

## Article

# Influence of the Built Environment on Older Adults' Travel Time: Evidence from the Nanjing Metropolitan Area, China

Jingrui Sun, Zhenjun Zhu \*, Ji Han, Zhanpeng He and Xinfang Xu

Department of Traffic Engineering, College of Automobile and Traffic Engineering, Nanjing Forestry University, No. 159 Longpan Road, Nanjing 210037, China

\* Correspondence: zhuzhenjun@njfu.edu.cn

**Abstract:** The built environment is among the critical factors in older adults' travel behavior, and a favorable built environment can encourage them to travel and engage in various activities. Existing studies have mostly focused on exploring the correlation between the built environment and travel behavior, ignoring the heterogeneity between the two at different times of the day. In this study, we conducted structured, face-to-face interviews in the Nanjing (China) metropolitan area to investigate the time consumed per trip by older adults using various travel modes and used the structural equation and random forest models to explore the relationship between the built environment and older adults' travel time. The results demonstrated that older adults had different perspectives on travel during different time periods. Different environments and the convenience of destinations affected their overall satisfaction during travel. We found a nonlinear relationship between the built environment and travel time. Metropolitan street connectivity initially had a positive effect on travel time until a certain threshold or peak, whereafter a gradual decline ensued. This nonlinear relationship also existed between the proportion of green space and the distance to subway stations. These results can guide the retrofitting and construction of age-friendly metropolitan infrastructure facilities that promote older adults' mobility.

**Keywords:** older adults; travel time; built environment; travel perception; age-friendly metropolitan



**Citation:** Sun, J.; Zhu, Z.; Han, J.; He, Z.; Xu, X. Influence of the Built Environment on Older Adults' Travel Time: Evidence from the Nanjing Metropolitan Area, China. *Land* **2023**, *12*, 1264. <https://doi.org/10.3390/land12061264>

Academic Editors: Thomas Panagopoulos and Rui Alexandre Castanho

Received: 27 March 2023

Revised: 9 June 2023

Accepted: 15 June 2023

Published: 20 June 2023



**Copyright:** © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

The aging of the human population is a global concern. According to the “2019 Revision of World Population Prospects”, one in six individuals globally will be 65 years old or older by 2050. The World Health Organization (WHO) has defined healthy aging as the process of maintaining functional ability to enable well-being at older ages [1,2]. The WHO, Member States, and Partners for Sustainable Development Goals created the “Global Strategy and Action Plan for Ageing and Health for 2016–2020” in continuation with the WHO program “The Decade of Healthy Ageing 2020–2030”. The WHO established main priorities, such as supporting country planning and action, collecting better global data, promoting research on healthy aging, aligning health systems to the needs of older people, laying the foundations and ensuring the human resources necessary for long-term integrated care, undertaking a global campaign to combat ageism, and enhancing the global network for age-friendly cities and communities.

China is among the 91 countries that have already entered the aging society period [3]. In the past 20 years in China, the proportion of individuals aged 60 years and older has significantly increased, from 10.3% to 18.9%. Estimated projections state that the proportion of older adults will reach 25% (487 million people) by 2050. Notably, the rapid growth of the aging population presents significant challenges for urban planners, transportation operators, and officials in developing and coordinating spatial strategies. Metropolitan areas are attracting migrating populations owing to the economic prosperity seen in these areas in recent years, promoting their gradual expansion and changes in the internal

spatial structure of cities. However, as adults age, their bodies grow weaker, and their mobility decreases considerably. Older adults perceive travel differently from the general population; moreover, they are less mobile relative to their younger counterparts [4]. Thus, older adults must be considered a special group in the current urban infrastructure development process. Consequently, older adults' unique and complex travel behavior must be considered when travel options and public urban spaces are developed. For example, the Chinese government has proposed improving the barrier-free travel service system to meet the transport needs of an aging society [5,6].

Older adults' travel behaviors are more sensitive to the effects of the built environment in their neighborhoods [7], as they are less likely to travel significant distances from their homes and require greater safety and convenience. The characteristics of the built environment, such as land-use density and diversity, street connectivity, proximity to public transportation services, and accessibility of important destinations, can significantly impact older adults' travel behaviors (which include the propensity to travel as well as the time and frequency of travel) [8]. Municipalities with more rapid or larger economic growth often have complex and dense built environments. Owing to older adults' sensitivity to comfort, the variation in the density of the built environment can significantly impact their travel behavior. Thus, metropolitan areas with high-density built environments can hinder the older population's travel plans and quality of life [9].

This study considered how the built environment, travel perceptions, and personal social attributes influence older adults' travel time. We defined travel time as the time needed for older adults to travel from their origin to their destination using various travel modes in order to complete each trip. An older adult was considered to have completed each trip when it took longer than 5 min. To reduce modeling complexity, this study did not delineate specific travel modes. These correlational analyses have been explored to some extent in previous studies [10,11]. However, with the growing population of older adults, there may be variability in the results of studies across regions, as the geography and economic levels of different cities in China vary greatly. In addition, previous studies have not clarified whether there are differences in the older adults' travel perceptions at different times of the day, and the impact of the built environment in urban high-density development areas on their travel behaviors must be studied further.

In this study, we explored the correlation between the urban built environment and older adults' travel behaviors using data from Nanjing, China. More specifically, the following two key questions were addressed (1) At different times of the day, do older adults have different perceptual preferences for the built environment when they travel? (2) Is there a linear or nonlinear relationship between various built environment factors and older adults' travel time? These questions are significant for improving older adults' travel experiences and increasing their sense of security. Meanwhile, the outcomes of this study can provide theoretical support for the layout of facilities near older adults' residences and the creation of a more suitable environment for retirement living.

The remaining part of this study is organized as follows. Section 2 presents a literature review, and Section 3 provides a description of the data and an explanation of the structural equation model (SEM) and the random forest model. Furthermore, Section 4 presents the results and provide a discussion, respectively. Section 5 proposes conclusion of the study. Section 6 concludes future work.

## 2. Literature Review

Several studies have focused on factors influencing older adults' travel behaviors, including the built environment, individual attributes, and psychological perceptions [10–12]. Curl et al. [13] demonstrated that older adults' personal preferences and social attributes lead to differences in their travel behaviors. Older adults' travel time decreased with age and becomes significantly limited in those aged over 75 years [14]. Older adults living alone have a lower propensity to travel than those living with their children [15,16]. Yanagihara [17] found that older adults with good physical health were more likely to drive to

their destinations. Zhang et al. [18] found that older adults' travel time was mainly related to the purpose of travel, with bicycles used for shorter travel times rather than walking.

Graham et al. [19] conducted in-depth interviews with older adults in a community and found that their main concern was safety; safer streets promoted their willingness to travel. Kahlert et al. [20] recruited older adults to simulate two different travel scenarios and demonstrated that the subjects walked more comfortably in scenarios with higher traffic safety and pedestrian-friendliness scores. The possibility of falling during travel increases with age, and safety risks associated with travel are important factors in the intention to travel [13,21]. Hino and Asami [22] used generalized linear mixed models to analyze the changing patterns of travel among citizens and demonstrated that older women's travel preferences were more influenced by the community environment and proximity to parks. Liu et al. used in-person structured interviews to analyze older adults' travel time and characteristics and used a random effects logit model to determine the association between neighborhood satisfaction and travel time. They concluded that interventions involving neighborhood environments were the most effective measures to promote travel in older adults [23].

The influence of the built environment's elements on travel continues to be actively studied. Hou et al. [24] discovered that the accessibility of leisure facilities significantly impacted older adults' travel mode choices; they found that the comfort and safety of transport services were also critical. Older adults living in suburban areas are less likely to travel [25]. Moreover, the number of parks, green-space occupancy, and streetscape environment directly impact older adults' travel behaviors [26–28]. Cheng et al. [29] found that land use had the most significant impact on older adults' travel behaviors and that its diversity in a community positively impacted their daily travel. Feng [30] observed that public transportation accessibility, distribution of vegetable markets, and open spaces are important factors influencing the travel behavior of older adults. High-quality public transport accessibility can encourage older adults to travel actively.

Studies have demonstrated that built environment elements and subjective psychological perceptions significantly impact older adults' travel behaviors [31]. Comfortable environments promote active travel among older adults. Travel time is an important indicator of perception and travel behavior [18,23]. It can also measure the intensity of physical activity in older adults [32]. The impact of the built environment on travel behavior can change over time [33,34]. Older adults' travel behaviors show variability at different times of the day; their mobility needs change at different departure times [35]. However, the factors that cause differences in older adults' travel behaviors at different times of the day must be further explored. Additionally, the relationship between travel time and the built environment has not been adequately investigated; a comprehensive analysis is required to develop a positive and effective environment that promotes older adults' travel.

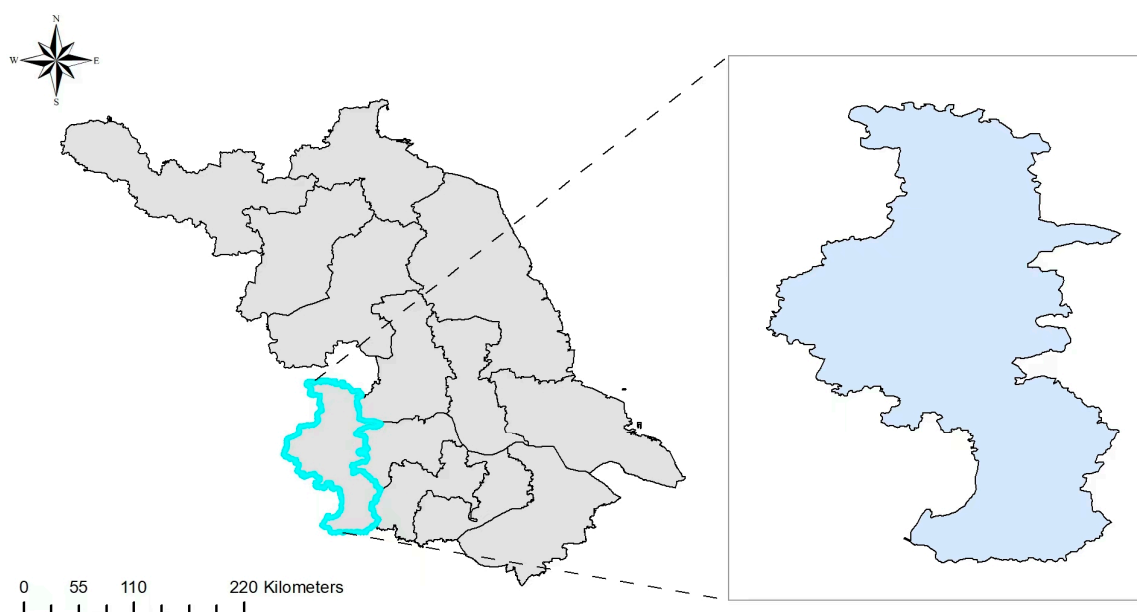
To address these problems, in this study, older adults' travel behaviors were comprehensively analyzed in the high-density built environment of a metropolitan area. The effect of the built environment was analyzed in different stages. First, considering older adults' subjective perceptions, the SEM was used to determine the variation in their perceptions of the built environment of megacities for different travel times; subsequently, important built environment factors in older adults' travel behaviors were identified. Second, the random forest model was used to explore the impacts of these factors on travel time and identify the complex patterns of variation in travel time, thereby revealing the impact of the complex, high-density built environment in a central urban area on travel time. The results provide insights into older adults' travel-related psychological needs and can help urban planners optimize age-friendly environments.

### 3. Materials and Methods

#### 3.1. Data

Nanjing is the only megacity in the Yangtze River Delta and is an important gateway city for the development of China's central and western regions, which is propelled by the

influence of the Yangtze River Delta. As the capital of Jiangsu Province in China, Nanjing has a significantly dense environment with a high population density. The location map of the survey area in Jiangsu Province is shown in Figure 1. In 2021, the city's resident population was 9,423,400 people, of whom more than 19% were over 60 years of age, representing a 0.38% increase from 2020 according to a travel survey conducted between 9 December 2021 and 15 January 2022 in Nanjing, China [36]. In this study, we chose three districts in Nanjing's main urban area that had a high proportion of older adults and diverse land use. The survey sites were mostly close to subway stations, parks, and riverside green spaces. Older adults in these areas typically earn high incomes and travel frequently, thus making it easier to observe the relationship between the built environment and travel time.



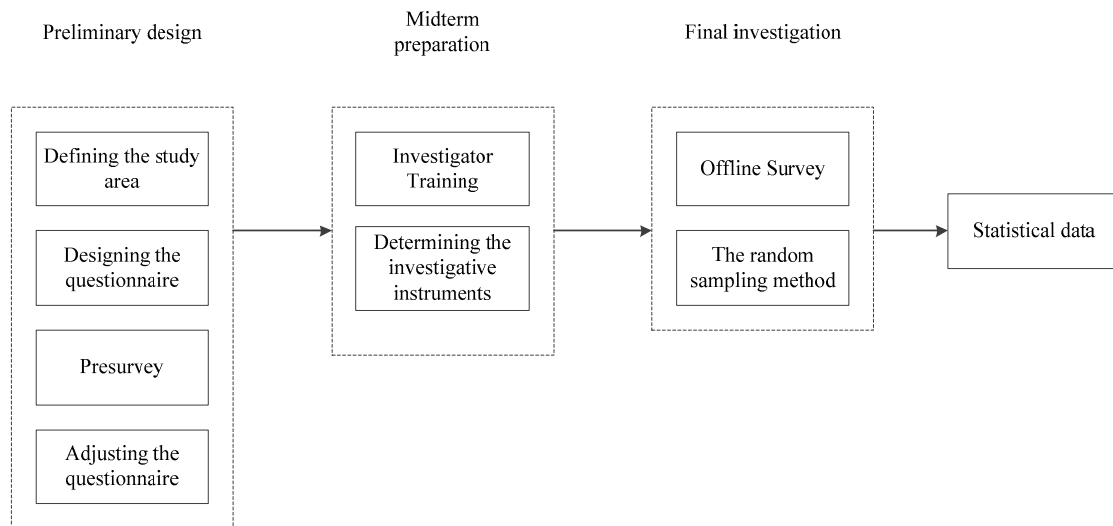
**Figure 1.** Map of the survey area of Nanjing.

The survey was available from 8:00 to 18:00. We randomly selected older adults for face-to-face structured interviews. The sample included individuals aged 60 years and above. The average response time for each survey respondent was 30 min. Specifically, the older adults were asked about their home locations, personal economic attributes, travel behavior, and psychological perception. The questions about travel behavior mainly addressed the origin and destination location, travel mode, travel purpose, travel time, and travel periods of each trip. ArcGIS software was used to calculate the data of the built environment in the area surrounding each respondent's home location and travel origination location.

Due to the potential difficulty that older adults might face when using smartphones, face-to-face structural interviews were conducted. To ensure the scientific validity of the survey results, 50 pre-survey questionnaires were distributed before the formal survey. We found that older adults required the assistance of enumerators to complete the questionnaire. The reliability and validity of the survey were determined via pilot tests, and questions were adjusted accordingly to create the final questionnaire. We conducted a survey using the final questionnaire to collect data from older adults. The survey process is shown in Figure 2.

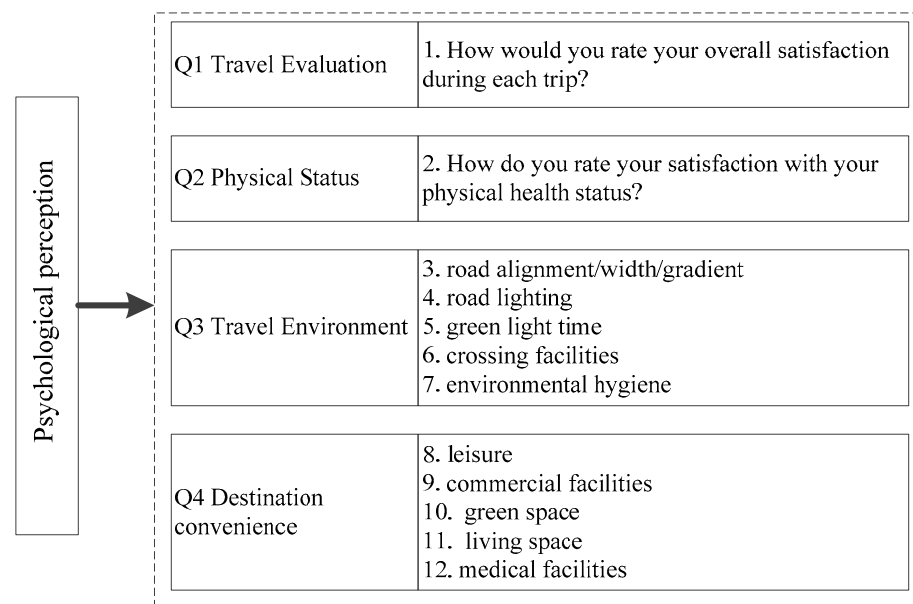
To explore the psychological perception of environmental factors by older adults at different travel times, the travel times of older adults were categorized as follows: before 6:00 (V13), 6:00–8:00 (V14), 8:00–12:00 (V15), 12:00–14:00 (V16), 14:00–16:00 (V17), 16:00–19:00 (V18), and after 19:00 (V19). On the basis of the literature review, several descriptive items were designed to describe the psychological perceptions of older adults

during travel in detail. For example, the “travel environment” factor was measured by five descriptive items: road alignment/width/gradient (V1), road lighting (V2), green light time (V3), crossing facilities (V4), and environmental hygiene (V5). The “destination convenience” factor was measured with five descriptive items: leisure (V6), commercial facilities (V7), green space, living space (V9), and medical facilities (V10). The life quality of older adults was assessed by “travel evaluation” and “physical status”.



**Figure 2.** Questionnaire design and travel survey process.

These factors involve professional concepts that many older adults may have difficulty understanding. Therefore, we designed several descriptive questions, which were used by the investigator to supplement the older adults’ understanding of the questions. A five-point Likert scale ranging from 1 (very unsatisfied) to 5 (very satisfied) was applied to quantify their satisfaction level. The travel environment factors and descriptive items of the questionnaire are shown in Figure 3.



**Figure 3.** Travel perception influencing factors and descriptive items.

A total of 550 questionnaires were distributed; after excluding invalid data, such as incomplete questionnaires and overly similar answers, 503 valid questionnaires were collected. This resulted in an efficiency rate of 91.5%. The final sample comprised 235 men

and 268 women. The frequency of walking for older adults was 52%, the frequency of using bicycles or electric bikes was 14%, the frequency of using public transportation was 33%, and the frequency of using cars was 1%. The profile of the older adults is summarized in Table 1.

**Table 1.** Individual economic attributes and travel behavior data.

Variable	Description	Mean	SD	
Individual economic attributes	Gender	Male = 1, female = 2	1.53	0.5
	Age	Age of the respondent (years)	72.25	7.94
	Income	Current monthly personal income (USD)	817.47	439.67
	Residential status	Solitary = 1,	2.27	0.706
		Living with partner = 2,		
		Living with children/grandchildren = 3		
	Educational level	Junior high school and below = 1,	2.04	1.029
		High school and secondary vocational school = 2,		
		Junior college = 3,		
	Pre-retirement work	Bachelor's degree = 4, Associate degree = 5,	4.49	2.145
Postgraduate degree = 6				
Farmer = 1,				
Worker = 2,				
Physical status	Company Staff = 3,	1.38	0.485	
	Government and institutional employee = 4,			
	Private and individual workers = 5,			
Travel behavior	Service workers = 6,	28.78	18.07	
	Educator = 7,			
	Science and technology, health care worker = 8			
	Have a chronic disease (Yes = 1, No = 2)			
	Car			
Travel time	The total amount of time for each trip (min)	28.21	11.39	
	Active travel (walking/cycling)	29.70	12.84	
	Public transportation	32.30	6.6	
	Car			

Table 2 summarizes the descriptive statistics of the built environment characteristics: distance to subway stations, population density, green space, street connectivity, and land use mix. The data were sourced from the Nanjing Urban GIS Database. These variables were determined on the basis of a review of relevant studies [26–30]. The land use mix was calculated using the following formula:

$$M_{\text{mix}} = - \left( \sum_{i=1}^n P_i \cdot \ln(P_i) \right) / \ln(n), \quad (1)$$

where  $P_i$  represents the proportion of the  $i$ th land use, and  $n$  refers to the number of land use types. On the basis of the literature review [37,38], the following five land use types were selected: residential, green space, commercial services, public administration, and others.

### 3.2. Methods

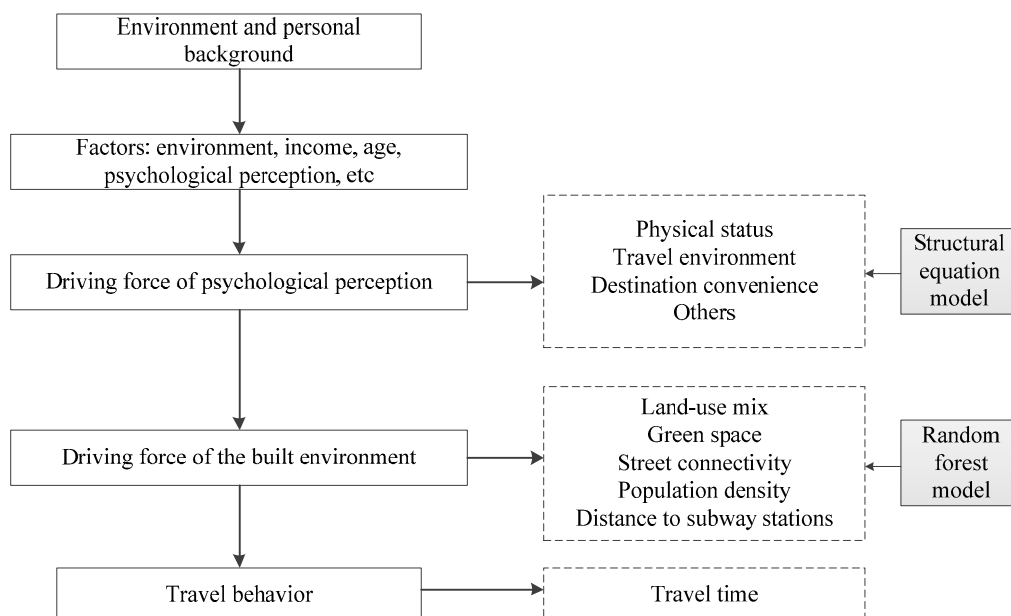
Analyzing older adults' travel requires a multidisciplinary approach involving the built environment, transportation, and behavioral science. It is important to consider older adults' psychological factors when analyzing the relationship between the built environment and travel time. Moreover, it is crucial to explore, in detail, how older adults' travel time changes when the variables of the built environment shift. To address these issues, this study combined the structural equation model (SEM) and the random forest model.

**Table 2.** Summary of the built environment data.

Variable	Description	Mean	SD
Distance to subway stations	Distance between the residence and subway stations (m)	808.25	472.45
Green space	Green area/total built area in a 500 m buffer zone (%)	0.29	0.17
Street connectivity	The total length of a street/total built area in a 1 km buffer zone (km/km <sup>2</sup> )	5.21	1.32
Land use mix	Land use diversity index measured by the equation in a 1 km buffer zone	0.60	0.19
Population density	Total residential population/total built area in a 1 km buffer zone (persons/1 km <sup>2</sup> )	18.85	4.19

The SEM can simultaneously model complex hypothetical relationships and calculate the fit measures between the hypothetical and observed models [39,40]. It can depict the relationship between personal, environmental, and psychological factors and has been widely applied across various domains. However, the relationship between the built environment and older adults’ travel behaviors is intricate, and the SEM cannot provide a detailed account of how changing environmental variables affect older adults’ travel time. The random forest model can measure the importance of each built environment variable and demonstrate the marginal effect of the independent variables. It can also reveal the linear or nonlinear relationships between the characteristics of the built environment and older adults’ travel time [41–44].

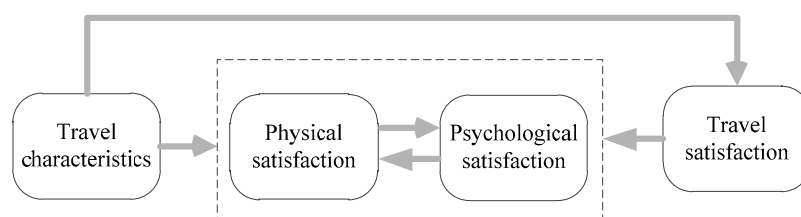
In this study, on the basis of the influence mechanism depicted in Figure 4, the effects of built environments on older adults were analyzed using a two-stage process. In the first stage, the SEM was used to explore older adults’ subjective perceptions of the travel environment and destination convenience at different travel time periods, through which older adults’ sensitivity to the travel environment could be demonstrated. In the second stage, the random forest model was used to accurately capture the effects of the built environment, the importance of each characteristic of the built environment, and the link between each characteristic and travel time.



**Figure 4.** A conceptual framework describing the impact mechanism of travel time.

### 3.2.1. Structural Equation Model

In the SEM, theoretical assumptions are verified using observable characteristics and the correlations between variables. This study considered the relationship between older adults' subjective perceptions during travel to explore whether psychological perception elements impacted travel. Therefore, it hypothesized that older adults' psychological perception elements during travel would affect their travel behaviors, which would impact their travel decisions [31]. Moreover, older adults' health status affects their psychological perceptions of travel. The hypothetical conceptual framework for the SEM is shown in Figure 5. Based on the aforementioned assumptions in constructing the model, the correlations between older adults' perceptual and travel features and feature parameters can be analyzed through the model operations.



**Figure 5.** Conceptual framework of SEM.

On the basis of the SEM theoretical framework, it was assumed that the environment affected older adults' perspectives of travel. After constructing and fitting the SEM, it is necessary to evaluate its goodness of fit. First, it is important to examine whether the model's estimated parameters are statistically significant, which requires performing significance tests on the path coefficients between variables, similar to parameter significance tests in regression analysis. The *t*-statistic and corresponding probability value (*p*-value) are used to determine whether a parameter is significantly effective when the *p*-value is less than the significance level. Thus, the model's overall goodness of fit is assessed. Because the SEM attempts to use statistical operation methods (such as least squares) to find the model parameters that minimize the difference between the sample variance–covariance matrix and the theoretical variance–covariance matrix, it is necessary to test the “gap” between the sample covariance and model covariance matrices to determine whether the fit meets certain requirements.

### 3.2.2. Random Forest Model

Considering the renewal of urban spaces and changes in the built environment, it was essential to observe the changing characteristics of older adults' travel time more intuitively. The SEM helped identify the significant factors in older adults' travel time, and further modeling was required to understand the complex patterns influencing travel time. Thus, this study employed a random forest model to analyze the association between the built environment and older adults' travel time.

The random forest model is an integrated learning algorithm that combines multiple decision trees to optimize model fitting and prediction and is widely used in the transportation sector. Each decision tree in a random forest is trained using a random sample with replacement, and each node feature variable in the tree is randomly selected. This algorithm improves the model's predictive performance by adjusting two parameters: the decision-tree number and the number of random variables. Random forest learning is highly accurate, good at managing higher-order relationships between variables, and effective in mining nonlinear relationships [45]. The working process of the random forest method is illustrated in Figure 6.

The algorithm comprises the following steps:

1. Randomly samples some training sets from the original dataset with replacement.
2. Constructs a decision tree for each training set and predicts the results.

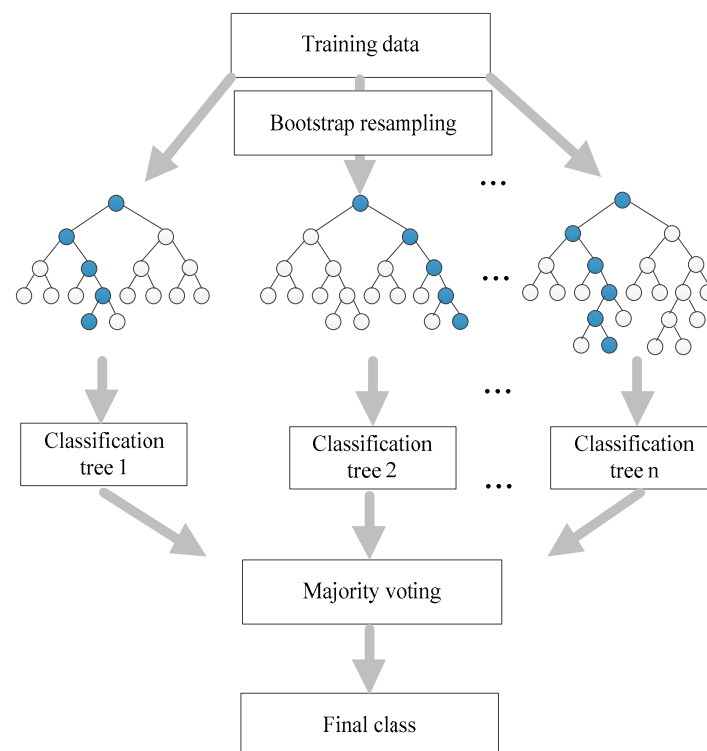


3. Using the voting method, the decision tree classification category with the most votes is the final category (non-weighted average method).

Let  $\{T(X; \theta_M), M = 1, 2, \dots, M\}$  be the  $M$  regression trees in RF; the RF regression results are expressed as follows:

$$\bar{T}(X) = \frac{1}{M} \sum_{m=1}^M \{T(X; \theta_M)\}, \quad (2)$$

where  $X$  is the independent variable and  $\theta_M$  is a random variable with independent identical distribution.



**Figure 6.** Illustration of the random forest method.

The root means square error (RMSE) and  $R^2$  are the primary indicators for evaluating a model's performance.  $R^2$  is the regression models' degree of fit to the out-of-bag (OOB) observations; a larger  $R^2$  value indicates a better fit. The RMSE is an indicator of the model's predictive capability for OOB observations. It is the square root of the ratio of the square of the deviation of the predicted value from the true value to the number of observations. A smaller RMSE indicates a higher predictive power for the regression model.

Additionally, random forests can quantify the relative importance of explanatory variables in predicting the outcomes, thereby enhancing the model's interpretation. The following expression is used to calculate the relative importance of variable  $X_i$ :

$$I_{X_i} = \frac{1}{M} \sum_{m=1}^M \left( M_{SE_{m, X_i}} - M_{SE_m} \right), \quad (3)$$

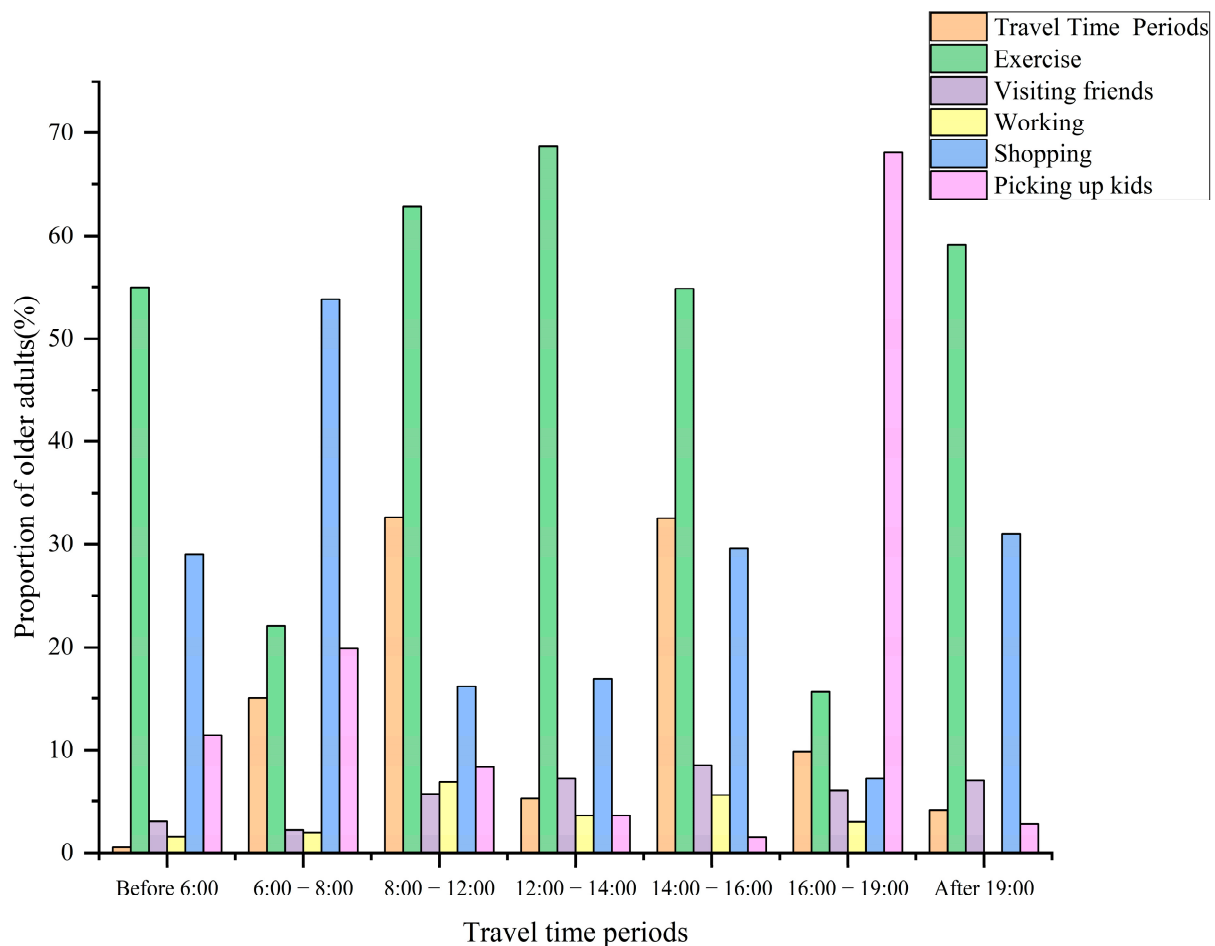
where  $I_{X_i}$  is the relative importance of the variable,  $X_i$ ;  $M_{SE_m}$  is the mean square error of the data outside the  $m$  bags of the trees; and  $M_{SE_{m, X_i}}$  is the mean square error of tree  $m$  after randomly rearranging the values of variable  $X_i$  in the OOB data.

## 4. Results and Discussion

### 4.1. Data Descriptive Results

In the valid sample, respondents made a total of 784 trips per day using various travel modes, with an average of 1.56 trips per person per day. On the basis of an analysis of their travel purposes, destinations were classified into the following five types: leisure and entertainment (e.g., nearby chess and card rooms), commercial shopping (e.g., commercial centers and supermarkets), maintenance (e.g., schools and food markets), medical treatment (e.g., hospitals and pharmacies), and green spaces (e.g., parks and riversides).

In Figure 7, the x-axis represents the travel period, the y-axis denotes the number of older adults, and the color of the bars indicates the purpose of travel. The following observations were made: the prominent peak features between 8:00–12:00 and 12:00–14:00 indicated that exercise was the main purpose of travel at these times. Before 12:00 p.m., older adults mainly traveled for shopping and exercising. Between 16:00 and 19:00, traveling mainly involved picking up their children from school. Older adults shopped during the hours of 6:00–8:00 and 14:00–16:00 to buy food and daily necessities, with their destinations mostly located near their places of residence.



**Figure 7.** Proportion of older adults per travel purpose and travel time period.

The statistical analysis revealed differences in older adults' behavioral characteristics concerning travel times and purposes. Consequently, the association between these factors in older adults' travel was thoroughly investigated using quantitative models.

### 4.2. Relative Importance of Explanatory Variables

In this study, we used the SEM to analyze older adults' travel times and travel satisfaction. The correlations between the model's endogenous variables and each observed

exogenous variable were demonstrated. The correlation coefficient between the exogenous variable of the environmental sanitation status and other variables was found to be less than 0.2, which was low; thus, other variables could substitute for those with lower correlation coefficients. By excluding the less-correlated variables and estimating the model to simplify it, standardized model-parameter estimates were obtained.

The goodness-of-fit indices, as shown in Table 3, included the  $\chi^2$ /degree of freedom (CMIN/DF), adjusted goodness-of-fit index (AGFI), comparative-fit index (CFI), root mean square error of approximation (RMSEA), and non-normed fit index (NNFI) with six indicators. The CMIN/DF = 3.419 < 5.000 indicated that the model met the requirements. The other indicators also met the requirements. Thus, the overall fit of the model was good.

**Table 3.** SEM model applicability.

Name	Judgment Criterion	Result
CMIN/DF	Better fit for <3; acceptable at 3–5	3.419
GFI	>0.9	0.930
AGFI	>0.8	0.901
RMSEA	<0.08	0.008
NNFI	>0.9	0.906
CFI	>0.9	0.900

Then, we constructed the random forest model in the R environment. The older adults' travel time dataset was randomly divided into training and testing subsets with a ratio of 70:30. Additionally, the model's important parameters were calibrated, including the number of trees in the model,  $n$ ; the maximum depth of the tree,  $d$ ; and the number of each partition variable,  $m$ . First, we used the number of trees (ranging from 10 to 1000) and the maximum depth of the trees (ranging from 10 to 1500) at intervals of 10. Second, we tested the best performance of the model using OOB errors. Finally, we obtained the best model performance at  $m = 5$ ,  $d = 1200$ , and  $n = 600$ . The reduction in RMSE was negligible when the model achieved optimal performance. At this point, the RMSE and pseudo  $R^2$  values were 30.20 and 0.325, respectively.

#### 4.3. Travel-Perception Analysis for Different Travel Times

Table 4 presents the path coefficients and significance levels, with the specific values for each path shown in Figure 8. When  $p < 0.05$ , the respective path relationship can be established. The  $p$ -values for most of the paths shown in Table 5 qualified and were thus sufficient to be used as a basis for determining valid path relationships.

Older adults' physical states did not significantly influence their choice to travel at different times. Older adults had sufficient leisure time due to retirement from work; their travel times differed from commuter groups and were mainly sensitive to the travel times of 12:00–14:00 and 16:00–19:00. It was previously discussed in this study that older individuals primarily traveled to exercise before 12:00.

Figure 8 demonstrates that older adults were more concerned with convenience in leisure and public places. Specifically, the influence of leisure and place of residence were the most significant. This is because the older adults' daily travel activities were primarily related to leisure and entertainment, daily-life activities, and shopping. More convenient travel from the place of residence to the destination result in higher travel satisfaction for older adults and a greater willingness to travel. Increased willingness to travel can lead to greater participation in travel and increase the chances of interaction with society through more travel, thereby increasing life satisfaction [46]. In particular, it is more helpful to increase the frequency and travel time of active travel to increase the well-being of older adults and enable them to avoid social isolation [47,48].

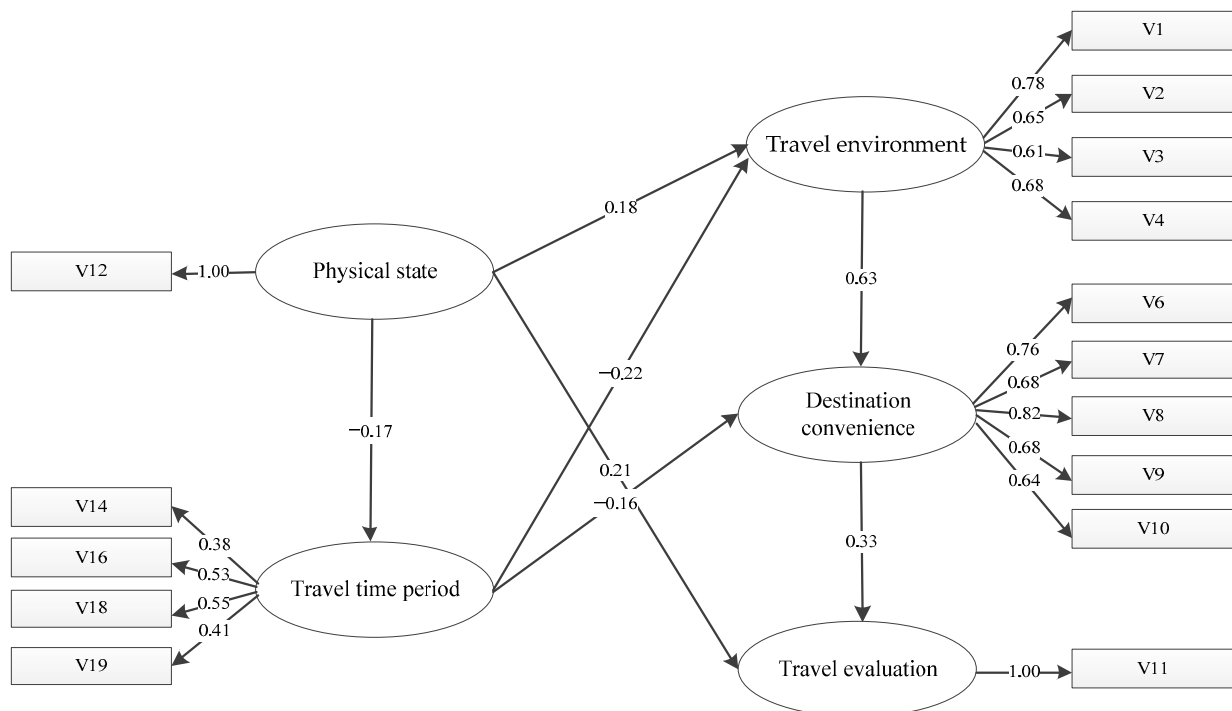
Furthermore, it has been observed that older adults' physical and psychological aging leads to a preference for traffic facilities. Streets with high traffic volumes and uneven

gradients tend to lower older adults' willingness to travel; older adults prefer to travel on streets that have better amenities and less traffic flow [49].

**Table 4.** Path coefficients of SEM and significance levels.

Model Path	Estimate	S.E.	C.R.	p
Travel times ← Physical status	−0.031	0.012	−2.562	0.010
Facility layout satisfaction ← Physical status	0.147	0.045	3.24	0.001
Facility layout satisfaction ← Travel times	−1.043	0.344	−3.032	0.002
Destination convenience satisfaction ← Facility-layout satisfaction	0.398	0.04	9.978	***
Destination convenience satisfaction ← Travel times	−0.487	0.197	−2.468	0.014
Travel evaluation ← Destination convenience satisfaction	0.47	0.067	7.006	***
Travel evaluation ← Physical status	0.165	0.033	5.022	***
V15 ← Travel times	1.464	0.278	5.274	***
V16 ← Travel times	1.944	0.398	4.881	***
V17 ← Travel times	1			
V18 ← Travel times	1.535	0.334	4.591	***
V12 ← Physical status	1			
V9 ← Destination convenience satisfaction	1			
V10 ← Destination convenience satisfaction	1.158	0.084	13.741	***
V7 ← Destination convenience satisfaction	1.143	0.075	15.289	***
V10 ← Destination convenience satisfaction	1.025	0.082	12.495	***
V6 ← Destination convenience satisfaction	1.09	0.077	14.24	***
V1 ← Facility layout satisfaction	1			
V2 ← Facility layout satisfaction	0.775	0.064	12.179	***
V3 ← Facility layout satisfaction	0.88	0.076	11.519	***
V4 ← Facility layout satisfaction	0.862	0.06	14.431	***
V11 ← Travel evaluation	1			

Note. \*\*\*  $p < 0.01$ .



**Figure 8.** SEM of older adults' travel times and travel perceptions.

**Table 5.** The relative importance of the explanatory variables.

	Variable	Relative Importance (%)	Total (%)
Built environment	Land use mix	9	72
	Green space	16	
	Street connectivity	22	
	Population density	10	
	Distance to subway stations	15	
Individual economic attributes	Age	9	28
	Gender	8	
	Education level	5	
	Income	6	
Total relative importance			100

The results obtained from the preliminarily SEM revealed older adults' travel perception of the travel environment and convenience of different destinations. Older adults' health statuses affected their perceptions of the travel process; furthermore, older adults were found to have various preferences for different travel times. Among these, road alignment/width/gradient and crossing facilities, with which older adults were more concerned, were closely related to street connectivity. The convenience of the destination was related to the characteristics of the built environment, such as the distance from the public transportation facilities and land use mix. The random forest model further refined and quantified the influence of the various characteristics of the built environment on travel time.

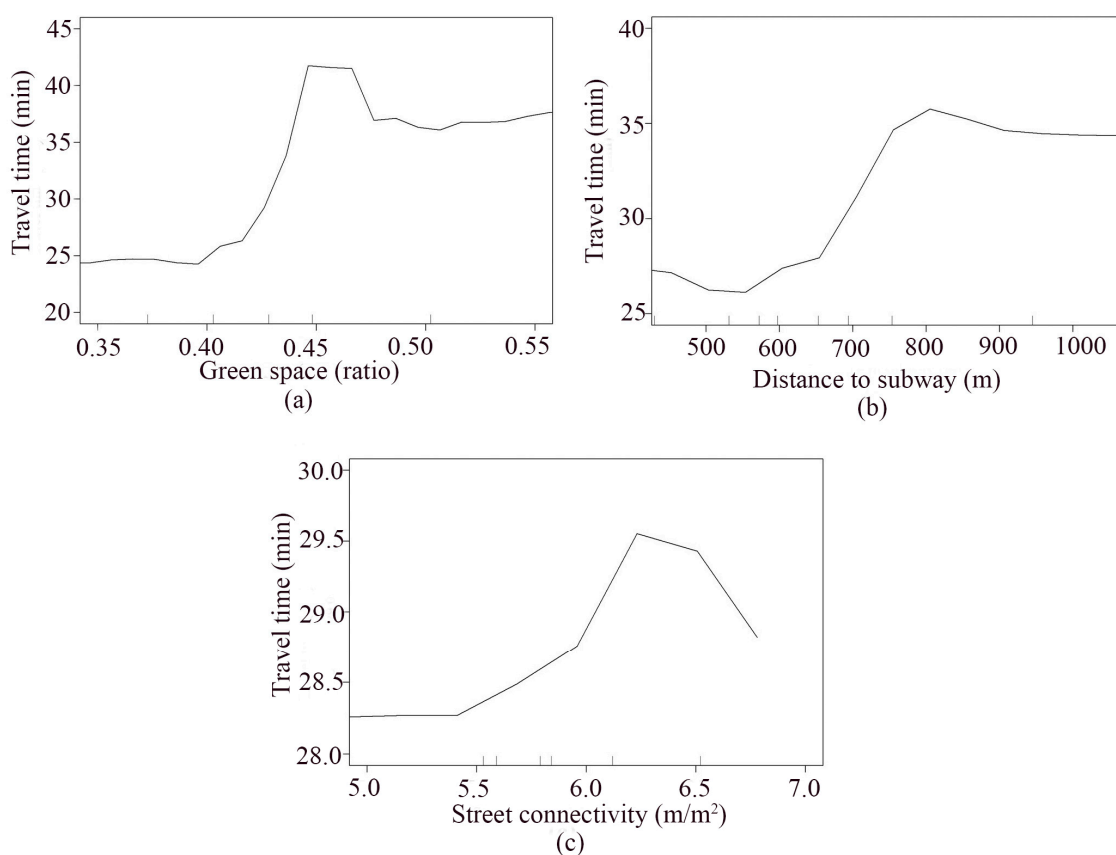
The differences in older adults' psychological perceptions of different travel periods were due to their different travel purposes. They were more likely to travel for leisure and exercise, and this was accompanied by a greater focus on the travel times of 12:00–14:00 and 16:00–19:00. Older adults' psychological perception of different environments showed that they had preferred needs during travel. Increased convenience from their place of residence to the travel destination contributed to the satisfaction of travel for older individuals, making them more inclined to actively travel. The results revealed that the layout of facilities and convenience of travel must be considered [40–43]. The differences in the perceptions of the layout of facilities and convenience during travel suggest that the built environment plays a key role. Therefore, this impact must be examined to ensure that subtle environmental interventions can influence older adults' travel. An analysis of the significant nonlinear impact of the built environment on traveling can help design more effective policies to promote traveling among older adults.

#### 4.4. Analysis of Constraints between the Built Environment and Travel Time

Certain socio-demographic variables and characteristics of the built environment, as shown in Table 1, have variance inflation factor (VIF) values of less than 5. Table 5 presents the relative importance of the explanatory variables in predicting travel times among older adults. This represents the relative improvement in reducing the prediction error. Analyzing the explanatory variables in Table 1 revealed that the collective contribution of the characteristics of the built environment was higher than that of the individual economic attributes. The results verified that the characteristics of the built environment had a more significant effect on older adults' travel time and that improvements in the built environment played a key role in promoting their travel. In addition, further analysis of the results on relative importance revealed that the importance of travel for older adults varied widely across different characteristics of the built environment. Street connectivity was the most important attribute (22%), followed by green space and distance to subway stations, with a nonsignificant attribute of more than 10%. Although population density and land use mix presented less predictive power, they still ranked higher than individual economic attributes. Among the personal economic attributes, age was the most important

variable affecting travel time, accounting for 9% of total relative importance. By contrast, education level had the lowest effect, accounting for only 5% of total relative importance.

The relationships between the subset of the built environment characteristics and economic attributes with high relative importance (more than 10%) and older adults' travel times were further analyzed (Figure 9). The x-axis of each graph represents the data distribution of the density changes for each built environment variable, while the y-axis represents travel time. Figure 9a demonstrates the nonlinear effect of green spaces on travel time after controlling for all other explanatory variables. The proportion of green spaces, ranging from 0.3905 to 0.4399, had a positive monotonic effect on travel time. This effect gradually increased until it reaches a critical value of the green space proportion, and then started to decrease. Green spaces help make travel more enjoyable, as fresh air alleviates bad moods and stress. A larger green space around residences results in a stronger willingness to travel in older adults. Additionally, older adults travel mostly for physical exercise and recreation; thus, an increased number of green spaces can encourage them to travel with friends and strengthen their relationships. However, when the proportion of green spaces exceeded 0.4729, there was a slight negative impact on older adults' travel time, which may have been due to the excessive green area, low density of the road network, and distance to transportation facilities, which are not suitable for certain older adults whose physical abilities limit long travel times.



**Figure 9.** Nonlinear associations between the built environment and travel time.

Previous studies have concluded that metropolitan green spaces play a significant role in promoting travel among older adults [50], with areas featuring more green spaces encouraging active travel [51,52]. Green spaces offer fresh air and a relaxing environment [53], and amenities such as parks are often equipped with public service equipment for visitors. Consequently, green spaces positively affect older adults' travel habits, particularly for pedestrians, who typically walk to their destinations along pathways lined with greenery. However, this study found that when the green space proportion exceeded a certain upper

limit (0.4399), older adults' travel time showed no increase; rather, it stabilized after a small decrease. This suggests that a greater amount of green space in the area surrounding a place of residence is not necessarily better and that there is a strong correlation between older adults' travel habits and the green space proportion.

When green space is limited, better destination accessibility, a more balanced distribution of facilities, and a higher density of the road network in the area around the residences of older adults can help them reach their destinations with shorter travel times. By contrast, larger proportions of green space in urban spaces do not have a significantly positive influence on older adults' travel time [54]. Owing to older adults' declining physical function, a greater proportion of green space implies that the distribution of regional living, medical, and commercial places in the neighborhood is more dispersed. In such a scenario, older adults spend a significant amount of time and physical energy traveling to their intended destinations and exercising [55]; thus, they generally do not wish to extend their travel time.

The distance to subway stations exhibited a positive correlation with older adults' travel time when the distance was less than 800 m (Figure 9b). Older adults who travel by subway usually travel long distances, and they are willing to choose it as a travel mode when the distance to the subway station is within an acceptable range. When subway stations are closer to the place of residence, the convenience of public transportation is higher. Older adults always walk to public transportation stops, which is made easier by the higher accessibility of these stops.

The distance to a subway station played a moderate role, corroborating the findings of prior research, such as that by Lin et al. [56] indicating that the distance from a starting point to a station affected older adults' access to subway stations. Notably, the number of public transportation stations has a threshold effect on travel time. As the distance increased to 550 m, the travel time substantially increased. This may be due to the fact that older adults usually walk to the stations; however, older adults kept moving for a long time as the distance increased, and they needed to rest or slow down their travel speed in the middle of the trip, which led to a sharp increase in travel time.

Subsequently, the curve became nearly horizontal (with 800 m as the cut-off point). Having subway stations closer to a community led to a better distribution of public service facilities around the community, making it easier for older adults to access subway stations. However, this sustained contribution was effective only within an 800 m radius. Beyond this range, older adults faced increased travel time to reach stations, discouraging them from choosing to travel via subway.

Additionally, this longer distance taxes their physical strength, compromises their travel safety, and ultimately diminishes their willingness to use the subway. In such a scenario, older adults are more likely to choose destinations near their residences, resulting in reduced reliance on the subway and shorter travel times. They may also choose to travel long distances with the assistance of their children (e.g., by car), which reduces travel time.

As shown in Figure 9c, older adults' travel time increased with street connectivity. The curve demonstrates that the relationship between street density and travel time increased up to a point and decreased thereafter. In low-density areas, an increase in street density promoted travel by older adults. Considering a street density of 6.12 (km/km<sup>2</sup>) as the cut-off point, a linear relationship was observed between street density and travel time when the density was lower than this value. By contrast, when the density was higher than the aforementioned value, the street density had a limiting effect on travel time. This may be because older individuals travel using more routes and can choose shorter distances to reach destinations, thus reducing travel time.

A higher number of routes signifies enhanced access to destinations. Prior research showed that older adults generally preferred walking as their primary travel mode [49]. In metropolitan areas, more vehicles travel on primary and secondary roads, which can pose risks to older pedestrians. A dense street network suggests an increased availability of pedestrian paths, fostering a greater willingness to travel and, consequently, longer travel

times. In addition, we found evidence supporting the positive impact of street density on older adults' travel times, contrasting with the results of previous studies [57].

Street connectivity and travel maintain a positive relationship until a certain threshold in street connectivity is reached, whereafter the relationship becomes negative [58,59]. This may be attributed to older adults' declining cognitive function, the high density of the built environment of metropolitan areas, and the excessive road network, which may complicate their travel [60]. Older adults tend to select familiar routes, and their travel times do not significantly fluctuate. This insight is crucial for designing metropolitan streets that facilitate older adults' travel.

## 5. Conclusions

This study was divided into two phases to investigate the effect of built environment on older adults' travel time. In the first stage, structural equation modeling explored the psychological perceptions of older adults for different travel periods. In the second stage, a random forest model was used to observe the nonlinear relationship between the built environment and the older adults' travel time. The model for each of the two phases showed that older adults' perceived sensitivity to different transport facilities was indicative of their more important needs during travel. The layout of facilities and the accessibility of destinations should be considered when building age-friendly communities [61–64]. The differences in perceptions of facility layout and convenience between travel periods suggested that the built environment has a significant impact. Secondly, there was a nonlinear relationship between the factors of the built environment and the travel times of the older adults. When the value of the built environment factors reached a specific threshold, the travel time of older adults showed a small decreasing trend.

## 6. Future Studies

This study has certain limitations in terms of the methods, survey size, and other factors. (1) The random forest model can return outputs (parameters), such as the feature importance, but it cannot demonstrate the relationship between each variable and the model decisions. However, boosting tree models, such as the gradient-boosting decision tree (GBDT) and extreme gradient boosting (XGBoost), are increasingly favored by scholars due to their advantages of adjustable parameters, fast operation speed, and high accuracy [65,66]. (2) Data from urban developments of similar scales can be used to test the generalizability of the results and validate the model's accuracy. Using the road network as a basis for defining the service area for older adults' travel and collecting built environment data could make future studies more accurate. (3) This study explored the factors that influence the travel time of older adults. However, there is variability in the travel time of older adults using different travel modes. The association between travel time and the built environment for different travel modes needs to be considered.

Future research can address the limitations of the study through the following aspects. (1) model interpretation tools such as Shapley additive explanation (SHAP) may be considered. This would address the limitations of the random forest model and provide insights into the extent to which each variable contributes to the model output and how it affects the model's decisions. (2) We can continue to expand the case area of the survey. More data on built environment factors can be obtained by delineating travel services on the basis of the road network where older adults live. Exploring the interaction between metropolitan street quality (such as safety, comfort, etc.) and older adults' travel times could provide valuable insights. The visualization of built environment metrics also makes it possible to clearly observe the correlation with travel time. (3) Exploring the correlation between environmental elements of different travel modes and older adults' travel times. Researchers can accompany older adults during their travels and collect GPS data. Such GPS data could help investigate older adults' travel preferences.



**Author Contributions:** Conceptualization, J.S., Z.Z. and J.H.; methodology, J.S. and J.H.; software, J.S., J.H. and X.X.; validation, Z.Z., J.H. and Z.H.; data curation, Z.Z.; writing—original draft preparation, J.S., Z.H. and X.X.; funding acquisition, Z.Z. and J.S. All authors have read and agreed to the published version of the manuscript.

**Funding:** This work was funded by the Scientific Research Foundation for Advanced Talents of Nanjing Forestry University, grant number 163106041; the general program of the Natural Science Foundation of the Jiangsu Higher Education Institutions of China, grant number 20KJB580013; the General Project of Philosophy and Social Science Foundation of the Jiangsu Higher Education Institutions of China, funding number 2020SJA0125; the Postgraduate Research and Practice Innovation Program of Jiangsu Province, grant number KYCX21\_0887.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not application.

**Acknowledgments:** Authors would like to acknowledge the anonymous reviewers for their constructive comments.

**Conflicts of Interest:** The authors declare that they have no conflict of interest.

## References

1. Michel, J.P.; Sadana, R. “Healthy Aging” concepts and measures. *J. Am. Med. Dir. Assoc.* **2017**, *18*, 460–464. [CrossRef] [PubMed]
2. Fallon, C.K.; Karlawish, J. Is the WHO definition of health aging well? Frameworks for “Health” after three score and ten. *Am. J. Public Health* **2019**, *109*, 1104–1106. [CrossRef] [PubMed]
3. World Population Prospects 2019: Highlights. Available online: <https://www.un.org/development/desa/publications/world-population-prospects-2019-highlights.html> (accessed on 17 June 2019).
4. Zhou, Y.; Yuan, Q.; Ding, F.Y.; Chen, M.Y.; Yang, C.; Guo, T.Y. Demand, mobility, and constraints: Exploring travel behaviors and mode choices of older adults using a facility-based framework. *J. Transp. Geogr.* **2022**, *102*, 103368. [CrossRef]
5. The State Council Issued the Outline for the Construction of A Strong Transportation Country. Available online: [http://www.gov.cn/zhengce/2019-09/19/content\\_5431432.htm](http://www.gov.cn/zhengce/2019-09/19/content_5431432.htm) (accessed on 19 September 2019).
6. The State Council Issued Outline of the National Comprehensive Three-Dimensional Transportation Network Plan. Available online: [http://www.gov.cn/gongbao/content/2021/content\\_5593440.htm](http://www.gov.cn/gongbao/content/2021/content_5593440.htm) (accessed on 20 October 2021).
7. Van Hoof, J.; Marston, H.R.; Kazak, J.K.; Buffel, T. Ten questions concerning age-friendly cities and communities and the built environment. *Build. Environ.* **2021**, *199*, 107922. [CrossRef]
8. Zhu, P.Y.; Wang, K.L.; Ho, S.N.; Tan, X.Y. How is commute mode choice related to built environment in a high-density urban context? *Cities* **2023**, *134*, 104180. [CrossRef]
9. Cerin, E.; Sit, C.H.P.; Barnett, A.; Johnston, J.M.; Cheung, M.C.; Chan, W.M. Ageing in an ultra-dense metropolis: Perceived neighbourhood characteristics and utilitarian walking in Hong Kong elders. *Public Health Nutr.* **2014**, *17*, 225–232. [CrossRef] [PubMed]
10. Yang, Y.J.; Sasaki, K.K.; Cheng, L.; Tao, S. Does the built environment matter for active travel among older adults: Insights from Chiba City, Japan. *J. Transp. Geogr.* **2022**, *101*, 103338. [CrossRef]
11. Yang, H.; Ruan, Z.H.; Li, W.S.; Zhu, H.J.; Zhao, J.; Peng, J.D. The impact of built environment factors on elderly people’s mobility characteristics by metro system considering spatial heterogeneity. *ISPRS Int. J. Geoinf.* **2022**, *11*, 315. [CrossRef]
12. Kim, J.; Schmocker, J.D.; Nakamura, T.; Uno, N.; Iwamoto, T. Integrated impacts of public transport travel and travel satisfaction on quality of life of older people. *Transp. Res. Part A Policy Pract.* **2020**, *138*, 15–27. [CrossRef]
13. Curl, A.; Fitt, H.; Tomintz, M. Experiences of the built environment, falls and fear of falling outdoors among older adults: An exploratory study and future directions. *Int. J. Environ. Res. Public Health* **2020**, *17*, 1224. [CrossRef]
14. Hou, Y.T.; Moogoor, A.; Dieterich, A.; Song, S.Q.; Yuen, B. Exploring built environment correlates of older adults’ walking travel from lifelogging images. *Transp. Res. D Transp. Environ.* **2021**, *96*, 102850. [CrossRef]
15. Domenech-Abella, J.; Mundo, J.; Leonardi, M.; Chatterji, S.; Tobiasz-Adamczyk, B.; Koskinen, S.; Ayuso-Mateos, J.L.; Haro, J.M.; Olaya, B. Loneliness and depression among older European adults: The role of perceived neighborhood built environment. *Health Place* **2020**, *62*, 102280. [CrossRef]
16. Whiting, S.; Mendes, R.; Abu-Omar, K.; Gelius, P.; Crispo, A.; McColl, K.; Simmonds, P.; Fedkina, N.; Andreasyan, D.; Gahraman, H.; et al. Physical inactivity in nine European and Central Asian countries: An analysis of national population-based survey results. *Eur. J. Public Health* **2021**, *31*, 846–853. [CrossRef] [PubMed]
17. Yanagihara, T. Travel behavior and IADL evaluation of elderly people. *J. Transp. Health* **2015**, *2*, S75. [CrossRef]
18. Zhang, S.; Zhang, K.; Liu, X.Y.; Zeng, J.; Liu, Y.; Zhao, L. Characterisation of elderly daily travel behaviour in Tianjin using a space-time cube. *Environ. Plan B Urban Anal. City Sci.* **2022**, *49*, 603–618.

19. Graham, H.; de Bell, S.; Flemming, K.; Sowden, A.; White, P.; Wright, K. Older people's experiences of everyday travel in the urban environment: A thematic synthesis of qualitative studies in the United Kingdom. *Ageing Soc.* **2020**, *40*, 842–868. [CrossRef]
20. Kahlert, D.; Schlicht, W. Older people's perceptions of pedestrian friendliness and traffic safety: An experiment using computer-simulated walking environments. *Int. J. Environ. Res. Public Health* **2015**, *12*, 10066–10078. [CrossRef]
21. Nordbakke, S.T.D. Out-of-home activity participation and needs fulfilment in later life. *Int. J. Environ. Res. Public Health* **2019**, *16*, 5109. [CrossRef]
22. Hino, K.; Asami, Y. Change in walking steps and association with built environments during the COVID-19 state of emergency: A longitudinal comparison with the first half of 2019 in Yokohama, Japan. *Health Place* **2021**, *16*, 102544. [CrossRef]
23. Liu, Z.Y.; Kemperman, A.; Timmermans, H. Correlates of older adults' walking trip duration. *J. Transp. Health* **2020**, *18*, 100889. [CrossRef]
24. Hou, Y.T.; Yap, W.; Chua, R.; Song, S.Q.; Yuen, B. The associations between older adults' daily travel pattern and objective and perceived built environment: A Study of three neighbourhoods in Singapore. *Transp. Policy* **2020**, *99*, 314–328. [CrossRef]
25. Golant, S.M. Stop bashing the suburbs: Mobility limitations of older residents are less relevant as connectivity options expand. *J. Aging. Stud.* **2019**, *50*, 100793. [CrossRef] [PubMed]
26. Yang, L.C.; Liu, J.X.; Lu, Y.; Ao, Y.B.; Guo, Y.Y.; Huang, W.C.; Zhao, R.; Wang, R.Y. Global and local associations between urban greenery and travel propensity of older adults in Hong Kong. *Sustain. Cities Soc.* **2020**, *63*, 102442. [CrossRef]
27. Zandieh, R.; Martinez, J.; Flacke, J.; Jones, P.; van Maarseveen, M. Older adults' outdoor walking: Inequalities in neighbourhood safety, pedestrian infrastructure and aesthetics. *Int. J. Environ. Res. Public Health* **2016**, *13*, 1179. [CrossRef] [PubMed]
28. Hanson, H.M.; Schiller, C.; Winters, M.; Sims-Gould, J.; Clarke, P.; Curran, E.; Donaldson, M.G.; Pitman, B.; Scott, V.; McKay, H.A.; et al. Concept mapping applied to the intersection between older adults' outdoor walking and the built and social environments. *Prev. Med.* **2013**, *57*, 785–791. [CrossRef]
29. Cheng, L.; Chen, X.W.; Yang, S.; Cao, Z.; De Vos, J.; Witlox, F. Active travel for active ageing in China: The role of built environment. *J. Transp. Geogr.* **2019**, *76*, 142–152. [CrossRef]
30. Feng, J.X. The influence of built environment on travel behavior of the elderly in urban China. *Transp. Res. D Transp. Environ.* **2017**, *52*, 619–633. [CrossRef]
31. Zhang, F.; Li, D. Multiple linear regression-structural equation modeling based development of the integrated model of perceived neighborhood environment and quality of life of community-dwelling older adults: A cross-sectional study in Nanjing, China. *Int. J. Environ. Res. Public Health* **2019**, *16*, 4933. [CrossRef]
32. Recommended Levels of Physical Activity for Adults Aged 65 and above. Available online: <https://www.who.int/publications/i/item/9789241599979> (accessed on 30 October 2022).
33. Zhou, M.; Wang, D.G.; Guan, X.D. Co-evolution of the built environment and travel behaviour in Shenzhen, China. *Transp. Res. D Transp. Environ.* **2022**, *107*, 103291. [CrossRef]
34. Gordon, C.J.; Comas, M.; Postnova, S.; Miller, C.B.; Roy, D.; Bartlett, D.J.; Grunstein, R.R. The effect of consecutive transmeridian flights on alertness, sleep-wake cycles and sleepiness: A case study. *Chronobiol. Int.* **2018**, *35*, 1471–1480. [CrossRef]
35. He, S.Y.; Cheung, Y.N.H.Y.; Tao, S. Travel mobility and social participation among older people in a transit metropolis: A socio-spatial-temporal perspective. *Transp. Res. A Policy Pract.* **2018**, *118*, 608–626. [CrossRef]
36. Nanjing's Ageing Population Continues to Grow. Available online: [http://tjj.nanjing.gov.cn/tjxx/202205/t20220505\\_3358775.html](http://tjj.nanjing.gov.cn/tjxx/202205/t20220505_3358775.html) (accessed on 5 May 2022).
37. Yang, Y.J.; Cheng, L.; Liu, X.W. Gender differences in active travel among older adults: Non-linear built environment insights. *Transp. Res D Transp. Environ.* **2022**, *110*, 103405. [CrossRef]
38. Zang, P.; Lu, Y.; Ma, J.; Xie, B.; Wang, R.Y.; Liu, Y. Disentangling residential self-selection from impacts of built environment characteristics on travel behaviors for older adults. *Soc. Sci. Med.* **2019**, *238*, 112515. [CrossRef] [PubMed]
39. He, Y.S.; Thøgersen, J.; Cheung, H.Y.Y.; Yu, H.Y.A. Ageing in a transit-oriented city: Satisfaction with transport, social inclusion and wellbeing. *Transp. Policy* **2020**, *97*, 85–94. [CrossRef]
40. Wang, Z.; Zhang, H.; Yang, X.L.; Li, G.X. Neighborhood streets as places of older adults' active travel and social interaction—A study in Daokou ancient town. *J. Transp. Health* **2022**, *24*, 101309. [CrossRef]
41. Liu, J.X.; Wang, B.; Xiao, L.Z. Non-linear associations between built environment and active travel for working and shopping: An extreme gradient boosting approach. *J. Transp. Geogr.* **2021**, *92*, 103034. [CrossRef]
42. Wu, J.N.; Zhao, C.L.; Li, C.Y.; Wang, T.; Wang, L.J.; Zhang, Y. Non-linear relationships between the built environment and walking frequency among older adults in Zhongshan, China. *Front. Public Health* **2021**, *9*, 686144. [CrossRef]
43. Wang, W.; Zhang, Y.; Zhao, C.; Liu, X.; Chen, X.; Li, C.; Wang, T.; Wu, J.; Wang, L. Nonlinear associations of the built environment with cycling frequency among older adults in Zhongshan, China. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10723. [CrossRef]
44. Wang, L.; Zhao, C.; Liu, X.; Chen, X.; Li, C.; Wang, T.; Wu, J.; Zhang, Y. Non-linear effects of the built environment and social environment on bus use among older adults in China: An application of the XGBoost model. *Int. J. Environ. Res. Public Health* **2021**, *18*, 9592. [CrossRef]
45. Cheng, L.; Jin, T.H.; Wang, K.L.; Lee, Y.S.; Witlox, F. Promoting the integrated use of bikeshare and metro: A focus on the nonlinearity of built environment effects. *MULTRA* **2022**, *1*, 100004. [CrossRef]
46. Bai, X.; Hung, K.; Lai, D.W.L. The role of travel in enhancing life satisfaction among Chinese older adults in Hong Kong. *Ageing Soc.* **2017**, *37*, 1824–1848. [CrossRef]

47. Zhang, F.Y.; Loo, B.P.Y.; Wang, B. Aging in place: From the neighborhood environment, sense of community, to life satisfaction. *Ann. Am. Assoc. Geogr.* **2022**, *112*, 1484–1499. [[CrossRef](#)]
48. McMullan, I.I.; Bunting, B.P.; Burns, A.; Smith, L.; Cunningham, C.; O’Sullivan, R.; Blackburn, N.E.; Wilson, J.J.; Tully, M.A. Is physical activity associated with loneliness or social isolation in older adults? Results of a longitudinal analysis using the Irish longitudinal study on ageing. *J. Aging Phys. Act.* **2021**, *29*, 562–572. [[CrossRef](#)] [[PubMed](#)]
49. Yang, C.M.; Tang, X.L.; Yang, L.C. Spatially varying associations between the built environment and older adults’ propensity to walk. *Front. Public Health* **2022**, *10*, 1003791. [[CrossRef](#)]
50. Pratiwi, P.I.; Xiang, Q.Y.; Furuya, K. Physiological and psychological effects of walking in urban parks and its imagery in different seasons in middle-aged and older adults: Evidence from Matsudo city, Japan. *Sustainability* **2020**, *12*, 4003. [[CrossRef](#)]
51. Astell-Burt, T.; Feng, X.Q.; Kolt, G.S. Green space is associated with walking and moderate-to-vigorous physical activity (MVPA) in middle-to-older-aged adults: Findings from 203,883 Australians in the 45 and up study. *Br. J. Sports Med.* **2014**, *48*, 5. [[CrossRef](#)]
52. Zhang, Y.; He, Q.; Wu, W.; Li, C.Y. Public transport use among the urban and rural elderly in China: Effects of personal, attitudinal, household, social-environment and built-environment factors. *J. Transp. Land Use* **2018**, *11*, 701–719. [[CrossRef](#)]
53. Grigoletto, A.; Loi, A.; Latessa, P.M.; Marini, S.; Rinaldo, N.; Gualdi-Russo, E.; Zaccagni, L.; Toselli, S. Physical activity behavior, motivation and active commuting: Relationships with the use of green spaces in Italy. *Int. J. Environ. Res. Public Health* **2022**, *19*, 9248. [[CrossRef](#)]
54. Zhang, W.T.; Gao, Y.X.; Li, S.; Liu, W.P.; Zeng, C.; Gao, L.; Li, M.X.; Peng, C. Accessibility measurements for urban parks considering age-grouped walkers? Sectorial travel behavior and built environment. *Urban For. Urban Green* **2022**, *76*, 127715. [[CrossRef](#)]
55. Hui, L.C.; Jim, C.Y. Unraveling visiting-activity patterns of heterogeneous communities for urban-park planning and design. *Forests* **2022**, *13*, 841. [[CrossRef](#)]
56. Lin, T.; Xia, J.H.; Robinson, T.P.; Goulias, K.G.; Church, R.L.; Oлару, D.; Tapin, J.; Han, R.L. Spatial analysis of access to and accessibility surrounding train stations: A case study of accessibility for the elderly in Perth, western Australia. *J. Transp. Geogr.* **2014**, *39*, 111–120. [[CrossRef](#)]
57. Laatikainen, T.E.; Haybatollahi, M.; Kytta, M. Environmental, individual and personal goal influences on older adults’ walking in the Helsinki metropolitan area. *Int. J. Environ. Res. Public Health* **2019**, *16*, 58. [[CrossRef](#)]
58. Zang, P.; Qiu, H.L.; Xian, F.; Zhou, X.; Ma, S.F.; Zhao, Y.B. Research on the difference between recreational walking and transport walking among the elderly in mega cities with different density zones: The case of Guangzhou city. *Front. Public Health* **2021**, *9*, 775103. [[CrossRef](#)] [[PubMed](#)]
59. Boakye-Dankwa, E.; Barnett, A.; Pachana, N.A.; Turrell, G.; Cerin, E. Associations between latent classes of perceived neighborhood destination accessibility and walking behaviors in older adults of a low-density and a high-density city. *J. Aging Phys. Act.* **2019**, *27*, 553–564. [[CrossRef](#)]
60. Mifsud, D.; Attard, M.; Ison, S. An exploratory study of the psychological determinants of mobility of older people in Malta. *Res. Transp. Bus. Manag.* **2019**, *30*, 100373. [[CrossRef](#)]
61. Moran, M.; Van-Cauwenberg, J.; Hercky-Linnewiel, R.; Cerin, E.; Deforche, B.; Plaut, P. Understanding the relationships between the physical environment and physical activity in older adults: A systematic review of qualitative studies. *Int. J. Behav. Nutr. Phys. Act.* **2014**, *11*, 79. [[CrossRef](#)]
62. Van-Cauwenberg, J.; Nathan, A.; Barnett, A.; Barnett, D.W.; Cerin, E. Relationships between neighborhood physical environmental attributes and older adults’ leisure-time physical activity: A systematic review and meta-analysis. *Br. J. Sports Med.* **2018**, *48*, 1635–1660. [[CrossRef](#)]
63. Cao, Y.X.; Heng, C.K.; Fung, J.C. Using walk-along interviews to identify environmental factors influencing older adults’ out-of-home behaviors in a high-rise, high-density neighborhood. *Int. J. Environ. Res. Public Health* **2019**, *16*, 4251. [[CrossRef](#)] [[PubMed](#)]
64. Van-Cauwenberg, J.; Van Holle, V.; Simons, D.; Deridder, R.; Clarys, P.; Goubert, L.; Nasar, J.; Salmon, J.; De Bourdeaudhuij, I.; Deforche, B. Environmental factors influencing older adults’ walking for transportation: A study using walk-along interviews. *Int. J. Behav. Nutr. Phys. Act.* **2012**, *9*, 85. [[CrossRef](#)]
65. Ding, C.; Cao, X.Y.; Wang, Y.P. Synergistic effects of the built environment and commuting programs on commute mode choice. *Transp. Res. Part A Policy Pract.* **2018**, *118*, 104–118. [[CrossRef](#)]
66. Lundberg, S.M.; Lee, S.I. A Unified Approach to Interpreting Model Predictions. In Proceedings of the 31st Annual Conference on Neural Information Processing Systems (NIPS), Long Beach, CA, USA, 4–9 December 2017.

**Disclaimer/Publisher’s Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.