Journal of Transport & Health 4 (2017) 152–161

Contents lists available at ScienceDirect

Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth

Socioeconomic and sociodemographic inequalities and their association with road traffic injuries

Ali Pirdavani [a,b,*], Stijn Daniels [b], Karin van Vlierden [b], Kris Brijs [b], Bruno Kochan [b]

[a] Hasselt University, Faculty of Engineering Technology, Agoralaan, BE-3590 Diepenbeek, Belgium
[b] Hasselt University, the Transportation Research Institute (IMOB), Agoralaan, BE-3590 Diepenbeek, Belgium

ARTICLE INFO

Article history:
Received 27 June 2016
Received in revised form 30 November 2016
Accepted 1 December 2016
Available online 15 December 2016

Keywords:
Crash prediction
Socioeconomic status
Traffic safety
Traffic analysis zone
Activity-based transportation models

ABSTRACT

Increasing evidence suggests that neighborhood-based measures of socioeconomic status are correlated with traffic injury. The main objective of this study is to determine the differences in associations between predictive variables and injury crashes (i.e. including injury and fatal crashes). This study makes a novel contribution by establishing the association between traffic casualties and socio-demographic, socioeconomic characteristics, traffic exposure data and road network variables, at the neighborhood-level while categorized by different genders and transport mode; 'car driver', 'car passenger' and 'active mode users' (i.e. pedestrians and cyclists). In this study an activity-based transportation model called FEATHERS (Forecasting Evolutionary Activity-Travel of Households and their Environmental RepercussionS) is utilized to produce exposure measures. Exposure measures are in the form of production/attraction trips for several traffic analysis zones (TAZ) in Flanders, Belgium. Analyzing crashes at a neighborhood-level provides important information that enables us to compare traffic safety of different neighborhoods. This information is used to identify safety problems in specific zones and consequently, implementing safety interventions to improve the traffic safety condition. This can be carried out by associating casualty counts with a number of factors (i.e. developing crash prediction models) which have macro-level characteristics, such as socio-demographic and network level exposure. The results indicate that socioeconomic variables are differently associated with casualties of different travel modes and genders. For instance, income level of residence of a TAZ is a significant predictor of male car driver injury crashes while it does not significantly contribute to the prediction of female car driver injury crashes.

1. Introduction

The association between road crashes and socioeconomic status has been extensively documented during the last decades. A large amount of literature points to the differing road crash involvement of various socioeconomic groups within countries. Several indicators of socioeconomic status (e.g., income, educational level, and occupational status) have already been investigated to that end. Generally it is concluded that low socioeconomic status and deprivation increase the fatality

* Corresponding author.
E-mail address: ali.pirdavani@uhasselt.be (A. Pirdavani).

http://dx.doi.org/10.1016/j.jth.2016.12.001
2214-1405/

risk (Chen et al., 2010) or the risk of being injured in traffic (Factor et al., 2008; Laflamme et al., 2009). Also in developing countries (Sehat et al., 2012), lower economic level seems to be associated with increased frequency and injury severity of traffic crashes.

Analyses of the link between casualties and deprivation either use information on the socio-economic status of victims or they take an area-based approach. The typical procedure is to test for association between spatial variation in casualty counts and area levels of deprivation (Graham et al., 2013). Laflamme and Diderichsen (2000) mention two different area-based designs. Some studies group geographic areas by socioeconomic status and compare injury rates across socio-economic groups. Other studies take the reverse approach and group areas by level of injury risk and compare socio-economic characteristics across risk levels.

Numerous area-based studies on road crash involvement are conducted from a sociological or health oriented point of view (Chakravarthy et al., 2010; Hosking et al., 2013; Jones et al., 2008; Males, 2009). Morency et al. (2012) conclude that it is plausible to argue that along the causal pathway that leads from neighborhood socioeconomic position to road traffic injuries, the number of people at risk, traffic volume and road characteristics are intermediate variables or mediators. Spoerri et al. (2011) include in their research both variables describing individuals (education, profession, marital status, nationality and household type) and variables describing areas (language region and population density).

Also in the domain of transportation plan development, there is a growing tendency to connect crash counts not only to the transportation characteristics of a zone, but to several socioeconomic and demographic characteristics as well (Zhang et al., 2014). Besides infrastructural characteristics, De Guevara et al. (2004) found population density and number of employees to be significant variables for the injury and property-damage crash prediction models they developed. Cottrill and Thakuriah (2010) explored geographic correlates of pedestrian-vehicle crashes. They particularly emphasized spatial variations of these events in areas with large low-income and minority populations versus other areas. Other studies were conducted in France and focused on all modes (Fleury et al., 2010; Licaj et al., 2011). Fleury et al. (2010) studied the traffic crash risk of residents of deprived areas (i.e. sensitive urban areas) as compared to the risk of residents of control areas. They wanted to differentiate between these risks to guide decisions made on safety actions. More in detail, they integrated both the social- and the spatial dimensions of the safety level. Living in a sensitive urban area induced excessive risk, especially in people over the age of 20, and among both male and female residents (with a much higher relative risk for the male population). Explanations for the origin of such an excessive risk were related to behavior (attitudes and risk-taking among certain social groups, notably young residents of these neighborhoods), and to variations in mobility in the different areal types (e.g., travelling significantly less by car in the sensitive urban areas). A similar study conducted by Licaj et al. (2011), included only young people (under 25) and also considered the severity of road trauma. It was found that the incidence of injuries as a pedestrian, cyclist or motorist was higher among young people living in deprived municipalities. The severity of road injuries was lower in deprived neighborhoods. Yet, after taking crash characteristics into account, the type of municipality no longer had a significant effect on severity. The authors concluded that deprived areas should be targeted by dedicated education programs as well as by further investigations on urban planning.

Based on the above mentioned literature, the association between socioeconomic status and crash risk may seem straightforward, with a higher risk for people of low socioeconomic status or living in deprived neighborhoods. However, that viewpoint changes when gender is taken into account. The evidence concerning socioeconomic differences in relation to gender is indeed inconsistent. While some studies find a similar social patterning, other studies show diverse or conflicting results across genders (Laflamme et al., 2009). Nolasco et al. (2009) found that motor vehicle crashes represent a greater fatality risk among men from lower socioeconomic level than among men from the most privileged socioeconomic level. Yet, for women, an inconsistent pattern has been found. Borrell et al. (2005) studied the different distributions of fatality by educational level in nine European settings. They found higher death rates in all settings for men with a low educational level. Contrary to that, female traffic fatality showed no inequalities in most of the settings. Only in Finland, Austria and Belgium was there an increase in traffic fatality for women with a lower educational level and of the youngest age group (30–49 years old). A reverse pattern was found in Norway where women with high educational levels had higher injury rates.

Besides socioeconomic variables, other network and exposure variables ought to be considered for model development completeness (Hauer, 2015). If not the most significant predictor of crashes, exposure is a key determinant of traffic safety. The relationship between crash occurrence and exposure is fairly straightforward. The higher the exposure, the greater the possibility for a crash to occur. Exposure can be expressed in different forms such as vehicle kilometers traveled or trip production/attraction (P/A). P/A numbers are basically the number of trips (NOTs) being produced or attracted by each zone. Typically, they are represented by means of origin-destination matrices.

Recently, some researchers constructed crash prediction models by associating crash counts with trip P/A and other network characteristics. Abdel-Aty et al. (2011a) identified and prioritized important variables which can be associated with crashes per traffic analysis zone (TAZ) by means of the classification and regression trees (CART) technique. They showed that considering NOTs can be helpful in predicting safety status for long term transportation planning. Abdel-Aty et al. (2011b) also developed several macroscopic prediction models for different crash severity levels using NOTs as the exposure variable. They concluded that different sets of predictors should be considered based on crash severity or type (e.g., total trip productions and attractions provided better model fit for the total and peak hour crashes while severe crashes were better predicted by different trip motive related variables). Naderan and Shahi (2010) investigated the feasibility of associating travel demand in urban areas with crash frequencies in each TAZ. They developed a series of zonal crash prediction models