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Article

# Impacts of built environment satisfaction on self-rated health outcomes in new-type village communities: A case study of Shanghai outskirts

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**Abstract:** The existing studies on the association between the built environment and health mainly concentrates on urban areas, while rural communities in China have a huge demand for a healthy built environment, and research in this area remains insufficient. There is a lack of research on the health impact of the built environment in rural communities in China, where there is a significant demand for advancements in the healthy built environment. Exploring the Influence of built environment satisfaction on self-rated health outcomes in New-type village communities has positive significance for advancing research on healthy village community. This paper selects four new-type village communities as typical cases, which are located in the far suburbs of Shanghai, China. A questionnaire survey was conducted on individual villagers, and 223 valid questionnaire samples were obtained. A PLS-SEM model was developed using survey data to examine how built environment satisfaction influences dwellers' self-rated health while taking into account the mediating function of the perceived social environment. Moreover, multi-group analysis was performed based on age. The results show that built environment satisfaction indirectly influences residents self-rated health through its impact on perceived social environment. The research also discovered that the relationship between built environment satisfaction, social environment satisfaction and self-rated health is not influenced by age as a moderating factor. The research offers new insights for the planning and design of new-type village community from a health perspective.

**Keywords:** new-type village community; built environment satisfaction; social environment satisfaction; self-rated health; PLS-SEM model

## 1. Introduction

Improving the population health of rural communities is a significant measure to attain the sustainable development goals (SDGs) of public health (Sachs et al., 2019; World Health Organization, 2015). In China, the guidance for creating a healthy rural living environment was first proposed in 2016 to address the problems of dirt, disorder, and poor living conditions in rural communities (Zhang and Zhang, 2020). Its main purpose is to improve people's living environment through rural infrastructure construction, policy advocacy, and other measures to promote health status. In recent years, the construction of healthy rural areas in China mainly focuses on improving the objective environment of rural areas, including the treatment of domestic waste and sewage (Qing et al., 2021), the establishment of fitness facilities (Shi et al., 2022), and the addition of medical infrastructure (Wang et al., 2019). However, these measures cannot fully meet China's health requirements from physiological to

psychological aspects, and from material conditions to services in 2030 (Tan et al., 2017).

Shanghai, as the center of urbanization and rural revitalization in China, is crucial for research on healthy rural revitalization. Since 1978, Shanghai's urbanization rate has increased from 58.7% to 91.78% in 2022, and its Gross Domestic Product (GDP) has risen from 27.281 billion RMB to 4.46528 trillion RMB, leading the country with a high level of urbanization and strong economic capacity (SMBS, 2022; Yang et al., 2019; Zhang et al., 2010). These changes have improved the living environment and economic conditions of rural residents, but they have also caused issues such as rural homogenization, population aging, and excessive urbanization (Yang et al., 2015). To achieve sustainable rural transformation, Shanghai launched the "Boutique Village" project in 2017 (Sun et al., 2017). In this process, Shanghai has built numerous new-type village communities, characterized by public space layouts that meet residents' needs, comprehensive supporting facilities, and distinctive regional features (Sima and Wen, 2022). These construction measures are expected to enhance the physical and mental well-being of residents. However, the practice of optimizing built environment in rural communities to promote health has not been fully explored, and related research is relatively insufficient. Therefore, with Shanghai's new-type rural communities as a research area, how their built environment affects health deserves thorough investigation to promote health-oriented rural revitalization in China.

The community environment, including the built and social environment, and covering objective and perceived dimensions, has become a key factor in environmental and population health research. Factors such as housing buildings, open spaces and service facilities in the objective built environment of the neighborhood will affect residents' behavior, thus affecting personal health, including objective health status and self-assessment health results (Gelormino et al., 2015; Matthews and Yang, 2010). According to recent empirical studies, the community built environment plays a key role in affecting the physical and mental well-being of residents (Zhang et al., 2019; Zhong et al., 2022). In addition, the influence of perceived social environment in neighborhoods on health has garnered considerable focus in public health studies, largely due to the increasing emphasis on the concept of "social capital" in recent years (Ehsan et al., 2019; Hill-Briggs et al., 2021; Nutakor et al., 2023).

Existing research has shown a strong connection between perceived community environment and human health (Kent et al., 2017; Ou et al., 2018). Perceived community environment refers to residents' subjective evaluation of community built and social environments, measured by residents' self-reported satisfaction with these environments, including built environment satisfaction as well as social environment satisfaction (Cerletti et al., 2021; Lin and Huang, 2018). Perceived built environment, such as higher satisfaction with housing, green areas and infrastructure, is linked with better physical and psychological well-being status (Cerletti, et al., 2021). The studies in China and Canada have confirmed a positive correlation between perceived social environment such as community support and sense of belonging and inhabitants' mental and physical health (Chai, 2023; Qiu et al., 2019).

Wen et al. (2006) demonstrated that perceived community environment, including perceptions of built environment and social environment, is a key pathway linking the objective community environment to self-rated health. Additionally, they

mentioned that, compared to the objective community environment, the perceived community environment's influence on individual health status could be more explanatory. Thus, assessing perceived built environment (built environment satisfaction) as well as perceived social environment (social environment satisfaction) may provide deeper insights into how the rural community environment influences inhabitants' self-rated health outcomes.

Self-rated health outcome is a subjective health measurement indicator which comprehensively reflects physical and mental health condition (Cislaghi and Cislaghi, 2019; Liang and Whitelaw, 1991). Compared with traditional health indicators, SRH indicators can more effectively reflect the objective health condition, and have the advantages of simplicity and ease of implementation (Au and Johnston, 2014). This research takes the four new-type village communities in Shanghai as the survey sites, and from the perspective of residents' subjective perception of the built and social environment, discusses the relationship between the rural built environment and social environment and residents' self-assessment of health status, so as to provide a basis for better promoting rural health environment construction. Moreover, the results of the research may guide policy decisions in township planning, landscape design, as well as environmental management to enhance the physical and psychological well-being of rural dwellers.

## 2. Theoretical background

To establish a theoretical foundation for this research, a review of the existing literature was conducted, highlighting the concepts of built environment, social environment, and self-rated health. Subsequently, based on this, the hypotheses and conceptual framework of the research were developed.

### 2.1. The relationship between built environment and self-rated health

Built environment can be divided into objective and subjective built environment. Ding et al. (2015) and Guo et al. (2017) proposed that objective built environment is defined as quality and features of artificial environment, while subjective built environment refers to people's subjective feelings and cognition of the built environment. Some studies have shown that five-point or seven-point Likert scales can be used to measure indicators such as housing quality, hygiene and greenery to evaluate residents satisfaction with the built environment (Adriaanse, 2007; Kim and Lee, 2020; Wang et al., 2021).

Self-rated health has increasingly become a significant indicator of health research. self-rated health may rely on the individual's definition of health, including social, physical, and psychological aspects, as well as the personal actual health condition and future well-being expectations, and conduct a multi-dimensional evaluation of the individual's health (Bailis et al., 2003; Hamplová et al., 2022; Sirois, 2020). Studies from multiple countries and social backgrounds have confirmed that this subjective and overall health indicator may be able to judge health status reliably, accurately, and quickly (Bacak and Schnittker, 2014; Bombak, 2013; Wang et al., 2023). In particular, self-evaluated health has proven to be a relatively reasonable predictive indicator of death rate in large-scale demographic surveys (Jylhä, 2009).

Due to these advantages, more and more scholars have taken self-assessed health as the indicator of health outcomes in recent studies regarding health cities. Further, health rating obtained from Likert scale is a commonly used index for self-rated health measurement in research (Cachioni et al., 2021; Lu et al., 2022; Xiao et al., 2020). Therefore, self-rated health can serve as the comprehensive indicator of the overall health status of participants in the setting of rural China communities.

Although numerous studies examine self-evaluated health, few concentrate on self-rated health among Chinese rural inhabitants. a limited number of known research in China mainly analyze the factors affecting the self-assessed health of rural citizens from the perspective of public health, including relative income and social environment (Cai et al., 2017; Lu et al., 2021; Yu et al., 2022). Furthermore, in China, many pertinent researches tended to concentrate on the older population (Li et al., 2022; Liu et al., 2022; Qin et al., 2021). However, the association between the self-rated well-being of rural inhabitants and their subjective views of the rural community built environment remains unclear and needs to be determined.

The existing literature shows that the building environment is related to self-assessed health of dwellers. Firstly, the influence of the built environment on health can be evaluated from two perspectives. On one hand, objective elements of the built environment impact individuals' behaviors, such as access to food, opportunities for physical activity, and social interactions (Hurvitz et al., 2014; Pinter-Wollman et al., 2018; Saarloos et al., 2009), and therefore influence health outcomes (Mouratidis, 2021). According to research of Hajrasoulih et al. (2018) and Wan et al. (2022) on the objective drivers of healthy communities, density, mixing, proximity to public transport, and accessibility of convenience facilities and green parks are positively linked with self-rated health of inhabitants. Conversely, poor environmental conditions, such as poor sanitation and inadequate medical facilities, generally have a negative effect on health, thus growing the possibility of dwellers judging themselves as suffering from physical and mental diseases (Liu et al., 2021; Made et al., 2020). On the other hand, personal subjective perception of the building environment will affect their behavior and choices. For example, whether they choose to walk or go to the park will affect their physical and mental health (Kent et al., 2017; van Dinter et al., 2022). Besides, satisfaction with the quality of residential housing and community facilities, such as sports, entertainment, commerce, medical care, schools, and transport, has a significant direct correlation with self-evaluation of health and subjective well-being (Gu and Ming., 2021; Mouratidis, 2020).

Moreover, Ou et al. (2018) demonstrated that perceived built environment has a greater influence on self-assessed health compared to objective built environment. Additionally, various people may have diverse views of the identical built environment (Kent et al., 2017). This is because perceived built environment is a subjective concept, influenced by individuals cognition, emotion, values, experiences, expectations and so on (Pessoa, 2013). As a result, if the target built environment remains constant, a prudent approach is to focus solely on perceived built environment. Hence, our first hypothesis is:

H1: Perceived built environment is positively associated with self-rated health.

## 2.2. The association between social environment and self-rated health

Social environment can also be divided into objective social environment and perceived social environment (Sallis et al. 2015). The objective social environment refers to the social structure, capital, and interaction within the social space in which people live, while the perceived social environment refers to the cognitive, emotional and behavioral responses of individuals to the objective social environment, including trust, support, and sense of control (Casper and Pathak, 2001). According to Forrest and Kearns (2001), social interaction among neighbors and a sense of community safety and belonging are elements of the perceived social environment. Thus, understanding and improving the perceived social environment is crucial for enhancing community dwellers' health.

A strong correlation between perceived social environment and self-evaluated health of residents has been observed. Some studies have separately verified that, after controlling for individual factors, social cohesion, sense of security and place attachment showed significant positive correlations with self-assessed health (Fang and Huang, 2021; Mouratidis, 2020; Ou et al., 2018). Studies have also found that more frequent interactions with neighbors are linked to better self-rated health among dwellers, particularly in terms of mental health outcomes (Dong et al., 2017; Gyasi et al., 2019). Moreover, more social participation and inclusion were confirmed to be linked with better self-rated health (Choi, 2020). However, few studies have demonstrated the comprehensive influence of multiple perceived social environment elements on self-assessed health, especially in the context of rural communities. Consequently, our second hypothesis is:

H2: Perceived social environment is positively linked with self-rated health.

## 2.3. The potential mediating effect of social environment satisfaction

Recent studies demonstrated the direct influence of built environment satisfaction on self-assessed health (Fang and Huang, 2021; Huang et al., 2023; Lyu et al., 2021; Mouratidis, 2020). However, this study proposes a further conjecture that this link may occur through the mediation of some perceived social environment factors. Therefore, this study argues that, beyond the direct association between built environment satisfaction and self-rated health discussed above, perceived social environment mediates the connection between built environment satisfaction and self-rated well-being.

The recent literature on built environment satisfaction has found that higher satisfaction with built environment is linked with better self-rated health of dwellers (Gardener and Oliveira, 2020; Mujan et al., 2019; Zhan et al., 2022). Built environment satisfaction can affect self-rated health through multiple aspects, such as community housing, community public facilities, transportation, community greening and sanitation (Cai et al., 2022; Song et al., 2021; Wan et al., 2022; Zhan et al., 2022). Mujan et al. (2019) discovered that built environment significantly influenced inhabitants' satisfaction and self-rated health. For example, dwellers who were satisfied with community facilities such as green spaces and transportation tend to rate their health status better.

On the contrary, dissatisfaction with housing quality is closely linked to poorer self-rated mental health (Huebner et al., 2022). Specifically, residents living in housing that is too damp, cold, cluttered, lacking furniture, or insecure feel anxious, depressed or stressed, resulting in negative mental health outcomes (Singh et al., 2019). Moreover, dissatisfaction with the built environment is connected with lower self-evaluated physical well-being (Domenech-Abella et al., 2020; Liu et al., 2022). Perceived lack of commercial service facilities increases the risk of type 2 diabetes and associated negative health issues by reducing walking and increasing weight (Dendup et al., 2021). And the weaker the sensitivity and protective association of homeowners to their residential green space, the lower their willingness to exercise outdoors and the worse their self-rated health status (Rodriguez-Loureiro et al., 2021).

As discussed earlier, there appears to be a close positive correlation between built environment satisfaction and self-assessed health. This is because perceived built environment not only has a direct effect on self-rated well-being but also influences it indirectly by shaping individuals' perceptions of their social environment (Bonaccorsi et al., 2020; Mouratidis, 2018; Yu et al., 2019). Perceived social environment can moderate or mediate the association between perceived built environment and self-evaluated well-being, because it can provide individuals with resources and opportunities to cope with environmental stress and challenges (Leyden et al., 2023; Yu et al., 2019). For example, some studies have found that residents who feel that their community is green, safe, and well-maintained may have high social capital, social cohesion and sense of security, which can enhance their psychological and physical well-being (Stronegger et al., 2010; Wang et al., 2019). Conversely, residents who feel that their community is noisy, polluted, and lacking services may have low social support, trust, satisfaction, and less outdoor public activities, which may impair their psychological and physical health outcomes (Hiller and Walker, 2007; Wei et al., 2022). This means that perceived built environment can shape the perception of social environment, and then affect self-assessed health. Thus, the study put forward the subsequent hypothesis:

H3: Social environment satisfaction mediates the connection between built environment satisfaction and self-rated health.

## 2.4. Young middle-aged and elderly groups

Socio-demographic factors, such as income, age, and education, may affect the connections between perceived built environment, perceived social environment, and self-evaluated well-being (Cai et al., 2022; Pietilä et al., 2015; Putrik et al., 2015). Yu et al. (2019) mentioned that age is strongly linked to the social, physiological, and psychological changes of residents, which may influence their perceptions of environment and health. Older residents may have stronger influences of perceived built environment on perceived social environment and self-rated health than youngers (Yang et al., 2016). As age increases, residents needs for built environment may change, including more emphasis on accessibility, safety, and convenience (Dendup et al., 2019; Xiao et al., 2022). Meanwhile, residents expectations for social environment may also change, such as more emphasis on belongingness, security, support, and respect (Guo et al. 2021; Lucchesi et al., 2021). Overall, age is an

important factor that influences the relationship between self-assessed health and perceived environment.

However, in different countries or regions, residents' perception of the built environment, social environment and wee-being is affected by age to varying degrees, which mainly depends on the socio-cultural background, population ageing degree and survey criteria and methods of the country or region (Dai et al., 2016; Liu et al., 2018; Yang et al., 2021). Therefore, given the results of regional variability, further investigation of this variable is warranted to gain valuable insights (Alvarez-Galvez et al., 2013; Kim, 2016; Pan et al., 2021). Besides, it is especially important to conduct research on the variable of age in China. Current related research in China largely focuses on the elderly population, primarily due to the country's rapidly aging population and the associated challenges, such as serious mental issues among older adults, insufficient social support and lifestyle, and imperfect medical insurance and services (Ahmad et al., 2014; Lin et al., 2015; Mao et al., 2020; Yang et al., 2019). However, there is a gap in research across different age groups. This implies that the differences in the connection between the perceived built environment, the perceived social environment and the self-rated well-being among the young, middle-aged and the elderly group are worth investigating, which help to enrich the existing literature on perceived environment and self-rated health. As a result, the study presents the following hypothesis:

H4: For the elderly group, the structural association between perceiving the built environment, perceiving the social environment and self-rated health is stronger than that of the young and middle-aged group.

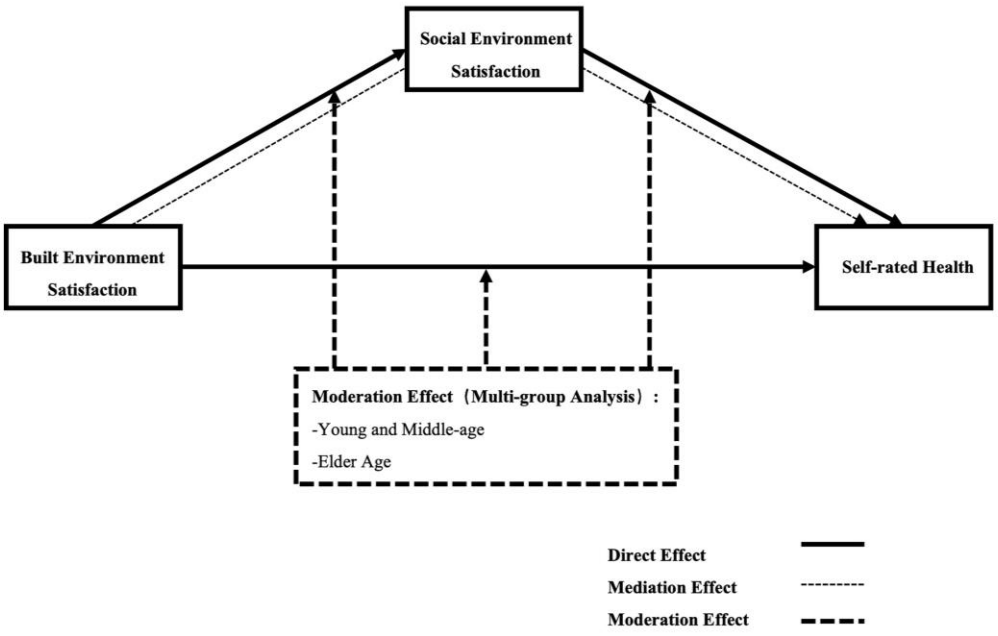


**Figure 1.** Theoretical models of research.

Based on existing literature, studies on the relationships among built environment satisfaction, social environment satisfaction, and self-assessed health are limited, especially in rural areas. This research hypothesizes that perceived social environment

satisfaction is crucial in these relationships, particularly by mediating the positive link between perceived built environment satisfaction and self-evaluated well-being. Regarding the role of age, the research suggests that it moderates the positive relationships among perceived built environment satisfaction, perceived social environment satisfaction, and self-rated health, as shown in the conceptual model in **Figure 1**.

This represents the relationship between built environmental satisfaction, social environmental satisfaction and self-rated health. The model will also be examined in both groups to investigate the moderating effect of age.

## 3. Research methods

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

### 3.1. Study area

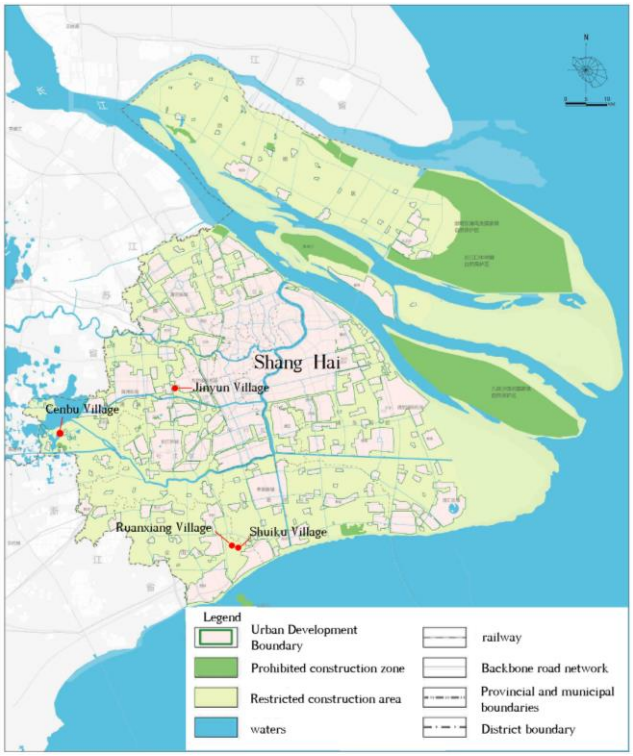


**Figure 2.** Location map of the four surveyed new-type village communities.

The research focused on four new rural communities in Shanghai, China, namely Ruanxiang Village, Shuiku Village, Cenbu Village, and Jinyun Village (**Figure 2**). The four new-type village communities are concentratedly distributed under the guidance of the government. They are all located in suburb, out of the urban development boundary. They are be selected to case studies according to the principles: 1) Community residents are mainly farmers, and the population structure is relatively stable, 2) Community land belongs to village collective organizations and is managed by village committees, 3) Residents have moved in as a whole for more

than one year. These principles can ensure that the selected cases are typical new rural communities, and villagers spend enough time in the communities, so their subjective perceptions of the built environment are sufficient to impact their self-assessed health.

## 3.2. Data collection

The questionnaire was designed, informed by previous studies, to gather data. It was divided into four sections. including: First, the demographic and socio-economic features of the respondents (see **Table 1**); second, the perception of the built environment; third, the perception of the social environment; fourth, the self-rated health. Then, from July to September 2021, 245 questionnaires were administered to households in the research area through face-to-face interactions. Of the total distributed questionnaires, 91% (223) of the answers were usable for this study.

Firstly, the sociodemographic characteristics of the respondents show that males make up 49.80%, while females account for 50.20%. Participants aged between 21 and 55 years account for 48.90%, while respondents aged above 55 years account for 51.10%. Moreover, most of the participants (61.90%) have junior high school education or below. In addition, the results show that farmers have the largest share among the participants, reaching 44.40%. The survey results also show that participants with annual income below 50,000 RMB and above 100,000 RMB each account for 31.84%, while respondents with annual income between 50,000 and 100,000 RMB account for 36.84%, as shown in **Table 1**. Furthermore, **Table 2** indicates the codes of the main variables and indicators in the following tables and figures.

**Table 1.** Social and demographic information of the respondents.

| **Variables** | **Frequency** | **%** |
|---|---|---|
| Gender | | |
| Male | 111 | 49.8 |
| Female | 112 | 50.2 |
| Age | | |
| Less than or equal 55 | 109 | 48.9 |
| Above 55 | 114 | 51.1 |
| House owner | | |
| Own | 160 | 71.7 |
| Parents own | 44 | 19.7 |
| Childrens own | 10 | 4.5 |
| Rent | 9 | 4 |
| Marital status | | |
| Unmarried | 11 | 4.9 |
| Married | 196 | 87.9 |
| Divorced | 7 | 3.1 |
| Widowed | 9 | 4 |

**Table 1.** (*Continued*).

| Variables | Frequency | % |
|---|---|---|
| Education level | | |
| Junior high school and below | 138 | 61.9 |
| Technical secondary school or high school | 44 | 19.7 |
| Junior college | 28 | 12.6 |
| Bachelor degree or above | 13 | 5.8 |
| Employment status | | |
| Farmer | 99 | 44.4 |
| Public servant | 44 | 19.7 |
| Self-employed/ | 4 | 1.8 |
| Worker | 37 | 16.6 |
| Other | 39 | 17.5 |
| Income | | |
| Less than or equal to 50,000 | 71 | 31.84 |
| 50,000–100,000 | 81 | 36.32 |
| More than 100,000 | 71 | 31.84 |

**Table 2.** Codes for variables and indicators.

| Variable | Code | Index | Code |
|---|---|---|---|
| Built environment satisfaction | BES | Housing quality satisfaction | BS01 |
| | | Village greening satisfaction | BS02 |
| | | Sanitary environment satisfaction | BS03 |
| | | Commercial service facilities satisfaction | BS04 |
| | | Elderly care facilities satisfaction | BS05 |
| | | Medical and health facilities satisfaction | BS06 |
| | | Transportation conditions and facilities satisfaction | BS07 |
| | | Indoor and outdoor activity places satisfaction | BS08 |
| | | Sports and fitness facilities satisfaction | BS09 |
| | | Leisure and recreation facilities satisfaction | BS10 |
| Social environment satisfaction | SES | Satisfaction with the health work management of the village committee and the ruling personnel | SS01 |
| | | Degree of closeness with neighbors | SS02 |
| | | Sense of belonging to the village | SS03 |
| | | Public activity participation | SS04 |
| | | Long-term residence intention | SS05 |
| | | Sense of security in village life | SS06 |
| Self-rated health | SRH | Self-rated mental health | MH |
| | | Self-rated physical health | PH |

## 3.3. Method

The study hypotheses were tested with the Partial Least Squares Structure Equation Model (PLS-SEM), a multivariate statistical tool for evaluating and testing

causal relationships between study parameters (Wong, 2013). Hair et al. (2021) demonstrated that PLS-SEM emphasizes the focus on predictive effect when estimating the model, rather than the focus on model fit. This makes PLS-SEM potentially suitable for exploratory or interpretive research, as well as for research where the theory is not perfect (Sarstedt et al., 2021). In addition, PLS-SEM is an variance-based method with low requirements in terms of data distribution, sample size, measurement error (Hair et al., 2019). Therefore, PLS-SEM may be applicable to this study with the goal of deriving causal relationships between variables, and characteristics of insufficient theoretical background, small data samples, and non-normality. Built environment satisfaction is an independent variable that influences dwellers' self-rated health, and the perceived social environment is a mediator in the relationship between this variable and self-rated health.

The hypothesis of this study was tested using PLS-SEM in five steps. The first step is to detect the study for common method bias (CMV). To reduce the single-source bias, this study used different types of variables for measuring impacts. For example, gender was measured by a binary categorical variable; age was measured by a continuous variable; income was measured by a discrete variable. And, a four-point Likert scale (from "1-Dissatisfied" to "4-Satisfied") was used to measure the independent variable and the mediator variable. In addition, a five-point Likert scale (from "1-Very poor" to "5-Very good") was used to measure the dependent variable. These different measurement methods could control the single-source bias (Podsakoff et al., 2003; Tehseen et al., 2017). Meanwhile, according to Aguirre-Urreta and Hus (2019) suggestion, Harman's single factor test was employed to examine CMV.

In the second step, the outcomes of the reflective measurement model are obtained, including internal consistency, structural reliability and convergence validity, and discriminant validity. First, the load of each factor is derived to judge the internal consistency. Second, "convergent validity" and "structural reliability" were assessed. According to Hair et al. (2017), convergent validity refers to "the degree to which indicators of a specific construct converge or share a high proportion of variance". To assess this, composite reliability (CR) and average variance extracted (AVE) were computed (Hair et al., 2010).

In the third step, discriminant validity may be evaluated by three approaches. Firstly, the average variance shared between each construct and its measures needs to exceed the variance shared between two distinct constructs (Fornell and Larcker, 1981). Secondly, the discriminant validity of this model can be assessed by matching the "cross-loadings" between the variables. Thirdly, the heterotrait-monotrait ratio test (HTMT) method proposed by Henseler et al. (2015) was used to assess "discriminant validity". All values are expected to fall below the HTMT threshold of 0.90 (Henseler et al., 2015). In addition, Clark and Watson (1995) and Kline (2011) used a more strict criterion, suggested that HTMT should be less than 0.85.

The fourth step is to analyze the mediation effect. PLS-SEM can effectively examine direct and indirect effects between latent variables and the role of mediating variables in these effects (Hair et al., 2017). Moreover, the Bootstrapping test was used to assess the significance of the mediating effect (Henseler et al., 2015).

The final step is to conduct multi-group analysis. PLS-SEM is a combination-based method which flexibly handles different types of measurement models and

structural models, as well as different types of multiple sets of variables (Matthews, 2017; Sarstedt et al., 2011). In the study, PLS-SEM used different methods to perform multiple sets of analyses, including parametric difference test, and Welch-Satterthwaite test.

## 4. Results

PLS-SEM was employed to test the study hypotheses by Smartpls 4.0. The results of the model are as follows:

### 4.1. Results of the reflective measurement model

The obtained result showed that a single factor explained 31.8% of variance, falling short of the upper limit of 50%. This means that there is no common method bias in this study.

In this study, factor load estimation was examined for internal consistency. As shown in **Table 3**, all variables had external loads between 0.56 and 0.931, both greater than 0.5 (Chin, 1998; Hulland, 1999). This means that the reflective measurement model is internally consistent.

**Table 3.** External loadings of the measurement model.

| No | Construct | Item | Outer Loading |
|---|---|---|---|
| 1 | BES | Housing quality satisfaction | 0.616 |
| 2 | | Village greening satisfaction | 0.818 |
| 3 | | Sanitary environment satisfaction | 0.813 |
| 4 | | Commercial service facilities satisfaction | 0.844 |
| 5 | | Elderly care facilities satisfaction | 0.87 |
| 6 | | Medical and health facilities satisfaction | 0.781 |
| 7 | | Transportation conditions and facilities satisfaction | 0.741 |
| 8 | | Indoor and outdoor activity places satisfaction | 0.888 |
| 9 | | Sports and fitness facilities satisfaction | 0.857 |
| 10 | | Leisure and recreation facilities satisfaction | 0.861 |
| 11 | SES | Satisfaction with the health work management of the village committee and the ruling personnel | 0.766 |
| 12 | | Degree of closeness with neighbors | 0.563 |
| 13 | | Sense of belonging to the village | 0.733 |
| 14 | | Public activity participation | 0.564 |
| 15 | | Long-term residence intention | 0.586 |
| 16 | | Sense of security in village life | 0.782 |
| 17 | SRH | Self-rated mental health | 0.931 |
| 18 | | Self-rated physical health | 0.894 |

**Table 4** shows that the CR values were all higher than the critical point of 0.70, while one of the three variables had an AVE value lower than 0.50. Fornelel and Larcker (1981) proposed that the convergent validity of the construct was still

sufficient when the AVE value was lower than 0.5 and the CR was higher than 0.6. Therefore, the reliability and convergent validity of the constructs were confirmed.

**Table 4.** Construct reliability and validity.

| Variables | Cronbach's Alpha | rho_A | Composite Reliability | Average Variance Extracted (AVE) |
|---|---|---|---|---|
| BES | 0.942 | 0.947 | 0.951 | 0.66 |
| SES | 0.757 | 0.791 | 0.829 | 0.453 |
| SRH | 0.801 | 0.824 | 0.909 | 0.833 |

The results show that the square root of AVE (the values on the diagonal) is greater than the correlation coefficient between the construct and other constructs (the values below the diagonal). This means that the whole collection of constructs has achieved adequate "discriminant validity". Secondly, it is essential to ensure that every indicator has a strong loading on its construct, while showing a weak loading on other indicators (Hair et al., 2019). Thus, the results of this study confirmed the attainment of discriminant validity. Thirdly, the results showed that the HTMT was less than 0.85. For each construct, the confidence interval excludes 1 (Henseler et al., 2015), verifying discriminant validity.

## 4.2. Evaluation of the structural model

The assessment of the structural model was conducted by examining predictive relevance (Q2), coefficient of determination ($R^2$), collinearity, and the associations between variables along with their significance. To assess collinearity, the variance inflation factor (VIF) was used. A VIF above 5 or below 0.2 signals potential multicollinearity concerns (Hair et al., 2019). Given that all VIF values in this model were 1, no multicollinearity issues were identified.

The bootstrap method with 5000 subsamples was applied to assess the significance of the path coefficients. The hypothesis is accepted when the t-value surpasses 1.96 and the p-value is below 0.05, indicating a significant effect (Kock, 2018). The results showed that built environment satisfaction was positively correlated with social environment satisfaction ($\beta$ = 0.726, $t$ = 25.302, $p$-value < 0.001), supporting H1, and that social environment satisfaction showed a positive association with self-assessed health ($\beta$ = 0.412, $t$ = 8.843, $p$-value < 0.001), supporting H2 (**Table 5**). The results of the SmartPLS model and PLS algorithm are shown in **Figure 3**.

**Table 5.** Path coefficients and hypothesis testing.

| No | Hypothesis | Coefficient | SD | *T* values | *P* values | Decision |
|---|---|---|---|---|---|---|
| 1 | BES → SES | 0.726 | 0.029 | 25.302 | 0.000 | Accepted |
| 2 | SES → SRH | 0.412 | 0.047 | 8.843 | 0.000 | Accepted |

$R^2$ (social environment satisfaction) = 0.527 and (self-rated health) = 0.17. Q2 (social environment satisfaction) = 0.221 and (self-rated health) = 0.132. Model fit summary: SRMR = 0.076.

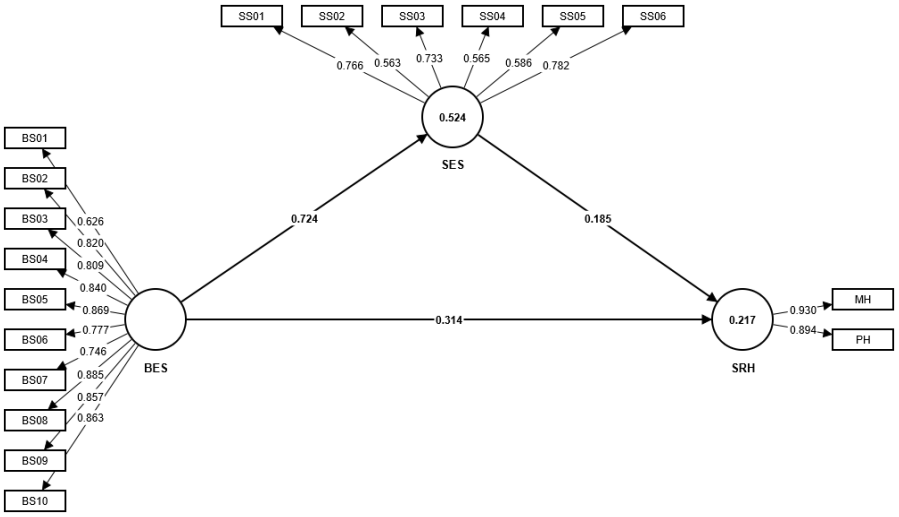


**Figure 3.** Structural model of the effects of built environment satisfaction (BES) on social environment satisfaction (SES) and self-rated health (SRH).

The main criterion for evaluating the structural model is the coefficient of determination ($R^2$), which indicates the amount of explained variance of the endogenous latent variables. $R^2$ values of 0.75 are considered substantial, 0.50 are moderate, and 0.25 are weak (Hair et al., 2019). The structural model explained 52.7% of the variance of social environment satisfaction (moderate) and 17% of the variance of self-rated health (weak). As an extra step, this study used blindfolding technique and calculated Q2. Yahaya et al. (2019) suggested that the Q2 value greater than 0 indicates predictive relevance. In addition, the thresholds for weak, moderate and large predictive relevance are 0.02, 0.15 and 0.35 respectively. The current study model for social environment satisfaction (0.221) showed moderate predictive relevance (**Table 5**).

In addition, Hair et al. (2019) and Schermelleh-Engel et al. (2003) mentioned using standardized root mean square residual (SRMR) to check goodness of fit to avoid model mis-specification. In this study, the value of SRMR was 0.076, which was lower than the recommended threshold of 0.08 (**Table 5**) (Bentler and Hu,1999).

## 4.3. The mediating function of social environment satisfaction

A mediation analysis was conducted to evaluate the mediating function of social environment satisfaction in the correlation between built environment satisfaction and self-rated health. The results showed that the total effect of built environment satisfaction on self-rated health was significant ($\beta = 0.448$, $t = 9.621$, $p < 0.000$). With the inclusion of social environment satisfaction, the direct effect of built environment satisfaction on self-rated health remained large ($\beta = 0.314$, $t = 4.010$, $p < 0.000$). The indirect effect of built environment satisfaction on self-rated health through social environment satisfaction was also large ($\beta = 0.134$, $t = 2.328$, $p < 0.05$). This indicates that the association between built environment satisfaction and self-rated health was partially mediated by social environment satisfaction, supporting H3 (**Table 6**).

**Table 6.** Hypothesis testing of mediation.

| **Total effect (BES → SRH)** | | **Direct effect (BES → SRH)** | | **Indirect Effects (BES → SRH)** | | | | |
|---|---|---|---|---|---|---|---|---|
| Coefficient | *P* value | Coefficient | *P* value | Coefficient | SD | *T* value | *P* value | BI[2.5%; 97.5%] |
| 0.448 | 0.000 | 0.314 | 0.000 | 0.134 | 0.058 | 2.328 | 0.020 | 0.017; 0.245 |
| H3: BES → SES → SRH (Accepted) | | | | | | | | |

## 4.4. Multi-group analysis

This study used multi-group permutation tests to cross-validate the structural model in the middle-aged and elderly groups (Fakih et al., 2016). **Table 7** shows that there were some distinctions in the significant path estimates between the two groups. Thus, the following hypotheses were proposed: The self-rated health and social environment satisfaction of elderly residents seem to have more influence on self-rated health than those of young and middle-aged residents.

**Table 7.** Comparison between middle-aged and elderly groups.

| | **Path (YMA)** | **Path (E)** | **STDEV (YMA)** | **STDEV (E)** | ***t*-Value (YMA)** | ***t*-Value (E)** | ***p*-Value (YMA)** | ***p*-Value (E)** |
|---|---|---|---|---|---|---|---|---|
| BES → SES | 0.693 | 0.763 | 0.046 | 0.034 | 15.107 | 22.199 | 0 | 0 |
| BES → SRH | 0.344 | 0.255 | 0.11 | 0.125 | 3.12 | 2.046 | 0.002 | 0.041 |
| SES → SRH | 0.205 | 0.278 | 0.108 | 0.124 | 1.906 | 2.252 | 0.057 | 0.024 |

**Table 8** presents the outcomes of the parameter tests along with the Welch-Satterthwaite test, assuming both equal and unequal variances between groups, respectively. This suggests that there were no significant differences between the two groups on any path. Therefore, age did not play a moderating function in the relationship between built environment satisfaction, social environment satisfaction and self-rated health (Hair et al., 2017). Consequently, H4 is not supported, as the structural model of built environment satisfaction, social environment satisfaction and self-evaluated well-being did not differ between the two groups.

**Table 8.** Multi-group analysis.

| | **Difference (YMA-E)** | ***t*-value (YMA vs. E)** | ***p*-value (YMA vs. E)** | **Difference (YMA-E)** | ***t*-value (YMA vs. E)** | ***p*-value (YMA vs. E)** |
|---|---|---|---|---|---|---|
| BES → SES | −0.07 | 1.227 | 0.221 | −0.07 | 1.22 | 0.225 |
| BES → SRH | 0.089 | 0.537 | 0.592 | 0.089 | 0.539 | 0.591 |
| SES → SRH | −0.073 | 0.446 | 0.656 | −0.073 | 0.448 | 0.655 |

# 5. Discussion

This study examines the theoretical derivative structural models of built environment satisfaction, social environment satisfaction and self-rated health. The results show that built environment satisfaction (housing quality satisfaction, village greening satisfaction, sanitary environment satisfaction, commercial service facilities satisfaction, elderly care facilities satisfaction, medical and health facilities satisfaction, transportation conditions and facilities satisfaction, indoor and outdoor activity places satisfaction, sports and fitness facilities satisfaction, and leisure and

recreation facilities satisfaction) was significantly and positively connected with self-assessed health (self-rated mental well-being and self-rated physical health). Besides, the satisfaction of the built environment has a significantly positive impact on the satisfaction of the social environment (satisfaction with the health work management of the village committee and the ruling personnel, degree of closeness with neighbors, sense of belonging to the village, public activity participation, long-term residence intention, and sense of security in village life).

The study found that social environmental satisfaction was significantly positively linked with self-rated health. When residents have high satisfaction with community health work, neighborhood intimacy, sense of belonging, activity participation, long-term residency intention, and security, improve residents' self-rated health by increasing personal well-being, reducing loneliness and stress, and promoting outdoor exercise (Mouratidis, 2020; Wong et al., 2018). Furthermore, this study provides new theoretical knowledge for the specification of social environment satisfaction structure in structural models. The results of the research support the reflective latent structure of social environment satisfaction structure, where the direction of causality is from structure to indicator. This implies that the latent variable of social environment satisfaction leads to changes in six social environment satisfaction indicators (Afthanorhan, 2014). The combination of social environment satisfaction in rural communities can be divided into six social environment satisfaction indicators, which can be substituted for each other without affecting the meaning of social environment satisfaction (Hair et al., 2021).

These findings provide correlation theories for perceived built environment, perceived social environment, and self-evaluated health (Stronegger et al., 2010; Yu et al., 2019) and offer empirical support in the new regional context of Shanghai's new rural communities. The results also show that rural residents with higher satisfaction with the built environment also have higher satisfaction with the social environment, which is consistent with Orban et al.'s (2017) theory that perceived built environment has an indirect effect on self-rated health specifically, perception of built environment can shape perception of social environment, which in turn influences self-rated health. Residents with high satisfaction with the built environment have a relatively high sense of belonging, participation, and satisfaction with their community (Stronegger et al., 2010; Zhang et al., 2022). This positive sense of community significantly positively influences residents' judgments about their own health status, ultimately leading to higher self-rated health (Buckley, 2022; Yu et al., 2019).

The study also makes new theoretical contributions by examining the extent to which the age of rural residents affects the relationship between satisfaction with the built environment, satisfaction with the social environment, and self-assessed health. structural models of the two groups predicts stronger structural relationships among older rural residents than among young and middle-aged rural residents. However, the PLS-SEM multi-group analysis failed to include age as a moderating variable, suggesting that age differences did not strengthen the relationship between built environment satisfaction, social environment satisfaction, and self-evaluated health.

This study results indicate that age did not play a significant moderating role in the relationship between built environment satisfaction, social environment satisfaction, and self-rated health. However, some studies mentioned that age, as an

important demographic factor, may play a significant role in the relationships between built environment satisfaction, social environment satisfaction, and self-rated health outcomes (Cai et al., 2022; Tang et al., 2022), which contrasts with the findings of this study. It is worth noting that, previous research also raised uncertainty regarding the role of age as a variable. For instance, Hawkley and Luhmann (2016) described age as a complex variable that may interact with or mediate other factors, such as income, education, and health, potentially confounding or weakening the connections between age and other variables. Additionally, some research showed that the relationship between age and perceptions of the built environment, social environment, and health conditions may vary across different regions (Kim, 2016; Liu et al., 2018). In the research, older adults accounted for 51.10% of the total participants, and this relatively high proportion of elderly participants may be one of the reasons why age did not exhibit a moderating effect. This suggests potential limitations in the sample structure of this study, which could be addressed in future research by optimizing sample selection to enhance the generalizability of the results.

## 6. Conclusion

The resarch used PLS-SEM to analyze the associations between independent variables (built environment satisfaction and social environment satisfaction) and the dependent variable (self-rated health). Besides, the research demonstrates that social environment satisfaction mediates the relationship between built environment satisfaction and self-evaluated health. And age is used as moderating variable for multi-group analysis of young and middle-aged group, and elderly group.

Through this rigorous approach, the study supports the importance of higher satisfaction with the social and built environment in improving residents' self-rated health and validates the positive correlation between built environment satisfaction and social environment satisfaction. The research also confirms that built environment satisfaction and social environment satisfaction are reflective latent variables and encourages future community environment satisfaction research to adopt this specification when applying SEM.

Besides, the study can provide theoretical foundations for professionals in the fields of architecture and urban planning, assisting them in designing rural community environments that better promote residents' health and well-being. Moreover, the research offers theoretical guidance and data support to rural planning and public health policymakers, providing scientific evidence to facilitate the implementation of health-oriented rural policies and contribute to rural revitalization.

The research has several limitations. First, the sample is drawn exclusively from four new rural communities in Shanghai, China. Thus, the model and conclusions should not be directly generalized to other countries and regions. Cross-validation in different contexts is necessary to ensure the generalizability of the findings. Future studies could expand the geographic scope to rural areas beyond Shanghai, such as Chengdu and Shenzhen, or include groups with diverse income and education levels to compare the influence of different regional or sample characteristics on the results.

Second, this study relies on participants' subjective assessments of the built environment, social environment, and health condition, which may introduce bias.

Individuals' emotions, personality traits, and health status could influence their environmental evaluations, leading to results that may deviate from actual conditions. For instance, individuals with more optimistic dispositions or better health not only tend to rate their self-rated health more highly but also tend to express greater satisfaction with their residential communities (Ellaway, 2001). To minimize such subjective bias, future research should incorporate both objective environmental and health indicators to more comprehensively investigate these relationships.

Finally, age did not significantly moderate in this study, possibly due to the broad age grouping and the high proportion of elderly participants. Future research could use more detailed age categories, increase sample size, and control for background factors such as family structure, occupation, and income to further explore the moderating role of age.

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