the influence mechanism of community-built environment on the health of the elderly: from the perspective of low-income groups

Zhenhua Zheng
University of Shanghai for Science and Technology
Wanting Liu
University of Shanghai for Science and Technology
Yingchen Lu
University of Shanghai for Science and Technology
Ning Sun
University of Shanghai for Science and Technology
Yusu Chu
University of Shanghai for Science and Technology
Hong Chen (ch_jhxy@sina.com)
Sichuan University

Research Article

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Abstract

Background: The international community has been paying attention to the health problems of the elderly and the age-friendly community of the elderly as the population ages, but there has not been enough discussion about the internal mechanism of the community-built environment to influence the health of the elderly.

Methods: In this study, descriptive statistical analysis, and structural equation Modeling (SEM) were used to make a group comparison between the elderly of different income groups. The data from this study, came from a sample survey in Shanghai, China. The study investigated the complex relationship among the community-built environment, social participation, outdoor exercise, and the health of the elderly, with a focus on the differences between in the elderly with different incomes level.

Results: The study found that health difference exists among the elderly in China: the lower the income, the worse the living environment, the worse the health. Community built environment has an important impact on the health of the elderly. And the community-built environment influences the elderly's health through the intermediary role of outdoor exercise and social participation. Furthermore, the lower the elderly's income level, the stronger the direct effect of the community-built environment on their health; the higher the elderly's income level, the stronger the mediating effect of outdoor exercise and social participation on the impact of the community-built environment on their health. Community built environment play a more important role on the low-income elderly healthy.

Conclusion: Governments should pay more attention to the health and living conditions of low-income elderly and take proactive steps to help them. Community design and building should pay more attention to the demands of low-income elderly groups, which will help to improve the health inequality of the elderly, consequently enhancing their overall health.

Background

Population aging is the current global population problem. The health problems of the elderly not only effect the solution of pensions and economic expenditures, but also determines the healthy level and quality of life in each country and even the global population. Since the publication of *The Black Report* (Black 1980 Black et al. 1999), health inequalities has been an important topic in the international academic community (Marmot, 2005 Scambler 2012 Zhou et al., 2016). Health disparities exist objectively. The health status of higher socioeconomic groups is often better than that of lower socioeconomic groups, which is a phenomenon of the health inequality(Braveman 2006 Claussen 2015 Nurujeter et al 2018). The health equality of the elderly has been extensively concerned as the aging process accelerates. Therefore, it is important to pay more attention to the health issues that vulnerable elderly groups face, especially low income.

From “successful aging” to “healthy aging” to “active aging”, the concept of international community to deal with population aging has changed. The role of the elderly should be changed from “passive recipients of support” to “active participants in social activities”(WHO 2002). Then the concept of “age-friendly

communities” emerged (WHO, 2007), with the ultimate objective of promoting more social activities and increasing health possibilities for the elderly (Menec Nowicki2014Scharlach2017). Because the community optimization construction has the characteristics of intervene ability and implementation, it has a lot of practical value for age-friendly communities to promote active aging (Plouffe & Kalache, 2010). The community is the basic activity places and living spaces. As a result, constructing a community-built environment that can effectively improve the health of various social groups has become a vital to promote social equity and improve the health of whole people. With the development of the practice of the age-friendly communities, international community, scholars, and governments are paying more and more attention to how the community-built environment affects the health of the elderly (De Vries et al., 2003; Xue & Cheng 2012Smith, Lehning, & Dunkle, 2013).

The relationship between the community-built environment and the health of the elderly has been extensively studied by scholars (Berke et al., 2007; Chen et al, 2014; Nowicki, 2014; Moore, 2014; Zheng et al.,2019). Social ecology emphasizes the interaction among environment, human behavior, and human health. The impact of the community-built environment on the elderly’s health was not isolated, but through affecting the elderly’s way of life and behavior, ultimately affecting their health. Previous studies have paid more attention to outdoor exercise as an intermediary variable of the community-built environment affecting the health of the elderly (Glicksman et al., 2013; Wang et al., 2017; Joseph & Zimring, 2007; Glicksman et al., 2013). At present, there are few studies on social participation as an intermediary variable. However, as social participation is of great significance to active aging (WHO, 2002; United Nations Population Fund, 2012; Cramm & Nieboer, 2015), it has also gotten increased attention (Rantakokko et al., 2010; Lehning et al., 2012; zheng et al., 2019). Nevertheless, the complicated interaction among the community-built environment, social participation, outdoor exercise, and the elderly’s health has not been adequately explored.

Furthermore, in the context of a rapidly aging population, ignoring the difference between elderly groups (zheng et al., 2021), designing and constructing community-built environment through homogeneous and extensive measures will be the opposite of “age-friendly community” (zheng et al., 2020; zheng et al., 2021). To improve the overall health level of the elderly, we must recognize the diverse demands of different elderly groups, especially low-income groups. The elderly with various income levels showed significant differences in the living conditions, behavior habits and psychological needs, as well as the health factors. Therefore, the comparative study about the impact of the community-built environment on the health of elderly not only contributes to the overall promotion of the elderly’s health, but also aids in the implementation of the concept of shared development in the field of environmental research, as well as promotes social equity and social harmony.

Our research focuses on the living environment and health of the elderly in China, particularly in low-income groups. This is due to China recently facing the largest and fastest-growing aging population of the world (WHO,2012) and the large low-income group of the elderly. Our research primarily raises the following questions based on the above literature review and analysis:

1. Are there significant differences in health status, behavior and living environment among the elderly at different income levels? Is there health inequality?

2. Does the community environment have significant influence on the elderly's behavior and health? Whether the behavior pattern is the intermediary variable of the community environment affecting the health of the elderly?
3. Are there significant differences in the way of community environment on the health of different elderly? What are the characteristics of low-income groups?

Method

Study population.

The data for this study came from a large sample survey conducted by Public Health College of Fudan University. This research place was selected in Xinhua Street, Changning District, Shanghai. The purpose of the survey was to investigate the relationship among the community-built environment, the behavior and health of the elderly. The survey was conducted using two-stage sampling method from June 2014 to October 2014. First, we selected 43 out of 198 communities. To make the sample as representative as possible, community samples should be selected as far as possible to cover different quality communities in Xinhua street. Due to geographical location, convenient transportation, and construction age, which often have a strong explanatory signification to the quality of the community. Therefore, this survey's primary sampling principle was based on the diversity of these aspects. See Figure 2 for details. Then, in the selected community, a sample survey of the elderly aged 60 and over without cognitive impairment was conducted. The sample principle was if the number of elderly people in selected community was less than 120, all of them were surveyed; if the number of elderly people in selected community was more than 120, 120 elderly people were chosen at random. The list of the elderly without cognitive impairment was provided by the neighborhood committee, and 2783 valid samples were obtained. There were 1292 low-income elderly samples, 964 middle-income elderly samples and 527 higher-income elderly samples.

Measurement

Dependent Variable: The health of the elderly

Self-evaluation of health has been widely used in self-perceived overall health(Jylhä, 2009Pagotto et al., 2013), which have highly predictive of functional disability, morbidity and mortality (Tsai et al., 2014) and even more important than actual medical measurements results (Maddox & Douglass, 1973). So, self-evaluation of health was thought an excellent predictor of objective health (Wu et al., 2013). This paper used self-rated health and health satisfaction to assess the health of the elderly. On a scale of 1 to 10, the higher the score, the better the health.

Independent variable: Community built Environment

Community-built environment includes leisure environment and landscape environment. They were based on two measurement models of the community-aware environment development by Mujahid et Al (2007). Leisure environment includes seven dimensions: walking convenient, walking fitness, sufficient trees, exercise opportunities, sports facilities, walking attraction and exercise attraction. And landscape environment includes three dimensions: the interest of architecture, environment cleanliness and the attraction degree. The

responses to each item ranged from 1 to 5 (1=completely, 2=disagree, 3=neutral, 4=completely, 5=agree) and the higher score indicated higher degree of acceptance of the walking support environment and sensory support environment.

Intermediary Variables: Social Participation, Outdoor exercise

The social participation of the elderly in this paper mainly refers to the activities of the elderly in the community, included five activities: volunteer work, self-management and mutual assistance activities, lectures and reports, participation in cultural activities, and participation in interest groups. The elderly's level of social participation was assessed by asking them about the frequency of participated in various activities over the past 12 months. The item was scored on a scale 1 to 5(1=never, 2=several times a year, 3= several times a month, 4= once a week, 5=2-3 times a week), with the higher score indicating more social participation.

Outdoor exercise includes two observation variables: walking frequency and walking duration. The walking frequency was measured by the number of walking per week. Walking duration was about the time of each walk.

Control Variable

Age, gender, education and community residence time were included as control variable in this paper's conceptual model. Gender as 2 categorical variables, male as 0, female as 1. Education levels are assigned as follows: 1=junior high school and below, 2=senior high school, technical secondary school and technical school, 3=junior college, 4=bachelor, 5=master and above.

Statistical Analysis

This study analyzed how the community-built environment effect the health of the elderly through outdoor exercise and social participation as the intermediary. Structural Equation Modeling (SEM) is more suitable for the analysis of this complex relationship. The SEM has benefits of visualization, intuition, and science in dealing with the comparative analysis of multi-group models. So, SEM and Maximum likelihood estimation method were used in this research. The structural equation model was fitted using MPLUS software.

Multi-factor confirmatory analysis was performed on all the measurement models in the conceptual model, and the compositional reliability of all the measurement models was greater than 0.6; the average variance extraction was greater than 0.5; the factor load of the observed variables was greater than 0.6; the reliability coefficient was greater than 0.36(Fornell & Larcker, 1981) and all the measurement models had good reliability and validity. The community sensory support environment and community walking support environment had a correlation coefficient of 0.632. Therefore, the community sensory support environment and the community walking support environment constituted the second-order model of the community-built environment.

The results of model fitting demonstrate that the CFI did not achieve the ideal standard, indicating that the model had to be improved. after establishing the converged relationship between "sport facilities" and "exercise facilities", "interesting design" and "attractive", and "attractive" and "clean and tidy", the final IFI, CFI

and X2/DF all achieved the criteria thereby the optimized model was fit. The final indexes (CFI>.90, TLI>.90, RMSER<.08) achieved the criteria, which show that the model was fit.

Results

Descriptive statistics

The descriptive statistics of variables in Table 1 revealed that the elderly's health satisfaction was greater than self-assessment health. It indicated that the whole elderly had a better mentality and the self-assessment health and health satisfaction improved with income increased. In the community-built environment, the average of community leisure environment was often greater than the average of the community landscape environment. The mean value of all measurement variables in community-built environment reflected that the low-income elderly have lower than middle-income and high-income elderly. The low level of the elderly's social participation and the average of all participation activities were both below 2, implying that the elderly's participation occurred several times a year. Walking frequency was 4.2 times a week with a walking time of 28.57 minutes; walking frequency and time increased as income increased. In the control variables, the average age of the elderly was 72.7 years, with balanced the gender structure, and the overall education level was above senior high school, having a more than 22 years' living time in average. With rising income, the average age of the old reduced, the level of education gradually increased, the number of men climbed, and the living time reduced.

Table 1 Variable descriptive statistics

		Observed variable	Variable items	Mean scores			
				The total sample	Low income	Middle income	High income
Health of the elderly		Self-assessment health	Your health condition	2.35	2.22	2.26	2.52
		Health satisfaction	satisfaction with your health status	3.61	3.38	3.56	3.80
Community environment	Walking environment	Walking attraction	Many people often walking in the residential district	3.32	3.17	3.30	3.39
		Exercise attraction	Seeing other people often exercise in the residential district	3.18	2.99	3.18	3.26
		Sports facilities	Abundant sports facilities in the residential district	2.95	2.76	2.93	3.04
		Exercise opportunities	Offering exercise opportunities in the residential district	3.00	2.73	3.01	3.09
		Enough trees	The trees in the residential district provide enough shade	3.14	3.09	3.16	3.13
		Walking convenience	Many places can be walked from our residential district	3.65	3.60	3.68	3.65
		Suitable for walking	Very pleasant	3.31	3.22	3.31	3.34

			walk in the residential district				
	Sensory environment	Interesting design	The buildings in the resident district are interesting	2.72	2.50	2.74	2.78
		attractive	The community is attractive	2.92	2.66	2.95	2.99
		cleanliness	The road and environment in the resident district are clean	2.87	2.69	2.85	2.95
Social participation		Interest groups	Frequency of participation in outdoor interest groups	1.87	1.93	1.78	1.94
		Community activities	Frequency of participation in activities in the residential district	1.76	1.75	1.68	1.76
		Lecture report	Frequency of learning lecture or reports	1.65	1.65	1.67	1.62
		Mutual assistance groups	Frequency of participation in self-management or mutual assistance groups	1.50	1.55	1.53	1.42
		volunteer	Frequency of being an volunteer	1.64	1.63	1.65	1.50
Outdoor exercise		Walking frequency	Walking several times a week (more than 10 minutes)	4.20	4.08	4.19	4.26
		Walking time	How long is the walk(minute)	28.57	24.85	29.67	29.02

Control variable	age	age	72.74	80.62	71.43	70.74
	gender	gender	0.58	0.687	0.61	0.49
	education	education	2.25	1.76	1.90	2.90
	Living time	Living time in the community	22.10	26.44	25.13	16.35

The study applied the SEM latent mean comparison approach to compare the community-built environment, social participation, outdoor exercise, and health status of the elderly with different income levels. The processing of the mean of latent variables was one advantage of the analysis method. Unlike other statistical methods that add the mean to latent variables, the structural equation model was systematically analyzed by the different weights of each measured variable and eventually appears as difference among the means of variables in different groups. MPLUS set the low-income group to 0 and used software analysis to determine the specific difference between middle-income group, high-income group, and low-income group. The use of a SEM latent mean comparison allows for a more precise measurement of the differences in variable means between various income groups (Figure 2).

The health status of the elderly and community-built environment both show a trend of gradual improvement as income level rise, especially the health status of the elderly showing a larger increase. The difference in health between the elderly with high-income and middle-income and the elderly with low-income was 0.125 and 0.490, respectively, and the difference in community-built environment was 0.189 and 0.918. According to the study's findings, there are significant difference in the health of the elderly based on their income. As a result, it is extremely important to discuss the health path of the elderly of different income. With the increase of income, the elderly's frequency of social participation activities gradually reduced as their income level increased; outdoor exercise exhibited an inverted V-shaped relationship, with middle-income elderly people having the highest intensity and low-income elderly people having the lowest. The differences in social participation were -0.92 and -0.148, respectively, while the differences in outdoor exercise were 0.144 and 0.106.

The results of the model fitting based on the entire sample are shown in Table 2 and figure 3. After controlling for age, gender, education, and community living time, the total effect value for community-built environment, social participation, and outdoor exercise on the health of the elderly were 0.230, 0.136, and 0.240, respectively.

The direct and indirect effects of community-built environment on elderly health are significant, indicating that there were some intermediary variables in the path, with the intermediary effect value of social participation was 0.021 and the intermediary effect value of outdoor exercise was 0.053. It proposed that the positive impact of community-built environment on elderly health should be realized by promoting outdoor exercise and social participation.

Table 2 Total, direct and indirect effects of the overall model path

Independent variable	Intermediate variable		Dependent variable		
	social participation	Outdoor exercise	the elderly's health		
			Total effect	Direct effect	Indirect effect
community built environment	0.152***	0.222***	0.230***	0.156***	0.074***
social participation	——	——	0.136***	0.136***	——
Outdoor exercise	——	——	0.240***	0.240***	——

Note: *** represents significant at the 1% level,

** represents significant at the 5% confidence level,

* represents significant at the 10% confidence level

Comparison of Model Differences among Different income Groups

We compared the model path of different elderly income groups, and the output results showed that the path coefficient was set to the same P value<0.05, indicating that there were significant differences in group model paths of different income levels. The results of model fitting based on different income groups were compared in Table 5, Figure 3 and 5.

The total effect value of community-built environment and outdoor exercise on the health of the low-income elderly were 0.340 and 0.231, respectively. On the other hand, social participation had no effect on them. The direct effect of community-built environment on the low-income elderly health was significant, but the indirect effect was not significant, indicating there was no intermediary effect in the path, which mean the effect of community-built environment on the low-income elderly health was direct and would not be interfered by the outdoor exercise and social participation.

Community built environment, outdoor exercise and social participation all had significantly positively effects on the health of middle-income elderly, with effect values were 0.223, 0.157, and 0.154, respectively. The direct and indirect impacts of the community-built environment on the health of middle-income elderly people were both significant, indicating that there was a section of the path that had an intermediary effect, including the intermediary effect value of social participation was 0.029. It suggested that outdoor exercise and social participation would help to achieve the positive effect of community-built environment on the health of the middle-income elderly.

The community-built environment, outdoor exercise and social participation all had significantly positively affected on the health of the high-income elderly, with impact values of 0.225, 0.118 and 0.187, respectively. The direct and indirect effects of the community-built environment on the health of middle-income elderly people were both significant, indicating that there was a part of the path with intermediary effect, including the intermediary effect value of social participation was 0.035, and the intermediary effect of outdoor exercise was 0.056. It suggested that outdoor exercise and social participation would help to realize the positive effect

of community-built environment on the health of the elderly. The total effect (0.225), direct effect (0.144), and indirect effect (0.081) of the community-built environment on the path of the high-income elderly can be seen, and outdoor exercise and social participation could reach 36%. This means that outdoor exercise and social participation play an essential intermediary role in how the community-built environment influenced the health of the high-income elderly.

Independent variable		Intermediate variable		Dependent variable		
		social participation	Outdoor exercise	the elderly's health		
				Total effect	Direct effect	Indirect effect
low income	community built environment	0.040	0.077	0.362***	0.340***	0.022
	social participation	—	—	0.110	0.110	—
	Outdoor exercise	—	—	0.231**	0.231**	—
middle income	community built environment	0.159**	0.186***	0.223***	0.169***	0.054**
	social participation	—	—	0.157***	0.157***	—
	Outdoor exercise	—	—	0.154**	0.154**	—
high income	community built environment	0.212**	0.302***	0.225***	0.144***	0.081**
	social participation	—	—	0.118**	0.118**	—
	Outdoor exercise	—	—	0.187***	0.187***	—

Table 3 Comparison of different income elderly model paths

Discussion

Our study explored the complex interaction among the community-built environment, social participation, outdoor exercise, and elderly health, as well as the difference between the elderly in different income groups, with a focus on low-income groups.

Our study confirmed the existence of health inequality problem (Braveman 2006 Claussen 2015 Nurujeter et al 2018) in the elderly. The greater income, the better health, and the living environment. The lower the income, the worse the health and living environment. The research also discovered that there are significant differences in the behavior of the elderly with difference income level: the higher the elderly's income, the lower the frequency of social participation. However, outdoor exercise showed an inverted V-shaped relationship, with the highest outdoor sports intensity in middle-income elderly and the lowest outdoor exercise intensity in the low-income elderly.

Our study confirmed the community-built environment had a significant impact on the health of the elderly (Menec & Nowicki, 2014; Moore, 2014; Zheng et al.,2019). Meanwhile, the community-built environment influenced the health of the elderly through the mediation of the outdoor exercise and social participation. That is, improving the quality of the community environment would increase the elderly's frequency of outdoor exercise and social participation, then improving their health.

More importantly, our study found significant differences in the pathways by which community-built environments affect the health of the elderly at different income levels. The lower the elderly's income level, the greater the direct impact of the community-built environment on their health. The higher the elderly's income level, the stronger the intermediary impact of outdoor exercise and social participation on the effect of the community-built environment on their heath. The community-built environment had a strong and direct impact on the health of the low-income elderly, and it was not influenced by their behavior. While the impact of the community-built environment on the health of the middle-income elderly and the high-income elderly should be achieved through the intermediary impact of outdoor exercise and social participation.

The influence path of community-built environment on health of the elderly with different income levels is different. Therefore, to truly improve the health of the elderly and reduce the health inequality, it was necessary to consider the needs of various income groups, with a particular focus on the characteristics of the low-income elderly, then achieve differentiated responses and accurate environmental governance. The community-built environment had an extremely important influence in the health of low-income elderly, with a total effect value of 0.362. At the same time, this influence was independent existence, will not be affected by behavior. The low-income elderly group had worst health status, and the community-built environment had the largest impact on the health of the low-income elderly, implying that improving their community-built environment would have the biggest impact on their health. Therefore, during the urban redevelopment process, relevant government departments and environmental designers should give special attention to the improving of the community-built environment of the low-income elderly.

However, the study still has some limitation. First, the survey scope and neighborhood sample quantity are limited. Since only Xinhua Community in Changning District of Shanghai was selected for the in-depth survey, research conclusion cannot represent all neighborhood environment of urban China and more empirical studies should be conducted in the future. Secondly, the representativeness of elderly samples requires further improvement. In terms of the selection of neighborhoods, although the current study takes geographical location diversity, transportation convenience and completion year as the sampling principles, it still fails to develop systematic random sampling. So, it needs to increase the uncertainty of elderly samples. Finally, since neighborhood environment in this study based on subjective assessments, follow-up research should combine subjective and objective system of neighborhood environmental assessments so as to better explore the association between neighborhood environment and health of the elderly.

Conclusion

The result show that there were issues of health inequality among the elderly. The higher the income, the better the health, and the lower the income, the worse the health status. As a result, extra attention must be paid to the health problems of the low-income elderly.

Our study shows that the community-built environment had a significant impact on the health of the elderly, and that behavior was an intermediary variable for the community-built environment to affect the health of the elderly. More importantly, we discovered differences in the impact of community-built environment on the health of different income groups. The lower the income level of the elderly, the stronger the direct effect of community-built environment on their health. The higher the income level of the elderly, the stronger the mediating effect of outdoor sports and social participation on their health.

We advise all governments to pay more attention to the health and living environment of low-income elderly people. We strongly suggest that, in the future planning, design, construction and renewal process of the community-built environment, more attention be paid to the needs of low-income elderly groups and that care be shown for them, which would assist to reduce health inequality. As a result, the elderly's health will improve.

Declarations

Consent for publication

Not applicable

Availability of data and materials

The data and samples in this study were collected by Fudan University. The ethical approval code number is IRB#2015-12-0574. Due to the problems related to the use right, if necessary, please contact the author of the communication.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions:

Each author of this manuscript conceived and designed the study, and ZZ drafted the original paper. All authors performed the statistical analyses, and HC contributed to revising the paper and provided further contributions and suggestions. All authors read and approved the final version.

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Authors' information

[a] College of Communication and Art Design, University of Shanghai for Science and Technology, Shanghai, China, zhenhuazheng@usst.edu.cn

[b] College of Communication and Art Design, University of Shanghai for Science and Technology, Shanghai, China

[c] College of Architecture & Environment, Sichuan University, Chengdu, China

[*] Correspondence: ch_jhxy@sina.com; Tel.: +86-1388-053-9664

Abbreviations

SEM: structural equation Modeling; CFI: goodness-of-fit index; IFI: incremental fit index; X2/DF: Chi-Square/Degree of freedom; RMSEA: Root Mean Square Error of Approximation

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Additional Files

Additional file 1: Table S1. Variable descriptive statistics. **Table S2.** Total, direct and indirect effects of the overall model path. **Table S3.** Comparison of different income elderly model paths. **Figure S1.** Map of Xinhua Street and Map of the community sample. **Figure S2.** Comparison of the community-built environment, social participation, outdoor exercise, and health differences between the elderly with different incomes

Analysis Based on the Models of Full Sample. **Figure S3.** The standardization coefficient of the path of the overall model for the elderly. **Figure S4.** Comparison of the path of the model for the elderly with different incomes.

Figures

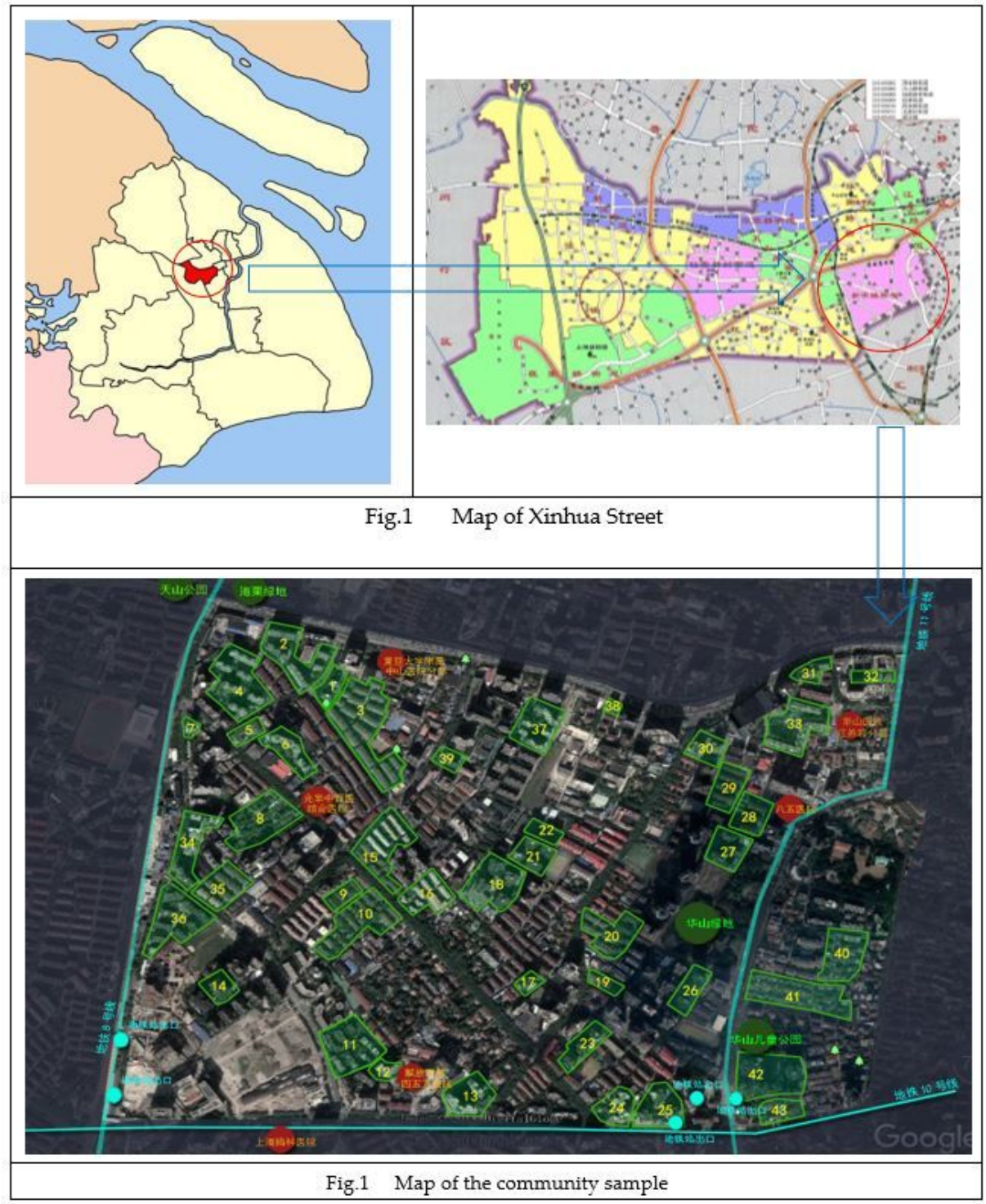


Figure 1

Map of Xinhua Street. Map of the community sample

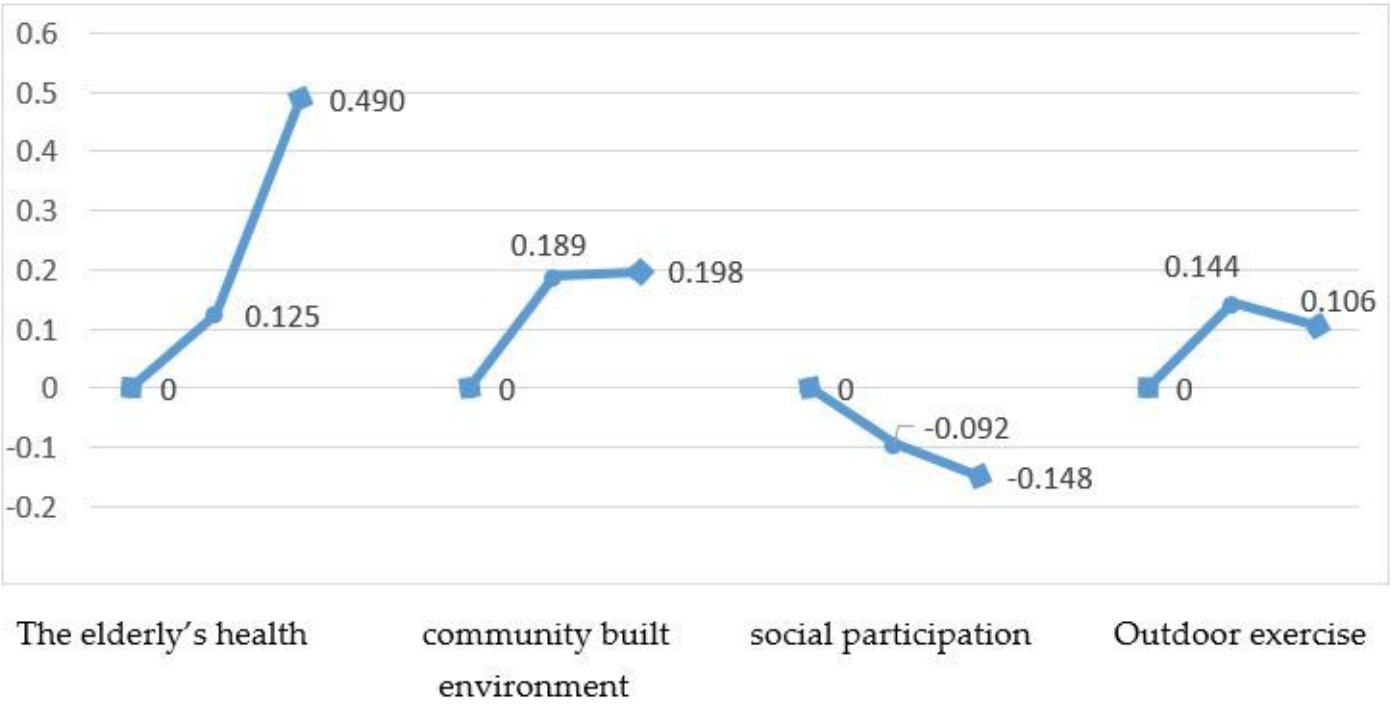


Figure 2

Comparison of the community-built environment, social participation, outdoor exercise, and health differences between the elderly with different incomes

Analysis Based on the Models of Full Sample

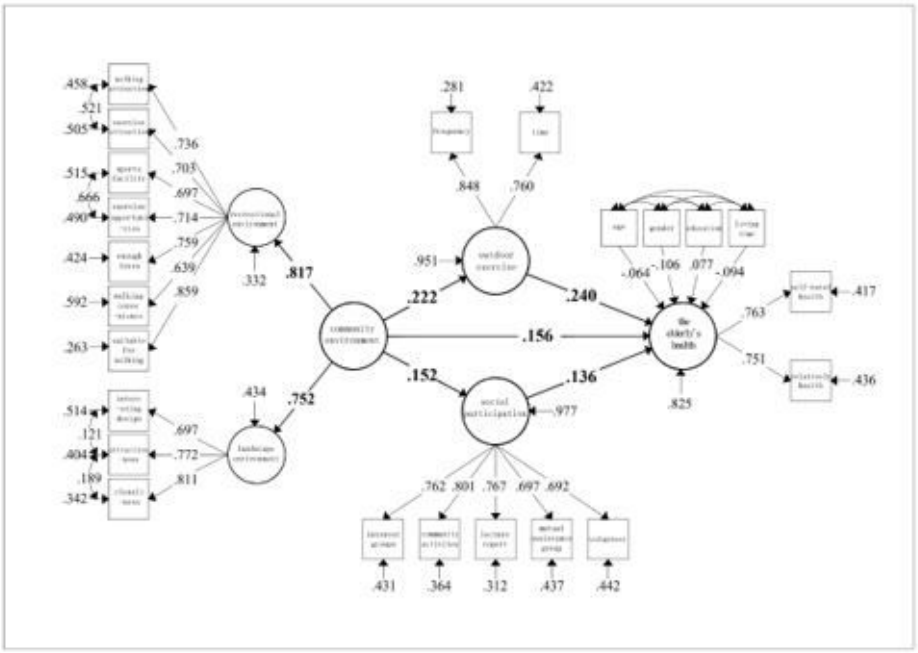
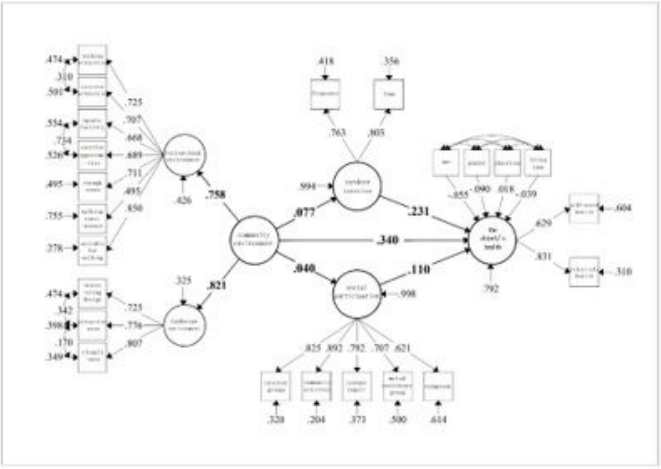
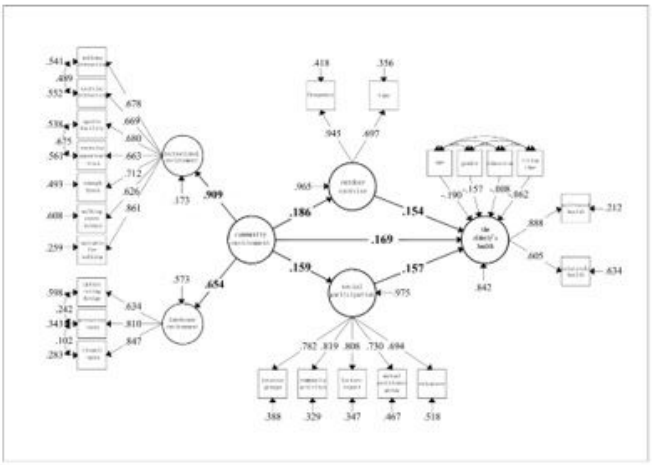


Figure 3

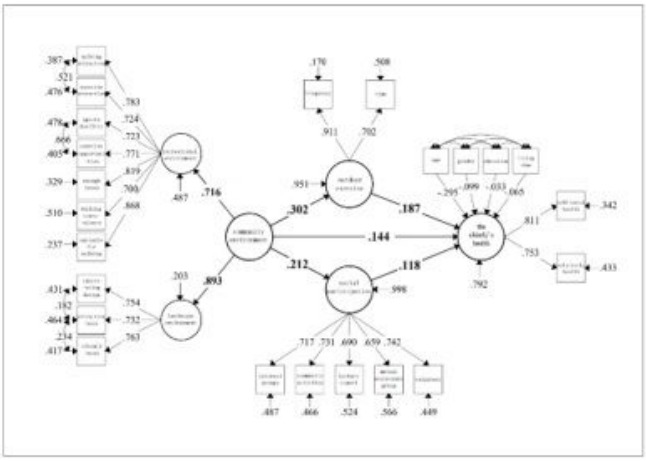
The standardization coefficient of the path of the overall model for the elderly



low income



middle income



high income

Figure 4

Comparison of the path of the model for the elderly with different incomes