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Associations between older adults' going-out frequency and land price of neighbourhoods: Potency of land price as an indicator of homebound tendency

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HIGHLIGHTS

- The tendency of homebound is one of the biggest concerns for older adults' health.
- Supportive environments for going out have received less attention than walkable environments.
- This study focuses on the relations between older adults' going-out frequency and land price.
- Older adults' going-out frequency has negative relations with land price of neighbourhoods.
- Positive relations of neighbourhood factors might be underestimated without land price.

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ABSTRACT

The aim of this study is to identify the potency of land price as a general indicator of the homebound tendency of neighbourhoods. For this purpose, we focus on the associations between land price and older adults' going-out frequency, while considering the similarities and differences from factors associated with walkability. The study targets are 19,270 individuals living in the Tokyo metropolitan area who are aged 65 years or older who are not certified as needing public long-term care insurance. This study uses a two-step procedure: a) the land price of each neighbourhood is estimated using rent price data from 2010 to 2019 collected by an official Japanese realtor organization; b) the associations between older adults' goingout frequency, according to the 2016 Japan Gerontological Evaluation Study, and the estimated land price of their neighbourhoods is identified using multilevel analysis. The results indicate that land price has strong negative associations with older adults' going-out frequency. Associations between land price or other walkability-associated factors, such as population density, ratio of commercial area, and proximity to the nearest train station, only appear when these factors and land price are included within the same model.

The results suggest that, when inspecting homebound tendency in some neighbourhoods, factors relating to the built environment must be considered alongside land prices. Furthermore, the homebound status of older adults is a pressing challenge, especially in neighbourhoods with high land prices.

1. Introduction

An increasing body of research has identified potential relationships between environment and health, leading interdisciplinary experts such as medical scientists and urban planners to enhance their efforts to retrofit existing neighbourhoods as health-oriented environments (e.g. DCP, 2010; Public Health England, 2017). Super-aging countries such as Japan expect the retrofitting of neighbourhoods to produce a fundamental improvement in older adults' health, which has the potential to reduce expenditure on medical welfare (MLIT, 2018). The walkability of neighbourhoods is a typical target in almost all retrofitting projects, and there is extensive knowledge on supportive built environments for

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walking. Compact environments, characterized by higher densities, mixed land-use, and proximity to destinations such as central business districts or green spaces, are associated with increased walking (Saelens & Handy, 2008; Ewing & Cervero, 2010; Stevenson et al., 2016; Mouratidis et al., 2019; Stefansdottir et al., 2019; Zuniga-Teran et al., 2019; Fonseca et al., 2022). Increased access to public transport contributes to an increase in walking to and from public transport stops, thereby helping to promote and maintain active lifestyles (Besser & Dannenberg, 2005; Freeland et al., 2013; Sallis et al., 2016).

The walkability of a neighbourhood is important in encouraging older adults to become more active in their daily lives, but the willingness of older adults to go out around their neighbourhoods is also of critical importance, because all outdoor activities necessitate going out. The simple act of going out is itself an important component of maintaining health in older age (Jacobs et al., 2018; Mikami et al., 2019), and going out and walking around the neighbourhood enhances physical health (Giles-Corti et al., 2003; Frank et al., 2004; Lee & Buchner, 2008; Pucher et al., 2010), mental health (Sugiyama et al., 2008; de Vries et al., 2013; Dadvand et al., 2016; McEachan et al., 2016), and social capital (House et al., 1988; Uchino, 2006; Holt-Lunstad et al., 2010). Although this is unremarkable for young workers or students, who are obliged to visit fixed offices or schools almost every day, older adults have fewer opportunities or reasons to go out than working generations, which could lead to social isolation and homebound status.

Supportive environments for going out have received less attention than walkable environments (several exceptions being the study of Murayama et al., 2012 or Pramitasari & Sarwadi, 2015). Hence, the differences between walkable environments and environments in which older adults are willing to go out are still obscure. If some environmental indicators had potential relations with older adults' going-out frequency in a considerable number of neighbourhoods, it would provide not only new insights into the associations between human behavior and the environment, but also practical information about inactive neighbourhoods where older adults are more likely to be homebound.

Here, this study focuses on the potency of land price as an indicator of the neighbourhood environment. Land prices provide a comprehensive evaluation of the neighbourhood environment, and the evaluation is associated not only with the built environment in terms of walkability such as through population density, mixed land-use, or access to public transport (Lavee, 2015), but also with social or historical contexts of the neighbourhood like background of development or brand recognition of the area (e.g. Cervero & Duncan, 2004), which could also influence the going-out frequency. The land prices of neighbourhoods are easily estimated using real estate data. Therefore, if the land price is potentially related with the going-out frequency of older adults, it would provide a strong measure for inspecting the general homebound tendency of neighbourhoods.

Based on the above discussion, this study aims to identify how the going-out frequency of older adults is related to the land price, while considering the similarities and differences between walkable environments and environments in which older adults are willing to go out. The results provide new perspectives into a vision of neighbourhoods that promote older adults' outside activities, which could contribute to future urban planning or policy-making practices.

2. Material and methods

2.1. Study site

The study sites cover five Japanese suburban cities in the Tokyo metropolitan area: Funabashi, Hachioji, Kashiwa, Matsudo, and Yokohama (Fig. 1). Three intensive business districts of Yokohama (Naka, Nishi, and Minami) were removed from this study to allow us to focus on areas around residential neighbourhoods. The two core business districts of Tokyo, Marunouchi and Shinjuku, are about 30–60 min from these cities by train. These suburban cities have developed rapidly since the 1960s, when Japan enjoyed high economic growth and large numbers of people emigrated from small local municipalities to the Tokyo metropolis for jobs and education.

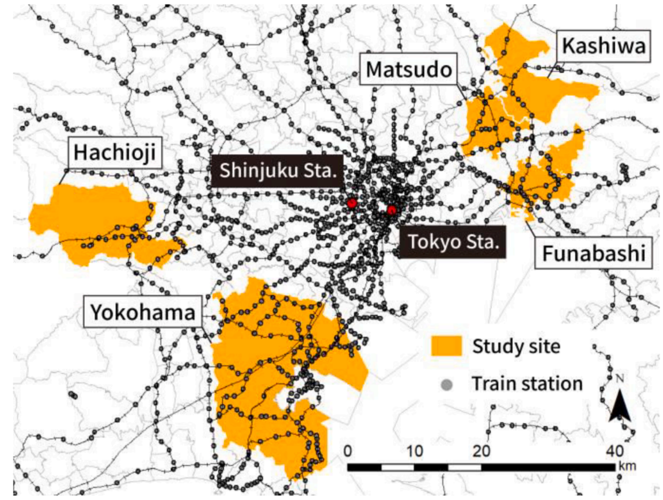

Fig. 1. Location of the study site.

The young workers and students of those days are now, however, reaching the age of 70 or so, meaning that suburban cities face the problem of a super-aging society. Social isolation is a salient issue in modern, highly urbanized Japan (Muramatsu & Akiyama, 2011). The Japan Gerontological Evaluation Study (JAGES) has been conducting large-scale questionnaires around the country to understand the health status of older Japanese adults; JAGES has been producing scientific evidence on health inequalities, how these inequalities prevent access to community resources, including health and medical services, and the development of health inequalities in older adults in Japan. JAGES uses high-quality, large-scale data that are mainly collected through self-administered mail surveys conducted under the auspices of municipal governments, who are the public insurers of long-term care (Kondo & Rosenberg, 2018).

All five of the study cities joined the JAGES survey in 2016, so they are ideal candidates for study using the associated JAGES data. The questionnaire was sent to residents aged 65 years or older who were not certified as needing public long-term care insurance. These targets enable us to identify general relations between older adults' going-out frequency and the land price or environmental parameters of neighbourhoods. The neighbourhoods of the five cities are officially divided into 1230 units by the government (Fig. 2).

2.2. Estimation of the land price of each neighbourhood

This study used a two-step procedure: a) the land price of each neighbourhood was estimated using rent price data from the period 2010–2019, according to a Japanese official realtor organization (Real Estate Information Network System); b) the associations between older adults' going-out frequency, according to the JAGES 2016 survey, and the estimated land price of their neighbourhoods was identified using multilevel analysis, which can describe both the fixed parameters and random parameters of compositional and contextual factors between individual and group levels.

Land prices in Japan are officially valued and announced by the government on an annual basis, but there are too few standardized points to provide adequate indicators of the land price of all neighbourhoods. The land price was therefore estimated using some alternative data related to the housing market, namely rent price data. These data are comprehensively collected for the Tokyo metropolis by the Real Estate Information Network System (REINS); the number of data points is far greater than other types of housing market data, such as house sale

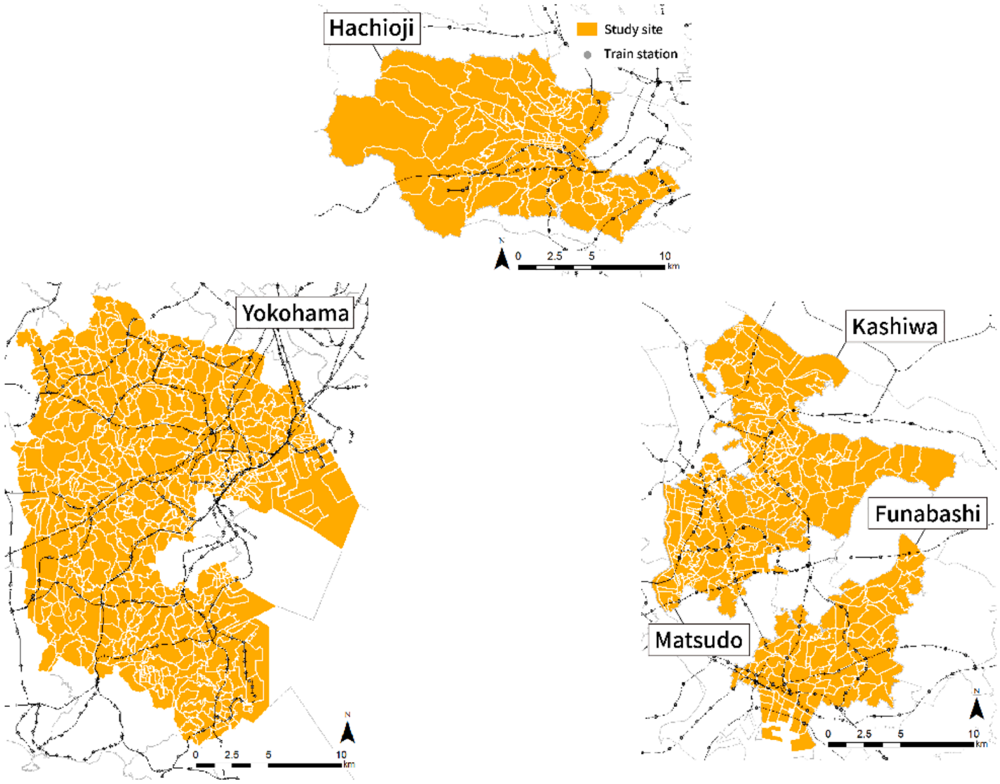

Fig. 2. Neighbourhood units in the study site.

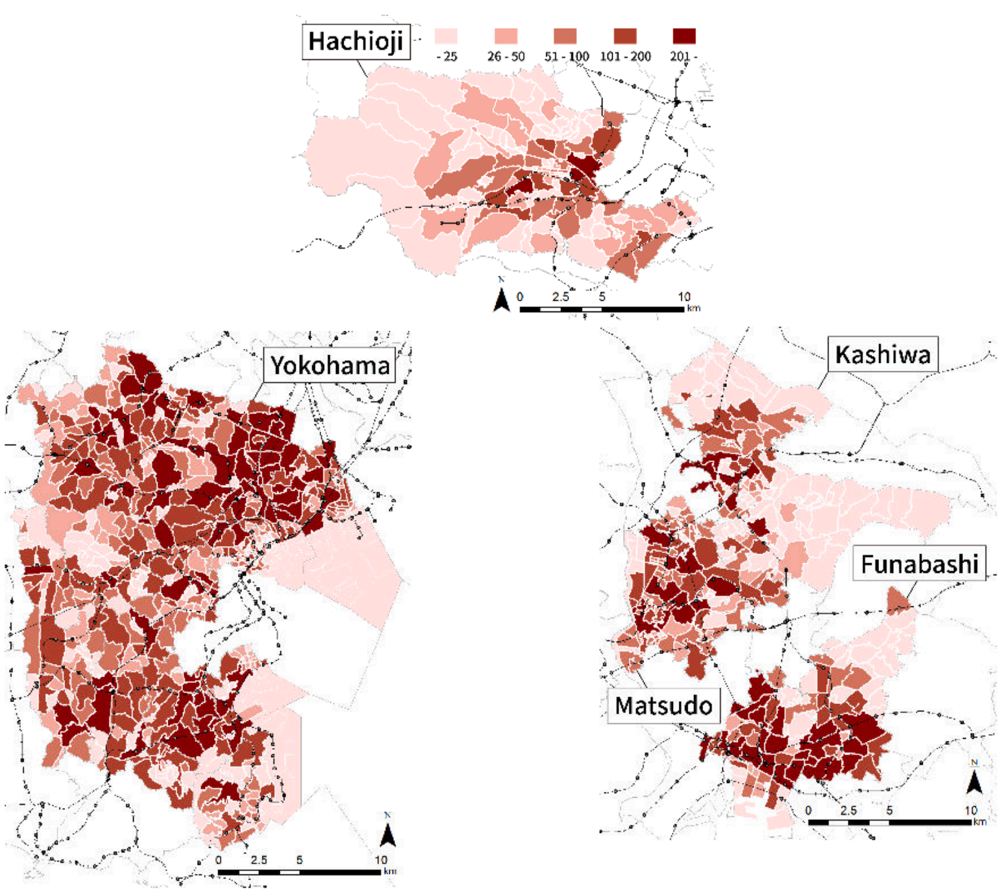

Fig. 3. Number of apartments rented between 2010 and 2019 in each neighbourhood.

prices. The target apartment types are those consisting of one or more bedrooms, because tiny rooms like studio apartments are mostly rented by single students, so their rental prices are unduly influenced by access to schools or colleges.

The land price of each neighbourhood was estimated by an ordinary least-squares regression model based on the theory of Rosen (1974). According to Chau et al. (2001), the rental price is determined by two aspects of attributes to the property: attributes of the building value (size, floor level, age, etc.) and attributes of the land value (access to urban facilities, proximity to green spaces, reputation of the neighbourhood, etc.). This study used room size (m^2), floor level, age (years), and building structure (wood, steel, concrete, or other) as attributes of the building value, and integrated attributes of the land value reflecting both the physical and socioeconomic environment supposed to explain land price into a neighbourhood unit dummy variable. Configuring the logarithm of the rent price as the response variable and the attributes of the building value and attributes of the land value as the explanatory variables, this model is formulated as

$$\ln\left(P_{i,j,k}\right) = \alpha + \sum_{j} \beta_{i,j,k} x_{i,j,k} + \beta_{LP,k} + \varepsilon_{i,j,k}$$

where $P_{i,j,k}$ is the rental price of apartment i in neighbourhood k, α is the intercept, $x_{i,j,k}$ is the j^{th} explanatory variable of the four attributes of the building value to apartment i in neighbourhood k, $\beta_{i,j,k}$ is the coefficient of $x_{i,j,k}$, $\beta_{LP,k}$ is the dummy variable indicating the land price of neighbourhood k by referring to rental prices between 2010 and 2019, and $\varepsilon_{i,j,k}$ is the residual.

The parameters were estimated by the least-squares method. A total of 100,171 apartments were rented between 2010 and 2019 in the 1230 neighbourhoods of the five cities (Fig. 3). For these apartments, data on the necessary attributes of the building value for estimating the land price level are available.

2.3. Multilevel regression analysis

The associations between the going-out frequency, built environment, and land price of neighbourhoods were analysed using multilevel analysis. The JAGES 2016 survey produced 19,270 individual data (at level 1) for all necessary variables described below, and these were nested within neighbourhoods (at level 2) whose land prices were estimated.

The response variable, i.e. the frequency of going out for any outside activities such as shopping, eating out, or attending hospital, was identified through the JAGES questionnaire survey at six nonlinear scales: four times or more per week, two or three times per week, once per week, one–three times per month, several times per year, and none. Regarding the older adults' going-out frequency, a 2017 survey found that 68.7% of older adults went outside almost every day, but the second-ranking frequency (once every two or three days, similar to two or three times per week), was significantly lower at 21.7% (Cabinet Office 2017). This suggests that the threshold of older adults' going-out frequency should be placed between four times or more per week and below. Therefore, the six scales of the frequency of going out can be divided into a binary variable: four times or more per week, or less frequently. This was used as the response variable in the subsequent multilevel analyses.

As for explanatory variables, the individual-level factors included sex, age, length of residency, educational experience, number of family members, household income, household property, frequency, and daily use of a private car (compositional factors), while the neighbourhood-level factors included population density, proportion of land use, expected catchment-area density of parks of three sizes (about 0.25 ha, 2.0 ha, and 4.0 ha or larger, as classified by the government), bus stop density, distance from the nearest station, distance from central Tokyo business districts/Tokyo station/Shinjuku station, and land price. Regarding the proportion of land use, the differences between low-rise residential areas and mid-to-high-rise residential areas are only the zoning regulations of the permitted building coverage and volume, so the differences between "low" and "mid-to-high" are irrelevant to the socioeconomic status of neighbourhoods. These variables are summarized in Table 1. The individual-level factors (at level 1) were

Table 1
. Definition of variables used in multilevel analysis.

Variable		Definition
Response variable	Frequency of going out	Binary variable: 3 or less: 0, 4 or more: 1 (times/per week)
Individual level factors (at level 1)	Sex	Binary variable: Female: 0, Male: 1
	Age	Integer variable
	Length of residency	Integer variable
	Educational experience	Ordinal variable 6 or less: 1, Between 6 and 9: 2, Between 10 and 12: 3, 13 or more: 4 (years)
	Number of family members	Integer variable
	Houshold income	Ordinal variable standardized by Number of family members: Less than 50: 1, Between 50 and 100: 2, Between 100 and 150: 3, Between 150 and 200: 4 Between 200 and 250: 5, Between 250 and 300: 6, Between 300 and 400: 7, Between 400 and 500: 8 Between 500 and 600: 9, Between 600 and 700: 10, Between 700 and 800: 11, Between 800 and 900: 12 Between 900 and 1000: 13, Between 1000 and 1200: 14, 1200 or more: 15 (10 thousand yen)
	Household property	Ordinal variable: Less than 50: 1, Between 50 and 100: 2, Between 100 and 500: 3, Between 500 and 1000: 4 Between 1000 and 5000: 5, 5000 or more: 6 (10 thousand yen)
	Housing type	Categorical variable: Owned detached house, Owned condominium, Rental detached house, Rental condominium Public housing, Other types of housing
	Daily use of private car	Binary variable: No: 0, Yes: 1
Neighborhood level factors (at level 2)	Population density	Numerical variable: Total population standerdized by the neighborhood area
	Park density	Numerical variable: Number of parks standerdized by the neighborhood area
	Bus stop density	Numerical variable: Number of bus stops standerdized by the neighborhood area
	Ratio of land use type	Numerical variable: Low residence, Tall residence, Commertial, industrial
	Expected catchment area density of parks	Numerical variable: expected catchment area of each type of parks by the neighborhood area small park:250 m radius circle, midium park: 500 m radius circle, large park: 1000 m radius
	Distance from the nearest station	Numerical variable: Distance from the centroid of a neighborhood to the nearest station
	Distance from central Tokyo business districts	Numerical variable: Nearest distance from the centroid of a neighborhood to Tokyo station or Shinjuku station
	Land price	Numerical variable estimated based on rent price data (2010–19)

standardized by group-mean centring beforehand to exclude differences among neighbourhoods from influencing the factors at level 1. The effects of contextual factors on the frequency of going out ("fixed parameters") and the variations in the frequency of going out between neighbourhoods ("random parameters") were estimated through multilevel logistic regression models (random intercept models). Descriptive statistics of variables and correlation matrixes of the individual- and neighbourhood-level factors are shown in Tables 2 and 3.

3. Results

The number of apartments rented in each neighbourhood unit of the study area (see Material and methods section) between 2010 and 2019 ranges from 0 to 1433 (mean value: 81). There are 349 neighbourhoods in which no apartments were rented during these years. The rental price ranges from 16,800 yen (about US$130) to 430,000 yen (about US $3300) per month, and the average monthly rent is 84,000 yen (about US$650). The room size ranges from 12.15 to 245.00 m^2 (average of 49.11 m^2), the floor level ranges from 0 (basement floor) to 41 (average of 2.55), and the apartment age ranges from 0 to 65 years (average of 20.81). The building structures are mainly wood (17%), steel (32%), or concrete (47%); the remaining 4% are made of other materials. Using these rent price data, the land prices were estimated for 881 neighbourhoods ($R^2 = 0.87$).

Of the 19,270 individuals, 76.4% reported that they went out four times or more per week and 23.6% went out less frequently (18.5% went out two or three times per week, 2.9% went out once per week, 1.9% went out one–three times per month, 0.2% went out several times per year, and 0.1% never went out). The explanatory variables of compositional and contextual factors are based on 19,270 target individuals living in 809 neighbourhoods. Table 3 presents the correlations among the variables used in the multilevel analysis, indicating that there is no considerable multicollinearity between them.

Table 2
. Descriptive statics of variables for multilevel logistic analysis.

Response variable	Frequency of going out (times/per week)	3 or less: 23.6%, 4 or more: 76.4%
Individual level factors (at level 1) *N* = 19,270	Sex	Female: 48.1%, Male: 51.9%
	Age	Mean: 73.3, Min: 65, Max: 101
	Length of residency	Mean: 31.9, Min: 0, Max: 92
	Educational experience	Mean: 3.28, Min: 1, Max: 5
	Number of family members	Mean: 2.41, Min: 1, Max: 12
	Houshold income	Mean: 4.85, Min: 0.35, Max: 15
	Household property	Mean: 4.63, Min: 1, Max: 6
	Housing type	Owned detached house: 65.4%, Owned condominium:22.5%, Rental detached house: 1.4%, Rental condominium: 3.9%, Public housing: 5.9%, Other types of housing: 0.9%
	Daily use of private car	No: 38.0%, Yes: 62.0%
Neighborhood level factors (at level 2) *N* = 809	Population density (10 thousand persons/km^2)	Mean: 1.01, Min: 0.01, Max: 2.73
	Ratio of land use type	Low residential area: 42.9%, Mid or high residential area: 37.2% Commercial area: 10.4%, Industrial area: 9.5%
	Expected catchment area density of parks (%)	Small park Mean: 116.8, Min: 0, Max: 556.8 Mid-size park Mean: 30.8, Min: 0, Max: 318.8 Large park Mean: 51.7, Min: 0, Max: 489.7
	Bus stop density (number/ha)	Mean: 73.3, Min: 65, Max: 101
	Distance from the nearest station (km)	Mean: 0.89, Min: 0.01, Max: 3.99
	Distance from central Tokyo business districts (km)	Mean: 14.8, Min: 26.4, Max: 44.0
	Land price (natural logarithm of yen)	Mean: −0.05, Min: −0.49, Max: 0.52

The results of multilevel analysis are presented in Table 4. If the odds ratios (ORs) are more than 1.00, it indicates positive relations between the response variable and the explanatory variables, while if the ORs are less than 1.00 on the contrary, it indicates negative relations. Model 1 is the NULL model, including no individual- or neighbourhood-level variables. The variance of random parameters between neighbourhoods is 0.041, which means that the random parameters of neighbourhoods contribute to 4.1% of the model determination. Model 2 includes only individual-level variables, indicating that large families, high income, abundant property, and access to a private car are positively related to the going-out frequency, while older adults become inclined to go out less as they get older. In addition, condominium housing has a greater positive relation to the going-out frequency than detached housing.

Model 3 includes only neighbourhood-level variables, except for land price. The model shows that the proportion of commercial area in the neighbourhood is positively related to the going-out frequency, while the proportion of industrial area in the neighbourhood has a negative relation with the going-out frequency. In this model, variables known as neighbourhood indicators associated with walkability, such as population density or access to public transport, do not exhibit a strong relation to older adults' going-out frequency. Model 4 includes only the land price, and suggests that land price has almost no relation to the frequency of going out.

Model 5 includes all neighbourhood variables (i.e. land price added to Model 3). In this model, population density, proportion of commercial area, and distance from the nearest train station have strong positive relations with the going-out frequency, which agrees with the known indicators of walkability identified through previous studies. Furthermore, land price, which shows no relation to the going-out frequency in Model 3, has a strong negative relation with going out in Model 5. Comparing the variance of random parameters between neighbourhoods in Model 1 (0.041) and Model 5 (0.018), 56.6% of the variance between neighbourhoods is explained by the neighbourhood-level variables. Model 6 is the FULL model, including all individual- and neighbourhood-level variables. Comparing Model 2 (with only individual-level variables) and Model 6, Akaike's information criterion is smaller in Model 6 than in Model 2 and the maximum log-likelihood is larger in Model 6 than in Model 2. This indicates that Model 6 is superior to Model 2 for explaining the older adults' going-out frequency. It proves that neighbourhood-level factors including land price are determinants of the going-out frequency. The results for Model 6 show that the negative relation between land price and going-out frequency (0.924 [0.879–0.970]) is stronger than that associated with distance from the nearest station (0.953 [0.912–0.995]).

4. Discussion

The results of individual-level variables suggest that the going-out frequency of older adults is highly related to their age and socioeconomic status including number of family members, household income, household property, housing type, and daily use of private car, which is consistent with previous knowledge (e.g. Adkins et al., 2017). In short, the younger or the richer a person is, he/she has more energy or options to go out frequently than others. Regarding the housing type, older adults living in rental houses tend to go out more frequently than those living in detached houses, and one possible explanation is that most detached houses are pertained by terraces or gardens, which more or less satisfies the desire to have outdoor physical activities so reduces the going-out frequency (Pattigrew et al., 2020). As to the number of family

Table 3
. Correlation matrixes of the individual- and neighbourhood-level factors.

Individual level factors, N = 19,270	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sex	1													
2. Age	0.06	1												
3. Length of residency	0.02	0.22	1											
4. Educational experience	0.15	−0.12	−0.04	1										
5. Number of family members	0.07	−0.02	0.08	−0.03	1									
6. Household income	0.04	−0.09	0.02	0.21	−0.11	1								
7. Household property	0.03	−0.03	0.18	0.22	0.08	0.39	1							
8. Owned detached house	0.01	0.08	0.38	0.02	0.18	0.08	0.30	1						
9. Owned condominium	0.02	−0.08	−0.19	0.05	−0.09	0.03	0.06	−0.70	1					
10. Rental detached house	−0.01	−0.01	−0.09	−0.04	−0.01	−0.05	−0.19	−0.21	−0.06	1				
11. Rental condominium	0.00	−0.03	−0.22	−0.04	−0.10	−0.06	−0.30	−0.29	−0.14	−0.03	1			
12. Public housing	−0.03	0.01	−0.13	−0.07	−0.09	−0.10	−0.28	−0.29	−0.18	−0.02	−0.09	1		
13. Other types of housing	−0.02	0.03	−0.06	−0.02	0.00	−0.04	−0.09	−0.15	−0.06	−0.01	−0.02	−0.03	1	
14. Daily use of private car	0.13	−0.17	0.08	0.08	0.11	0.11	0.16	0.16	−0.05	−0.02	−0.09	−0.11	−0.03	1

Neighbourhood level factors, N = 809	1	2	3	4	5	6	7	8	9	10	11	12
1. Population density	1											
2. Ratio of low residential area	−0.36	1										
3. Ratio of mid-high residential area	0.19	−0.57	1									
4. Ratio of commercial area	0.40	−0.47	−0.17	1								
5. Ratio of industrial area	−0.08	−0.36	−0.28	−0.05	1							
6. Expected catchment area of small park density	0.26	0.12	−0.03	0.04	−0.18	1						
7. Expected catchment area of mid-size park density	0.12	0.01	−0.02	0.04	−0.04	0.00	1					
8. Expected catchment area of large park density	−0.01	0.08	0.00	−0.05	−0.07	−0.07	0.08	1				
9. Bus stop density	0.27	−0.24	0.04	0.36	−0.04	0.09	0.09	0.05	1			
10. Distance from the nearest station	−0.42	0.29	−0.13	−0.31	0.04	−0.02	−0.04	−0.04	−0.05	1		
11. Distance from central Tokyo business districts	−0.33	0.16	−0.19	0.00	0.01	0.04	−0.06	−0.11	−0.03	0.29	1	
12. Land price	0.57	−0.33	0.04	0.40	0.07	0.00	0.26	0.15	0.23	−0.42	−0.29	1

members and the household income positively related to the going-out frequency, it could be interpreted as that the existence of housemates or maidservants increases time and opportunities of older adults to go out because they help to deal with household errands instead of older adults.

The results of neighbourhood-level variables, the focus of this study, indicate that land price has strong negative associations with older adults' going-out frequency, but the associations only appear when other neighbourhood-level factors that are known to contribute to the walkability of neighbourhoods, such as population density, proximity to the parks, ratio of commercial area, and distance from the nearest train station are included. Moreover, the strong positive associations of these walkability-associated factors with the going-out frequency only appear when land price is adjusted at the same time. This suggests that, to understand the associations between neighbourhood environment and older adults' going-out frequency correctly, land price should also be considered. Otherwise, the positive effects of these neighbourhood factors on the going-out frequency might be underestimated. The underestimation of environmental factors probably occurs because land price has positive correlations with walkability-associated factors such as population density, ratio of commercial area, and proximity to the nearest train station (see Table 3). Therefore, the positive relations between these walkability-associated factors and the going-out frequency are indirectly canceled by the negative effects of land price if the model is not adjusted to account for the land price.

One possible explanation for the negative associations between older adults' going-out frequency and land price is that higher land prices in a neighbourhood tend to increase the cost of going-out, which inhibits older adults from going out. Most going-out activities are accompanied by shopping, eating, or using other paid-for services. It is natural that the level of payment accords with the land price of the neighbourhood (Stroebel & Vavra, 2019), and hence the going-out frequency will be suppressed if a person cannot afford the payment. This supposition appears to be supported by the strong positive relations between the going-out frequency and household income (OR=1.172 [1.126–1.219]) and property (OR=1.090 [1.046–1.136]) illustrated in Table 4. This suggests that more affluent older adults are more willing to go out.

If the affluence of the family explains the tendency of older adults to become homebound in neighbourhoods with high land prices, it is reasonable to assume that the affluence of the family is commensurate with the land price of the neighbourhood. However, in the case of this study on suburban neighbourhoods of Tokyo, the land price of neighbourhoods is almost unrelated to the average household income or household property of older adults. This means that any neighbourhoods with high land prices include older adults with comparatively low economic status, and these are much more likely to become homebound. Hence, when inspecting the general health condition of neighbourhoods, land price could provide a strong indicator of the homebound status of older adults, and future plans or policies for retrofitting existing neighbourhoods should consider the provision of places that older adults can visit casually to promote their going-out frequency, especially in neighbourhoods with high land prices.

5. Conclusions

This study has tested the potency of land price as an indicator of the homebound tendency of neighbourhoods, focusing on the associations with older adults' going-out frequency in suburban neighbourhoods of Tokyo. The results show that land price has strong negative associations with older adults' going-out frequency, and found that positive associations between the going-out frequency and other environmental factors, including population density, proportion of commercial area, proximity to the nearby parks, and distance from the nearest train station, hardly appear if land price is not considered at the same time. These findings suggest that, when inspecting the tendency for older adults to become homebound in some neighbourhoods, factors associated with the built environment should be considered alongside local land prices. Furthermore, the homebound status of older adults presents

Table 4
. Estimated effects of individual and neighbourhood factors on the going-out frequency of older adults through multilevel analytical models.

Fixed parameters		Model1 OR (with 95%CI)	Model2 OR (with 95%CI)	Model3 OR (with 95%CI)	Model4 OR (with 95%CI)	Model5 OR (with 95%CI)	Model6 OR (with 95%CI)
	Intercept	3.255 *** (3.131–3.383)	3.390 *** (3.255–3.530)	3.256 *** (3.138–3.378)	3.255 *** (3.132–3.384)	3.256 *** (3.138–3.378)	3.399 *** (3.273–3.531)
Individual level factors	Sex		0.973 (0.940–1.008)				0.973 (0.940–1.008)
	Age		0.737 *** (0.712–0.764)				0.738 *** (0.712–0.764)
	Length of residency		1.030 (0.992–1.070)				1.030 (0.992–1.070)
	Educational experience		1.004 (0.970–1.040)				1.004 (0.970–1.040)
	Number of family members		1.053 *** (1.016–1.091)				1.053 *** (1.016–1.091)
	Houshold income		1.172 *** (1.126–1.219)				1.172 *** (1.126–1.219)
	Household property		1.090 *** (1.046–1.136)				1.090 *** (1.046–1.136)
	(Ref. Owned detached house)		1.000				1.000
	Owned condominium		1.065 *** (1.026–1.106)				1.066 *** (1.026–1.107)
	Rental detached house		1.009 (0.975–1.044)				1.009 (0.975–1.044)
	Rental condominium		1.044 ** (1.005–1.085)				1.044 ** (1.005–1.085)
	Public housing		1.047 ** (1.008–1.087)				1.047 ** (1.008–1.087)
	Other types of housing		1.001 (0.969–1.034)				1.001 (0.969–1.034)
	Daily use of private car		1.050 *** (1.014–1.088)				1.050 *** (1.014–1.088)
Neighborhood level factors	Population density			1.024 (0.976–1.074)		1.059 ** (1.006–1.115)	1.059 ** (1.004–1.116)
	(Ref. Ratio of low residential area)			1.000		1.000	1.000
	Ratio of mid or high residential area			1.018 (0.977–1.061)		1.013 (0.972–1.054)	1.014 (0.973–1.057)
	Ratio of commertial area			1.052 ** (1.008–1.099)		1.064 *** (1.019–1.111)	1.066 *** (1.020–1.114)
	Ratio of industrial area			0.969 * (0.933–1.006)		0.977 (0.941–1.014)	0.977 (0.940–1.015)
	Expected catchment area density of small park			1.019 (0.979–1.061)		1.012 (0.972–1.052)	1.012 (0.972–1.054)
	Expected catchment area density of midium park			1.009 (0.972–1.048)		1.022 (0.984–1.062)	1.022 (0.983–1.062)
	Expected catchment area density of large park			0.979 (0.944–1.016)		0.991 (0.956–1.029)	0.991 (0.954–1.029)
	Bus stop density			0.987 (0.949–1.027)		0.995 (0.956–1.035)	0.995 (0.955–1.036)
	Distance from the nearest station			0.968 (0.929–1.010)		0.955 ** (0.916–0.995)	0.953 ** (0.912–0.995)
	Distance from the central Tokyo business districts			0.974 (0.936–1.014)		0.976 (0.938–1.015)	0.975 (0.936–1.016)
	Land price				0.997 (0.959–1.035)	0.923 *** (0.880–0.969)	0.924 *** (0.879–0.970)
Random parameters	Neighborhoods ($N = 809$)	VAR. 0.041 S.D. 0.203	VAR. 0.049 S.D. 0.221	VAR. 0.025 S.D. 0.158	VAR. 0.041 S.D. 0.202	VAR. 0.018 S.D. 0.134	VAR. 0.024 S.D. 0.156
	AIC	21,035	20,521	21,026	21,037	21,018	20,504
	Maximum log likelihood	−10,516	−10,245	−10,501	−10,516	−10,496	−10,226

*** $P < 0.01$.
** $P < 0.05$.
* $P < 0.1$.

a pressing challenge, especially in neighbourhoods with high land prices. Therefore, the provision of places that older adults can visit casually is a possible response measure to promote their going-out frequency. For example, retrofit of existing parks according to older adults' needs and preferences seems comparatively easy to address (Levy-Storms et al., 2016), without drastically raising the land price of the neighbourhood (Glaesener & Caruso, 2015).

There are some limitations of the data used for the multilevel analyses in this study. The going-out frequency was surveyed through self-declarations, so the accuracy of the data could be improved by using more objective behavioural data of residents. In addition, this study used rent price data to estimate the land price level on the premise that the rent and the actual land price are sufficiently correlated that they can be substituted for each other. However, the use of actual land price data could provide further insights, so accessibility to such data is worth investigating. Moreover, it is likely that the tendency for older adults to go out has been greatly modified by the explosive spread of COVID-19, so comparisons of previous and current conditions are essential in ensuring the effectiveness of land price as a general health indicator of neighbourhoods, even in the age of the "new normal" lifestyle.

CRediT authorship contribution statement

KS mainly conducted statistical analyses and drafted the original manuscript. **KH and MH developed the analyses and contributed to the interpretation of the results. YA and KK** supervised the conduct of this study. **All authors** reviewed the manuscript draft and revised it critically on intellectual content. **All authors** approved the final version of the manuscript to be published.

Declaration of Competing Interest

We confirm that this manuscript has not been published elsewhere and is not under consideration in whole or in part by another journal. All authors have approved the manuscript and agree with submission to the *Archives of Gerontology and Geriatrics*. The authors have no conflicts of interest to declare.

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