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Neighbourhood socioeconomic status and individual lung cancer risk: Evaluating long-term exposure measures and mediating mechanisms

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ABSTRACT

Neighbourhood socioeconomic status (SES) has been associated with numerous chronic diseases, yet little information exists on its association with lung cancer incidence. This outcome presents two key empirical challenges: a long latency period that requires study participants' residential histories and long-term neighbourhood characteristics; and adequate data on many risk factors to test hypothesized mediating pathways between neighbourhood SES and lung cancer incidence. Analysing data on urban participants of a large Canadian population-based lung cancer case-control study, we investigate three issues pertaining to these challenges. First, we examine whether there is an association between long-term neighbourhood SES, derived from 20 years of residential histories and five national censuses, and lung cancer incidence. Second, we determine how this long-term neighbourhood SES association changes when using neighbourhood SES measures based on different latency periods or at time of study entry. Third, we estimate the extent to which long-term neighbourhood SES is mediated by a range of individual-level smoking behaviours, other health behaviours, and environmental and occupational exposures. Results of hierarchical logistic regression models indicate significantly higher odds of lung cancer cases residing in the most compared to the least deprived quintile of the long-term neighbourhood SES index (OR: 1.46; 95% CI: 1.13–1.89) after adjustment for individual SES. This association remained significant (OR: 1.38; 1.01–1.88) after adjusting for smoking behaviour and other known and suspected lung cancer risk factors. Important differences were observed between long-term and study entry neighbourhood SES measures, with the latter attenuating effect estimates by over 50 percent. Smoking behaviour was the strongest partial mediating pathway of the long-term neighbourhood SES effect. This research is the first to examine the effects of long-term neighbourhood SES on lung cancer risk and more research is needed to further identify specific, modifiable pathways by which neighbourhood context may influence lung cancer risk.

Introduction

Lung cancer represents approximately 18% of all cancer deaths worldwide (Jemal et al., 2011). In Canada, there are 25,600 new lung cancer cases and 20,200 lung cancer deaths annually, representing 14% of new cancers and 27% of all cancer deaths (CCS, 2012). Strong social (and spatial) gradients in lung cancer are present in Canada and many other countries, with significantly higher incidence rates among disadvantaged populations as well as places (Sidorchuk et al., 2009). These differences remain after accounting for individual smoking behaviour as well as other established lung cancer risk factors (Mao, Hu, Ugnat, Semenciw, & Fincham, 2001; Sidorchuk et al., 2009).

Neighbourhood context, especially neighbourhood socioeconomic status (SES), has an independent association with a number of health outcomes, including all-cause mortality (Meijer, Röhl, Bloomfield, & Grittner, 2012) and cardiovascular disease (Diez-Roux et al., 2001; Kawakami, Li, & Sundquist, 2011; Major et al., 2010). Neighbourhood SES is a latent construct representing complex socioeconomic contextual conditions within neighbourhoods — conditions that may influence an individual's health

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behaviours and health status through numerous material and psychosocial pathways (Carpiano, Link, & Phelan, 2008; Diez-Roux & Mair, 2010). The role of neighbourhood SES in shaping lung cancer risk, however, has not been adequately examined to date (Chaix, Rosvall, Lynch, & Merlo, 2006; Martikainen, Kauppinen, & Valkonen, 2003; Matukala Nkosi, Parent, Siemiatycki, & Rousseau, 2012; Meijer, Bloomfield, & Engholm, 2012). In fact, neighbourhood influences on cancer incidence in general have only recently been examined in a relatively small number of studies (Freedman, Grafova, & Rogowski, 2011; Major et al., 2010; Webster, Hoffman, Weinberg, Vieira, & Aschengrau, 2008).

The lack of research examining neighbourhood SES and cancer may be the result of two specific challenges. First, long latency periods are typically associated with cancer development and properly incorporating latency periods into health research requires information on study participants' residential histories. In addition, corresponding measures of neighbourhood context over multiple time points are required – information that is not commonly available or collected. Studies have highlighted differential residential mobility patterns based on socioeconomic factors (Hurley et al., 2005; Kan, 2007) as well as important individual health-behaviours (Pearce & Dorling, 2010), which could bias results of neighbourhood studies that do not account for residential mobility. A review of neighbourhood studies of older adults found that only 10 of the 33 identified studies accounted for respondents' length of residence in a neighbourhood, and only one study accounted for changes in neighbourhood environments (Yen, Michael, & Perdue, 2009). Several studies have also examined area-level influences over the life course (Carson et al., 2007; Clarke et al., 2013; Curtis, Southall, Congdon, & Dodgeon, 2004; Leyland & Næss, 2009; Naess, Claussen, Smith, & Leyland, 2008; Ohlsson & Merlo, 2011) as well as neighbourhood context at multiple time points (Lloyd, Li, & Hertzman, 2010; Sampson, Sharkey, & Raudenbush, 2008; Wheaton & Clarke, 2003), but associations are mixed and the majority of this literature has not examined cancer.

Second, is the challenge of interpreting how neighbourhood SES may influence cancer risk and the numerous direct and mediating pathways through which neighbourhood SES may operate. Though studies have found that neighbourhood SES is associated with the onset of cancer after controlling for individual-level socioeconomic characteristics (e.g. Freedman et al., 2011; Meijer, Bloomfield, et al., 2012; Webster et al., 2008), there have been few studies that examine whether such associations remain after accounting for a comprehensive set of individual risk factors and whether these factors are mediators of the neighbourhood SES effect. For lung cancer, the effects of neighbourhood SES may be mediated through a number of known or suspected lung cancer risk factors (Alberg, Ford, & Samet, 2007): smoking, other health behaviours (e.g. diet, physical activity, alcohol consumption), occupational exposures to cancer causing substances, and exposure to environmental hazards such as ambient air pollution.

A number of hypothesized mechanisms underlie how these risk factors may mediate the neighbourhood SES and lung cancer association. Several pathways have been identified that link lower neighbourhood SES to smoking (Pearce, Barnett, & Moon, 2012), as well as to other health behaviours such as unhealthy diet (Dubowitz et al., 2008), physical inactivity (Boone-Heinonen et al., 2011), and excessive alcohol consumption (Karriker-Jaffe, 2011). Specifically, neighbourhood SES may shape a resident's exposure to: (a) the availability of local amenities and resources, such as park and recreation facilities (Kaczynski & Henderson, 2008), food markets (Larson, Story, & Nelson, 2009), and tobacco and alcohol outlets and advertising (Chuang, Cubbin, Ahn, & Winkleby, 2005; Pollack, Cubbin, Ahn, & Winkleby, 2005); (b) local community networks and norms, attitudes, belonging, and knowledge about healthy lifestyles (e.g. Boneham & Sixsmith, 2006; Carpiano, 2007; Frohlich, Potvin, Chabot, & Corin, 2002; Hystad & Carpiano, 2012); and (c) potentially stressful neighbourhood social and physical disorder, such as local crime and safety (Diez-Roux & Mair, 2010; Weden, Carpiano, & Robert, 2008). As such, higher SES neighbourhoods typically have more health promoting than health damaging features, which support the pursuit of a healthy lifestyle and the avoidance of unhealthy behaviours – including many behavioural risk factors for lung cancer. By contrast to health behaviours, little research has examined occupational exposures as a mediating pathway of neighbourhood SES effects (Evans & Kantrowitz, 2002); however, living in low SES neighbourhoods may shape occupational opportunities towards working class or "blue collar" jobs that are associated more frequently with exposure to cancer causing substances, such as asbestos, arsenic, beryllium, cadmium, chromium, diesel engine exhaust, and silica. In terms of exposure to environmental hazards, an extensive body of literature demonstrates low SES neighbourhoods may be disproportionately exposed to several environmental hazards, especially industrial and vehicle air pollution (Mohai, Pellow, & Roberts, 2009).

The present study aims to determine whether long-term neighbourhood SES is associated with lung cancer incidence and the importance of long-term neighbourhood measures and mediating factors. Specifically, we examine the relationship between long-term neighbourhood SES, derived using 20 years of residential histories and five censuses, and lung cancer incidence for urban participants of a large Canadian population-based case-control study. In doing so, we compare long-term neighbourhood estimates to commonly used study entry and latency neighbourhood measures and determine the extent to which the association between long-term neighbourhood SES and lung cancer risk is mediated by smoking behaviour, other health behaviours, and occupational and environmental exposures.

Methods

Study population

We used the National Enhanced Cancer Surveillance System (NECSS), a collaborative project between Health Canada and provincial cancer agencies to provide a better understanding of the environmental causes of 19 different types of cancer in Canada. The lung cancer case-control study component of the NECSS was conducted between 1994 and 1997 where a total of 3340 lung cancer cases and 5039 population controls were collected by cancer agencies in eight of 10 Canadian provinces: Newfoundland, Nova Scotia, Prince Edward Island, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia (Johnson et al., 1998).

All newly diagnosed histological confirmed primary lung cancer cases were identified by each participating provincial cancer registry and 25% of cases were sampled continuously through-out a pre-selected year for inclusion in the study. After obtaining physician consent, cases were mailed questionnaires (within three months of diagnosis) and telephone follow up conducted if needed. The response rate for contacted lung cancer cases was 61.7%.

Population controls without cancer were selected from a random sample of individuals within each province, frequency matched on age and sex to all cancer cases collected in the NECSS. Recruitment methods for a population sample of controls depended on data availability and accessibility. Five provinces used health insurance plans, which include 95% of residents (individuals were excluded only if covered through other federal plans (e.g. first nations, military and prisoners)). Ministry of Finance Property Assessment data, which is updated monthly and intended to include all residents, was used in Ontario, and random digit dialling