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Lung cancer incidence trends by histologic type in areas of California vs. other areas in the Surveillance, Epidemiology and End Results Program

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ABSTRACT

Background: This study compared temporal trends in incidence rates for the major histological types of lung cancer in areas of California (CA), which started a comprehensive state tobacco control program in 1989, and other selected geographic areas for which data on long-term trends were available. *Methods*: Age-standardized incidence rates (ASIRs) within age 25–64 years, most likely to have been affected by tobacco control programs, were compared for lung-bronchus adenocarcinoma, squamous cell carcinoma, and small cell carcinoma in 1992–2005 for non-Hispanic whites in three areas of CA in the Surveillance, Epidemiology and End Results (SEER) Program vs. 10 non-CA SEER areas. For 1985–2005, data were available for all whites in the San Francisco-Oakland CA SEER area and eight non-CA SEER areas. *Results*: ASIRs were roughly similar in CA and non-CA areas in 1992, but declines from 1992 to 2005 were larger in CA than non-CA areas for each histological type. In San Francisco-Oakland CA, declines were not clearly evident from 1985 to 1988 (before the tobacco control program started) but from 1992 to 2005 declines were larger than in the non-CA areas. *Conclusions*: These findings provide further support for expansion of statewide tobacco control programs, in order to reduce incidence rates for all histologic types of lung cancer.

1. Introduction

California (CA) established in 1989 the first comprehensive statewide tobacco control program including an increase in the state cigarette tax, but also mandated funding for mass media anti-tobacco campaigns, local support for adherence to anti-smoking laws, and community-based interventions [1,2]. The CA program has been associated with larger declines in smoking rates, and in per-capita cigarette consumption, in CA vs. the U.S. exclusive of CA in the 1990s [1]. In national surveys of samples of the general U.S. adult population, "successful" (i.e., 1 year or longer) smoking cessation rates at age 20–64 years increased from 1980 to 1990 but in the 1990s these rates were higher among non-Hispanic white adults age 20–49 years in CA, than in six southern "tobacco growing" states with low cigarette taxes and no statewide program in the 1990s [3]. From 1992–1993 to 2001–2002 smoking prevalence at age 20–64 years in non-Hispanic whites declined significantly in CA but not in the other geographic areas compared [4].

These geographic (i.e., CA vs. non-CA) differences in smoking habits in non-elderly age groups should have resulted in geographic differences in temporal trends in incidence rates for tobacco-related cancers (especially in younger adults) from the 1990s through the early-mid 2000s. Using a 1-year time lag from the start of the CA tobacco control program, age-standardized lung cancer incidence rates fell significantly after 1990 in the San Francisco-Oakland CA area of the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program of high-quality population-based cancer registries, and not in the other SEER areas; data were not analyzed for histologic types of lung cancer [5].

A report from the CA Department of Health Services in 2000 showed that the estimated annual percentage changes in age-adjusted lung-bronchus cancer incidence rate from 1988 through 1997 was −0.4% per year (not significantly different from zero) for eight non-CA SEER areas combined vs. −1.9% per year ($p < .01$) for the entire state of CA (i.e., including parts of CA not covered by the SEER Program at that time) [6]. These reports [5,6] did not present data for young adults. Jemal et al. [7], however, showed that lung cancer mortality rates (and trends from 1990–1994 through 1995–1999) at age 30–39 years among 33 U.S. states (including CA) was inversely associated with an index of state tobacco control efforts. Mortality data cannot be used to analyze trends in lung cancer by

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histologic subgroups, due to the limitations of death certificates; cancer incidence data from high-quality population-based registries must be used.

Declines in lung cancer risk after smoking cessation (relative to current smokers or never smokers) have been shown for each of the major histologic types of lung cancer in men and women, including adenocarcinoma (ADC), small cell lung carcinoma (SCLC), squamous cell carcinoma (SQC) and large cell carcinoma (LCC), in early studies reviewed in a Surgeon General Report [8], a recent meta-analysis [9], and two cohort studies of women in the U.S. [10,11]. While trends in incidence rates for specific histological types of lung cancer have been reported in the U.S. [12,13], apparently no reports have examined such rates in U.S geographic areas that have differed in tobacco control efforts. ADC, the most common histologic type, is less strongly associated with current smoking than SQC or SCLC and other specific causal factors for ADC have been suggested [14].

Thus, if declines in incidence rates were larger in CA than non-CA areas for ADC and not the other major histologic types, then explanations other than the CA tobacco control program could be suggested. In contrast, an early divergence (shortly after 1989) of CA from the rest of the U.S. in incidence rates (especially among young adults) for each histologic group would support an impact of CA's comprehensive tobacco control program, and this could provide additional support for expanding comprehensive programs nationally.

The present study examined trends in ASIRs using data from the SEER Program [15]. The focus was on a comparison trends in CA vs. non-CA SEER areas, because of the unique history of comprehensive state tobacco control efforts in CA, its apparent impact on trends in smoking habits in CA [1,3,4] and its association with significantly greater declines in mortality from heart disease in CA compared to the rest of the U.S. in the 1990s [16].

2. Methods

Age-standardized incidence rates (ASIRs) for lung-bronchus cancers by histologic type category in 1992–2005, directly standardized to the U.S. 2000 standard population using 5-year age intervals, were available for 13 SEER areas; the combined population of all 13 areas represents about 14% of the entire U.S. population [15]. The 13 areas are: Atlanta, Georgia, metropolitan area; Detroit, Michigan, Metropolitan area; Connecticut; Hawaii; Iowa; New Mexico; Seattle-Puget Sound, Washington; Los Angeles County, San Jose-Monterey, and San Francisco-Oakland, in CA; rural Georgia, and Alaskan natives [15]. ASIRs for 1992–2005 for the three CA areas combined were compared with those for all other 10 SEER areas combined area (and by gender) were also examined.

The SEER database is a unique resource for the study of temporal trends in U.S. cancer incidence rates (e.g., lung cancer ASIRs by histological category). Although data from 29 population-based cancer registries were used to assess "short-term trends (1996–2005)" in cancer incidence rates in a recent Report to the Nation on the Status of Cancer, only data from the nine original SEER registries were available to evaluate long-term trends and have been used to estimate cancer incidence trends for the entire U.S. (in the absence of historical data for all states) [17].

Although the CA state cigarette tax increase started in January (and a statewide tobacco control program in April) 1989 [1,2], data for 13 SEER areas were available only starting in 1992 [15,18]. However, an immediate impact of the CA program on lung cancer ASIRs would not be expected because it would take some time for the program to affect smoking habits (including cessation) and (hence) for former smokers (with their reduced lung cancer risk) to accumulate in the population. Also, a 2-year lag in onset of decline in lung cancer risk after quitting smoking has been reported to fit models based on data from the largest prospective epidemiologic study, although histologic type of lung cancer was not considered [19].

Geographic differences (i.e., California vs. other areas) in trends in ASIRs from 1992 to 2005 could be continuations of earlier trends that differed by geographic area. For years of diagnosis prior to 1992, the SEER database includes only one CA area (San Francisco-Oakland) and eight non-CA areas [15,18]. For this report, ASIRs were obtained for several years prior to 1992 (i.e., 1985–1991) as well as 1992–2005, in San Francisco-Oakland vs. the other eight areas combined, to assist in the interpretation of geographic differences (CA vs. non-CA) in time trends in ASIRs.

The racial-ethnic composition of the population of CA differs from that for other SEER areas, including much higher proportions of Hispanic Americans (especially in San Jose-Monterey and Los Angeles) and Asian Americans in CA. For 1992–2005, however, ASIRs could be calculated for non-Hispanic whites, using an algorithm that includes Spanish-surname matching to identify patients possibly of Hispanic ethnicity [15,18]. For earlier years, ASIRs could be calculated only for all whites (i.e., not specifically for non-Hispanic whites), so that pre-1992 data for "all whites" are included in this report. Numbers of lung cancers by histological category were too small for meaningful analyses of trends in ASIRs for specific racial-ethnic groups such as African Americans/blacks and Asian Americans.

Because of the sex difference in history of smoking habits in the U.S., and consequent sex differences in temporal trends in lung cancer rates, separate analyses of trends in ASIRs for lung cancer by histologic group were conducted for men and women.

Histologic groups were defined, using International Classification of Diseases for Oncology Version 3 (ICD-O-3) Morphology codes in the SEER database [15,18]. For the present study, ADC included "ADC not otherwise specified" and specific adenocarcinomas, bronchioalveolar carcinoma, papillary adenocarcinoma, adenosquamous carcinoma, and bronchial gland carcinoma (codes 8050, 8140-8143, 8200, 8250-8251, 8260, 8290, 8310, 8320, 8430, 8480, 8490, 8550, 8571), consistent with a 1995 SEER monograph on cancer trends by histology [20]. ICD-O-3 was used for diagnoses in 2001–2005, while ICD-O-2 was used for diagnoses in 1992–2000 (i.e., most of the time period covered by the present study) and pre-1992 cases had been machine-converted to ICD-O-2 by SEER [15,18]. SQC was defined as code 8070 in a 1995 SEER Monograph [20], while codes 8070-8076 were used in the present study (as in a previous report using SEER data) [13]. SLCL was defined as codes 8041-8045 [15,20]. Data for LCC are not tabulated because ASIRs were low (especially in women) and inconsistency in classification by pathologists has been reported [13].

Annual percent change (APC) in the ASIR could be calculated for 1992–2005 [18], using weighted least squares regression of natural logarithms of ASIRs; standard errors and confidence limits (Tiwari method) were calculated from the fitted regression, assuming a constant rate of change by calendar year [15,18]. ASIRs and APCs were calculated separately for age at diagnosis groups 25–64 years, because the impact of tobacco control efforts on smoking cessation rates in CA vs. other areas may have been greatest among persons who were age <50 years [3] in 1989 and the 1990s (and would not have reached age 65 years by 2005).

ASIRs for individual calendar years were plotted, in order to examine consistency in trends over time (relevant to the linear assumption involved in calculating confidence limits for APCs) [15,18], and to compare trends before and after the start of the comprehensive tobacco control program in CA in 1989; also, the potential impact of delayed reporting of cancers to central (SEER) cancer registries should affect mainly the latest year of diagnosis covered (i.e., 2005 in this study) [15,18]. To examine potential