Neighborhood Deprivation and Lung Cancer Incidence and Mortality

A Multilevel Analysis from Sweden

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Background: Neighborhood deprivation has been implicated in lung cancer but no study has simultaneously analyzed the potential effect of neighborhood deprivation on both lung cancer incidence and mortality, after adjusting for individual-level socioeconomic factors, and comorbidities. The aim of this study was to analyze whether there is an association between neighborhood deprivation and incidence and mortality rates of lung cancer, beyond individual-level characteristics.

Design: The incident and mortality cases of lung cancer were determined in the entire Swedish population aged over 50 (3.2 million individuals) between 2000 and 2010. Multilevel logistic regression was used in the analysis with individual-level characteristics (age, marital status, family income, education, immigration status, urban/rural status, mobility, and comorbidities) at the first level and level of neighborhood deprivation at the second level. A neighborhood deprivation index, constructed from the variables education, income, unemployment, and welfare assistance, was used to assess the level of neighborhood deprivation.

Results: There was a strong association between level of neighborhood deprivation and incidence and mortality of lung cancer. In the fully adjusted model, the odds of lung cancer were 1.27 and 1.32, respectively, in the most deprived neighborhood. The between-neighborhood variance (i.e., the random intercept) was over 1.96 times the standard error in all models, indicating that there were significant differences in incidence and mortality rates of lung cancer between neighborhoods.

Conclusions: Results suggest that neighborhood deprivation is associated with incident and mortality cases of lung cancer in Sweden, independently of individual-level characteristics.

Key Words: Neighborhood deprivation, Lung cancer, Risk factors, Sweden.

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Lung cancer is considered to be one of the major public health challenges, as the most common cancer in terms of both incidence and mortality worldwide. Many risks factors for lung cancer are known, such as tobacco smoking, air pollution, and family history. Studies have also shown associations between individual-level socioeconomic status (SES) and lung cancer risk and survival.[1–8] During the first decade of this millennium an increasing number of studies have described the separate influences of individual- and neighborhood-level SES on health.[9–13] The concept that disease determinants are in part environmental was described by Durkheim over a century ago. He stated that a population is more than only the sum of all individuals.[14] This concept was further developed in Rose's idea of the importance of distinguishing between the causes of individual cases of disease within a population, and the causes of differences in the rates of disease across populations.[15] For example, if people within the same neighborhood share the same socioeconomic environment, access to healthcare resources, norms settings, and lifestyles, they may shape a common level of cardiovascular health beyond individual characteristics. Thus, in addition to individual-level sociodemographic factors, neighborhood-level factors may also increase the risk of disease. However, only a few studies have documented the potential effects of neighborhood-level SES on lung cancer risk.[16–19] In a study from Taiwan between 2002 and 2007, lung cancer survival was significantly associated with low income but only among individuals younger than 65 years.[14] Neighborhood deprivation, defined by income, had, however, no significant influence on lung cancer survival when adjusting for individual income. In a Danish study between 2004 and 2008, lung cancer incidence was higher in neighborhoods with high unemployment rates, independently of individual-level socioeconomic factors.[15] A Swiss study conducted between 2001 and 2008 showed hazard ratios of 1.49 of lung cancer mortality in neighborhood with the lowest socioeconomic position compared with the highest position.[18] The results were adjusted for individual-level socioeconomic factors. Moreover, a study from the US conducted between 1995 and 2007 showed that a decreased survival of non–small-cell lung cancer is associated with neighborhood deprivation.[19] However, some studies have found no association between lung cancer survival and individual socioeconomic factors.[20–22] Moreover, a Swedish

study conducted between 1990 and 2004 found no association between neighborhood deprivation and lung cancer mortality.[23] To the best of our knowledge, no study to date has simultaneously analyzed the effect of neighborhood-level SES on both lung cancer incidence and mortality, after adjusting for individual-level socioeconomic factors and comorbidities, such as chronic pulmonary disease (COPD) and alcoholism.

The first aim of this study was to investigate whether there is an association between neighborhood deprivation and incident and mortality rates of lung cancer between 2000 and 2010. The second aim was to investigate whether this possible difference remains after accounting for individual-level socio demographic characteristics, i.e., age, marital status, family income, education, immigration status, urban/rural status, mobility, and comorbidities (chronic obstructive pulmonary disease [COPD], tobacco abuse, and alcoholism or alcohol-related liver disease).

MATERIALS AND METHODS

The data sources were several national Swedish data registers, such as the Swedish National Population and Housing Census (1960–1990), the Total Population Register, the Multi-Generation register, the Swedish Cancer Registry (1958–2010), the Swedish Hospital Discharge Register (1964–2010), and the Swedish Out-patient Register (2001–2010), provided to us by Statistics Sweden and the National Board of Health and Welfare. We used the primary diagnoses for lung cancer in the Swedish Cancer Register. Additional linkages were carried out to national census data to obtain individual-level SES, occupation, geographical region of residence, to the National Registry of Causes of Death (1961–2010) to identify date and cause of death, and to the Immigration Registry to identify date of emigration. All linkages were performed by the use of an individual national identification number that is assigned to each person in Sweden for their lifetime. This number was replaced by a serial number for each person to provide anonymity.

The study period started on January 1, 2000 and proceeded until first incident of lung cancer, mortality of lung cancer, death from any other cause, emigration or the end of the study period on December 31, 2010.

Outcome (Dependent) Variable

The outcome (dependent) variable was incident (yes/no) and mortality (yes/no) cases from lung cancer. The unit of observation was individuals. We used the Swedish Cancer Registry to identify primary diagnoses of lung cancer in the study population during the study period. We then linked this information with records in the Cause of Death Register to identify deaths among lung cancer patients during the same period. All cases of cancer in Sweden must be registered in the Swedish Cancer Registry. The completeness of cancer registration is currently considered to be close to 100%. Only primary neoplasms of the lung classified according to the 7th revision of the International Classification of Diseases (ICD-7) (The Swedish Cancer Registry has transferred all the cancer ICD codes into ICD-7) (codes 162, 163) were studied.

The 10th revisions of the International Classification of Diseases (ICD-10 C33 to C34) were used to define the outcome variable of mortality due to lung cancer in the Cause of Death register.

Independent Variables

Independent variables included sex, age at the start of the study, marital status, family income, educational attainment, immigration status, geographical region, mobility, diagnosis of COPDs, tobacco abuse, and alcoholism or alcohol-related liver disease of the subjects.

Sex. Men and women.

Age. Age was greater than or equal to 50 years and was divided into 10-year category.

Marital status. Individuals were classified as married/cohabitating or single.

Family income by quartile. Information on family income in 2000 came from the Total Population Register, which was provided by Statistics Sweden. We used this information to determine the distribution of family incomes in Sweden, and then used the distribution to calculate empirical quartiles.

Educational attainment. Educational attainment was classified as completion of compulsory school or less (less than or equal to 9 years), practical high school or some theoretical high school (10–12 years), or theoretical high school and/or college (greater than 12 years).

Immigration status. (1) Born in Sweden and (2) Born Outside Sweden.

Urban/rural status. Individuals were classified as living in a large city, a middle-sized town, or a small town/rural area. This variable was included because urban/rural status may be associated with access to care. Large cities were those with a population of greater than or equal to 200,000 (Stockholm, Gothenburg and Malmö). Middle-sized towns were towns with a population of greater than or equal to 90,000 but less than 200,000. Small towns were towns with a population of greater than or equal to 27,000 and less than 90,000; rural areas were areas with populations smaller than those of small towns.

Mobility. Length of time lived in the neighborhood, categorized as lived in the neighborhood less than 5 years or greater than 5 years.

Comorbidities. COPD and tobacco abuse: Patients' previous diagnosis of COPD, which was suspected to be one important prognostic factor for lung cancer and used as a surrogate of smoking, was identified in the Hospital Registry 10 years before the follow-up period and Out-patient Register accordingly (COPD: ICD-91990–1996 = 490–496; ICD-10 1997–2010 = J40–J49. The same approach was used to identify tobacco abuse: ICD-9 = 305.1, 292.0, 292.1, 292.2, 292.8, 292.9, V15.8, V65.3, V65.8; ICD-10 = F17, T65.2, Z71.6, Z72.0). Patients' COPD and tobacco abuse in the patient Registries was individually linked to their lung cancer status using a serial number. Alcoholism and alcohol-related liver disease was identified in the Hospital Registry and Out-patient Register according to the International Classification of Diseases codes (ICD-9 = 291, 303, 571; ICD-10 = F10 and K70).

