SSM - Population Health 3 (2017) 435–441

Contents lists available at ScienceDirect

SSM - Population Health

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

Article

Built environment and active commuting: Rural-urban differences in the U.S

Jessie X. Fan[a,*], Ming Wen[b], Neng Wan[c]

[a] Department of Family and Consumer Studies, University of Utah, 225 S 1400 E AEB 228, Salt Lake City, UT 84112-0080, United States
[b] Department of Sociology, University of Utah, 380 S 1530 E Rm 301, Salt Lake City, UT 84112-0250, United States
[c] Department of Geography, 332 S 1400 E, RM. 217, Salt Lake City, UT 84112-9155, United States

ARTICLE INFO

Keywords:
Active commuting
Active transportation
Rural
Urban
Built environment
Census tracts

ABSTRACT

The purpose of this research was to investigate rural-urban differences in participation rates in three modes of active commuting (AC) and their built environmental correlates. The 2010 Census supplemented with other datasets were used to analyze AC rates in percent of workers age 16+ walking, biking, or taking public transportation to work in 70,172 Census tracts, including 12,844 rural and 57,328 urban. Random-intercept factional logit regressions were used to account for zero-inflated data and for clustering of tracts within counties. We found that the average AC rates were 3.44% rural and 2.77% urban ($p < 0.01$) for walking to work, 0.40% rural and 0.58% urban ($p < 0.01$) for biking to work, and 0.59% rural and 5.86% urban ($p < 0.01$) for public transportation to work. Some environmental variables had similar relationships with AC in rural and urban tracts, such as a negative association between tract greenness and prevalence of walking to work. Others had opposite correlational directions for rural vs. urban, such as street connectivity for walking to work and population density for both walking to work and public transportation to work. We concluded that rurality is an important moderator in AC-environment relationships. In developing strategies to promote AC, attention needs to be paid to rural-urban differences to avoid unintended consequences.

1. Introduction

In the United States, rural areas have significantly higher prevalence of overweight and obesity, diabetes, coronary heart disease, hypertension, stroke, and cancers than urban areas (Befort, Nazir, & Perri, 2012; Bennett, Olatosi, & Probst, 2008; Jones, 2010). Research has suggested that disparities in physical activity (PA) between rural and urban residents may partially explain such rural-urban health disparity (Bennett et al., 2008; Martin et al., 2005; Patterson, Moore, Probst, & Shinogle, 2004; Weaver, Palmer, Lu, Case, & Geiger, 2013). However, evidence regarding rural-urban difference in PA is mixed depending on whether PA was subjectively or objectively measured, and what intensity threshold was used in objectively measured PA (Fan, Wen, & Kowaleski-Jones, 2014a). A study using both subjective and objective PA data from the National Health and Nutrition Examination Survey (NHANES) found that compared to urban residents, rural residents reported more PA but spent less time in higher-intensity PA. However, rural residents spent more time in lower-intensity PA, especially household PA, than urban residents (Fan et al., 2014b). Because different PA domains tend to have different levels of intensity, this finding likely implies that patterns of PA differ for rural and urban residents for different PA domains, which typically included leisure-time PA, occupational PA, household PA, and transportation PA. Yet, little is known regarding rural-urban differences in these more detailed PA domains. Such knowledge can be very important in helping us better understand factors contributing to health disparities between rural and urban areas, and to potentially inform community efforts and public health strategies to address such disparity (Bennett et al., 2008; Martin et al., 2005; Patterson et al., 2004; Weaver et al., 2013).

Active commuting (AC), an important part of transportation-related PA, offers an effective way of increasing PA by integrating activities into people's daily life (Bopp, Kaczynski, & Besenyi, 2012; Bopp, Kaczynski, & Campbell, 2013; Shephard, 2008). AC has many well-documented health benefits such as a reduced risk of obesity, diabetes, cardiovascular disease and risk factors, and all-cause mortality (Andersen, Schnohr, Schroll, & Hein, 2000; Hamer & Chida, 2008). AC also leads to a reduction of carbon dioxide emissions by reducing vehicle uses and traffic congestions, therefore generating indirect health benefits (Shephard, 2008). In addition, there are economic benefits through savings in vehicle operating and maintenance costs (Shephard, 2008).

However, when compared with other countries and with historical numbers in the U.S., the current AC rate in the U.S. is low despite these multiple benefits (Bassett, 2012; Kruger, Ham, Berrigan, & Ballard-

* Corresponding author.
E-mail addresses: fan@fcs.utah.edu (J.X. Fan), ming.wen@soc.utah.edu (M. Wen), neng.wan@geog.utah.edu (N. Wan).

http://dx.doi.org/10.1016/j.ssmph.2017.05.007
Received 19 April 2017; Received in revised form 2 May 2017; Accepted 8 May 2017

Barbash, 2008). Among the potential factors associated with PA in general and AC in particular, the built environment has received much attention because modifications in built environment features can potentially benefit large groups of people without being cost-prohibitive. Some studies have found that better street connectivity, better neighborhood aesthetics (e.g., more greenness), enhanced infrastructure factors (e.g., sidewalks), safer traffic conditions, higher population density, and mixed land-use patterns were positively associated with AC (Bassett, 2012; Bauman et al., 2012). However, other studies have found null or even opposite relationships (Panter & Jones, 2010). One potential contributor of these mixed results is the rural-urban status of the area as relationships between the built environment and PA may differ due to very different physical layouts in rural vs. urban settings (Frost et al., 2010).

In our previous research, we investigated environmental correlates of AC in rural settings using 2000 Census data (Fan, Wen, & Kowaleski-Jones, 2015). We also used a subset of the 2010 Census data that had the same tract codes as the 2000 Census, which is about half of all 2010 Census tracts, to investigate environmental correlates of PA in urban settings (Fan, Wen, & Kowaleski-Jones, 2014a). In this study, we aimed to utilize the full 2010 Census data in combination with several other national datasets to estimate participation rates in three modes of AC – walking, biking, or taking public transportation to work - in both rural and urban tracts, and to investigate if and how the relationship between built environment features and AC differ by rural-urban status. We were particularly interested in finding out if important built environmental features have the same relationship with AC participation rates in both rural and urban areas, or if certain built environmental features work differently in rural settings compared to urban settings in terms of effect size, or, more drastically, with opposite effect directions.

2. Methods

The 2010 Decennial Census (U.S. Bureau of the Census, 2010) and the 2007–2011 American Community Survey (U.S. Bureau of the Census, 2014a) were used as our primary datasets. The American Community Survey is an ongoing survey conducted annually by the US Census Bureau that captures changes in the socioeconomic, housing, and demographic characteristics of communities cross the US. We used census tract-level measures along with county-level measures to account for potential commuting across tract boundaries. Census tracts typically contain between 1200 and 8000 people, and are relatively permanent statistical subdivisions of a county. When first established, Census tracts are designed to be relatively homogeneous units with respect to economic status, population characteristics, and living conditions (U.S. Bureau of the Census, 2014b). Studies have found that tract-level indicators are more consistently related to residents' health than indicators at other geographic levels (Fan et al., 2014; Krieger, Chen, Waterman, Rehkopf, & Subramanian, 2003; Wan, Zhan, & Cai, 2011).

2.1. Rural-urban definition

Tract rural-urban status was defined using the U.S. Department of Agriculture (USDA) 2010 primary Rural-Urban Commuting Areas (RUCA) codes. The primary RUCA codes uses a flexible scheme to classify sub-county components into 10 detailed rural/urban categories (Environmental Systems Research Institute, 2010; U.S. Department of Agriculture, 2013). For this analysis, we followed the literature to define urban as all metro tracts (RUCA = 1–3, areas with a population of at least 50,000 people) and rural as all non-metro tracts (RUCA = 4–10, areas with a population of less than 50,000 people) (Befort et al., 2012; Martin et al., 2005). Based on RUCA codes, this study includes a total number of 70,172 tracts, including 12,844 rural and 57,328 urban tracts, encompassing all U.S. tracts in the 2010 Census where there was a population.

2.2. AC measures

In order to capture the multiple dimensions of AC, three tract-level aggregate AC measures were created: (1) *percent of workers age 16+ who walked to work (WTW)*, (2) *percent of workers age 16+ who biked to work (BTW),* and (3) *percent of workers age 16+ who utilized public transportation to work (PTTW)*. These were five-year averages generated from the 2007–2011 American Community Surveys based on the question "How did the person usually get to work last week?" If the respondent usually used more than one method of transportation during the trip then the method used for most of the distance was marked.

2.3. Built environment measures

Our main independent variables of interest were the built environmental variables indicating the 3D's of density, diversity, and design (Cervero & Kockelman, 1997), including population density, street connectivity, housing age, greenness, proximity to parks, and air quality. *Tract population density* measured the density aspect of the 3D's and was obtained from the 2010 U.S. Census. A tract-level street connectivity measure was used to capture the design aspect of the 3D's. The measure was defined as the number of intersections per square kilometer in the tract. Only roads with the speed limit of 25 miles/hour or lower were used in the connectivity analysis because roads with higher speed limits are considered highways or major roads that do not contribute to neighborhood walkability (Wang, Wen, & Xu, 2013). The census tract boundaries and road network data were derived from Environmental System Research Institute (ESRI) and the StreetMap USA file (Environmental Systems Research Institute, 2010). A greenness measure at a spatial resolution of 30 m was derived from the tree canopy dataset in the National Land Cover Database 2001 (Homer et al., 2007). Based on this dataset, a tree canopy density indicator was generated for each Census tract to describe the average percentages of tree canopy coverage of all pixels that fell in the Census tract. The park access variable at the tract level was constructed from the 2006 park layer in the ESRI GIS Data DVD (Environmental Systems Research Institute, 2010). Specifically, seven parks (Miller, 1956) closest to all census block centroid were identified, and average distances from the census block centroid to each of these parks weighted on population and park sizes were calculated. These distances were then aggregated to the census tract level (Zhang, Lu, & Holt, 2011). Air quality was measured by a dummy variable indicating Environmental Protection Agency (EPA) air quality nonattainment status at the county level (U.S. Environmental Protection Agency, 2006). Finally, *Tract median housing age* was used to add information on aspects of neighborhood walkability not captured in our other measures (e.g., side walk availability), because older neighborhoods were built before car-dependency and are generally more walkable than newer neighborhoods (Berrigan & Troiano, 2002). This measure was obtained from the 2007–2011 American Community Surveys.

2.4. Control variables

Controls included additional factors that were likely associated with preferences and constraints related to AC decision making, including demographic factors such as age, race/ethnicity, nativity, and education level, economic factors such as income and homeownership, and other constraints such as commuting distance and neighborhood safety (Bauman et al., 2012; Bopp et al., 2012; Lemieux & Godin, 2009). These factors are important because they modify the costs and benefits associated with AC. For example, a neighborhood with poor walkability and/or a high crime rate is likely to discourage AC by increasing the total costs associated with walking/biking, while a neighborhood that is walkable, safe, and close to work destinations is likely to encourage AC by lowering the total costs associated with walking/biking. For this