

Article

Informal Adaptations by Older Adults as Behavioural Evidence for Age-Friendly and Socially Sustainable Urban Green-Space Renewal: An Exploratory Multiple-Case Study in Nanjing, China

Yan Li, Cheng Wei, Hao Zou and Yijing Wang *

College of Architecture, Nanjing Tech University, Nanjing 211816, China; liyan0903@njtech.edu.cn (Y.L.); weicheng@njtech.edu.cn (C.W.); hao.zou@njtech.edu.cn (H.Z.)

* Correspondence: yijingwang@njtech.edu.cn

Abstract

Population ageing is reshaping the use and evaluation of everyday urban green spaces, especially in old urban districts where nearby public spaces support walking, resting, exercise, and social contact. Conventional age-friendly assessments often emphasise whether formal infrastructure is provided, but facility provision alone does not ensure experiential fit with older adults' functional capacities, daily routines, and social practices. This exploratory multiple-case study examines user-initiated informal adaptations in three neighbourhood-scale green spaces in Gulou District, Nanjing, China. Facility audits, approximately 30 h of non-participant observation, semi-structured interviews with 36 older users, and 220 valid questionnaires were combined through cross-case coding and qualitative triangulation. Three adaptation types were identified: supplementary, modifying, and appropriative adaptations. These practices were interpreted as context-dependent behavioural signals potentially associated with safety and convenience, ergonomic support and material-thermal comfort, social accessibility and spatial accommodation, and social support. Adaptation patterns varied descriptively across sites and age groups in relation to facility conditions, spatial organisation, activity intensity, and user characteristics. The findings suggest that, when interpreted alongside facility audits, interviews, and site context, older adults' everyday adaptations may help identify possible mismatches between formal provision and actual use, offering a low-cost interpretative perspective for inclusive, incremental, and socially sustainable green-space renewal.

Keywords: urban green spaces; older adults; informal adaptations; age-friendly environments; social sustainability; experiential fit; inclusive micro-renewal; neighbourhood public space

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1. Introduction

Population ageing is increasingly shaping the agenda of sustainable urban and rural development. Recent sustainability research further frames urban green infrastructure as a multidimensional strategy for sustainable development, urban co-benefits, and poverty-sensitive wellbeing [1–3]. It affects not only demographic structures, but also the ways in which neighbourhood environments are used, the kinds of public spaces that are needed,

and the criteria by which renewal priorities are assessed [4]. In ageing cities, the value of green infrastructure cannot be judged only by its amount or distribution. It also depends on whether everyday public spaces can accommodate users with different bodily capacities, mobility constraints, activity rhythms, and social routines [5]. Neighbourhood parks and small urban green spaces are especially important in this regard. They provide accessible settings for walking, resting, light exercise, informal care, and routine social contact among older residents [6–9]. In dense old urban districts, where private outdoor space is limited and daily mobility often remains within a relatively small neighbourhood radius, nearby green spaces become part of the basic spatial conditions for everyday participation and community wellbeing [10]. Recent studies also show that public-space social cohesion, social barriers to green-space use, older adults' subjective wellbeing, and climate-responsive blue-green-space preferences are important dimensions of sustainable and inclusive provision [11–14]. Recent research in China further shows that urban parks can support older adults' social interaction through the combined influence of park accessibility, environmental conditions, facilities, and activity opportunities [15].

Age-friendly urban development is therefore closely connected with the renewal of everyday public spaces. Previous studies have shown that parks and urban green spaces can support older adults' health, wellbeing, outdoor activity, and social participation [16,17]. Research on age-friendly parks has also identified a range of important environmental attributes, including accessible paths, seating, shade, lighting, exercise equipment, toilets, signage, and safety conditions [18,19]. These criteria are necessary because they indicate whether basic facilities are provided. However, the presence of a facility does not necessarily mean that it works well in practice. A seat may be available but uncomfortable, poorly located, or unsuitable for social use; a path may exist but still be difficult for users with reduced mobility; and an activity space may be physically open but unable to support the routines of older groups. Qualitative research on older adults with disabilities likewise shows that park accessibility and detailed design conditions can substantially shape whether formally available green spaces are experienced as usable in everyday life [20]. In this sense, age-friendly assessment needs to consider not only formal provision, but also whether facilities and spaces fit older adults' everyday bodily, temporal, and social needs [21].

Older adults' own adaptive practices offer a useful way to observe this gap between provision and use. Older users do not simply receive planned design passively. In daily use, they often make small adjustments that enable public spaces to better support their activities [22]. They may bring portable stools, water bottles, cushions, or support aids; place soft materials on hard seats; combine wheelchairs with fixed benches; use railings, signboards, or trees as temporary bodily supports; or gather in shaded corners and paved open areas for social and collective activities. These practices are usually modest, temporary, and easily overlooked. Previous research suggests that such everyday adjustments can make users' practical responses to public-space conditions more visible and may draw attention to possible mismatches between formal provision and actual use [23].

In this article, user-initiated informal adaptations refer to visible, user-led, temporary, and non-institutional adjustments through which older adults supplement, modify, reinterpret, or appropriate facilities and spaces. This concept is informed by several related perspectives. Person-environment fit highlights the relationship between user capacities and environmental demands [24]. Affordance theory helps explain how users perceive and activate possibilities for action within a given setting [25]. Everyday urbanism and temporary appropriation draw attention to the ways ordinary users reshape public space through situated and routine practices [26,27]. Social sustainability further directs attention to whether public spaces support inclusion, participation, equity, and commu-

nity life, rather than merely providing physical facilities. Together, these perspectives suggest that informal adaptations can be interpreted as context-dependent behavioural responses to experiential misfit and as practical clues for more inclusive renewal.

Although age-friendly environments and sustainable communities have attracted growing research attention, the interpretative value of older adults' everyday adaptive practices has not been sufficiently examined [28,29]. Existing studies have identified many facilities and environmental qualities that older adults require. Less attention has been paid to how observed self-reliant practices, when considered alongside facility conditions and user accounts, may inform interpretations of possible age-friendly needs and potential small-scale, low-cost, and socially responsive interventions. This issue is particularly relevant in old urban districts, where large-scale reconstruction is often difficult. In such contexts, renewal more often depends on incremental and user-sensitive improvements that enhance daily use while maintaining established public-space routines [30,31]. Evidence from high-density Asian neighbourhoods also suggests that older adults' use of small urban parks is shaped by spatial layout, sitting opportunities, and the capacity of public spaces to accommodate diverse everyday activities [32]. Observing informal adaptations can therefore provide context-sensitive clues about where, when, and for whom formal provision may not fully support everyday use. Such clues are especially useful for neighbourhood-scale green spaces, where modest design and management changes may have immediate effects on older adults' comfort, participation, and social connection.

Against this background, this study examines user-initiated informal adaptations in three neighbourhood-scale urban green spaces in Nanjing, China. It addresses three research questions:

- (1) What types of informal adaptations are used by older adults in everyday green-space use?
- (2) How are these adaptations associated with formal facility conditions across different case sites?
- (3) How can these adaptations, when interpreted in relation to facility conditions and user accounts, provide context-dependent clues to potential needs for age-friendly and socially sustainable green-space renewal?

The study makes three main contributions. First, it treats older adults' informal adaptations not as incidental or disorderly behaviour, but as context-dependent signals for interpreting experiential fit. Second, it connects age-friendly design and social sustainability through everyday spatial practices. Third, it proposes an adaptation-informed perspective for exploring inclusive, incremental, and low-cost renewal priorities in ageing old urban districts.

2. Materials and Methods

2.1. Study Area and Case Selection

This study was conducted in Gulou District, an old urban district of Nanjing, China (Figure 1). By the end of 2023, Nanjing had a resident population of 9.547 million, including 2.097 million residents aged 60 years and above (21.97%) and 1.529 million aged 65 years and above (16.01%) [33,34]. Nanjing's built-up area had a green coverage rate of 45.04%, a green-space ratio of 40.86%, and 16.23 m² of park green space per capita, with approximately 1100 parks larger than 500 m², including 78 pocket parks [35]. Within this broader context of green-space provision and 15 min community living-circle planning [36], Gulou is characterised by dense, established residential communities and frequent daily use of nearby public open spaces by older residents. Many neighbourhoods in the district were developed before recent age-friendly design standards became widely

adopted, which makes it suitable for observing how formal provision relates to actual everyday use.

In this study, urban green spaces refer to small parks, squares, and park-like public open spaces with greenery that support older adults' everyday outdoor activities. These spaces are understood as neighbourhood-level public infrastructures that contribute to social sustainability by supporting access, participation, informal interaction, and low-burden outdoor life. The district therefore provides a suitable empirical context for examining how older users negotiate everyday green-space conditions through small-scale adaptive practices.

All figures in this study were prepared, edited, and laid out using Adobe Photoshop 2025 (Adobe Inc., San Jose, CA, USA).

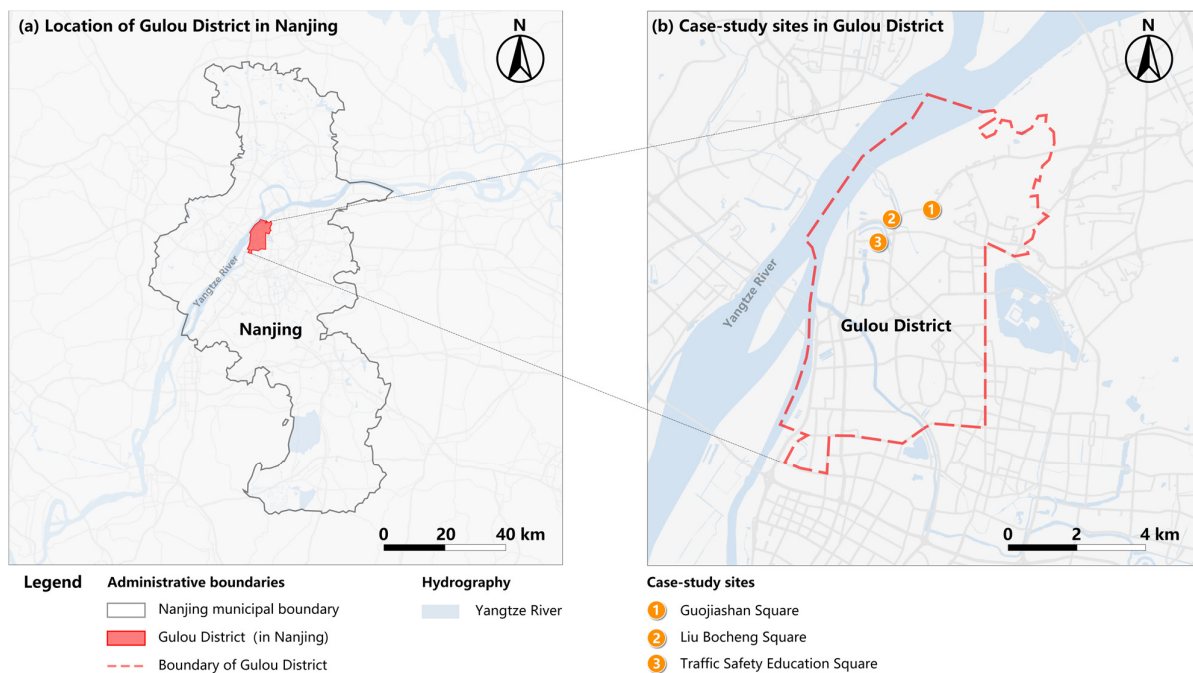


Figure 1. Location of the study area and case-study sites: (a) location of Gulou District within Nanjing; and (b) locations of Guojiashan Square (1), Liu Bocheng Square (2), and Traffic Safety Education Square (3) within Gulou District.

Three neighbourhood-scale green spaces were selected as case sites: Guojiashan Square, Liu Bocheng Square, and Traffic Safety Education Square. The selection considered both contextual similarity and variation across cases. All three sites are located near residential communities in the old urban district and are regularly used by older adults. At the same time, they differ in size, spatial layout, activity intensity, and existing facility conditions.

Together, the three cases represent common but varied forms of everyday green space in ageing old urban districts, including compact neighbourhood squares, open paved activity spaces, and mixed spaces with greenery and hard surfaces. These differences made it possible to compare how different environmental settings were associated with older users' informal adaptation practices and whether similar potential needs could be interpreted through different forms of user-led adjustment. Table 1 summarises the main characteristics of the three case sites.

Table 1. Profiles of the three case green spaces.

Case Site	Urban Context	Area	Spatial Character	Approximate Older-User Intensity	Dominant Observed Activities	Preliminary Facility Limitations
Guojiashan Square	Older residential neighbourhood in Gulou District, Nanjing	~6000 m ²	Compact square near older residential communities	20–50 older users/day	Resting; chatting; bird keeping	Limited service facilities; weak accessibility; fixed seating layout
Liu Bocheng Square	Road-intersection area in Gulou District, Nanjing	~10,000 m ²	Open hard-paved plaza with a central activity space	150–200 older users/day	Group exercise; singing; dancing; resting	Lack of designated collective activity areas; insufficient supporting facilities
Traffic Safety Education Square	Road-intersection area in Gulou District, Nanjing	~5500 m ²	Compact space with mixed paving and greenery	10–40 older users/day	Resting; walking; accompanying grandchildren	Insufficient seating; hard seating materials; weak service provision

Note: Older-user intensity was estimated based on field observations during the study period and should be interpreted as an approximate indication rather than a continuous visitor count.

2.2. Facility Audit

Facility audits were conducted to document formal environmental attributes relevant to older adults' everyday use across the three case sites. The audit recorded the presence and approximate number of seating units, public toilets, drinking-water facilities, and wayfinding signs. Seating was further documented by type and material, fixed or movable condition, and observable spatial arrangement. For paths, the audit recorded approximate width, slope or level condition, surface condition, and the observed presence of anti-slip treatment. Barrier-free access was examined in terms of route continuity and the observed presence of handrails. Exercise equipment and other supporting facilities were also recorded when present. These observations were used for descriptive cross-case comparison and were not converted into a weighted compliance score. Instead, the audit provided a descriptive baseline for interpreting observed adaptations together with field observations, interviews, and questionnaire responses.

2.3. Non-Participant Observation

Non-participant observation was carried out from 19 November to 23 November 2025. Each site was observed for approximately 10 h, covering key daily use periods in the morning, late morning, and afternoon. In total, approximately 30 h of observation were completed across the three sites. The observation records covered activity types, personal objects brought into the site, temporary modifications of facilities, appropriation of under-designed spaces, spontaneous groupings of users, typical locations of adaptation practices, and the social situations in which these practices occurred.

The observation records were then compared across the three sites. A practice was treated as a meaningful adaptation pattern when it appeared repeatedly during the observation period or was supported by interview explanations. This helped distinguish recurrent everyday practices from isolated individual behaviours.

2.4. Interviews and Questionnaire Survey

Semi-structured interviews were conducted with 36 older users who had been observed engaging in typical informal adaptation practices across the three case sites. Each interview lasted approximately 5–9 min and focused on site-use frequency, facility-use experience, reasons for self-reliant practices, perceived problems, and desired improvements. The interviews were used to interpret the meanings and motivations behind observed practices rather than to produce a statistically representative sample.

Participants were recruited on site during the observation period through a voluntary, intercept-based approach. Before participation, the research team explained the academic purpose of the study, the voluntary nature of participation, and the anonymous handling of responses. A total of 240 questionnaires were distributed, of which 220 were valid after incomplete or clearly invalid responses were excluded, yielding a valid response rate of 91.7%.

The valid questionnaires provided descriptive information on respondents' demographic characteristics, mobility condition, visit patterns, activity purposes, facility satisfaction, emotional relaxation, overall satisfaction, and desired improvements. The questionnaire included single-choice, multiple-choice, five-point satisfaction, and open-ended items. All percentages are reported as descriptive statistics rather than inferential test results. No personally identifiable information is reported. Table 2 summarises the fieldwork profile and respondent characteristics by case site, while Figure A1 presents the demographic composition and regular use characteristics of the questionnaire respondents.

Table 2. Fieldwork profile and participant characteristics by case site.

Case Site	Observation Period	Observation Time	Interviews (n)	Questionnaires (n)	Gender Distribution	Age-Group Distribution	Main Activities
Guojiashan Square	19–23 November 2025	Approx. 10 h	12	67	Male: 33; Female: 34	60–64: 10; 65–69: 23; 70–74: 15; 75–79: 10; ≥80: 9	Resting; chatting; bird keeping
Liu Bocheng Square	19–23 November 2025	Approx. 10 h	15	99	Male: 49; Female: 50	60–64: 13; 65–69: 35; 70–74: 23; 75–79: 14; ≥80: 14	Group exercise; singing; dancing; resting
Traffic Safety Education Square	19–23 November 2025	Approx. 10 h	9	54	Male: 26; Female: 28	60–64: 6; 65–69: 16; 70–74: 13; 75–79: 8; ≥80: 11	Resting; walking; accompanying grandchildren
Total	Five consecutive fieldwork days	Approx. 30 h	36	220	Male: 108; Female: 112	60–64: 29; 65–69: 74; 70–74: 51; 75–79: 32; ≥80: 34	Walking, resting, social interaction, exercise, singing/dancing, bird keeping, and family-accompaniment activities

Note: The table summarises fieldwork arrangements, interview counts, valid questionnaire respondents, demographic characteristics, and main activities by case site. Gender and age-group values refer to valid questionnaire respondents. Observations were conducted in morning, late-morning, and afternoon sessions during 19–23 November 2025.

As shown in Table 2, the three case sites differed in the number of valid questionnaires, interviewees, respondent characteristics, and dominant activities. These differences provide contextual information for interpreting cross-case variation in informal adaptation practices. Because the questionnaire was used to support qualitative case interpretation rather than hypothesis testing, the results are reported as descriptive evidence and should not be interpreted as representative estimates of all older residents or all urban green-space users in Nanjing.

2.5. Coding and Analysis

The analysis followed an exploratory qualitative coding process based on facility audits, field observations, photographs, interviews, and questionnaire information. Excel-based coding tables were used to organise the materials and compare evidence across the three case sites. Facility-audit records were first reviewed to identify formal provision conditions and possible limitations in capacity, material, layout, accessibility, comfort, service provision, and age-friendly suitability. Observation notes and field photographs were then examined to identify recurrent practices through which older adults supplemented, modified, reinterpreted, or appropriated facilities and spaces.

Two researchers independently reviewed the observation and interview materials and developed initial open codes. The codes were compared and revised through discussion within the research team, with a third researcher consulted when needed. The final codes were grouped into three adaptation types: supplementary adaptations, modifying adaptations, and appropriative adaptations.

These adaptation types were interpreted through triangulation of facility audits, observations, photographs, interviews, and questionnaire information. Facility audits provided a baseline of formal provision and possible limitations; observations and photographs documented recurrent practices; interviews clarified users' motivations; and questionnaire results offered descriptive contextual information. Questionnaire percentages were used only as contextual evidence, not for hypothesis testing. To avoid over-interpretation, adaptation signals were included only when repeatedly observed or supported by more than one source, and were not treated as one-to-one indicators of environmental deficiency. Figure 2 summarises the coding process from field evidence to adaptation types, potential age-friendly needs, and socially sustainable renewal implications.

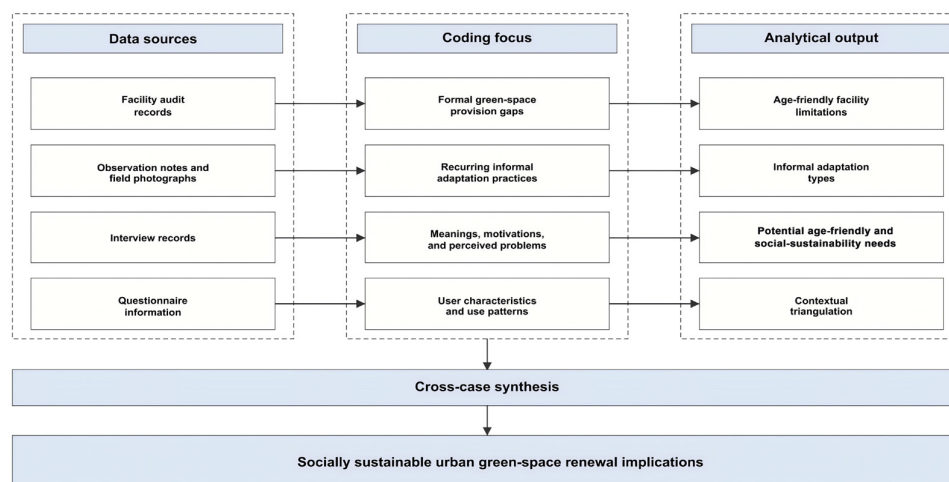


Figure 2. Analytical procedure for interpreting informal adaptation types, potential age-friendly needs, and socially sustainable renewal implications. Dashed boxes delineate the three stages of the analytical procedure: data sources, coding focus, and analytical output.

3. Results

3.1. Observed Facility Conditions and Limitations Across the Three Case Sites

The facility audit documented several observable facility conditions and limitations across the three case sites (Table 3). Seating provision ranged from 16 seating sets in Guojiashan Square to only 3–5 seats or stools in Traffic Safety Education Square, while Liu Bocheng Square relied mainly on fixed strip seating. No drinking-water facility was observed at any of the three sites. Wayfinding was limited to two signs in Liu Bocheng

Square and was not observed in the other two sites. Public toilets were not observed in Guojiashan Square, whereas one toilet was observed in each of the other two sites.

Accessibility-related limitations were also recorded. No continuous barrier-free access was observed in any of the three sites. Path widths ranged from 1.2 to 1.5 m in Guojiashan Square to approximately 2.5 m in Liu Bocheng Square and 1.5–2.0 m in Traffic Safety Education Square; no anti-slip treatment was observed on the audited walking routes. Fixed seat locations, hard seating materials, limited service provision, and incomplete barrier-free connections were recurrent physical conditions relevant to older adults' everyday use across the cases. Stone seating materials were particularly evident in Traffic Safety Education Square, while Liu Bocheng Square included both stone and wooden fixed seating.

Table 3. Formal facility audit results across the three case green spaces.

Facility Dimension	Guojiashan Square	Liu Bocheng Square	Traffic Safety Education Square	Age-Friendly Implication
Seating quantity	16 seating sets	Fixed strip seats observed	3–5 seats/stools	Uneven seating provision may encourage portable seating.
Seating type/material	Fixed square-shaped seats; mainly wood	Fixed strip seats; stone and wood	Fixed stone stools/seats	Fixed or hard seating limits comfort and social reconfiguration.
Drinking water	Not observed	Not observed	Not observed	Absence of drinking water increases reliance on portable water.
Wayfinding signs	Not observed	2 signs observed	Not observed	Limited signage may increase orientation difficulty.
Public toilet	Not observed	1 toilet observed	1 toilet observed	Uneven toilet provision may affect long-stay use.
Path condition	1.2–1.5 m; partly sloped; no anti-slip texture observed	~2.5 m; generally flat; no anti-slip treatment observed	1.5–2.0 m; generally flat; no anti-slip treatment observed	Basic walking is supported, but fall-prevention details remain weak.
Wheelchair access	No continuous barrier-free access observed	No continuous barrier-free access observed	No continuous barrier-free access observed	Discontinuous access may limit circulation and social seating.

Note: Facility conditions were recorded during the field audit period. “Not observed” indicates that the facility was not identified within the audited case site during fieldwork.

3.2. Supplementary Adaptations

Supplementary adaptations occurred when older adults brought personal objects into the case sites to address perceived insufficiencies, inflexibility, or inconvenience in formal facility provision. These practices were mainly related to resting, hydration, safety support, and other basic convenience needs.

Portable seating and mobility aids were among the most visible forms of supplementary adaptation. Small stools, folding chairs, wheelchairs, or small carts were used to supplement resting opportunities where fixed seats were insufficient, poorly located, or unsuitable for particular users. Two wheelchair-related forms were observed. When positioned beside fixed benches during group activities, wheelchairs enabled users with mobility limitations to remain within ordinary seating clusters. During accompanied walks, wheelchairs were also provided for temporary rest support where fixed seating was absent or distant. These practices may draw attention to possible needs for social accessibility, spatial accommodation, and more evenly distributed resting opportunities.

Interview accounts helped explain why portable objects were repeatedly used. Several older users mentioned that existing seats were insufficient, uncomfortable, or poorly suited to longer stays. One respondent stated, “There is too little shade, so sometimes I have to bring my own umbrella” (Interviewee G-05, Guojiashan Square, 60–64 years). This comment suggests that supplementary adaptations were not limited to seating or drinking water but also included personal adjustments to cope with insufficient shade, environmental thermal discomfort, and sun exposure during longer stays. In this context, portable stools, umbrellas, water bottles, and other personal objects became practical ways to make the space more usable during daily visits.

Safety-related supplementary objects were less frequent, but they appeared in areas perceived as unstable, slippery, sloped, or uncomfortable. Canes, anti-slip aids, or other temporary support objects were associated with local conditions such as paving texture, ground slope, lack of handrails, and users’ bodily mobility.

3.3. *Modifying Adaptations*

Modifying adaptations occurred when older adults adjusted existing facilities to improve usability, ergonomic support, material-thermal comfort, or bodily fit. These practices included adding soft materials to seating surfaces and using fixed elements for functions other than their intended purpose.

Ergonomic and material-thermal adjustments were observed on hard or cold seating surfaces. Older users placed cushions, clothing, or other soft materials on stone or metal seats to improve contact comfort and reduce material-thermal discomfort.

The interviews showed that these adjustments responded to distinct comfort-related conditions. One respondent stated, “The seats are too hard and have no backrests” (Interviewee L-04, Liu Bocheng Square, 70–74 years), indicating limited ergonomic and biomechanical support. Another noted, “The seats are made of stone, so they are very cold in winter” (Interviewee L-07, Liu Bocheng Square, 75–79 years), indicating material thermal discomfort. These accounts help explain why older users added cushions, clothing, or other soft materials to hard seating surfaces.

Functional reinterpretation was another form of modifying adaptation. Some older adults used handrails, signboards, bench armrests, trees, or similar fixed elements as temporary stretching, balance, or bodily support facilities. Fixed seating surfaces were also temporarily used as platforms for bird cages, water containers, and other activity-related items, thereby supporting bird-keeping routines rather than sitting.

3.4. *Appropriative Adaptations*

Appropriative adaptations occurred when older adults transformed undesigned or weakly programmed spaces into resting, social, recreational, or interest-based settings. These practices were most visible in shaded corners, path edges, paved open areas, and stable gathering points.

Static social activities, such as chatting, card playing, and resting, tended to occur in shaded or edge spaces, whereas active collective activities, such as singing, dancing, tai chi, and group exercise, were concentrated in open paved areas. These locations offered shade, visibility, access to paths or seating, familiarity among regular users, and room for collective movement. The coexistence of quieter and louder activities suggests the need to consider acoustic comfort through spatial zoning and negotiated time-based management.

Questionnaire and interview evidence further supported the social and collective functions of these appropriated settings. Among the 220 valid respondents, temporary chess or card-playing areas were linked to familiar conversation by 76%, shaded gathering

areas to casual conversation and neighbourhood information exchange by 63%, open activity areas to collective singing or dancing by 81%, and informal fitness areas to group exercise and mutual guidance by 74%. As multiple responses were allowed, these figures are descriptive frequencies rather than mutually exclusive categories.

Interview accounts clarified why some spaces were repeatedly appropriated. Older users valued places for card playing, familiar conversation, and “feeling less lonely”, while others described shaded corners or edge spaces as suitable places to “gather and talk about nearby affairs”. For interest-based activities, one respondent explained, “I like bird keeping, but there is no place for me to hang the bird cage” (Interviewee T-02, Traffic Safety Education Square, 70–74 years). Other users mentioned the need for space for square dancing, singing, group exercise, sound equipment, simple storage, and staying nearby while children played. These accounts suggest that appropriative adaptations were associated with social contact, interest-based gathering, collective recreation, and intergenerational companionship, while also reflecting shared interests, established routines, and familiarity among regular users.

Figure 3 provides representative field examples of the three adaptation types and illustrates how older adults adjusted formal facilities and spaces in response to everyday use needs.

Adaptation type	Representative examples		
Supplementary adaptation			
Modifying adaptation			
Appropriative adaptation			

Figure 3. Representative examples of informal adaptations observed in the three case green spaces. (A–C) show supplementary adaptations; (D–F) show modifying adaptations; (G–I) show appropriative adaptations.

3.5. Cross-Case and Age-Group Patterns

Questionnaire-reported adaptation practices varied across the three case green spaces (Figure 4). Supplementary adaptations accounted for the largest share of coded adaptation responses in Traffic Safety Education Square, whereas appropriative adaptations accounted for the largest share in Liu Bocheng Square. Because respondents could report more than one adaptation type, the percentages are presented as the distribution of coded adaptation responses within each case site rather than as mutually exclusive respondent groups. These cross-case patterns suggest that informal adaptations were shaped by site-specific facility conditions, activity intensity, and spatial organisation.

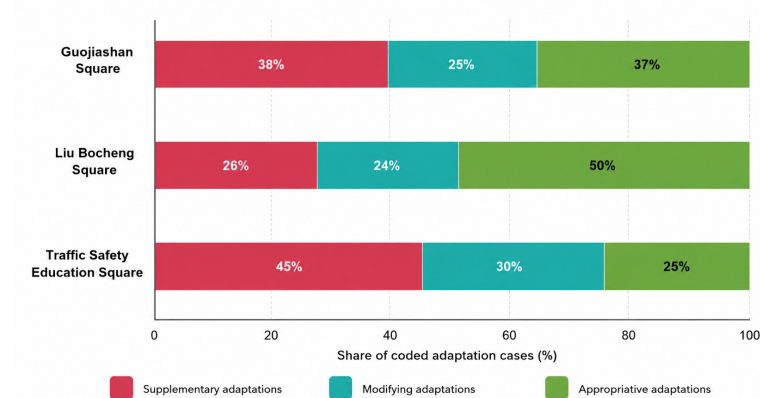


Figure 4. Questionnaire-reported informal adaptation practices across the three case green spaces. Percentages show the distribution of coded adaptation responses within each site; multiple responses were allowed, so categories do not represent mutually exclusive respondent groups.

Descriptive age-group patterns further clarified how reported adaptation practices varied among older users (Figure 5). Respondents aged 60–74 reported modifying adaptations more frequently, which may reflect more active facility adjustment and bodily exercise practices. In contrast, respondents aged 75 and above reported a higher proportion of supplementary adaptations, which may indicate greater reliance on portable support, flexible resting opportunities, and low-burden social use. Because multiple responses were allowed and no inferential tests were conducted, these percentages should be interpreted as descriptive prevalence patterns rather than statistically tested age-group differences.

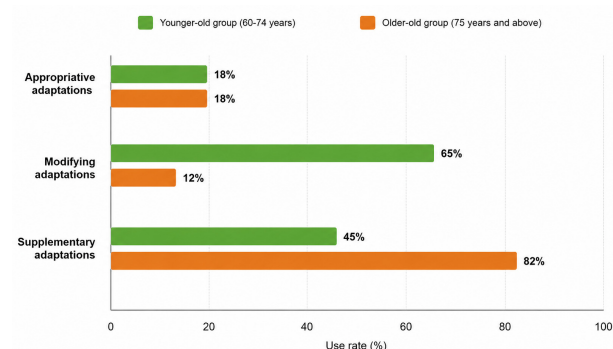


Figure 5. Descriptive age-group patterns in questionnaire-reported informal adaptation practices. Percentages indicate the proportion of respondents within each age group who reported each adaptation type; multiple responses were allowed, and comparisons are descriptive rather than inferential.

3.6. Interpretative Mapping Between Adaptation Types and Potential Age-Friendly and Social-Sustainability Needs

Based on qualitative triangulation, the three types of informal adaptations were interpreted as being associated with different but overlapping potential age-friendly and social-sustainability needs (Figure 6). Supplementary adaptations were mainly linked to safety assurance, convenience, and social accessibility/spatial accommodation; modifying adaptations to ergonomic support and material-thermal comfort; and appropriative adaptations to static social interaction, active collective interaction, and belonging. Other associations were interpreted as secondary or context-dependent, reflecting variation across

site conditions, user routines, bodily capacities, activity rhythms, and local social organisation.

In this study, qualitative triangulation refers to the comparison of repeated field observations, facility-audit findings, and older users' interview and questionnaire accounts. The shading categories in Figure 6 indicate interpretative emphasis rather than measured statistical strength. Primary associations refer to relationships that were central to the interpretation of a given adaptation type and consistently supported across the empirical materials. Secondary associations refer to relationships that were present but less central or more variable across cases. Context-dependent associations refer to possible relationships that depend strongly on site conditions, user routines, bodily capacities, activity rhythms, or local social organisation. The mapping should therefore be understood as an interpretative synthesis rather than a statistically validated, diagnostic, or causal model.

Informal adaptation type	Safety assurance	Convenience	Ergonomic support and material-thermal comfort	Social accessibility and spatial accommodation	Static social interaction	Active collective interaction	Belonging
Supplementary adaptation	Primary	Primary	Secondary	Primary	Context-dependent	Context-dependent	Context-dependent
Modifying adaptation	Secondary	Secondary	Primary	Secondary	Secondary	Context-dependent	Context-dependent
Appropriative adaptation	Secondary	Context-dependent	Context-dependent	Secondary	Primary	Primary	Primary

Primary
 Secondary
 Context-dependent

Figure 6. Interpretative mapping between informal adaptation types and potential age-friendly and social-sustainability needs, based on qualitative triangulation. Dark, medium, and light shading indicate primary, secondary, and context-dependent associations, respectively. These categories denote interpretative emphasis rather than statistical strength, diagnostic proof, or causal relationships.

3.7. Social-Sustainability Dimensions of Informal Adaptation Signals

Through qualitative triangulation, the observed adaptation signals were interpreted in relation to several social-sustainability dimensions of everyday green-space use: safety assurance, convenience, bodily comfort, social accessibility and spatial accommodation, static social interaction, active collective interaction, and belonging. These dimensions provide an analytical lens for considering how older adults maintained access, physical support and comfort, social accessibility, participation, social connection, and routine public-space use. They do not imply that each observed adaptation resulted from a single facility gap or corresponded to one fixed need.

Accordingly, informal adaptations may serve as context-dependent signals for further inquiry into whether public green spaces support inclusive and sustained participation. The same observed practice may have multiple possible meanings and may be shaped by facility conditions, personal preferences, health conditions, social routines, group identity, cultural practices, seasonal factors, and site-specific circumstances. Table 4 therefore presents an interpretative matrix linking observed signals with possible contextual interpretations and potential design or management options, rather than a linear decision-making model.

Table 4. Social-sustainability dimensions and renewal implications of informal adaptation signals.

Dimension	Observed Adaptation Signal	Possible Contextual Interpretation	Potential Renewal Option	Potential Management Option
Safety assurance	Canes, anti-slip aids, or fixed elements used for bodily support	Stronger fall-prevention details and low-intensity bodily-support facilities	Add anti-slip paving, handrails, and low-intensity support facilities	Conduct regular safety inspections and hazard reporting
Convenience	Portable stools and large water bottles brought by users	More flexible resting opportunities and drinking-water provision	Add movable or semi-movable seats and drinking-water points	Maintain water points and resting areas
Bodily comfort	Cushions, clothing, or other soft materials added to hard or cold seating surfaces	Ergonomic and material-thermal discomfort related to hard/cold or poorly supported seating	Improve seating materials, back and arm support, shade, and options for softer contact surfaces	Implement seasonal maintenance and accommodate safe temporary cushion use
Social accessibility and spatial accommodation	Wheelchairs positioned beside fixed seating during group activities	Wheelchair-compatible positions within ordinary seating clusters	Provide wheelchair-compatible positions within ordinary seating clusters	Keep wheelchair-compatible positions clear and unobstructed
Static social interaction	Chatting and card playing in shaded corners or edge spaces	Shaded, semi-enclosed social nodes for quiet interaction	Create shaded social corners with tables and face-to-face seating	Coordinate cleaning, noise, and shared-use norms
Active collective interaction	Dancing, singing, tai chi, or group exercise in open paved spaces	Flexible collective activity zones and negotiated use arrangements	Define flexible activity zones with lighting, power supply, and storage	Apply time-based and negotiated activity management
Belonging	Stable bird-keeping or singing zones	Recognised group activity nodes and shared-use rules	Provide identifiable and flexible activity nodes	Negotiate shared-use rules with regular user groups

Note: Associations are interpretative and context-dependent. The same adaptation may have multiple meanings, and the proposed renewal and management options are not automatic prescriptions.

3.8. Observed Characteristics of Informal Adaptations

Across the three case sites, informal adaptations showed three recurrent characteristics. First, they were spatially specific: a self-brought stool was tied to a particular resting location, while wheelchairs positioned beside fixed benches during group activities or used as temporary rest support during accompanied walks drew attention to possible social-accessibility and resting-support considerations. Second, they were composite: a single adaptation could simultaneously involve safety, convenience, ergonomic support, material-thermal comfort, social accessibility, and social participation. Third, they were temporally flexible, changing with daily activity rhythms, weather conditions, group size, and users' bodily condition.

These characteristics suggest that informal adaptations should not be reduced to a general shortage of facilities. Rather, they provided context-dependent clues to the possible location, timing, and conditions of person–environment mismatches. In this respect, they linked facility auditing, everyday-use observation, and consideration of design-oriented micro-renewal.

4. Discussion

4.1. Principal Findings

This exploratory multiple-case study examined how older adults' user-initiated informal adaptations in neighbourhood-scale urban green spaces may inform interpretations of potential needs relevant to socially sustainable green-space renewal. The analysis identified three types of informal adaptations: supplementary, modifying, and appropriate adaptations. These practices were associated with overlapping concerns related to

safety and convenience, ergonomic support and material-thermal comfort, social accessibility and spatial accommodation, and social support. The results suggest that, when interpreted alongside facility conditions and user accounts, informal adaptations can provide situated clues to possible mismatches between formal provision and older adults' everyday spatial practices. Rather than being dismissed as incidental, disorderly, or purely individual behaviours, such adaptations can be considered context-dependent signals for interpreting experiential fit and possible misfit in everyday green-space use.

4.2. From Formal Provision to Socially Sustainable Experiential Fit

The results suggest that socially sustainable renewal should move beyond checking whether facilities are formally present [37]. A seat may exist, yet still be uncomfortable, immovable, poorly oriented, or socially unsuitable for older users. A path may be available, but it still lacks adequate support for people with reduced mobility [38]. Similarly, an open paved space may be physically accessible without offering the shade, lighting, storage, safety, or management arrangements needed for sustained collective activities.

This interpretation is consistent with person-environment fit perspectives, which emphasise the relationship between user capacities and environmental demands. In older adults' use of urban green spaces, fit depends not only on facility availability but also on location, material quality, flexibility, accessibility, and support for social configurations. From a social-sustainability perspective, such fit matters because public spaces become sustainable only when they support repeated, inclusive, and low-burden participation in everyday life. Recent research on Toronto neighbourhood indicators has similarly shown that neighbourhood design and sustainability indicators are closely related to residents' wellbeing, suggesting that age-friendly green-space renewal should be understood not only as facility improvement but also as part of broader neighbourhood wellbeing and social-sustainability support [39]. The adaptations observed in this study helped draw attention to these possible mismatches.

4.3. Informal Adaptations as Behavioural Signals for Inclusive Micro-Renewal

This study complements conventional facility audits and post-occupancy evaluation by foregrounding everyday adaptive practices [40]. Facility audits show whether formal elements exist, and surveys capture users' reported evaluations. Both are valuable, but they may overlook the small strategies through which older adults negotiate facilities and spaces in daily use. Informal adaptations add a behavioural layer of interpretative evidence by showing what users do when facilities do not fit their bodily capacities, activity rhythms, or social routines.

The interpretative value of informal adaptations lies in their precision, composite character, and temporal flexibility. A self-brought stool may point to a need for flexible resting opportunities, while a wheelchair positioned beside a fixed bench may indicate a need for social accessibility and spatial accommodation within ordinary seating clusters. Soft materials placed on hard or cold seating may respond to limited ergonomic support or material-thermal discomfort. These examples show why adaptation signals should not be interpreted as direct one-to-one indicators of facility deficiencies. Rather, they are multidimensional signals that require contextual interpretation. Such practices may also reflect personal habits, preferred social companions, shared interests, or established group routines. Their possible environmental implications should therefore be interpreted alongside users' accounts and local activity patterns.

Building on the synthesis in Table 4, the same observed adaptation signal can generate both design and management implications. For example, portable stools and large water bottles may suggest not only insufficient seating and drinking-water provision, but also the need to maintain resting areas and reduce the physical burden of long-stay use.

Similarly, stable bird-keeping or singing zones indicate not only a lack of recognised group activity nodes, but also the need to negotiate regular-use rules with recurring user groups. In this sense, everyday user improvisation can provide a contextual source of evidence for considering small-scale, low-cost, and socially responsive renewal.

4.4. Implications for Socially Sustainable Age-Friendly Green-Space Renewal

The findings point to several directions for socially sustainable renewal in ageing established urban districts. First, seating should be understood as flexible social infrastructure rather than only resting equipment [41,42]. Recent research has highlighted seating density, backrest support, and handrail assistance as important elements of older adults' satisfaction [43]. In this study, age-friendly seating also involved material comfort, shade, orientation, ease of sitting and standing, proximity to activity areas, and opportunities for face-to-face interaction. These qualities extend beyond ergonomics; they shape whether older adults can remain visible, connected, and socially included in public space. Supportive local settings, including open and green spaces, can also contribute to everyday social engagement, although their role depends on local conditions and user routines [44].

Second, accessibility should be understood as part of everyday spatial use and social participation rather than only circulation compliance [45,46]. Wheelchair users and older adults with mobility limitations should be able to participate in ordinary social settings without being spatially separated. This may require wheelchair-compatible positions within seating clusters, smoother barrier-free connections, and flexible layouts.

Third, service facilities should be treated as basic conditions for long-stay and low-burden use [47]. Drinking-water points, accessible toilets, shaded resting nodes, wayfinding signs, and simple storage or power facilities may reduce uncertainty and physical burden during extended outdoor activities. Public green spaces should also support both quiet social interaction and active collective activity [48,49]. Shaded social nodes, semi-enclosed seating clusters, flexible activity zones, and negotiated time-based management may help balance different user groups while maintaining the openness and shared character of public space.

4.5. Conceptual Contribution to Sustainable Public-Space Renewal

Based on the findings, this study proposes an adaptation-based interpretative framework for sustainable public-space renewal (Figure 7). The framework links formal green-space provision, experiential misfit, user-initiated informal adaptations, potential age-friendly and social-sustainability needs, and context-dependent renewal responses. It is intended as an interpretative synthesis rather than a validated causal model. When considered alongside facility conditions, user accounts, and site context, observed adaptations can provide clues to possible mismatches between formal provision and older adults' everyday use.

The main contribution of this framework is to add a behavioural perspective to facility-based assessment. Rather than evaluating urban green spaces only through static environmental attributes, it draws attention to everyday interactions among users, personal objects, formal facilities, and social routines. By bringing together person-environment fit, affordance theory, everyday urbanism, and social sustainability, the framework shows how small everyday behaviours can be considered alongside facility-based evidence when identifying micro-renewal priorities [50]. This helps avoid treating older users' improvised practices as marginal events and instead recognises them as situated signals for more responsive public-space renewal.

This contribution can be understood in three ways. First, the framework shifts attention from what facilities are provided to how they are negotiated and used in daily life. Second, it treats informal adaptations as low-cost situated signals that can inform renewal

priorities in resource-constrained established urban districts. Third, it connects age-friendly design with sustainable public-space governance by showing how recurrent user practices can complement facility inventories and general design standards in supporting more inclusive and context-sensitive renewal.

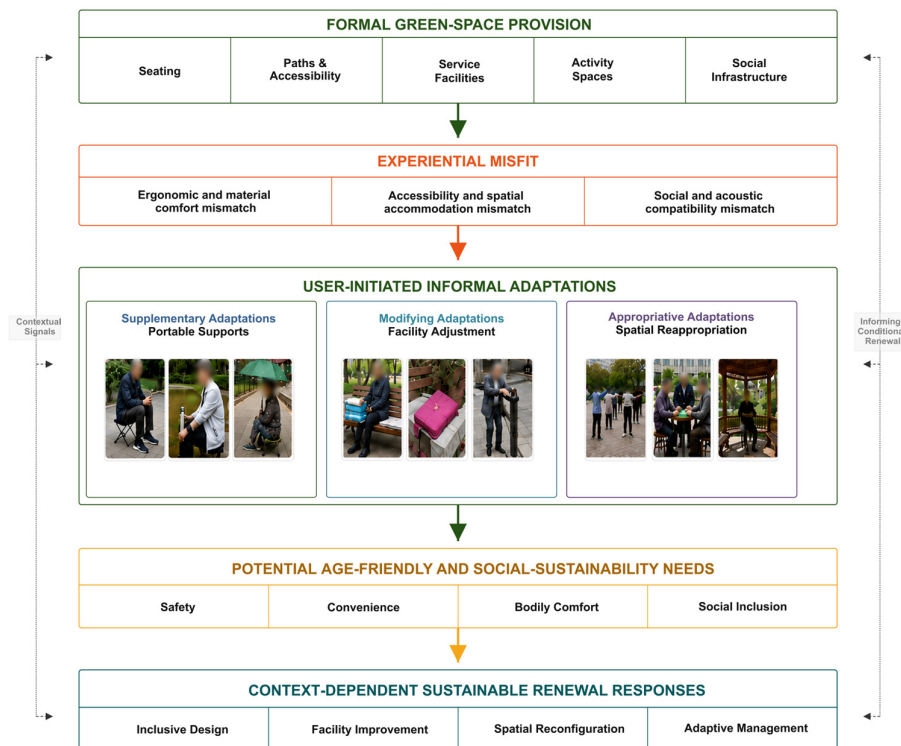


Figure 7. Adaptation-based interpretative framework for sustainable public-space renewal. Informal adaptations are interpreted with facility audits, user accounts, and site context to identify possible age-friendly and social-sustainability needs and context-dependent renewal responses. Arrows indicate interpretative relationships rather than diagnostic proof or causal pathways. Arrows indicate the interpretative pathway and contextual feedback, while colours distinguish the main analytical components and adaptation types.

4.6. Limitations and Future Research

Several limitations should be acknowledged. First, the study examined three neighbourhood-scale green spaces in one old urban district of Nanjing. The findings should therefore be understood as exploratory and context-specific, rather than statistically generalisable to all urban parks or green spaces. Second, the questionnaire data were used descriptively to support qualitative interpretation and were not designed for confirmatory statistical testing. Third, despite triangulation, some adaptations may reflect personal preferences or established social routines as well as environmental conditions; their interpretation is therefore context-dependent.

Fourth, the study did not record whether individual respondents also visited one or both of the other case-study sites. Therefore, the findings do not address cross-site recreational mobility or park-substitution behaviour among older adults. Fifth, the observation period was relatively short and did not cover seasonal variation, extreme weather, evening use, or holiday use. Sixth, although the study identified design and management implications from observed adaptation signals, it did not test whether specific renewal interventions would change older adults' use experience over time.

Future research could include a wider range of urban green spaces, such as community parks, pocket parks, linear parks, waterfront spaces, large comprehensive parks, and public spaces in rural or peri-urban ageing communities. Longer-term observation, behavioural mapping, interviews, questionnaire surveys, and comparative studies could further examine how informal adaptations vary across space, time, user groups, and seasons. Mobility diaries, site-use histories, or GPS-based tracking could also be used to examine how older adults combine multiple nearby green spaces in their everyday recreational routines. Further studies could assess whether renewal responses based on adaptation signals improve older adults' satisfaction, activity frequency, perceived safety, comfort, social participation, and perceived inclusion.

5. Conclusions

This study investigated older adults' user-initiated informal adaptations in three neighbourhood-scale urban green spaces in Nanjing, China. By combining facility audits, field observations, photographs, interviews, and questionnaire information, it examined how everyday self-reliant practices may inform interpretations of possible needs not always captured by conventional facility-based assessments. Three recurring types of informal adaptations were identified: supplementary, modifying, and appropriative adaptations. These practices were associated with overlapping concerns related to safety and convenience, ergonomic support and material-thermal comfort, social accessibility and spatial accommodation, and social support.

The findings suggest that, when interpreted alongside facility conditions and user accounts, informal adaptations can draw attention to possible mismatches between formal provision and actual everyday use. Age-friendly green-space evaluation should therefore not stop at checking whether seats, paths, toilets, or activity areas are present. More attention should be paid to whether these facilities are reachable, flexible, socially usable, and able to support older adults' bodily capacities, comfort needs, activity routines, and social participation. From this perspective, informal adaptations can inform consideration of micro-renewal measures, such as improving seating flexibility, ergonomic support, and material comfort, increasing shaded resting opportunities, refining barrier-free details, strengthening service facilities, and supporting both quiet social interaction and collective activities.

As an exploratory study, the evidence was drawn from three case sites in one old urban district and a limited observation period. Future studies could examine the proposed adaptation-based perspective in different urban, rural, and peri-urban contexts, across different park types, seasons, and cultural settings. Longitudinal research could further explore whether design and management interventions change the frequency, form, or meaning of informal adaptations over time. Overall, the study shows that older adults' everyday adaptive practices can serve as a useful behavioural and interpretative lens for making urban green-space renewal more responsive, inclusive, and socially sustainable.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data supporting the findings of this study were derived from facility audits, field observations, semi-structured interviews, and questionnaire surveys conducted by the research team. Due to privacy considerations involving older adult participants and field photographs, the raw data are not publicly available. An anonymised coding framework and aggregated questionnaire data can be made available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

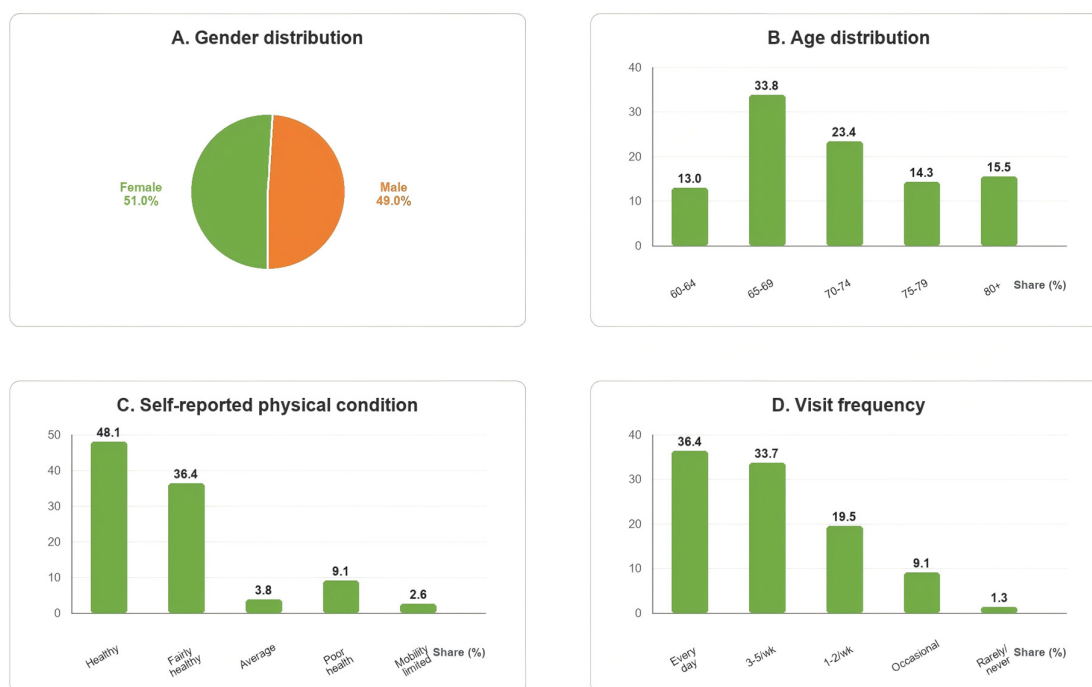


Figure A1. Respondent and use characteristics of questionnaire participants. Values indicate the percentage distribution of valid questionnaire respondents; the figure describes the questionnaire sample and regular use background rather than inferential statistical results.

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