Association Between Physical Function and Neighborhood Environment in Healthy, Older Adults: An Exploratory Study Using Regression Tree Analysis

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Abstract
The aim of this study was to perform an exploratory investigation of the individual characteristics of older adults that affect the relationships between physical function and neighborhood environment. A total of 624 community-dwelling older adults living independently, aged ≥65 years, participated in this cross-sectional study. Physical function was assessed by muscle strength (grip strength and knee extension strength) and physical performance (5-m walking time and Timed Up and Go Test). The neighborhood environment was assessed using the International Physical Activity Questionnaire Environmental Module. The individual characteristics that affect the association between both were analyzed using multiple regression analysis and Classification and Regression tree (CaRT) analysis. In both older men and women, multiple regression analysis showed that neighborhood environment was significantly associated with physical function. On the other hand, on CaRT analyses, older men ≤80 years of age without low back pain and depressive symptoms and perceived good access to recreational facilities had the shortest 5-m walking time. However, CaRT analyses found no relationship between physical function and neighborhood environment in older women. The relationships between physical function and neighborhood environment may be altered by sex, age, and physical and mental health conditions.

Keywords
community-dwelling, older adults, physical function, neighborhood environment, regression tree analysis

Introduction
The elderly populations of developed countries are continuing to grow in number. In Japan, in particular, the proportion of adults aged ≥65 years reached 28.8% in 2020 (Cabinet Office, Government of Japan, 2021), making the country a “super-aged society” with the highest proportion of older adults in the world. For many countries with aging populations, maintaining and improving the functional capacity of older adults and extending their healthy life expectancy are important issues.

Older adults’ physical function is an important determining factor in maintaining and improving their functional capacity (Nakamoto et al., 2015; Sugiura et al., 2013). Because physical function, such as muscle strength and physical performance, decreases with advancing age (Ishizaki et al., 2011), appropriate interventions and support are...
required. Exercise-based interventions in particular improve older adults’ physical function (Cadore, Rodriguez-Manas, Sinclair, & Izquierdo, 2013; Chase et al., 2017; Csapo & Alegre, 2016; Sherrington et al., 2008) and are an effective method that contributes to maintaining and improving functional capacity. Accordingly, identifying factors that affect physical function and improving these factors may offer a means of helping to maintain and improve the functional capacity of older adults.

In recent years, it has been reported that factors related to the environment in which people live affect their health. The life space of older adults in particular contracts because their physical activity diminishes as a result of retirement and advancing age. As a result, the neighborhood environment around the area where they live is more likely to affect their state of health. In fact, systematic reviews and meta-analyses have shown that, in older adults, the neighborhood environment affects a variety of health-related outcomes, including physical activity (Barnett et al., 2017), cognitive function (Besser et al., 2017), and cardiovascular disease (Malambo et al., 2016). Systematic reviews of the effect of the neighborhood environment on the physical function of older adults have also been published (Rachele et al., 2019; Won et al., 2016). These reviews reported that both the physical environment (such as pedestrian infrastructure and aesthetics) and the social environment (such as crime and traffic) affect physical function. However, only around 30% of studies have reported positive findings with respect to the association between the neighborhood environment and physical function, and most of the other studies have reported that the results were not statistically significant (Rachele et al., 2019). Thus, the results of previous studies are inconsistent, and the effect of the neighborhood environment on physical function has yet to be fully established. One possible reason for the inconsistencies in the results of previous studies is that the individual characteristics of each study’s participants, such as their age, sex, and state of health, may affect the relationship between their physical function and the neighborhood environment. Identifying the individual characteristics of older adults that alter the effect of the neighborhood environment on their physical function may help lead to innovative interventions for maintaining and improving the physical function of older adults.

The objective of this study was therefore to conduct an exploratory investigation of the individual characteristics of older adults that affect the association between their physical function and their neighborhood environment.

**Methods**

**Study Design and Participants**

This was a cross-sectional study of community-dwelling older adults who underwent health check-ups for geriatric syndrome in Sagamihara City, Kanagawa Prefecture, Japan, between 2016 and 2018. The participants were recruited via community newsletters and advertisements on notice boards at sports facilities in the city. The exclusion criteria for the participants in this study were as follows: (1) age ≥65 years, (2) living in the community, and (3) able to engage independently in activities of daily living (ADL). Independence in ADL was defined as not receiving support under the long-term care insurance (LTCI) system or having obtained certification of support or care level, and this was confirmed by the researchers at the time of recruitment. The exclusion criteria were as follows: (1) unable to travel independently to the health check-up venue, (2) serious cardiopulmonary or neurological disease, and (3) unable to complete the physical function tests described below. Of a total of 638 community-dwelling older adults who underwent health check-ups, 14 were excluded for missing data, leaving 624 in the final analysis population.

**Physical Function**

Muscle strength (grip strength and knee extension strength) and physical performance (5-m walking time, Timed Up and Go Test (TUG) (Podsiadlo & Richardson, 1991)) were measured as indicators of physical function.

Grip strength was measured with a Smedley-type dynamometer (T.K.K.5401, TAKEI Scientific Instruments Co., Ltd., Niigata, Japan). Maximum grip strength with the dominant hand was measured with the participant standing upright in a stable posture with the feet placed a natural distance apart. Knee extension strength was measured with a handheld dynamometer (μ-Tas F-1; Anima Inc., Tokyo, Japan). The participant sat in a chair with the hip and knee joints flexed at 90°, and isometric knee extension strength at maximum effort was measured. Five-meter walking time was measured using a 9-m walkway, consisting of a measurement zone (5 m) and acceleration and deceleration zones (each 2 m). The time to walk the 5-m length in the middle of the walkway at a comfortable pace was measured with a digital stopwatch (ALBA W072; Seiko Watch Corporation, Tokyo, Japan). In the TUG test, the time taken for the participant to stand up from a chair without hand support, walk 3 m as quickly as possible, turn around, walk back, and then sit down again (Shumway-Cook et al., 2000) was measured with a digital stopwatch (ALBA W072; Seiko Watch Corporation). All measurements were conducted twice, and the best value of each measurement was used for the analysis.

**Neighborhood Environment**

The Japanese version of the International Physical Activity Questionnaire Environmental Module (IPAQ-E) (Inoue et al., 2009) was used as an indicator of the neighborhood environment. The IPAQ-E is a questionnaire that asks study participants about the features of the environment in the neighborhood of their home (within a 10–15-minute walk).
The reliability of the IPAQ-E has been reported by the test-retest method (Inoue et al., 2009). It has also been used to survey community-dwelling older people (Inoue et al., 2011). In the present study, previous reports (Inoue et al., 2009, 2011) were followed in using 10 items included in the IPAQ-E: residential density, access to shops, access to public transport (bus stops/stations), presence of sidewalks, presence of bike lanes, access to recreational facilities, crime safety (at night), traffic safety, social environment (seeing people being active), and aesthetics. Following previous studies, the IPAQ-E responses were converted into dichotomous variables and used in the analysis (Inoue et al., 2009, 2011).

### Individual Characteristics

As individual characteristics, age, sex, medical history, pain, medications, height, weight, body mass index (BMI), habitual exercise, cognitive function, depressive symptoms, social isolation, and functional capacity were investigated. These individual characteristics were found to be factors related to physical function in previous studies (Chase et al., 2017; Kuo et al., 2005; Nieto et al., 2008; Sakurai et al., 2019).

Medical history (hypertension, diabetes mellitus, dyslipidemia, cerebrovascular disease, and heart disease), pain (low back pain and knee pain), and medications were surveyed using a self-administered questionnaire. The Trail Making Test part A (TMT-A) (Tombaugh, 2004) was used as an index of cognitive function. Depressive symptoms were assessed using the five-item version of the Geriatric Depression Scale (5-GDS). The GDS-5 score ranges 0–5 points, with ≥2 points defined as “with depressive symptoms” (Hoyl et al., 1999). Social isolation was surveyed by a self-administered questionnaire asking about the frequency of interactions with family members or friends other than members of the same household. “Social isolation” was defined as <1 interaction per week (Satto et al., 2015). Functional capacity was assessed by the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) (Koyano et al., 1991). The TMIG-IC score ranges from 0–13 points, with a higher score indicating greater functional capacity.

### Statistical Analysis

Because sex differences in the effect of the neighborhood environment have been reported (Koohsari et al., 2020; Soma et al., 2017), all statistical analyses in this study were stratified by sex. For descriptive variables, continuous variables are expressed as means ± SDs, and categorical variables as frequencies and percentages. Comparisons of continuous variables between groups were conducted using an unpaired t-test, Welch’s test, or the Mann–Whitney U test. Comparisons of categorical variables between groups were conducted using the χ² test.

To explore the individual characteristics of older adults that affect the association between physical function and neighborhood environment, the following analysis was performed. Multiple regression analysis (Akaike’s information criterion stepwise method) was performed first to identify latent neighborhood environmental factors and individual characteristics associated with physical function. Neighborhood environmental factors, age, medical history, pain, medications, BMI, habitual exercise, TMT-A, depressive symptoms, and social isolation were entered into a multiple regression model, with the indicators of each physical function being the dependent variables.

Regression tree analysis was then conducted using the Classification and Regression Tree (CART) algorithm to explore the associations between physical function and neighborhood environmental factors in light of the individual characteristics of older people. In this regression tree analysis, the indicator of each physical function was set as a dependent variable, and the neighborhood environmental factors and individual characteristics adopted in the previous multiple regression analysis were used. To generate the optimal tree with the highest predictive performance, tree pruning was conducted by means of complexity parameters (cps) taking minimum cross-validation error as the criterion, based on 10-fold cross-validation. Finally, the physical function indices of the groups of participants classified by this regression tree model (terminal nodes) were compared using the Kruskal–Wallis test and a post hoc test (Steel method).

Statistical analysis was carried out using IBM SPSS Statistics 27.0 (IBM Japan, Tokyo, Japan), R version 4.0.3 (R Core Team, 2020), and the package rpart (Therneau & Atkinson, 2019), with p < .05 regarded as significant.

### Ethical Considerations

The study protocol was approved by the ethics committee of the authors’ institution. All participants provided written, informed consent with respect to the study purpose and that their data would only be used for research purposes. Participants were informed that they could withdraw from the study at any time.

### Results

#### Characteristics of Participants

Table 1 shows the characteristics of the participants. The mean age of the participants was 71.7 ± 4.7 years. Their mean TMIG-IC score was 11.9 ± 1.4 points. Sex differences were significant for all indicators of physical function. There were also sex differences in TMT-A, depressive symptoms, social isolation, and TMIG-IC scores.

### Multiple Regression Analysis Results

Tables 2 and 3 show the results of the multiple regression analyses stratified by sex. For men, there were significant
associations between 5-m walking time and access to recreational facilities ($B = -0.31, p = .004$) and between TUG time and residential density ($B = -0.27, p = .042$). For women, both grip strength and knee extension strength were significantly associated with access to recreational facilities ($B = 0.91, p = .024$ and $B = 1.66, p = .043$, respectively). In addition, age, medical history, pain, medications, BMI, habitual exercise, TMT-A, and depressive symptoms were identified as individual characteristics of older adults related to physical function.

Regression Tree Analysis Results

On regression tree analysis, a regression tree model including neighborhood environmental factors was generated for the 5-m walking time of older men (Figure 1). In this model, the study subjects were divided into five groups according to age, low back pain, depressive symptoms, and access to recreational facilities. Individuals aged ≤80 years with no low back pain and no depressive symptoms and good access to recreational facilities were therefore classified in node 5. A
|                     | Grip Strength | Knee Extension Strength | 5-m Walking Time | TUG |
|---------------------|---------------|-------------------------|-----------------|-----|
|                     | B             | 95%CI                   | p value         | B   | 95%CI   | p value | B   | 95%CI   | p value | B   | 95%CI   | p value |
| **Neighborhood environment** |               |                         |                 |     |         |         |     |         |         |     |         |         |
| Residential density (ref. low) | ——           | ——                      | ——              | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| Access to shops (ref. poor) | -1.91         | (-3.89–0.07)            | .059            | 3.04| (-0.51–6.59)| .093    | —— | ——      | ——      | 0.12| (-0.04–0.28)| .150    |
| Presence of sidewalks (ref. poor) | ——           | ——                      | ——              | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| Access to recreational facilities (ref. poor) | ——           | ——                      | ——              | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| Crime safety (ref. good) | 1.52          | (-0.35–3.40)            | .110            | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| Traffic safety (ref. good) | -1.60         | (-3.34–0.14)            | .072            | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| **Individual characteristics** |               |                         |                 |     |         |         |     |         |         |     |         |         |
| Age (y)              | -0.44         | (-0.58–0.29)            | <.001           | -0.71| (-0.97–0.44)| <.001  | .02 | (0.00–0.03)| .035    | 0.08| (0.06–0.10)| <.001  |
| Hypertension (ref. no) | ——            | ——                      | ——              | 2.51| (-0.47–5.50)| .098   | —— | ——      | ——      | —— | ——      | ——      |
| Diabetes mellitus (ref. no) | ——            | ——                      | ——              | -4.44| (-8.86–0.01)| .050   | —— | ——      | ——      | —— | ——      | ——      |
| Dyslipidemia (ref. no) | 1.46          | (-0.47–3.39)            | .140            | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| Cerebrovascular disease (ref. no) | ——            | ——                      | ——              | -5.43| (-11.91–1.05)| .100   | —— | ——      | ——      | 0.38| (-0.15–0.92)| .160   |
| Heart disease (ref. no) | ——            | ——                      | ——              | 5.54 | (0.69–10.39)| .025   | —— | ——      | ——      | —— | ——      | ——      |
| Low back pain (ref. no) | ——            | ——                      | ——              | —— | ——      | ——      | —— | ——      | ——      | 0.21| (0.06–0.36)| .006   |
| Knee pain (ref. no) | -2.11          | (-3.76–0.46)            | .013            | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| Medications (ref. no) | -2.10          | (-3.84–0.36)            | .018            | -3.90| (-7.33–0.47)| .026   | —— | ——      | ——      | 0.30| (0.04–0.55)| .025   |
| BMI (kg/m²) | 0.63           | (0.34–0.92)             | <.001           | 1.76 | (1.24–2.28)| <.001  | —— | ——      | ——      | —— | ——      | ——      |
| TMT-A (sec)          | ——            | ——                      | ——              | —— | ——      | ——      | —— | ——      | ——      | —— | ——      | ——      |
| Depressive symptoms (ref. no) | ——            | ——                      | ——              | —— | ——      | ——      | —— | ——      | ——      | 0.18| (-0.06–0.42)| .140   |
| (Intercept)          | 57.00         | (43.48–70.52)           | <.001           | 46.44| (22.17–70.70)| <.001  | 2.45| (1.39–3.51)| <.001  | -0.87| (-2.46–0.73)| .290   |
| F-test               | p < .001      |                         |                 | p < .001|                         | p < .001  | p < .001|                         | p < .001  |
| AIC                  | 563.51        |                         |                 | 766.68|                         | -247.67  | -99.24|                         |          |
| R²                   | 0.35          |                         |                 | 0.38 |                         | 0.13     | 0.40   |                         |          |
| Adjusted R²          | 0.32          |                         |                 | 0.35 |                         | 0.10     | 0.38   |                         |          |

**Note.** Dependent variable: physical function. Independent variables: neighborhood environment (residential density, access to shops, access to public transport, presence of sidewalks, presence of bicycle lanes, access to recreational facilities, crime safety, traffic safety, social environment, and aesthetics), age, medical history (hypertension, diabetes mellitus, dyslipidemia, cerebrovascular disease, and heart disease), pain (low back and knee), medications, BMI, habitual exercise, TMT-A, depressive symptoms, and social isolation. 5-m walking time at comfortable pace. TUG at maximum pace. Social environment (seeing people being active). B = partial regression coefficient; CI = confidence interval; AIC = Akaike’s information criterion; R = coefficient of determination; TUG = timed up and go test; BMI = body mass index; TMT-A = trail making test part A.
### Table 3. Multiple regression models in women (n = 450).

|                     | Grip Strength          | Knee Extension Strength | 5-m Walking Time          | TUG                  |
|---------------------|------------------------|-------------------------|---------------------------|----------------------|
|                     | B 95%CI p value        | B 95%CI p value         | B 95%CI p value           | B 95%CI p value      |
| **Neighborhood environment** |                       |                         |                           |                      |
| Residential density (ref. low) | — — —                | — — — —               | 0.07 (-0.03–0.17) .160 | — — — —             |
| Access to public transport (ref. poor) | — — —                | — — — —               | — — — — — —               | — — — —             |
| Presence of bicycle lanes (ref. poor) | 0.52 (-0.15–1.18) .130 | — — — —               | -1.75 (-4.05–0.54) .130 | — — — —             |
| Access to recreational facilities (ref. poor) | 0.91 (0.12–1.70) .024 | 2.16 (0.49–3.84) .011 | 2.16 (0.49–3.84) .011 | — — — —             |
| Crime safety (ref. good) | — — — —                | — — — —               | — — — — — —               | — — — —             |
| Traffic safety (ref. good) | — — — —                | — — — —               | — — — — — —               | — — — —             |
| Aesthetics (ref. poor) | — — — — — — — — — — — | — — — — — — — — — — | — — — — — — — — — — | — — — — — — — — — — |
| **Individual characteristics** |                       |                         |                           |                      |
| Age (y) | -0.23 (-0.30–0.15) <.001 | -0.32 (-0.48–0.16) <.001 | 0.02 (0.01–0.03) .002 | 0.07 (0.05–0.09) <.001 |
| Diabetes mellitus (ref. no) | -1.91 (-3.19–0.63) .004 | — — — —               | 0.17 (0.00–0.34) .046 | 0.43 (0.15–0.71) .002 |
| Dyslipidemia (ref. no) | — — — —                | — — — —               | — — — — — —               | — — — —             |
| Cerebrovascular disease (ref. no) | — — — —                | — — — —               | 0.13 (-0.04–0.29) .130 | — — — —             |
| Heart disease (ref. no) | -1.25 (-2.60–0.11) .072 | 2.62 (5.18–0.25) .073 | 0.15 (-0.02–0.33) .087 | 0.26 (-0.03–0.55) .082 |
| Knee pain (ref. no) | — — — —                | — — — —               | — — — — — —               | — — — —             |
| Medications (ref. no) | — — — — — — — — — — | — — — — — — — — — — | — — — — — — — — — — | — — — — — — — — — — |
| BMI (kg/m²) | 0.14 (0.04–0.24) .006 | 0.36 (0.15–0.57) .001 | 0.02 (0.01–0.03) .003 | 0.03 (0.01–0.06) .003 |
| Habitual exercise (ref. no) | — — — —                | — — — —               | 1.44 (-0.13–3.00) .072 | -0.14 (-0.23–0.04) .005 |
| TMT-A (sec) | — — — —                | — — — —               | — — — — — —               | — — — —             |
| (Intercept) | 36.13 (30.37–41.88) <.001 | 40.59 (28.07–53.12) <.001 | 1.84 (1.09–2.60) <.001 | -0.13 (-1.41–1.14) .840 |
| F-test p < .001 | p < .001 | p < .001 | p < .001 | p < .001 |
| AIC | 1121.38 | 1800.76 | -715.11 | -260.46 |
| R² | 0.14 | 0.11 | 0.12 | .28 |
| Adjusted R² | 0.13 | 0.09 | 0.11 | .26 |
Comparison of the 5-m walking times of these five groups showed that the participants classified in node 5 had significantly shorter 5-m walking times compared with those of the other four groups (Table 4). No regression tree model including a neighborhood environmental factor was generated for any physical function for men other than 5-m walking time. For women, no regression tree model including a neighborhood environmental factor was generated for any physical function.

Discussion

In this study, an exploratory investigation of the individual characteristics of older adults that affect the association between their physical function and their neighborhood environment was conducted by means of regression tree analysis. The results showed that, for older men aged ≤80 years with no pain and no depressive symptoms, access to recreational facilities was associated with shorter 5-m walking time. The participants in this study were older adults living independently in the community, and their mean TMIG-IC score was somewhat higher than in previous studies (Iwasa et al., 2008; Koyano et al., 1993). The present study participants were therefore considered to constitute a population with a rather high functional capacity.

Multiple regression analysis of the associations between physical function and the neighborhood environment found that access to recreational facilities and residential density...
were significantly associated with physical performance in men. In women, access to recreational facilities was significantly associated with muscle strength. Some previous studies have also found that access to recreational facilities and residential density are associated with physical function (Koohsari et al., 2020; Soma et al., 2017), consistent with the present results. Other studies, however, have not identified any significant associations between these neighborhood environmental factors and physical function (Etman et al., 2016; Freedman et al., 2008). Physical functions such as walking ability and muscle strength are affected not only by age and sex, but also by numerous other factors, including physical activity (Chase et al., 2017), cognitive function (Nieto et al., 2008), disease (Kuo et al., 2005), and social isolation (Sakurai et al., 2019). Associations between these factors and the neighborhood environment have also been reported (Barnett et al., 2017; Besser et al., 2017; Malambo et al., 2016), and the associations between physical function and the neighborhood environment are believed to be highly complex. We therefore conjectured that the results of studies of the associations between physical function and the neighborhood environment may vary in accordance with differences in the individual characteristics of the participants.

In this study, regression tree analysis was used to conduct an exploratory study of the individual characteristics of older adults that affect the relationship between physical function and neighborhood environmental factors. For older men aged <80 years without low back pain and depressive symptoms, access to recreational facilities was associated with 5-m walking time. For these men, 5-m walking time was 0.25–0.62 s shorter than that of any of the other groups. The minimum detectable change in the 5-m walking time of older people has been reported to be 0.23 s (Suzuki et al., 2019). The difference among the five groups in 5-m walking time found in the present study was therefore not considered to be due to measurement errors. In a previous study that reported a significant association between neighborhood recreational facilities and physical function (Soma et al., 2017), the study participants tended to be younger and to include a lower proportion of older adults with low back pain or depressive symptoms. This is also consistent with the present results. On the other hand, one study that did not identify any significant association between physical function and the neighborhood environment included frail older adults with impaired ADL (Freedman et al., 2008). Their study participants may therefore have been in worse health than those of the present study. The present results showed that the association between the neighborhood environment and physical function is affected by sex, age, physical health-related factors including pain, and mental health-related factors including depressive symptoms.

In the present study, it appears that the association between 5-m walking time and access to recreational facilities may be mediated by physical activity such as daily walking time. In fact, total neighborhood walking, as well as transportation walking and recreational walking, has been reported to increase if there is good access to recreational facilities (Inoue et al., 2011). That is, comparatively younger older men who are in good health may engage in more physical activity if recreational facilities are available, and this may contribute to maintaining and improving their walking ability. However, no regression tree model that included neighborhood environmental factors was generated for grip strength, knee extension strength, or TUG time. Exercise programs that include resistance training and balance exercises are effective in improving muscle strength and physical performance (Cadore et al., 2013; Csapo & Alegre, 2016; Sherrington et al., 2008). This means that good or poor access to recreational facilities probably has little effect on physical function other than walking. In the present study, however, the amount and detailed content of physical activity were not examined. It is necessary to verify the mediating effect of physical activity on the relationship between physical function and the neighborhood environment in future research.

In women, multiple regression analysis identified an association between access to recreational facilities and muscle strength. However, regression tree analysis did not identify any individual characteristics of the participants that affected the association between both. As described above, a range of different factors contributes to physical function, and in multiple regression analysis, these factors may be insufficiently controlled. In particular, women are thought to possess a wider variety of social resources than men (Antonucci & Akiyama, 1987). In this study, the rate of social isolation, a social factor, was clearly lower in women than in men. A previous study has also reported that the effect of social participation on health is greater for women than for men (Tomioka et al., 2015, 2017). This suggested that social factors in older women may have a stronger influence on physical function than neighborhood environment. However, one cannot say what sort of social factors may be important for women on the basis of the results of the present study alone. Social resources that were not investigated in this study may also be in play, and further studies are required in the future.

This study had several limitations. First, causal relationships cannot be ascertained because of the cross-sectional nature of the study. Longitudinal studies will be required to verify the causal relationships involved in the effects of the neighborhood environment on physical function. Second, the evaluation of the neighborhood environment in this study was subjective. Geographic information systems (GIS) have been widely used for objective evaluation in recent years, and differences in the effects on health of objective and subjective evaluations have been identified (Gebel et al., 2011). Although the participants in the present study were a population with comparatively good functional capacity, as described above, and it was considered that the quality of the subjective evaluation of the neighborhood environment was assured, the possibility that an objective evaluation might have led to different results cannot be excluded. Third, in this study,
socio-economic status (such as family structure and income) or the number of years of residence in the locality was not examined. One can therefore say nothing about the effect of these factors on physical function or on perceived neighborhood environment. Fourth, this study was conducted in a single region of metropolitan suburbs. To confirm the validity of the regression tree models obtained and generalize them will require their validation in regions other than metropolitan suburbs. Due to the existence of cultural and racial differences in physical function between Japanese and Western older adults (Ando & Kamide, 2015), caution is required in the generalization of the results of the present study to other countries.

Conclusion

In the present study, regression tree analysis was used to conduct an exploratory analysis of the individual characteristics of community-dwelling older adults that affect the relationship between physical function and neighborhood environment. The results showed that sex, age, and physical and mental health are individual characteristics of older people that affect the association between physical function and the neighborhood environment. In particular, they suggested that, for comparatively younger older men with no pain and no depressive symptoms, access to recreational facilities may be associated with the maintenance of walking ability. Thus, we conclude that the relationships between physical function and neighborhood environment may be altered by individual characteristics. Older adults’ individual characteristics should be taken into account when investigating the effects of the neighborhood environment on physical function and when developing or promoting the use of environmental resources.

Declaration of Conflicting Interests

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Ethical Approval

This study was approved by the Ethics Committee of the School of Allied Health Sciences of Kitasato University (approval no. 2018-008B). Written, informed consent was obtained from all study participants.

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