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The association between objective measures of residence and worksite neighborhood environment, and self-reported leisure-time physical activities: The Aichi Workers' Cohort Study

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ABSTRACT

The possible effects of a neighborhood's built environment on physical activity have not been studied in Asian countries as much as in Western countries. The present study cross-sectionally examined the relationship between geographic information system (GIS) measured residence and worksite neighborhood walkability, and the number of parks/green spaces and sports facilities within a 1 km radius of home and workplace, with self-reported leisure-time habitual (3–4 times per week or more) walking and moderate-to-vigorous intensity habitual exercise among local government workers aged 18 to 64 years living in an urban-suburban area of Aichi, Japan in 2013. A single-level binomial regression model was used to estimate the multivariable odds ratios (ORs) and 95% confidence intervals (95% CIs). Of the 1959 male and 884 female participants, 288 (15%) and 141 (16%) reported habitual walking, respectively, and 18% and 17% reported habitual exercise, respectively. Compared with women who resided in neighborhood with a walkability index of 4–30, those living in an area with that of 35–40 were significantly more likely to engage in leisure-time habitual exercise (multivariable OR: 1.70, 95% CI: 1.08–2.68). Marginally significant positive associations were found between leisure-time habitual exercise and the residential neighborhood's number of parks/green spaces among women, as well as the number of sports facilities among men. In conclusion, a residential neighborhood environment characterized by higher walkability may contribute to the initiation or maintenance of moderate-to-vigorous intensity leisure-time exercise among working women living in an urban-suburban area of Japan.

1. Introduction

Promoting physical activity is a public health priority worldwide, with major implications for the prevention of non-communicable diseases of populations (Kohl et al., 2012). There is growing interest in intervening environmental factors to promote physical activity within communities (Bauman et al., 2012), whereby studies conducted primarily in Western countries have indicated possible positive effects of neighborhood environment on physical activity (Astell-Burt et al., 2014; Kaczynski et al., 2008a, 2008b; Karusisi et al., 2013; Owen et al., 2007; Sallis et al., 2016; Sugiyama et al., 2014; Sundquist et al., 2011). For example, a multi-country study found that geographic information system (GIS) measures, such as the net residential density and the number of parks, were positively associated with the total amount of moderate-to-vigorous physical activity in adults living in urban cities (Sallis et al., 2016). Given that environment features, and social cultures and norms differ substantially between continents, the findings derived from Western countries are not necessarily applicable to Asian countries. To date, a limited number of studies have been carried out in Asian countries utilizing objectively measured environment

Abbreviations: CIs, confidence intervals; GIS, geographic information system; ORs, odds ratios; NLNI, National Land Numerical Information

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information (Hanibuchi et al., 2015b; Kondo et al., 2009; Koohsari et al., 2017; Lee et al., 2011; Ying et al., 2015). In addition, the majority of previous studies in Japan have been conducted on the inhabitants of small cities (Kondo et al., 2009; Lee et al., 2011), especially in rural areas (Eshak et al., 2017), which are defined by administrative borders that do not necessarily reflect residential functions.

Thus, we conducted the present study by enrolling workers who resided in areas with geographical and functional variability, including multiple municipalities and a metropolitan area that consisted of functionally-interrelated urban and suburban areas. The study participants were civil servants of a local government aged 18 to 64 years; therefore, their limited socio-economic status variability provided the unique opportunity to study behaviors relating to their neighborhood-specific geographical information. Furthermore, several potential confounding variables, including past medical history and body mass index, were obtained and could be included in the analyses, which is not always the case in studies of geographical characteristics and health. Finally, in previous studies, the features of worksite neighborhood built environments were not weighted as highly as those of residential neighborhood built environments (Adlakha et al., 2015), despite the fact that individuals, especially those of working age, are away from home approximately one-third of the day.

In the present study we examined the association between GIS-measures of residence and worksite neighborhood environmental features and the frequency of self-reported leisure-time physical activities in middle-aged local government workers without a history of major chronic diseases. Analyses were conducted separately for men and women, as the environment may influence lifestyle differently based on gender (Hanibuchi et al., 2015a).

2. Methods

2.1. Subjects and study location

The Aichi Workers' Cohort Study, initiated in 1997, is an ongoing epidemiologic study on non-communicable diseases, including diabetes and cardiovascular disease (Muramatsu et al., 2010; Toyoshima et al., 2009). The subjects are local government workers in a central part of Japan. The area (called Aichi prefecture) includes both urban areas and their rural surrounds. The capital city of the prefecture is Nagoya, which is the fourth-largest metropolitan city by population in Japan. A self-reported questionnaire on leisure-time physical activity and other lifestyles, and medical history was distributed to subjects at their worksite in 2013. Of the total 5630 subjects (3889 men and 1741 women) who responded to the survey, 4592 subjects (3212 men and 1380 women) provided their residential address and were successfully geocoded. The proportion of female workers stands at 30% in the present study, this is slightly lower than the national average of 38% in statistics (Gender Equality Bureau Cabinet Office, 2013). As geocoding accuracy may differ between urban and rural areas (Faure et al., 2017), the present study included only those living in the Nagoya metropolitan area. This area consisted of Nagoya city and the surrounding 30 municipalities (i.e., the urban-suburban area defined by the Urban Employment Area (Kanemoto and Tokuoka, 2002) and comprised 3077 subjects. Based on the 2010 Japanese Census, the studied area covered approximately 4.8 million people with a density of 3226 people/km^2. We further excluded 154 subjects with self-reported histories of cancer or cardiovascular disease, and 77 subjects with missing values for the selected confounding variables leaving 2843 subjects (1959 men and 884 women) in the analysis; subjects whose worksites were located in rural areas (non-Urban Employment Area) (17%) were not excluded. The study protocol was approved by the Ethics Review Committee of Nagoya University School of Medicine, Nagoya, Japan and Fujita Health University.

Table 1
Subject characteristics, Aichi Workers' Cohort, 2013.

	Men	Women
Number of subjects	1959	884
Age, mean (standard deviation)	43.9 (10.2)	39.2 (10.6)
Leisure-time habitual walking[a] (%)	15	16
Leisure-time habitual exercise[a] (%)	18	17
Neighborhood		
Walkability, median (range)	33 (9–40)	33 (12–40)
Numbers of parks or green space, median (range)	5 (0 – 22)	6 (0 – 21)
Numbers of sports facilities, median (range)	2 (0 – 33)	2 (0 – 23)
Worksite		
Walkability, median (range)	23 (5–39)	26 (11–39)
Numbers of parks or green spaces, median (range)	4 (0–18)	3 (0–18)
Numbers of sports facilities, median (range)	7 (0 – 31)	3 (0–31)
Central headquarter (%)	45.4	25.0
Office workers (vs. professional workers) (%)	58.6	41.6
Educational attainment (≥16 years) (%)	86.2	56.6
Married (%)	74.9	54.4
History of hypertension (%)	9.4	2.2
History of diabetes (%)	1.8	0.6
Depression (CES-D ≥ 9) (%)	22.7	31.3
Eating breakfast every day (%)	77.6	71.0
Body mass index (%)		
< 21 (kg/m^2)	24.1	56.7
21– < 25 (kg/m^2)	54.9	35.2
≥25 (kg/m^2)	21.0	8.1
Smoking status (%)		
Never	58.7	92.4
Former	24.1	4.8
Current	17.2	2.8
Alcohol drinking habits (%)		
Never	12.9	25.6
Former	1.1	2.0
Current	86.0	72.4
Sleeping hours (%)		
< 6	11.2	17.5
6– < 7	51.9	50.2
≥7	36.9	32.2

[a] Habitual walking was defined as walking 3–4 times or more per week during leisure-time; habitual exercise was defined as brisk walking, or moderate-or-vigorous physical activity 3–4 or more times per week during leisure-time.

2.2. Definition of the environmental indices

We used three environmental indices: one composite variable of neighborhood walkability, and two physical activity-specific environmental features including availability of parks/green spaces and sports facilities. The details of the walkability index in Japan have been described elsewhere (Hanibuchi et al., 2015b). Briefly, the walkability index consists of population density, road density, access to parks, and access to retail areas. As an objective unit of neighborhood, we employed *chocho-aza*, the smallest administrative unit. All of our data were based on National Land Numerical Information (NLNI), the Japanese population census (Statistics Bureau, 2010), and the retail area data by Zenrin Co. Ltd. as of 2011. The availability of parks/green spaces and sports facilities was measured as the number of respective facilities within 1 km of the individual's residence based on the street network (i.e., the network buffer) using ArcGIS. Data on parks/green spaces were also obtained from NLNI. The locations of public or commercial sports/recreational facilities, such as sports centers, gyms, or fitness facilities (hereafter referred to as sports facilities) were based on point data from the Yellow Pages telephone directory of businesses.

2.3. Definition of leisure-time walking and exercise habits

The participants were asked to estimate their average frequency and duration of four levels of leisure-time physical activities throughout the past year. Namely, the four levels were 1) walk/stroll (walking), 2) brisk walking, 3) moderate-intensity physical activity such as golf,