Wellbeing, Space and Society 9 (2025) 100298

Contents lists available at ScienceDirect

Wellbeing, Space and Society

journal homepage: www.sciencedirect.com/journal/wellbeing-space-and-society

Exploring the impact of urban green spaces on behavioral and psychological well-being: Based on the context of urban villages and ordinary neighborhoods in Shenzhen, China

Luoan Chen [a,#,*], Qiantong Liang [b,$], Haoran Zhao [a,$$]

[a] School of Design, The Hong Kong Polytechnic University, Hong Kong, China
[b] School of Fine Arts & Design, Guangzhou University, Guangzhou, China

ARTICLE INFO

Keywords:
Urban green spaces
Urban villages
Residents' health
Green space use
Environmental behaviour

ABSTRACT

With the acceleration of urbanization, the impact of urban green space (UGS) on public health has received increasing attention. The aim of this study is to investigate the behavioral and psychological impacts of UGS use on residents of urban village areas (UVAs) and ordinary residential areas (ORAs) in Shenzhen from different economic backgrounds. A quantitative survey of 184 ORA residents and 205 UVA residents was conducted. We analyzed the relationships of the frequency of green space use, the duration of green space use, the level of activity participation, and social interaction with residents' health status. Significant correlations were found between the use of UGSs and residents' living environment, social characteristics and physical and mental health. Residents of ORAs not only accessed green spaces more frequently and for longer periods, but also exhibited more stable physical and mental health profiles than their UVA counterparts. Structural-equation modelling revealed two partially mediated pathways: 1) higher use frequency bolstered social networks, which in turn improved mental health; 2) greater activity participation was associated with higher blood-oxygen saturation. Crucially, these pathways were significantly attenuated among UVA residents, underscoring how deficits in green-space availability, quality and perceived safety erode health benefits. By highlighting these differences, the study provides planners with evidence-based strategies to promote environmental justice and health equity in China's rapid urbanization process.

1. Introduction

Against the backdrop of rapid urbanization worldwide, mental and behavioral health issues among urban residents are becoming increasingly prominent (Ventriglio et al., 2021). As a typical example of a high-density city, Shenzhen has experienced unprecedented population and spatial expansion over the past four decades. The unique "urban village-commodity housing" dual residential system provides a natural experimental setting for exploring the relationship between urban green spaces and health (Guo et al., 2023). Urban villages are a unique byproduct of China's rapid urbanization process. Under the dual-track land system, where collective land and state-owned land are separated, villages that have not been expropriated by the state are gradually surrounded by the expanding urban landscape (He et al., 2025; Zhan, 2018). These settlements are interspersed among towering office buildings and residential complexes, with many located within or adjacent to the city center's employment hubs (Pan and Du, 2021). On one hand, urban village areas (UVAs) are characterized by high floor area ratios and limited public amenities, while on the other hand, ordinary residential areas (ORAs) typically feature relatively balanced green space allocations. Whether and how this disparity influences residents' mental health and daily environmental behaviors remains understudied in systematic comparative research.

Over the past five years, interdisciplinary research has repeatedly confirmed through social big data that UVAs lag significantly behind ORAs in terms of green space supply and accessibility, and this gap has

* Corresponding author.
E-mail address: chenluoan2023@163.com (L. Chen).

[#] These authors wrote the Method design, data preparation, data analysis, first draft writing, tabular data visualization, review and revision of first draft.
[$] These authors wrote the Data organization, review and revision of first draft, figure making.
[$$] These authors wrote the Data analysis, data organization, review and revision of first draft.

https://doi.org/10.1016/j.wss.2025.100298
Received 29 May 2025; Received in revised form 26 August 2025; Accepted 18 September 2025
Available online 19 September 2025

become a core issue in urban health equity. Taking Beijing as an example, it was found that within a 15-minute walking radius, ordinary residential areas have an average of 9.7 square meters of community-level green space, while urban villages have only 2.3 square meters; the accessibility inequality index (Gini coefficient = 0.67) is approaching the "highly unfair" threshold set by the United Nations Human Settlements Programme (UN—Habitat) (J. Zhao et al., 2024). Additionally, using a sample of 166 urban villages (UVAs) and 3347 residential communities (ORAs) within the Fifth Ring Road in Beijing, the study also revealed systematic green space accessibility inequality across the three dimensions of "area-quality-coverage" (T. Zhang et al., 2023b). Therefore, this paper will focus on this structural inequality, exploring how it is continuously reproduced through planning logic, capital flows, and governance models in different urban spaces, and assessing its profound impacts on resident health and social equity.

Urban green spaces (UGS) are multifunctional composite venues that provide both environmental regulation services and cultural services. They promote physical activity and social interaction among residents, thereby enhancing residents' psychological well-being and influencing human health and well-being (Cardinali et al., 2024; Chen et al., 2021; Reyes-Riveros et al., 2021). However, most of these studies have focused on the average effects between "green spaces and health," neglecting the potential moderating effects of different community forms. For example, a study in Guangzhou found that the positive relationship between community greenness and mental health was more pronounced in high-density, older residential areas, suggesting that spatial context may amplify or attenuate the health benefits of green spaces (Liu et al., 2019). Additionally, a 10 % decrease in residential green coverage was associated with a 0.09 standard deviation increase in loneliness and a 0.07 standard deviation increase in anxiety (Helbich et al., 2022). Green space quality (Wang et al., 2021) and accessibility (Peschardt et al., 2012) have been shown to influence residents' mental health outcomes. Meanwhile, residents' frequency of green space use and place attachment have been proven to be key mediating variables linking "green space exposure—mental health" (Kuo et al., 2021).

The relationship between green spaces and population well-being has been extensively studied, but within urban villages, this relationship is often weakened or distorted due to socio-environmental inequalities (Kronenberg et al., 2020; Du et al., 2025). Empirical evidence on mental health dimensions indicates a dose-response relationship between green space exposure and significant reductions in psychological stress, depression, and anxiety symptoms (Alcock et al., 2014). However, longitudinal studies have further revealed that in low-income or minority communities, the psychological benefits of green spaces are often diminished by "social filters" such as safety concerns and inadequate maintenance (Xian et al., 2024). Residents of UVAs develop a "psychological distance" from green spaces due to discriminatory policing and deteriorating infrastructure, thereby failing to achieve equivalent mental health benefits (Jennings et al., 2024). In terms of physical health, green spaces can significantly reduce the risk of obesity, and cardiovascular disease by lowering air pollution, promoting physical activity, and regulating the autonomic nervous system (Nwana et al., 2024; Cao et al., 2025). However, recent cohort studies indicate that when green space quality (e.g., canopy cover, facility completeness) falls below a threshold, the aforementioned protective effects are no longer significant (Cao et al., 2025). UVA communities often fall below this threshold due to "green space deserts," exacerbating physical health inequalities (Hoseini et al., 2025).

Recent studies have shown that different age groups exhibit significant preferences for the physical, social, and management attributes of urban green spaces (UGS). Older adults place greater emphasis on accessibility, safety, and the completeness of recreational facilities, while younger groups prefer spaces with sports facilities, open lawns, and diverse activity zones(Dmitrović et al., 2025; Reece et al., 2024). Zhang et al. (2022) further confirmed that when green spaces lack these age-appropriate features, physical activity levels and social interaction frequencies decline across all age groups. Studies on the elderly indicate that perceived safety, spatial belonging, and health-promoting facilities are key predictors of their frequent use of green spaces (Wu and You, 2024). In contrast, adolescents are more likely to engage in peer interaction and stimulating activities in green spaces with sports fields, seating, and landscape water features (Rivera et al., 2021). Additionally, green spaces not only support intergenerational social interaction but also provide individuals with opportunities for solitude, reflection, and self-discovery, thereby strengthening community belonging (Roba et al., 2025). In terms of attention restoration, older users rely more on natural tranquillity and visual aesthetics for psychological recovery, while younger users achieve the same recovery effects through social interaction and physical activity (Zhao et al., 2025).

Although previous studies have separately explored issues such as green spaces and mental health, green spaces and physical health, green space exposure and health, and residents' green space behavior, few studies have used comparative methods to simultaneously examine the effects of ultraviolet UVAs and ultraviolet ORAs in the same urban context. This study explores how differences in green space use simultaneously influence mental and physical health inequalities, as well as how individual, community, and urban-level factors jointly moderate this relationship. Additionally, urban villages, as "informal" residential areas, often have lower quantities and qualities of green spaces compared to urban averages. However, due to their high accessibility and strong social networks, they may exhibit unique usage patterns and health effects (Zhang et al., 2022). Therefore, comparing the similarities and differences between urban villages and ordinary communities in terms of green space use, environmental behavior, and psychological well-being not only helps clarify the community-dependent nature of green space health effects but also provides scientific basis for targeted green space renewal strategies.

This study uses two UVAs and two ORAs in Shenzhen as data collection areas. Specific socio-cultural factors related to green spaces are collected, such as the frequency and duration of residents' visits to nearby green spaces and their overall perception of green spaces in UVAs. The following questions are explored:

RQ1: What are the differences in the quantity, quality, and accessibility of green spaces between urban villages and ordinary communities?
RQ2: Are there significant differences in the relationship between green space usage frequency and residents' psychological well-being across different community types?
RQ3: Do environmental behaviors (such as physical activity and social interaction) play a mediating role in the "green space–psychological well-being" pathway?

The research findings will provide empirical support for developing differentiated green space renewal policies and promoting health equity in high-density urban areas.

2. Materials and methods

2.1. Study area

This study takes Shenzhen as its empirical research area, covering both urban village collective units (UVAs) and official residential areas (ORAs). In Shenzhen, there exists a unique urban phenomenon: settlements officially designated as "Urban Village Collective Units" (UVAs). These UVAs form a grid of 2042 enclaves embedded within the city's formal fabric. Collectively, they house roughly 60 % of the city's population while occupying less than 5 % of its land area (China (Shenzhen) Comprehensive Development Institute, 2023). These zones exhibit an average population density of 83 000 persons per square kilometre: up to 97 400 persons per square kilometre in the core areas and 55 400 persons per square kilometre in the non-core areas. Moreover, per-capita living space in Shenzhen's urban village collective areas is markedly lower than both the citywide average and the average of major Chinese cities (Tong, 2023). Consequently, residents living in these two distinct housing environments serve as the study population, reflecting the typical challenges faced by inhabitants in the urban periphery and the inner city alike.

Therefore, four residential neighbourhoods in Shenzhen with different economic backgrounds were selected as the sample collection areas in this study (Fig. 1). To facilitate the use of UGS for people with different residential backgrounds. Two residential neighbourhoods were selected as UVAs (Nanyuan Village and ShuiKu New Village), and two ORAs (Golden Henry Yu King Court Garden and Dongle Garden) were also included. Among them, ShuiKu New Village and Dongle Garden are located in the centre of Shenzhen (economic centre area), and Nanyuan Village and Golden Henry Yu King Court Garden are located in the urban function expansion area (economic development area). To collect data on populations in different residential contexts, the sample populations were drawn from the regions mentioned above.

2.2. Participants and analytical tools

Data collection was conducted offline from May to July 2024. A total of 408 paper questionnaires were distributed during face-to-face interviews and were completed and returned immediately; 389 usable questionnaires were ultimately obtained, yielding an effective response rate of 95.3 %. All quantitative statistical analyses were performed using IBM SPSS Statistics 25 software.

The final convenience sample comprised 389 residents (184 from ORAs and 205 from UVAs). Within this sample, 121 respondents were young adults aged 18–35 years (ORA = 57, UVA = 64), 141 were middle-aged adults aged 36–60 years (ORA = 70, UVA = 71), and 127 were older adults aged $\geq$ 60 years (ORA = 57, UVA = 70). Power calculations prior to fieldwork indicated that the achieved sample keeps the sampling error below 5 % for the overall dataset and below 10 % for each age–neighbourhood subgroup, meeting the requirements for descriptive statistics, subsequent one-way ANOVAs and ANCOVAs. Before completing the questionnaire, participants were instructed to abstain from alcohol consumption and to avoid staying up late the night before to ensure physiological stability. Descriptive statistics revealed that the sample's mean BMI ($M = 22.1$, SD = 2.4) fell within the healthy range (18.5 $\leq$ BMI $<$ 24).

2.3. Materials and data collection

In this study, the focus is on the use of UGSs and their characterization of health-related social impacts on residents' access to health in different residential contexts. We designed this study (Fig. 2) to determine the relationships of the use of UGS and the economic situation and social attributes of the residents with the level of physical and mental health of the residents. Moreover, we explored how the reduction in UGS quality and the socioenvironmental circumstances of the residents contribute to social problems such as socialization barriers and the presence of pseudo-community spaces. This set of issues increases individual health risks and contributes to the mental and physical health of residents. However, UGSs have the potential to mitigate health risks and maintain balanced social development. Therefore, four indices, including FU (frequency of use), TU (time of use), AP (activity participation) and SN (social networking), were used in this study to reflect the use of UGSs. Moreover, the health-related data were categorized into two dimensions, RT (reciprocity and trust) and EI (economy and income), and the basic health condition of the residents was based on two initial indicators, BP (blood pressure) and peripheral arterial oxygen saturation (SpO2), to explore the health impacts and differences in UGSs among populations with different economic and residential

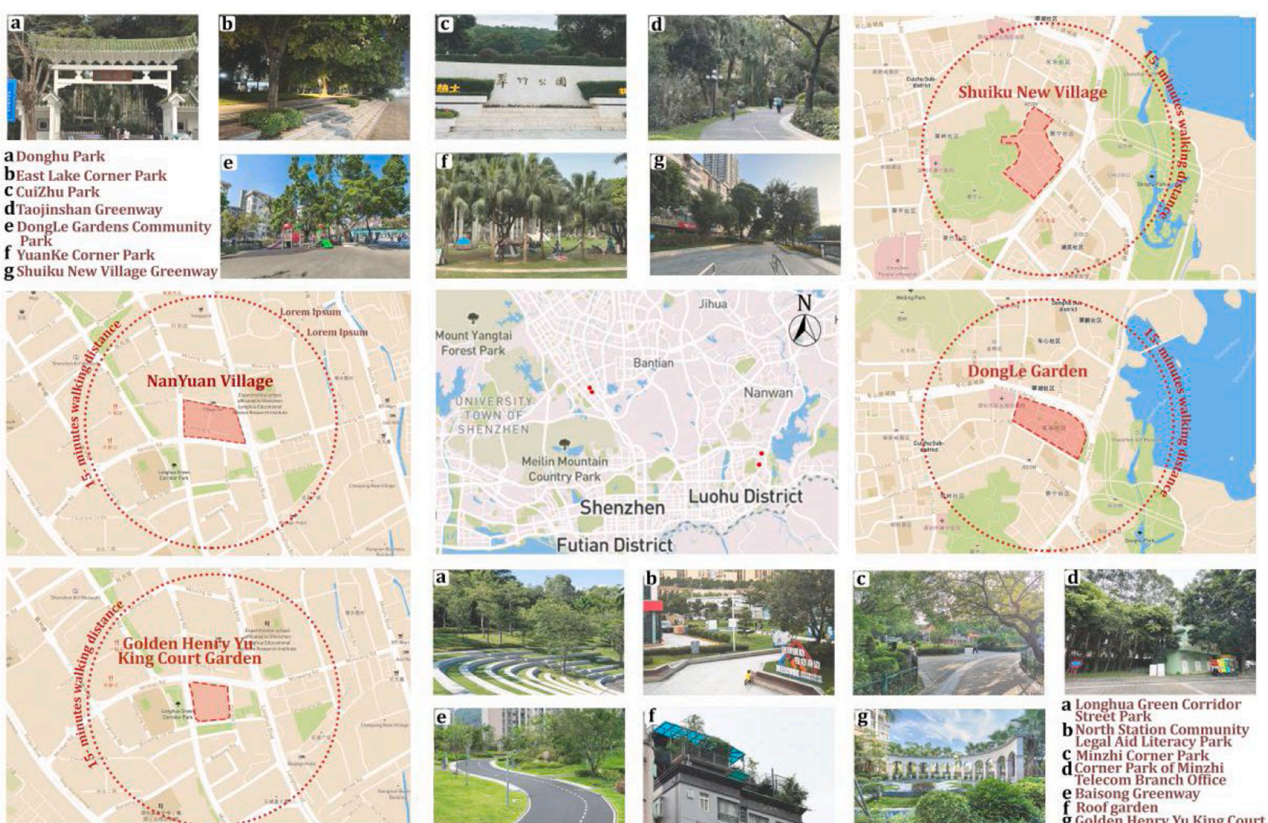

Fig. 1. Distribution of UGSs across four sites, Shenzhen.

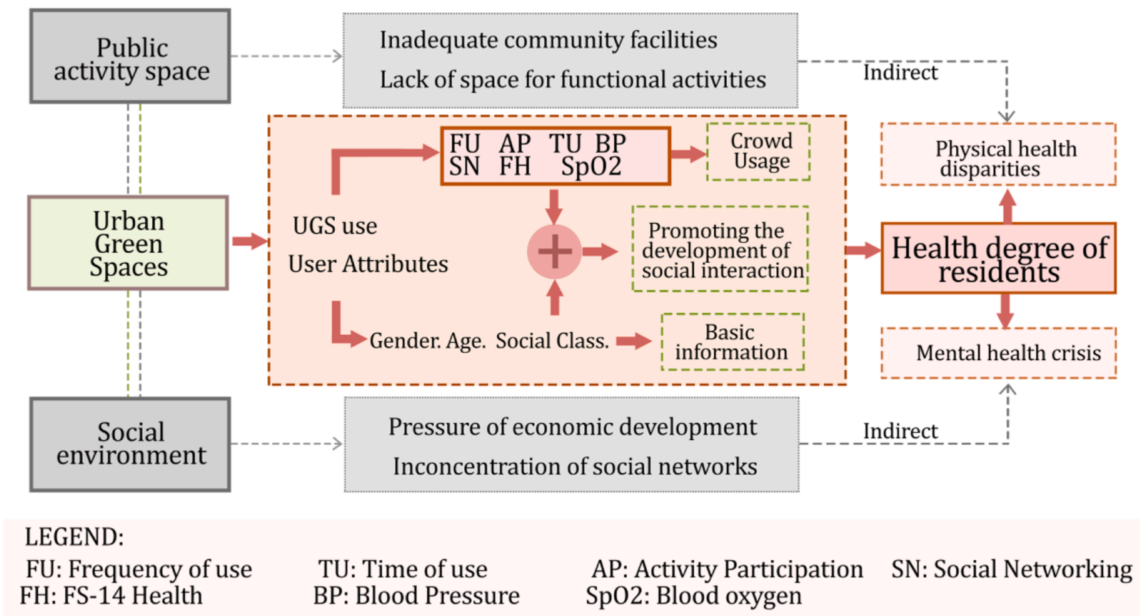

Fig. 2. The research design used in this study.

backgrounds. Differences in the impact of green space use on social capital among residents of different sexes, ages and social classes. The results of this study serve to illustrate the impact of the social environment and public space, especially UGSs, on the health of the population in the context of urbanization.

Data for the study were collected via questionnaires and population categorization. In this study, 28 research indicators were selected by screening the indicators used in previous related green space studies while several new indicator measurements were added. To ensure that the population samples actually resided within UVAs and ORAs, all questionnaires and samples were collected at each UGS and in the four site-selected communities. The main equipment and materials used in this experiment were an OMRON HPO-100 oximeter and a BOSO MedicusX sphygmomanometer. Additionally, data was collected through offline questionnaire completion (via iPad) after prior notification and informed consent. The survey was divided into three parts. The first part asked respondents if they had spent any time in any public green space that day; the second part collected demographic information, including respondents' current health status; and the third part completed the questionnaire (Fig. 3).

The two test questionnaire sections utilized the Fatigue Scale-14 (FS-14) and the UGS-related questionnaire: 1) Selection of model attributes and their attribute levels; 2) Residents' perceptions of the quality of 15-minute UGS. The survey took 12 to 15 min to complete, depending on the number of times the participants visited the green space. The general health of the participants was assessed via BP and SpO2 measurements to help determine their physical and mental health (Chalder et al., 1993). Participants who indicated that they had not visited a public green space in the city that day were not included in the analysis.

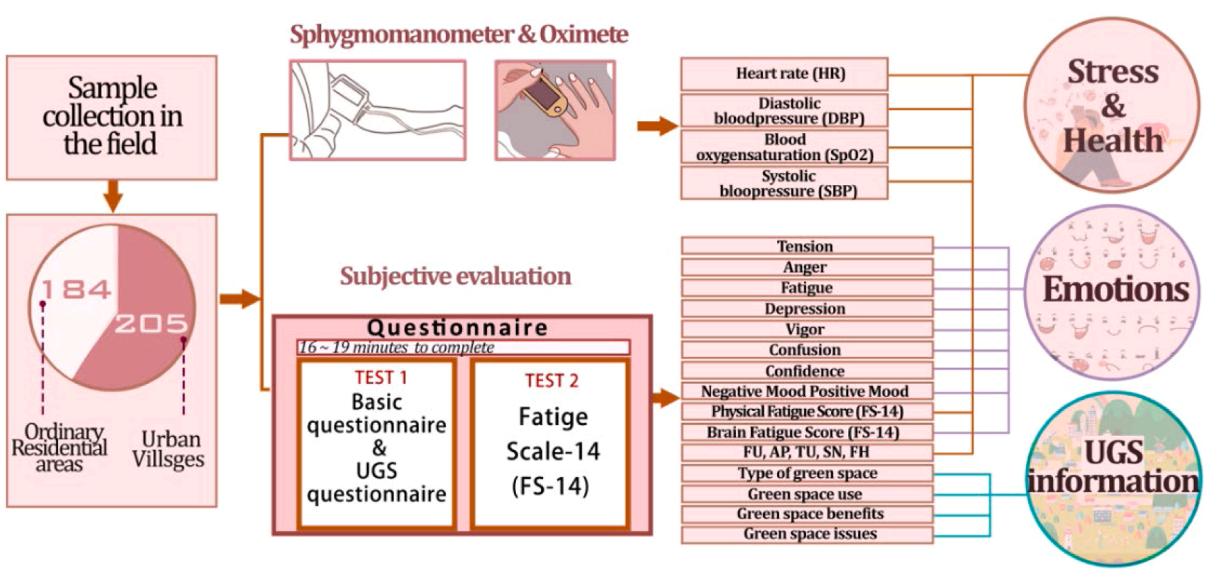

Fig. 3. Data collection process.

3. Results

3.1. Sample characteristics and recreational behaviour

The data were divided into six samples of young, middle-aged, and elderly people living in ORAs and UVAs (Table S1). The ratios of the samples living in ORAs and UVAs were almost balanced, with a ratio of 1:1.1. The average age of young people in ORAs was 26.51 years, whereas that of young people in UVAs was 26.47 years; the average age of middle-aged people in ORAs was 44.49 years, whereas that of middle-aged people in UVAs was 47.70 years; and the average age of elderly people in ORAs was 65.89 years. The average age of the older persons in ORAs was 65.46 years.

Descriptive statistics on the economic and social attributes of the respondents were conducted (Table S1). Differences in the characteristics of the sample in terms of economic and social attributes indicate that the sample of respondents is dominated by young, middle-aged and elderly people. It is worth noting that more than about 85 % of the respondents had incomes below the average wage level (14,540 RMB/month) published by the Shenzhen Municipal People's Government (Shenzhen Municipal Bureau of Statistics, 2024). 11,000–13,000 and greater than 13,000, totalling 62, or about 16 per cent of the total sample. The median income of residents in ordinary residential areas is generally higher than that of residents in urban villages. This difference is most evident in the 36–60 age group, with the median income of residents in ORAs being approximately 8000 yuan, compared to about 6000 yuan for residents in UVAs (Fig. 4).

Meanwhile, a comparison was made of the trend data on preferences for UGS (Table S1). Both the ORA and UVA groups show a preference for parks, with the elderly group having a particularly evident preference, which is confirmed by the high proportion of park usage (54.39 % for the ORA group and 38.57 % for the UVA group). In ORA communities, the usage rate of community parks is the highest among people aged 18–35 and 30–60, at 42.11 % and 40 % respectively. Moreover, parks are the second most frequently visited places for these two age groups, accounting for 29.82 % and 34.29 % respectively. For the UVA group, street corners are popular among young people (37.5 %), middle-aged people (25.35 %) and the elderly (37.14 %).

The dataset highlights differences in recreational engagement across age segments within the ORAs and UVAs, focusing on demographic activity characteristics. A review of Table S1 indicates a preference for weekend engagement with Urban Green Spaces (UGS) among the younger and middle-aged populations, while a significant proportion of the senior population, 85.04 %, partakes in activities on both weekdays and weekends. In terms of hours of use, the older population is the most active UGS user, with over 90 % of older adults in ORAs and over 80 % of older adults in UVAs spending more than an hour on their UGS. In addition, a comparative analysis of people of different age groups reveals that residents in ORA tend to stay in urban green spaces for significantly longer periods compared with those in UVA. In terms of residents' frequency of using UGS, residents in ORA have a higher daily usage rate (58.68 % vs. 46.21 %), with a more dispersed and balanced usage pattern. At the same time, comparative analyses of different age groups show that residents of ORAs exhibit a clear trend toward longer UGS use compared to residents of UVAs.

3.2. Health-related causes of UGS use by different groups

We collected data on health-related reasons for visiting green spaces through a questionnaire (Table 1) and learned that the majority of people in the six categories believed that going to the UGS relieves stress and provides a sense of belonging. Moreover, in the same age group, whether young, middle-aged or old, UVA residents (76.56 %, 61.97 %, 74.29 %) were significantly less motivated to use UGS than ORA residents were (91.23 %, 78.57 %, 84.21 %).

The results of the health level measurements for the six different groups are shown in Table 2. The mean systolic and diastolic blood pressures of the participants were 115.61 mmHg and 75.46 mmHg, respectively. The normal range of blood pressure is 90–139 mmHg systolic and 60–89 mmHg diastolic. Therefore, those whose blood pressures did not fall within these ranges were first identified as having abnormal blood pressure. The mean systolic and diastolic BPs of the participants were 115.61 mmHg and 75.46 mmHg, respectively, and adults with Abnormal BP accounted for 8.74 % of the total number of participants; therefore, people with high BP were first identified as an unhealthy group. Moreover, the health status data of the population were determined on the basis of the FS-14 test data, SpO2 data and BP indices (Table 2). The FS-14 scale was calculated as follows: the physical fatigue scores of items 1–8 were summarized, and the sum of the scores of items 9–14 was used as the mental fatigue score. The higher the score is, the more severe the fatigue. We set the physical fatigue scores as A1 (0,1,2), B1 (3,4,5), and C1 (6,7,8) and the mental fatigue scores as A2 (0,1,2), B2 (3,4), and C2 (5,6) to analyse the population's health level. In addition, residents with BP and SpO2 above or below normal values were considered unhealthy. The health level was assessed via FS-14 scale scores, where A1A2 represents very healthy; A1B2, B1A2 and B1B2 represent basically healthy; and C1C2, B1C2, C1B2, A1C2, A2C1 and B2C1 were considered unhealthy. Fig. 5 shows a U-shaped

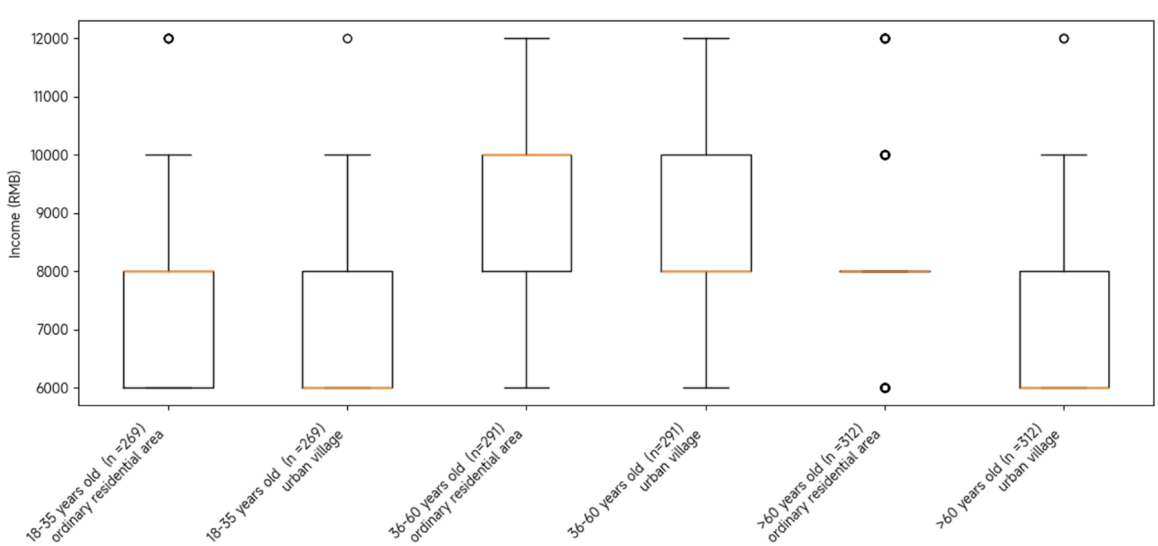

Fig. 4. EI (Economy and income) distribution by residence type and age group.

Table 1
Health-related reasons for visiting green spaces per study group ($n = 389$).

Items	18–35 years old in ORA (n = 57)	18–35 years old in UV (n = 64)	36–60 years old in ORA (n = 70)	36–60 years old in UV (n = 71)	>60 years old in ORA (n = 57)	>60 years old in UV (n = 70)
The UGS is a source of stress relief and makes you feel a sense of belonging (in %)	c	abc	bc	a	bc	ab
Yes	91.23 %	76.56 %	78.57 %	61.97 %	84.21 %	74.29 %
No	8.77 %	23.44 %	21.43 %	38.03 %	15.79 %	25.71 %
When I want to recover, I deliberately seek out UGS (in %)	ab	bc	a	c	abc	c
Never	1.75 %	4.69 %	0.00 %	0.00 %	0.00 %	0.00 %
Seldom	12.28 %	17.19 %	8.57 %	35.21 %	22.81 %	34.29 %
Frequently	49.12 %	54.69 %	55.71 %	45.07 %	47.37 %	40.00 %
Very frequently	36.84 %	23.44 %	35.71 %	19.72 %	29.82 %	25.71 %
When I want to relieve stress and keep my focus, I deliberately seek out UGS (in %)	a	c	ab	cd	b	d
Never	1.75 %	6.25 %	0.00 %	0.00 %	0.00 %	2.86 %
Seldom	3.51 %	15.63 %	10.00 %	42.25 %	1.75 %	34.29 %
Frequently	28.07 %	48.44 %	35.71 %	30.99 %	61.40 %	51.71 %
Very frequently	66.67 %	29.69 %	54.29 %	26.76 %	33.33 %	11.43 %
When I want to body healthy, I deliberately seek out green Spaces (in %)	a	c	b	bc	b	c
Never	3.51 %	3.12 %	1.43 %	1.41 %	5.26 %	5.71 %
Seldom	3.51 %	23.44 %	17.14 %	26.76 %	8.77 %	17.14 %
Frequently	35.09 %	62.50 %	44.29 %	42.25 %	43.90 %	51.43 %
Very frequently	57.89 %	10.94 %	37.14 %	29.58 %	42.13 %	24.29 %

a,b,c,d Study groups with the same superscript do not differ at the $p < 0.05$ level.

distribution of "very healthy" responses across age groups, peaking in the young and elderly and dipping in mid-life. Specifically, 50 % of 18–35-year-olds and 43 % of those >60 report "very healthy" in ORAs, while the corresponding figures in UVAs are 40 % and 36 %. Conversely, "basically healthy" follows an inverted-U, cresting at 36–60 years (52 % in ORAs, 57 % in UVAs). Notably, the 18–35 cohort reports markedly more "unhealthy" cases in UVAs (14 %, only 1 % in ORAs), whereas the elderly profiles are nearly identical across sites.

3.3. Analysis of differences in attributes between residents in different residential contexts

3.3.1. Relationship between green space use and social attributes

UGS use was associated with variability in residential background, and the relationship between respondents' use of green space and health was verified through analysis. Therefore, we also assessed the index variability and significance levels between respondents via SPSS (Table 3). At the level of green space use, there were significant differences across sexes, ages and residential backgrounds.

Correlation analysis verified the relationship between respondents' use of green spaces and health-related social capital. Therefore, the indices were ranked separately according to the order of the options in Table S1 and the level of variability and significance among respondents was assessed by ANOVA (Table 3). In terms of green space use, there were significant differences in the use of green space among respondents of different genders, ages and classes. In particular, per capita use was generally higher among the 60+ age group ($M = 1.54$, SD=0.63). There were significant differences in the use of green space by age and class, with those living in ORAs being more active users of green space than those living in UVAs.

Males and those over 60 years of age were high-frequency users of UGSs. Moreover, UVA residents had fewer hours of green space use (TU) than ORA residents did, and young and middle-aged groups had lower TU than older groups did. In addition, we found differences in health-related socialization among respondents in different age groups. In particular, in the SN (social networking) dimension, there were significant differences between respondents of different ages and classes. The respondents living in ORAs and those over 60 years of age typically had higher SN values because they had denser social networks in their neighbourhoods. There were significant differences in the EI dimensions by sex and age. The middle-aged group and those living in ORAs had relatively higher EI.

3.3.2. Differences in green space use among different residential contexts

The standardized total associations between the use of UGS and residents in all the models are summarized in Fig. 6. With respect to whether FH (FS-14 health) or hypertension was used as the outcome, almost all the models showed significant associations. The use of FU, EI, AP, TU, and SN as indicators of residents' use of UGS are shown in Table 1. The health of residents was significantly correlated with their living environment (β = 0.173**), which, when combined with the results of the above analysis of variance (ANOVA), indicates that the health of residents living in ORAs was more stable than that of those living in UVAs. At the same time, the comparison in Table 2 shows that regardless of age, residents living in ORAs have better overall health status than those living in UVAs.

The correlation between the health status of the residents and the use of UGS was analysed by analysing age, sex, occupational status, income of the residents, and residential background. The direct effects of residents' exposure to UGS on mental health and physical activity were statistically significant. Standardized indirect and total correlations for green spaces are presented (Fig. 6). The frequency of green space use (FU) had significant indirect correlations with BP (β = 0.149**), FS-14 health (FH) with FU (β = 0.239**), Social Networking (SN) (β = −0.409**) and SpO2 (β = −0.360**). The correlations of FS-14 residents' health (FH) status with Live are (β = 0.173**), SN (β =−0.381**), TU (β = −0.335**), FU (β = 0.239**), and work status (β = 0.169**) were significant, but the correlation with EI was not significant (β = 0.043*). This result shows that there is a significant correlation between residents' health and their living environment. Residents' health is affected by the frequency, duration, activities, social networks and social work they use. At the same time, there is a significant correlation between the health of the population and the living environment. Residents' health was influenced by the frequency and duration of their use, activities, social networks, and social work. Residents' residential context was significantly correlated with green space use SN (β = −0.307**), duration of use TU (β = −0.259**), and income status EI (β = −0.318**). This suggests that residential context affects residents' activity motivation and thus their health status.

Table 2
Data on the health status of the population and Health-related reasons for visiting green spaces per study group (n = 389).

Items (in %)	18–35 years old in ORA (n = 57)	18–35 years old in UV (n = 64)	36–60 years old in ORA (n = 70)	36–60 years old in UV (n = 71)	>60 years old in ORA (n = 57)	>60 years old in UV (n = 70)
Systolic pressures	111.93bd	111.86bcd	113.98cd	113.94bc	120.88b	121.06a
Diastolic pressures	73.87b	73.92b	75.41b	75.40ab	76.96b	77.21a
BP (Physiological health)	c	bc	bc	ab	c	a
Normal	98.25 %	93.75 %	94.29 %	85.92 %	98.25 %	80.00 %
Abnormal	1.75 %	6.25 %	5.71 %	14.08 %	1.75 %	20.00 %
Blood oxygen	96.55bc	96.53abc	97.03a	97.01ab	96.40abc	96.40c
FS-14 physical fatigue scores A1,B1,C1	a	a	a	a	b	ab
A1 (0,1,2)	70.18 %	68.75 %	70.00 %	64.79 %	91.23 %	81.43 %
A2 (3,4,5)	28.07 %	29.69 %	30.00 %	33.80 %	7.02 %	15.71 %
A3 (6,7,8)	1.75 %	1.56 %	0.00 %	1.41 %	1.75 %	2.86 %
FS-14 mental fatigue score. A2,B2,C2	b	ab	a	a	b	a
A2 (0,1,2)	84.21 %	67.19 %	50.00 %	49.30 %	77.19 %	64.83 %
B2 (3,4)	15.79 %	31.25 %	48.57 %	47.89 %	21.05 %	23.45 %
C2 (5,6)	0.00 %	1.56 %	1.43 %	2.82 %	1.75 %	11.72 %

a,b,c,d Study groups with the same superscript do not differ at the $p < 0.05$ level.

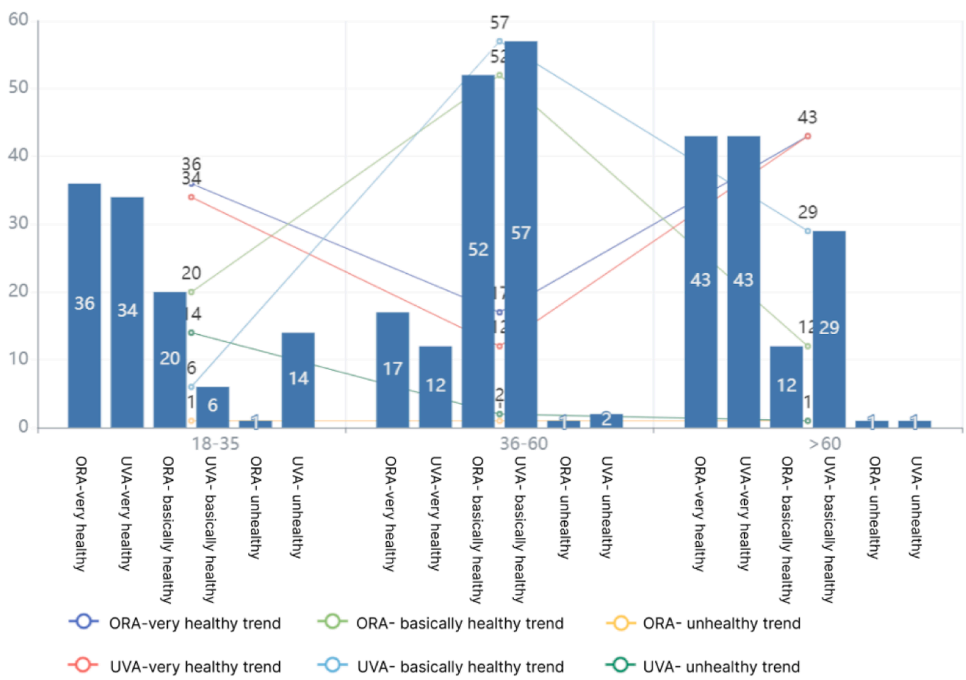

Fig. 5. Comprehensive analysis of the number of people with mental health.

3.4. Residence, age, and green-space use shape self-rated health: Ancova evidence

After controlling for income as a covariate, a significant main effect of age group on self-rated health scores was observed, $F = 19.43$, $p < 0.001$ (Fig. 7). Post-hoc comparisons revealed that the 36–60 age group reported the lowest scores ($M = 2.09$, SD = 0.41), significantly lower than both the 18–35 age group ($M = 2.48$, SD = 0.38, $p < 0.001$) and the >60 age group ($M = 2.53$, SD = 0.44, $p < 0.001$); the latter two did not differ significantly from each other ($p = 0.42$). Boxplots further illustrated that the 36–60 age group not only exhibited a markedly lower median score but also contained a disproportionate number of low-score outliers. In contrast, although the >60 age group shared a similar median with the 18–35 age group, its upper whisker extended further, indicating a higher prevalence of extremely favorable ratings. Finally, the covariate income failed to reach significance ($p = 0.167$), suggesting that income differences alone do not account for the age-related variations in self-rated health.

After adjusting for monthly income as a covariate, the main effect of residence type on self-rated health remained significant, $F = 18.21$, $p < 0.001$, whereas the income effect was only marginally significant, $F = 1.88$, $p = 0.097$. This indicates that living environment exerts a substantially stronger influence on perceived health than income level. Fig. 8 illustrates these patterns across seven income strata: 1) Within every income band, residents of ordinary residential areas (ORAs) consistently exhibited higher median health scores than their urban-village (UVAs) counterparts, with the entire distribution shifted upward; 2) Although health scores rose with income in both residence types, the slope was markedly steeper for ORA residents, suggesting that economic gains translate into greater health benefits when the living environment is more favorable; 3) The disparity was most pronounced among the lowest-income group (< ¥5000 per month), where the median health score in ORAs (≈2.5) far exceeded that in UVAs (≈1.7). This underscores the pronounced moderating role of residence type for vulnerable populations.

After controlling for age, ANCOVA revealed a significant main effect

Table 3
Results obtained by ANOVA.

Social Attribute	Gender		Age			Residential background	
	Male	Female	18–35 years old	36–60 years old	>60 years old	ORA	UVA
$N = 389$	217 (55.78 %)	172 (44.22 %)	121 (31.11 %)	141 (36.25 %)	127 (32.65 %)	184 (47.30 %)	205 (52.70 %)
FU	2.21±1.11	2.56±1.39	2.87±1.28	2.69±1.28	1.54±0.63	2.22±1.18	2.50±1.30
	$P = 0.006$ (*)		$P = 0.000$ (**)			$P = 0.025$ (*)	
EI	3.19±1.41	2.19±1.33	2.40±1.27	3.72±1.36	2.98±1.17	3.53±1.31	2.65±1.31
	$P = 0.046$		$P = 0.000$ (**)			$P = 0.000$ (**)	
AP	3.06±1.53	3.44±1.83	2.75±0.94	3.07±1.67	3.84±2.01	3.10±1.61	3.34±1.73
	$P = 0.026$ (*)		$P = 0.000$ (**)			$P = 0.161$	
TU	3.05±1.06	3.11±1.01	3.00±1.20	2.72±0.88	3.54±0.83	3.36±1.05	2.82±0.95
	$P = 0.57$		$P = 0.000$ (**)			$P = 0.000$ (**)	
SN	2.32±1.02	2.26±1.07	1.63±0.70	2.09±0.97	3.15±0.79	2.63±1.13	1.99±0.85
	$P = 0.53$		$P = 0.000$ (**)			$P = 0.000$ (**)	
BP	1.11±0.31	1.06±0.25	1.04±0.20	1.10±0.30	1.12±0.32	1.03±0.18	1.14±0.34
	$P = 0.146$		$P = 0.084$			$P = 0.000$ (**)	
SpO2	2.34±0.48	2.32±0.48	2.03±0.18	2.04±0.24	2.94±0.24	2.32±0.47	2.34±0.49
	$P = 0.663$		$P = 0.000$ (**)			$P = 0.668$	
FH	1.68±0.64	1.60±0.69	1.51±0.62	1.91±0.55	1.47±0.73	1.52±0.57	1.75±0.72
	$P = 0.247$		$P = 0.000$ (**)			$P = 0.001$ (*)	

Significance levels: *$P < 0.05$, ** $P < 0.01$.
FU stands for Frequency of use, El stands for Economy and income, AP stands for Activity Participation, TU stands for Time of use, SN stands for Social Networking, BP stands for Blood Pressure, FH stands for FS-14 health, SpO2 stands for Blood oxygen.

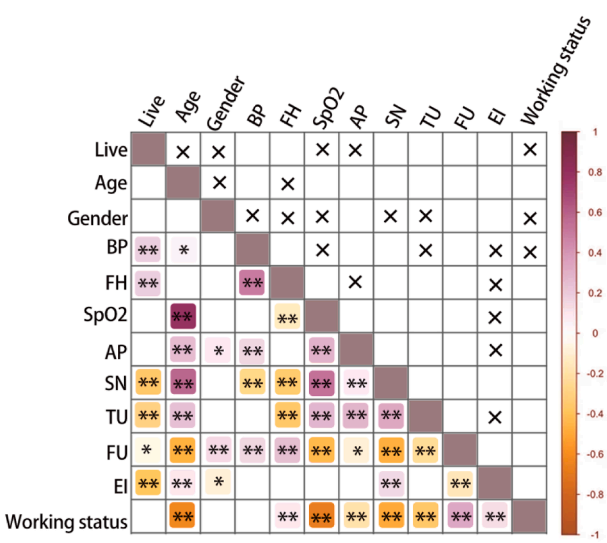

Fig. 6. Relevance heatmap.
(FU stands for frequency of use, TU stands for time of use, AP stands for activity participation, SN stands for social networking, RT stands for reciprocity and trust, El stands for economy and income, BP stands for blood pressure, FH stands for FS-14 health, SpO2 stands for peripheral arterial blood oxygen saturation.).

of residence type on health scores (Fig. 9), $F = 9.59$, $p = 0.002$, $\eta^2 = 0.025$, indicating a medium-sized effect. More importantly, the interaction between residence type and age group was highly significant (Fig. 10), $F = 14.36$, $p < 0.0001$, demonstrating that the health benefits conferred by living environment vary across the lifespan. Among participants aged 18–35, residents of ordinary residential areas (ORAs) reported a substantially higher median health score (≈ 4.2) than those in urban villages (UVAs≈ 3.7), representing the largest disparity observed. In the 36–60 age group, the distributions converged, and differences were minimal; in the > 60 cohort, the gap widened again in the same direction as the youngest group.

Fig. 10 further shows that ORAs residents reported greater green-space use across all age brackets, with the 18–35 age group exhibiting the most pronounced difference (Mdn ORAs ≈ 3.6 vs. Mdn UVAs ≈ 2.8). Correlational analyses indicated that green-space use frequency was positively associated with health scores, and this relationship was markedly stronger for ORAs residents ($r = 0.42$) than for UVAs residents ($r = 0.21$). Age itself did not significantly predict health scores ($p = 0.474$), underscoring that the observed health disparities are attributable to residence type and its downstream impact on green-space use rather than to chronological age.

4. Discussion

This study reveals significant disparities in green-space exposure and health outcomes across age-by-context groups, echoing recent scholarship on green-space equity. Li et al. (2025) demonstrate that Beijing's

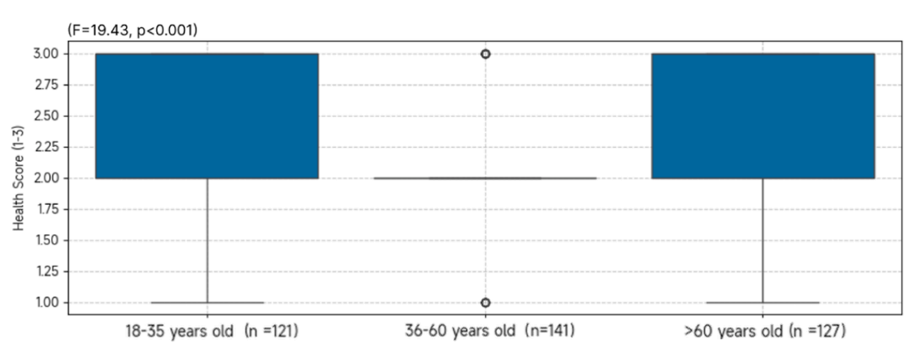

Fig. 7. Health score distribution by age group.

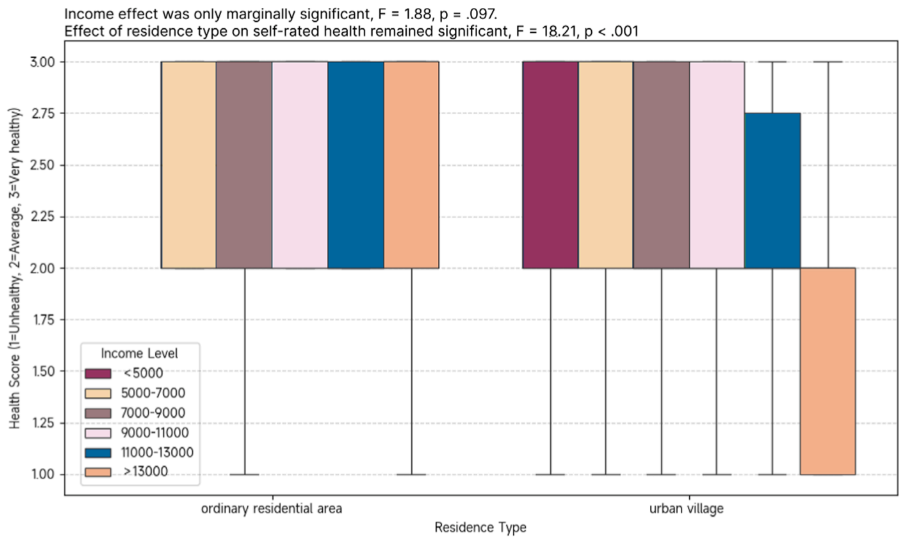

Fig. 8. Health score distribution by residence type and income level.

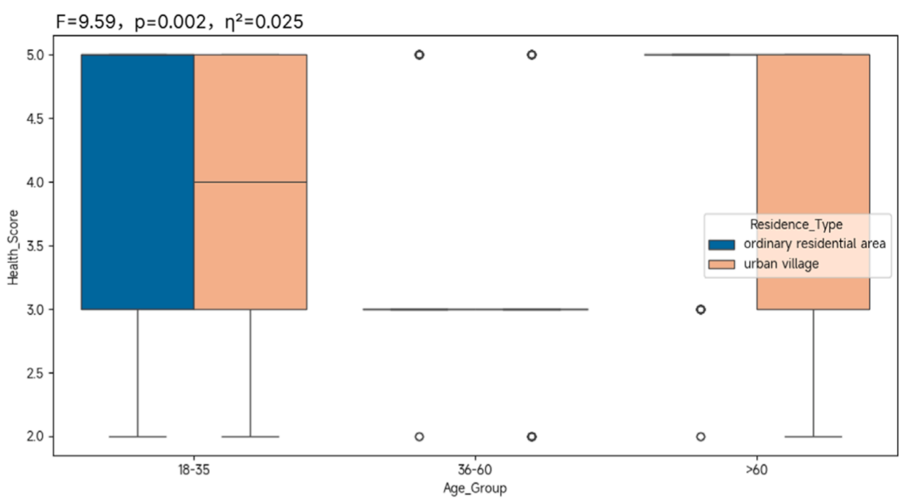

Fig. 9. Health score by age group and residence type.

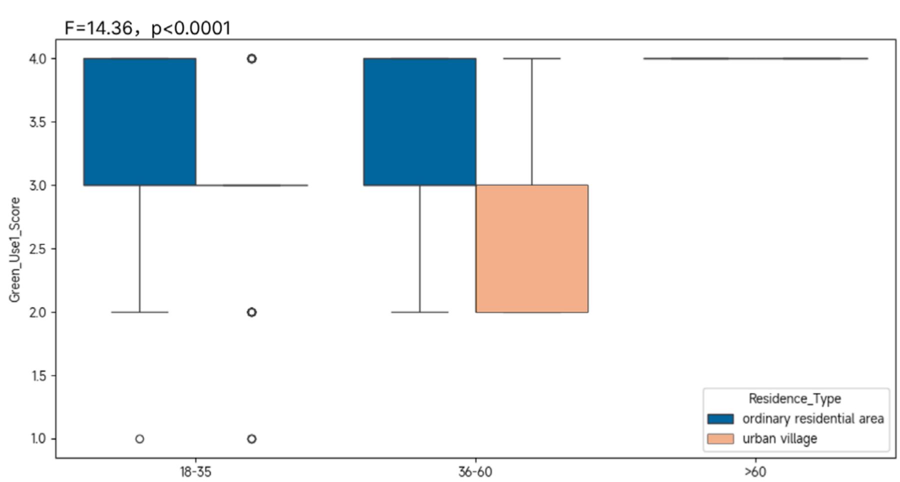

Fig. 10. Green space usage frequency by age group and residence type.

inner-city urban villages exhibit a pronounced "high–low" gradient: low-income communities simultaneously confront elevated air-pollution levels and diminished access to green areas. In our sample, adults older than 60 living in ORAs (older residential areas) display a significantly higher prevalence of hypertension, suggesting that this combined environmental burden may be driving observed health inequities. Owing to the cross-sectional design, however, we cannot establish whether restricted green-space availability is a causal determinant or merely a correlate of these disparities. As Heikinheimo et al. (2020) warn, causal inferences based on cross-sectional data risk overestimating the protective effects of green space while underestimating confounding by air pollution, traffic noise, and other environmental stressors.

Although both ORA and UVA residents exhibit a pronounced "high-use skew" in overall visitation frequency, daily use of urban green space is markedly higher among ORA residents (58.68 %) than among their UVA counterparts (46.21 %). With respect to timing, ORA users have forged stable daily routines, whereas UVA users display a "weekend-centric" pattern. This divergence persists after adjustment for income, age, and sex, indicating that the relationship between green-space provision and usage frequency is not a simple linear one. When per-capita green space within a 15-minute walking radius falls below 3 m^2, residents tend to abandon daily high-frequency visits and instead adopt a compensatory weekend strategy (Zhao et al., 2024a; Xu et al., 2024).

Both ORAs and UVAs residents show a clear preference for parks, with the preference most pronounced among older adults. Park use accounts for 54.39 % of all visits in ORAs and 38.57 % in UVAs, underscoring its central role. Within ORAs communities, community parks attract the highest proportion of users in the 18–35 age bracket (42.11 %) and the 36–60 cohort (40 %), making parks the second-most visited green-space type for these groups (29.82 % and 34.29 %, respectively). In UVAs areas, pocket parks along streets are favoured across generations, with 37.5 % of young adults, 25.35 % of middle-aged residents, and 37.14 % of older adults reporting regular visits.

These patterns align with Bai et al., (2025), who found that older adults rely heavily on both accessibility and the completeness of amenities. Consequently, both ORAs and UVAs samples exhibit a U-shaped distribution in mental health (FH), with the highest proportion of "very healthy" individuals appearing among the youngest and oldest cohorts. Middle-aged residents (36–60 years) deviate from this trend, recording the highest share of "generally healthy" ratings—suggesting a critical transition period for health risk. Targeted lunchtime micro-green-space interventions for this group may therefore represent a precise and timely public-health entry point.

Structural-equation modelling revealed two partially mediated pathways through which green-space use influences health: a) Frequency of use (FU) → social networking (SN) → mental health (indirect $\beta = -.100$, $p < 0.05$); b) FU → activity participation (AP) → blood oxygen saturation (SpO_2) (indirect $\beta = -.069$, $p < 0.05$). Both indirect effects were significantly weaker in UVA than in ORA. This attenuation is attributable to UVA residents' markedly lower scores on SN ($\beta = -.307$, $p < 0.01$) and time-of-use stability (TU, $\beta = -.259$, $p < 0.01$), corroborating Trope and Liberman, (2010) "psychological distance" mechanism: when a sense of belonging and safety is lacking, proximity alone fails to translate into consistent use and, consequently, into health benefits.

Indeed, the direct effect of daily green-space use on mental-health scores was substantially larger in ORA ($\beta = 0.28$, $p < 0.01$) than in UVA ($\beta = 0.11$, $p < 0.05$). In ORA, this effect is fully mediated by social networking (SN), whereas in UVA the mediating role of SN in corner pocket parks is negligible ($\beta = 0.03$, ns). These findings align with A. Rigolon et al.'s (2018) "safety–social filtration" model: corner spaces lacking seating, lighting, and maintenance fail to foster meaningful social interaction, thereby undermining their restorative potential. Therefore, regeneration strategies for UVA neighbourhoods should prioritize the "micro-kit" of seating, lighting, and simple exercise amenities over mere expansion of green-space area.

In summary, multilevel modelling shows that green-space use frequency (FU) is positively associated with FS-14 mental-health scores ($\beta = 0.239$, $p < 0.01$). However, this benefit is significantly moderated by residential context: residents of ORAs report mental-health scores that are, on average, 0.32 SD higher than those of residents of UVAs ($\beta = 0.173$, $p < 0.01$). This pattern aligns with A. Rigolon et al.'s (2018) findings in disadvantaged U.S. neighbourhoods, where fragmented green space and perceived safety deficits attenuated mental-health gains through a "social filter." Of particular concern, our results reveal that 21.9 % of young adults (18–35 years) in UVAs classify as "unhealthy," a rate markedly higher than the 1.8 % observed among their ORA counterparts. This discrepancy underscores a pronounced green-space–mental-health mismatch among young renters in high-density urban villages.

4.1. Limitations

While this study is the first to contrast green-space use and its health correlates between urban villages and ordinary residential areas within the same city, the findings should be interpreted cautiously. Four limitations may partially explain the observed associations and point toward avenues for improvement. 1) Cross-sectional design. By restricting recruitment to individuals who had visited green space on the day of the survey, we may have underestimated the true effect; 2) Sampling constraints. Convenience sampling was conducted in only four Shenzhen communities (two ordinary residential areas and two urban villages), potentially introducing selection bias and measurement error (J. Zhao et al., 2024); 3) Health indicators. Self-rated health is a subjective measure that omits key covariates such as chronic disease status and lifestyle behaviors; 4) Unmeasured confounders. $PM_{2.5}$, traffic noise, and occupational stress were not assessed, yet prior research indicates these factors can attenuate or even nullify the cardiovascular benefits of green space(Liu et al., 2018).

4.2. Policy implications and future research

In view of the above limitations, we propose to carry out the renewal of green spaces in urban villages following a "progressive-verifiable" approach:

a) Embed rooftop-garden interventions in longitudinal or quasi-experimental designs to quantify changes in residents' health before and after installation.
b) Concurrently monitor $PM_{2.5}$ concentrations, thermal comfort, and usage frequency in rooftop gardens to isolate the effects of air pollution and heat stress.
c) Include low-cost, easily maintained ground-level pocket parks as an alternative strategy and conduct comparative cost-effectiveness analyses with rooftop gardens.
d) Implementing targeted micro-upgrades: Adding modular, flexibly configurable UVA activity spaces in communities or on street corners. By installing modular seating, movable greenery, and convertible activity facilities on street corners, the average daily visit rate to public spaces increased by approximately 10 % (Zhang, 2025).
e) Launch a cohort study combining mobile experience-sampling and high-resolution GPS to track dynamic changes in green-space exposure, social interaction, and mental health, thereby providing causal evidence of how shifting usage patterns influence health trajectories over time.

5. Conclusion

This study shows that unequal access to urban green space (UGS) for residents of ordinary residential areas (ORAs) and urban villages (UVAs) is not only an issue of land-use injustice but also a systemic mechanism that undermines the physical and mental health of urban-village dwellers. Among urban-village residents, UGS use is significantly correlated with health indicators. The two health-promotion pathways identified: 1) The indirect effect of use frequency on mental health via social networks and 2) The direct association between activity participation and blood-oxygen saturation are significantly attenuated in urban villages. The shortage of green space is further exacerbated by a "temporal–spatial compensation" pattern: residents rely on infrequent, weekend-centred visits that are too brief to secure the sustained benefits enjoyed by residents in ordinary residential areas. These findings highlight the need for governments and society to prioritise the well-being of urban-village residents and warn against one-size-fits-all greening strategies in high-density settings. Future interventions should focus on low-cost, ground-level pocket parks and the rapid deployment of micro-scale green-space upgrades within existing footprints. Combined with longitudinal cohort studies and real-time air-quality monitoring, such targeted actions can simultaneously advance environmental justice and public-health equity in China's rapidly expanding cities.

CRediT authorship contribution statement

Luoan Chen: Writing – original draft, Visualization, Resources, Methodology, Formal analysis, Data curation. **Qiantong Liang:** Writing – review & editing, Validation, Software, Project administration, Methodology, Formal analysis. **Haoran Zhao:** Writing – review & editing, Visualization, Validation, Supervision, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.wss.2025.100298.

References

Alcock, I., White, M.P., Wheeler, B.W., Fleming, L.E., Depledge, M.H., 2014. Longitudinal effects on mental health of moving to greener and less green urban areas. Environmental Science & Technology 48 (2), 1247–1255. doi:10.1021/es403688w.

Bai, X., Cao, K., & Tian, W. (2025). How do community parks affect environmental justice for older adults: Insights from availability, accessibility, and attractiveness. Urban Forestry & Urban Greening, 113, Article 129017. doi:10.1016/j.ufug.2025.129017.

Cao, X., Tuerdi, N., Tang, H., Zhang, Y., Wang, X., Zheng, C., Tian, Y., Yu, X. (2025). Long-term exposure to residential greenness and cardiovascular disease and all-cause mortality in China. BMC Public Health, 25, Article 1645. doi:10.1186/s12889-025-22899-7.

Cardinali, A., Lafortezza, R., Colangelo, G., 2024. Examining green space characteristics for social cohesion and mental health outcomes: a sensitivity analysis in four European cities. Urban For Urban Green 85, 128230. https://doi.org/10.1016/j.ufug.2024.128230.

Chalder, T., Berelowitz, G., Pawlikowska, T., Watts, L., Wessely, S., Wright, D., Wallace, E., 1993. Development of a fatigue scale. J. Psychosom. Res. 37 (2), 147–153. https://doi.org/10.1016/0022-3999(93)90081-P.

Chen, K., Zhang, T., Liu, F., Zhang, Y., Song, Y., 2021. How does urban green space impact residents' mental health: a literature review of mediators. Int. J. Environ. Res. Public Health 18 (22), 11746. https://doi.org/10.3390/ijerph182211746.

China (Shenzhen) Comprehensive Development Research Institute. (2023). Dictionary of urban village buildings in Shenzhen 2022. https://baijiahao.baidu.com/s?id=1778333885549619320.

Dmitrović, V., Ignjatijević, S., Vapa Tankosić, J., Prodanović, R., Lekić, N., Pavlović, A., & Cavlin, M. (2025). Sustainability of urban green spaces: A multidimensional analysis. Sustainability, 17(9), Article 4026. doi:10.3390/su17094026.

Du, S., Sun, Y., Yang, H., Liu, M., Tang, J., Hu, G., & Tian, Y. (2025). Is green space more equitable in high-income areas? A case study of Hangzhou, China. Land, 14(6), Article 1183. doi:10.3390/land14061183.

Guo, Y., Lei, G., Zhang, L., 2023. Quality evaluation of park green space based on multi-source spatial data in Shenzhen. Sustainability 15 (11), 8901. https://doi.org/10.3390/su15118991.

He, C., Chen, Y., Liu, Z., Yang, J., 2025. From urban village housing to tenant mental health: the crucial role of community attachment in Chinese megacities. Front. Public Health 13, 1490105. https://doi.org/10.3389/fpubh.2025.1490105.

Heikinheimo, V., Tenkanen, H., Bergroth, C., Järv, O., Hiippala, T., Toivonen, T., 2020. Understanding the use of urban green spaces from user-generated geographic information. Landsc. Urban Plan. 201, 103845. https://doi.org/10.1016/j.landurbplan.2020.103845.

Helbich, M., Poppe, R., Oberski, D., Zeylmans van Emmichoven, M., Schram, R., 2022. Can't see the wood for the trees? An assessment of street view- and satellite-derived greenness measures in relation to mental health. Landsc. Urban Plan. 214, 104181. https://doi.org/10.1016/j.landurbplan.2021.104181.

Hoseini, P., Mohseni, P., Veeroja, P., & Foliente, G. (2025). Urban green space inequity, socioeconomic disparities, and potential health implications in metropolitan Melbourne. Applied Sciences, 15(7), Article 3940. doi:10.3390/app15073940.

Jennings, V., Rigolon, A., Thompson, J., Murray, A., Henderson, A., & Schulterbrandt Gragg, R. (2024). The dynamic relationship between social cohesion and urban green space in diverse communities: Opportunities and challenges to public health. International Journal of Environmental Research and Public Health, 21(6), Article 800. https://doi.org/10.3390/ijerph21060800.

Kronenberg, J., Haase, A., Łaszkiewicz, E., Antal, A., Baravikova, A., Biernacka, M., Dushkova, D., Filak, R., Haase, D., Ignatieva, M., Khmara, Y., Nita, M.R., Onose, D. A., Badiu, D.L., 2020. Environmental justice in the context of urban green space availability, accessibility, and attractiveness in postsocialist cities. Cities 106, 102862. doi:10.1016/j.cities.2020.102862.

Kuo, H.M., Su, J.Y., Wang, C.H., Kiatsakared, P., Chen, K.V., 2021. Place attachment and environmentally responsible behavior: the mediating role of destination psychological ownership. Sustainability 13 (12), 6809. https://doi.org/10.3390/su13126809.

Li, Q., Duan, W., Chen, Y., Ma, M., Zheng, X., 2025. Assessment of urban green space equity in Beijing's central urban villages: a remote sensing perspective on environmental justice. Sustainability 17 (10), 4561. https://doi.org/10.3390/su17104561.

Liu, J., Li, W., Wu, J., 2018. A framework for delineating the regional boundaries of $PM_{2.5}$ pollution: A case study of China. Environmental Pollution 235, 642–651. doi:10.1016/j.envpol.2017.12.064.

Liu, Y., Wang, R., Grekousis, G., Liu, Y., Yuan, Y., Li, Z., 2019. Neighbourhood greenness and mental well-being in Guangzhou, China: what are the pathways? Landsc. Urban Plan. 190, 103602. https://doi.org/10.1016/j.landurbplan.2019.103602.

Nwana, N., Javed, Z., Jones, S.L., Lee, C., Maddock, J.E., Al-Kindi, S., Nasir, K., 2024. Green streets, healthy hearts: Exploring the roles of urban nature and walkability in cardiovascular health. Methodist DeBakey Cardiovascular Journal 20 (5), 37–46. doi:10.14797/mdcvj.1455.

Pan, W., Du, J., 2021. Towards sustainable urban transition: a critical review of strategies and policies of urban village renewal in Shenzhen, China. Land. use policy. 111, 105744. https://doi.org/10.1016/j.landusepol.2021.105744.

Peschardt, K.K., Schipperijn, J., Stigsdotter, U.K., 2012. Use of small public urban green spaces (SPUGS). Urban For Urban Green 11 (3), 235–244. https://doi.org/10.1016/j.ufug.2012.04.002.

Reece, R., Elliott, L., Bray, I., & Bornioli, A. (2024). How properties of urban greenspaces shape well-being across age groups: A qualitative study. Wellbeing, Space and Society, 7, Article 100206. doi:10.1016/j.wss.2024.100206.

Reyes-Riveros, R., Altamirano, A., De La Barrera, F., Rozas-Vásquez, D., Vieli, L., Meli, P., 2021. Urban green space and health in low and middle-income countries: A critical review. Urban Forestry & Urban Greening 61, 127105. doi:10.1016/j.ufug.2021.127105.

Rigolon, A., Browning, M., Jennings, V., 2018a. Inequities in the quality of urban park systems: an environmental justice investigation of cities in the United States. Landsc. Urban Plan. 178, 156–169. https://doi.org/10.1016/j.landurbplan.2018.05.026.

Rivera, E., Timperio, A., Loh, V. H. Y., Deforche, B., & Veitch, J. (2021). Critical factors influencing adolescents' active and social park use: A qualitative study using walk-along interviews. Urban Forestry & Urban Greening, 58, Article 126948. doi:10.1016/j.ufug.2020.126948.

Roba, H.S., Bidle, S.J.H., Kolbe-Alexander, I., 2025. The perceived role of green spaces on mental well-being in adults living in regional communities: A qualitative study. Health Promotion Journal of Australia 36 (3), e70072. doi:10.1002/hpja.70072.

Shenzhen Municipal Bureau of Statistics, July 25, 2024. Annual average wages of employees in urban units in Shenzhen in 2023. https://tjj.sz.gov.cn/gkmlpt/content/12/12253/post_12253352.html#4222.

Tong, D., 2023. China Urban Hundred Forum 2023 Autumn Forum and cross-border seminar on Chinese-style modernization and transformation of urban villages in mega mega cities - sketch of urban villages in Shenzhen and analysis of transformation patterns. Retrieved from https://web.pkusz.edu.cn/tongde/info/1017/1115.htm.

Trope, Y., Liberman, N., 2010. Construal-level theory of psychological distance. Psychological Review 117 (2), 440–463. doi:10.1037/a0018963.

Ventriglio, A., Torales, J., Castaldelli-Maia, J.M., De Berardis, D., Bhugra, D., 2021. Urbanization and emerging mental health issues. CNS Spectr. 26 (1), 43–50. https://doi.org/10.1017/s1092852920001236.

Wang, R., Feng, Z., Pearce, J., Liu, Y., Dong, G., 2021. Are greenspace quantity and quality associated with mental health through different mechanisms in Guangzhou, China: a comparison study using street view data. Environ. Pollut. 290, 117976. https://doi.org/10.1016/j.envpol.2021.117976.

Wu, Y., You, Y., 2024. Nonlinear relationship between the elderly's perception of green spaces and their activity characteristics. Landscape Archit. 2024 (5), 94–103. https://doi.org/10.3724/j.fjyl.202409200552.

Xian, Z., Nakaya, T., Liu, K., Zhao, B., Zhang, J., Zhang, J., Lin, Y., & Zhang, J. (2024). The effects of neighbourhood green spaces on mental health of disadvantaged groups: A systematic review. Humanities and Social Sciences Communications, 11, Article 488. doi:10.1057/s41599-024-02970-1.

Xu, S., Yuan, S., Li, J., Gao, X., & Hu, J. (2024). Urban park green space use analysis based on trajectory big data: Experience from a medium-sized city in China. Heliyon, 10(4), Article e26445. doi:10.1016/j.heliyon.2024.e26445.

Zhan, Y., 2018. The urbanisation of rural migrants and the making of urban villages in contemporary China. Urban Studies 55 (7), 1525–1540. doi:10.1177/0042098017716856.

Zhang, J., Liu, Y., Zhou, S., Cheng, Y., Zhao, B., 2022. Do various dimensions of exposure metrics affect biopsychosocial pathways linking green spaces to mental health? A cross-sectional study in Nanjing, China. Landsc. Urban. Plan. 226, 104494. https://doi.org/10.1016/j.landurbplan.2022.104494.

Zhang, T., Li, J., Wang, Y., 2023b. Assessment of urban green space equity in Beijing's central urban villages: a remote sensing perspective on environmental justice. Landsc. Urban Plan. 237, 104787. https://doi.org/10.3390/su17104561.

Zhang, Q., 2025. Community public-space micro-regeneration under the urban renewal perspective. Urban Archit. Dev. 6 (3), 61–63. https://www.researchgate.net/publication/391209364.

Zhao, J., Chen, L., Li, H., 2024a. The inequity of urban green space availability between urban villages and residential quarters: an empirical study in Shenzhen, China. J. Clean. Prod. 435, 141704. https://doi.org/10.1016/j.jclepro.2024.141704.

Zhao, K., Zhang, S., Zhao, F., 2025. How the natural environment affects psychological recovery: A case study in Changsha, China. PLoS One 20 (6), e0325755. doi:10.1371/journal.pone.0325755.