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Neighborhood Environment, Lifestyle, and Health of Older Adults: Comparison of Age Groups Based on Ecological Model of Aging

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Abstract: Worldwide population aging is currently in acceleration, which is especially true for China. Echoing the advocacy of "active aging" and "age-friendly communities", governments and researchers across the world are paying more attention to the impact of neighborhoods on the health of older adults. Using the Ecological Model of Aging, this study aimed to discuss the relationships between neighborhood environment, lifestyle, and health of older adults, and to compare the differences among older adults of different age groups. The results showed that landscape environment has a direct effect on the health of older adults, while leisure environment has an indirect effect through lifestyle. Both leisure environment and landscape environment directly encourage older adults to take part in outdoor activity, in which the former mainly promotes the social participation of the high-aged (aged 80+) group, while the latter merely promotes that of the middle-aged (aged 70–79) group. The positive effect of social participation on health is gradually strengthened with the increase of age. Meanwhile, outdoor activity has its greatest effect on the middle-aged (aged 70–79) group, but not the low-aged (aged 60–69) group. To effectively boost the health of older adults and promote active aging, adequate considerations should also be given to the differentiated demands of older adults of different age groups, optimization of neighborhood environment, as well as cultivation of an amicable atmosphere.

Keywords: health of older adults; neighborhood environment; age group; social participation; outdoors activity; mediating role

1. Introduction

With the acceleration of population aging all over the world, the views of international society concerning this issue have shifted from "successful aging" to "healthy aging" and then to "active aging". Due to the growing proportion of the aging population in the global population, the role of older adults should be transformed from "passive dependents" into "active participants" of social activities. Active aging encourages older adults to positively face life, maintain physical and mental health, participate in social development, realize self-value, and shift their focus from longevity to quality of life [1]. The concepts of "age-friendly cities" and "age-friendly communities" were subsequently proposed with the aim to urge and help the governments to improve the community environment, which would promote the outdoor activities and social participation of older adults to boost their health [2]. "Age-friendly communities" highlighted the importance of communities as the main activity site and living space for older adults, as well as the practical value of community optimized intervention for active aging [3]. In recent years, increased attention has been paid to how the community environment affects health of the elderly [4].

In reality, the concept of "age-friendly communities" originated from the Ecological Model of Aging in environmental gerontology [5]. The model provided a general framework for comprehending the influence of environment on actions and welfare of older adults [6]. In brief, the Ecological Model of Aging assumed that the dynamic influences among people, physical environment, behavior, and quality of life, which constitute the living ecosystem of older adults [7]. Based on extensive studies on the relation between neighborhood environment and older adults' health [8,9], an increasing number of researchers start to focus on the Ecological Model of Aging [6,7].

Studies on health must be multi-dimensional [10]. The impact of neighborhood environment on older adults' health is not isolated. Instead, it affects the health of older adults by influencing their lifestyle and behaviors. In particular, outdoor activity is deemed to play the most prominent and distinctive facilitating role in the older adults' health. Therefore, most research lists outdoor activity as a mediator of the relationships between neighborhood environment and older adults' health [11,12]. Although social participation was used as a mediator in few studies, it has received increasing attention due to its importance to active aging [13,14]. According to existing literatures, scholars studied from different perspectives on the relationships between neighborhood environment, lifestyle, and health of older adults, and have achieved fruitful results. However, few studies regarded the different dimensions of lifestyle, such as outdoor activities and social participation, as mediators simultaneously.

For the older adults living in the communities, the influence of environment on health involves a complex path from neighborhood environment to lifestyle and then to health. Furthermore, there are significant differences in physiological functions, behavioral habits, and psychological status among the older adults at different age stages, which lead to different factors affecting their health. Thus, it is of practical significance to explore the effects of neighborhood environment on the health of older adults according to specific age sub-groups.

In the recent years, China is encountering the largest and fastest population aging in the world [15]. Shanghai, the economic and financial center of China, is also one of the cities with the fastest rate of population aging. Older adults aged 65 or above account for 14.5% of the total population of Shanghai. It is predicted that the figure will be increased to around 20% till 2030 [16]. Consequently, it is of great importance to explore how the neighborhood environment acts on older adults' health and age-friendly community construction in Shanghai and even whole China.

In this study, a conceptual model of "neighborhood environment—lifestyle—health of older adults" was constructed first. Then, we examined the role of lifestyle in mediating neighborhood environment and elderly health, based on the data collected from a survey in Shanghai. Moreover, differences in mediating effects of lifestyle among the older adults at different age stages were explored. The conclusions provide valid support for the formulation of related urban public policy, fine design, and implementation of urban planning, as well as aging-oriented community construction proposals.

2. Theoretical Model and Hypotheses

2.1. Theoretical Model

The Ecological Model of Aging was proposed by Lawton and Nahemow in 1973 [5]. It is the primary theoretical concept of environmental gerontology, devoted to exploring the behavioral, physical, and psychological influences of encounters between older adults and the environment they live in [17]. As for the older adults living in communities, their ecosystem is composed of multiple factors including older adults themselves, neighborhood environment, older adults' lifestyle or the mode of activity, and the older adults' health. It emphasizes not only the significance of neighborhood environment to older adults' health, but also the combined effect of their lifestyle in this ecosystem [7,18].

Neighborhood environment reflects the tangible infrastructure inside the neighborhoods [19]. Although researchers have different opinions on the measurement of neighborhood environment, leisure environment and landscape environment are generally regarded as its two most important

aspects [20,21]. To be specific, Leisure environment mainly includes the layout of the fitness facilities and the barrier-free facilities, etc., which shows the support capability of neighborhood outdoor space for the residents' outdoor activities or communications [22]. Landscape environment covers the architectural aesthetics, green, tidiness, and maintenance of the neighborhood [23], which reflects the support for the visual and sensory comfort of the neighborhood residents [24]. Leisure environment and landscape environment provide support for older adults in different aspects and have different effects on their health. Therefore, it is necessary to discuss them separately.

Lifestyle is an integral research object in sociology. In this study, it primarily refers to the healthy lifestyle, that is, a series of behaviors of maintaining and improving health conditions generated by the individual motivation and ability [25]. In fact, outdoor activity and social participation are both important parts of the healthy lifestyle, as well as key factors affecting the health of older adults in the overall community ecosystem that can promote active aging. Therefore, inclusion of both outdoor activity and social participation into one ecological model for comparative analysis will make the study more systematic and comprehensive.

Moreover, some studies on community ecosystems ignored the correlation and interaction between the different dimensions of lifestyle. In fact, outdoor activity and social participation do not act on the health of older adults independently; instead, they interact with each other in the community ecosystem. Social participation can lead to more outdoor activities and social interactions, thereby improving the health of older adults [26]. In view of the above, we constructed an ecological model of "neighborhood environment—lifestyle—health of older adults", as shown in Figure 1. This model framed the main hypotheses in this study, which are introduced in Section 2.2. Hypotheses.

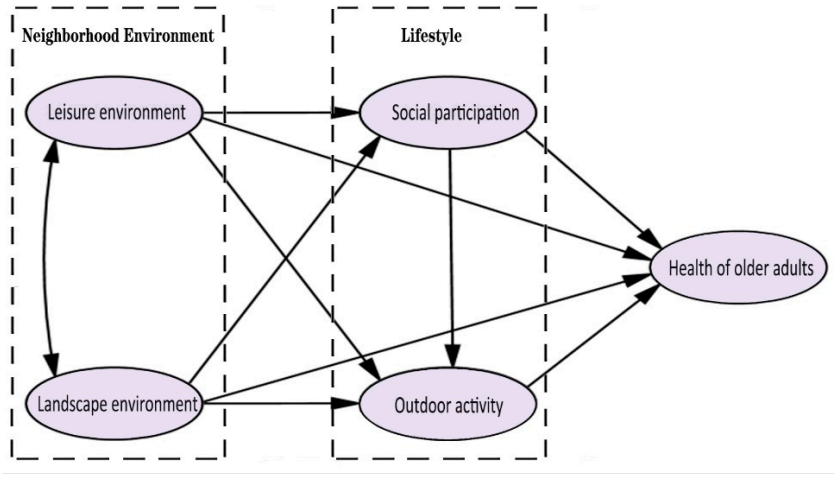

Figure 1. The conceptual model of "neighborhood environment—lifestyle—health of older adults".

The structural equation model (SEM) combines factor analysis with path analysis, showing an edge over the quantitative research on multi-variable interaction and group comparison. Therefore, this study adopted SEM to analyze the complex relations among the health, lifestyle, and neighborhood environment of older adults in different age groups. Group comparison of SEM was employed to examine whether there are significant differences between different groups, which can make the results rigorous, intuitive, and explicit.

2.2. Hypotheses

Many previous studies have confirmed that the better the leisure environment or landscape environment is, the healthier status the older adults will be [8,27–30]. Moreover, social participation can make older adults feel respected and recognized [31] and benefit their health [32–35]. Outdoor activity has also been proved to be good for elderly health [36–41]. Therefore, this study paid more attention to the complex relations between the variables in the ecological model. Specifically, the mediating

effects of social participation and outdoor activities on the relationship between neighborhood environment and health of older adults, and the differences among various age groups of the older adults were examined.

Studies of human behavior and social environment in sociological theory consider that social environment plays a crucial role in human lifestyle [42]. The structural theory endows outdoor environment with social meaning which deems that human behaviors and social interaction normally take place in specific spatial environment. People under different neighborhood environments would choose different types of activity, and high-quality outdoor environment would stimulate more outdoor activities [43–47] and social participation [48,49].

With the development of environmental gerontology and age-friendly communities, more and more researchers regarded a neighborhood as an ecosystem [50]. The relationship between the neighborhood environment and the health of older adults is not simply linear, but also influenced by the lifestyle in the neighborhood ecosystem. Due to their promotion of "active aging", outdoor activities and social participation have received increasing attention.

Outdoor activity as a mediator of the relationships between neighborhood environment and elderly health has been reported [11,12,51–53]; however, the difference in its effects in mediating the relationships between elderly health and the two different dimensions of neighborhood environment has rarely been systematically compared. To clarify the paths of different dimensions of neighborhood environment affecting health of older adults, the following hypotheses are proposed.

Hypothesis 1 (H1). *Outdoor activity serves as a mediator of relationship between leisure environment and health of older adults.*

Hypothesis 2 (H2). *Outdoor activity serves as a mediator of relationship between landscape environment and health of older adults.*

Rare studies have regarded social participation as a mediator of the relation between neighborhood environment and older adults' health. Although several researchers have dealt with the impact of social participation on the welfare of the elderly in the neighborhood environment [13,14,28], systematic studies are still lacking. Accordingly, we proposed hypotheses as follows.

Hypothesis 3 (H3). *Social participation serves as a mediator of relationship between leisure environment and health of older adults.*

Hypothesis 4 (H4). *Social participation serves as a mediator of relationship between landscape environment and health of older adults.*

Furthermore, from an ecological perspective, outdoor activity and social participation will also interact in the neighborhood ecosystem, rather than acting solely on the elderly health. More social participation can lead to more outdoor activity, which in turn benefits the health. Therefore, we propose the last hypothesis.

Hypothesis 5 (H5). *Outdoors activity serves as a mediator of relationship between social participation and health of older adults.*

3. Materials and Methods

3.1. Sampling

To explore the relations between neighborhood environment and health of older adults, Fudan University conducted a neighborhood survey on the health of older adults living in the communities in

Xinhua Sub-district, Changning District of Shanghai in June 2014. Xinhua Sub-district includes 17 residence districts with a coverage of 2.2 km^2 and a population of around 78,000 residents. The population of older adults aged 60 or above accounts for 20.2%. The two-stage sampling method is adopted here. At first, the diversified geographical location, transportation convenience, and the completion year were taken as the sampling evidence. In this study, we chose 43 neighborhoods from 198 neighborhoods in 17 residence districts as shown in Figure 2. The second step is to acquire the list of older adults aged 60 or above in 43 neighborhoods from the community committee. For communities with less than 120 older adults aged above 60, the present research investigates all older adults without cognitive disorder; for communities with more than 120 older adults of the same age, the research takes the pure random sampling method to investigate 120 older adults without cognitive disorder. The paper altogether collects 2839 samples, removes 56 invalid samples, and finally preserves 2783 valid samples. The details are shown in Table 1.

Table 1. Description of the neighborhood samples.

Location	No.	Neighborhoods	Year of Completion	Housing Unit Price (RMB)	Number of Floors	Number of Samples
Xizhen	1	Youlie Mansion	2004	70,640	31	51
	2	Donghu Garden	2003	72,383	20	27
	3	Xizhen Neighborhood	1990	68,185	6	75
Yangzhai	4	Xinhua Century Park	2003	80,655	20	120
	5	Zhiyin Neighborhood	1991	70,696	7	35
	6	Shenya New Mansion	2002	76,860	30	26
Mei'an	7	Kaixin Garden	2002	56,013	21	55
	8	Meiquan Villa	1996	220,782	2	15
	9	Mei'an Neighborhood	1993	73,929	6	82
Xinhua	10	Wenyuancun	1999	71,584	4	94
	11	Xinhua House	2001	79,983	7	77
Zuojiazhai	12	Zhongyin Huaihai Garden	1999	72,348	24	44
	13	Huaihai Garden	2001	77,381	26	24
	14	Changfeng Pujiang	1997	52,135	32	78
Xianghua	15	Baihuacun	1986	71,031	6	120
	16	Xianghuaqiao Neighborhood	1988	66,345	6	70
Fanyu	17	Jingcai Mansion	2000	76,861	28	62
	18	Haifu Apartment	1999	65,956	24	120
Xingfu	19	385 Alley, Fanyu Road	1991	72,771	6	104
	20	Youyicun	1991	70,640	6	86
Niuqiao	21	Fanyu Mansion	1993	56,952	29	78
	22	222 Alley, Fanyu Road	1993	57,131	7	69
Hongzhuang	23	Shenxin Garden	1980	75,182	18	84
	24	Hongfa Garden	1997	79,941	20	78
	25	Hongzhuang Neighborhood	1991	75,160	18	21
Dongzhen	26	Huashan Garden	2001	81,857	26	88
	27	Pingwu Neighborhood	1990	73,285	19	69
Heping	28	Heping Neighborhood	1988	65,096	7	36
	29	Xingfu Neighborhood	1987	63,967	6	64
	30	Shengyuan Mansion	1997	61,456	23	36
Zhangjiazhai	31	Zhangjia-zhai	1998	63,383	6	33
	32	722Alley Jiangsu Road	1996	63,856	7	60
	33	Jiaxin City Garden	1998	69,263	16	68
Tiandu	34	Contemporary Xinhua	2001	71,742	18	24
	35	Tiandu Neighborhood	1997	70,997	6	60
	36	Kaixuan Apartment	1997	69,714	8	84

Table 1. *Cont.*

Location	No.	Neighborhoods	Year of Completion	Housing Unit Price (RMB)	Number of Floors	Number of Samples
Renmin	37	Modern Garden	2003	77,935	29	63
	38	Yan'an Apartment	1986	69,870	14	73
	39	Huayun Building	1991	61,497	16	20
Tai'an	40	Xinguoming Park	2001	119,168	5	65
	41	Tai'an 120	1996	263,717	3	71
	42	Huashan Garden	1995	80,978	28	120
	43	Huaihai Villa	1939	107,208	3	54

Notes: Housing unit price was retrieved from "https://sh.lianjia.com/" in December 2018.

Comparing samples in "Neighborhood Survey of Elderly Health in Communities" with samples aged over 60 in Shanghai City in the sixth national population census 2010, it can be found that the two have basically the identical age distribution trend. In consequence, it can be fitly judged that samples of the research well represent older adults in Shanghai City.

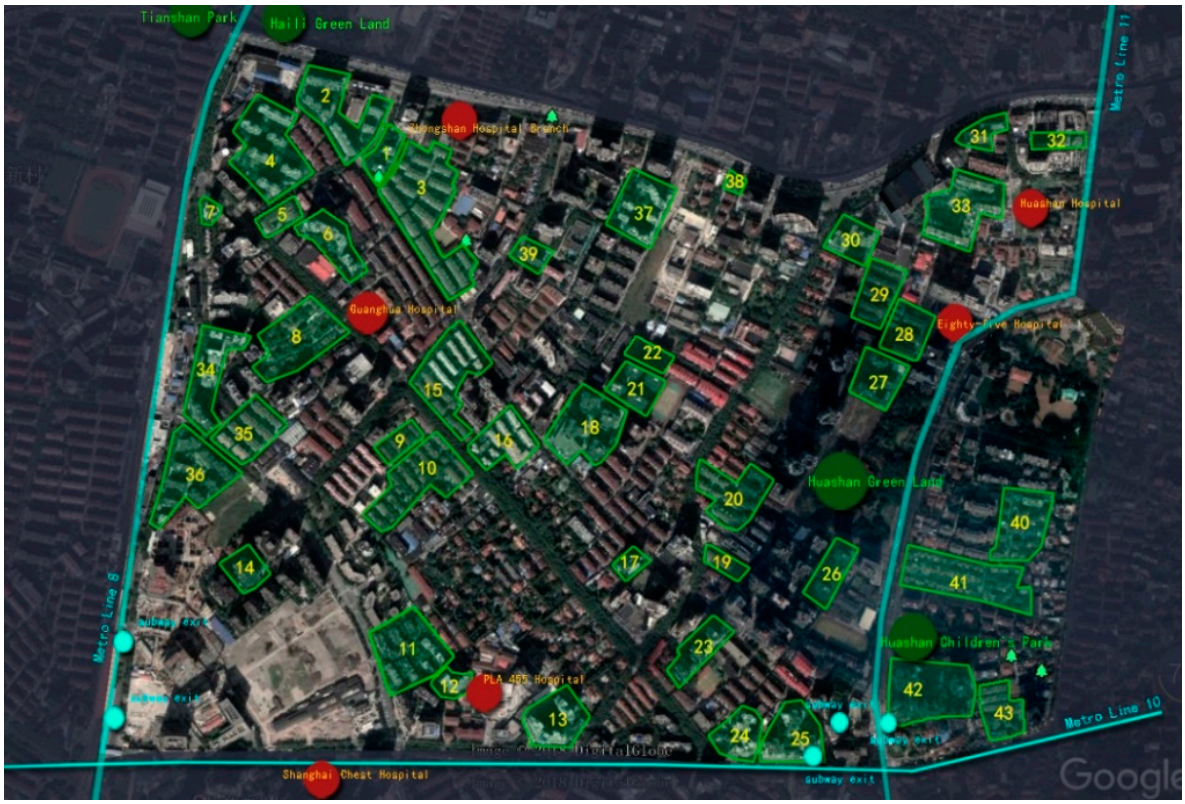

Figure 2. Map of the neighborhood samples.

3.2. Variables

3.2.1. The Dependent Variable

Self-rated health has been widely applied in the self-perceived health condition [54,55] owing to its high predictability of the functional disability, morbidity and mortality [56]. Therefore, it is deemed as an ideal indicator used to assess objective health conditions [57]. According to Maddox et al. [58], subjective assessment of health as a means of health measurement outweighs practical medical measurement. This study takes the self-rated health method to measure older adults' health conditions and assess older adults' self-rated health by the question "How do you assess your general health

condition?" Respondents are required to grade their health conditions from one point to five points, where higher points mean better health conditions.

3.2.2. The Independent Variable

Regarding the measurement of leisure environment and landscape environment, this study adopts two measurement models concerning neighborhood perceived environment developed by Mujahid et al. [24]. Leisure environment includes "walking convenience inside the neighborhood", "an environment suitable for walking", "adequate trees inside the neighborhood", "exercise opportunities", "enough sports facilities", "residents attracted to take a walk" and "residents attracted to do exercise". Landscape environment incorporates "interesting architecture inside the neighborhood", "clean and tidy environment", "attractive environment", "well maintenance of architecture and houses", and "favorable acoustic environment". All items fall into five grades from one point to five points, successively indicating "totally disagree", "disagree", "neutral", "agree", and "totally agree". Higher points signify higher approval of respondents for leisure environment and landscape environment.

3.2.3. The Mediating Variable

This study contains two mediating variables, namely social participation and outdoors activity. Social participation is assessed by respondents' participation frequency in five different activities during the past 12 months, including the interest group, community activity, the lecture, the mutual-help group, and the volunteer. All items are split into five grades from one point to five points, successively manifesting "never", "a few times per year", "a few times per month", "once a week" and "twice or three times per week". Higher points represent respondents' higher social participation degrees.

Outdoors activity consists of two observable variables, namely walking frequency and walking duration. In particular, walking frequency indicates respondents' times of walking per week, and walking duration signifies respondents' times of walking per time.

3.2.4. The Control Variable

While examining the relation among neighborhood environment, lifestyle, and health of older adults, we should pay attention to older adults' socio-economic status. Therefore, this research incorporates the income level and the education level into the conceptual model as control variables. Monthly income level falls into six levels. The assignment of each level is "<1500 RMB = 1, 1500–2500 RMB = 2, 2500–3500 RMB = 3, 3500–4500 RMB = 4, 4500–5500 RMB = 5, and >5500 RMB = 6" in sequence. The education level is split into five levels. The assignment of each level is "1 = the junior high school and below, 2 = the senior high school, the technical secondary school, and the technical school, 3 = the junior college, 4 = the undergraduate, and 5 = the master and above", respectively. (1 USD = 6.9066 RMB. Cited at 19:45 on 1 February 2019 from Bank of China. Available via http://srh.bankofchina.com/search/whpj/search.jsp).

3.3. Reliability, Validity, the Fitness Test, and Model Optimization

The test results of all observable variables in the high score and low score group are significant (the high score group and the low score group are differentiated by 27 quantile and 73 quantile) with excellent discriminability. As the number of samples in the research totals 2783 (>1000) and samples approximately conform to normal distribution, sample data in the present research is suitable for SEM analysis.

By performing multi-factor confirmatory analysis on all measurement models in the conceptual model, this study finds that the load capacity of observable variable noise environment and maintenance conditions in the landscape environment measurement model are not up to 0.6. Accordingly, another multi-factor confirmatory analysis is made after deleting the two observable variables. The composite reliability of all adjusted measurement models is above 0.6; mean variance extraction quantity is over 0.5; observable variable factor load capacity is above 0.6 and the reliability coefficient is above 0.36. All measurement models are fit for SEM analysis because of good reliability and validity.

As indicated by model fitting output results, GFI (goodness-of-fit index), AGFI (adjusted goodness-of-fit index) and RMSER (root mean square error of approximation) met the ideal criterion, while the X^2/DF (ratio of chi-square to degree of freedom), IFI (incremental fit index) and CFI (comparative fit index) did not. It suggested the necessity to optimize the model. Model fitting output results demonstrate that the value of revised index between residual of "residents attracted to take a walk" (e4) and residual of "residents attracted to do exercise" (e5) was maximum. Due to the co-variation relation between the two, the chi-square value can be reduced by 57.112 at least. Subsequently, the co-variation relation between e4 and e5 was set up for the model fitting, then IFI, CFI and X^2/DF did not meet the ideal criterion. Therefore, model still needed to be optimized. After setting up the co-variation relation between residual e2 and e3, as well as e10 and e11, we found that all index met the ideal criterion. Therefore, the optimized model had favorable fit goodness. Table 2 shows more details.

Table 2. Comparison of the fit index before and after model optimization.

	GFI	AGFI	IFI	CFI	RMSEA	X^2/DF
Pre-optimization model	0.929	0.913	0.843	0.842	0.063	6.013
Post-optimization model	0.948	0.946	0.902	0.901	0.045	3.777
Ideal criterion	>0.9	>0.9	>0.9	>0.9	<0.08	<5.0

4. Results

4.1. Descriptive Statistics of Variable

Among the 2783 valid samples of older adults, there are 1163 of male and 1620 of female, in which the gender proportion is consistent with the national level. As for the division of the aging stage, the international society tends to take 60 or 65 as the benchmark of the aging population, while the scholars in China usually divide the older adults into three age groups: low-aged group (persons aged 60–69), middle-aged group (persons aged 70–79) and high-aged group (persons aged 80 or above) [59]. Consequently, this study followed this criterion to sort all samples, finally obtaining 1292 of low-aged (aged 60–69) group, 964 of middle-aged (aged 70–79) group, and 527 of high-aged (aged 80+) group. The self-rated health of older adults gradually decreases with age. The mean values of the scores of items of leisure environment and landscape environment showed little differences among various age groups. Table 3 shows more details.

Table 3. Characteristics of variables.

Latent Variables	Observable Variables	Items	Mean Scores of Items			
			All Samples	Low-Aged	Middle-Aged	High-Aged
Health of older adults	self-rated health	Your general health condition	2.35	2.52	2.26	2.08
Leisure environment	Suitability for walking	It is a pleasant thing to take a walk in the neighborhood	3.31	3.33	3.28	3.32
	Exercise opportunities	Our neighborhood affords many opportunities to do exercise	3.00	3.02	2.94	3.05
	Adequate trees	Trees inside the neighborhood provide enough shade	3.14	3.11	3.11	3.25
	Attracted to take a walk	I often see others walking in the neighborhood	3.32	3.27	3.32	3.45
	Attracted to do exercise	I often see others doing exercise in the neighborhood	3.18	3.16	3.17	3.27
	Sports facilities	Our neighborhood provides lots of sports facilities	2.95	2.97	2.89	2.98
Landscape environment	Attraction	Our neighborhood is very attractive	2.92	2.92	2.95	2.68
	Tidy and clean	There are lots of garbage and waste on roads inside the neighborhood	3.61	3.61	3.58	3.65
	Interesting architecture	Architecture and houses inside our neighborhood are interesting	2.72	2.72	2.70	2.76
Social participation	Interest group	Frequency of joining in outdoor interest groups	1.87	1.92	1.89	1.47
	Community activity	Frequency of joining in community cultural or sports activities	1.76	1.77	1.77	1.41
	Lecture	Frequency of listening to lecture or report	1.65	1.65	1.71	1.43
	Mutual-help group	Frequency of joining in self-management or mutual-help group	1.50	1.45	1.53	1.38
	Volunteer	Frequency of joining in volunteer work	1.64	1.72	1.68	1.23
Outdoor activity	Walking frequency	Times of walking per week (just recording the times of walking lasting for at least ten minutes)	4.20	4.50	3.58	3.44
	Walking duration	Duration of walking per time (just recording the times of walking lasting for at least ten minutes)	28.6	31.25	28.7	22.5
Control variable	income	Monthly income per person of your family	3.33	3.30	3.42	3.22
	education	Your level of education	2.24	2.17	2.51	1.95

4.2. Comparison of Model Paths of Older Adults in Different Age Groups

Regardless of the influence of factor load capacity, the model sets up the same path coefficient for the low-aged (aged 60–69) group, the middle-aged (aged 70–79) group and the high-aged (aged 80+) group. As shown in Figures 3–5, there exists significant discrepancy among the three age groups in terms of the model path. Consequently, it is necessary to compare the varying influence of the independent variable on the dependent variable in different age groups. Table 4 presents detailed model fitting results of different age groups.

Table 4. Group comparison of total effect, direct effect, and indirect effect.

Independent Variables	Groups	Mediating Variables				Dependent Variable		
		Social Participation	Outdoor Activity			Health of Older Adults		
			Total Effect	Direct Effect	Indirect Effect	Total Effect	Direct Effect	Indirect Effect
Leisure environment	Low-aged group	0.059	0.500 **	0.499 **	0.002	0.058	0.014	0.044
	Middle-aged group	0.053	0.341 **	0.323 **	0.018	0.134 **	0.044	0.120 **
	High-aged group	0.154 **	0.290 **	0.336 **	0.046	0.121 **	0.051	0.078 **
Landscape environment	Low-aged group	0.024	0.046	0.045	0.001	0.187 **	0.183 **	0.004
	Middle-aged group	0.122 **	0.155 **	0.113 **	0.042	0.051	−0.020	0.071
	High-aged group	0.035	0.437 **	0.452 **	0.011	0.177 **	0.205 **	−0.028
Social participation	Low-aged group	–	0.024	0.024	–	0.008	0.006	0.002
	Middle-aged group	–	0.346 **	0.346 **	–	0.284 **	0.172 **	0.112 **
	High-aged group	–	0.302 **	0.302 **	–	0.317 **	0.343 **	−0.026
Outdoor activity	Low-aged group	–	–	–	–	0.118 **	0.118 **	–
	Middle-aged group	–	–	–	–	0.324 **	0.324 **	–
	High-aged group	–	–	–	–	−0.087	−0.087	–

*** means significant at the 0.01 confidence level; ** means significant at the 0.05 confidence level; the significance test chooses the Percentile 95% confidence interval two-tailed test method. In case of any mediating variable in the model, the influence of the independent variable on the dependent variable can be divided into "total effect", "direct effect" and "indirect effect". In particular, total effect is the sum of direct and indirect effect. Total effect represents the total influence of the independent variable on the dependent variable, and indirect effect denotes the influence of the independent variable on the dependent variable via the role of the mediating variable, while direct effect represents the influence of the independent variable on the dependent variable without the role of the mediating variable (i.e., the path coefficient as shown in the model path figure).

Firstly, to study the relationships between environments and health, according to the model fitting results of low-aged (aged 60–69) group, only the positive effect of landscape environment on their health was significant. Furthermore, we examined the hypotheses about the mediating effects of social participation and outdoor activity. The results showed that only the total effect and the direct effect of landscape environment on health of older adults were significant, while all the indirect effects were not. It implied that the mediating role of lifestyle did not exist, so all the hypotheses of H1-H5 were rejected in low-aged group model. This indicated that the effects of the neighborhood environment on health of low-aged (aged 60–69) older adults were not affected by lifestyle. Figure 3 shows more details.

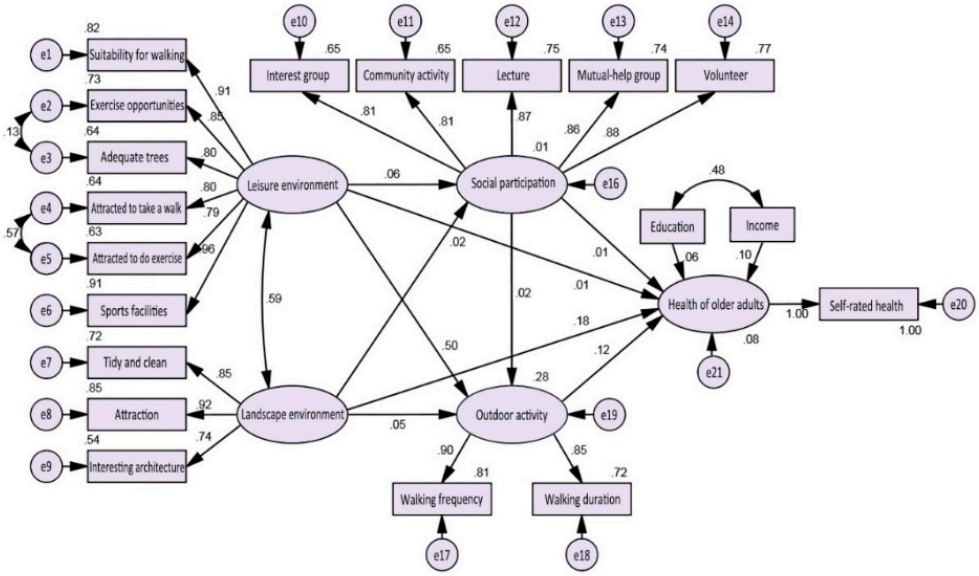

Figure 3. Standardization coefficients for low-aged group model.

Secondly, we continued to focus on the relations between environments and health. As revealed by the fitting results of middle-aged (aged 70–79) group, leisure environment had a significant positive effect on their health, but landscape environment did not. It reflected the difference with the low-aged (aged 60–69) group. The mediating effects of social participation and outdoor activity were further examined. The results clearly showed that the total effect and indirect effect of leisure environment on health of the elderly are significant, while the direct effect is not, indicating that there is a fully mediating effect of lifestyle. Since the effect of leisure environment on social participation was not significant, outdoor activities served as the only one mediator of the relationship between leisure environment and health of the middle-aged (aged 70–79) older adults. In addition, outdoor activities also partly mediated the relation between social participation and health of middle-aged (aged 70–79) older adults. Therefore, H1 and H5 were accepted, but H2-H4 were rejected. It suggested that the health of middle-aged (aged 70–79) older adults is not directly affected by neighborhood environment, but completely by the mediating role of outdoor activities. Figure 4 shows more details.

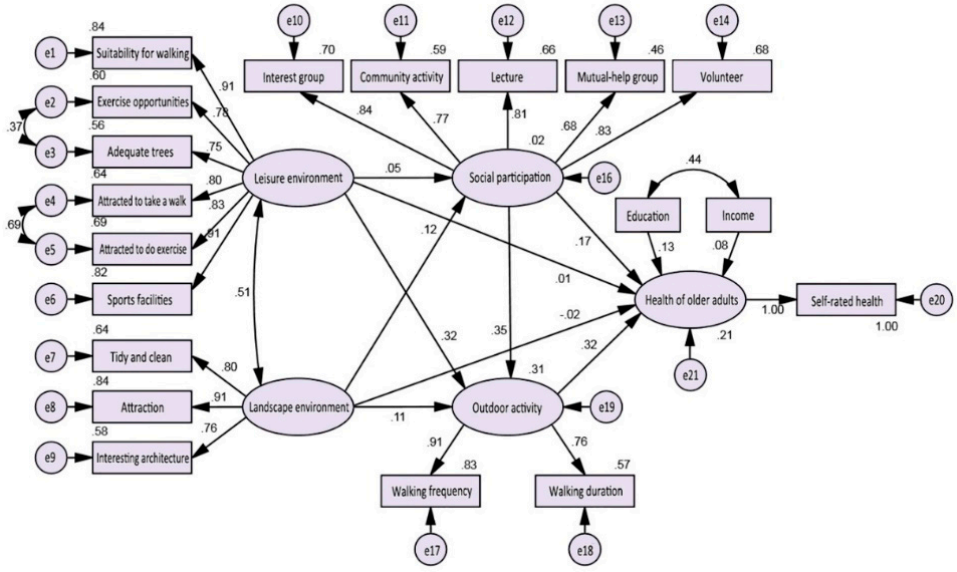

Figure 4. Standardization coefficients for middle-aged group model.

Finally, considering the fitting results of high-aged (aged 80+) group, we found that in addition to outdoor activity, the positive effects of leisure environment, landscape environment, and social participation on their health were significant. Among them, social participation had the greatest effect. This is quite different from low-aged (aged 60–69) and middle-aged (aged 70–79) group. Next, we examined the mediating effects of social participation and outdoor activity. The results showed that leisure environment did not have direct effect on health of high-aged (aged 80+) older adults, but by the fully mediating effect of social participation. Meanwhile, landscape environment and social participation had only direct effects on their health. Accordingly, all the hypotheses except H3 were rejected in the high-aged group model. In contrast to the low-aged (aged 60–69) and middle-aged (aged 70–79) group, the older adults in high-aged (aged 80+) group were more dependent on the support of social participation, which not only had direct effect on their health, but also served as a mediator of relationship between neighborhood environment and health. Figure 5 shows more details.

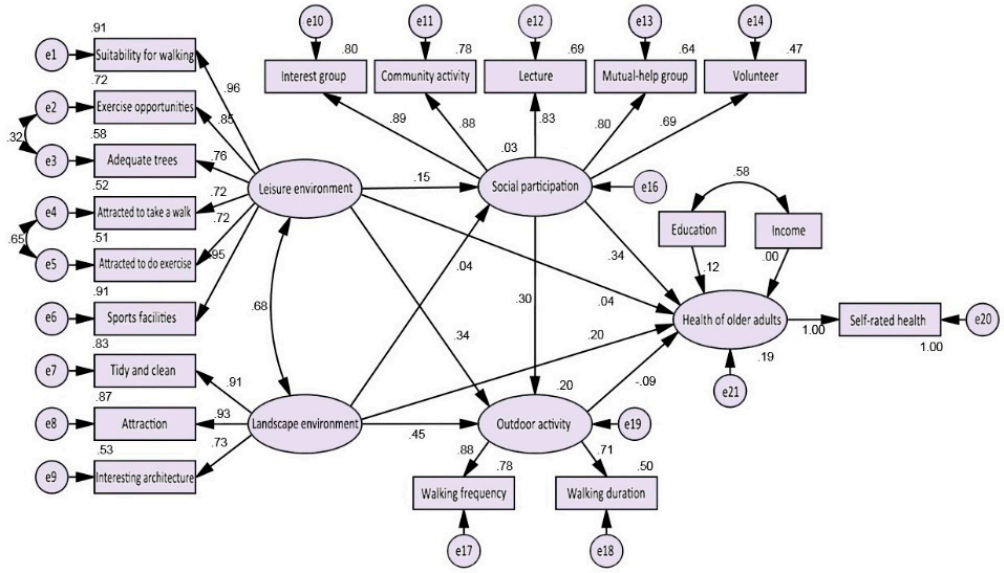

Figure 5. Standardization coefficients for high-aged group model.

5. Conclusions and Discussion

This study aimed to promote active aging and the construction of the age-friendly communities. The prime theoretical foundation of the research is the Ecological Model of Aging. We discussed the complex relations between neighborhood environment, lifestyle and the health of older adults, and compared the discrepancy of older adults in different age groups. According to the results of our study, the active lifestyle of older adults, outdoor activity and social participation, were mediators of the relationship between neighborhood environment and health in different age groups. Meanwhile, the paths of "neighborhood environment-lifestyle-health of older adults" model showed significant discrepancy among older adults in different age groups.

The low-aged (aged 60–69) older adults, rely more on the sensory comfort provided by landscape environment and the exercise of physical functions. For middle-aged (aged 70–79) older adults, their health depends more on the support of leisure environment for outdoor activity and social participation. For high-aged (aged 80+) older adults, their health is subject to the support of leisure environment for social participation. This conclusion confirmed the necessity to study neighborhood environment and health of older adults in different age groups. As proposed by Germain et al. [60], ignoring the influence of age discrepancy may bring about biased and even erroneous conclusions in older adults' health and welfare-related research.

"Neighborhood environment-lifestyle-health of older adults" model described the sophisticated relation among various factors, and stressed on the importance of lifestyle in the neighborhood

ecosystem. Despite the positive or mediating effects of lifestyle on health were different in age groups, some rules can be still seen from such complex relations. In general, leisure environment has an indirect effect on the health of older adults by mediating role of lifestyle, while landscape environment has a direct effect on it.

The discrepancy among older adults of different ages in paths of the model "neighborhood environment-lifestyle-the health of older adults" revealed that pertinent opinions and strategies must be proposed in accordance with various group traits to boost health of older adults in China generally. For low-aged (aged 60–69) group, besides the cultivation of personal healthy habits such as physical exercise, government departments should help improve the landscape environment of their residential communities. For middle-aged (aged 70–79) group, efforts should be made to increase their outdoor activity intensity, reinforce leisure environment quality, and organize activities to promote social participation. For high-aged (aged 80+) group, it is imperative to build a friendlier atmosphere in neighborhood to satisfy their urgent demands for social participation and further contribute to their health.

Additionally, this study verified the importance of neighborhood environment to lifestyle and health of older adults, provided new thoughts for the solution of government elderly-care problems, as well as offer new reference to the improvement of relevant elderly-care public policies. Governments of all the countries, especially in China, should not just focus on the elderly-care service, medical treatment, insurance problems, but also pay more attention to the building of the age-friendly communities and put neighborhood environment optimization and cultivation of the interaction atmosphere on the agenda.

It is important to note several limitations of this study. Firstly, the survey of neighborhood environment is primarily based on subjective assessment, which need more in-depth investigation and more detailed spatial analysis. Moreover, the mere provision of outdoor amenities is often not a sufficient measure of environment quality, and it should include more objective assessment indicators concerning accessibility, aesthetics, and interactivity, etc. To gain deeper insights and more comprehensive knowledge about the influential mechanism of neighborhood environment on the health of older adults, follow-up studies should scientifically and systematically combine the neighborhood environment subjective assessment with objective assessment. Secondly, social participation and lifestyle are issues that cannot be addressed solely through surveys and statistical methods, which require further interviews, fieldwork, and some big data on individual behaviors. Thirdly, the neighborhood sample size is rather limited. Since the researcher just carries out the survey in Xinhua Sub-district, Changning District of Shanghai, the representativeness of research conclusions is not adequate. More empirical studies need to be developed in the future. Finally, the representativeness of older adult samples can be further improved. Although the study has taken into full consideration of the diversity of the geographical location, transportation convenience, and completion in respect of the selection of the neighborhoods, it still failed to strictly comply with random sampling principle. Therefore, the structure of final older adult samples is uncertain, which is in need for further improvement by future research.

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