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The cumulative effect of nuisances from road transportation in residential sectors on the Island of Montreal – Identification of the most exposed groups and areas

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ABSTRACT

Air pollution and road traffic noise are considered to be the two most important nuisances that could negatively affect the quality of life. A prolonged exposure to high concentrations of these pollutants could conduct to various health problems. Studies in environmental equity have often considered these nuisances individually whenever it comes from the same source. The main objective of this paper is to determine if the 15 years of age, those aged 65 and over, visible minorities and low income individuals located in a portion of the Island of Montreal are overrepresented in city blocks characterized by having among the highest levels of transportation-related air pollutants (i.e., ambient concentrations of NO_2 and road traffic noise in decibels (dB(A)). The results show that low-income individuals and, to a lesser extent, visible minorities, are significantly overrepresented in city blocks characterized by the higher levels of NO_2 and road traffic noise in dB(A). Multinomial logistic regression analysis confirms these results, and also shows that young people under 15 years are under-represented in the most polluted areas. However, contrary to the previous bivariate results, people aged 65 and over are negatively and significantly associated with the likelihood of their living in a city block located in an advantaged area after controlling for the independent effects of the other explanatory variables. Moreover, visible minorities are significantly overrepresented in advantaged areas. Considering the observed results, some solutions are identified to reduce road traffic noise and air pollution in the city blocks localized near major traffic arteries.

Introduction

Road transportation represents a major element of a given area's spatial organization, in allowing for personal mobility and fostering economic development (Geurs et al., 2009). On the other hand, quality of life has been found to be lower for populations living in the immediate proximity of major traffic arteries (Barros et al., 2013; Liu, 2001). Indeed, areas located less than 200 m from the center of a highway generally show high concentrations of air pollutant and road traffic noise levels, creating substantial impacts on the health and well-being of the people living there (Brugge et al., 2007; Rioux et al., 2010; Zhu et al., 2002b). Exposure to high concentrations of road transportation-related air pollutants, such as nitrogen

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dioxide (NO_2), can lead to increases in respiratory difficulties and asthma (Jerrett et al., 2008; McConnell et al., 2006), impaired lung development in children (Gauderman et al., 2007) and heart problems (Hoffmann et al., 2009; Kan et al., 2008; Van Hee et al., 2009). As for road traffic noise, prolonged exposure can lead to sleep problems (Bluhm et al., 2004; Öhrström and Skånberg, 2004), high blood pressure (Bluhm et al., 2007), development of cardiovascular disease (Babisch, 2008), increased cognitive difficulties in children (Evans et al., 2001), issues with diabetes (Sorensen et al., 2012), and hearing loss (Moudon, 2009; Seto et al., 2007; van Kempen et al., 2002). Air pollution and road traffic noise-related health impacts are also said to be greater in children and the elderly. Children are in fact more vulnerable to the effects of pollutants because their organs and nervous systems are not fully developed (Bolte et al., 2010) and they breathe in more air per unit of body mass (Landrigan et al., 2004) than do adults. Older people are also vulnerable to the negative aspects of their environment given that some of their vital functions decline with age (Day, 2008; Kelly et al., 2003; OMS, 2007). In addition, due to their more limited mobility, these two groups tend to be more restricted to their residential area (Day, 2010; Greenberg, 1993; Philipps et al., 2005). So if there are poor conditions in that area, they may be affected more strongly than those in other age groups.

Environmental equity and nuisances from road transportation

Proximity to major traffic arteries and disproportionate exposure to concentrations of road transportation-related pollutants have been the subject of studies from an environmental equity perspective. These studies have focused on the identification of social inequities in exposure to transportation-related pollution. The main objective of these studies is to answer the following question, which we paraphrase from Schweitzer and Valenzuela (2004)'s query: "Who gets what kind of environmentally undesirable effects, and why?"

The first generation of environmental equity studies, performed in the United States, analyzed the propensity of low-income populations and visible minorities to live near expressways and other major traffic arteries by using buffer zones ranging from 0 to 200 m around major roads (Bae et al., 2007; Chakraborty, 2006; Chakraborty et al., 1999; English et al., 1999; Jacobson et al., 2004) or creating density indices based on road network hierarchy (Houston et al., 2004). In the past decade, other studies carried out in Canada (Carrier et al., 2014; Crouse et al., 2009b; Jerrett et al., 2004, 2007), the United Kingdom (Briggs et al., 2008; Mitchell, 2005; Namdeo and Stringer, 2008; Wheeler and Ben-Shlomo, 2005), New Zealand (Kingham et al., 2007) and the United States (Chakraborty, 2009; Grineski, 2007) showed, with varying statistical evidence, that low-income individuals were overrepresented in areas where concentrations of air pollutants from transportation or other sources were significantly higher compared with more advantaged groups. Similar findings were also obtained in Germany (Schikowski et al., 2008), Finland (Rotko et al., 1999), France (Havard et al., 2009) and Norway (Næss et al., 2007).

Considering their physiological vulnerability to exposure to air pollution, the category of children has recently been addressed in environmental equity studies on transportation-related pollution. These studies have most often concentrated on the location of schools near major roads and the children's socioeconomic backgrounds. A number of U.S. studies have shown that children from low-income backgrounds and Hispanic or African–American communities are more likely to attend schools that are located near major roads and in the most polluted areas than are children from the least deprived backgrounds (Green et al., 2004; Gunier et al., 2003; Houston et al., 2006). Regarding the population over 65 years of age, Brainard et al. (2002), Mitchell and Dorling (2003), and Chakraborty (2009) found no environmental inequities experienced by this group in terms of air pollution exposure in Birmingham (United Kingdom) and Tampa Bay (United States). In considering potential environmental inequities related to the socioeconomic status of this group, we found only one study comparing the level of pollutant emissions that looks at different characteristics of the population over 65 years of age. Collins et al. (2011) examined disparities linked to risks of cancer from pollutant emissions in El Paso, Texas, and concluded that Hispanics aged 65 and older were more likely to develop various health problems when compared with the white population of the same age.

Studies on road traffic noise conducted from an environmental equity perspective have for their part shown inconsistent results. On the one hand, Nega et al. (2013) found that low-income individuals and visible minorities in Minneapolis, in the United States, were likely to live in sectors where road traffic noise levels were higher. Brainard et al. (2004) and Lam and Chan (2006) respectively showed that low-income individuals in Birmingham (United Kingdom) and Hong Kong live in residential areas where the level of road traffic noise is slightly higher. On the other hand, Bocquier et al. (2012) and Havard et al. (2011) report that road traffic noise levels are not statistically correlated with the level of socioeconomic disadvantage, whether in the cities of Marseille or Paris (France). Despite their observed physiological vulnerability to the effects of noise on their state of health, people younger than 15 years of age and those aged 65 and over have rarely been considered in studies on noise. We identified only two studies, those of Brainard et al. (2004) and Nega et al. (2013), which moreover conclude that there is no environmental inequity with regard to noise for these groups.

Cumulative effects of nuisances from road transportation

The spatial distributions of road traffic noise and air pollution have long been examined separately in the literature. Some studies have reported a significant and strong correlation between air pollutant concentrations and road traffic noise levels (Allen et al., 2009; Davies et al., 2009; Foraster et al., 2011). They have emphasized that the combination of strong air pollutant concentrations and high road traffic noise levels can intensify certain health impacts, especially in relation to