Preventive Medicine 59 (2014) 31–36

Contents lists available at ScienceDirect

Preventive Medicine

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

Neighborhood commuting environment and obesity in the United States: An urban–rural stratified multilevel analysis

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ARTICLE INFO

Available online 19 November 2013

Keywords:
Obesity
Neighborhood automobile dependency
Neighborhood commuting time
Geocoded National Health Interview Survey (NHIS)
Regional urbanization levels
The United States

ABSTRACT

Objective. Automobile dependency and longer commuting are associated with current obesity epidemic. We aimed to examine the urban–rural differential effects of neighborhood commuting environment on obesity in the US

Methods. The 1997–2005 National Health Interview Survey (NHIS) were linked to 2000 US Census data to assess the effects of neighborhood commuting environment: census tract-level automobile dependency and commuting time, on individual obesity status.

Results. Higher neighborhood automobile dependency was associated with increased obesity risk in urbanized areas (large central metro (OR 1.11[1.09, 1.12]), large fringe metro (OR 1.17[1.13, 1.22]), medium metro (OR 1.22 [1.16, 1.29]), small metro (OR 1.11[1.04, 1.19]), and micropolitan (OR 1.09[1.00, 1.19])), but not in non-core rural areas (OR 1.00[0.92, 1.08]). Longer neighborhood commuting time was associated with increased obesity risk in large central metro (OR 1.09[1.04, 1.13]), and less urbanized areas (small metro (OR 1.08[1.01, 1.16]), micropolitan (OR 1.06[1.01, 1.12]), and non-core rural areas (OR 1.08[1.01, 1.17])), but not in (large fringe metro (OR 1.05[1.00, 1.11]), and medium metro (OR 1.04[0.98, 1.10])).

Conclusion. The link between commuting environment and obesity differed across the regional urbanization levels. Urban and regional planning policies may improve current commuting environment and better support healthy behaviors and healthy community development.

Introduction

Obesity prevalence has increased substantially in all demographic groups and social strata in the last three decades in the United States (US) (Wang and Beydoun, 2007). The estimated age-adjusted obesity prevalence has increased from 14.5% in 1976–1980 to 35.7% in 2009–2010 among adults age 20 years and older in the US (Flegal et al., 1998, 2010, 2012; Kuczmarski et al., 1994). The increasing dependence of the population on automobile travel, resulting from modern urbanization, may have contributed to the US obesity epidemic (Jacobson et al., 2011).

Over the past forty years, modern urbanization has created a more differentiated land use pattern: residential, commercial and industrial areas are located in a more spatially separated form (Southworth and Owens, 1993). The modern transportation system, which is heavily oriented toward automobile commuting, has evolved to support the connections among these different land uses. More-frequent and longer motor-vehicle trips have become a necessity rather than simply a choice, in order to go to work, to shop, to access open spaces or other routine services or activities (Rodrigue, 2013). Commuting by car, and spending ever-increasing time doing so because of a jobs-housing imbalance (Sultana, 2002), has become an essential part of daily life for almost all Americans.

A growing number of studies have shown the striking link between commuting burden and obesity outcomes. A study in San Francisco indicated that urban residents with higher BMI scores reported high levels of automobile use for work/school commuting and trips to the grocery store (Pendola and Gen, 2007). Another study in Atlanta, Georgia, suggested that each additional hour spent in a car per day was associated with a 6% increase in the likelihood of obesity (Frank et al., 2004). A recent study in 12 Texas metropolitan counties reported that the commuting distance between home and workplaces was adversely associated with obesity outcomes (physical activity, BMI, and waist circumference) (Hoehner et al., 2012). A county-level ecological analysis of obesity and vehicle miles of travel in California supported the associations between obesity, motorized transportation, and commuting time (Lopez-Zetina et al., 2006). Similar ecological associations

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0091-7435/$ – see front matter © 2013 Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.ypmed.2013.11.004

were also observed at the neighborhood level (census block groups) (Lathey et al., 2009). A nation-level trend analysis in the US found that increased noncommercial automobile travel was ecologically associated with increased obesity prevalence over 22 years (1985–2007) (Jacobson et al., 2011).

However, research evidence suggested that the impact of the neighborhood built environment on obesity could vary across levels of regional urbanization (Joshu et al., 2008; Wang et al., 2013). We hypothesized that neighborhood commuting environment's association with obesity may be sensitive to regional urbanization levels. Almost all previous studies linking obesity and commuting were based on local population samples from urban settings (Frank et al., 2004; Hoehner et al., 2012; Lathey et al., 2009; Lopez-Zetina et al., 2006; Pendola and Gen, 2007). The potential urban–rural differences in the association between population automobile dependency and commuting time and obesity in the US are less well understood. For example, neighborhood automobile dependency may not be associated with obesity in less urbanized areas; and the commuting time may have more impact on obesity in suburban areas. The neighborhood commuting environment may contribute to the unexplained urban–rural disparities in obesity prevalence (Befort et al., 2012). Thus, the major aim of this study is to examine the associations between neighborhood commuting environment and obesity across the levels of regional urbanization, using a large geocoded nationally representative survey, the National Health Interview Survey (NHIS) that allows geographic linkages to local neighborhood commuting environment measures: automobile dependency and commuting time.

Methods

Study population

We used cross-sectional data from the 1997–2005 NHIS (National Center for Health Statistics (NCHS), 2010), which is collected annually via in-person household interviews of a nationally representative sample of the US civilian non-institutionalized population, with oversampling of blacks and Hispanics, in 50 states and the District of Columbia. The NHIS data include the following four basic modules: household composition, family, sample child and sample adult. The adult sample with the obesity measure (BMI) was used to examine the associations between neighborhood (census tract-level) commuting environment and obesity. The 1997–2005 NHIS used the same sampling design, annually, which means the same sampling strata and primary sampling units were visited, over this nine-year period. The shared geographic framework of the 1997–2005 NHIS data also provided a better platform to make geographic comparisons of obesity trends in residential populations over time. The final response rate for the combined 1997–2005 NHIS adult samples is 73.3%, yielding a sample size of 289,707. We excluded 354 participants without geocodable residential addresses and also 12,061 participants with missing body mass index (BMI) values or those with extreme BMI values that are biologically implausible (BMI > 70 kg/m^2 or BMI < 12 kg/m^2) (Li et al., 2009). The final study sample was 277,292, comprising 95.8% of the geocoded 1997–2005 NHIS adult participants. The average sample size per year was 30,810 with a minimum sample of 29,326 in 2003 and a maximum sample of 34,989 in 1997. The individual NHIS data were linked with the corresponding residential census tract-level variables via the 2000 census tract identifiers in the geocoded 1997–2005 NHIS.

Data and measures

Region-level urbanization measure

Regional urbanization level was based on a six-level urban–rural classification scheme for the 3141 US counties and county-equivalents developed by the National Center for Health Statistics (NCHS) in 2006 (from highly urbanized metropolitan to remote rural areas): large central metro, large fringe metro, medium metro, small metro, micropolitan, and non-core rural counties. The 2006 NCHS urban–rural classification scheme for counties had been linked with National Vital Statistics System (NVSS) mortality records and National Health Interview Survey (NHIS) data using restricted-use files and demonstrated its ability to identify health differentials across urbanization levels (National Center for Health Statistics (NCHS), 2006) (see Table 1 for detailed classification rules).

Table 1
Categories and classification rules: NCHS urban–rural classification scheme for counties, 2006.
This table was adopted from page 10 in Ingram DD, Franco SJ. NCHS urban–rural classification scheme for counties. National Center for Health Statistics. Vital Health Statistics 2(154). 2012. MSA means metropolitan statistical area.

Urbanization level	Classification rules
Metropolitan counties	
Large central metro	Counties in MSA of 1 million or more population that: 1) contain the entire population of the largest principal city of the MSA, or 2) are completely contained within the largest principal city of the MSA, or 3) contain at least 250,000 residents of any principal city in the MSA
Large fringe metro	Counties in MSA of 1 million or more population that do not qualify as large central
Medium metro	Counties in MSA of 250,000–999,999 population
Small metro	Counties in MSA of 50,000–249,999 population
Nonmetropolitan counties	
Micropolitan	Counties in micropolitan statistical area
Non-core	Counties not in micropolitan statistical area

Individual obesity outcome

A binary outcome of obesity status was defined on the basis of an NHIS participant's BMI value as either obese if BMI > = 30 kg/m^2 or not obese if BMI < 30 kg/m^2. The participants' BMI values were based on self-reported height and weight as originally reported during the interviews and calculated by dividing participants' weight in kilograms by their height in meters squared.

Individual covariates

The individual characteristics from NHIS included sex, age, race-ethnicity, educational attainment, and survey year (1997–2005). Age was categorized into 6 groups (18–24, 25–34, 35–44, 45–54, 55–64, and 65 years and older). Race-ethnicity was categorized into 6 groups (non-Hispanic white, non-Hispanic black, non-Hispanic Asian, non-Hispanic other races, Mexican Hispanic, and non-Mexican Hispanic). Educational attainment was categorized as 4 groups: less than high school, high school graduate, some college, and bachelor degree or higher. These selected individual variables all have well documented relationships with obesity in the literature (Wang and Beydoun, 2007).

Neighborhood-level variables

Neighborhood commuting environment in this study was measured by two census tract-level indicators: the percentage of workers age 16 years and over who commute to work by car, van or truck; and the average commuting time of workers age 16 years and older. The first is usually referred to as neighborhood automobile dependency and the second as neighborhood commuting time. Neighborhood poverty was measured by the census tract-level percentage of individuals under the federal poverty level, which has been shown to be associated with obesity in previous studies (Black et al., 2010; Ludwig et al., 2011). It was often included as a control variable in the analysis of neighborhood context impact on obesity (Boardman et al., 2005; Rundle et al., 2007). In addition, neighborhood economic poverty measures were most robust to detect population health outcome gradients (Krieger et al., 2002). All these neighborhood-level covariates were extracted from census 2000 Summary File 3 for all 65,443 census tracts in the US. Table 2 presents the basic summary of neighborhood level variables. All three neighborhood variables keep their original continuous scales to avoid the potential bias of artificial cut-points in the analysis.

Statistical analysis

The NHIS data were collected through a complex sampling design, involving stratification, clustering and multi-stage sampling. All the data analyses in this study were weighted by using the final adult sample weights that account for differential probabilities of selection and the NHIS complex sampling design. Six multilevel logistic models, corresponding to the six levels of urbanization, were developed to assess the urban–rural differential associations between neighborhood commuting environment and obesity, while controlling the