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ORIGINAL ARTICLE

Temporal patterns in lung cancer death rates in Ireland

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Abstract

Background Distinct temporal patterns can be identified through estimating annual-percent-changes (APC) in age-specific disease rates, but APCs in lung cancer rates among the youngest adults can also reflect the recent changing smoking habits of a population.

Method Lung cancer mortality rates from 1970 to 1999 were investigated in Ireland, using the Joinpoint regression modelling technique.

Results In the most recent decade (1989–1999) male lung cancer death rates showed a significant annual decline (–2.4%), but female annual rates have scarcely decelerated (0.1%). The combined gender youngest adults (30–39 year-olds) showed decreasing rates, but the annual decline in the youngest female rates were significant only from 1970 to 1990 and thereafter increased non-significantly.

Conclusion Unlike male lung cancer death rates, the overall female rates are increasing significantly. While the combined gender youngest adult rates are decreasing, the apparent reversal in trends among the youngest female rates from 1990 onwards is worrying.

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Introduction

Lung cancer is currently the most common cancer death in Ireland [1]. The causal association between smoking and lung cancer (almost 90%) is also very strong [2]. Therefore, within country temporal variations in age and sex-specific lung cancer death rates can provide important clues to population-specific smoking patterns.

A recent study has validated lung cancer rates as an index of tobacco smoke exposures [3]. Sometimes comprehensive smoking history data are also not available for a specific population. Smoking patterns, especially among the younger population, can change periodically depending on the marketing strategies of the powerful tobacco industry [4]. Likewise, strong anti-smoking legislative measures, such as increased taxation or preventing youth access to smoking products, can influence adult smoking rates [5]. Because of such compelling methodological and public-health implications, lung cancer rates especially in the youngest adults (30–39 year-olds) can be a good surrogate measure for changing smoking exposure levels in a general population.

Furthermore, studies have used the US National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Joinpoint regression programme [6], as a powerful tool for identifying and describing temporal patterns of cancer mortality by estimating annual-percent-changes (APC) in disease rates [7, 8]. Therefore, the overall study objective is to calculate APCs in recent lung cancer mortality rates in Ireland over a 30-year period using Joinpoint regression models, and focusing on changing lung cancer mortality rates in specific age-groups as a function of smoking exposure levels.

Methods

The available data on lung cancer deaths from 1970 to 1999 were requested from the Irish Central Statistics Office (CSO). The coding used for lung cancer was the International Classification of Diseases [ICD 9: 162] [9]. Such data sources report causes of deaths based on death certificates. The age and sex-specific population data for each census years between 1970 and 1999, as well as the intercensal population estimates were obtained from the CSO website (www.cso.ie) for standardisation of death rates.

For temporal patterns in lung cancer death rates across different time-periods for each specific age group, log-linear Poisson regression models were used to calculate APCs, using Joinpoint programme (version 3.0). The four relatively young adult age-groups (30–34, 35–39, 40–44 and 45–49 year-olds, respectively) were collapsed into two broad age-bands (30–39 and 40–49 year-olds, respectively), because of fewer lung cancer deaths. The remaining age-groups were categorised into 5-year age-bands. Consequently, the 30–39 year-olds in both sexes were considered to be the youngest adults in this study.

In brief, the Joinpoint [6] analysis fits a series of joined straight lines on a log scale to the age-specific and age-standardised lung cancer death rates. Line segments are joined at points called joinpoints. Each Joinpoint denotes a statistically significant change in trend. The best-fitting points are the years of death that change significantly (increasing or decreasing trends). The analysis starts with the minimum number of joinpoints, and tests whether one or more joinpoints are statistically significant and should be added to the model. A maximum of three joinpoints can be added to the final model.

Results

Figures 1, 2 show the absolute number of total annual lung cancer deaths, and their corresponding annual Irish age-standardised death rates from 1970 to 1999. Male lung cancer age-standardised death rates showed an earlier peak around the mid 1980s followed by a declining death rate (Fig. 1), while female lung cancer age-standardised death rates are yet to decline, but have stabilised since the early 1990s (Fig. 2).

Annual-percent-changes are shown in Table 1, 2. Female death rates showed a significant annual rise of 2.4% overall (1970–1999) in Table 2, unlike the male death rates (Table 1). Although not significant (Table 2), the truncated (30–84 age-groups) APCs in female rates have also begun showing a declining trend (–0.3%) in the most recent decade (1990–1999).

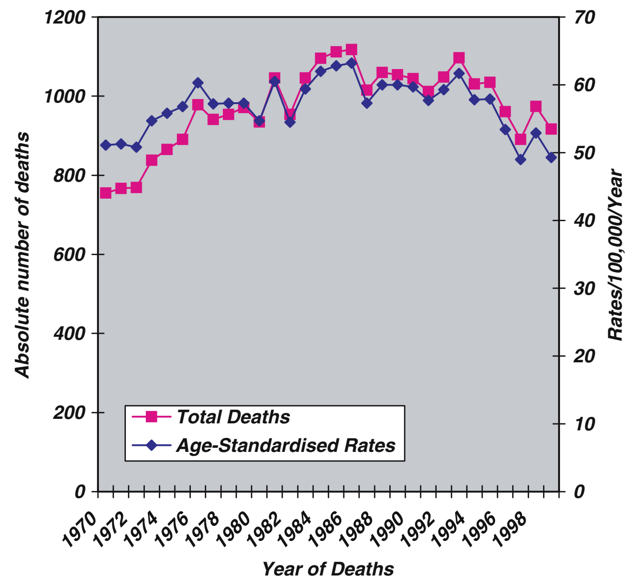

Fig. 1 Male total lung cancer deaths and corresponding age-standardised lung cancer death rates by year in the Republic of Ireland: 1970–1999

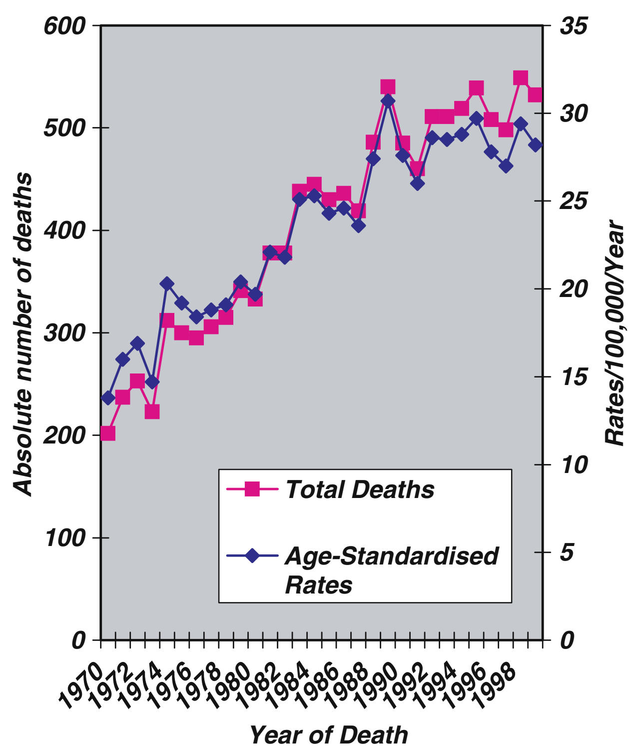

Fig. 2 Female total lung cancer deaths and their corresponding age-standardised lung cancer death rates by year in the Republic of Ireland: 1970–1999

Table 1 Annual percent changes (APC) with 95% confidence intervals (CI) of lung cancer death rates and joinpoint analysis among males: age-specific and age-standardised rates in the Republic of Ireland: 1970–1999

Age-specific	EAPC (95% CI) 1970–1999	Trend 1 years	(First slope) EAPC (95% CI)	Trend 2 years	(Second slope) EAPC (95% CI)
30–39	–4.0 (–5.0; –3.0)	1970–1977	–7.9 (–14.8; –0.3)	1977–1999	–3.1 (–4.8; –1.4)
40–49	–2.5 (–3.5; –1.4)	1970–1983	–0.7 (–4.2; 2.8)	1983–1999	–3.9 (–6.5; –1.1)
50–54	–2.3 (–2.9; –1.6)	1970–1984	–0.6 (–2.5; 1.3)	1984–1999	–3.9 (–5.6; –2.0)
55–59	–1.5 (–2.1; –0.8)	1970–1982	1.1 (–0.9; 3.2)	1982–1999	–3.2 (–4.5; –1.8)
60–64	–1.1 (–1.7; –0.5)	1970–1988	0.3 (–0.6; 1.2)	1988–1999	–4.2 (–6.2; –2.1)
65–69	–0.04 (–0.4; 0.3)	1970–1985	1.1 (0.3; 2.0)	1985–1999	–1.3 (–2.2; –0.4)
70–74	0.5 (–0.1; 1.1)	1970–1984	3.1 (1.9; 4.3)	1984–1999	–1.6 (–2.5; –0.6)
75–79	1.2 (0.4; 2.0)	1970–1976	14.7 (7.6; 22.2)	1976–1999	0.1 (–0.5; 0.7)
80–84	3.0 (1.9; 4.0)	1970–1985	8.1 (6.3; 9.9)	1985–1999	–0.8 (–2.1; 0.5)
85+	7.7 (6.3; 9.2)	1970–1989	11.0 (8.8; 13.3)	1989–1999	–0.2 (–5.4; 5.3)
Age standardised					
Overall (0–85+)	0.05 (–0.3; 0.4)	1970–1990	0.8 (0.4; 1.2)	1990–1999	–2.4 (–3.5; –1.2)
Truncated (30–84)	0.9 (0.3; 1.4)	1970–1985	3.2 (2.5; 3.9)	1985–1999	–1.6 (–2.4; –0.9)

Table 2 Annual percent changes (APC) with 95% confidence intervals (CI) of lung cancer death rates and joinpoint analysis among females: age-specific and age-standardised rates in the Republic of Ireland: 1970–1999

Age-specific	EAPC (95% CI) 1970–1999	Trend 1 years	(First slope) EAPC (95% CI)	Trend 2 years	(Second slope) EAPC (95% CI)
30–39	–1.1 (–2.5; 0.3)	1970–1990	–3.3 (–6.0; –0.6)	1990–1999	5.4 (–3.0; 14.4)
40–49	–1.2 (–2.5; 0.1)	1970–1993	–0.7 (–2.7; 1.4)	1993–1999	–4.8 (–17.6; 9.8)
50–54	–0.6 (–1.6; 0.3)	1970–1979	4.1 (–1.2; 9.6)	1979–1999	–1.9 (–3.3; –0.6)
55–59	–0.3 (–1.4; 0.8)	1970–1983	3.6 (0.5; 6.9)	1983–1999	–3.1 (–5.3; –0.8)
60–64	0.5 (–0.4; 1.4)	1970–1988	3.1 (2.0; 4.3)	1988–1999	–4.6 (–6.8; 2.4)
65–69	2.0 (1.2; 2.8)	1970–1983	4.8 (2.0; 7.6)	1983-1999	0.4 (–1.2; 1.9)
70–74	2.3 (1.6; 3.1)	1970–1988	4.0 (2.6; 5.5)	1988–1999	–0.4 (–2.7; 1.9)
75–79	4.0 (3.1; 4.9)	1970–1990	5.8 (4.3; 7.3)	1990–1999	0.3 (–2.7; 3.4)
80–84	4.2 (3.5; 5.0)	1970–1993	5.1 (4.0; 6.3)	1993–1999	0.1 (–5.1; 5.6)
85+	5.6 (3.8; 7.4)	1970–1975	–5.2 (–23.4; 17.1)	1975–1999	6.7 (4.6; 8.8)
Age-standardised					
Overall (0–85+)	2.4 (2.0; 2.8)	1970–1989	3.3 (2.7; 3.9)	1989–1999	0.1 (–1.3; 1.6)
Truncated (30–84)	2.7 (2.3; 3.2)	1970–1989	3.9 (3.4; 4.6)	1989–1999	–0.3 (–1.9; 1.3)

For the age-specific APCs in lung cancer rates, significant changes in the direction of lung cancer death rates occurred across two specific time-periods for both sexes in all age-groups (Table 1, 2). The changes were particularly significant in the most recent decade, namely from 1990 onwards.

Compared with male annual death rates of similar age-groups, the relatively old females (>65 years of age) showed a greater annual rise overall (1970–1999), as opposed to a slower annual decline among the relatively young females (<65 years of age). However, the oldest adults (85+ years) showed gender variations in an opposite direction from 1970 to 1999: an annual rise of 7.7% in males (Table 1) and of 5.6% in females (Table 2).

Most importantly, lung cancer death rates among the youngest males (30–39 years of age) were significantly decreasing at the rate of 4% annually overall (1970–1999), but the decline was steeper (–7.9%) in the beginning (1970–1977) and becoming slower (–3.1%) in the later period (Table 1). The male 40–49 year-olds were also showing a significant annual decline of 2.5% overall (1970–1999). Although the youngest females (30–39 years of age) did not show a significant annual decline in death rates overall (1970–1999), they did show a significant an-

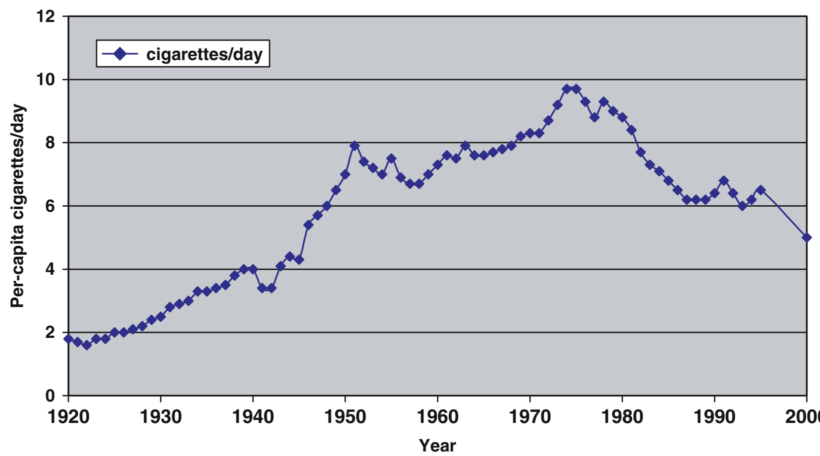

Fig. 3 Per-capita annual cigarette consumption among adults (15 years and above) in the Republic of Ireland: 1920–2000

nual decline of 3.3% over the first two decades (1970–1990), but increased non-significantly thereafter (Table 2).

Figure 3 shows the historical annual per-capita cigarette consumption pattern of adults (above 15 years) in the Republic of Ireland, ranging from less than two cigarettes a day in year 1920, then peaking in the mid-1970s to almost ten cigarettes a day, and finally falling to five cigarettes a day in the most recent year, namely 2000.

Discussion

Despite a slower annual decline in male lung cancer rates from 1990 onwards, the overall sustained annual decline in males is indeed a favourable trend in Ireland, and the apparent reversal in trends among the youngest females in the most recent decade is not so encouraging. Such a temporal pattern clearly reflects the recent changing smoking habits in the Irish population. Some improvements in diagnostic and in therapeutic interventions have occurred, but the 5-year survival for lung cancers are still poor [1]. Hence, the observed declines in lung cancer rates could largely be attributed to both past and recent tobacco control efforts in Ireland. Also, the recent temporal patterns observed in female lung cancer rates reflects the birth cohort effects due to the historical delay in the uptake of smoking habits in females, as observed elsewhere [10, 11].

Such distinct patterns in female lung cancer rates can also be related to the two contrasting scenarios observed in this study reciprocal to male rates (1) a slower annual decline in the youngest females, (2) a greater annual rise in the relatively old females. Consistent with an age-cohort effect, other potential explanations may include the lack of gender-sensitive tobacco control activities in Ireland, gender differences in smoking behaviour and in nicotine addiction levels [12, 13], or a genetic variation in tobacco-specific carcinogenesis [14]. Such information is not available for the Irish population. This study also suggests that current lung cancer rates in the oldest age-cohorts could in part drive the future lung cancer pattern in Ireland, reinforcing the age-cohort effect of past smoking habits across successive generations reported recently [15].

Nonetheless, sudden periodic interventions, such as a workplace smoking ban or an increased taxation, can have a calendar effect on all age-groups simultaneously [16]. Consequently, the significant inflexions observed in lung cancer mortality rates from 1990 onwards across both sexes for all age-groups is interesting. First, there was no major public-health intervention coinciding with this time-period apart from the Coal Ban in Dublin in 1990 [17]. Second, such positive trends can be a reflection of the patchy tobacco control efforts in the past. Such a phenomenon does, however, correlate well with the reported annual decline in smoking prevalence since the early 1980s [18]. Another study also reported a fall in teenage smoking prevalence from 20% in 1995 to 13% in 2003 [19]. However, a recent study showed that post Coal Ban in Dublin in 1990 the lung cancer death rates did decline even after adjusting for smoking prevalence [17].

In conclusion, smoking exposure levels are changing in the general Irish population, with male lung cancer rates showing an overall encouraging trend. However, the apparent reversal in the youngest female cancer rates recently is worrying. Steps are necessary to identify plausible reasons and the means to address such issues. This can have long-term consequences on the burden of other major tobacco-related conditions, such as cardiovascular disorders and COPD. The Irish government is also committed to a Tobacco Free Society [20]. Non-cancer health gains are already evident following the smoking ban [21]. It would be sometime before any significant declines in lung cancer rates are seen post ban. However, for dramatic effects in lung cancer rates as early as 2–4 years [22], a national comprehensive tobacco control programme is imperative similar to California, and also in line with the Massachusetts Tobacco Control Programme [23].

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