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# Study on the Impact of the Objective Characteristics and Subjective Perception of the Built Environment on Residents' Physical Activities in Fuzhou, China

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**Abstract:** Many researchers have confirmed a correlation between the built environment and physical activity. However, most studies are based on the objective characteristics of the built environment, and seldom involve the residents' subjective perception. The purpose of this study is to explore the relationship between the subjective and objective characteristics of the built environment and physical activity at the community scale. Data consists of that collected from a social survey, Points of Interest (POI), the road network, and land use in Fuzhou, China. The duration of moderate-to-vigorous physical activity (MVPA) within a week is used to represent the general physical activity of residents. Security perception is introduced as an intermediary variable. SPSS software is used for factor analysis and Amos software for statistical analysis. Structural equations are set up to analyse the relationship between these variables. The final results show that: (1) The objective characteristics of the built environment have no direct impact on the development of leisure MVPA, but it can indirectly affect leisure MVPA through residents' subjective perception of the built environment; (2) The subjective perception of residents has a significant impact on the duration of MVPA, the subjective perception of humanized space has a direct impact on the duration of MVPA, and destination accessibility and urban environment maintenance has an indirect impact through community public security perception; and (3) The individuals' attributes such as gender and self-evaluated socioeconomic status have negative effects on the duration of leisure MVPA, and an individual's love of sports has a positive effect on MVPA.

**Keywords:** moderate-to-vigorous physical activity; built environment; objective characteristics; subjective perception; structural equation modelling

## 1. Introduction

Since entering the 20th century, new health problems have arisen due to the deterioration of the environment and changes in lifestyle. In particular, many chronic diseases have been on the rise in recent years [1]. The World Health Organization identified ten threats to human health in 2019, one of which was noncommunicable diseases. Lack of exercise was one of the five main factors for the growing severity of these diseases. Studies have shown that regular physical exercise and reducing excessive overtime were effective ways to reduce chronic diseases such as obesity and diabetes, and thus to promote the health of the population [2,3]. As an administrative means, urban planning can create a human settlement environment to support physical activities by optimizing urban space and using active intervention policies.

Research of international physical activity promotion through the built environment began in the 1960s [4]. Jane published a book, *The Death and Life of Great American Cities*, which is one of the most famous works in the field of urban planning [5]. Since then, relevant research has continued to this day. Stokols published a paper in which a social ecology model was used to consider the impact of the environment on physical activity [6]. On the premise of controlling sociodemographic variables, Frank et al. made an in-depth study on the relationship between objectively measured sports activities and the physical environment around the home of each participant [7]. Among the numerous research results exploring the relationship between physical activity and physical environment factors, the project *Environment Strategy and AC Active Life Policy* (Alpes) established by San Diego State University in the United States was the most remarkable. These results had a very good role in promoting human physical activity. The social ecological model was an important theoretical basis for later research of the relationship between the two.

For measurement of the urban built-up environment, most research has been based on the 5D aspects of Density, Diversity, Design, Destination, and Distance [8,9]. Karmeniemi et al. conducted 21 cohort studies and 30 natural experiments, and found that objective measurements, public transport accessibility and land-use mixing could promote physical activity [10]. At the same time, subjective aesthetic perception and sense of security also had an impact on physical activity. Sallis et al. found that park density, public transport density, and MVPA were significantly positively correlated with the number of residents in 14 cities around the world [11]. In Australian studies, a mixed increase in land use resulted in an almost 1.33-fold increase in walking trips [12]. Walking communities in Baltimore and Atlanta also had a positive impact on the duration of MVPA [13,14].

Subjective perception of the built environment was mainly based on respondents' perception of the environment considering their responses to questionnaires and scales, mostly involving accessibility, aesthetic perception, security, satisfaction and convenience. Subjective aesthetic perception and safety perception had an influence on physical activity [10]. Humpel et al. found that destination accessibility and aesthetic attributes had a significant impact on physical activity, while climate and sense of security had a relatively weak impact [15]. Other researchers have shown that community environments that are good and with high green coverage and good public order can promote daily physical activity [16–18]. The accessibility of commercial and recreational places and the beauty of the environment are more conducive to walking [19]. However, in most of the current studies, the subjective perception factors of the built environment have not been taken seriously [20,21].

Other studies show that road accessibility, space usage rate and degree of mixed functions of the built environment are significantly correlated with a sense of residential safety [22]. It can be seen that the mediating variable effect of security perception also needs to be paid attention to in the research. Urban safety covers two aspects: objective criminal activities and subjective safety perception [23]. In 42.7%, 10.1%, and 47.2% of the studies, the residents' safety perception had significant positive, significant negative, and no significant impact on physical activity, respectively [24]. Foster et al. found that an individual's subjective perception of social order and fear of their own safety were also important factors affecting MVPA [23]. Vojnovic's research based in Michigan showed that shorter distances from destinations, and perception of safer and more attractive street views, can improve physical activity [25].

Research shows that the objective characteristics and subjective perception of the built environment have significant effects on physical activity [10]. However, little research has been done on the relationship between subjective perception and objective characteristics and their impact on physical activity [26]. Gebel et al. found that subjective perception and objective indicators did not align for one third of the population, but the relationship between the two was not clear [27]. It is also necessary to continue to verify whether objective characteristics affect the length of physical activity through subjective perception.

At the same time, physical activity is also affected by the self-selection effect of individual physiological attributes such as age, gender, physical condition and social and economic attributes

such as income. In South Carolina, United States, two county-level case studies have been conducted, showing that young and middle-aged Afro-American women with better self-health perception and higher social comprehensive score have more active physical activity [28], and that the relationship between intersection density and MVPA was positive in females, but not in males [29]. Men's perception of community environmental safety was negatively correlated with their walking trips. The opposite was true for women [30]. Low-income respondents tend to participate in transportation activities, while high-income people tend to engage in recreational activities [31].

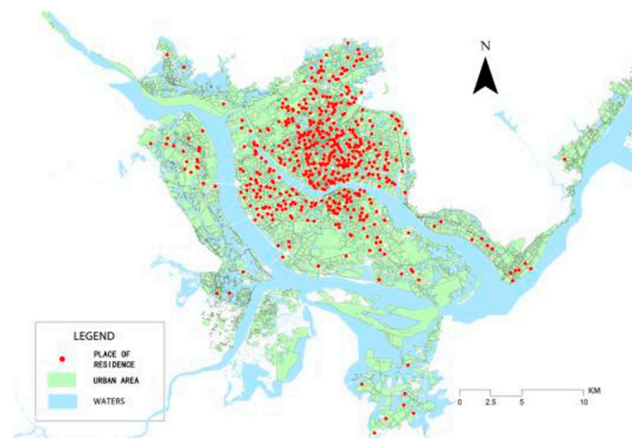
Western developed countries have done a lot of research on the objective characteristics and subjective perception of the built environment to promote physical activity. However, from the research content, there are few studies on the integration of objective characteristics and subjective perception that affect physical activity. Because empirical studies on the impact of the built environment and physical activity in China are more concentrated on ultra-large cities such as Beijing and Shanghai, and limited attention has been paid to the remaining types of cities, the universality of the research conclusions in China remains to be discussed. For the current study, Fuzhou was chosen as the research object to explore the mechanism between the objective characteristics, subjective perception, and safety perception of the built environment and physical activity. This study collected a variety of geographic data such as social survey data, spatial interest points, road traffic network, and land use properties in the central urban area of Fuzhou. The leisure type of moderate-to-vigorous physical activity (MVPA) with the main purpose of physical exercise was the index used to evaluate the physical activity of residents. At the community scale, a structural model method was used to explore the relationship between the objective characteristics, the subjective perception, the destination accessibility, the maintenance of the urban environment, safety perception, and MVPA.

## 2. Data Sources, Variable Analysis, and Model Construction

### 2.1. Data Sources

The city of this study is Fuzhou. Fuzhou is located on the southeast coast of China and it is the capital of Fujian Province. Fuzhou has a history of more than 2200 years. Fuzhou has a typical subtropical monsoon climate; the temperature is suitable, warm, and humid, with evergreen seasons. The data of this study are mainly from social survey data collected in the central city of Fuzhou from June to August 2017. This survey included MVPA, environmental perception, and individual characteristics of residents. The measurement range of the variables was unified within a buffer zone of 500 m from the residential area, i.e., the activity range of residents for 15 min. At the same time, it avoided the uncertainty of geographical background and controlled individual attributes. A total of 2000 questionnaires were sent out and 1712 were recovered. After eliminating the questionnaires lacking major information such as family address and environmental assessment, 1308 valid samples were obtained to provide the basic database of this study. After manual inquiry and coordinate correction, the spatial locations of the respondents' residences were obtained (Figure 1).

In order to measure the objective characteristics of the built environment, the study also uses the data of the Fuzhou traffic road network and land use status in 2016, as well as all the spatial points of interest (POI) of the city in a map website of that year. Referring to the classification standard of urban construction land (GB50137-2011), POI was classified into 16 types according to functions, namely administrative office (A1), cultural facilities (A2), educational and scientific research (A3), sports (A4), medical and health (A5), social welfare, cultural relics, and religions (A6, A7, A9), commercial facilities (B1), business facilities (B2), recreation and sports (B3), business outlets of public facilities and other service facilities (B4, B9), Green Plaza (G), industry (M), residence (R), transportation facilities (S), public facilities (U), logistics warehousing (W).



**Figure 1.** Spatial distribution of survey samples.

## 2.2. Variable Analysis

The selection of variables is based on existing theory and research and combined with the research questions. Specific types of physical activity play an important role in studying the relationship between the environment and physical activity [32]. Different types of physical activity are often affected by different building environment attributes. Traffic-type physical activity may be related to destination and infrastructure related to walking and driving [33], and family-type physical activity may be mostly related to housework behaviour. For the measurement of physical activity, the public health field primarily considers the intensity and total amount of physical activity [34]. Therefore, in this study, the duration of MVPA within a week in the community for the purpose of physical activity was chosen as the research object.

In this study, four latent variables were proposed. These are the built environment's humanized space characteristics, subjective perception of the built environment's humanized space, subjective perception of destination accessibility, and urban environment maintenance. When evaluating the objective characteristics of the built environment, the observed variables were selected according to the 5D framework. The density of POI was used to evaluate the compactness of economic and social activities, the ratio of sports facility POIs (exercise places, parks, green spaces, etc.) was used to reflect the number of facilities, and the entropy index of POI of 16 types of urban land was used to reflect the diversity of urban functions, and the closer the coefficient was to 1, the more mixed the land was. Road network density reflects the accessibility of road design. When evaluating subjective perception, the explanatory variables were also selected according to the 5D framework. The subjective perception of POI density, ratio of sports facility POIs, and POI entropy index in the buffer ring of 500 m around the community were extracted from the questionnaire information of the respondents. In addition, related variables were further introduced. The subjective perception of destination accessibility was evaluated from the convenience of public transport and the convenience of shopping facilities. The maintenance of the urban environment was evaluated from four aspects of greening rate, environmental cleanliness, facility aesthetics, and community illumination.

SPSS software was used for exploratory factor analysis of variables. The factor load matrix after orthogonal rotation is shown in Table 1.

In the structural equation, the intermediate variables of environmental security were added to study the interaction between variables. At the same time, the study controlled the following variables, including gender, age, socioeconomic status and level of love for sports (Table 2).

**Table 1.** Factor loading matrix after orthogonal rotation.

Observed Variables	Extract Components			
	1	2	3	4
Road Network Density		0.626		
Entropy Index of POI Type		0.565		
POI Density		0.835		
Ratio of Sports Facility POIs		0.833		
Entropy Index of Subjective POI Type			0.829	
Subjective POI Density			0.813	
Ratio of Subjective Sports Facility POIs			0.856	
Subjective Convenience of Public Transportation				0.853
Subjective Convenience of Shopping Facilities				0.884
Environment Cleanliness	0.781			
Subjective Coverage Ratio	0.788			
Beauty Degree of Sketch	0.790			
Community Illuminance	0.757			

POI: points of interest.

**Table 2.** Measurement of Variables.

Latent Variable	Index Variable	Measurement Method	Mean Value	Standard Deviation
Physical Activity	MVPA	The duration of leisure MVPA in the community within a week; Unit: hours	3.04	8.99
Humanized Space Characteristic	Entropy Index of POI Type	$EI = \sum Si \times \ln(1/Si)$ , 'Si' is the proportion of class 'i' POI amongst the total POI.	2.08	0.30
	POI Density	Unit area POI number in buffer zone; Unit: per square metre.	0.05	0.04
	Ratio of Sports Facility POIs	POI ratio of sports places and green plazas in buffer zone.	5.73	6.85
	Road Network Density	Total length of road per unit area in buffer zone; Unit: km/km <sup>2</sup> .	11.02	3.18
Subjective Perception of Humanized Space	Entropy Index of Subjective POI Type	$EI = \sum Si \times \ln(1/Si)$ , 'Si' is the proportion of class I POI amongst the total POI in the buffer.	0.44	0.08
	Subjective POI Density	The number of POI per unit area in the buffer zone mentioned in the questionnaire; Unit: per square metre.	16.16	7.87
	Ratio of Subjective Sports Facility POIs	The ratio of POI of sports venues and green squares was mentioned in the questionnaire.	1.00	0.98
Subjective Perception of Destination Accessibility	Subjective Convenience of Public Transportation	very dissatisfied = 1 to very satisfied = 10	7.30	2.06
	Subjective Convenience of shopping facilities	ditto	7.60	1.96

Table 2. Cont.

Latent Variable	Index Variable	Measurement Method	Mean Value	Standard Deviation
Urban Environmental Maintenance	Environment Cleanliness	Very unclean = 1 to very clean = 4	2.78	0.71
	Subjective Green Coverage Ratio	Poor shading effect = 1 to good shading effect = 4	2.59	0.78
	Beauty Degree of Sketch	Very ugly and messy = 1 to very beautiful and harmonious = 4	2.71	0.73
	Community Illuminance	Very dull = 1 to very bright = 4	2.61	0.76
Sense of Security	Public Security Perception	Very dissatisfied = 1 to very satisfied = 10	6.82	2.18
Control Variable	Gender	Dummy Variable: female = 1, male = 0	0.39	0.49
	Age	Unit: year	31.32	9.04
	Social Stratum Self-evaluation	5-point scale: Uppermost layer = 5 to bottom layer = 1	2.45	0.90
	Love for Sports	4-point scale: Very fond = 4 to very loathsome = 1	2.79	0.74

2.3. Structural Equation Model

In this study, there are many factors affecting residents’ physical activity. While objective characteristics and subjective perception have an effect on the duration of leisure MVPA, there may be a correlation between them. This paper used a structural equation model to explore the influence mechanism among variables. After selecting the variable system, the sample database of variables was established in SPSS 17.0 and imported into AMOS 24.0 for structural equation analysis. Because latent variables need to be introduced in this study, the direct, indirect, and overall effects among variables were analyzed by using the latent variable path analysis method (Figure 2).

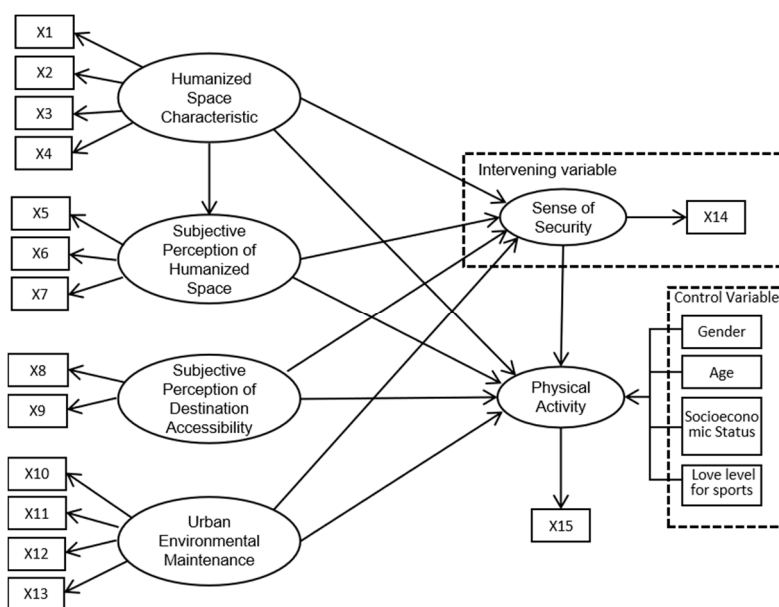


Figure 2. Structural Equation Model Setting.

Firstly, the structural equation modelling is established to study the relationship among humanized space characteristics, subjective perception of humanized space, subjective perception of destination accessibility, urban environmental maintenance and MVPA. Then, the intermediary variable of security perception is introduced and another new structural equation model is established to explore the relationship between the variables.

### 3. Result Analysis

#### 3.1. Influence of Objective Characteristics and Subjective Perception of the Built Environment on the Duration of Leisure MVPA in the Community within a Week

Model 1 directly studies the relationship among the characteristics of humanized space, the subjective perception of humanized space, the subjective perception of destination accessibility, the urban environmental maintenance, and the duration of leisure MVPA in the community within a week (Figure 3).

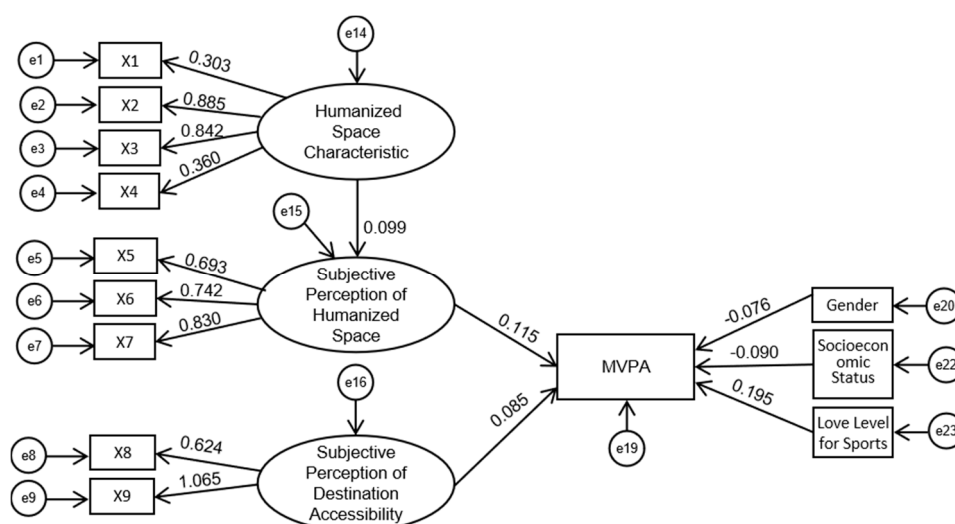


Figure 3. Structure Model 1: Standardized Path Coefficient Diagram.

The chi square degree of freedom (CMIN/DF) of the model was 9.898, which is relatively large. However, because chi square is closely related to the sample size, the root mean square of approximate error (RMSEA) is the primary index of good fitting quality when considering the number of samples used in this study. The smaller the RMSEA value, the better the model fit. Generally speaking, RMSEA less than 0.08 was an acceptable model, less than 0.05 was a better model, and less than 0.01 was a perfect model [35]. The RMSEA value of this model was 0.060, less than 0.08, and close to 0.05. The goodness-of-fit index of the structural equation model shows that the causal model can be accepted. The model results show that there is no direct correlation between the impact of the built environment humanized spatial characteristics on the duration of MVPA. This shows that the residents' leisure MVPA in the community is not directly affected by the objective characteristics of the built environment. This may be because Fuzhou is located in the eastern part of China with a high population density. The city is basically a development mode of relative agglomeration. The density and diversity of the urban environment has little influence on the physical activity of residents in the community.

The study of subjective perception of the built environment was carried out considering three dimensions: subjective perception of the built environment's humanized space, subjective perception of destination accessibility, and urban environment maintenance. The subjective perception of the built environment's humanized space has a significant positive impact on the duration of MVPA. This shows that the subjective perception of the density and diversity of human space could directly affect the duration of physical activity in the community. From this perspective, it can be seen that

the objective characteristics of the built environment's humanized space are influenced by human subjective perception, which is also consistent with the hypothesis of this study. The above conclusion is the same as the research conclusion that the urban sprawl was not conducive to health in some North American cities. The subjective perception of destination accessibility has a significant impact on MVPA, which indicates that the convenience of facilities will increase residents' willingness to carry out physical activities. However, the impact of urban environmental maintenance on duration of MVPA is not statistically significant.

The results of the model show that the characteristics of the humanized space of the built environment has a significant positive impact on the subjective perception of the humanized space of the built environment. The subjective perception of the built environment's humanized space has a significant positive impact on the duration of MVPA. Although the objective characteristics of the built environment do not directly affect the duration of MVPA, the objective characteristics of the built environment have an indirect positive impact on the duration of MVPA through subjective perception of the built environment. This is essentially consistent with the North American study on the correlation between the built environment and physical activity. Excessive low-density urban sprawl is not conducive to the travel of non-motor vehicles, easily produced air pollution and increased reduction of physical activity of residents [36].

From the results of the model, the gender and socioeconomic status of the control variables have a negative impact on the duration of leisure MVPA, which is more significant. The impact of age was not obvious. There was a significant positive correlation between the love of sports and the duration of leisure MVPA. (See Table 3 for structural equation analysis results).

**Table 3.** Analysis Results of Structural Equation.

Structural Equation			Model 1		Model 2	
			Estimate	P	Estimate	P
Subjective Perception of Humanized Space	<—	Humanized Space Characteristic	0.099	***	0.100	***
Entropy Index of POI Type	<—	Humanized Space Characteristic	0.303	-	0.303	-
POI Density	<—	Humanized Space Characteristic	0.885	***	0.886	***
Ratio of Sports Facility POIs	<—	Humanized Space Characteristic	0.842	***	0.841	***
Road Network Density	<—	Humanized Space Characteristic	0.360	***	0.360	***
Entropy Index of Subjective POI Type	<—	Subjective Perception of Humanized Space	0.693	-	0.693	-
Subjective POI Density	<—	Subjective Perception of Humanized Space	0.742	***	0.744	***
Ratio of Subjective Sports Facility POIs	<—	Subjective Perception of Humanized Space	0.830	***	0.828	***
Subjective Convenience of Public Transportation	<—	Subjective Perception of Destination Accessibility	0.624	-	0.857	-



Table 3. Cont.

Structural Equation			Model 1		Model 2	
			Estimate	P	Estimate	P
Subjective Convenience of Shopping Facilities	<—	Subjective Perception of Destination Accessibility	1.065	***	0.775	***
Environment Cleanliness	<—	Urban Environmental Maintenance	0.721	-	0.740	-
Subjective Green Coverage Ratio	<—	Urban Environmental Maintenance	0.699	***	0.694	***
Beauty Degree of Sketch	<—	Urban Environmental Maintenance	0.758	***	0.745	***
Community Illuminance	<—	Urban Environmental Maintenance	0.658	***	0.658	***
MVPA	<—	Humanized Space Characteristic	-0.043	0.141	-0.042	0.154
MVPA	<—	Subjective Perception of Humanized Space	0.115	***	0.120	***
MVPA	<—	Subjective Perception of Destination Accessibility	0.085	***	0.045	0.255
MVPA	<—	Urban Environmental Maintenance	-0.016	0.594	-0.050	0.150
MVPA	<—	Gender	-0.076	***	-0.075	***
MVPA	<—	Age	0.005	0.856	0.004	0.884
MVPA	<—	Socioeconomic Status	-0.090	***	0.202	***
MVPA	<—	Love for Sports	0.195	***	-0.088	***
Public Security Perception	<—	Humanized Space Characteristic			-0.029	0.218
Public Security Perception	<---	Subjective Perception of Humanized Space			-0.016	0.504
Public Security Perception	<---	Urban Environmental Maintenance			0.390	***
Public Security Perception	<---	Subjective Perception of Destination Accessibility			0.560	***
MVPA	<---	Public Security Perception			0.066	*

CMIN = 1296.598; DF = 131; CMIN/DF = 9.898; RMSEA = 0.060

CMIN = 1359.670; DF = 144; CMIN/DF = 9.442; RMSEA = 0.058

Notes: 1. \*\*\*, \*\*, \* are significant at the levels of 0.01, 0.05, and 0.1, respectively. 2. The model analysis results were standardized coefficients. CMIN/DF: chi square degree of freedom; RMSAE: root mean square of approximate error.

### 3.2. Influence of Mediating Variables in Security Perception

According to the research literature, safety perception is related to the built environment and physical activity. Therefore, this variable was introduced and studied for its role as an intermediary variable. In Model 2, the intermediary variable of safety perception was added to study the relationship

among the characteristics of humanized space, the subjective perception of humanized space, the subjective perception of destination accessibility, the urban environmental maintenance, the safety perception, and the duration of leisure MVPA within a week in the community. The model operation results are shown in Figure 4.

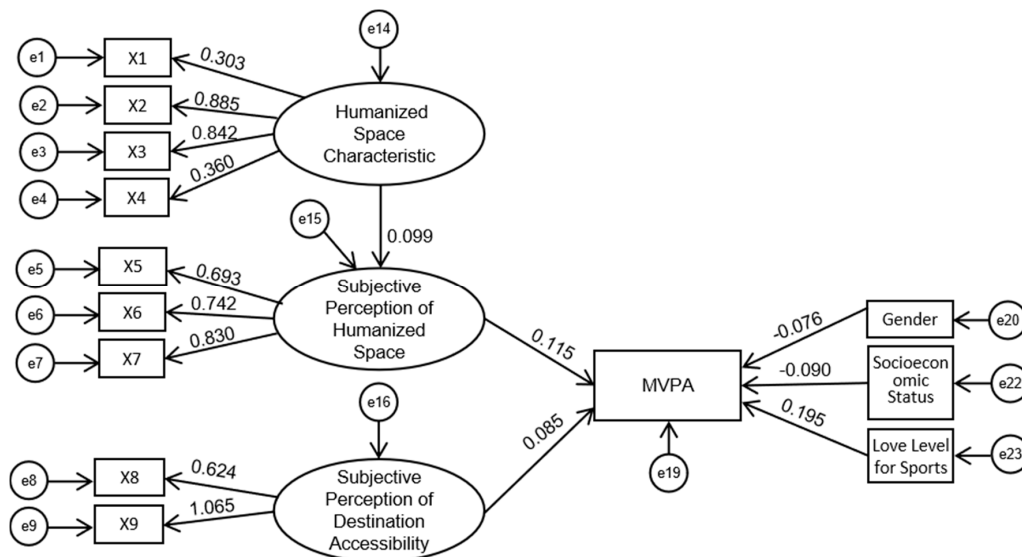


Figure 4. Structure Model 2: Standardized Path Coefficient Diagram.

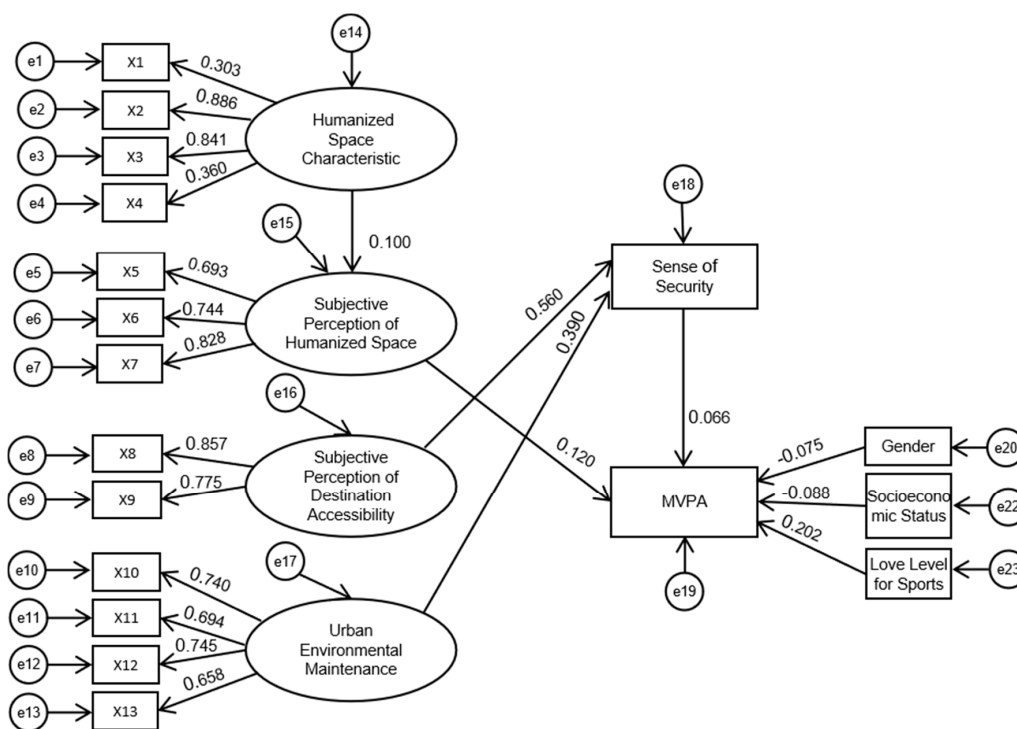
The results of the model show that, after the introduction of the intermediary variable community public security perception, the humanized space characteristics and subjective perception of the built environment had no significant impact on community public security perception; community public security had no mediating effect on these two variables. The subjective perception of destination accessibility had no significant effect on MVPA. However, the subjective perception of destination accessibility had a significant impact on community public safety perception at the level of 0.01, and the community public safety perception had a significant impact on the duration of MVPA at the level of 0.1. The subjective perception of destination accessibility was through the intermediary variable of community public security perception, to have an indirect impact on the duration of MVPA. In Model 1, the results showed that the destination accessibility directly affected the physical activity of community residents. From a statistical point of view, this public security had a strong intermediary mechanism for destination accessibility. It can be understood that the more convenient the destination is, the more secure the residents feel, and the more conducive it is to physical activity in the community, thus promoting the health of residents.

Similarly, urban environmental maintenance had no direct significant impact on the duration of MVPA. However, urban environmental maintenance had a significant impact on community public safety perception at the level of 0.01, and community public safety perception had an impact on the duration of MVPA at the level of 0.1. It can be seen that the subjective perception of urban environmental maintenance had an indirect impact on the duration of MVPA through the intermediary variable of community public safety perception. It can be understood that if the community is green, the landscape is beautiful, the environment is clean, and the lighting is bright at night, the residents will have a heightened sense of security, be more willing to carry out physical activities in the community, and be more inclined toward physical health. The influence of the control variables of Model 2 is basically consistent with that of Model 1.

### 3.3. Influence between Objective Characteristics and Subjective Perception of the Built Environment

When subjective perception was added to the study of the built environment and physical activity, the objective characteristics of built environment had a significant positive impact on subjective

perception. The direct and indirect impacts between them were further analysed. In the analysis results of Model 1 and Model 2, it can be seen that the indirect influence of objective characteristics of the built environment was greater than the direct influence. The subjective perception of the built environment and destination accessibility had a more direct than indirect effect. In Model 1, the effect of urban environmental maintenance was not significant, while in Model 2, the indirect effect was greater than the direct effect. According to the analysis results, it can be known that the key factor that had a direct impact on the length of MVPA was the subjective perception of the built environment, and the objective characteristics of the built environment played a role through the intermediary variable of subjective perception (Table 4).



**Table 4.** Effect of Subjective and Objective Characteristics of the Built Environment on Leisure MVPA.

Latent Variables	Model 1			Model 2		
	Direct Effects	Indirect Effects	Total Effects	Direct Effects	Indirect Effects	Total Effects
Humanized Space Characteristic	-0.043	0.011	-0.032	-0.042	0.010	-0.032
Subjective Perception of Humanized Space	0.115	0.000	0.115	0.120	-0.001	0.119
Subjective Perception of Destination Accessibility	0.085	0.000	0.085	0.045	0.037	0.775
Urban Environmental Maintenance	-0.016	0.000	-0.016	-0.050	0.026	-0.025
Public Security Perception				0.066	0.000	0.066

Notes: The influence effect values were all standardized coefficients.

#### 4. Discussion and Conclusions

Based on the data of the social survey, spatial POI, road network, and land use in a central urban area, this paper discussed the influence mechanism of the objective characteristics and subjective perception of the urban built environment on the duration of MVPA in the community within a week. The results of the Fuzhou case study are shown below.

(1) The objective characteristics of the built environment had no direct impact on the development of leisure MVPA, but it can indirectly affect leisure MVPA through residents' subjective perception of the built environment. This was essentially consistent with European and American studies. The quality of the urban built environment will affect residents' willingness to carry out physical activities.

(2) The subjective perception of residents had a significant impact on the duration of MVPA. Like European and American urban research, the improvement of subjective perception and accessibility of humanized space would bring a significant increase in the duration of leisure MVPA. The impact of urban environmental maintenance on the duration of MVPA was indirect through safety perception, and the impact was relatively weak. This may be related to the small sample size and the influence of occupational habits on residents' self-evaluation. Therefore, residents' subjective perception in the optimization of the urban built environment should be carefully considered. Communities should be built with pleasant spaces and proper functions, with more attention paid to the convenience of facilities.

(3) In the structural equation model, the individual attributes such as gender and social status self-evaluation had negative effects on the duration of leisure MVPA, but the effect of age was not obvious. An individual's level of love for sports had a positive effect on duration of MVPA.

The conclusion shows that the objective characteristics of the built environment affect physical activity through subjective perception. There was a certain intermediary role in community safety perception; community environment maintenance will affect people's safety perception. Generally, the better the community environment is maintained, the stronger the sense of human security, and the more people would be willing to carry out physical activities in the community. To sum up, urban planners should not only consider the standardization of material elements, but also pay attention to the subjective perception of people when they design the built environment. City managers should not only pay attention to the supply of sports venues, but also constantly improve the beauty, lighting, cleanliness and other environmental maintenance of the facilities in the community. The urban environment should better meet the needs of all levels of physical exercise, so that they can share the constructive results of a healthy city.

All of the above conclusions were based on data of Fuzhou City. The results of this study can be used for reference for cities with a similar scale and climate to Fuzhou; however, cities that are too cold, too large or too small may have some differences. Influenced by data and research methods, the research still had the following shortcomings.

(1) The duration of MVPA in this paper was based on the subjective reported numerical value of the respondents. The respondents may overestimate or underestimate their weekly physical activity. In the future, more targeted paper-based testing tools can be developed. At the same time, combined with GPS (Global Positioning System) and accelerometers, physical activity can be measured objectively.

(2) The mediating role of objective criminal activities and other factors needs to be researched further.

(3) The effect of temperature comfort in different seasons on physical activity was not considered in the study.

(4) This paper was mainly a horizontal study, only to determine the correlation between variables. In the future, longitudinal and experimental research methods can be integrated to explore the unknown mechanisms.

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