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Research Article

Understanding the Relationship between Neighbourhood Built Environment and Older Adults' Health from the Perspective of Housing Differentiation

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Studies have revealed an association between the built environment and the health of older adults. However, few studies distinguish between the objective and perceived built environments and explore their associations with older adults' health, especially when considering housing differentiation. Drawing on a survey of 426 older adults in ten residential neighbourhoods in Dongfeng Township, Beijing, this study employed structural equation modelling and the Kruskal–Wallis test to analyse the relationship between the built environment of different housing types and older adults' health. The findings revealed that the objective and perceived environments were significantly associated with older adults' health, with physical activity and social interactions as mediating factors. The perceived built environment mediates the relationship between the objective built environment and older adults' health. Moreover, it was observed that the relationship between the built environment and older adults' health varied depending on housing type, which is a crucial reflection of spatial non-stationary in the relationship between health and environment. Therefore, the varying impacts of different housing types on older adults' health should not be overlooked when developing planning and other policies for aging-friendly cities.

1. Introduction

Population aging has become a significant demographic trend in the twenty-first century [1]. World Population Prospects 2022 highlights that the population aged 65 and above will rise from 10% in 2022 to 16% in 2050. China is one of the countries that have experienced rapid population aging. According to the Seventh National Population Census in 2020, 190 million adults in China are 65 years and older, representing 13.5% of the total population. Due to older adults' decreased physical mobility, their reliance on their daily living surroundings intensifies, making them more vulnerable to certain features of, or changes to, the built environment [2–4].

The existing literature often employs the "5D" framework, which includes density, diversity, design, destination accessibility, and public transportation distance, to measure the built environment and investigate its association with residents' health [5, 6]. Numerous empirical studies have demonstrated that factors associated with the objective built environment, such as good walkability, high building density, mixed land uses, dense road network, and convenient public transportation, are positively correlated with the health of older adults [7–10]. The perceived built environment was also found to be significantly related to the health of older adults [11–13].

The perceived built environment refers to individuals' subjective feelings and psychological judgments regarding their surrounding environment. Older adults residing in the same neighbourhood may have varying perceptions of their shared built environment due to different attitudes and values, which, in turn, influence their daily behaviour and subsequently impact their health [14]. Few studies have integrated objective and perceived built environments within a comprehensive framework to examine their relationship with older adults' health [15, 16]. For instance, Kim [17] showed that a perceived walkable destination near one's home is significantly associated with a favourable health assessment, while the influence of the objective built environment is not statistically significant. Yue et al. [18] also found that the accessibility of daily life service facilities was positively correlated with older people's mental health through the indirect effect of the perceived built environment. Therefore, this study adopts a comprehensive conceptual framework to explore the complicated relationship between objective and perceived built environments and older adults' health.

Beyond identifying the association between the built environment and older adults' health, exploring how the built environment affects older adults' health has also been a point of contention in urban planning and public health fields [19]. Social ecology theory states that people's health is a consequence of interactions between human behaviour and the environment [20]. The environment-stress theory further suggests that older adults' healthy behaviours, including physical exercise and social interaction, are crucial when assessing environmental health effects [21]. Empirical studies have found that physical activity (e.g., outdoor exercise time and activity types) is a significant mediating variable in the impact of the built environment on older adults' health [22]. Additionally, place attachment theory emphasizes the connections between people and places [23]. As individuals age, place attachment becomes crucial for older adults to strengthen their self-reliance and enhance life experiences. Drawing on place attachment theory, some studies have incorporated social capital, a sense of community, and community cohesion into the mechanisms of how the built environment affects residents' health [24–28].

Due to the gradual decline in physical and cognitive functions of older adults, their range of daily activities has become limited. Coupled with the traditional concept of family-based older adult care in China and other Asian countries, local residential neighbourhoods have become older adults' primary spaces for life and leisure. In 2002, the World Health Organization proposed the concept of active aging, which had six determinants: economic, social, health and social services, behavioural, personal, and physical environment. The significance of the physical environment in affecting active aging has been highlighted [29]. In 2021, the World Health Organization further proposed the concept of healthy aging, which also emphasized the role of the residential built environment as a crucial component for the inclusive, safe, and healthy quality of life of older adults [30]. Improving their residential built environments has become a widely adopted policy strategy to promote older adults' health.

Though academic studies have increasingly focused on the association between residential built environments and older adults' health, most empirical investigations are grounded in the urban context of Western countries [31, 32]. Given the differences in the characteristics of urbanization and social and cultural backgrounds, it remains unclear whether the findings from the Western countries can be applied to elucidate the relationship between residential-built environments and the health of older adults in China and other countries. Furthermore, in China's rapid urbanization and housing market reform, housing types have transitioned from working units (*danwei*) to commercial and social housing [33–35]. Diverse housing types have contributed to spatial differentiation and social stratification based on socioeconomic status, resulting in inequalities in individuals' and families' access to health resources and opportunities [36, 37]. However, whether and how the housing differentiation plays a role in the association between the built environment and older adults' health is largely unknown.

In summary, despite compelling evidence indicating an association between the residential built environment and residents' health, the perceptual awareness of the built environment is more pronounced among older adults compared to other age groups. It is imperative to integrate both the objective and perceived aspects of the built environment into a unified research framework to explore the potential mediating role of the perceived built environment. Moreover, it is crucial to note that the current research mostly overlooks housing type variations. Whether the relationship between the built environment and older adults' health remains consistent across different housing types remains unclear. This study examines Dongfeng Township in Beijing and investigates the connections between the objective built environment, perceived built environment, physical activity, social interaction, and health of older adults. It also intends to explore whether the impact of a residential neighbourhood's built environment on older adults' health varies according to housing type. After the first section of the Introduction, Section 2 introduces the conceptual framework and hypotheses of the study, as well as the study area, data collection, and analysis methods. Section 3 reports the empirical analysis results of the case study of Dongfeng Township. Section 4 discusses the empirical findings in the context of the extant literature, and Section 5 concludes.

2. Materials and Methods

2.1. Conceptual Framework and Hypotheses. Against the existing literature, we propose a comprehensive conceptual framework that includes the objective built environment, perceived built environment, physical activity, social interaction, and the health of older adults, as shown in Figure 1. Based on the conceptual framework, we develop the following research hypotheses: (H1) the objective built environment is directly associated with older adults' health; (H2) the perceived built environment is also directly associated with older adults' health; and (H3) the perceived built environment, physical activity, and social interaction have mediating effects on the association between the objective built environment and older adults' health.

Empirically, we employ structural equation modelling to examine (1) whether the associations between objective and perceived built environments and older adults' health are statistically significant and (2) how physical activity, social interaction, and perceived built environments have potential mediating effects on the aforementioned associations.

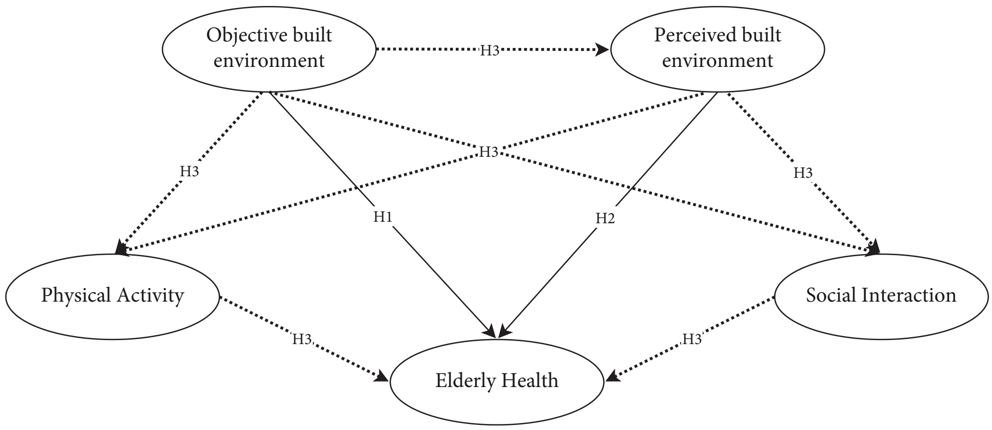

Figure 1: Conceptual framework and hypothesis.

2.2. Data Collection. Dongfeng Township is in the middle of Chaoyang District, Beijing, covering 7.38 square kilometres and 29,000 households. According to the Seventh National Population Census data in 2020, the township's permanent population was 63,000, with 21.33% aged 60 and above. With diverse housing types and a high share of older adults in the total population, Dongfeng was chosen as an ideal case study to examine the relationships among built environment, housing types, and the health of older residents. The questionnaire survey encompassed ten neighbourhoods within the Dongfeng Township, categorized according to their distinct housing types, including traditional residential, commercial, and resettlement resident neighbourhoods.

The data analysed in this study comprise both individual surveys and objective built environment measurements. Individual survey data were derived from a questionnaire survey conducted in December 2021. The sample was selected using a quota sampling method. The sampling procedure was as follows. First, ten neighbourhoods were selected from Dongfeng Township in Chaoyang District. Second, a list of older adults without cognitive impairments, provided by the neighbourhood committees in each neighbourhood, was used to randomly select 50 respondents from each neighbourhood. Participants were required to meet the following criteria: (a) be aged 60 years or older; (b) be capable of engaging in simple physical activities such as walking; (c) have unimpaired hearing and language functions for face-to-face interviews; and (d) have been residents of the local community for over one year. Fifty questionnaires were distributed in each neighbourhood, resulting in 500 distributed questionnaires. Among them, 426 questionnaires were deemed valid, yielding an effective response rate of 85%. The sample characteristics are shown in Table 1. Ethical approval for this study has been obtained from the Ethics Committee of the School of Public Administration and Policy, the Renmin University of China, and all participants provided informed consent before enrolment.

The objective built environment data for each residential neighbourhood originated from points of interest (POI), road network data, and field reconnaissance.

The traditional residential areas in Dongfeng, specifically those constructed before the 1990s, possess run-down infrastructure that impacts the living conditions of its inhabitants. Their high-density, low-rise residential structures predominantly distinguish these neighbourhoods from others. Since the launch of China's housing reforms in the late 1990s, commercial housing, usually in gated residential neighbourhoods, has been developed in Dongfeng. These commercial housing neighbourhoods feature high-quality public spaces, primarily low-to-middle-density and mid-to-high-rise residential buildings.

Resettlement residents refer to the displaced households because of the demolition of their original neighbourhoods. Resettlement resident neighbourhoods are the product of China's distinct urbanization process and specific demolition policies [38]. In Dongfeng, as in many other places in China, the resettlement resident neighbourhoods come into being following urban renewal and dilapidated housing renovation policies. Private-owned houses or public-owned houses within the renovation area are removed by the developer. Subsequently, displaced households are resettled based on resettlement policy standards and the previously signed demolition agreements with the developer. The notable characteristic of these resettlement resident neighbourhoods is the presence of high-density multistory residential buildings.

2.3. Variable Measurement. This study investigated the health status of older adults from three dimensions: self-rated health, the prevalence of chronic diseases, and mental health. Self-rated health possesses strong predictive power for morbidity and mortality rates, making it a widely used indicator in health research. Participants were asked "How do you feel about your physical health?" and they responded on a Likert scale ranging from 1 (very poor) to 5 (very good), with higher scores indicating better health. The participants were then asked about the presence of the following eight chronic diseases: hypertension, diabetes, depression, severe insomnia, cardiovascular disease, cerebrovascular disease, respiratory disease, or joint conditions. The total number of

Table 1: Characteristics of participants ($N = 426$).

	Category	Number	Percentage (%)
Age (years)	60–69	286	67.14
	70–79	104	24.41
	80 and older	36	8.45
Gender	Female	235	55.16
	Male	191	44.84
Education	Primary school and below	36	8.45
	Middle school	144	33.80
	High school	151	35.45
	Associate degree	72	16.90
	Bachelor's degree or above	23	5.40
Career	Farmers	19	4.46
	Company staff	274	64.32
	Self-employed	14	3.29
	Civil service	68	15.96
	Service staff	24	5.63
	Freelance	12	2.82
	Others	15	3.52
Personal monthly income	Less than 2000	23	5.40
	2000–4000	247	57.98
	4000–6000	119	27.93
	6000–8000	12	2.82
	More than 8000	25	5.87
Marital status	Married	372	87.32
	Other	54	12.68
Residence status	Living with others	366	85.92
	Living alone	60	14.08
Housing type	Resettlement housing	126	29.58
	Old residential neighbourhood	151	35.45
	Commercial housing	149	34.97

chronic diseases reported by the respondents was tallied, with higher values indicating a poorer health status. Mental health was assessed using the short form of the Warwick-Edinburgh Mental Well-Being Scale, a seven-item, 5-point Likert scale, with 1 representing "never" and 5 representing "always," to gauge the respondents' feelings about the questions. The average total score was calculated, with higher scores indicating better mental health.

Prior research has demonstrated a strong correlation between the objective built environment, measured within a 500-meter buffer zone of a resident's home, and older adults' health [39]. Considering the daily travel activities of older adults, and based on the "5D" framework, indicators such as road network density, land use diversity, the shortest distance to service facilities (including shopping, health, leisure), and vegetation coverage were identified to measure objective built environment factors (Table 2). All indicators were measured within a 500-meter buffer zone of each residential neighbourhood.

Drawing on the Neighbourhood Environment Walkability Scale [40], the perceived built environment was evaluated through the responses of older individuals to questions concerning their overall satisfaction with the neighbourhood environment, accessibility of service facilities, travel safety, and their perception of environmental pollution. A traffic environment that is safe for walking and favourable air quality may motivate older adults to engage in more outdoor activities, thereby improving their health. During the interviews, some older adults stated that "walking on roads with separate lanes for pedestrians and vehicles feels safer." In contrast, others noted that they would only participate in outdoor activities "when air pollution levels are low."

One of the aims of this study was to investigate the influence of the built environment on older adults' outdoor activities at the residential neighbourhood level. The frequency of walking, duration, and intensity of physical activity were chosen to measure physical activity. The number of weekly outdoor walks assessed walking frequency, whereas walking duration was the average time spent on these outdoor walks. The intensity of physical activity was calculated using the short version of the International Physical Activity Questionnaire (IPAQ) [41].

Social interactions among the residents in the neighbourhood play a crucial role in fostering healthy interpersonal relationship networks and, consequently, improving mental health. This study measured social interactions from three dimensions: familiarity with residents, frequency of participation in neighbourhood activities, and mutual assistance among residents. Each aspect was assessed using a 5-point Likert scale ranging from 1 (very poor/low) to 5 (very good/high), with higher scores signifying closer interactions and increased social capital among older adults within the residential neighbourhood.

Table 2: Variable measures and descriptive statistics.

	Variables	Abbreviation	Measure	Cronbach α (KMO)	Overall average	Resettlement housing	Old residential neighbourhood	Commercial housing	P value
Older person's health	Self-rated health	SRH	How do you feel about your health?	0.89	3.65	3.57	3.63	3.70	<0.001
	Number of chronic diseases	NCD	Number of chronic diseases		2.13	2.22	2.17	2.08	0.238
	Mental health	MH	WEM-WBS		3.89	3.91	3.84	3.97	<0.001
Objective built environment	Road network density	OBE1	Length of road/area of buffer (km/km^2)	0.68	0.96	0.97	0.99	0.87	<0.001
	Land use mix	OBE2	EI of different types of POI		2.21	2.20	2.25	2.15	<0.001
	Distance to nearest shop	OBE3	Distance from residence of older person to nearest shop (km)		0.21	0.29	0.16	0.22	<0.001
	Distance to nearest health service	OBE4	Distance from residence of older person to nearest health service (km)		0.31	0.28	0.22	0.55	<0.001
	Distance to nearest recreational site	OBE5	Distance from residence of older person to nearest recreational site (km)		0.44	0.44	0.43	0.47	0.026
	Green space	OBE6	NDVI = (IR − R)/(IR + R)		0.23	0.22	0.21	0.27	<0.001
Perceived built environment	Overall satisfaction with neighbourhood environment	PBE1	What is your overall satisfaction with your neighbourhood environment?	0.81 (0.713)	3.70	3.85	3.55	3.83	<0.001
	The convenience of service facilities	PBE2	What is your overall satisfaction with the surrounding services?		3.62	3.59	3.51	3.97	0.002
	Travel safety perception	PBE3	Do you feel safe in traffic when you walk outdoors?		2.62	2.44	2.72	2.67	0.001
	Environmental pollution perception	PBE4	Do you think the environmental problems such as air pollution and noise pollution are serious?		3.57	3.55	3.49	3.78	0.005
Physical activity	Walking time	PA1	Duration of each outdoor walk (hr)	0.86 (0.671)	1.12	1.18	0.94	1.16	0.112
	Walking frequency	PA2	Number of outdoor walks per week		5.19	5.27	5.07	5.20	0.048
	Physical activity intensity	PA3	MET × Weekly activity time (min)		2266	2456	1812	2325	0.039
Social interaction	Familiarity among residents	SI1	How well do you know each other and the other residents in your neighbourhood?	0.85 (0.762)	4.09	4.14	4.17	3.78	0.002
	Frequency of participation in community activities	SI2	How often do you participate in cultural and recreational activity organized by the residential neighbourhood?		4.03	4.12	3.96	4.05	<0.001
	Mutual help among residents	SI3	Do you think neighbours are willing to help each other?		4.00	4.07	3.99	3.89	0.035
Control variables	Age		Age		68.23	68.39	68.12	68.28	
	Gender		Female = 0, male = 1		0.45	0.44	0.46	0.46	
	Residence status		Living alone = 0, living with others = 1		0.86	0.81	0.85	0.94	

EI denotes the Entropy Index of land use. Within this equation, S_i represents the proportion of the i^{th} type of POI (Point of Interest) to the total number of POIs in a 500-meter buffer zone, while N signifies the number of POI categories present in the buffer zone. These categories include dining and food, companies and enterprises, shopping and consumption, transportation facilities, financial institutions, hotels and accommodations, science, education and culture, tourist attractions, automobile-related services, commercial and residential areas, daily life services, leisure and entertainment, healthcare, sports, and fitness. The NDVI was derived from the differential surface reflectance in the red (R) and infrared (IR) bands from a multispectral satellite image dataset.

As older adults' physical capabilities diminish differently, individual sociodemographic characteristics influence their health status. We used gender (male and female), age (60–69, 70–79, and 80+), and residential status (living alone or not) as control variables [42].

2.4. Statistical Analysis. This study used the Kruskal–Wallis (KW) test and structural equation modelling. The KW test examined the statistical significance of the mean value differences among various housing types. Structural equation modelling was employed to analyse the relationships between the objective built environment, perceived built environment, physical activity, social interaction, and the health of older people.

Before conducting the structural equation model analysis, a thorough reliability and validity assessment of the variables was conducted to ensure the adaptability and dependability of the model (Table 2). Confirmatory factor analysis was conducted on all latent variables within the model by examining standardized factor loadings, composite reliability, and average variance extracted/convergent validity. Upon evaluation, all observed variable factor loadings exceeded 0.6, composite reliability surpassed 0.6, and convergent validity exceeded 0.5. Thus, the measurement model demonstrated strong reliability and validity, suggesting that it is appropriate for structural equation model analysis.

To assess the goodness of fit of the structural equation model, the goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), chi-square/DF, and root mean square error of approximation (RMSEA) were employed. Using these general test criteria on the model produced GFI > 0.9, AGFI > 0.9, CFI > 0.9, RMSEA < 0.08, and X2/DF < 5. The structural equation model operated within the AMOS environment, and the statistical significance of the mediation effect was examined using bootstrap analysis.

3. Results

3.1. Descriptive Statistics. Tables 1 and 2 present the basic characteristics of the interviewees and descriptive statistics for each variable, respectively. Table 2 reveals the differences in the objective built environment, perceived built environment, physical activity, social interaction, and health of the older adults in various housing types. A significant majority (89%) of the surveyed older adults rated their health as good or above, with an average self-rated health score of 3.65, and mental health scores were even higher, with an average of 3.89, even though 78% of patients had at least one chronic disease.

Regarding the built environment, traditional residential neighbourhoods exhibited the highest road network density, land-use mix, and the shortest distances to service facilities and green spaces. However, commercial housing neighbourhoods demonstrated better accessibility and greenery levels compared to the other two housing types. In terms of the perceived built environment, older adults in resettlement resident neighbourhoods expressed the highest satisfaction with their neighbourhood environment, suggesting that the newly constructed housing has been designed in a manner that significantly enhances living conditions. In contrast, older adults in traditional residential neighbourhoods reported the lowest satisfaction level, indicating that their built environment and infrastructure may be less capable of meeting their daily travel and activity needs. Commercial housing neighbourhoods outperformed others regarding the convenience of service facilities, travel safety, and environmental pollution perception levels.

Regarding physical activity, older adults in resettlement neighbourhoods achieved the highest average scores for walking time, frequency, and intensity of physical activity, reflecting positive walking habits and exercise behaviours. In contrast, those living in traditional residential neighbourhoods had the lowest average physical activity scores. Regarding social interaction, older adults in resettlement resident neighbourhoods scored the highest (on average) regarding familiarity with other residents, frequency of participation in community activities, and mutual assistance, indicating a higher degree of social capital within resettlement resident neighbourhoods.

Descriptive data revealed numerical disparities in health levels and built environments across various neighbourhood types. The KW test results further demonstrated that except for the number of chronic diseases and walking time per week, the remaining variables exhibited statistically significant differences among the distinct neighbourhood types (Table 2). Nevertheless, the associations and potential influencing mechanisms among the built environment, physical activity, social interaction, and health remain ambiguous. We established statistical models by employing a structural equation model to delve deeper into the connections between these factors.

3.2. Regression Results of Structural Equation Models. Figure 2 illustrates the relationships among the variables in the conceptual framework of the study (objective built environment, perceived built environment, physical activity, social interaction, and health of older adults). In mediating variables within the structural equation model, associations among latent variables can be more accurately investigated through total, direct, and indirect effects (Table 3).

After accounting for individual factors such as age, gender, and residence status, all path coefficients in the structural equation model were significant, thereby supporting the hypotheses in Section 2.1 (Table 3). The standardized path coefficients revealed that the total effect values for the objective built environment, perceived built environment, physical activity, and social interaction with older adults' health were 0.349, 0.504, 0.153, and 0.114, respectively. The perceived built environment was significantly associated with older adults' health. The positive correlation coefficients between the perceived built environment and older adults' health were greater than those of the objective built environment, indicating that the perceived built environment was more strongly associated with older adults' health than the objective built environment. The relationship between the objective built environment and older adults'

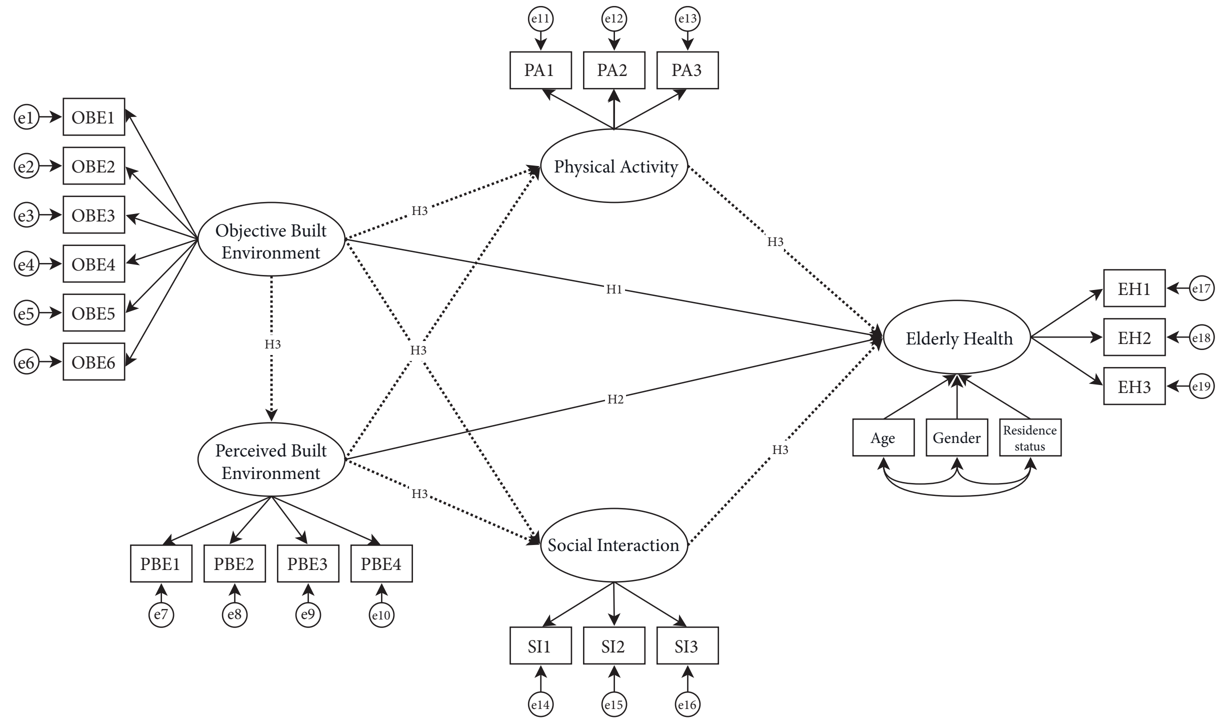

Figure 2: Structural equation model fitting diagram.

health was mediated by perceptual built environment, physical activity, and social interaction, with mediation effect values of 0.126, 0.018, and 0.021, respectively.

3.3. Comparison of Regression Results among Different Housing Types. The structural equation model analyses relationships among multiple variables and calculates path coefficients between groups using the group comparison method, revealing path differences between these groups. We employed the group comparison method within the structural equation model to compare the various housing types. Initially, we tested the unrestricted model fit of different housing type groups. Then, we tested the model fit after restricting all path coefficients of different housing type sample groups to be equal and comparing the chi-square value differences between the two models. The presence of significant differences between groups was determined using a p value test. Finally, the structural path coefficients were analysed based on the significant differences between the group models. With the model unaffected by the amount of factor loading, the structural equation model path coefficients of the old communities, resettlement housing, and commercial housing were set equal. The output results show that $p < 0.05$, indicating significant differences in the structural equation model path coefficients of the different housing type groups. Table 4 presents the structural equation model fitting results for various housing types.

In old residential neighbourhoods, the objective built environment, perceived built environment, physical activity, and social interaction exhibited significant positive correlations with the health of older adults, with total effect values of 0.278, 0.146, 0.315, and 0.143, respectively. The path coefficients of the relationship between the objective built environment, the perceived built environment and older adults' health were 0.184 and 0.124, respectively, supporting Hypotheses 1 and 2. The perceived built environment was significantly positively correlated with older adults' health, without mediation by physical activity or social interaction. Physical activity served only as a mediating factor in the relationship between objective built environment and older adults' health, with a mediating effect value of 0.033. While social interaction was positively correlated with older adults' health, it did not serve as a mediating variable in the relationship between the objective and perceptual built environment and older adults' health. Therefore, Hypothesis 3 is not supported by the results in older residential neighbourhoods.

In resettlement resident neighbourhoods, the path coefficients of the structural equation model for older adults' living conditions were significant, and the regression results aligned with the total sample. The objective built environment, perceived built environment, physical activity, and social interaction exhibited significant positive correlations with older adults' health, with total path coefficients of 0.285, 0.323, 0.274, and 0.308, respectively. The indirect effect coefficients of the relationship between the objective and perceived built environment and the health of older adults were greater than the direct effect coefficients, suggesting that the positive relationship between the objective built environment and the health of older adults was more likely to be mediated by mediating variables such as the perceived built environment, physical activity, and social interactions.

Table 3: The regression results of full samples (direct, indirect, and total effects).

Variables	Perceived built environment			Mediating variables: Physical activity			Social interaction			Dependent variable: Older adult health		
	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect
OBE	0.277***	0.277***		0.115***	0.094***	0.021***	0.191**	0.102***	0.089***	0.349***	0.184***	0.165***
PBE				0.076***	0.076***		0.323***	0.323***		0.504***	0.455***	0.048***
PA										0.153***	0.153***	
SI										0.114***	0.114***	

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.001$.

Table 4: Regression results for different types of housing (direct, indirect, and total effects).

		Mediating variables									Dependent variable		
		PBE			PA			SI			EH		
		Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect
Old residential neighbourhood	OBE	0.390***	0.390***		0.107***	0.088***	0.019	0.088	0.068	0.020	0.278***	0.184***	0.094**
	PBE				0.048	0.048		0.050	0.050		0.146***	0.124***	0.022
	PA										0.315***	0.315***	
	SI										0.143*	0.143*	
Resettlement housing	OBE	0.321***	0.321***		0.280***	0.158***	0.122***	0.336**	0.154***	0.182***	0.285***	0.091***	0.194***
	PBE				0.379***	0.379***		0.568***	0.568***		0.323***	0.044***	0.279***
	PA										0.274***	0.274***	
	SI										0.308***	0.308***	
Commercial housing	OBE	0.215***	0.215***		−0.145	−0.148	0.003	−0.050	−0.103	0.054	−0.093	−0.157	0.064
	PBE				0.015***	0.015***		0.250	0.250		0.483***	0.466***	0.017***
	PA										0.230***	0.230***	
	SI										0.053***	0.053***	

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.001$.

The mediating effect value of the perceived built environment was 0.014, whereas those of physical activity and social interaction were 0.076 and 0.103, respectively. Hypotheses 1, 2, and 3 are supported by these findings.

Because of their perception of the built environment, older adults in resettlement resident neighbourhoods were more likely to engage in physical activity and social interaction than those of the other two housing types. Compared to the fitting results of the other two housing types, older adults in relocated houses perceived the built environment as being more conducive to promoting physical activity and social interaction. Additionally, the correlation between social interaction and older adults' health was higher in the relocated house group than in the other two groups, further emphasizing the differences among the three housing types.

The regression results of the structural equation model for the commercial housing neighbourhoods deviated from those of the other two groups and exhibited inconsistencies with the total sample fitting results. The path coefficient of the relationship between the objective-built environment and older adults' health was insignificant, suggesting that the objective-built environment may not be directly associated with older adults' health. This finding demonstrates that perceived built environment, physical activity, and social interaction were positively correlated with older adults' health, with total path coefficients of 0.483, 0.230, and 0.053, respectively. The perceived built environment was directly associated with older adults' health, confirming Hypothesis 2. However, only the perceived built environment and physical activity had mediating effects, indicating that Hypothesis 3 was invalid. The mediating effect value of the perceived built environment was 0.103, whereas that of physical activity was 0.003. The mediating effect of social interaction between the built environment and older people's health was not significant. This aligns with the regression results for traditional residential neighbourhoods and suggests the need for further investigation.

4. Discussion

4.1. Neighbourhood-Built Environment Is Significantly Associated with the Health of Older Adults. The residential built environment at the neighbourhood level, encompassing objective and perceived aspects, demonstrates a significant association with older adults' health. It suggests that an age-friendly built environment could help reduce older adults' health risks arising from declining physical function. The objective built environment of man-made facilities and public spaces within a residential neighbourhood can be altered through planning policies and design. A favourable walking environment, a suitable land-use mix, and easily accessible service facilities can decrease the likelihood of chronic diseases among older adults [43].

The perceived built environment involves individuals' subjective feelings and psychological status about the neighbourhood environment and its transformation. Based on the standardized coefficients of the total sample's regression results, the direct correlation between the perceived built environment and older adults' health (0.504) is greater than that of the objective built environment (0.349). A favourable perception of the built environment could influence the health of older adults by promoting health-related behaviours, increasing opportunities to access services and facilities, and positively affecting individual psychological well-being in the social environment. Owing to the decline in physical function and reduced activity range of older adults, the immediate surrounding residential environment at the neighbourhood level is vital to their daily activities. The level of satisfaction with the built environment is thus closely related to the health of older residents.

The association between a neighbourhood's built environment and the health of its older adults may be mediated by physical activity and social interaction. As both objective and perceived built environments are associated with older adults' health through physical activity, the mediating effect of physical activity on the association between the objective built environment and older adults' health is more significant. A well-designed residential neighbourhood could positively influence older adults' health by encouraging individual physical activity. Features such as a well-designed pedestrian traffic system, easily accessible service facilities, mixed land use, and expansive green spaces could enhance physical activity among older residents, thereby promoting their health. Research evidence in public health demonstrates that maintaining a certain intensity of physical activity can improve metabolic function, enhance physical resistance, improve cardiovascular and musculoskeletal system health, and has a significant positive effect on the prevention of chronic diseases and the maintenance of physical and mental health [44–46]. Active social interactions could promote the dissemination of health-related information among older adults and enhance social cohesion and belonging by strengthening communication and trust [47, 48].

During the field survey, it was also observed that older adults residing in residential neighbourhoods with high building densities, limited public spaces, mixed traffic, and insufficient road signs often felt uncomfortable. When planning and constructing healthy residential areas, improvements in the quality of the built environments should be considered. The design of outdoor public spaces should accommodate the older adults' physical exercises, mobility, and living habits, enhancing their perception of the built environment's safety, comfort, accessibility, and convenience [49].

4.2. Association between Neighbourhood-Built Environment and Older Adults' Health Varies with Housing Type. The different housing types in Dongfeng exhibited significant differences in the relationships between the objective built environment, perceived built environment, physical activity, social interaction, and the health of older adults. Previous research has primarily focused on the built environment's impact on the health of older adults using the entire sample population, overlooking the distinctions between housing types. It may have resulted in skewed findings.

Residential self-selection mechanisms may be present because survey participants may choose their living environments based on personal preferences, potentially leading to biased model-fitting results. Nevertheless, resettlement resident neighbourhoods served as a sample of non-self-selected residents, thus effectively reducing the possible skewing caused by residential self-selection. The regression results for the resettlement resident neighbourhoods aligned with the entire sample, validating the robustness of the overall sample results to some extent.

More importantly, uncovering the differences in the relationship between the built environment and older residents' health in various housing types has significant theoretical implications for studying health inequality among older adults. Existing research suggests that physical activity in neighbourhoods with low socioeconomic status relies more heavily on the objective built environment. In contrast, the association between physical activity and the objective built environment in neighbourhoods with high socioeconomic status may be limited [50]. The regression results for old residential and commercial housing neighbourhoods supported this argument. Some scholars have characterized health inequality arising from the heterogeneity of the built environment as the spatial non-stationary of the environment-health relationship [51], which means the built environment's potential impacts on residents' health vary across neighbourhoods within the same city.

The differences in the regression results of various housing types in this study serve as a crucial illustration of the spatial non-stationary of the health-environment relationship. The reasons for spatial non-stationary are twofold: first, it stems from the heterogeneity of the built environment, and second, it may be associated with omitting other built environment variables during the model-calibration process [52]. Housing disparities contribute to built environment inequality, leading to differential participation among older adults in behaviours that affect health, such as physical activity and social interaction, ultimately resulting in different health outcomes. Future research should investigate the impact of the spatial non-stationary on the association between the built environment and older adults' health to unveil health inequality issues further and minimize research bias.

4.3. Limitations. This study has several limitations. First, it focused solely on Dongfeng Township in Chaoyang District, Beijing, resulting in a relatively small survey scope and sample size of older adults. While this study employs group analysis to consider housing differences, the generalizability of the findings to other residential neighbourhoods in Beijing or elsewhere in China and other countries remains uncertain. Given the complex relationship between the built environment and the health of older adults, which may be specific to certain housing neighbourhood environments, future research should utilize citywide or nationwide survey samples to conduct more comprehensive empirical studies.

Second, this study relied on cross-sectional data, which can elucidate the association between the built environment and older adults' health but cannot establish a causal relationship. Future research should utilize urban renewal or old neighbourhood upgrade projects as opportunities to conduct longitudinal tracking surveys and reveal the influencing mechanism of the urban built environment's impact on health through quasi-natural experiments. This would help identify whether and how causal relationships exist.

Finally, the selection of indicators for housing type, built environment, and health status in this study has been limited. This analysis solely focuses on the relationship between the built environment of different housing types and older adults' health, neglecting other potential mediating pathways such as environmental exposure, dietary behaviour, family support, transportation safety, and other demographic and socioeconomic characteristics of older adults. Future studies should incorporate a broader range of built environments and individual variables for a more comprehensive understanding of this issue.

5. Conclusions

We employed structural equation modelling to examine the relationships between objective and subjective built environments, physical activity, social interaction, and older adults' health in a particular township in the Chaoyang District of Beijing. Our findings revealed that objective and perceived built environments were significantly related to older adults' health, with physical activity and social interactions as important mediators. The perceived built environment also mediates the influencing pathway through which an objective built environment affects older adults' health.

In addition, we examined the potential influence of housing differences on the association between the built environment and older adults' health. The findings demonstrate that the influence of the built environment on older adults' health varies across neighbourhood types. This suggests that neighbourhood type has heterogeneous effects on older adults' health, potentially leading to health inequality stemming from housing inequality. Urban planners should implement targeted built environment renovations based on the characteristics of different neighbourhoods and the behavioural tendencies of older adults. By providing proactive health behaviour intervention strategies and encouraging residents to actively engage in physical activities and social interactions, we could alleviate health inequality and improve the health levels of older adults.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Bo Qin was responsible for methodology, review and editing, supervision, and investigation. Seungju Choi was responsible for data curation and software. Wangsheng Dou was responsible for conceptualization, formal analysis, data curation, and original draft preparation. Meizhu Hao was responsible for data curation and review and editing.

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