Female mortality trends in Spain due to tumors associated with tobacco smoking

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Age- and period-specific mortality rates for esophageal, laryngeal, lung, and bladder cancers in Spanish women from 1952 to 1986 were analyzed using an age-period-cohort model for each location. The four sites exhibit a similar pattern, characterized by a decline in mortality (cohort effect) in post-1900 generations. In the case of cancers of the esophagus and larynx, the model and curvature analysis show a slight rise in mortality in post-1932 generations. In cancers of the esophagus and lung, the period effect parallels the trend traced by the cohort effect. Prevalence estimates of smoking among women in Spain would seem to suggest that the degree of exposure in cohorts studied has been very low. The study indicates that smoking in Spanish women is relatively frequent only in recent generations and that this exposure has not produced, as yet, relevant variations in time trends. Special attention should be paid to the well known synergistic effect of smoking and alcohol consumption, which might already have determined changes in esophageal and laryngeal mortality.

Key words: Bladder cancer, cancer mortality, esophageal neoplasms, females, laryngeal cancer, lung cancer, Poisson models, Spain, tobacco smoking.

Introduction

Recent years have witnessed a consolidation of knowledge regarding the effects of tobacco consumption on cancer incidence and mortality. The 1987 National Health Survey in Spain included information on smoking habits, grouped according to age and gender. From the results as published, we proceeded to calculate the percentage of past and present women smokers for different generations: pre-1923; 1923-42; 1943-62; and post-1962. The female smoker prevalences were 4.6 percent, 9.3 percent, 42.3 percent, and 56.6 percent, respectively. The prevalence of female smokers (ever-smokers) over the age of 15 in 1987 was recorded as 29 percent compared with 73 percent for men. Since the rise in mortality from smoking-related tumors in Spanish men has been dramatic, the upsing in the proportion of female smokers in Spain would lead one to expect a concomitant rise in tumor-related deaths associated with this habit. Age-standardized rates have been used traditionally for evaluating incidence and mortality time-trends. Directly adjusted rates on the other hand, being essentially a weighted summary-type measure, tend to reflect the progress charted by the older age groups. Recently, advances made in the field of log-linear models allow for a better and more attractive approach to trends in mortality indices.
Age-period-cohort models have been used in this paper in order to study female mortality time-trend patterns in Spain, attributable to tumors associated with cigarette consumption (i.e., cancers of the esophagus, larynx, lung, and bladder).

Materials and methods

Mortality statistics

The national population figures together with data (duly broken down by age and gender) on the number of deaths due to cancers of the esophagus, larynx, lung, and bladder were obtained from the official annual reports of the National Statistics Institute. During the period under study, four consecutive revisions of the International Classification of Diseases and Causes of Death (ICD) were in use. The sixth revision was used until 1961, at which point the seventh was introduced in force, 1968, when the eighth revision was introduced in Spain; this revision was then subsequently replaced by the ninth in 1980. In all four ICD revisions, rubrics 150 and 161 corresponded to esophageal and laryngeal cancer, respectively. Bladder cancer was classified first under rubric 181 in the sixth and the seventh, and then under rubric 188 in the eighth and the ninth ICD revisions. Lung cancer corresponded to rubrics 162 and 163 in the sixth and the seventh ICD revisions and to rubric 162 in the most recent editions.

Specific and adjusted rates

Age- and gender-specific mortality rates were calculated for five-year periods. The rates were adjusted for age using the world population as standard. Male to female mortality ratios were computed from age-adjusted rates. Population estimates used were those standing at the midpoint of each quinquennium studied, as calculated by the National Statistics Institute.

Age, period, and cohort modeling

The abovementioned matrices, namely age- and gender-specific rates, were used for studying the effects of age, birth cohort, and period of death. Evaluation, based on the procedure described by Osmond and Gardner, was effected by means of a log-linear Poisson model, fitted using appropriate GLIM macros.

The predictive variables were included subsequently in the model. Age was taken first, since incidence and mortality from these tumors increase remarkably with age. Thereafter, the 'age + drift' model, which assumes a constant change in the rates logarithm between adjacent cohorts or periods, was fitted. In the next step, two-factor 'age + period' and 'age + cohort' models were considered. Finally, the model came to include all three factors—age, cohort, and period—which minimized the sum of the Euclidean distances from the three two-factor models. Cohorts and periods were defined according to their corresponding midpoints. Analysis was restricted to the under-age-85 segment of the population. The youngest age group included in the model was the first group, over the age of 14 years, found to have suffered at least five deaths from this cause in each quinquennium. Output age values are interpretable in terms of mean age-specific death rates for the period considered. Cohort and period-of-death values were averaged to unity.

The resulting, adjusted values for the cohort and period effects were then plotted. Cohort values linked to the earlier and more recent periods are based on fewer age-specific rates, hence proving less reliable than central ones. Further, recent values are based on fewer deaths.

It is well known that age-period-cohort models must be interpreted with caution due to the identifiability problem. However it is possible to interpret the results using estimates that do not depend on any arbitrary constraints. We conducted a curvature analysis as proposed by Holford. Curvature is the deviation exhibited by each value estimated for a concrete cohort (or period) of the predicted value, taking into account the overall trend over time.

The co"h ort effects can be represented as the sum of two components:

\[
\Phi_k = k - (K-1)/2 \beta_c + \gamma_c
\]

where \(k\) is the number of cohorts, \(\beta_c\) is the overall slope of cohort effect, and \(\gamma_c\) is the curvature. Curvature values are independent of the solution chosen for the final model. It is also possible to determine the sum of the cohort and period slopes (\(\beta_c + \beta_p\)), representing the 'net drift.' This parameter is useful for assessing the overall trend over time.

Goodness-of-fit was evaluated on the basis of the deviance in each model. Deviance changes in the exclusively 'age-based' model were calculated for the contribution of the added factor. Pearson's residuals were calculated for the final model and the assumed distribution checked by means of a normal quantile plot. In addition, Filliben's probability plot correlation-coefficient between predicted and observed distributions of residuals was carried out.

Results

The evolution seen in the adjusted mortality rates for these tumors has not been uniform (Table 1). Adjusted mortality rates for cancer of the lung and esophagus...

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