A prospective investigation of neighborhood socioeconomic deprivation and physical activity and sedentary behavior in older adults

Qian Xiao[a,b,*], Sarah K. Keadle[c], David Berrigan[d], Charles E. Matthews[e]

[a] Department of Health and Human Physiology, University of Iowa, Iowa City, IA, United States
[b] Department of Epidemiology, University of Iowa, Iowa City, IA, United States
[c] Kinesiology Department, California Polytechnic State University, San Luis Obispo, CA, United States
[d] Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, MD, United States
[e] Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD, United States

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ABSTRACT

Neighborhood conditions may have an important impact on physical activity and sedentary behaviors in the older population. Most previous studies in this area are cross-sectional and report mixed findings regarding the effects of neighborhood environment on different types of physical activity. Moreover, little is known about the prospective relationship between neighborhood environment and sedentary behaviors. Our analysis included 136,526 participants from the NIH-AARP Diet and Health Study (age 51–70). Neighborhood socioeconomic deprivation was measured with an index based on census variables and developed using principal component analysis. Physical activity and sedentary behaviors were measured both at baseline (1995–1996) and follow-up (2004–2006). Multiple regression analyses were conducted to examine the prospective relationship between neighborhood deprivation and exercise, non-exercise physical activity, and sedentary behaviors, adjusting for baseline physical activity and sedentary behaviors as well as potential confounders. We found that more severe neighborhood socioeconomic deprivation was prospectively associated with reduced time for exercise ($\beta_{Q5 \text{ vs } Q1}$ (95% confidence interval), hour, -0.85 (-0.95, -0.75)) but increased time spent in non-exercise physical activities (1.16 (0.97, 1.34)), such as household activities, outdoor chores, and walking for transportation. Moreover, people from more deprived neighborhoods were also more likely to engage in prolonged ($\geq 5\,h/day$) TV viewing (Odds ratio $_{Q5 \text{ vs } Q1}$ (95% confidence interval), 1.21 (1.15, 1.27)). In conclusion, neighborhood socioeconomic deprivation is associated with physical activity and sedentary behavior in the older population. These associations may differ for different types of physical activities.

1. Introduction

Maintaining regular physical activity and avoiding prolonged sedentary behavior have numerous health benefits and are crucial for healthy aging (Stewart et al., 2015). Despite the well-known benefits of exercise, physical inactivity is highly prevalent among the older population. A recent study using three national surveys in the US estimated that only 27% to 44% of older adults meet activity guidelines of 150 min of moderate-to-vigorous physical activity or 75 min of vigorous activity throughout the week (Keadle et al., 2016). There are also health risks associated with too much sitting (Keadle et al., 2015), and yet older adults (age 60 or older) spend an average of 60% of their waking time in sedentary behavior (Matthews et al., 2008). The public health burden associated with low physical activity and excessive sedentary behavior is an important concern in the aging population and therefore

it is important to identify factors that shape the physical activity pattern in older adults.

Like many health behaviors, physical activity and sedentary behavior are affected not only by individual factors but also the characteristics of the environment in which older adults live (Satariano, 2006; Satariano and McAuley, 2003). Because of declines in physical and mental functioning, decrease in social contact, and increased difficulties with driving, people become increasingly confined to their immediate residential environment as they age. As a result, the neighborhood environment may play a particularly important role in shaping health behaviors in the older population. Two recent systematic reviews synthesized previous findings from a wide variety of studies and reported a number of relevant associations between some aspects of the neighborhood environment and physical activity and sedentary behavior in the older population (Chastin et al., 2015; Van Cauwenberg et al.,

2011). For example, characteristics associated with disadvantaged neighborhood environments, such as lack of commercial services and recreational facilities, high crime rates and poor safety have been linked to lower levels of physical activity, and prolonged sedentary behavior (Chad et al., 2005; Chastin et al., 2014; Piro et al., 2006; Van Cauwenberg et al., 2014; Wilcox et al., 2003). However, 48 of the 53 studies included in these reviews were cross-sectional in nature, so the temporal relationship between neighborhood environments and relevant behaviors remains uncertain. The few longitudinal studies available have noted that proximity to parks and trails, access to physical activity facilities, and safe walking environments were associated with more physical activity in older adults (Li et al., 2005; Michael et al., 2010); but another study found no prospective relationship between walking and urban sprawl in older men (Lee et al., 2009). To the best of our knowledge, there has been no prospective investigation on neighborhood characteristics and sedentary behavior in older populations. Furthermore, both aforementioned reviews emphasized the need for future studies to focus on specific types of physical activity and sedentary behaviors, because neighborhood environment may have different effects on different types and domains of physical activity and sedentary behavior.

To address the limitations in the literature, we prospectively investigated the relationship between neighborhood socioeconomic deprivation characterized using commonly available census data and detailed measures of physical activity and sedentary behavior in a large cohort of middle-to-old aged US men and women. Based on the findings from previous studies, we hypothesize that more severe neighborhood socioeconomic deprivation is associated with lower levels of physical activity and prolonged sedentary time. We also hypothesize that the associations may differ by types of exercise, non-exercise activity, and sedentary behaviors.

2. Methods

2.1. Study population

Details of the NIH-AARP study were reported previously (Schatzkin et al., 2001). Briefly, the NIH-AARP Diet and Health Study recruited AARP members who were 50 to 71 years old and resided in one of six US states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and two metropolitan areas (Atlanta, Georgia, and Detroit, Michigan) in 1995–1996. In total, 566,399 participants satisfactorily completed the baseline questionnaire. Within 6 months of the baseline, a risk factor questionnaire was mailed to the cohort; and in 2004–2006, an additional follow-up questionnaire was mailed to baseline participants. Residential address was reported at baseline, and in 2004, the Study compiled a list of updated addresses in preparation for mailing the follow-up questionnaire. Information on physical activity and sedentary behavior was reported in both risk factor and follow-up questionnaires. Of the 221,189 participants who completed all three questionnaires, we excluded those with no baseline neighborhood information ($N = 224$), missing physical activity and sedentary behavior information at baseline ($N = 3819$) or follow-up ($N = 78,043$). We further excluded those who had emphysema and end-stage renal disease at baseline ($N = 2577$). The final analytic cohort consisted of 136,526 participants. The study was approved by the National Cancer Institute Special Studies Institutional Review Board.

2.2. Area-level socioeconomic deprivation

Baseline addresses were geocoded to latitude/longitude and linked to the 2000 US Census at the census tract level. We applied the method developed by Messer et al. (2006). to generate an empirical neighborhood socioeconomic deprivation index (Doubeni et al., 2012). In brief, we selected 19 census tract variables that were related to seven components of the neighborhood environment (housing characteristics,

residential stability, poverty, employment, occupation, racial composition, and education). We performed principal component analysis (PCA) on these 19 variables, stratified by state, and we retained ten variables with consistent high loadings across states (% total with less than high school education, % non-Hispanic blacks, % total unemployed, % females in management, % males in management, % households with income (1999) below poverty, % female head of household, % households with public assistance income, % households with income < 30k, % households with no vehicle). Finally, we calculated the neighborhood socioeconomic deprivation index for each census tract by summing the PCA loadings of these ten variables and categorized it into quintiles for analysis. Distributions of census variables used in the deprivation index in this population according to state of residence are presented in Supplementary Table 1.

2.3. Assessment of physical activity and sedentary behavior

We used information collected in the risk factor questionnaire to measure baseline levels for physical activity and sedentary behavior. In the questionnaire, participants were given a list of examples of "moderate and vigorous" recreational and household activities (MVPA), and were asked to indicate how often (never, rarely, weekly but < 1 h per week, 1–3 h per week, 4–7 h per week, and > 7 h per week) they participated in these activities in the past 10 years (questionnaire is presented in the Supplementary Fig. 1). Participants also reported the amount of time they spent in a typical day sitting overall (< 3, 3–4, 5–6, 7–8, and ≥9 h) and watching television or videos (none, < 1 h, 1–2, 3–4, 5–6, 7–8, and ≥9 h), during the past year.

The follow-up questionnaire asked "During the past 12 months approximately how much time each week did you participate in each of the following activities?", and 16 activities were listed as were response options for each activity (None, 5 min, 15 min, 30 min, 1 h, 1.5, 2–3, 4–6, 7–10, > 10 h). Activities were classified as exercise activities (walking for exercise, jogging or running, playing tennis, squash or racquetball, playing golf, swimming, bicycling, other aerobic exercise and weight training) and non-exercise activities (light household chore, moderate to vigorous household chore, moderate outdoor chores, vigorous outdoor chores, house repair, caring for children, caring for another adult, walking for daily activities; see Supplementary Fig. 2). The follow-up questionnaire also asked about the average number of hours spent "in a typical 24-hour period during the past 12 months" in three sitting behaviors: Sitting watching television/video/DVD; Sitting or driving in a car bus or train; and Other sitting-reading, knitting, using computer (None, < 3, 3–4, 5–6, 7–8, 9–10, 11–12, or ≥12 h).

2.4. Covariates

The baseline questionnaire collected information on a broad range of covariates, including demographic characteristics, smoking history, alcohol consumption, the use of dietary supplements and non-steroidal anti-inflammatory drugs, sleep duration and menopausal hormone therapy in women. Diet was measured using a 124-item food-frequency questionnaire. Participants reported their current height (in inches and feet) and weight (in pounds) at baseline. We calculated body-mass index (BMI) as the weight at these respective times divided by baseline height squared (kg/m^2). Both the baseline and follow-up questionnaires asked about medical history on conditions including cancer, cardiovascular disease, and diabetes. Additionally, incident cancer cases were identified through linkage to eight original and three additional (Arizona, Nevada, and Texas) state cancer registry databases. Age at retirement was assessed by the follow-up questionnaire.

2.5. Statistical analysis

We assigned a numeric value for each categories of physical activity (0 for "None", 0.083 for "5 min", 0.25 for "15 min", 0.5 for "30 min", 1