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Older Adults' Perceived Visual Safety in Urban Pocket Parks: Environmental Problems and Design Implications from Four Cases in Nanjing, China

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Abstract

Urban pocket parks support older adults' daily activities, yet unclear visual–spatial information can complicate movement. This multiple-case study examined perceived visual safety among older users of four pocket parks in Nanjing, China, using 386 questionnaires, interview notes from 45 participants, and field records. Predictor-specific de-overlap models, in which overlapping outcome items were removed, served as the primary association analyses. None of the six environmental-problem ratings was significant after Holm correction. In a secondary model using the exploratory 20-item composite, boundary ambiguity and interface conflict were associated with lower values of the exploratory 20-item composite, although the outcome retained conceptually overlapping items. The preliminary questionnaire had a Cronbach's α of 0.890, but parallel analysis supported four rather than five prespecified domains; visual comfort did not form a distinct factor, and the resulting 20-item composite was treated as exploratory. Mean values of the exploratory 20-item composite were higher in P1 and P2 than in P3 and P4. Interview and field evidence linked reported difficulties to routes, boundaries, level transitions, obstructed sightlines, and movement–activity interfaces. The findings locate perceived visual-safety problems at specific spatial decision points and suggest potential renewal priorities, including clearer route cues, more legible boundaries and level changes, unobstructed sightlines, and clearer organization of walking and activity areas.

Keywords: urban pocket parks; older adults; perceived visual safety; spatial judgement; environmental legibility; age-friendly renewal

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1. Introduction

As urban populations age, nearby public open spaces are becoming increasingly important to everyday life in dense neighbourhoods. Older adults particularly value spaces close to home that support recreation, light exercise, informal social interaction, and contact with nature [1–4]. Pocket parks are particularly relevant in dense urban areas because their small scale and accessibility can bring green-space opportunities closer to residents' daily lives [5,6]. Their compact form places paths, planting, facilities, resting areas, activity spaces, and street interfaces in close proximity, making the clarity of spatial information particularly relevant to everyday use.

Research on age-friendly parks and urban green spaces has commonly examined accessibility, path quality, seating, vegetation, facilities, maintenance, opportunities for

physical activity, and perceived safety [7–10]. These attributes provide a broad account of park usability but offer less insight into how older users interpret space while choosing a route, approaching a facility, avoiding an obstacle, or deciding where to stay. A park may contain suitable paths, seating, lighting, planting, and exercise facilities yet remain difficult to negotiate when views are obstructed, boundaries are indistinct, route cues are interrupted, or circulation overlaps with other activities.

Visual information becomes especially important when age-related changes in contrast sensitivity, depth perception, and visual acuity affect movement. Research on neighbourhood mobility has linked older adults' experiences to visibility, enclosure, spatial occlusion, and physical barriers [11,12]. Experimental studies have also shown that the visibility and contrast of step edges, obstacles, and path cues influence foot placement, obstacle crossing, and gait adaptation [13–16]. The design relevance of a visible feature lies not simply in whether it can be seen, but in whether it helps users recognize a spatial change and respond in time. This is particularly important at entrances, turns, level transitions, and shared-use routes, where several sources of spatial information may need to be interpreted simultaneously.

Perceived visual safety overlaps with several established concepts but is not identical to them. Environmental legibility concerns the comprehensibility of spatial organization, while wayfinding refers to orientation and route choice, including the use of visible landmarks at decision points [17]. Spatial cognition encompasses the broader mental processes involved in understanding and navigating space. General perceived safety may include crime-related and other environmental concerns and does not necessarily correspond directly to objectively measured conditions [18,19]. In this study, perceived visual safety refers more specifically to an older adult's appraisal of whether the visible environment provides enough information to decide how to proceed at a particular location. It concerns seeing what lies ahead, identifying a walkable route, recognizing boundaries and level changes, and anticipating nearby movement.

For questionnaire development, perceived visual safety was organized into five provisional content domains: sightline clarity, boundary legibility, visual comfort, cue continuity, and walking confidence. Sightline clarity, boundary legibility, and cue continuity concern the availability and organization of information used to recognize routes, edges, transitions, and direction. Visual comfort concerns the readability of this information under glare, shadow, reflection, or visual clutter, while walking confidence reflects the user's perceived ability to act on the information available. Together, the five domains cover the availability of visual–spatial information, its readability, and users' confidence in proceeding. They were used to organize the preliminary questionnaire, while their empirical structure was examined rather than assumed. The questionnaire addresses subjective appraisals of visible movement conditions rather than clinical visual ability, physical mobility, objectively recorded hazards, or observed wayfinding performance.

Older adults' park use is shaped by neighbourhood-scale factors such as walkability, perceived environmental quality, park-use intentions, and the organization of activity areas [20–24]. Site-level studies have also examined gradients, surface quality, shade, spatial continuity, supporting facilities, and visual character [25–27]. Much of this work evaluates park attributes at an aggregate level or treats preference, satisfaction, use, and perceived safety as broad outcomes. Less is known about the particular locations where visual information becomes insufficient for judging a route, boundary, level transition, or nearby movement. Localized difficulties may therefore be overlooked in park-wide assessments, especially in pocket parks where circulation, resting and other stationary activities, planting, facilities, and surrounding street movement meet within a limited area.

This study investigates older adults' perceived visual safety in four selected pocket parks in Nanjing, China, with particular attention to the locations where movement decisions are made. It evaluates the empirical structure of a preliminary 20-item questionnaire, compares the exploratory 20-item composite across the four cases, and examines associations with six perceived environmental problems while accounting for direct overlap between predictor and outcome content. Interview notes and field records are used to locate reported difficulties and relate them to site-specific spatial conditions. Through this problem-centred multiple-case design, the study aims to clarify how perceived visual-safety problems are situated at particular movement locations and to inform case-specific considerations for age-friendly pocket-park renewal.

2. Materials and Methods

2.1. Study Design and Setting

An exploratory multiple-case design was used to examine older adults' perceived visual safety during everyday pocket-park use. Each park was treated as a bounded case. Questionnaire data characterized participants' appraisals, while interview notes and field records were used to locate reported difficulties and relate them to site-specific spatial conditions.

The study was conducted in Gulou District, Nanjing, China. The Seventh National Population Census recorded 940,387 permanent residents in the district [28]. By the end of 2023, adults aged 60 years or older accounted for 29.2% of its registered population [29]. Gulou contains established neighbourhoods with ageing populations and a compact urban fabric. Many small public spaces have been created through the renewal of street-edge, roadside, corner, and residual sites. Their proximity to residential areas and neighbourhood walking and activity networks made the district suitable for examining how older adults interpret visible spatial information during park use.

Four pocket parks were purposively selected to vary in area, spatial form, internal circulation, surrounding interfaces, and everyday use: Former Xiaguan Power Plant Site Pocket Park (P1), Mufu South Road Community-Square Green Space (P2), East Guangdong Road Linear Green Space (P3), and Wutong Yucheng Community Living Room/Yuanmei Plaza (P4). Eligible sites were publicly accessible, served nearby neighbourhoods, formed part of local walking and activity networks, and fell within the area range specified in the national Pocket Park Construction Guidelines (Trial) [30]. The guidelines classify pocket parks as small (400–2000 m^2), medium-sized (2000–5000 m^2), or large (5000–10,000 m^2). P1 was classified as small, P4 as medium-sized, and P2 and P3 as large. At 10,000 m^2, P2 lies at the upper boundary of the specified range. P4 also functions as a community living room and plaza but meets the same accessibility, neighbourhood-service, area, and functional criteria. These spatial descriptors characterize the selected cases and were not treated as general park-type categories in the analysis.

The four cases encompassed compact block-edge, community-square, linear roadside, and plaza/interface settings, with different relationships among circulation, resting and other stationary activities, and surrounding movement. Figure 1 shows their locations, and Table 1 summarizes their areas, spatial characteristics, and selection rationale. Questionnaire and interview coverage, principal observation contexts, and the environmental-problem categories represented in the field records for each case are summarized in Appendix A (Table A1).

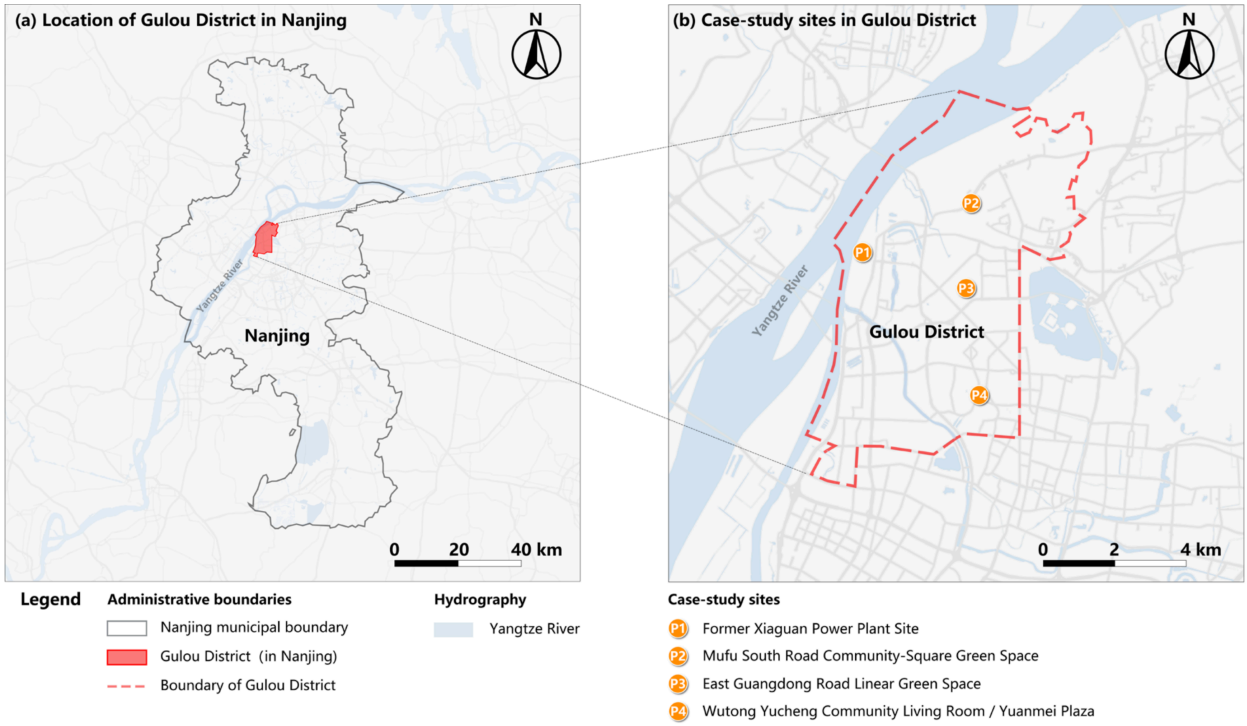

Figure 1. Study area and locations of the four selected pocket-park cases in Gulou District, Nanjing, China.

Table 1. Characteristics of the four selected pocket-park cases and rationale for case selection.

Case Code	Case Name	Approximate Area and Size Class	Spatial and Interface Characteristics	Rationale for Inclusion
P1	Former Xiaguan Power Plant Site Pocket Park	1500 m^2; small	Compact block-edge setting adjoining residential entrances; short internal walking routes; relatively enclosed resting and activity areas	A residentially embedded case linking neighbourhood entrances with short internal routes and enclosed resting and activity spaces
P2	Mufu South Road Community-Square Green Space	10,000 m^2; large	Community-square configuration with multiple internal paths, dispersed planting, and concentrated resting, exercise, gathering, and social-activity areas	A large neighbourhood green-space case combining a multi-route circulation network with resting, exercise, gathering, and social activities
P3	East Guangdong Road Linear Green Space	5100 m^2; large	Narrow linear roadside configuration; strong street-edge exposure; close proximity to pedestrian, bicycle, electric-bicycle, parking, and traffic movement	A roadside case in which linear park circulation directly interfaces with surrounding street movement
P4	Wutong Yucheng Community Living Room (Yuanmei Plaza)	4000 m^2; medium	Open plaza/interface configuration adjoining commercial frontage; multiple pedestrian approaches; overlapping walking, resting, and social-use areas	A multifunctional plaza/interface case combining circulation with resting and social activity

Note. Areas are approximate. The four cases were purposively selected to vary in area, spatial configuration, internal circulation, surrounding interfaces, and everyday use. The descriptors summarize the characteristics of the selected sites rather than a general typology of pocket parks.

2.2. Participants and Data Collection

Participants were park users aged 60 years or older. Convenience intercept sampling was conducted at the four sites from 21 to 28 October 2025, covering weekdays, weekends, and different periods of the day. Fieldwork hours were neither fixed nor systematically logged. The sample represents older adults encountered while using the selected parks during the study period rather than the wider older population, particularly residents who seldom used or avoided these spaces. Because the numbers of eligible individuals approached and those declining participation were not recorded, a survey response rate could not be calculated.

Before data collection, the research team held several meetings to establish common procedures for approaching potential participants, explaining the study, administering the questionnaire, protecting privacy, and respecting voluntary participation. Eligible users were informed of the study purpose, the intended use of the data, the anonymity of their responses, and their right to decline or withdraw. Verbal informed consent was obtained before participation, and no directly identifying information was collected.

A total of 420 paper questionnaires were collected and entered into Microsoft Excel 2021 (Microsoft Corporation, Redmond, WA, USA). The questionnaires were screened for missing required responses, selections outside the available options, clearly erroneous or internally inconsistent responses, and highly repetitive response patterns. Highly repetitive responses included straight-line completion, defined as selecting the same response option throughout the questionnaire. Thirty-four questionnaires were excluded: 25 had missing required responses, three contained responses that could not be validly coded or were internally inconsistent, and six showed highly repetitive or straight-line response patterns. The six response-pattern exclusions were confirmed through review of the original paper forms. The resulting analytical sample comprised 386 questionnaires, representing 91.9% of those collected: 94 from P1, 104 from P2, 89 from P3, and 99 from P4. This percentage represents the proportion of collected questionnaires retained rather than a survey response rate. Questionnaire completion time and any assistance provided during completion were not systematically recorded.

During questionnaire administration, respondents were invited to share experiences related to the study topics and asked whether they were willing to allow at least 15 min for an interview. Forty-five respondents agreed and were interviewed in Chinese: 9 in P1, 14 in P2, 11 in P3, and 11 in P4. No demographic quotas were applied. The interviews addressed participants' impressions of the visible environment, locations they found difficult to interpret, obstructed sightlines, recognition of routes and boundaries, route judgement, and walking confidence. Follow-up questions asked where and under what circumstances these experiences occurred. Interviews were conducted by pairs of researchers, with one leading the conversation and the other taking contemporaneous notes. Actual interview durations were not systematically timed. The interviews were not audio-recorded or transcribed verbatim, and the notes were not linked to individual questionnaire responses. They were used as contextual, case-based evidence rather than as material for formal inductive qualitative analysis.

Site observations, photographs, and field notes were collected during the same period. These records documented conditions at entrances, turns, path intersections, planting edges, surface and level transitions, internal routes, activity areas, and interfaces among walking, cycling, parking, exercise, and social activities. They were used to relate participant-reported difficulties to observable spatial conditions within each case.

2.3. Measures

2.3.1. Individual Characteristics and Park-Use Behaviour

The questionnaire recorded gender, age group, income level, and self-reported ease of mobility to characterize the demographic and mobility profiles of the sampled users. Park-use behaviour was measured by walking time from home to the park, visit frequency, and whether participants reported visiting the park at night. These variables were used to describe the sample and were included as covariates in the regression analyses.

2.3.2. Perceived Visual Safety

Perceived visual safety was assessed using a preliminary 20-item questionnaire developed in Chinese for this study. Item development was informed by research on perceived neighbourhood attributes related to walking among Chinese older adults [31], perceived environmental barriers to outdoor mobility [32], community wayfinding [33], route configuration [34], park lighting [35], and walking self-confidence [36], together with preliminary field observations undertaken during questionnaire development. Candidate items were adapted to situations encountered during pocket-park use and organized into five prespecified content domains. Before data collection, the research team reviewed the Chinese questionnaire for content coverage, clarity, readability, and suitability for older respondents. The review did not include external expert assessment, cognitive interviewing, or independent pilot validation. One author translated the items into English, and the other authors checked the wording against the original Chinese questionnaire. The English version was prepared solely for publication and was not administered to participants. The complete English item statements are provided in Appendix A (Table A2).

The five domains were sightline clarity, boundary legibility, visual comfort, cue continuity, and walking confidence, with four items assigned to each domain. Sightline clarity, boundary legibility, and cue continuity concerned the availability and organization of visual–spatial information. Visual comfort addressed the readability of this information under glare, shadow, reflection, brightness contrast, or visual clutter. Walking confidence captured participants' perceived ability to select and follow a route on the basis of the visible conditions around them; it was not intended as a measure of general falls efficacy or physical capacity. Visual comfort and walking confidence were treated as related aspects of visually guided spatial appraisal rather than as equivalent to its core spatial-information components. Table 2 summarizes the evaluative focus and environmental conditions addressed by each domain.

The five domains served as provisional categories for organizing item content rather than as validated subscales. Their empirical structure was examined as described in Section 2.4. For descriptive reporting, the four items assigned to each domain were averaged. The mean of all 20 items was calculated as an exploratory 20-item composite and interpreted in light of the measurement-structure analyses.

All items used a five-point Likert-type response format. The Chinese questionnaire paired agreement and satisfaction labels at each response point: 1 = strongly disagree/very dissatisfied, 2 = disagree/dissatisfied, 3 = neutral, 4 = agree/satisfied, and 5 = strongly agree/very satisfied. The paired labels accommodated the agreement- and satisfaction-oriented wording used across the item set while maintaining a common scoring direction. Higher scores indicated a more favourable appraisal of the visible conditions associated with park use.

2.3.3. Perceived Environmental Problems

Six environmental-problem categories were prespecified before formal data collection on the basis of the literature cited in Section 2.3.2 and preliminary site observations. The

categories covered obstruction, unclear spatial boundaries and level transitions, changing light conditions, visual complexity, discontinuous spatial cues, and interference among movement and stationary activities.

Table 2. Prespecified content domains of the perceived visual safety questionnaire.

Prespecified Content Domain	Evaluative Focus	Visual–Spatial Conditions Addressed
Sightline clarity	Ability to see ahead and anticipate relevant conditions	Routes, entrances, turning points, obstacles, and approaching users
Boundary legibility	Ability to distinguish spatial and functional boundaries	Paths, planting areas, resting and activity spaces, steps, ramps, kerbs, paving changes, and level transitions
Visual comfort	Comfort and clarity under changing visual conditions	Lighting, glare, shadows, reflections, brightness contrast, and visual clutter
Cue continuity	Ability to follow consistent directional and spatial information	Path direction, paving, railings, lighting, planting edges, turning points, and connections between destinations
Walking confidence	Confidence in selecting and following a route based on visible conditions	Obstacles, corners, ramps, steps, entrances, exits, and shared movement–activity interfaces

Note. Each prespecified content domain comprised four items. Higher scores indicate a more favourable appraisal of perceived visual safety.

The six categories were vegetation/facility obstruction (EV1), boundary ambiguity (EV2), glare or shadow disturbance (EV3), visual complexity (EV4), cue discontinuity (EV5), and interface conflict (EV6). Each category was operationalized as a single Chinese-language item referring to conditions in the park where the respondent was surveyed. The items were specified before the interviews and were not derived from the interview notes. They were treated as separate perceived environmental-problem variables rather than as components of a multi-item scale.

All six items were worded as statements describing potentially problematic conditions and used the five-point response format reported in Section 2.3.2. For these statement-based items, scoring followed the agreement labels. Higher scores indicated stronger endorsement of the stated problem and greater perceived problem severity. English translations of the complete item statements are presented in Table 3.

2.4. Quantitative Analysis

Descriptive statistics were calculated for participant characteristics, park-use behaviour, perceived visual safety, and the six environmental-problem ratings. Differences in the exploratory 20-item composite across the four cases were examined using one-way analysis of variance (ANOVA), followed by Tukey's HSD pairwise comparisons. Eta squared (η^2) was calculated as the effect-size estimate.

Internal consistency was assessed using Cronbach's alpha for the complete item set and Cronbach's alpha and McDonald's omega for each prespecified content domain. Factorability was evaluated using the Kaiser–Meyer–Olkin statistic and Bartlett's test of sphericity. All 20 perceived visual safety items had five response options. Response-category use, item skewness, and excess kurtosis were examined to assess whether treating the items as approximately continuous was reasonable. Exploratory factor analysis used a Pearson correlation matrix, maximum-likelihood extraction, and Promax rotation. The number of factors was determined by parallel analysis. A supplementary five-factor solution was also examined for correspondence with the prespecified content domains.

Table 3. Perceived environmental problem ratings and item statements.

Variable	Perceived Environmental Problem	Item Statement
EV1	Vegetation/facility obstruction	Trees, shrubs, or facilities noticeably obstruct sightlines.
EV2	Boundary ambiguity	Road edges, steps, ramps, or paving changes are not sufficiently clear.
EV3	Glare or shadow disturbance	Glare, reflection, shadows, or light–dark changes affect my ability to see the environment clearly.
EV4	Visual complexity	The visual elements in the park are complex and may distract me or make environmental judgement difficult.
EV5	Cue discontinuity	Route, directional, or spatial cues are discontinuous and may cause hesitation.
EV6	Interface conflict	Walking, resting, fitness, or gathering activities interfere with each other and make me feel unsafe.

Note. Each environmental problem was assessed using one item. Higher scores indicate stronger endorsement and greater perceived problem severity.

The primary association analyses comprised six predictor-specific ordinary least-squares regression models. For each focal environmental problem, items with directly overlapping content were removed before the outcome mean was recalculated. Direct overlap was defined as explicit correspondence between the focal problem rating and the content of a perceived visual safety item. The removals were EV1: SC3; EV2: BL1–BL3; EV3: VC1–VC3; EV4: VC4; EV5: CC1–CC4; and EV6: SC2, SC4, BL4, WC2, and WC3. The resulting outcomes contained 19, 17, 17, 19, 16, and 15 items, respectively.

All six environmental-problem ratings were entered simultaneously in each model. The models adjusted for gender, age group, income level, self-reported ease of mobility, walking time to the park, visit frequency, night-time park use, and case membership. Environmental-problem ratings and ordered covariates were entered using their numerical category codes, so their coefficients represent the estimated mean change associated with a one-category increase. Case membership was represented by dummy variables, with P1 as the reference. HC3 robust standard errors and 95% confidence intervals were calculated. Because the outcome composition differed across the six models, their focal coefficients were not compared directly.

A secondary model used the exploratory 20-item composite and retained the same predictors and covariates. Unstandardized coefficients were reported for all models; standardized coefficients for the secondary model were calculated as $\beta = B \times SD(X)/SD(Y)$. Sensitivity analyses treated the ordered covariates as categorical variables and re-estimated the secondary model after omitting each park in turn.

Multicollinearity and model assumptions were examined using variance inflation factors, tolerance values, the Jarque–Bera and Breusch–Pagan tests, externally studentized residuals, leverage values, and Cook's distance. HC3 robust standard errors were retained irrespective of the Breusch–Pagan result. Case indicators adjusted for average differences among the four sites; multilevel and cluster-robust models were not estimated because only four parks were included.

Analyses were conducted in Python 3.12. All tests were two-tailed, with statistical significance evaluated at $p < 0.05$. Holm adjustment was applied separately to the six focal environmental-problem tests in the primary analyses, the secondary model, and each sensitivity specification.

2.5. Problem Classification and Evidence Integration

Interview notes, site photographs, field notes, and questionnaire data were integrated at the case level. The interview notes recorded participants' descriptions of difficult locations and associated movement responses, while the photographs and field notes documented the spatial settings and visible conditions at those locations. The interview notes were treated as contextual, case-based evidence rather than as data for formal inductive thematic analysis. No independent qualitative coding or formal assessment of thematic saturation was conducted, and the interview material was not used to estimate the frequency or prevalence of individual problems.

The interview and field materials were organized by park and according to the six prespecified environmental-problem categories. For each category, the research team compared participants' descriptions with the relevant locations, spatial arrangements, photographs, and field notes. Classification questions were resolved through discussion among the research team. Questionnaire summaries and association estimates were then considered alongside the case-indexed interview and field materials. This process was used to interpret how each problem appeared within the selected parks and to develop case-specific design implications. The five prespecified perceived visual safety content domains were not used as qualitative themes.

3. Results

3.1. Respondent and Park-Use Characteristics

The analytical sample comprised 234 women (60.6%) and 152 men (39.4%). The largest age groups were 65–69 years (n = 102, 26.4%) and 70–74 years (n = 101, 26.2%). Daily park use was reported by 149 respondents (38.6%), and 113 (29.3%) visited three to five times per week. A total of 233 respondents (60.4%) lived within a 10-min walk of the park: specifically, 103 (26.7%) reported a walking time of less than 5 min, and 130 (33.7%) reported 5–10 min. Overall gender, age, visit-frequency, and walking-time distributions are shown in Figure A1, and selected respondent and park-use characteristics for each case are presented in Table A3, both in Appendix A.

3.2. Visual-Safety Problems Encountered in Everyday Pocket-Park Use

Across the four cases, the interview notes recorded difficulties at locations where participants needed to interpret routes, boundaries, level changes, sightlines, or nearby movement. Reported responses included slowing before turns or transitions, looking down to judge the walking surface, checking a route repeatedly, changing direction, detouring around unclear areas, and feeling less confident where circulation overlapped with other activities. These accounts referred mainly to entrances, turns, path intersections, planting edges, surface transitions, and shared movement–activity interfaces.

Figure 2 shows the park boundaries, entrances, principal pedestrian routes, activity and resting areas, planting areas, and the approximate locations of documented environmental problems, identified by matching the interview notes and site photographs with the site plans. The documented problems differed across the four cases. At P1, vegetation/facility obstruction and boundary ambiguity were identified near internal routes and level transitions. P2 contained the broadest range of documented problems, including vegetation/facility obstruction, glare or shadow disturbance, visual complexity, and interface conflict. At P3, vegetation/facility obstruction and boundary ambiguity were documented within the park, while interface conflict occurred where entrances and circulation routes adjoined the street. At P4, vegetation/facility obstruction and cue discontinuity were documented along planting edges and minor routes.

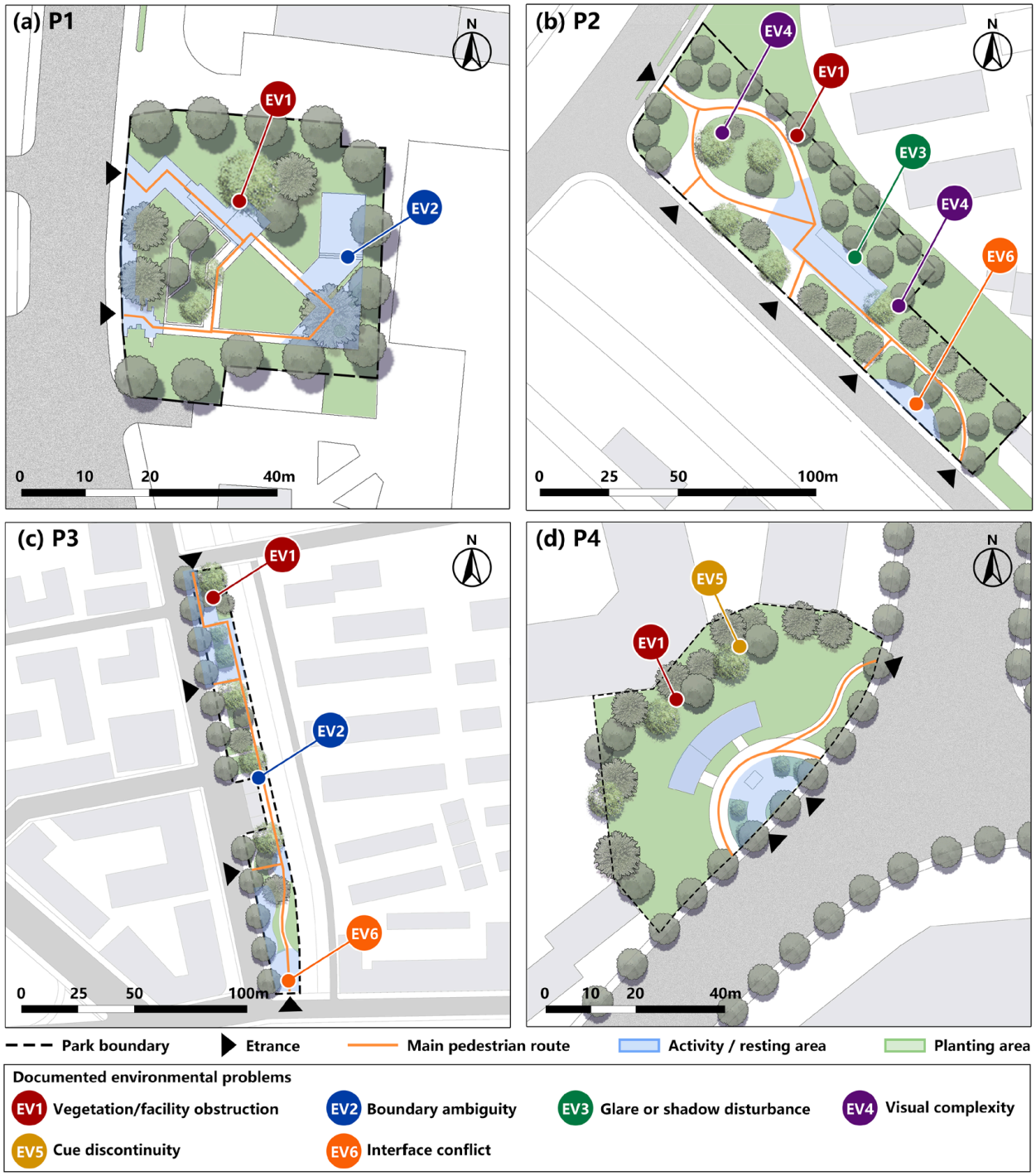

Figure 2. Simplified site plans of the four selected pocket parks: (**a**) P1; (**b**) P2; (**c**) P3; and (**d**) P4. The plans show park boundaries, entrances, principal pedestrian routes, activity and resting areas, planting areas, and the approximate locations of documented environmental problems (EV1–EV6). Panels use different scales for clarity.

Figure 3 presents one documented field condition from each case: a discontinuous minor route at P4, vegetation-obstructed sightlines at P3, a roadside movement interface at P2, and a poorly legible level transition at P1.

3.2.1. Vegetation and Facility Obstruction

Vegetation or facilities restricted forward views near entrances, turns, and path intersections in all four cases. Participants described difficulty seeing the space beyond these

obstructions or anticipating approaching users. Recorded responses included slowing, changing viewing position, and checking ahead before continuing. Field examples included low branches, dense shrubs, street furniture, and other installations located close to walking routes.



Figure 3. Examples of field conditions documented in the four cases: (**a**) P4—discontinuous cues along a minor path or stepping-stone route in a planting area; (**b**) P3—vegetation obstructing sightlines; (**c**) P2—a roadside interface adjoining bicycle parking and street movement; and (**d**) P1—a poorly legible level transition.

3.2.2. Boundary Ambiguity

Boundary ambiguity was documented at P1 and P3. The relevant locations included steps, ramps, kerbs, paving transitions, and edges separating paths from planting or activity areas. Participants described uncertainty about the extent of the walkable surface and reported looking down, slowing, or checking their footing near visually indistinct edges and level changes. The field records identified poorly legible steps at both parks and indistinct park–street boundaries at P3.

3.2.3. Glare or Shadow Disturbance

Glare or shadow disturbance was documented at P2, where glare and uneven brightness occurred beneath a pergola with limited shade and along light–dark transitions. Participants described watching the ground more closely and slowing where shadows or reflections resembled changes in paving or elevation. The reported difficulties concerned the visibility of path edges, surface patterns, obstacles, and minor level changes under changing light conditions.

3.2.4. Visual Complexity

Visual complexity was documented at P2 in areas containing mixed paving patterns, clustered facilities, dense planting, and overlapping activities. Participants described

checking route direction and nearby movement before proceeding through visually busy locations. The interview notes also recorded repeated route checking where circulation, resting, and activity areas were not clearly distinguished.

3.2.5. Cue Discontinuity

Cue discontinuity was documented at P4, particularly along minor paths and stepping-stone routes. Gaps between stepping stones and indistinct planting edges made route alignment difficult to identify. Participants described hesitation, repeated route checking, and changes in direction where paving, path alignment, or other route-defining features did not provide continuous guidance.

3.2.6. Interface Conflict

Interface conflict was documented at P2 and P3. P2 contained a roadside interface adjoining an arterial road, while several entrances at P3 opened directly onto the street. Participants described slowing, waiting, detouring, and checking nearby movement where walking routes overlapped with resting, exercise, gathering, bicycle, electric-bicycle, parking, or street-edge activities. The field records also documented parked vehicles and temporary occupation of circulation areas at these interfaces.

Table 4 summarizes the participant responses, corresponding field conditions, and spatial contexts associated with the six problem categories.

Table 4. Participant-reported responses and corresponding field conditions associated with the six perceived environmental-problem categories.

Problem Category	Recorded User Responses	Corresponding Field Conditions	Documented Locations or Spatial Contexts
Vegetation/facility obstruction	Slowing before turns; repeated forward checking	Low branches, dense shrubs, or facilities restricting sightlines	Entrances, turns, and path intersections
Boundary ambiguity	Looking down; slowing; concern about misjudging edges or level changes	Weak material contrast, unclear path edges, or indistinct paving and level transitions	Path edges, paving transitions, steps, ramps, and slopes
Glare or shadow disturbance	Avoiding bright or visually unstable segments; slowing at light–dark transitions	Reflective paving, strong glare, deep or changing shadows, or uneven illumination	Sun-exposed surfaces, shaded segments, and light–dark transition areas
Visual complexity	Slower movement and repeated route checking in visually busy areas	Dense signage, mixed paving, clustered facilities, or crowded visual elements	Multifunctional activity areas and visually crowded interfaces
Cue discontinuity	Hesitation, detours, and repeated route checking	Interrupted paving cues, unclear turning points, or discontinuous planting edges and other route-defining elements	Internal paths, turning points, and route transitions
Interface conflict	Slowing, waiting, detouring, or expressing uncertainty near overlapping activities	Overlap among walking, resting, fitness, gathering, bicycle, electric-bicycle, or parking activities	Entrances, roadside edges, and shared movement–activity interfaces

Note. Entries summarize contemporaneous interview notes and corresponding field records. They describe the types of responses, conditions, and locations documented and do not represent frequency counts.

3.3. Preliminary Measurement Properties of the Perceived Visual Safety Instrument

Among the 20 perceived visual safety items included in the factor analysis, responses spanned all five categories for 17 items and four categories (2–5) for SC2, VC1, and WC4. Item skewness ranged from −0.525 to −0.247, and excess kurtosis ranged from −0.423 to 0.405, with no marked skewness or kurtosis. The complete questionnaire yielded a Cronbach's α of 0.890, an average inter-item correlation of 0.287, and corrected item–total correlations ranging from 0.459 to 0.556. Across the five prespecified content domains, Cronbach's α ranged from 0.718 to 0.804 and McDonald's ω ranged from 0.719 to 0.804. Boundary legibility had the highest internal-consistency estimates (α = 0.804; ω = 0.804), while visual comfort had the lowest (α = 0.718; ω = 0.719). The item correlation matrix was suitable for exploratory factor analysis (KMO = 0.903; Bartlett's test of sphericity, $\chi^2(190) = 2556.75$, $p < 0.001$).

Parallel analysis supported a four-factor solution: the fifth observed eigenvalue (1.178) was lower than the corresponding 95th-percentile simulated value (1.231). In the maximum-likelihood Promax solution, primary loadings ranged from 0.683 to 0.776 for sightline clarity, 0.625 to 0.840 for boundary legibility, 0.576 to 0.742 for cue continuity, and 0.598 to 0.832 for walking confidence. The visual-comfort items did not define a separate factor; their largest absolute pattern loadings ranged from 0.197 to 0.286, and their communalities ranged from 0.236 to 0.290. Correlations among the four retained factors ranged from 0.451 to 0.658. Table 5 summarizes the internal-consistency estimates and pattern-loading ranges, and the complete four-factor pattern matrix is provided in Appendix A (Table A4).

Table 5. Internal consistency and four-factor pattern-loading results of the preliminary perceived visual safety questionnaire.

Prespecified Content Domain	No. of Items	Cronbach's α	McDonald's ω	Four-Factor Pattern Loadings
Sightline clarity	4	0.780	0.780	0.683–0.776 on sightline factor
Boundary legibility	4	0.804	0.804	0.625–0.840 on boundary factor
Visual comfort	4	0.718	0.719	No distinct factor; largest |loading| per item = 0.197–0.286
Cue continuity	4	0.785	0.786	0.576–0.742 on cue factor
Walking confidence	4	0.778	0.778	0.598–0.832 on confidence factor
All items	20	0.890	—	Broad composite; not interpreted as unidimensional

Note. KMO = 0.903; Bartlett's test of sphericity, $\chi^2(190) = 2556.75$, $p < 0.001$. Exploratory factor analysis used a Pearson correlation matrix, maximum-likelihood extraction, and Promax rotation. Parallel analysis supported a four-factor solution. No visual-comfort item had an absolute pattern loading ≥ 0.30. The dash (—) indicates that McDonald's ω was not calculated for the 20-item composite because it was not interpreted as a unidimensional measure.

In the supplementary five-factor extraction, primary loadings ranged from 0.529 to 0.813, and the visual-comfort items formed a separate factor only when five factors were imposed. For the subsequent analyses, the 20-item mean was retained as a prespecified broad exploratory composite and was not interpreted as evidence of unidimensionality.

3.4. Differences in the Exploratory 20-Item Composite Across the Four Selected Cases

An unadjusted one-way ANOVA showed that the exploratory 20-item composite differed across the four selected cases ($F(3, 382) = 24.727$, $p < 0.001$, $\eta^2 = 0.163$). P1 had the highest mean (M = 4.046, SD = 0.423), followed by P2 (M = 4.029, SD = 0.420), P3 (M = 3.715,

SD = 0.448), and P4 (M = 3.621, SD = 0.433). The difference between the highest and lowest case means was 0.425 points.

Tukey's HSD showed no statistically significant difference between P1 and P2 or between P3 and P4. Exploratory 20-item composite values were significantly higher in P1 and P2 than in P3 and P4. The five prespecified content-domain means followed the same descriptive ordering. Figure 4 presents the composite-score distributions and Tukey pairwise groupings, while the content-domain and composite-score statistics are reported in Appendix A (Table A5).

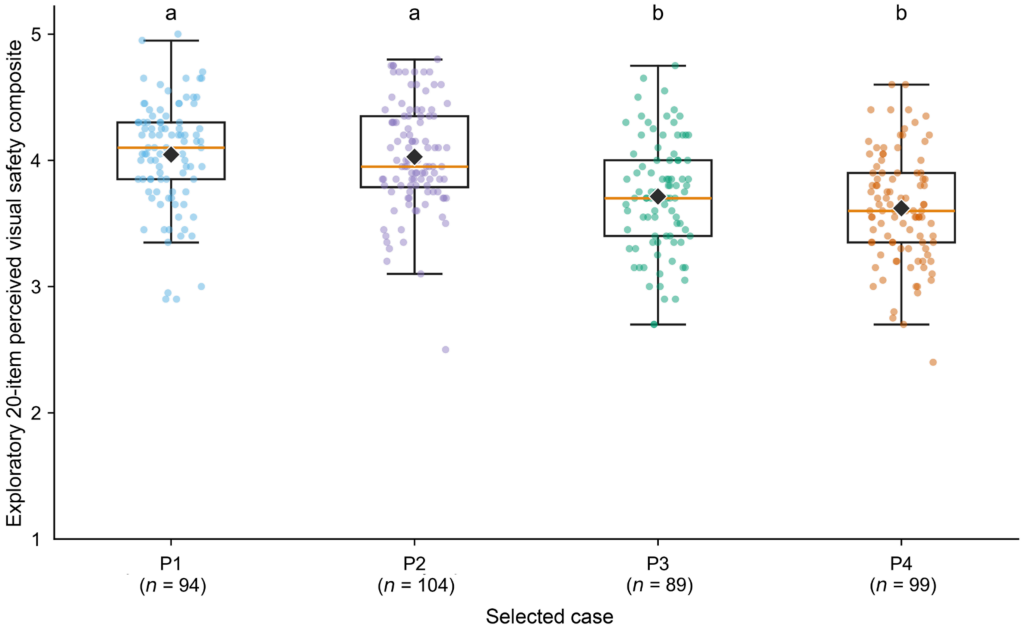

Figure 4. Distribution of the exploratory 20-item perceived visual safety composite across the four selected pocket-park cases. Boxes indicate interquartile ranges; horizontal lines indicate medians; whiskers extend to the most extreme observations within 1.5 times the interquartile range; points represent individual respondents; and diamonds indicate case means. Different letters indicate significant pairwise differences based on Tukey's HSD test ($p < 0.05$).

3.5. Primary De-Overlap and Secondary 20-Item Composite Analyses

In the predictor-specific de-overlap models, none of the six focal associations met the Holm-adjusted significance threshold. Interface conflict was associated with a lower de-overlapped score before correction (B = −0.0658, 95% CI [−0.1161, −0.0156], raw $p = 0.010$), but its Holm-adjusted p value was 0.062. The other five focal associations were also nonsignificant after correction (Table A6A).

The secondary model using the exploratory 20-item composite explained 25.1% of the variance in the exploratory 20-item composite ($R^2 = 0.251$; adjusted $R^2 = 0.218$). Boundary ambiguity (B = −0.0799, 95% CI [−0.1332, −0.0267], Holm-adjusted $p = 0.017$) and interface conflict (B = −0.0810, 95% CI [−0.1310, −0.0310], Holm-adjusted $p = 0.009$) were associated with lower composite values. Vegetation/facility obstruction met the unadjusted significance threshold (B = −0.0516, raw $p = 0.044$) but not the Holm-adjusted threshold ($p = 0.175$); the remaining three environmental-problem ratings were not statistically significant. Compared with P1, adjusted composite values were lower in P3 (B = −0.2358, $p < 0.001$) and P4 (B = −0.3211, $p < 0.001$), whereas P2 did not differ from P1 (B = −0.0089, $p = 0.885$). Figure 5 presents the environmental-problem coefficients from this model. These estimates were treated as secondary because the outcome retained items that overlapped conceptually with some environmental-problem ratings.

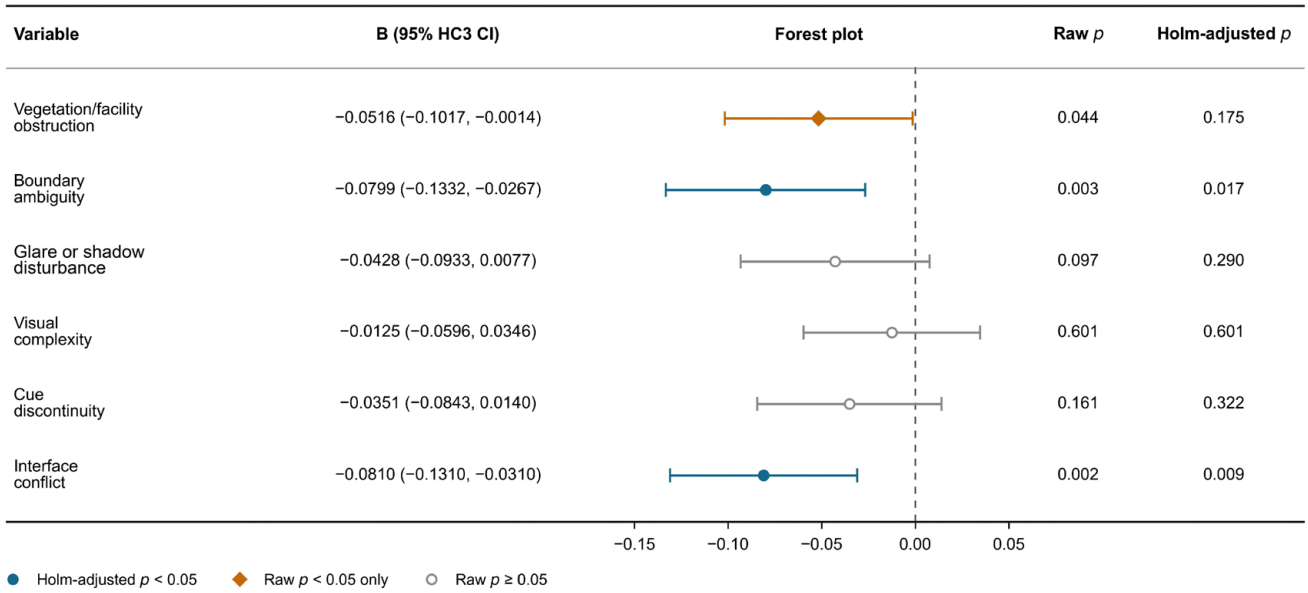

Figure 5. Covariate-adjusted associations between perceived environmental-problem ratings and the exploratory 20-item perceived visual safety composite in the secondary model. Points represent unstandardized regression coefficients, and horizontal lines show 95% confidence intervals based on HC3 robust standard errors. The vertical dashed line marks a coefficient of zero. Raw and Holm-adjusted *p* values are reported for the six environmental-problem coefficients. All six ratings were entered simultaneously, with adjustment for respondent characteristics, park-use variables, and selected-case indicators.

For the secondary model, the maximum VIF was 4.615 and the minimum tolerance was 0.217. The Breusch–Pagan test did not indicate heteroskedasticity ($p = 0.811$), the maximum Cook's distance was 0.0256, and the largest absolute externally studentized residual was 3.230. Complete model estimates are reported in Table A7, with descriptive statistics, correlations, multicollinearity statistics, and diagnostic results shown in Table A8.

3.6. Sensitivity Analyses of the Secondary 20-Item Composite Model

When the ordered covariates were treated as categorical variables, boundary ambiguity (B = −0.0817, 95% CI [−0.1385, −0.0249], Holm-adjusted $p = 0.025$) and interface conflict (B = −0.0817, 95% CI [−0.1347, −0.0288], Holm-adjusted $p = 0.016$) remained associated with lower composite values.

The coefficients for boundary ambiguity and interface conflict were negative in all four leave-one-case-out models, although their statistical significance varied according to the case omitted. After Holm correction, boundary ambiguity remained significant when P1 ($p = 0.027$) or P2 ($p = 0.038$) was omitted, but not when P3 ($p = 0.068$) or P4 ($p = 0.130$) was omitted. Interface conflict remained significant when P2 ($p = 0.014$), P3 ($p = 0.009$), or P4 ($p = 0.040$) was omitted. When P1 was omitted, the interface-conflict coefficient was smaller and did not reach statistical significance (B = −0.0560, raw $p = 0.056$, Holm-adjusted $p = 0.278$). None of the other four environmental-problem ratings was significant after Holm correction in these sensitivity analyses. Complete results are presented in Appendix A (Table A6B,C).

4. Discussion

4.1. Principal Findings

Interview notes and field records linked participants' reported difficulties to entrances, turns, route transitions, level changes, planting edges, and shared movement–activity

interfaces. At these locations, users needed to see what lay ahead, distinguish boundaries and level changes, follow route cues, interpret changing light and surface conditions, and anticipate nearby movement. The documented difficulties reflected relationships among routes, planting, facilities, surfaces, and surrounding activities rather than isolated park elements. The exploratory 20-item composite was higher in P1 and P2 than in P3 and P4.

Parallel analysis supported four factors rather than the five prespecified content domains, with the visual-comfort items failing to form a distinct factor. None of the six environmental-problem ratings was significant after Holm correction in the primary de-overlap analyses. Boundary ambiguity and interface conflict were associated with lower composite values in the secondary model, but this outcome retained conceptually overlapping items, and statistical significance varied across the leave-one-case-out analyses. Together, these results support treating the questionnaire evidence as exploratory.

The spatial evidence complements age-friendly park research concerned with access, amenities, maintenance, safety, and opportunities for recreation [37]. It is also consistent with studies showing that perceived safety reflects both the physical configuration of green spaces and the social and movement conditions encountered within them [38–40]. By linking reported uncertainty to specific routes, boundaries, transitions, and shared interfaces, the study provides a spatially resolved account of the situations in which older users may experience difficulty interpreting environmental information during park use.

4.2. Perceived Visual Safety as Situated Spatial Judgement

The findings suggest that perceived visual safety is situated at particular spatial decision points rather than experienced uniformly across an entire park. What mattered was not simply whether individual elements were visible, but whether the available information allowed users to recognize a walkable route, distinguish an edge or level change, and anticipate intersecting movement. Uncertainty arose when these spatial relationships were obscured or difficult to interpret.

This perspective builds on research into environmental legibility and wayfinding. Studies of older adults' walkway preferences highlight the importance of path surfaces and related design features [41]. Visibility and perceived safety have also been linked to lighting and greenery [42], while route complexity and environmental organization shape navigational demands [43]. These strands of research help explain why conditions at individual decision points may not be fully represented by an appraisal of the park as a whole.

Perceived visual safety is understood here as a subjective appraisal of whether visible environmental information is sufficient to support movement decisions. Reported adjustments such as slowing, looking down, checking a route, or detouring are consistent with the additional effort required to interpret uncertain spatial conditions; they do not necessarily indicate an immediate physical hazard. This distinction separates perceived visual safety from objective hazard assessment and observed wayfinding performance. Within the study's provisional framework, visual comfort was intended to capture the readability of spatial information under glare, shadow, reflection, or visual clutter, while walking confidence represented the user's perceived ability to act on the information available. Paths and facilities may therefore be present even when their spatial relationships remain difficult to interpret.

4.3. Interpretation and Sensitivity of the Questionnaire Associations

The attenuation of the associations after directly overlapping outcome items were removed shows that the estimates were sensitive to outcome composition. The associations for boundary ambiguity and interface conflict in the secondary model may partly reflect

content shared between the predictors and the exploratory 20-item composite outcome. These results should not be used to rank the six environmental problems or to infer causal environmental effects.

Variation in individual exposure may also have contributed to the weak or inconsistent associations for vegetation/facility obstruction, glare or shadow disturbance, visual complexity, and cue discontinuity. Respondents may have used different routes and encountered different locations, lighting conditions, and activity levels within the same park. Each problem was assessed using a single item referring to the surveyed park rather than exposure at a particular location or time. The vegetation/facility obstruction item also combined several possible sources of restricted visibility and cannot be interpreted as a measure of vegetation quantity. Previous evidence similarly suggests that perceived safety may depend more on spatial organization and signs of disorder than on vegetation cover alone [44].

The measurement analysis provides additional context for interpreting the associations. The four-factor solution, particularly the absence of a distinct visual-comfort factor, means that the five prespecified content domains are best regarded as provisional content groupings rather than validated subscales. Positive corrected item–total correlations and correlations among the retained factors are consistent with using the 20-item composite as a broad exploratory summary, but not with treating it as a unidimensional measure. The secondary findings were relatively insensitive to the coding of ordered covariates, while their variation across the leave-one-case-out analyses indicates some dependence on case composition. The questionnaire is therefore most useful as an exploratory comparative measure interpreted alongside the interview notes and field records.

4.4. Case-Specific Configurations of Perceived Environmental Problems

The exploratory 20-item composite values did not vary consistently with park area. Despite differing substantially in size and spatial form, P1 and P2 had similar composite values, whereas P3 and P4 had lower values in two contrasting settings. These comparisons direct attention to the relationships among routes, boundaries, sightlines, activity areas, and surrounding movement. Previous research likewise indicates that pocket-park use reflects a combination of internal features and surrounding land uses [45].

The same problem category could occur in different spatial contexts. Vegetation/facility obstruction was documented in all four cases but affected different routes, turns, entrances, and planting edges. Boundary ambiguity concerned internal level transitions at P1, whereas at P3 it involved both poorly legible steps and indistinct park–street boundaries. P2 combined vegetation obstruction, changing light conditions, visual complexity, and overlapping circulation and activity areas near a major road. At P4, vegetation-obstructed views occurred alongside discontinuous cues on minor paths. These combinations placed different demands on users' interpretation of routes, transitions, and nearby movement.

Because each spatial configuration was represented by one park, these patterns are case-specific and should not be interpreted as general differences among park types. Park area and spatial form also cannot be separated from maintenance, surrounding land use, activity intensity, and user composition. Taken as case evidence, the comparison shows how the location of a problem and its relationship with adjacent uses shape the circumstances in which it is encountered. Assessing routes, spatial cues, boundaries, and movement interfaces together may provide more informative evidence than considering park size or individual facilities in isolation. This focus on the relationship between environmental arrangements and everyday use is consistent with research on older adults' informal adaptations in neighbourhood green spaces [46].

4.5. Implications for Age-Friendly Pocket-Park Renewal

Age-friendly park planning often emphasizes accessibility and environmental equity [47], while pocket-park renewal in high-density settings also considers where new green spaces should be provided [48]. The present findings add a more localized concern to this agenda: the spatial decision points at which users interpret routes and surrounding movement. Entrances, turns, intersections, level changes, and movement–activity interfaces deserve particular attention because users must distinguish edges and transitions, determine how to proceed, and anticipate approaching movement.

The interview notes and field records, considered alongside the exploratory questionnaire findings, suggest several potential renewal responses. These include maintaining sightlines, making boundaries and level changes more visually distinct, coordinating route-defining elements, managing glare and visual clutter, and clarifying movement priorities at shared interfaces. Appropriate responses will depend on the conditions at each location. Planting, for example, may provide shade and visual comfort but restrict forward views when positioned close to an entrance, turn, or path intersection.

Table 6 links the six problem categories to relevant locations and potential renewal responses. It is intended to support site-specific observation and consultation with older users, rather than serve as a uniform checklist. The proposed responses should be evaluated following implementation through before-and-after observation and user feedback. Night-time lighting and route visibility should be examined separately under appropriate evening conditions.

4.6. Limitations and Future Research

This cross-sectional study included four purposively selected parks in one district. Each case combined a particular spatial form with its own maintenance conditions, traffic exposure, activity intensity, surrounding land uses, and user composition. Differences among P1–P4 cannot therefore be attributed to any one of these characteristics or interpreted as causal effects. Convenience sampling represented people using the parks during the study period but not residents who seldom visited or avoided them. The numbers of eligible individuals approached and those declining participation were not recorded, so a response rate could not be calculated.

Data collection took place during a single eight-day period in autumn and covered different periods of the day, but fieldwork hours and environmental conditions were not standardized or systematically logged. Seasonal variation, weather, pedestrian flow, and night-time lighting were not evaluated systematically. Information on visual status, corrective-lens use, contrast sensitivity, fall history, and familiarity with the parks was also unavailable. Participants within the same park shared aspects of their environmental context. Case indicators accounted for average differences among the four sites but not for within-park dependence, and four parks were insufficient for reliable multilevel or cluster-robust estimation.

The questionnaire evidence is subject to several measurement constraints. Environmental-problem ratings and perceived visual safety items were completed by the same respondents, leaving the estimates open to common-method variance and conceptual overlap. Each environmental problem was assessed with a single item, preventing internal-consistency assessment and limiting evaluation of discriminant validity. The perceived visual safety questionnaire also remains preliminary. Its response format combined agreement and satisfaction labels, and its development relied on internal review without external expert assessment, cognitive interviewing, or independent pilot testing. The factor structure was examined in the same sample used for the association analyses. Independent vali-

dation should test revised response labels and examine the measurement structure using polychoric correlations, ordinal estimators, and new samples.

Table 6. Site-assessment considerations and potential renewal responses related to older adults' perceived visual safety in pocket parks.

Problem Category	Relevant Location or Condition	Potential Renewal Response
Vegetation/facility obstruction	Entrances, turns, intersections, and internal paths with restricted forward views	Check visibility from older users' eye level; selectively prune dense planting or relocate facilities; maintain key sightline corridors
Boundary ambiguity	Path edges, paving and level transitions, planting borders, steps, ramps, and activity boundaries	Strengthen material or luminance contrast; maintain continuous edge cues; make level changes and route transitions visually distinct
Glare or shadow disturbance	Reflective or sun-exposed surfaces, deeply shaded routes, and abrupt daytime brightness transitions	Reduce reflective finishes; coordinate planting and paving; moderate abrupt brightness contrasts; assess night-time lighting separately
Visual complexity	Areas with clustered facilities, dense signage, mixed paving, or overlapping activities	Reduce unnecessary visual clutter; organize facilities and signs into a clear hierarchy; preserve the visual prominence of principal routes
Cue discontinuity	Internal paths, turning points, material changes, and connections between entrances and destinations	Coordinate paving, planting edges, signs, and handrails; maintain guidance across changes in direction or material
Interface conflict	Entrances, roadside edges, plaza interfaces, and shared movement–activity zones	Clarify movement priorities and circulation paths; separate movement routes from resting and activity areas where feasible; reduce cross-flow conflict and preserve visibility

Note. The locations and potential responses were developed from the integrated interpretation of interview notes, field records, and exploratory questionnaire findings. The proposed responses are context-dependent design considerations whose effectiveness requires evaluation after implementation.

The interviews were documented through contemporaneous notes rather than audio recordings and verbatim transcripts. The material was organized partly according to the six prespecified problem categories, without independent coding or formal assessment of thematic saturation. It was therefore used as contextual, case-based evidence rather than as a formal inductive thematic analysis. Photographs and field notes helped locate the reported difficulties but did not constitute standardized environmental measurements.

Future research could include a larger number of parks with comparable spatial and interface conditions and recruit both current users and residents who seldom use or avoid these spaces. Data collected across seasons, weather conditions, activity levels, and standardized daytime and evening periods would provide a fuller account of variation in park use. Subjective appraisals could be combined with measures of visual status and park familiarity, visibility analysis, illuminance and luminance measurement, boundary-contrast assessment, environmental audits, pedestrian-flow recording, and behavioural mapping. Longitudinal and before-and-after studies could then examine whether proposed changes to sightlines, boundaries, route cues, and movement interfaces influence park use and perceived visual safety.

5. Conclusions

This study examined older adults' perceived visual safety in four selected pocket parks in Nanjing using questionnaire responses, interview notes, and field records. The case-based evidence linked participants' reported uncertainty to spatial decision points, including entrances, turns, path intersections, boundaries, level transitions, and movement–activity interfaces. At these locations, users needed to identify how a route continued, distinguish changes in the walking environment, and anticipate nearby movement.

The questionnaire provided exploratory rather than confirmatory evidence. Factor analysis supported four factors rather than the five prespecified content domains, with visual comfort failing to form a distinct factor. None of the six environmental-problem ratings was significant after Holm correction in the primary de-overlap analyses. Associations for boundary ambiguity and interface conflict appeared in the secondary 20-item composite model, whose outcome retained conceptually overlapping items. Differences among the four parks remain specific to the selected cases and cannot be attributed independently to park area or spatial form.

The findings suggest that age-friendly renewal should consider the legibility of spatial relationships as well as the provision of paths and facilities. Potential responses include maintaining sightlines, making boundaries and level changes easier to distinguish, reinforcing route continuity, and clarifying movement priorities at shared interfaces. These responses require evaluation across a wider range of parks through longitudinal or before-and-after studies. For age-friendly renewal, the central consideration is whether older users can readily interpret the relationships among routes, boundaries, facilities, and surrounding activities during everyday movement.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki. Under the applicable institutional regulations, this non-interventional, anonymous questionnaire- and interview-based study did not require formal ethics review.

Informed Consent Statement: Verbal informed consent was obtained from all participants prior to data collection. Participation was voluntary, and participants were informed of the study purpose and their right to decline or withdraw at any time.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request. The data are not publicly available because participants did not provide consent for public data sharing.

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

Abbreviations

The following abbreviations are used in this manuscript:

ANOVA	analysis of variance
CI	confidence interval

KMO	Kaiser–Meyer–Olkin
SD	standard deviation
SE	standard error
PVS	perceived visual safety
EFA	exploratory factor analysis
HC3	heteroskedasticity-consistent covariance estimator type 3
PA	parallel analysis

Appendix A

Table A1. Case-indexed evidence coverage and documented visual–spatial problems.

Case	Questionnaires	Interviews	Spatial Configuration	Principal Observation Contexts Used in Case Interpretation	Problem Categories Documented in the Field Records
P1	94	9	Compact block-edge	Residential entrances, short internal paths, turns, planting edges, and relatively enclosed resting or activity spaces	Boundary ambiguity: poorly legible steps; vegetation/facility obstruction: vegetation obstructing sightlines
P2	104	14	Community-square	Internal route junctions, dispersed planting edges, and concentrated resting, exercise, gathering, and social-activity areas	Interface conflict: exposure to movement along an adjacent arterial road; visual complexity: complex path materials; vegetation/facility obstruction: vegetation obstructing sightlines; glare or shadow disturbance: glare associated with insufficient shading beneath the pergola
P3	89	11	Linear roadside	Linear circulation, park access, and interfaces with pedestrian, bicycle, electric-bicycle, parking, and traffic movement	Interface conflict: entrances directly adjoining the street; boundary ambiguity: poorly legible steps and indistinct park–street boundaries; vegetation/facility obstruction: vegetation obstructing sightlines
P4	99	11	Plaza/interface	Commercial-frontage approaches, level transitions, and shared circulation, resting, and social-use interfaces	Cue discontinuity: minor paths or stepping-stone routes that were difficult to identify; vegetation/facility obstruction: vegetation obstructing sightlines

Note. The matrix summarizes the sampled cases, the principal spatial contexts covered by the field records, and the visual–spatial problems documented at each site. The entries identify case-specific observations and do not indicate their prevalence among participants or establish that the listed problems were unique to a particular park.

Table A2. Items of the preliminary perceived visual safety questionnaire.

Prespecified Content Domain	Item Code	Item Statement
Sightline clarity	SC1	I can clearly see the paths ahead, turning points, and entrance locations.
	SC2	I can notice approaching pedestrians, electric bicycles, or other activity groups in advance.
	SC3	Trees, shrubs, or facilities in the park rarely obstruct my view.
	SC4	When turning, passing through activity areas, or moving through entrances and exits, I can clearly judge the surrounding conditions.
Boundary legibility	BL1	The boundaries between paths, planting areas, resting areas, and activity spaces are easy to recognize.
	BL2	The locations of steps, ramps, kerbs, or paving changes are easy to see.
	BL3	Differences in paving materials or colours help me judge where I can walk safely.
	BL4	The spatial relationship between seating areas, fitness areas, and walking routes is clear and not easily confused.
Visual comfort	VC1	The lighting in the park feels comfortable and is not dazzling.
	VC2	Tree shadows, building shadows, or light–dark changes do not affect my ability to see the path clearly.
	VC3	Reflections from paving, walls, or facilities are limited and do not cause visual discomfort.
	VC4	The overall visual environment of the park is not cluttered, and I do not feel visually fatigued.
Cue continuity	CC1	The direction and continuity of park paths are easy to judge.
	CC2	Paths, paving, railings, lighting, or planting edges provide continuous guidance for walking.
	CC3	Routes from entrances to resting areas, activity areas, or exits are clear.
	CC4	When walking in the park, I am unlikely to hesitate because of interrupted routes or unclear signs.
Walking confidence	WC1	I feel at ease when walking in this park.
	WC2	Even when other people are active nearby, I can judge my walking route calmly.
	WC3	I feel confident passing through corners, ramps, steps, or activity-intersection areas safely.
	WC4	Overall, the visual environment of this park increases my walking confidence.

Note. All items used the shared five-point response header described in Section 2.3.2. Responses were coded in the same direction, with higher scores indicating more favourable perceived visual safety.

Table A3. Selected respondent and park-use characteristics by case.

Characteristic	P1 (n = 94)	P2 (n = 104)	P3 (n = 89)	P4 (n = 99)
Female	52 (55.3%)	68 (65.4%)	52 (58.4%)	62 (62.6%)
Age ≥ 75 years	20 (21.3%)	21 (20.2%)	25 (28.1%)	31 (31.3%)
Any mobility difficulty	45 (47.9%)	47 (45.2%)	49 (55.1%)	53 (53.5%)
Park within a 10-min walk	59 (62.8%)	64 (61.5%)	52 (58.4%)	58 (58.6%)
Visits daily	39 (41.5%)	47 (45.2%)	26 (29.2%)	37 (37.4%)
Any night-time visits	56 (59.6%)	69 (66.3%)	53 (59.6%)	64 (64.6%)

Note. Values are n (% within each case). "Age ≥ 75 years" combines the 75–79 and ≥80 age groups. "Any mobility difficulty" combines responses ranging from "occasionally inconvenient" to "requiring supportive facilities". "Any night-time visits" combines "often" and "occasionally".

Table A4. Pattern-loading matrix and communalities for the four-factor solution retained by parallel analysis.

Item	Sightline Clarity	Cue Continuity	Walking Confidence	Boundary Legibility	Communality
SC1	**0.760**	−0.030	−0.019	−0.058	0.488
SC2	**0.776**	0.056	−0.083	−0.139	0.453
SC3	**0.683**	0.001	−0.046	−0.023	0.410
SC4	**0.757**	0.045	−0.186	0.081	0.520
BL1	0.092	−0.028	0.014	**0.625**	0.469
BL2	0.025	0.026	−0.061	**0.693**	0.467
BL3	−0.140	0.031	−0.032	**0.840**	0.565
BL4	−0.024	−0.043	−0.054	**0.809**	0.553
VC1	0.242	−0.068	0.269	0.095	0.251
VC2	0.286	−0.053	0.262	0.091	0.290
VC3	0.280	−0.071	0.243	0.105	0.269
VC4	0.187	0.067	0.197	0.123	0.236
CC1	0.031	**0.632**	−0.009	0.062	0.454
CC2	0.004	**0.742**	0.053	−0.080	0.544
CC3	0.043	**0.576**	0.036	0.058	0.422
CC4	0.017	**0.686**	0.028	0.013	0.512
WC1	−0.106	0.067	**0.832**	−0.081	0.570
WC2	−0.131	−0.007	**0.789**	−0.051	0.459
WC3	−0.145	0.026	**0.663**	0.100	0.426
WC4	0.107	0.006	**0.598**	−0.059	0.408

Note. Values are pattern loadings from exploratory factor analysis using a Pearson correlation matrix, maximum-likelihood extraction, and Promax rotation. Bold values indicate the largest absolute loading for items with $|\text{loading}| \geq 0.30$. No visual-comfort item reached this threshold.

Table A5. Content-domain and 20-item composite scores across the four selected cases.

Questionnaire Score	P1 (n = 94)	P2 (n = 104)	P3 (n = 89)	P4 (n = 99)
Sightline clarity	4.074 ± 0.567	4.005 ± 0.652	3.739 ± 0.668	3.619 ± 0.605
Boundary legibility	4.029 ± 0.617	4.022 ± 0.602	3.621 ± 0.655	3.588 ± 0.654
Visual comfort	4.029 ± 0.540	4.024 ± 0.571	3.817 ± 0.605	3.677 ± 0.531
Cue continuity	4.035 ± 0.599	4.034 ± 0.632	3.663 ± 0.646	3.654 ± 0.621
Walking confidence	4.064 ± 0.670	4.062 ± 0.595	3.733 ± 0.568	3.568 ± 0.591
20-item composite	4.046 ± 0.423	4.029 ± 0.420	3.715 ± 0.448	3.621 ± 0.433

Note. Values are means ± SDs. Each content-domain score was calculated as the mean of its four prespecified items, and the 20-item composite was calculated as the mean of all items. Higher scores indicate a more favourable appraisal of perceived visual safety.

Table A6. Primary conceptual de-overlap analyses and sensitivity analyses of the secondary model.

(**A**) Predictor-specific conceptual de-overlap analyses

Focal Problem	Removed PVS Items	Retained Items	B	HC3 SE	95% CI	Raw *p*	Holm-Adjusted *p*
Vegetation/facility obstruction	SC3	19	−0.0442	0.0255	[−0.0944, 0.0060]	0.084	0.420
Boundary ambiguity	BL1, BL2, BL3	17	−0.0390	0.0280	[−0.0940, 0.0161]	0.165	0.659
Glare or shadow disturbance	VC1, VC2, VC3	17	−0.0330	0.0257	[−0.0835, 0.0175]	0.199	0.659
Visual complexity	VC4	19	−0.0133	0.0240	[−0.0606, 0.0339]	0.580	0.659
Cue discontinuity	CC1, CC2, CC3, CC4	16	0.0299	0.0260	[−0.0213, 0.0811]	0.252	0.659
Interface conflict	SC2, SC4, BL4, WC2, WC3	15	−0.0658	0.0256	[−0.1161, −0.0156]	0.010	0.062

(**B**) Ordered covariates treated as categorical

Focal Problem	*N*	B	HC3 SE	95% CI	Raw *p*	Holm-Adjusted *p*
Vegetation/facility obstruction	386	−0.0514	0.0275	[−0.1056, 0.0028]	0.063	0.251
Boundary ambiguity	386	−0.0817	0.0289	[−0.1385, −0.0249]	0.005	0.025
Glare or shadow disturbance	386	−0.0480	0.0278	[−0.1027, 0.0068]	0.086	0.257
Visual complexity	386	−0.0108	0.0251	[−0.0601, 0.0385]	0.667	0.667
Cue discontinuity	386	−0.0282	0.0254	[−0.0782, 0.0218]	0.269	0.537
Interface conflict	386	−0.0817	0.0269	[−0.1347, −0.0288]	0.003	0.016

(**C**) Leave-one-case-out analyses

Case Omitted	Focal Problem	*N*	B	HC3 SE	95% CI	Raw *p*	Holm-Adjusted *p*
P1	Vegetation/facility obstruction	292	−0.0558	0.0297	[−0.1144, 0.0027]	0.062	0.278
	Boundary ambiguity	292	−0.0909	0.0317	[−0.1534, −0.0285]	0.004	0.027
	Glare or shadow disturbance	292	−0.0418	0.0292	[−0.0993, 0.0158]	0.154	0.463
	Visual complexity	292	−0.0135	0.0287	[−0.0701, 0.0430]	0.638	0.638
	Cue discontinuity	292	−0.0430	0.0304	[−0.1028, 0.0168]	0.158	0.463
	Interface conflict	292	−0.0560	0.0291	[−0.1134, 0.0014]	0.056	0.278
P2	Vegetation/facility obstruction	282	−0.0357	0.0292	[−0.0932, 0.0219]	0.223	0.827
	Boundary ambiguity	282	−0.0848	0.0315	[−0.1467, −0.0228]	0.008	0.038
	Glare or shadow disturbance	282	−0.0152	0.0335	[−0.0812, 0.0507]	0.649	1.000
	Visual complexity	282	−0.0017	0.0283	[−0.0574, 0.0540]	0.952	1.000
	Cue discontinuity	282	−0.0382	0.0302	[−0.0977, 0.0212]	0.207	0.827
	Interface conflict	282	−0.0940	0.0305	[−0.1541, −0.0339]	0.002	0.014
P3	Vegetation/facility obstruction	297	−0.0427	0.0280	[−0.0979, 0.0124]	0.128	0.385
	Boundary ambiguity	297	−0.0789	0.0318	[−0.1415, −0.0164]	0.014	0.068
	Glare or shadow disturbance	297	−0.0549	0.0294	[−0.1128, 0.0029]	0.063	0.251
	Visual complexity	297	−0.0122	0.0261	[−0.0636, 0.0391]	0.639	0.639
	Cue discontinuity	297	−0.0352	0.0290	[−0.0922, 0.0219]	0.226	0.452
	Interface conflict	297	−0.0961	0.0298	[−0.1548, −0.0374]	0.001	0.009
P4	Vegetation/facility obstruction	287	−0.0740	0.0325	[−0.1380, −0.0099]	0.024	0.119
	Boundary ambiguity	287	−0.0651	0.0320	[−0.1282, −0.0020]	0.043	0.130
	Glare or shadow disturbance	287	−0.0613	0.0284	[−0.1172, −0.0055]	0.031	0.126
	Visual complexity	287	−0.0276	0.0297	[−0.0861, 0.0308]	0.353	0.645
	Cue discontinuity	287	−0.0272	0.0274	[−0.0812, 0.0268]	0.323	0.645
	Interface conflict	287	−0.0811	0.0296	[−0.1394, −0.0228]	0.007	0.040

Note. All models adjusted for the six environmental-problem ratings, respondent and park-use variables, and available case indicators, with HC3 standard errors. Panel A reports the primary predictor-specific

analyses, in which the perceived visual safety outcome was recalculated after removing items that overlapped conceptually with each focal problem. The coefficients in Panel A are not directly comparable because the retained outcome items differ. Panels B and C report sensitivity analyses of the secondary 20-item composite model using categorical coding of the ordered covariates and leave-one-case-out specifications, respectively. Holm correction was applied separately across the six focal environmental-problem tests within each specification.

Table A7. Secondary multiple regression results using the exploratory 20-item composite and HC3 robust standard errors.

Variable Group	Variable	B	Standardized β	HC3 SE	95% CI	Raw *p*	Holm-Adjusted *p*
Environmental problem	Vegetation/facility obstruction	−0.0516	−0.098	0.0255	[−0.1017, −0.0014]	0.044	0.175
	Boundary ambiguity	−0.0799	−0.145	0.0271	[−0.1332, −0.0267]	0.003	0.017
	Glare or shadow disturbance	−0.0428	−0.084	0.0257	[−0.0933, 0.0077]	0.097	0.290
	Visual complexity	−0.0125	−0.023	0.0239	[−0.0596, 0.0346]	0.601	0.601
	Cue discontinuity	−0.0351	−0.068	0.0250	[−0.0843, 0.0140]	0.161	0.322
	Interface conflict	−0.0810	−0.149	0.0254	[−0.1310, −0.0310]	0.002	0.009
Control variable	Gender	−0.0114	−0.012	0.0448	[−0.0995, 0.0766]	0.799	—
	Age group	−0.0082	−0.022	0.0370	[−0.0810, 0.0646]	0.825	—
	Income level	−0.0188	−0.040	0.0220	[−0.0621, 0.0245]	0.395	—
	Mobility difficulty	0.0029	0.008	0.0354	[−0.0666, 0.0725]	0.934	—
	Walking time	0.0190	0.046	0.0188	[−0.0181, 0.0561]	0.314	—
	Visit frequency	−0.0261	−0.063	0.0198	[−0.0650, 0.0129]	0.189	—
	Night-time visits	0.0308	0.047	0.0309	[−0.0299, 0.0915]	0.319	—
Selected case	P1: Compact block-edge (reference)	—	—	—	—	—	—
	P2: Community-square	−0.0089	−0.008	0.0616	[−0.1299, 0.1122]	0.885	—
	P3: Linear roadside	−0.2358	−0.212	0.0667	[−0.3669, −0.1047]	<0.001	—
	P4: Plaza/interface	−0.3211	−0.299	0.0667	[−0.4523, −0.1899]	<0.001	—

Note. This secondary model used the exploratory 20-item perceived visual safety composite as the dependent variable. B values are unstandardized coefficients; standardized beta values were calculated as B × SD(X)/SD(Y). HC3 standard errors and 95% confidence intervals are reported. $N = 386$; $R^2 = 0.251$; adjusted $R^2 = 0.218$. All predictors were entered simultaneously, with P1 as the reference case. Holm correction covered the six environmental-problem ratings. The model is exploratory because the outcome retains conceptually overlapping items. The dash (—) indicates either statistics not estimated for the reference case or Holm-adjusted *p* values not calculated for the control variables and case indicators.

Table A8. Descriptive statistics, correlations, multicollinearity, and diagnostic statistics for the secondary 20-item composite model.

(**A**) Descriptive statistics and Pearson correlations among the focal questionnaire variables

No.	Variable	M	SD	1	2	3	4	5	6	7
1	Exploratory 20-item PVS composite	3.856	0.469	1.000	—	—	—	—	—	—
2	Vegetation/facility obstruction	2.601	0.895	−0.240 ***	1.000	—	—	—	—	—

Table A8. *Cont.*

3	Boundary ambiguity	2.687	0.851	−0.274 ***	0.241 ***	1.000	—	—	—	—
4	Glare or shadow disturbance	2.510	0.921	−0.083	0.043	−0.021	1.000	—	—	—
5	Visual complexity	2.658	0.860	−0.066	−0.066	0.055	−0.012	1.000	—	—
6	Cue discontinuity	2.650	0.914	−0.135 **	0.086	0.096	−0.102 *	0.059	1.000	—
7	Interface conflict	2.588	0.864	−0.245 ***	0.133 **	0.092	0.036	0.020	0.143 **	1.000

(**B**) Variance inflation factors in the secondary model

Predictor	**Code**	**VIF**
Vegetation/facility obstruction	EV1_vegetation_obstruction	1.161
Boundary ambiguity	EV2_boundary_ambiguity	1.144
Glare or shadow disturbance	EV3_glare_shadow	1.038
Visual complexity	EV4_visual_complexity	1.043
Cue discontinuity	EV5_cue_discontinuity	1.071
Interface conflict	EV6_interface_conflict	1.076
Gender	gender	1.028
Age group	age_group	4.615
Income level	income	1.053
Mobility difficulty	mobility	4.594
Walking time	walk_time	1.033
Visit frequency	visit_frequency	1.046
Night-time visits	night_visit	1.026
P1: Compact block-edge (reference)	—	—
P2: Community-square	case_2	1.586
P3: Linear roadside	case_3	1.629
P4: Plaza/interface	case_4	1.706

(**C**) Secondary 20-item composite model diagnostic statistics

Diagnostic	**Value**	**Screening Interpretation**
Maximum VIF	4.615	Below 5; highest values occurred for age and mobility coding
Minimum tolerance	0.217	Above 0.20
Breusch–Pagan LM (p)	10.975 (0.811)	No evidence of heteroskedasticity in this screening test; HC3 retained
Jarque–Bera statistic (p)	5.082 (0.079)	No strong departure from residual normality at $p < 0.05$
Maximum |externally studentized residual|	3.230	One or more observations exceeded |3| and were inspected
Maximum Cook's distance	0.0256	No value approached 1
Cook's D > 4/N	22	Screening flag only; no observation was removed solely on this criterion

Note. N = 386. Correlations are Pearson coefficients; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed). Higher environmental-problem scores indicate greater perceived problem severity, whereas higher values of the exploratory 20-item PVS composite indicate a more favourable appraisal of perceived visual safety. VIFs cover all predictors in the secondary model using the exploratory 20-item composite. Diagnostic thresholds were used for screening, and HC3 inference was retained regardless of the Breusch–Pagan result. The dash (—) indicates correlations omitted from the upper triangle of the correlation matrix or a VIF value not applicable to the reference case (P1).

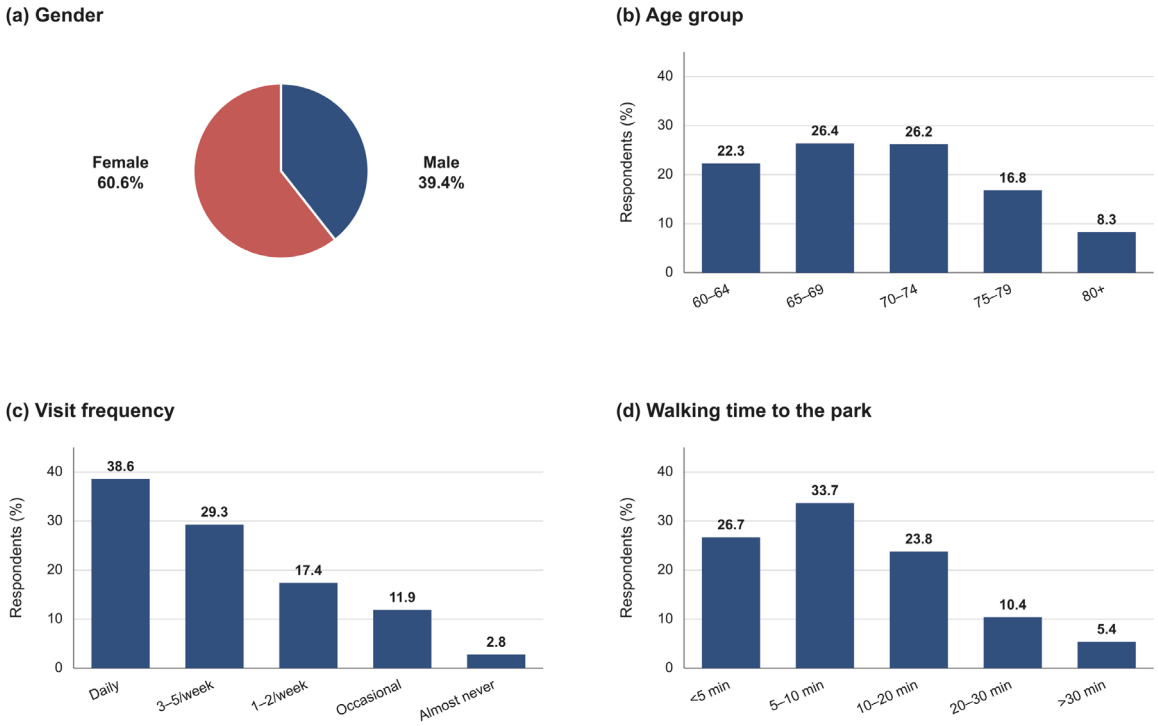

Figure A1. Respondent and park-use characteristics of questionnaire participants.

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