking-attributable mortality, Scotland vs. England and Wales, 1950–2009, men

Note: Differences in life expectancy (Scotland – England and Wales) are calculated both before and after the removal of smoking-attributable deaths. Each trend line represents a third-degree polynomial.

Source: As for Figure 2.

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Table 1

Life expectancy at birth, $e(0)$, and age 50, $e(50)$, in 2009 for Scotland and comparison countries.

Country	Females		Males	
	$e(0)$	$e(50)$	$e(0)$	$e(50)$
Scotland	80.45	32.41	75.87	29.00
Australia	84.16	36.07	79.70	32.35
Canada	83.28	35.52	78.85	31.60
England and Wales	82.43	34.17	78.29	30.78
Ireland	82.23	33.68	77.24	29.78
New Zealand	82.34	33.98	78.37	30.96
United States of America	81.04	33.58	76.13	29.85
Austria	82.87	34.18	77.43	29.62
Belgium	82.44	33.91	77.16	29.43
Finland	83.14	34.54	76.51	29.18
France	84.46	35.96	77.80	30.35
Italy	84.24	35.72	79.22	31.20
Portugal	82.46	34.06	76.42	29.19
Sweden	83.33	34.39	79.33	31.20
Switzerland	84.20	35.39	79.63	31.56
Japan	86.39	38.63	79.55	31.80
Mean, English-Speaking Comparison Countries	82.58	34.50	78.10	30.89
Mean, Non-English Speaking European Countries	83.39	34.77	77.94	30.22
Mean, All Comparison Countries	83.27	34.92	78.11	30.59

Note: 2008 estimates are shown for New Zealand.

Source: Human Mortality Database (accessed November 2014).

Table 2

Estimated smoking-attributable fraction of deaths at age 50+ in 1955, 1980, 2009, by sex and country.

Country	Females				Males			
	PGW		Peto-Lopez		PGW		Peto-Lopez	
	1955	1980	2009	2009	1955	1980	2009	2009
Scotland	0.02	0.10	0.28	0.25	0.16	0.33	0.25	0.26
Australia	0.00	0.04	0.13	0.12	0.07	0.22	0.16	0.17
Canada	0.01	0.06	0.22	0.21	0.07	0.22	0.22	0.22
England and Wales	0.02	0.09	0.19	0.18	0.17	0.30	0.20	0.20
Ireland	0.02	0.07	0.16	0.19	0.04	0.17	0.20	0.21
New Zealand	0.00	0.06	0.15	0.17	0.08	0.21	0.16	0.18
United States of America	0.01	0.08	0.20	0.21	0.08	0.23	0.21	0.22
Austria	0.01	0.03	0.07	0.07	0.15	0.21	0.15	0.18
Belgium	0.00	0.01	0.07	0.07	0.09	0.30	0.26	0.26
Finland	0.01	0.02	0.05	0.05	0.18	0.28	0.15	0.16
France	0.00	0.00	0.05	0.05	0.05	0.17	0.19	0.20
Italy	0.00	0.01	0.07	0.06	0.04	0.20	0.23	0.22
Portugal	0.00	0.00	0.01	0.01	0.02	0.07	0.12	0.15
Sweden	0.00	0.02	0.09	0.10	0.03	0.10	0.10	0.11
Switzerland	0.00	0.01	0.06	0.09	0.09	0.19	0.14	0.16
Japan	0.00	0.03	0.10	0.05	0.01	0.11	0.21	0.18
Mean, English-Speaking Comparison Countries	0.01	0.07	0.18	0.16	0.08	0.22	0.19	0.20
Mean, Non-English Speaking European Countries	0.00	0.01	0.06	0.08	0.08	0.19	0.17	0.18
Mean, All Comparison Countries	0.01	0.04	0.11	0.11	0.08	0.20	0.18	0.19

Note: PGW denotes estimation using the Preston-Glei-Wilmoth method. Peto-Lopez denotes use of the Peto-Lopez method. 2008 estimates are shown for New Zealand.

Source Human Mortality Database (accessed November 2014) and the World Health Organization Mortality Database (accessed November 2014).

Table 3

Life expectancy at age 50 (e50) in 2009 before and after the removal of deaths attributable to smoking.

Country	Females		Males		Difference
	With Smoking	Without Smoking	With Smoking	Without Smoking	
Scotland	32.41	35.99	29.00	32.09	-3.10
Australia	36.07	37.53	32.35	34.23	-1.88
Canada	35.52	38.46	31.60	34.40	-2.80
England and Wales	34.17	36.45	30.78	33.09	-2.31
Ireland	33.97	35.85	29.95	32.21	-2.26
New Zealand	34.24	36.05	31.21	33.05	-1.83
United States of America	33.58	36.34	29.85	32.42	-2.57
Austria	34.52	35.38	29.82	31.58	-1.76
Belgium	34.25	35.19	29.62	32.81	-3.19
Finland	34.88	35.47	29.33	31.04	-1.71
France	36.49	37.16	30.62	33.08	-2.46
Italy	35.72	36.49	31.20	33.78	-2.58
Portugal	34.06	34.23	29.19	30.59	-1.40
Sweden	34.39	35.56	31.20	32.21	-1.01
Switzerland	35.66	36.44	31.76	33.33	-1.57
Japan	38.63	40.02	31.80	34.57	-2.77
Mean, English-Speaking Comparison Countries	34.59	36.78	30.96	33.23	-2.28
Mean, Non-English Speaking European Countries	35.00	35.74	30.34	32.30	-1.96
Mean, All Comparison Countries	35.08	36.44	30.69	32.83	-2.14

Note: 2008 estimates are shown for New Zealand.

Source As for Table 2.