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# Striking Changes in Smoking Behaviour and Lung Cancer Incidence by Histological Type in South-east Netherlands, 1960–1991

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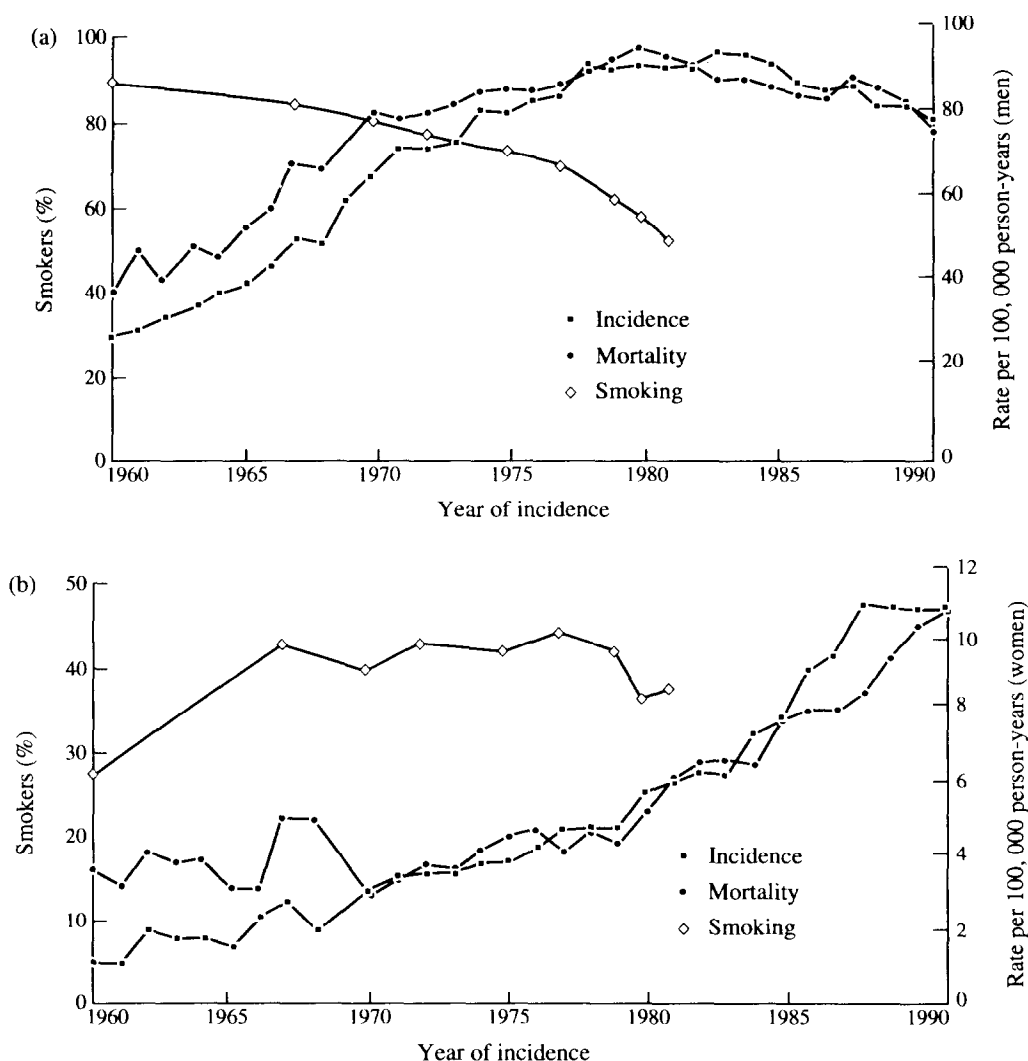
Changes in lung cancer incidence in south-east Netherlands between 1960 and 1991 were analysed, using data from the Eindhoven Cancer Registry, and related to previous changes in smoking habits. Male lung cancer incidence rates increased markedly from birth cohorts 1890–1899 to 1910–1919, followed by a decline. The peak incidences for both squamous cell carcinoma and small cell carcinoma were reached in 1978, while for adenocarcinoma it was 1985. A rising trend in female lung cancer incidence up to 1988 was found for each successive birth cohort and for every histological type. These changes in lung cancer incidence rates are most likely related to the pattern of past smoking habits: the percentage of male adult smokers in the southern part of the Netherlands decreased from 95% in 1960 to 40% in 1981 and the percentage of female adult smokers increased from 27% in 1960 to 40% in 1967, slightly decreasing only after 1979. In view of the trends in smoking behaviour, the incidence rates for male lung cancer will decline further, whereas female lung cancer incidence may decrease after the year 2000.

**Key words:** lung cancer, incidence, cancer registry, histology, trends  
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## INTRODUCTION

IN SOUTH-EAST Netherlands, male lung cancer incidence and mortality were among the highest in Europe from 1969 up to 1990, whereas female lung cancer incidence and mortality were among the lowest until 1980 [1–4]. Previous reports have

suggested that the mortality rate for lung cancer among Dutch men has changed markedly: a decline is now apparent after a marked increase since World War II. In contrast, female lung cancer mortality has increased steadily [5, 6]. In this survey, temporal trends in the incidence of lung cancer in the south-east



**Figure 1.** (a) Age-standardised male incidence and mortality rates for lung cancer, 1960–1991, and percentage of male smokers in southern Netherlands between 1960 and 1981. (b) Age-standardised female incidence and mortality rates for lung cancer, 1960–1991, and percentage of female smokers in southern Netherlands between 1960 and 1981.

Netherlands during the period 1960–1991 were investigated, using data from the Eindhoven Cancer Registry. To assess completeness, regional mortality data were also considered. We analysed the changing trends according to period of diagnosis and 10-year birth cohort. Since smoking is by far the most prominent risk factor for lung cancer [7], and relative risks of smoking are higher for squamous cell carcinoma and small cell carcinoma than for adenocarcinoma [8–10], the trend in incidence was also analysed according to histological type. Regional patterns in smoking habits, obtained from national surveys held since 1958, were considered.

#### PATIENTS AND METHODS

Data were obtained from the Eindhoven Cancer Registry, which contains data on patients with cancer newly diagnosed since 1955 in community hospitals (data collected from clinical records after notification by pathologists, radio-therapists and medical record administrations). This registry covers a large part of the south-eastern area of the Dutch province of North Brabant since 1960, and this complete area together with the northern part of the adjacent province of Limburg since 1970. The ICD code for lung cancer was 162. We distinguished between squamous cell carcinoma, adenocarcinoma, small cell carcinoma and 'other plus not otherwise specified (NOS)', according to the WHO classification [11]. Because of the poor reproducibility for large cell and undifferentiated carcinoma, we classified these tumours into the group of 'other and not otherwise specified' [12]. Analyses according to histological type were only applied to patients diagnosed since 1971, because then the percentage of 'not otherwise specified' became small enough (10%). The composition of the population was determined annually from data of the Department of Population Statistics of

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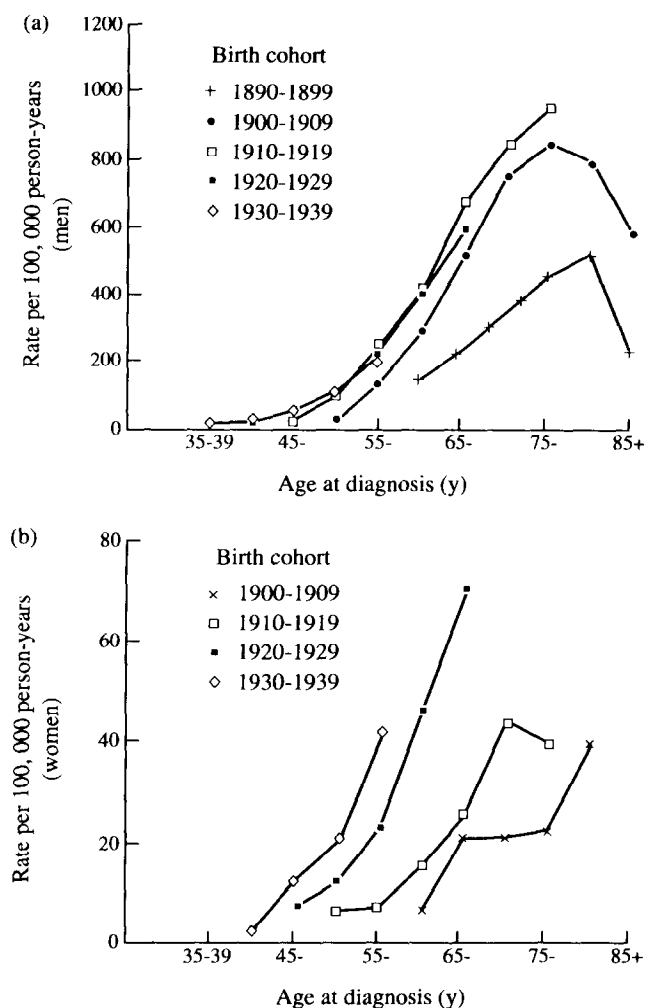


Figure 2. (a) Age-specific incidence rates for male lung cancer in south-east Netherlands, according to 10-year birth cohort. (b) Age-specific incidence rates for female lung cancer in south-east Netherlands, according to 10-year birth cohort.

the Central Bureau of Statistics (CBS). Because the registry does not receive data from death certificates, the incidence data were compared with mortality data to assess completeness. Regional mortality data were derived from the CBS.

Incidence rates were computed per 100 000 person-years for each sex and displayed as 3-year moving means. Age adjustment was performed by direct standardisation according to the World Standard Population (WSR: World Standard Rate) [3]. Age-specific incidence rates were calculated per 10-year birth cohort since 1890. Smoking habits of the Dutch population were derived from periodic surveys conducted in every region of the Netherlands from 1958 to 1981 [13].

## RESULTS

Between 1960 and 1991, 10 223 lung cancer patients (9412 men and 811 women) were registered in the south-east Netherlands. The age-adjusted male lung cancer incidence rate increased from 30 per 100 000 person-years in 1960 to 95 in 1983 and then decreased to 78 in 1991. The percentage of male adult smokers in the southern Netherlands decreased remarkably, from the very high 95% in 1960 to 40% in 1981 (Figure 1a). Between 1960 and 1981, the number of cigarettes smoked per day among males rose from 18 to 23. Age-adjusted incidence

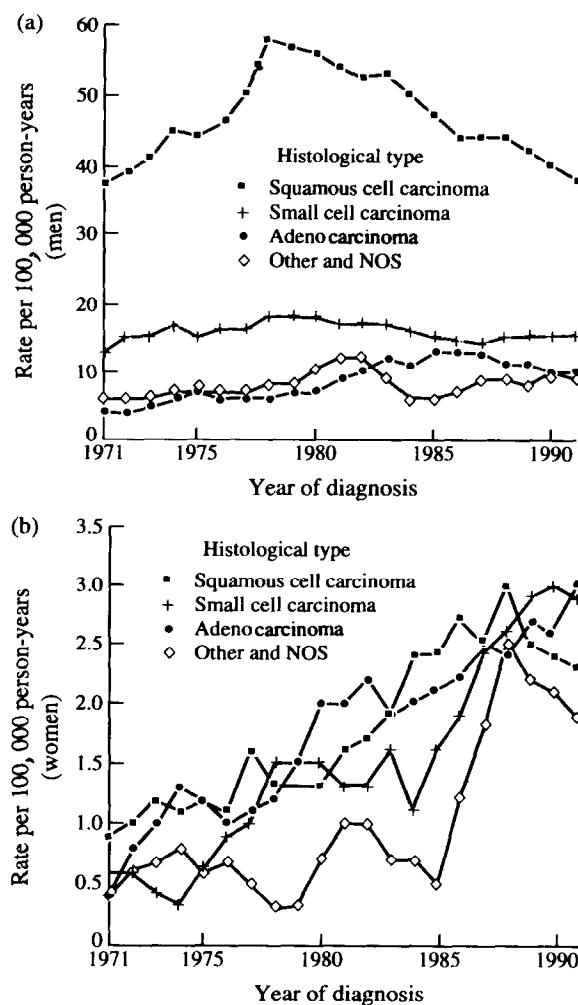


Figure 3. (a) Age-standardised male incidence rates in south-east Netherlands, according to histological type. (b) Age-standardised female incidence rates in south-east Netherlands, according to histological type.

rates for females increased from 1 per 100 000 person-years in 1960 to 11 in 1988 and then stabilised (Figure 1b). In contrast to men, the percentage of female adult smokers in the southern Netherlands increased strongly from 27% in 1960 to 40% in 1967. After 1979, it decreased to 36% in 1981 (Figure 1b). Between 1960 and 1981, the number of cigarettes smoked per day among females rose from 8 to 19.

The trends of lung cancer mortality rates were similar to the incidence rates, but until 1977 lung cancer mortality was higher than incidence. Lung cancer incidence and mortality rates for males were markedly higher than for females. However, the male/female ratio declined from 20 between 1960 and 1976 to 8 in 1991 (Figures 1a and b). The incidence rate increased for men born between 1890 and 1919 and then decreased (Figure 2a), while for females it has increased continuously for every successive birth cohort between 1900 and 1939 (Figure 2b).

Among men, the age-standardised incidence rate for squamous cell carcinoma, being the most common histological type of lung cancer, and small cell carcinoma increased until 1978, whereas that for adenocarcinoma increased until 1985 (Figure 3a). The proportion of adenocarcinoma varied between 4 and 7% until 1980, thereafter rising steadily to 15%. Among women,

the incidence of all histological types increased between 1971 and 1988 (Figure 3b).

### DISCUSSION

Dramatic changes have occurred in the male lung cancer incidence rates in the south-east Netherlands, increasing markedly until 1983, for birth cohorts from 1890–1899 to 1910–1919 and then declining. For squamous cell carcinoma and small cell carcinoma, the peak incidence rates were reached in 1978 and for adenocarcinoma in 1985. Female lung cancer incidence rates, initially at a very low level, increased continuously to a plateau in 1988. This rising trend was found for every successive birth cohort and for every histological type.

From trends in lung cancer mortality, it also appears that a small part of the increase (especially among the elderly) can be explained by better detection and verification of the diagnosis through flexible bronchoscopy and cytology [14]. The percentage of cytological verification increased from 0% in 1960 to 11% in 1977 and to 22% in 1991. The presumably more rapid decrease in mortality due to cardiovascular diseases since 1970 may also play a role [15, 16].

The trends in lung cancer incidence are most likely related to the changing habits in cigarette smoking, the greatest single cause of lung cancer [7]. The decline of male smokers since 1958 was followed by a reduction in male lung cancer incidence after 20–25 years. In the earlier male birth cohorts, the average duration of exposure to cigarettes was longer than in later birth cohorts. Whereas the number of cigarettes smoked per day by those who continued to smoke rose from 18 to 23 for males and from 8 to 19 for females, more low-tar and/or filter cigarettes were smoked [13, 17].

Whereas previous studies, covering the Netherlands as a whole, have shown similar trends in lung cancer mortality, our study seems to show a more extreme situation [4, 5, 18]. Firstly, the male lung cancer incidence in the south-east Netherlands was one of the highest in Europe and between 1969 and 1990 regional mortality was also higher than in other parts of the Netherlands [1, 2, 4, 19]. Between 1958 and 1981, the percentage of male smokers was 5% higher in the southern part of the Netherlands than in the rest of the country, which was possibly related to high social acceptance due to the presence of many tobacco processing industries. Secondly, female lung cancer incidence and mortality in the south-east Netherlands were among the lowest in the Netherlands and in Europe up to 1980 [1, 2, 4, 19], due to the very low initial percentage female smokers in this part of the Netherlands, which may be explained by the traditional life-style of largely Catholic women.

Another argument for the role of smoking habits is the fact that the peak incidences for males of squamous cell carcinoma and small cell carcinoma, both of which are related to smoking more than adenocarcinoma [8–10], were reached in 1978, while that of adenocarcinoma was not reached until 1985. The changing histopathology of lung cancer, which was also seen in other surveys [20, 21], is not likely to be related to the use of the new WHO classification since 1981 [22], because solid carcinomas with mucus formation were classified in the group of adenocarcinoma during the whole period. It is uncertain whether the increased incidence of adenocarcinoma for males points to a more delayed effect of tobacco on adenocarcinoma and/or (combined) exposure to other risk factors relevant to this area, such as occupational exposure (heavy metals) [8, 19].

In view of the trends in known risk factors and latency time, the incidence rates for male lung cancer will probably decline

further in the near future. A decrease in female lung cancer incidence is not expected before the beginning of the next century.

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