

Systematic Review

Associations Between the Built Environment and Older Adults' Mental Health: A Systematic Literature Review (2015–2025)

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Abstract

As the global population continues to age, mental health issues such as depression, anxiety, stress, loneliness, and social isolation among older adults are receiving increasing attention. The built environment is closely associated with older adults' daily mobility, environmental perception, social participation, and mental health and well-being, but the evidence remains heterogeneous across spatial contexts, environmental indicators, and study designs. Previous umbrella reviews have summarized broad links between the built environment and healthy aging, but less attention has been paid to recent original empirical studies published after the COVID-19 pandemic, the distinction between objective environmental exposure and subjective environmental perception, and the role of social participation as a pathway linking environmental conditions to mental health and well-being. This study employs a systematic literature review approach, searching and screening peer-reviewed empirical studies published between 2015 and January 2026 that focus on the associations between the built environment and older adults' mental health and well-being. PubMed, Scopus, and Web of Science databases were used for searching, supplemented by manual searching. After title and abstract screening and full-text evaluation, a total of 60 studies were included. Subsequently, a comprehensive analysis was conducted on aspects such as research design, spatial scale, environmental indicators, types of mental health outcomes, and potential pathways of action. In this review, core mental health and well-being outcomes included negative outcomes, such as depression, anxiety, stress, psychological distress, loneliness, and social isolation, and positive outcomes, such as life satisfaction, subjective well-being, psychological well-being, and mental well-being. Social participation was examined as a behavioral and psychosocial pathway rather than as a core outcome. Emerging methods, including street-view image analysis, FCN-based semantic segmentation, and XGBoost-SHAP, were examined because they can refine environmental exposure measurement and support variable-importance interpretation, rather than because they provide causal evidence. The main synthesis suggests that several built environment factors are associated with older adults' mental health and well-being, although the strength



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and consistency of evidence vary across outcome types, spatial contexts, and study designs. (1) Exposure to green and blue spaces, quality of public open spaces, walkability and accessibility, accessibility of neighborhood facilities and services, housing and living conditions, and positive environmental perception are mostly associated with lower levels of depression, anxiety, stress, and loneliness, as well as higher levels of life satisfaction, subjective well-being, and psychological well-being. (2) Conversely, adverse environmental exposures such as proximity to roads, pollution, non-vegetated spaces, and high-intensity urbanization are more likely to exacerbate negative psychological outcomes. Existing evidence also suggests that social participation is one of the important behavioral pathways through which the built environment is linked to the mental health of older adults, but it is not the only mechanism. (3) In addition, the direction and intensity of environmental associations remain heterogeneous under different spatial scales, indicator types, and research methods. Overall, this review contributes by organizing recent empirical evidence into a built environment–social participation–mental health and well-being framework, while emphasizing that most findings should be interpreted primarily as evidence of association rather than as stable or uniform causal effects.

Keywords: built environment; older adults; mental health; systematic literature review; role of social participation

1. Introduction

The trend of global population aging will continue to intensify. According to projections by the World Health Organization (2025), the proportion of the global population aged 60 and older is expected to rise from approximately one-sixth in 2030 to about one-fifth in 2050 [1]. As people age and experience changes in social relationships, older adults may become more susceptible to loneliness and social isolation, which are associated with adverse health outcomes and increased mortality risk [2]. Loneliness and social isolation may also be linked to daytime functional impairment and depression in later life [3]. In 2019, 57.78 million older adults worldwide suffered from depression [4]. These mental-health challenges are not only individual or medical issues; they are also shaped by the everyday environments in which older adults live, walk, rest, interact, and access services. Therefore, the relationship between the built environment and older adults' mental health should be understood as both a public health issue and an environmental urbanism issue.

Although the shrinking of social networks with advancing age makes older adults more prone to loneliness and social isolation [2], social engagement—as a key component of healthy aging [5]—contributes to improved mental health and well-being among older adults [6]. Furthermore, increasing social participation among older adults can significantly improve symptoms of depression [7,8]. In this sense, social participation should not be treated only as a health outcome, but also as a behavioral and psychosocial pathway through which everyday environments may become relevant to mental health and well-being.

From the perspective of environmental-behavior theory and environmental urbanism, the built environment provides both resources and constraints for older adults' daily life [9,10]. Age-friendly neighborhoods, walkable streets, accessible public spaces, green and blue spaces, housing conditions, and nearby services may support mobility, perceived safety, environmental comfort, restorative experience, and opportunities for social interaction [11,12]. Recent evidence on older people further suggests that micro-scale open-space attributes, such as green ratio, pathway width, plant diversity, signage, and sitting-area lighting, may be linked to cognitive health, indicating that age-friendly environmental research should consider not

only accessibility and land-use patterns but also detailed spatial and facility attributes [13]. Conversely, traffic risk, poor accessibility, environmental disorder, pollution, noise, and inadequate public-space quality may restrict outdoor activity, reduce social contact, and increase environmental stress [14]. Rather than functioning as a passive physical background, the built environment can be understood as an active context in which older adults encounter restorative resources, environmental stressors, opportunities for action, and conditions for social connection. In this sense, environmental exposure, environmental perception, and social participation are interrelated processes through which everyday urban environments may be linked to older adults' mental health and well-being.

Recent studies have reported associations between built-environment conditions and social participation among older adults. Community insecurity and inconvenient home entrances may hinder older adults with disabilities from leaving home and participating in social activities [15], while subjective perceptions of the built environment may be linked to mental health through social participation [16]. Evidence on intergenerational participation further suggests that slower vehicle speeds, open spaces, rest facilities, safe crossings, and walkability may support older adults' participation in community activities [17,18]. These findings indicate that social participation can function as a behavioral pathway through which built-environment conditions become relevant to older adults' mental health and well-being.

In addition to its relevance to social participation, the built environment has been increasingly examined in relation to older adults' mental health and well-being [19,20]. For example, urban green spaces have been associated with older adults' well-being and stress relief [21], while access to daily facilities and public transport may be linked to mental health through physical activity and everyday mobility [20]. Studies on older adults with low socioeconomic status also indicate that green spaces, blue spaces, historic environments, and open spaces can provide positive emotional experiences [22]. A study conducted in a developing-country context also suggests that residential green settings, such as home gardens, may be related to psychological conditions, indicating that mental-health-related environmental resources are not limited to open public spaces but may also include domestic and semi-private green environments [23]. These findings suggest that built-environment conditions may be linked to mental health and well-being through multiple pathways, including restorative experience, physical activity, everyday mobility, environmental perception, and social participation.

The COVID-19 pandemic further highlighted the importance of everyday environments for older adults. Restrictions on mobility, reduced access to formal services, fear of infection, and changes in public-space use increased older adults' dependence on nearby residential environments, neighborhood streets, parks, open spaces, and semi-public or semi-private green spaces. Recent post-pandemic evidence suggests that everyday activities in urban green spaces, such as walking and relaxed sitting, may be associated with psychological restoration and emotional experience, indicating that the mental-health relevance of nearby green spaces became more visible after mobility restrictions and changes in public-space use [24].

In recent years, especially during and after the COVID-19 pandemic, increasing attention has been paid to the importance of nearby residential environments, public open spaces, and everyday activity routes for older adults' mental health, well-being, and social participation. However, existing reviews have not fully synthesized original empirical evidence published over the past decade. Previous reviews have summarized broad links between the built environment and healthy aging, or older adults' mental health, well-being, and social participation [25–27]. However, two of these were umbrella reviews that mainly synthesized evidence from earlier reviews rather than integrating recent original empirical

studies [26,27], while another review focused primarily on built-environment factors that support or hinder older adults' social participation [28]. Consequently, several gaps remain. First, recent original empirical studies published between 2015, and January 2026 have not been systematically integrated, particularly those reflecting methodological developments and changes in everyday environmental experience during and after the COVID-19 period. Second, objective environmental exposure and subjective environmental perception have rarely been compared within the same synthesis. Third, limited attention has been paid to whether associations differ across housing, neighborhood, street, park, public open-space, and city-level contexts. Fourth, social participation has often been treated as an outcome, whereas its role as a behavioral and psychosocial pathway linking environmental conditions to mental health and well-being remains insufficiently synthesized. Finally, emerging approaches such as street-view image analysis, deep-learning-based exposure extraction, and machine-learning-based variable-importance interpretation have not been fully discussed in relation to environmental measurement and evidence synthesis.

Therefore, this systematic review synthesizes peer-reviewed empirical studies published between 2015 and January 2026 on the associations between the built environment and older adults' mental health and well-being. This review distinguishes mental health and well-being outcomes from social participation: the former includes both negative psychological outcomes and positive well-being outcomes, whereas the latter is examined as a behavioral and psychosocial pathway linking environmental conditions to these outcomes. To clarify the scope and contribution of the review, the following research questions are addressed:

- (1) Which built-environment dimensions have been associated with older adults' mental health and well-being, and how consistent are these associations across outcome types?
- (2) How has social participation been examined as a behavioral pathway, mechanism mediating, or explanatory framework linking the built environment to mental health and well-being?
- (3) How do these associations vary across spatial contexts, objective and perceived environmental indicators, and research designs?

2. Theoretical Review

2.1. Age-Friendly Built Environment

The built environment encompasses the man-made spaces where people live, work, and engage in leisure activities, including public spaces and public facilities [27]. Rather than being treated as a single physical exposure, the built environment in this review is understood as a multi-dimensional environmental condition that may shape older adults' mobility, environmental perception, social participation, and mental health and well-being. The built environment has therefore been increasingly examined in relation to older adults' mental health and well-being [26,27]. In its publication *Global Age-Friendly Cities: A Guide*, the World Health Organization identifies "outdoor spaces, buildings, transportation, and housing" as key dimensions of the urban physical environment. It emphasizes that improvements in walkability, accessibility, safety, the livability of public spaces, and the accessibility of facilities may reduce environmental barriers for older adults and increase opportunities for social participation, thereby supporting a healthier and more dignified later life.

The built environment can be further categorized into two types: the objective environment and the subjectively perceived environment. The former is typically characterized using GIS or spatial data to assess density, land-use mix, street network connectivity, green coverage, and facility accessibility [29,30]; the latter is reflected through questionnaire

scales measuring perceived safety, perceived convenience, walking comfort, and environmental satisfaction [31]. Objective environmental exposure and subjective environmental perception may reflect different dimensions of older adults' environmental experience. For example, objectively measured facility accessibility or street connectivity may not fully correspond to older adults' perceived safety, convenience, comfort, or willingness to use nearby spaces.

From the perspective of "ageing in place," an age-friendly built environment constitutes a systemic support system: it implies not only residing in familiar surroundings but also maintaining the ability to move independently within a familiar community, accessing necessary services, and sustaining social integration and psychological well-being [27]. Consequently, research on the built environment must simultaneously focus on the provision of facilities and public spaces at the community level, as well as walking and public transportation infrastructure [32]. It must also examine the age-friendliness of the built environment, such as accessibility, lighting, slip resistance, and daily safety supports, to identify which environmental factors may reduce barriers to mobility and participation and may support older adults' outdoor activities, social engagement, and mental health [33].

Built-environment conditions should also be understood across spatial scales. Residential and neighborhood environments are related to daily comfort, independence, service access, walkability, and routine social encounters. Street and mobility-route environments shape everyday exposure during movement, including greenery, traffic safety, noise, and walking comfort [34,35]. Parks, public open spaces, and blue-green spaces provide settings for restoration, leisure, and social interaction [36,37], while city-level environments reflect broader patterns of urban livability, service distribution, and environmental risk [38]. Therefore, spatial scale is not only a measurement issue but also a theoretical issue, because different spatial scales may activate different behavioral, perceptual, and psychosocial pathways.

2.2. Social Participation Among Older Adults

Social participation can be understood as activities that involve interaction with others through engagement in community life and significant shared spaces [39]. In this review, social participation is not treated as a core mental-health outcome but as a behavioral and psychosocial pathway that may link built-environment conditions to older adults' mental health and well-being. Social participation can be categorized into three types: (a) informal socializing (neighborhood interactions, visits, and casual conversations) [39], (b) organized participation (community activities, volunteering, religious or interest groups) [39], and (c) public space use and outdoor behavior (frequency of going out, lingering in parks or community spaces, participation in activities) [40].

The built environment may increase the likelihood of chance encounters and willingness to participate by providing accessible destinations, continuous and safe pedestrian systems, public spaces conducive to lingering, and recognizable social settings. Social participation may support mental health and well-being by increasing social support, reinforcing a sense of identity and meaning, and reducing loneliness and negative emotions [5,7,40]. However, social participation should not be understood as a simple linear mediator between the built environment and mental health. Older adults' participation in public life may be shaped by environmental accessibility, perceived safety, physical capability, social opportunities, and familiarity with place. In turn, repeated participation may also reshape how older adults perceive and use the environment by strengthening familiarity, social support, and meaningful everyday connections. Therefore, this review treats social participation as a dynamic pathway that may interact with environmental exposure and environmental perception, rather than as a fixed or universal mechanism.

2.3. Mental Health in Older Adults

Mental health and well-being in later life are closely related but analytically distinguishable concepts. Mental health is commonly discussed in relation to negative psychological conditions, such as depression, anxiety, psychological distress, stress, loneliness, and social isolation, which have been widely examined in previous reviews of the built environment and older adults' mental health [41]. Well-being, by contrast, refers more directly to positive psychological and evaluative outcomes, including life satisfaction, subjective well-being, psychological well-being, mental well-being, and the mental component of health-related quality of life, which have also been included in broader reviews on aging, the built environment, and well-being [42]. Therefore, mental health and well-being are treated in this study as related but distinct outcome categories.

In this review, mental health and well-being outcomes were organized into two levels. The core outcome group included negative mental health outcomes, such as depression, anxiety, stress, psychological distress, loneliness, and social isolation, as well as positive psychological outcomes, including life satisfaction, subjective well-being, psychological well-being, mental well-being, and the mental component of health-related quality of life. In addition, some age-friendly built-environment studies reported broader health-related perceived outcomes, such as self-rated health or general health. These outcomes were not treated as direct mental-health outcomes. Instead, they were considered secondary or contextual health-related outcomes when they were theoretically linked to psychosocial processes such as sense of community, social inclusion, perceived safety, social participation, or environmental satisfaction. Therefore, findings based solely on self-rated health were not used as primary evidence for conclusions specifically concerning older adults' mental health.

The relationship between the built environment and mental health can be understood through several interrelated pathways rather than through a single linear mechanism. First, the restorative pathway emphasizes how green spaces, blue spaces, and high-quality public open spaces may provide restorative experiences, tranquility, positive emotions, and opportunities for psychological recovery, and thus may be associated with better mental health and well-being [43,44]. Second, the safety and environmental stress pathway emphasizes how traffic risk, inadequate lighting, noise, environmental decay, poor accessibility, and perceived disorder may generate threat perception, avoidance behavior, reduced sense of control, and psychological distress [45,46]. Third, the social relations pathway highlights how accessible, safe, and socially usable environments may create opportunities for informal encounters, social interaction, social support, and community participation, thereby linking environmental conditions to loneliness, social isolation, and well-being [41,45]. These pathways are not mutually exclusive. The same environmental setting may simultaneously provide restorative resources, reduce or intensify environmental stress, and create opportunities for social participation. For example, a park or public open space may support emotional recovery through natural exposure, enable social interaction through shared activity spaces, and influence perceived safety through lighting, maintenance, and spatial visibility. Therefore, this review treats restorative experience, perceived safety, environmental stress, and social participation as interacting processes through which built-environment conditions may be linked to older adults' mental health and well-being. Given the dynamic changes in older adults' functional abilities, the role of age-friendly neighborhood environments in mental health may also vary across groups and contexts. Age-friendly neighborhood conditions may buffer the negative association between functional decline and depressive symptoms, but this relationship may differ across urban and rural contexts [47]. Therefore, this review maps mental health and well-being outcomes to specific types of built-environment factors and spatial contexts in

order to examine whether different environmental dimensions, outcome types, population characteristics, and regional contexts lead to divergent conclusions.

Overall, existing quantitative, qualitative, and mixed-methods studies suggest that the built environment is associated with older adults' mental health and well-being through multiple behavioral, perceptual, and psychosocial processes. However, the strength and direction of these associations may vary by outcome type, spatial scale, environmental indicator, and research design. This makes it necessary to synthesize the evidence systematically while distinguishing between association, pathway explanation, and causal inference.

3. Methods

3.1. Inclusion Criteria

First, we selected studies focusing on health-related outcomes among older adults. These studies must meet the following criteria: This review includes original empirical studies that examine outcomes related to the mental health and well-being of older adults. Included studies must meet the following criteria: (1) Studies were included in the main synthesis only when the participants were older adults aged 60 years or older, or when studies with broader age ranges reported distinct results for older-adult subgroups. Studies based on middle-aged/general adult samples, or mixed-age samples without separately reported older-adult mental health and well-being outcomes, were not incorporated into the main synthesis. These studies were retained only as supplementary evidence and examined separately in the sensitivity analysis. Because definitions of "older adults" vary across countries, disciplines, and datasets, this review adopted 60 years and older as the operational threshold for the main synthesis. This threshold was used to maintain consistency across culturally different studies and to align with common international definitions of older populations. Studies using broader or lower age thresholds were included in the main synthesis only when they reported distinct results for adults aged 60 years and older or clearly defined older-adult subgroups. (2) The study must involve factors related to the built environment; (3) the study had to report at least one core mental health or well-being outcome, such as depression, anxiety, stress, psychological distress, loneliness, social isolation, life satisfaction, subjective well-being, psychological well-being, mental well-being, or the mental component of health-related quality of life. Studies reporting only self-rated health or general health were not treated as primary evidence for mental health. They were retained only as secondary or contextual evidence when they explicitly involved older adults and when the built environment–health association was linked to psychosocial processes, such as sense of community, social inclusion, perceived safety, social participation, or environmental satisfaction; (4) the study must be published in an English-language peer-reviewed journal. Social participation was not included as a core outcome variable in the studies, but it was organized and analyzed in the subsequent review as a potential pathway, mediating mechanism, or explanatory factor. Second, we excluded literature that was not based on empirical and quantitative or qualitative analysis, such as review studies, book chapters, and reports. Methodological quality was not used as an eligibility criterion during the initial screening stage. Instead, it was assessed after full-text screening to evaluate the robustness of the evidence synthesis and to inform the sensitivity analysis.

3.2. Search Strategy

We developed keywords using the Population, Exposure, and Outcome (PEO) framework [48] for the systematic search (Table 1). Database research was conducted in early January 2026, covering Web of Science, Scopus, and the PubMed database. Manual searches were also performed by reviewing the reference lists of relevant literature reviews and the

Health Design Center’s knowledge base to identify additional relevant studies. Database search criteria included peer-reviewed articles written in English and published between 2015 and January 2026. Although this search strategy helped ensure the academic quality and comparability of the included studies, it may have introduced language bias and publication bias. To reduce the possibility of missing relevant studies, additional manual searches were conducted by reviewing relevant literature through Google Scholar. The search strings combined population, exposure, and outcome terms using Boolean operators, mainly “AND” between concept groups and “OR” within each concept group. The syntax was adapted to the requirements of each database, and the complete database-specific search strings are provided in Supplementary Table S1 to ensure reproducibility. In the main manuscript, Table 1 summarizes the core Population–Exposure–Outcome keyword structure used to construct these searches.

Table 1. Search Terms.

Population	Exposure (Setting)	Outcomes
Older adult(s) Older people Aged; Elderly Geriatric Senior(s)	Built environment	
	Physical environment	
	Environmental design	
	Architecture	mental health
	Urban environment	well-being
	Neighborhood environment	quality of life
	Street	social inclusion
	Public space	social participation
	park	depression prevention
	green space	
	blue space	

Source: Author statistics.

3.3. Selection Process

Based on the aforementioned inclusion criteria, studies identified through database searches were first screened for titles and abstracts using Rayyan [49]. Those studies determined to meet the inclusion criteria following the title and abstract review were subsequently imported into EndNote (Version X8.0.2) for full-text screening. The entire screening process was conducted independently by two reviewers to ensure consistent and comprehensive screening of all eligible studies.

3.4. Quality Assessment

For each study included in the evaluation following the title, abstract, and full-text screening, methodological quality was assessed using a pre-developed and adapted evaluation tool (see Supplementary Table S2 in the Supplementary Materials). Given that this review includes quantitative, qualitative, and mixed-methods studies and that the research topics focus on built environment exposure, mental health and well-being outcomes, and the role of social participation, this study did not directly apply a single quality assessment tool. Instead, corresponding evaluation criteria were developed based on specific research designs. Specifically: (1) The evaluation criteria for quantitative studies primarily referenced the quantitative research quality assessment framework proposed by the Effective Public Health Practice Project [50,51]; (2) the evaluation dimensions for qualitative studies primarily drew on the core critical appraisal logic of the Critical Appraisal Skills Programme [52]; (3) the evaluation criteria for mixed-methods studies were revised based on the core dimensions of the Mixed Methods Appraisal Tool 2018 [53]. The methodological quality assessment was conducted after the eligibility screening and was used to assess the strength and robustness of the evidence rather than to automatically exclude studies. Only

studies classified as low methodological quality according to the predefined threshold were considered for exclusion from the main synthesis.

For quantitative studies, this study primarily evaluates the following seven aspects: (1) clarity of the research objective; (2) appropriateness of the sample; (3) reliability of built environment exposure indicators; (4) reliability of mental health and well-being outcome measures; (5) control of confounders; (6) appropriateness of statistical methods; (7) completeness of results reporting.

For qualitative studies, the evaluation primarily focuses on the following seven aspects: (1) clarity of the research question; (2) appropriateness of the sample and recruitment; (3) appropriateness of data collection; (4) transparency of analysis; (5) strength of evidence supporting the results; (6) credibility/consistency; and (7) discussion of limitations.

For mixed-methods studies, the evaluation focuses on the following five aspects: (1) Adequacy of the rationale for the mixed-methods design; (2) Effective integration of quantitative and qualitative components; (3) Adequacy of the interpretation of the integrated results; (4) Appropriate handling of discrepancies or inconsistencies between quantitative and qualitative results; (5) Compliance of each component with the quality standards of its respective methodological tradition.

To facilitate consistent recording and comparison across different study types, all methodological quality scores were converted to a 10-point scale. For quantitative studies, the seven criteria were converted to a 10-point scale by assigning two points to three methodologically central domains—sample size, reliability of mental health and well-being outcome measurement, and control for confounders—and one point to each of the remaining four domains, including clarity of research objective, selection bias, reliability of built-environment exposure indicators, and appropriateness of statistical methods. These three two-point domains were assigned greater weight because they directly influence statistical precision, outcome validity, and internal validity, respectively, whereas the remaining four domains were treated as essential but more binary indicators of reporting and methodological adequacy. Qualitative studies were assessed using ten binary criteria adapted from the CASP logic, with each criterion scored as 0 or 1 and a maximum score of 10 points. These ten criteria covered seven broader domains: clarity of the research question, sample and recruitment, data collection, transparency of analysis, evidentiary support, credibility/consistency, and discussion of limitations. Mixed-methods studies were assessed using five criteria scored from 0 to 2, with a maximum score of 10 points.

Although the item-level scoring formats differed by study design, all total scores were standardized to the same 10-point scale before assigning methodological quality levels. In the scoring system, 0 indicated that the criterion was not met or was clearly insufficient; 1 indicated basic or partial compliance, depending on the study-type-specific checklist; and 2, where applicable, indicated adequate compliance, meaning that the criterion was clearly reported, methodologically appropriate, and sufficient for answering the review question. Based on the standardized total score, studies were classified into three methodological quality levels: high quality, 8–10 points; moderate quality, 6–7 points; and low quality, ≤ 5 points.

Studies rated as high or moderate quality were eligible for inclusion in the main synthesis. Studies rated as low quality would not be used as primary evidence in the main synthesis and would be considered only in the sensitivity analysis. However, after methodological quality appraisal, no study included in the main synthesis was rated as low quality; therefore, no study was excluded solely on the basis of methodological quality. This finding should be interpreted cautiously, because the adapted appraisal framework used a relatively inclusive threshold and emphasized reporting completeness, measurement adequacy, and basic methodological appropriateness across different study designs.

Accordingly, the absence of low-quality studies should not be equated with a low risk of bias or strong causal evidence, particularly given the predominance of observational and cross-sectional studies. Methodological quality assessment was conducted after eligibility screening and was used to evaluate the robustness and interpretive strength of the evidence synthesis rather than as an initial eligibility criterion. Before the formal assessment, the two reviewers piloted the checklist on a subset of quantitative, qualitative, and mixed-methods studies to calibrate the interpretation of the scoring criteria. All studies were then independently assessed by two reviewers according to the study-type-specific quality assessment criteria presented in Supplementary Table S2, and the quality assessment results were used to inform the interpretation of evidence strength in the synthesis. The item-level scores, total scores, and methodological quality levels of all included studies are reported in Supplementary Table S5.

3.5. Data Extraction

We used a pre-designed data extraction form to systematically extract the following information from each included study: study number, title, first author, year of publication and journal/field of study, study design and methodological approach, study location and spatial context, sample characteristics, built environment categories, specific environmental indicators and their measurement methods, mental health and well-being outcomes and their measurement tools, social participation-related processes (e.g., mediating pathways, mechanisms of action, or related variables), mediating/moderating/control variables, analytical methods or models, key findings regarding the association between the built environment and mental health and well-being, item-level methodological quality scores, total quality score out of 10, and methodological quality level. Two reviewers independently conducted the data extraction and resolved any discrepancies through discussion.

3.6. Study Identification

Two reviewers independently conducted title/abstract screening, full-text eligibility assessment, methodological quality appraisal, and data extraction using the predefined inclusion criteria, quality assessment checklist, and data extraction form. Inter-reviewer agreement was evaluated before reconciliation by calculating the proportion of records or extracted items for which the two reviewers reached different initial judgments. The initial disagreement rate was below 2% for title/abstract and full-text eligibility decisions, below 2% for methodological quality ratings, and below 4% for extracted data items. All discrepancies were recorded during the screening and extraction process and were resolved through consultation and discussion between the two reviewers.

Figure 1 illustrates the literature search and screening process, which followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [54]. The initial search identified a total of 4333 records. After screening titles and abstracts, removing 54 duplicate records and 4115 irrelevant records, 164 articles were retained for full-text screening. Full-text screening determined that 60 articles met the criteria, while 104 did not. The excluded articles were either studies whose results and conclusions were not relevant to the impact of the built environment on older adults' mental health or studies where the population included the general public, but the results and conclusions did not explicitly address the older adult population. According to the predefined threshold, no study included in the main synthesis was classified as low methodological quality ($\leq 5/10$). Therefore, no study was excluded solely on the basis of methodological quality. However, to test the robustness of the synthesis, sensitivity analyses were conducted by excluding the lowest-scoring studies and by separately examining studies with non-exclusive older-adult samples.

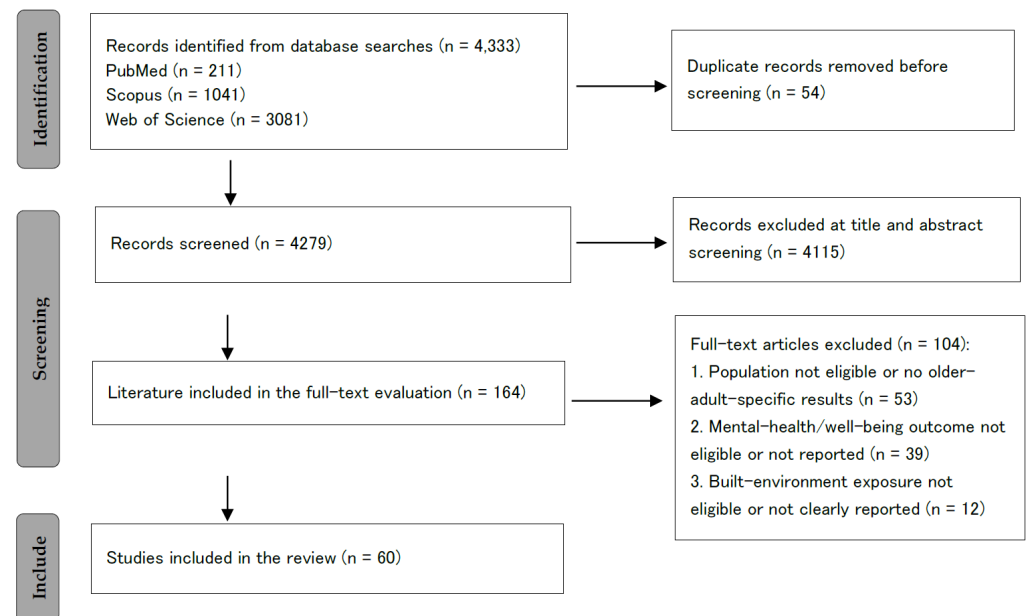


Figure 1. PRISMA flow diagram of study selection.

Studies with non-exclusive older-adult samples were not incorporated into the main synthesis. They were retained only as supplementary evidence and were examined separately in sensitivity analysis. These studies were used to assess whether evidence based on broader age boundaries changed the overall interpretation of the associations between the built environment and mental health and well-being. Conclusions specifically concerning older adults were based primarily on studies that included participants aged 60 years or older or reported distinct older-adult subgroup results. A total of 19 supplementary studies were identified. Among them, seven studies used samples consisting exclusively of older adults or samples with a clear older-adult focus, mostly aged 55, 57, or 60 years and above; nine studies used middle-aged and older-adult samples, with lower age thresholds generally ranging from 40 to 50 years; and three studies used general adult or broad age-range samples. These studies were not used as primary evidence for the core conclusions regarding older adults in the main synthesis. They were retained as supplementary evidence for two main reasons. First, some studies with broader age ranges explicitly reported relevant results for adults aged 60 years and above or older-adult subgroups, but their overall sampling frame or reporting structure was not fully consistent with the main inclusion criteria. Second, the built-environment exposures and mental health and well-being outcomes examined in these studies were directly relevant to the review question. Therefore, these studies were used only in the sensitivity analysis to examine whether evidence based on broader age boundaries changed the direction or interpretation of the main findings. The main synthesis and primary conclusions were based only on older-adult-specific studies or studies that provided sufficiently clear older-adult-specific results. The sample sources included community-dwelling older adults, urban residents, national cohorts, and populations from multiple cities.

3.7. Evidence Strength and Causal Inference Assessment

To clarify the level of causal inference supported by the included studies, this review further classified the strength of evidence according to study design and analytical approach. Because the included studies used heterogeneous exposure indicators, outcome measures, and statistical models, a formal pooled GRADE assessment was not conducted. Instead, an adapted evidence-level framework was used to distinguish experimental/intervention evidence, longitudinal evidence, cross-sectional evidence, and qualitative or mixed-methods

evidence. Experimental and intervention studies were considered to provide stronger causal support when they directly tested changes in environmental exposure or environmental intervention. Longitudinal studies were considered to provide moderate evidence because they could examine temporal ordering and cumulative exposure but remained subject to residual confounding. Cross-sectional studies were considered to provide low causal evidence because they primarily identified associations at a single time point. Qualitative and mixed-methods studies were used mainly to explain mechanisms, experiences, and contextual processes rather than to establish causal effects. These methods can support fine-grained environmental exposure measurement and variable-importance interpretation; however, their relevance to spatial mental-health research depends on data quality, model specification, spatial transferability, and whether model outputs can be linked to theoretically meaningful environmental processes.

Because the review question focused on associations, pathways, and contextual processes rather than on estimating a pooled effect size, different study designs were synthesized within a common conceptual framework of built environment, environmental perception, social participation, and mental health and well-being. Quantitative, longitudinal, and experimental studies were used mainly to identify association patterns and assess the strength of evidence, whereas qualitative and mixed-methods studies were used to interpret mechanisms, lived experiences, and contextual meanings. Therefore, different types of evidence were integrated narratively, while their causal implications were interpreted separately according to study design.

4. Results

4.1. General Characteristics and Evidentiary Profile of the Included Studies

This review included a total of 60 empirical studies published between 2015 and January 2026. These studies examined associations between the built environment and older adults' mental health and well-being outcomes, including depression, anxiety, psychological distress, stress, loneliness/social isolation, life satisfaction, subjective well-being, psychological well-being, and mental well-being.

The included studies covered multiple regions, including Asia, Europe, North America, South America, and Oceania. As shown in Figure 2, China contributed the largest number of studies ($n = 23$, 38.3%), followed by the United States ($n = 10$, 16.7%) and cross-national European studies ($n = 4$, 6.7%). Japan, the United Kingdom, and Canada each contributed three studies, while most other countries contributed one or two studies. Overall, the evidence base was concentrated mainly in China, North America, and Europe, with relatively limited research from other regions. Figure 3 presents the annual number of included studies and the cumulative growth trend from 2015 to 2026. The cumulative number of publications was fitted to the time sequence using a power function ($y = ax^b$), and the parameters were estimated through log-linear transformation and linear regression. The fitted model was $y = 1.6026x^{1.4597}$, with $R^2 = 0.9902$, indicating a continuously accelerating growth trend in publications in this field.

In terms of research design, the included studies were dominated by cross-sectional observational designs, which were useful for identifying broad association patterns but provided limited causal inference because exposure and outcome were usually measured at a single time point [55–58]. Some cross-sectional studies further introduced machine-learning and deep-learning-assisted methods. The XGBoost-SHAP approach was used to support prediction modeling and variable-importance interpretation [59], while fully convolutional network-based street-view image analysis improved street-level environmental exposure extraction [34]. These methods refined exposure measurement and interpretation but should not be understood as providing stronger causal evidence in themselves. Longi-

tudinal studies offered relatively stronger temporal evidence [44,60–63], while intervention and experimental studies provided stronger causal support by directly testing structured environmental exposure or environmental interventions [64–66]. Experience sampling and ecological momentary assessment studies captured short-term exposure–response associations [35,67], whereas qualitative and mixed-methods studies mainly contributed to explaining lived experience, behavioral pathways, environmental perception, and contextual mechanisms [36,68–72]. Therefore, the subsequent synthesis interpreted findings according to study design, exposure-measurement robustness, and outcome-measurement validity, as summarized in Table 2.

Table 2. Research Design Types and Evidentiary Roles.

Research Design Type	Specific Design Features	Evidentiary Role and Causal Inference Level	Representative Studies and Analytical Approaches
Cross-sectional studies	Based on community health surveys, questionnaires, public health surveys, spatial environmental data, or street-view image data, these studies examine the association between the built environment and older adults' mental health and well-being at a single time point.	Association evidence; low causal-inference strength. Machine-learning-assisted analyses improved exposure extraction but did not strengthen causal inference.	• [57]: binary logistic regression; • [34]: fully convolutional network (FCN) street-view image segmentation + multilevel regression analysis; • [55]: multiple regression analysis + robustness tests; • [58]: multivariable regression analysis; • [59]: XGBoost-SHAP; • [56]: structural equation modeling (SEM) + bootstrap test;
Longitudinal studies	Based on follow-up surveys, panel data, or repeated measurements, these studies examine temporal relationships between built-environment change, long-term environmental exposure, and older adults' mental health and well-being outcomes.	Relatively stronger temporal evidence; residual confounding and residential self-selection may remain.	• [61]: longitudinal multilevel regression model; • [60]: longitudinal multilevel regression model + moderation analysis; • [62]: outcome-wide longitudinal analysis + Bonferroni correction; • [63]: latent growth curve model (LGCM) + parallel-process latent growth curve model (PP-LGCM); • [44]: cross-sectional regression analysis + longitudinal regression analysis;

Table 2. *Cont.*

Research Design Type	Specific Design Features	Evidentiary Role and Causal Inference Level	Representative Studies and Analytical Approaches
Intervention or experimental studies	Through quasi-experiments, randomized trials, or experimental exposure designs, these studies directly test the effects of environmental interventions or short-term environmental exposure on mental-health-related outcomes among older adults.	Relatively stronger causal support through direct testing of environmental exposure or intervention.	• [64]: randomized experiment + pre-post comparison analysis; • [65]: randomized parallel-group trial + between-group comparison analysis; • [66]: three-stage green-space exposure experiment + repeated-measures analysis;
Experience sampling/ecological momentary assessment studies	Within daily-life or short-term time windows, these studies combine mobile data, momentary psychological-state records, or real-time environmental exposure data to capture dynamic relationships between environmental exposure and psychological responses.	Short-term temporal and contextual evidence on momentary exposure–response relationships.	• [35]: geographic ecological momentary assessment (GEMA) + multilevel regression model; • [67]: experience sampling method + multilevel regression model;
Mixed-methods and qualitative studies	These studies combine quantitative statistical analysis with qualitative data analysis, or use interviews, walking interviews, Photovoice, participant observation, and related qualitative methods to explain how the built environment influences older adults' mental health and well-being through process and experience.	Mechanism and contextual evidence; not used to independently establish causal effects.	• [36]: semi-structured in-depth interviews + walking interviews + framework analysis + NVivo 10 + constant comparison; • [68]: mobile EEG analysis + VAS self-report scale + video-elicitation interviews + inductive thematic analysis; • [72]: qualitative interviews + participant observation + thematic analysis; • [71]: Photovoice analysis + thematic analysis; • [69]: GLM Poisson regression analysis + NVivo 12 thematic analysis; • [70]: Natural Go-Along walking interviews + qualitative thematic analysis;

Source: Author statistics.

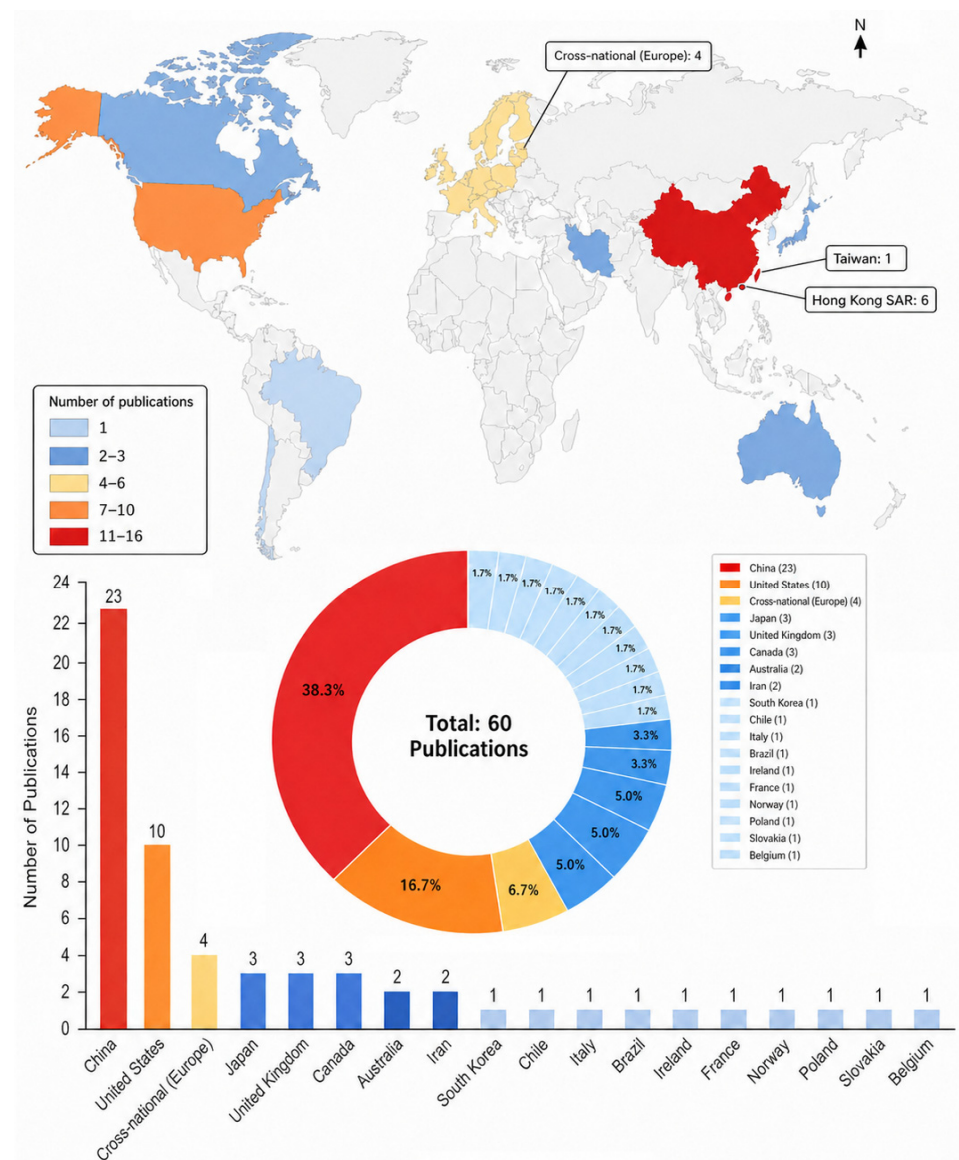


Figure 2. Geographic Distribution of Included Studies by Country and Region.

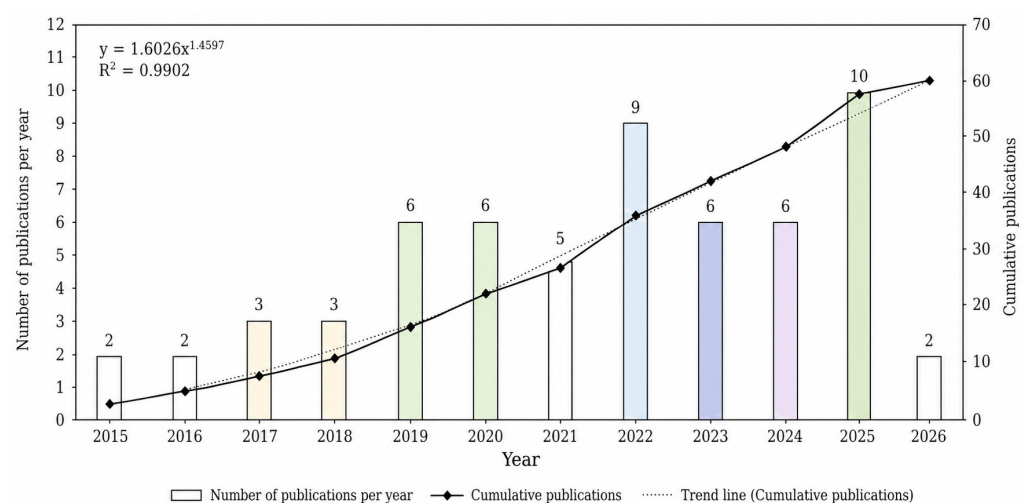


Figure 3. Annual Publication Trends and Cumulative Growth of Included Studies from 2015 to 2026.

In terms of environmental indicator types, the included studies encompassed both objective built-environment indicators and subjective perceived environmental indica-

tors. Objective indicators included GIS mapping or spatial analysis [73,74], remote sensing indicators [34,57,75], street-view image indicators [34,75], spatial audits or on-site built-environment assessments [37,56], road-network buffer measurements [55,76], and field-based environmental measurements [21,66,77]. These objective indicators provided relatively standardized and spatially explicit exposure measures, but their interpretive strength varied according to data source, spatial resolution, and measurement context, and they did not necessarily capture older adults' perceived accessibility, safety, comfort, or willingness to use nearby spaces.

Subjective perceived environmental indicators were mainly obtained through questionnaires or perception scales, including NEWS-A [78], the 53-item Age-Friendly City questionnaire and Community Perception Scale [79], perceived public open-space quality items [40], an adapted version of A-NEWS [80], and perceived neighborhood environment measures related to subjective well-being [47]. These indicators were more closely related to older adults' lived experience and environmental perception, but they were also more vulnerable to self-report bias and individual psychological conditions. Studies integrating objective and subjective indicators, such as the Dalian study [55] and the Taipei community park study [37], were therefore useful for comparing measured environmental exposure with perceived environmental experience. Accordingly, the findings were interpreted with attention to the spatial precision, perceptual relevance, and limitations of each measurement approach, as summarized in Table 3.

In addition to the environmental indicator types summarized in Table 3, machine-learning-assisted approaches were treated as analytical and exposure-interpretation methods rather than as separate environmental indicator categories. XGBoost-SHAP supported prediction modeling and variable-importance interpretation [59], while fully convolutional network-based street-view image segmentation refined street-level green and blue space exposure extraction [34]. These methods improved exposure extraction and interpretability, but they did not by themselves strengthen causal inference.

In terms of spatial scale, the included studies examined the built environment across multiple levels, including neighborhood, residential, street, park or blue-green space, and city or administrative-district scales. Community or neighborhood scale was the most common level of analysis, with spatial units including ZIP codes, census tracts, school districts, residential communities, and community buffer zones [55,56,61,82,83]. Other studies focused on residential environments [80,84], street or mobility-route environments [34,35,68], parks, public open spaces, and blue-green spaces [37,75,77,85,86], or broader city and administrative-district environments [38,57]. Overall, the reviewed literature examined the built environment across multiple spatial scales, ranging from housing units and streets to neighborhoods, parks, and cities (Table 4).

Based on the types of mental health and well-being outcomes, the included studies covered several outcome domains. Negative mental health outcomes included depression [34,83,84,87–91], anxiety [64,66,88,89], and stress or psychological distress [65–67,88,89]. Social and psychological experiences were mainly represented by loneliness and social isolation [69,71,92]. Positive mental health and well-being outcomes included life satisfaction [63], subjective well-being, psychological well-being, mental well-being, vitality, and health-related quality of life measures [40,58,63,67,70,74,78,81,86]. In addition, qualitative and momentary well-being studies described psychological experiences such as emotional recovery, sense of belonging, sense of integration, satisfaction, frustration, pleasure, stress, and momentary mood states [35,36,64–68,72,93]. Broader self-rated or general health measures were treated only as secondary or contextual health-related outcomes [73–75,78,80,82]. Overall, the reviewed studies covered a broad outcome spectrum, ranging from negative psychological symptoms to positive

well-being and social-psychological experiences (Table 5). Self-rated health and general health were treated as secondary health-related perceived outcomes rather than direct mental-health outcomes. Studies reporting these outcomes only were used for contextual interpretation of psychosocial pathways and were not counted as core mental-health evidence. Outcome evidence was interpreted with attention to whether studies used validated, outcome-specific mental health or well-being measures.

Table 3. Types of Environmental Indicators.

Types of Environmental Indicators	Specific Indicators/Measurement Methods	Representative Studies and Exposure Indicators
Objective Environmental Indicators	GIS Mapping/Spatial Analysis	[73]: Study of Older Adults in Flint, Michigan; [74]: BRFSS Green Space/Blue Space Study in Washington State.
	Remote Sensing Indicators	[75]: Guangzhou Blue Space Study, using NDWI, proportion of water area, and per capita water area; [34]: Beijing Study, comparing NDVI, NDWI, and GlobeLand30 land cover indices.
	Street View Image Indices	[34]: Extraction of green and blue spaces from street view images using Tencent Street View and fully convolutional neural networks; [75]: Joint analysis of street view images with remote sensing and questionnaire data.
	Spatial Audit/On-site Environmental Assessment	[37]: Study on the quality of community parks in Taipei, employing NGST auditing; [56]: Study in Hangzhou, conducting on-site built environment assessments.
	Network Buffer Zone Measurements	[76]: Hong Kong study, measuring environmental exposure within 200 m and 500 m road network buffers; [55]: Dalian study, measuring built environment indicators within 300 m and 500 m buffers.
Subjective Perceived Environmental Indicators	On-site Measurement Indicators	[77]: Tokyo SPUGS study, measuring PET and microclimate; [21]: U.S. walking pilot study, measuring air quality, noise, and HRV; [66]: Huangshan neighborhood green space winter exposure experiment, jointly measuring TCV, TSV, PET, and STAI/VAS.
	Questionnaires/Perception Items	[78]: Used the NEWS-A Neighborhood Environment Perception Scale; [79]: Used the 53-item AFC questionnaire and the Community Perception Scale; [40]: Used Perceived POS Quality items; [80]: Used an adapted version of A-NEWS to assess community environmental perception; [81]: Conducted a canonical correlation analysis based on perceived neighborhood environment and subjective well-being.
Objective and Subjective Integrated Indicators	Multi-source integrated measurements	[55]: Simultaneously incorporated objective built environment and perceived environmental attributes; [37]: Simultaneously incorporated park quality audits and individual environmental perceptions.

Source: Author statistics.

Table 4. Spatial scale classification and measurement index types in the study.

Types of Spatial Scales	Specific Spatial Units/Scales	Representative Studies and Exposure Indicators
Neighborhood Scale	Community, neighborhood, ZIP code, census tract, school district, residential community, community buffer zone	[82]: Defined neighborhood types using ZIP codes; [61]: Characterized neighborhood environmental changes using census tracts; [83]: Analyzed green space types using school districts as neighborhood units; [55]: Analyzed environmental exposure among the elderly in Dalian using residential communities; [56]: Analyzed environmental exposure among the elderly in Hangzhou using community buffer zones
Residential Environment Scale	External architectural features of housing, interior layout, household facilities, and perceived characteristics of the residential environment	[84]: Examined external architectural features, interior layout, and household facilities; [80]: Focused on perceived characteristics of the residential environment, such as the presence of grocery stores, pharmacies, banks, and nighttime safety
Street scale	Street scenery, walking routes, GPS trajectory exposure, and the microenvironment surrounding mobility paths	[34]: Measured green and blue spaces in the streetscape; [68]: Compared walking routes along busy streets with those through green spaces; [35]: Calculated urban landscape exposure within a 25 m radius based on GPS trajectories from the two hours preceding the questionnaire
Parks, public open spaces, or blue-green spaces	Small-scale urban green spaces, neighborhood parks, urban riverside green spaces, neighborhood blue spaces, urban blue spaces	[77]: Small-scale urban green spaces in Tokyo; [37]: Neighborhood parks in Taipei; [85]: Urban riverside green spaces in Mianyang; [75]: Neighborhood blue spaces in Guangzhou; [86]: Urban blue spaces in Hong Kong
City or administrative district scale	City level, administrative district level, urban livability domains, proportion of green space in administrative districts	[57]: Using the proportion of green space in administrative districts as an exposure; [38]: Measuring urban-level environmental conditions using five domains of urban livability

Source: Author statistics.

As shown in Tables 6 and 7, built-environment factors were categorized into several subcategories, and their associations with older adults' mental health and well-being outcomes were coded as favorable (+), unfavorable (−), null (N), or mixed/ambiguous (A). These symbols indicate the direction and desirability of the association from the perspective of mental health and well-being, rather than the mathematical sign of the environmental coefficient.

Based on the synthesis of the included studies, built-environment factors were grouped into six major categories: green/blue environments, public open spaces, streetscapes, neighborhood environments, adverse environmental exposures, and community types, with detailed subcategories summarized in the evidence matrices. These categories were examined in relation to key mental health and well-being outcomes, including depression, anxiety, stress, psychological distress, loneliness, social isolation, life satisfaction, subjective well-being, and psychological well-being. The following sections provide an evidence-weighted synthesis of these associations, with findings interpreted according to study design, exposure-measurement robustness, outcome specificity, and spatial context.

Table 5. Classification of mental health and well-being outcome types and representative measures.

Outcome Type	Outcome Domain	Specific Outcome Variables	Representative Studies and Measurement Instruments
Negative mental health outcomes	Depression	Depression; depressive symptoms; depression risk; major depression	[87]: GDS-30; [88,89]: CESD-11; [90]: PHQ-9; [34]: GDS-15; [91]: CES-D.
	Anxiety	Anxiety; anxiety symptoms; anxiety level	[86,88,89]: HADS-A; [64]: cognitive, arousal, and somatic anxiety measures; [66]: anxiety outcome.
	Stress/psychological distress	Stress; perceived stress; chronic stress; psychological distress; mental distress	[86,89,90]: PSS-4; [74]: K6 and HRQOL-4; [65]: hair cortisol and emotional health indicators; [67]: stress, pleasure, and momentary well-being measures.
Social and psychological experiences	Loneliness/social isolation	Loneliness; social isolation; related socio-psychological experiences	[92]: loneliness and major depression; [86]: depression, anxiety, and loneliness; [66]: feelings of loneliness.
Positive mental health/well-being outcomes	Life satisfaction	Life satisfaction; satisfaction with life; functional ability-related life satisfaction	[63]: life satisfaction and functional ability.
	Subjective/psychological/mental well-being	Subjective well-being; psychological well-being; mental well-being; emotional, social, and psychological well-being; vitality; mental component of health-related quality of life	[81]: subjective well-being; [59]: WHO-5 mental well-being; [86]: quality of life, vitality, loneliness, and psychological distress; [40]: emotional, social, and psychological well-being; [78]: SF-36 mental-health-related dimensions.
Psychological well-being experiences	Qualitative and momentary well-being experiences	Emotional recovery; sense of belonging; sense of integration; satisfaction; frustration; pleasurable experiences; momentary mood states	[22]: walk-along and photo-elicitation interviews; [36]: qualitative interviews on perceived physical, psychological, and social well-being; [68]: mobile EEG, self-report measures, and video-elicitation interviews; [72]: natural Go-Along walking interviews; [67]: experience sampling measures of stress, pleasure, and momentary well-being. [93]: qualitative evidence on older adults, perceptions of small urban green spaces
Secondary/contextual health-related outcomes	Self-rated/general health	Self-rated health; general health; perceived health	[73–75,79]: self-rated health measures; [80]: single-item poor self-rated health measure; [78,82]: broader health-related perceived outcome measures.

Source: Author statistics.

Table 6. Associations between Comprehensive Built Environment Factors and Mental Health in Older Adults, and the Number of Studies Involved.

Built Environment Category	Subcategory	Depression				Anxiety/Stress/Psychological Distress				Loneliness/Social Isolation			
		+	N	–	A	+	N	–	A	+	N	–	A
Green and Blue Environments	Residential Greenness and Neighborhood Green Spaces	4	1		2	3			1				
	Blue Space Exposed	1			1	1			1				
Public Open Spaces	Park Quality and Social Interaction Spaces	2			1	1				1			
	Internal Park Types and Microenvironmental Characteristics	1		1	1	1							
Street Scenery	Street View Green-Blue and Movement Path Exposure	2				1			1				
Neighborhood Environment	Walkability, Accessibility, and Transportation	1				1			1	1			
	Accessibility of Neighborhood Facilities and Services	4			1								
	Housing and Living Conditions	3											
	Environmental Quality and Perceived Characteristics	1			1				1	1			
Exposure to Adverse Environments	Roads, pollution, urbanization, and non-vegetated areas		1	3	1		1	1					
Community Type	Age-Friendly Environments and Livable Community Types	1											

Note: “+” indicates a favorable association from the perspective of each specific negative mental-health outcome, meaning that a built-environment factor was associated with lower symptom levels or lower risk. “–” indicates an unfavorable association, meaning higher symptom levels or higher risk. “N” indicates no statistically significant or no clear association, and “A” indicates mixed, nonlinear, inconsistent, or context-dependent findings. The numbers refer to study–environment–outcome association entries rather than the number of unique studies. A single study may be counted in more than one cell when it examined multiple built-environment factors or multiple outcome domains. The symbols were interpreted within each specific outcome column and were not used to aggregate heterogeneous outcomes into a single generalized mental-health score. Anxiety, stress, and psychological distress were grouped in the matrix because several studies reported these outcomes together or because outcome-specific entries were limited; however, they were interpreted separately in the narrative synthesis where possible.

Table 7. Associations between Comprehensive Built Environment Factors and Older Adults’ Mental Health, and the Number of Studies Involved.

Built Environment Category	Subcategory	Life Satisfaction				Subjective Well-Being/Psychological Well-Being			
		+	N	–	A	+	N	–	A
Green and Blue Environments	Residential Greenness and Neighborhood Green Spaces	1				3			1
	Exposure to Blue Spaces					3			1
Public Open Spaces	Park Quality and Social Interaction Spaces					4			
	Park Subtypes and Microenvironmental Characteristics					2			
Street Scenery	Street-Scape Greenery and Blue Spaces and Exposure to Mobility Routes					1			1
Neighborhood Environment	Walkability, Accessibility, and Transportation	1				1			1
	Accessibility of Neighborhood Facilities and Services	1				1			
	Housing and Living Conditions	1							
	Environmental Quality and Perceived Characteristics					4			1
Exposure to Adverse Environments	Roads, Pollution, Urbanization, and Non-vegetated Spaces								
Community Types	Age-Friendly Environments and Livable Community Types	1				2			

Note: “+” indicates a favorable association from the perspective of each specific positive well-being outcome, meaning that a built-environment factor was associated with higher outcome levels. “–” indicates an unfavorable association, meaning lower outcome levels. “N” indicates no statistically significant or no clear association, and “A” indicates mixed, nonlinear, inconsistent, or context-dependent findings. The numbers refer to study–environment–outcome association entries rather than the number of unique studies. A single study may be counted in more than one cell when it examined multiple built-environment factors or multiple outcome domains. The symbols were interpreted within each specific outcome column and were not used to aggregate heterogeneous outcomes into a single generalized mental-health score. Self-rated health and general health were not included as core mental-health or well-being outcomes in this matrix; they were treated as secondary/contextual health-related outcomes and summarized separately in Table 5 and Section 4.2.6.

4.2. Associations Between Built Environment Factors and Older Adults’ Mental Health

4.2.1. Built Environment Factors Associated with Depression Among Older Adults

Sections 4.2.1–4.2.5 focus on the primary evidence, while supplementary evidence is analyzed separately in Section 4.2.6. Existing research indicates that the associations between the built environment and depression among older adults are primarily reflected

in factors such as green space exposure, green space types, neighborhood facilities, and housing and living conditions. A study of older adults in Shanghai communities found that higher residential green space levels were associated with lower levels of depressive symptoms among older adults [87]. Research in Japan further indicates that higher tree cover in urban areas is associated with a lower risk of depression, while moderate grass coverage in rural areas is associated with a lower risk of depression [83]. A study of an elderly sample in Beijing showed that exposure to green and blue spaces at the street level was associated with lower GDS-15 scores [34].

Regarding neighborhood facilities and housing conditions, a Chinese cross-sectional study indicated that a dust-free environment, nearby green spaces, accessibility to barrier-free facilities, and proximity to hospitals are all associated with depressive symptoms in older adults [90]. Compared with other mental health outcomes, depression showed the most consistent association with built environment factors. The evidence was particularly concentrated in green/blue space exposure, residential environment quality, neighborhood facilities, and housing and living conditions.

4.2.2. Built Environment Factors Associated with Anxiety, Stress, and Psychological Distress Among Older Adults

Compared to depression, research on anxiety, stress, and psychological distress has focused more on green spaces, blue spaces, and restorative nature exposure. A study of a Polish sample aged 65 and older showed that direct exposure to green and blue spaces was associated with significantly lower stress levels and higher levels of well-being [67]. A quasi-experimental study in Iranian long-term care facilities found that a green garden intervention significantly reduced cognitive, arousal, and somatic anxiety among older adults [64]. A randomized controlled trial further demonstrated that one month of continuous forest walks reduced hair cortisol levels and improved emotional well-being among older adults [65]. In contrast to depression, evidence for anxiety, stress, and psychological distress was less consistent and more dependent on specific exposure contexts. Studies in this group more often emphasized restorative environmental exposure and short-term nature contact.

4.2.3. Built-Environment Factors Associated with Loneliness and Social Isolation Among Older Adults

Although research on loneliness and social isolation is relatively scarce, existing evidence suggests that neighborhood accessibility, walkability, and access to activity spaces are key factors. A European study of older adults found that low perceived accessibility of the built environment was associated with higher levels of loneliness, and low walkability was also linked to higher loneliness, with this association being more pronounced among those experiencing depressive symptoms [92]. Furthermore, a qualitative study by [36] also indicated that green spaces and blue spaces not only provide older adults with opportunities for planned or spontaneous interactions with family, friends, and neighbors but also help alleviate concerns about loneliness and isolation among older adults living alone. Evidence for loneliness and social isolation was more limited than that for depression and was less directly linked to physical exposure itself. Instead, these outcomes were more often explained through accessibility, walkability, public space use, and opportunities for social connection.

4.2.4. Built-Environment Factors Associated with Older Adults' Life Satisfaction

Evidence on life satisfaction was relatively limited in the primary older-adult-specific evidence base. One longitudinal study from Japan examined life satisfaction as part of a broader outcome-wide assessment of neighborhood walkability and older adults' health

and well-being. The study suggested that associations between walkability and well-being outcomes differed across urban and rural contexts [62].

4.2.5. Built-Environment Factors Associated with Older Adults' Subjective Well-Being and Psychological Well-Being

Regarding positive psychological outcomes, evidence primarily focuses on the quality of public open spaces, exposure to blue-green spaces, environmental perception, and conditions supporting social interaction. A study in Hong Kong indicates that natural elements, diverse facilities, and spaces for social interaction in public open spaces can enhance older adults' emotional, social, and psychological well-being through neighborhood social cohesion and place attachment [40]. A study of an elderly migrant sample indicates that higher perceived neighborhood environmental quality, walkability, and social cohesion are associated with greater subjective well-being among older adults [81]. A study of an elderly sample in Dalian shows that built environment factors—such as the concentration of daily service facilities, recreational and landscape amenities, and elevators—can influence the psychological well-being of older adults through perceived environmental attributes [55]. A qualitative interview study further noted that green spaces (such as parks, gardens, and street greenery) and blue spaces (such as lakes and oceans) may jointly shape older adults' physical, psychological, and social well-being [36]. A study of a sample of Poles aged 65 and older further demonstrated that direct exposure to green and blue spaces is associated with higher levels of pleasure [67].

To move beyond a descriptive synthesis, Tables 6–8 were interpreted together with the narrative findings in Sections 4.2.1–4.2.5 as cross-tabulated evidence matrices linking built environment categories with specific mental health and well-being outcomes. Because the included studies varied substantially in study design, exposure indicators, outcome measures, and statistical models, effect sizes were not directly pooled or compared across all studies. Instead, the synthesis compared the direction, consistency, and outcome specificity of the reported associations. Overall, depression-related outcomes showed the most consistent pattern of association with built environment factors, particularly residential greenness, neighborhood green space, blue space exposure, neighborhood facilities, and housing and living conditions. Evidence for anxiety, stress, and psychological distress was more limited and more dependent on restorative green/blue spaces and short-term nature exposure. Evidence for life satisfaction was relatively limited in the primary evidence base, while subjective well-being and psychological well-being were more closely linked to perceived environmental quality, public open space quality, blue–green space exposure, and social interaction spaces than to a single environmental exposure. This pattern suggests that different mental health dimensions may be related to different environmental mechanisms: depression appears more closely related to cumulative residential and neighborhood exposure, anxiety and stress to restorative or stressful environmental experiences, and loneliness or well-being outcomes to accessibility, public space use, social participation, and perceived environmental quality. Overall, the built environment factors associated with older adults' mental health can be summarized into seven primary categories, as shown in Figure 4.

4.2.6. Supplementary Evidence and Sensitivity Analysis

Supplementary evidence was analyzed separately from the main synthesis. Studies with non-exclusive older-adult samples, broader age boundaries, or broader perceived health outcomes were used only to examine whether expanding the evidence boundaries altered the interpretation of the main findings. They were not treated as the primary basis for conclusions specifically concerning older adults, nor were they used to increase the evidentiary weight of the main synthesis.

Overall, the sensitivity analysis showed that, after excluding supplementary evidence, the main interpretations in Sections 4.2.1–4.2.5 did not substantially change. For depression-related outcomes, the supplementary evidence was generally consistent with the main synthesis. Studies with broader age boundaries showed that green space, residential environmental conditions, neighborhood conditions, and adverse environmental exposure were associated with depressive symptoms. Grassy areas within parks were associated with fewer depressive symptoms, whereas non-vegetated areas were associated with more depressive symptoms among U.S. adults aged 50 years and above [94]. Residential proximity to green spaces, accessibility to barrier-free facilities, access to medical services, and other residential environmental conditions were associated with depressive symptom risk among Chinese middle-aged and older adults [84]. In the United States, greater proximity to major roads and higher urbanicity were associated with more severe depressive symptoms in a sample aged 57–85 years [89]. Similarly, a multiethnic New York study found that adverse neighborhood changes were associated with higher CES-D scores among adults aged 45–84 years [61]. Increased residential green space was also associated with lower levels of depressive symptoms in an urban Canadian sample aged 45–86 years [95]. Housing quality and community living conditions in livable cities were also associated with lower levels of depressive symptoms in an elderly sample in China [38]. However, not all supplementary evidence was consistent. One study found no clear association between distance to green space or the amount of green space within residential buffers and depressed affect [96]. Another study showed that the associations of air pollution and NDVI with depressive symptoms differed across cohorts and age groups [97].

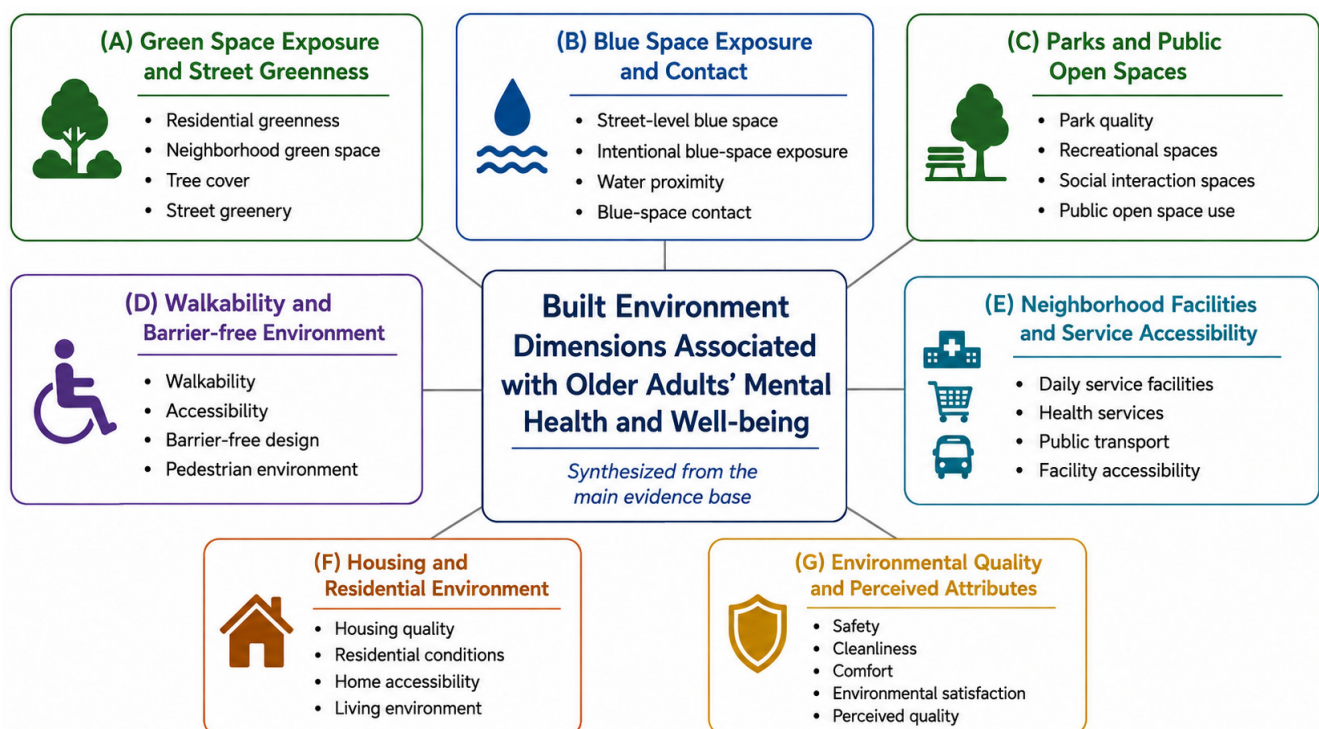


Figure 4. Seven Built Environment Dimensions Related to Older Adults' Mental Health. (Note: This figure was prepared by the authors with the assistance of AI-based visualization tools. The conceptual structure, evidence categories, and final content were developed and verified by the authors).

For anxiety and stress, the supplementary evidence was generally consistent with the main synthesis. A longitudinal study of a U.S. sample aged 57–85 years found that higher neighborhood greenness was associated with lower self-reported stress and, in some subgroups, with lower anxiety symptoms [88]. Another U.S. study of adults aged

57–85 years indicated that roadway proximity was associated with higher anxiety symptoms, although this association became non-significant after adjustment for traffic- and noise-related factors [89]. Evidence from supplementary studies on psychological distress, loneliness, and social isolation remained relatively limited.

For life satisfaction, the supplementary evidence was broadly consistent with the main synthesis. A study based on an urban Chinese sample aged 50 years and above found that age-friendly neighborhood environments may influence life satisfaction by supporting functional abilities. Housing conditions were associated with baseline life satisfaction. Communication and information environments appeared to play a more important role in newly developed communities, while transportation and health service conditions appeared to be more important in older communities [63]. However, a European multi-city study did not find that older adults benefited more from neighborhood green space than other population groups. This finding suggests that age, education, employment status, and urban context may moderate the relationship between green space and health-related outcomes [98].

For subjective well-being and psychological well-being, supplementary evidence also emphasized the role of public spaces and park environments. A study of women aged 55–75 years in Beijing found that social interaction in public spaces was significantly associated with well-being [99]. Another park-based study of adults aged 55 years and above in Taiwan showed that park accessibility, facility quality, and the management of uncivilized behavior influenced the relationship between environmental perception, recreational activities, and well-being [37]. These findings suggest that public space quality may shape psychological experiences by providing opportunities for social interaction.

Regarding social participation as a behavioral pathway linking the environment to mental health, the supplementary evidence was generally consistent with the main synthesis. It mainly supported explanatory pathways related to social connection [69], social inclusion, and belonging [70,71], but did not provide new evidence sufficient to change the main synthesis. Parks and natural environments helped maintain social connections and alleviate loneliness, further supporting the social-connection pathway [69]. As secondary contextual evidence, the Hong Kong age-friendly city study showed that perceived physical and social environments were associated with self-rated health through sense of community. The perceived physical environment showed both direct and indirect associations with self-rated health, whereas the perceived social environment mainly operated through sense of community [79]. However, because self-rated health is a broad perceived health indicator rather than a direct mental-health outcome, this finding was used only to illustrate a psychosocial pathway linking the built environment, sense of community, and perceived health. It was not used as primary evidence for conclusions concerning older adults' mental health. Overall, the supplementary evidence strengthened the explanatory role of the social participation pathway, but it did not indicate that social participation is a necessary mediator in all built environment–mental health relationships.

Taking together, the sensitivity analysis showed that the main conclusions of this review did not substantially change after excluding supplementary evidence. The association between built environment factors and depression-related outcomes remained the most stable. In contrast, after excluding studies with broader age boundaries, the evidence base for anxiety, stress, psychological distress, loneliness, life satisfaction, and subjective well-being became relatively smaller. Therefore, supplementary evidence was used mainly to examine the stability and boundary conditions of the main synthesis, rather than to replace conclusions based on older-adult-specific samples or studies reporting distinct older-adult subgroup results.

4.3. Social Participation as a Behavioral Pathway Linking the Built Environment to Older Adults' Mental Health

Social participation was synthesized as a behavioral pathway linking the built environment and older adults' mental health and well-being rather than as a uniform mediator. According to the included studies, social participation-related variables were operationalized in different ways, including public space use and social interaction, sense of community and belonging, perceived social support, and loneliness reduction. Because the studies used different outcome measures, mediation models, and reporting formats, the proportion of the total effect mediated by social participation could not be consistently calculated across studies. Therefore, this review synthesized mediation patterns according to whether direct effects, indirect effects, or both were reported. Table 8 summarizes the corresponding studies' social participation pathway types and mediation models.

Table 8. Social participation-related pathways and mediation patterns.

Study	Built Environment Factor	Participation-Related Variable	Outcome	Mediation Pattern
[56]	Public restrooms, public dining halls, indoor activity spaces	Social interaction	Mental health	Mainly indirect/closer to full mediation
	Elderly care facilities	Social interaction	Mental health	Competitive mediation
	Outdoor fitness spaces	Social interaction	Mental health	Direct effect retained; not full mediation
[100]	Green space use	Perceived social support	Geriatric depression	Full mediation
[89]	Road distance, urbanization	Loneliness, social support	Depression	Partial mediation

Source: Author statistics.

Overall, the evidence suggests that social participation is an important but not universal pathway between the built environment and mental health. First, studies focusing on public space use and social interaction indicate that social interaction can help explain the associations between some neighborhood facilities and mental health. In the Hangzhou study, public restrooms, public dining halls, and indoor activity spaces were linked to older adults' mental health mainly through social interaction, whereas outdoor fitness spaces retained a significant direct effect. This suggests that social interaction may be closer to a full mediating pathway for some service and activity facilities, but not for all environmental factors [56].

Second, studies focusing on social support and loneliness indicate that these variables may mediate the relationship between environmental exposure and depressive symptoms. In a South Italian older-adult sample, the direct association between green space use and geriatric depression was not significant after perceived social support was included, whereas the indirect pathway through perceived social support was significant; this pattern is consistent with full mediation [100]. In the U.S. study, road distance and urbanization retained direct associations with depression while also showing indirect pathways through loneliness and social support, indicating partial mediation rather than full mediation [89].

Taken together, social participation-related pathways can be summarized into three types: public space use and social interaction, sense of community and belonging, and social support or loneliness reduction. The evidence does not indicate that social participation is a necessary mediator in all built environment–mental health relationships. Instead, its mediating role appears to be strongest when environmental factors directly shape op-

portunities for interaction, community belonging, or social support. Where environmental factors operate through restorative exposure, traffic-related stress, or physical accessibility, direct effects may remain important. Thus, social participation should be understood as one important behavioral pathway, rather than the sole mechanism linking the built environment to older adults' mental health and well-being. Based on these findings, Figure 5 presents an integrated framework showing how the built environment may be linked to older adults' mental health through social participation pathways, including outings and space use, social interaction and community participation, and a sense of community, social support, and belonging.

Conceptual Framework Linking the Built Environment, Social Participation, and Older Adults' Mental Health and Well-being

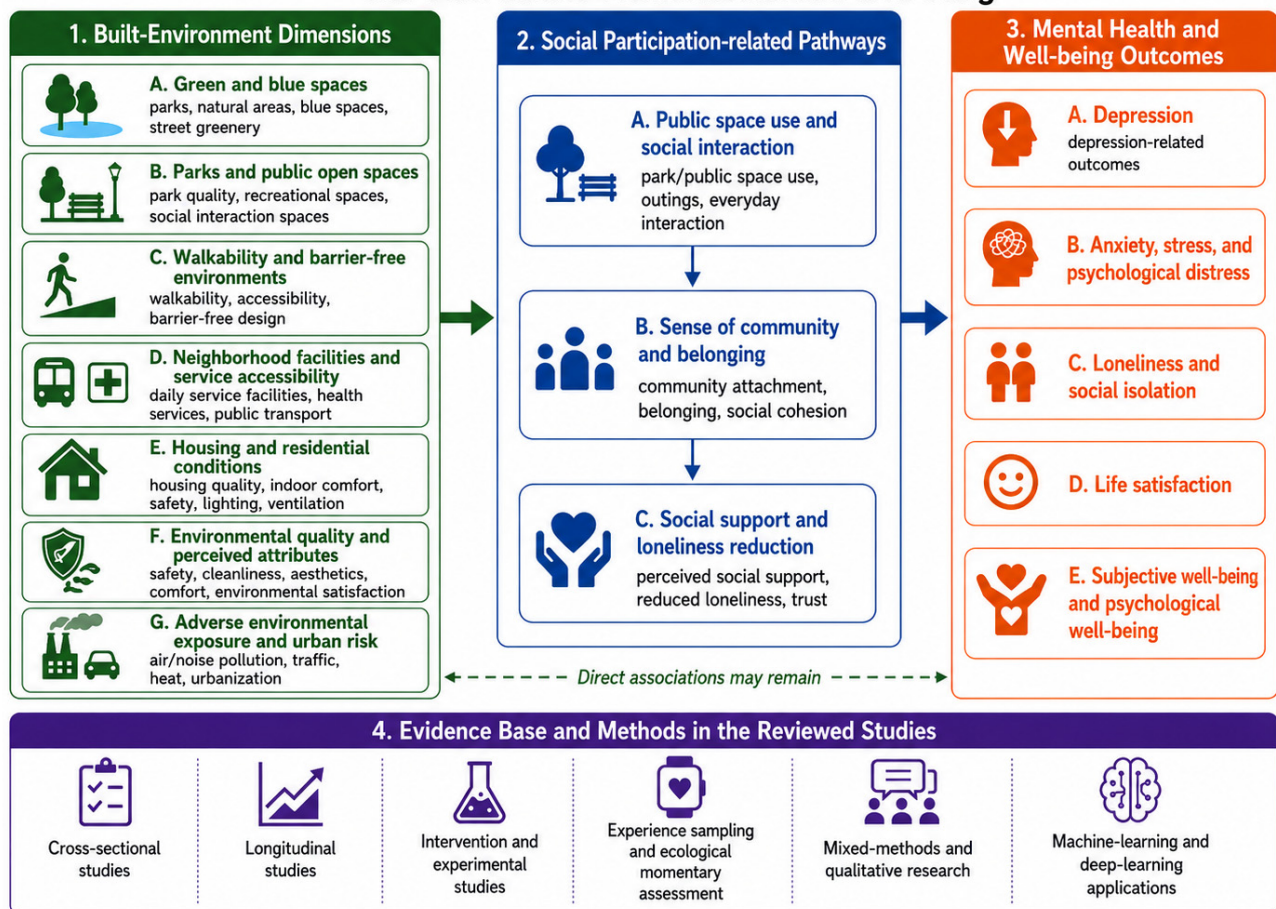


Figure 5. Integrated Framework of Pathways Linking the Built Environment to Older Adults' Mental Health and Well-being (Note: This figure summarizes the conceptual relationships identified from the included studies. It presents evidence-informed pathways rather than causal effects. The framework was derived from the narrative synthesis, association matrices, and social participation pathway analysis. This figure was prepared by the authors with the assistance of AI-based visualization tools. The conceptual structure, evidence categories, and final content were developed and verified by the authors). Source: Authors' synthesis based on the 60 studies included in the main synthesis.

4.4. Heterogeneity Across Different Spatial Contexts, Indicator Types, and Research Methods

Heterogeneity in the reviewed evidence was interpreted across three dimensions: spatial context, environmental indicator type, and research design. Because these dimensions shaped the direction, statistical significance, and evidentiary weight of the reported associations, findings from different spatial scales, exposure measurements, and study designs were not treated as equivalent evidence. Instead, they were interpreted accord-

ing to their relevance to older-adult-specific populations, outcome-measurement validity, exposure-measurement robustness, and causal-inference strength.

In terms of spatial contexts, research findings in neighborhood settings generally present more supportive evidence. A study in Hangzhou indicates that neighborhood facilities such as barrier-free access, public restrooms, community kitchens, elderly care services, and activity spaces are associated with older adults' mental health [56]. Contextual evidence from Hong Kong suggested that age-friendly neighborhood environments may be linked to sense of community and self-rated health [79]. Supplementary evidence from urban China further indicated that age-friendly neighborhood environments may be associated with functional ability and life satisfaction, and that these associations varied by community development period [63]. However, because self-rated health is not a direct mental-health outcome and the life-satisfaction evidence was based on a broader age boundary, these studies were interpreted as contextual or supplementary support rather than as core mental-health evidence. Longitudinal studies in Japan also indicate that neighborhood walkability is associated with subsequent health and well-being outcomes [62]. This suggests that, within neighborhood spaces, the relationship between the built environment and older adults' mental health is generally characterized by supportive findings.

In contrast, while research on public open spaces and parks generally yields supportive findings, it places greater emphasis on differences in spatial composition, and some indicators show opposite results. A study of public open spaces in Hong Kong indicates that natural elements, diverse facilities, and spaces for social interaction are associated with older adults' well-being [40]. A study of older women in Beijing indicates that social interaction in public spaces is significantly associated with their well-being [99]. However, a study of parks in the United States found that grassy areas within parks were associated with fewer depressive symptoms, whereas non-vegetated areas were associated with more depressive symptoms [94]. Thus, research in public open spaces and park settings suggests that different internal spatial types may yield supportive or opposite results, respectively.

These differences are even more pronounced in urban and rural contexts. A Japanese longitudinal study showed that higher walkability in urban areas is primarily associated with increased walking, whereas in rural areas, it is associated with both increased outings and participation in interest/exercise groups but also with a higher risk of functional limitations, more sedentary behavior, and lower levels of reciprocity norms [62]. Another Japanese study further indicates that different types of green spaces play distinct roles in urban and rural settings: higher tree coverage in urban areas is associated with a lower risk of depression, whereas in rural areas, moderate amounts of grassland are associated with a lower risk of depression [83]. This suggests that in urban and rural contexts, the same indicator may yield mixed results—that is, it may produce supportive outcomes while also being accompanied by some adverse effects.

In the context of community types, these differences further manifest as variations in the combinations of various environmental conditions. Research on livable communities in the United States indicates that differences in the combinations of the built environment, social environment, and service environment across different community types lead to varying self-reported health outcomes among older adults, with these differences being more pronounced among older adults with functional limitations [82]. This suggests that research on community types generally supports the conclusion that “environmental combinations influence mental health.” Overall, the reviewed evidence suggests that heterogeneity is not limited to spatial contexts, indicator types, or research methods, but also reflects differences in how older adults access, perceive, and use age-friendly built-environment factors. Evidence on older adults with disabilities or functional limitations indicates that accessibility, entrance design, barrier-free facilities, pedestrian safety, and

service accessibility may be particularly relevant to outdoor activity, social participation, and health-related outcomes. Evidence on gender and socioeconomic status remains more limited, although existing studies suggest that public-space interaction and positive emotional experiences in green spaces, blue spaces, historic environments, and public open spaces may vary across older-adult groups. Together with urban–rural differences, these findings indicate that subgroup differences in access, perception, and use remain an important but insufficiently developed dimension of the current literature.

Regarding indicator types, there are also differences in the results obtained from objective and subjective indicators. A study in Dalian indicates that objective built environment characteristics are associated with older adults' psychological well-being, but this relationship is mediated by perceived environmental attributes [55]. Another study in Dalian further revealed that the strength of the association between different methods of measuring green space and mental health varies. NDVI, vegetation cover, park cover, and street-level grass areas were all associated with mental health, but the strength of the mediating effects of perceived noise, aesthetics, and satisfaction with recreational opportunities was inconsistent across these measures [101]. A Beijing study also indicated that street-level green space and blue space indicators were associated with depressive symptoms, whereas some satellite-based indicators did not show significant associations [34]. Therefore, differences in indicator types primarily manifest as follows: objective exposure and subjective perception are not interchangeable, and different measurement methods may yield results that vary in strength or even in statistical significance.

In terms of research methods, evidence from cross-sectional, longitudinal, and intervention studies was not entirely consistent in inferential strength. Most cross-sectional studies support an association between the built environment and older adults' mental health, but they primarily reveal correlational patterns, with relatively limited causal explanations [40,55,88]. Longitudinal studies provided stronger temporal information by examining whether environmental exposure was associated with later mental-health or well-being outcomes, although residual confounding and residential self-selection could not be fully ruled out [60,62,63]. Some supplementary studies also provided contextual evidence on life satisfaction [63], residential green space [95], and housing quality or community life in livable cities [38]. Intervention and experimental studies provide stronger causal support for some of these relationships; for example, green garden interventions were associated with reduced anxiety in older adults, and forest walks were associated with reduced chronic stress and improved emotional health [64,65]. In other words, in terms of research methodology, the existing evidence is generally supportive; however, cross-sectional studies primarily address “whether an association exists,” longitudinal studies primarily address “whether there is a temporal association,” while intervention studies are better positioned to examine whether structured environmental exposure or environmental intervention may contribute to improved mental health.

From a causal inference perspective, the strongest evidence came from intervention and experimental studies, which directly tested whether short-term or structured exposure to green environments could improve anxiety, stress, or emotional well-being. Longitudinal studies provided moderate evidence by showing temporal associations between environmental exposure and later mental health and well-being outcomes, although residual confounding and residential self-selection could not be fully eliminated. Cross-sectional studies formed the largest part of the evidence base and were useful for identifying associations across different environmental categories, but their causal interpretation remained limited. Machine-learning and deep-learning studies improved exposure measurement and variable-importance interpretation but did not establish causal relationships by themselves. Therefore, the conclusions of this review should be interpreted as evidence of associations

with varying degrees of causal support rather than as uniformly causal effects. Table 9 summarizes the evidence strength of the included studies by study design and causal inference level.

Taken together, these findings suggest that research on the built environment and older adults' mental health can be organized into an integrated framework consisting of built-environment dimensions, mental health and well-being outcomes and pathways, research methods and measurement approaches, and future research directions. Existing studies have expanded from conventional built-environment factors, such as green and blue spaces, walkability, neighborhood facilities, housing conditions, and public open spaces, to objective environmental measurement, subjective environmental perception, multi-source data integration, and machine-learning-assisted analysis. Methods such as XGBoost-SHAP and FCN-8s illustrate emerging efforts toward more refined exposure measurement and variable-importance interpretation. Figure 6 summarizes the overall research structure, current methodological applications, and future research directions, rather than presenting a new statistical result.

Conceptual Synthesis of Research on the Built Environment and Older Adults' Mental Health

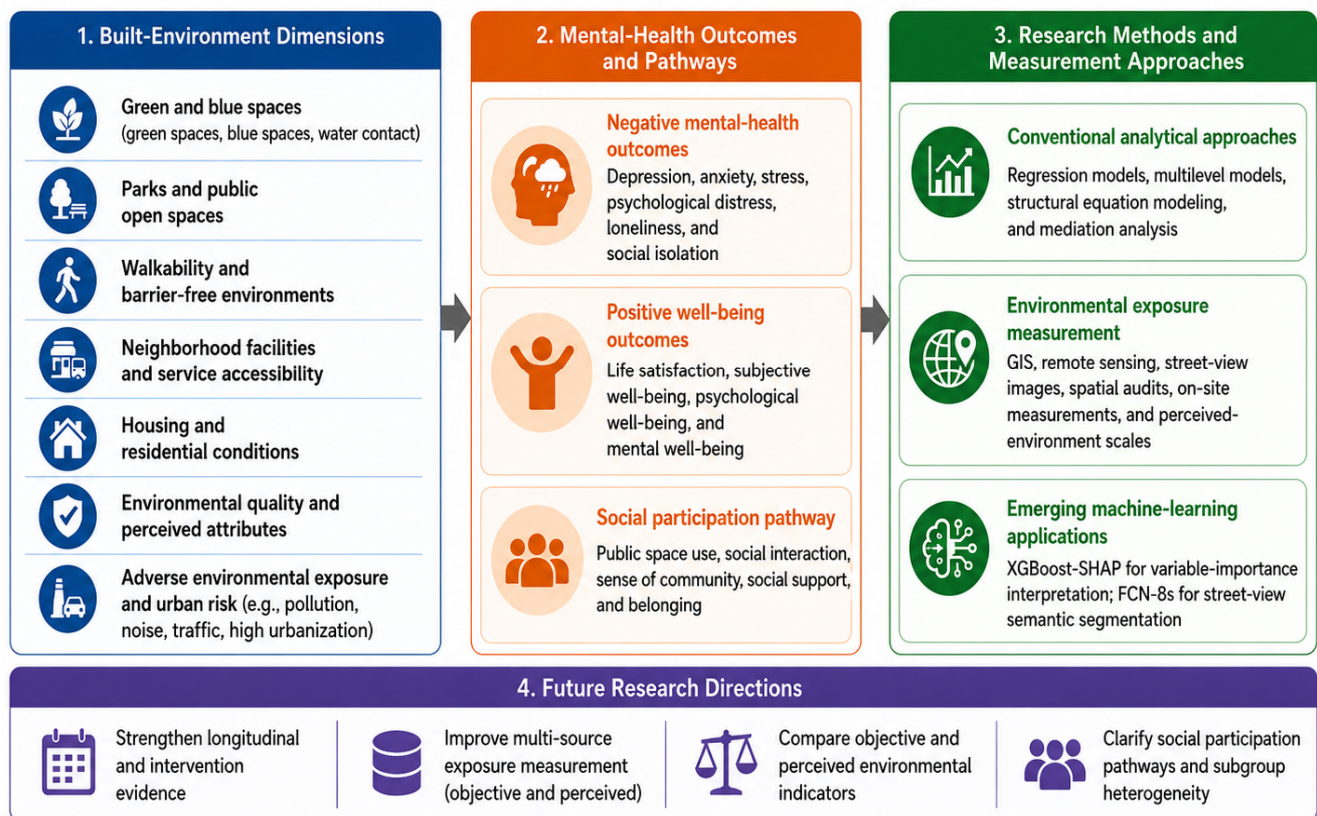


Figure 6. Conceptual synthesis of built-environment dimensions, mental health outcomes, social participation pathways, methodological approaches, and future research directions. (Note: This figure summarizes the main research topics, outcome domains, methodological approaches, and future directions identified from the reviewed studies. It is a conceptual synthesis and does not present statistical results. Machine-learning applications were identified in a small number of studies and are therefore interpreted as emerging methodological examples rather than an established trend. This figure was prepared by the authors with the assistance of AI-based visualization tools. The conceptual structure, evidence categories, and final content were developed and verified by the authors.) Source: Authors' synthesis based on the 60 studies included in the main synthesis.

Table 9. Evidence strength by study design and causal inference level.

Evidence Level	Study Design	Role in Causal Inference	Examples
Stronger causal support	Intervention or experimental studies	Directly test whether short-term environmental exposure or environmental intervention is associated with changes in mental health and well-being outcomes.	[64–66]
Moderate evidence	Longitudinal studies	Examine temporal ordering, persistence, or cumulative exposure, but cannot fully eliminate residual confounding or residential self-selection.	[60,62,63]
Low causal evidence	Cross-sectional studies	Identify associations between built environment factors and mental health and well-being outcomes at a single time point, but cannot establish temporal order.	[40,55,56,88]
Mechanism/contextual evidence	Qualitative or mixed-methods studies	Explain environmental experience, behavioral pathways, and contextual mechanisms, but do not independently establish causal effects.	[36,68–72]
Exploratory methodological evidence	Machine-learning or deep-learning-assisted studies	Improve exposure measurement, prediction, or variable-importance interpretation, but do not establish causal relationships by themselves.	[34,59]

Source: Author statistics.

5. Discussion

This systematic review synthesized 60 empirical studies published between 2015 and January 2026 on the associations between the built environment and older adults' mental health and well-being. Overall, the reviewed evidence suggests that several built-environment dimensions are related to older adults' mental health and well-being, although the strength, direction, and consistency of these associations vary across outcome types, spatial contexts, environmental indicators, and study designs. Green and blue spaces, public open spaces, walkability and barrier-free environments, neighborhood facilities and service accessibility, housing and residential conditions, and positive environmental perceptions were more often associated with lower levels of negative mental-health outcomes or higher levels of well-being. Conversely, adverse environmental exposures, such as road proximity, air pollution, noise, non-vegetated spaces, heat-related stress, and high-intensity urbanization, were more often associated with poorer mental-health-related outcomes.

However, the observed associations between green space exposure and mental health may partly reflect broader socio-spatial processes. Socioeconomic inequality, mobility limitations, baseline health status, and residential self-selection can shape both access to high-quality green spaces and mental-health outcomes. Green space exposure should therefore be understood within a wider urban context in which environmental resources, social inequality, functional ability, and residential location are interrelated. Given the predominance of cross-sectional studies and the heterogeneity of exposure and outcome measures, these findings should be interpreted primarily as evidence of association rather than as evidence of uniform causal effects.

The main theoretical contribution of this review is that it organizes a fragmented body of evidence into an integrated built environment–social participation–mental health and well-being framework. First, the review distinguishes between multiple built-environment dimensions rather than treating the built environment as a single exposure. Second, it clarifies that older adults' mental health and well-being should be understood through both negative outcomes, such as depression, anxiety, psychological distress, stress, loneliness, and social isolation, and positive outcomes, such as life satisfaction, subjective well-being, psychological well-being, and mental well-being. Third, it identifies social participation as an important but not universal behavioral and psychosocial pathway. Public space use, social interaction, community participation, sense of community, social support, and belonging may help explain how environmental conditions are linked to mental health and well-being. However, this pathway was not consistently observed across all environmental domains or outcome types, and several studies also reported direct associations between environmental conditions and mental-health-related outcomes. In this sense, the review contributes to environmental urbanism research by shifting attention from isolated environmental attributes to the combined interpretation of spatial exposure, environmental perception, social participation, and differentiated mental-health outcomes.

Despite these contributions, this review also identifies several knowledge gaps that should guide future research. First, the coverage of study populations, outcome variables, and spatial contexts remains uneven. Existing studies have focused more on depression, stress, and subjective well-being, whereas loneliness, social isolation, and life satisfaction have received comparatively less systematic attention. Most evidence is concentrated at the neighborhood or general community scale, while systematic comparisons remain limited for the internal composition of parks, environmental exposure along daily activity routes, and differences across urban, rural, and cultural contexts. Second, several built-environment dimensions remain underexplored, including traffic and accident safety, crime safety, public transport accessibility, access to social and recreational venues, micro-facility quality, and indoor environmental control in residential settings. In particular, more attention is needed to built-environment factors related to older adults' daily activity destinations and location-specific exposure. Third, methodological gaps remain evident. Machine-learning and deep-learning methods, such as XGBoost-SHAP and FCN-8s, have been introduced in a small number of studies to support environmental exposure measurement and variable-importance interpretation. However, their application remains limited, and future research should further examine how these methods can be integrated with objective exposure, subjective perception, and specific spatial contexts.

From a planning and policy perspective, the findings suggest that age-friendly urban environments should not be limited to the provision of green space or recreational facilities alone. The promotion of older adults' mental health and well-being should begin with the everyday environments in which older adults live, walk, rest, interact, and access services, rather than relying only on medical or social-service interventions. Urban planning and design interventions need to address multiple environmental domains simultaneously, including accessible green and blue space networks, walkable and barrier-free street systems, safe and inclusive public open spaces, proximity to daily services and health facilities, housing quality, perceived safety, cleanliness, environmental comfort, and the mitigation of adverse exposures such as traffic risk, air pollution, noise, and heat stress. These findings support the use of age-friendly environmental audits, health-oriented neighborhood planning, public-space quality assessment, universal design standards, and participatory design processes involving older adults. Planning governance should also connect physical design with maintenance, service provision, mobility support, and community programming, because the mental-health relevance of the built environment often depends on whether

older adults can use spaces safely, comfortably, repeatedly, and socially. Machine-learning-assisted environmental identification may serve as a complementary tool for prioritizing environmental factors in different spatial contexts, but it should be used together with field audits, participatory assessment, and contextual interpretation.

Several limitations should be acknowledged. First, this review included only English-language peer-reviewed journal articles, which may have introduced language bias and publication bias and may have excluded relevant evidence published in other languages, reports, regional studies, or local planning documents. In addition, the included evidence was geographically uneven, with a strong concentration of studies from China, North America, and Europe and comparatively limited representation from Global South contexts. This geographic imbalance may limit the transferability of the findings to regions with different urbanization patterns, welfare systems, climatic conditions, public-space cultures, and aging-related service infrastructures. Second, most included studies were cross-sectional, which limits the ability to infer temporal ordering or causal relationships. Although longitudinal, intervention, ecological momentary assessment, and experimental studies provided more informative evidence, they remained limited in number. Third, the included studies varied substantially in spatial scale, exposure measurement, outcome indicators, sample definitions, measurement instruments, and analytical models, which limited direct comparability and made pooled effect-size estimation inappropriate. Therefore, this review was more suitable for systematic comparison and narrative synthesis than for quantitative meta-analysis. Although publication bias was considered qualitatively by examining search restrictions, study design distribution, sample size, geographical context, and the direction of reported findings, publication bias and selective reporting cannot be fully ruled out. Fourth, some supplementary evidence involved broader age ranges or broader health-related perceived outcomes, such as self-rated health. These studies were interpreted cautiously and were not used as primary evidence for conclusions specifically concerning older adults' mental health. Finally, only a limited number of studies used machine-learning methods, and these studies differed in model objectives, input variables, and environmental measurement approaches. Therefore, this review could not systematically compare model performance, variable-importance rankings, or generalizability.

Future research should move beyond cross-sectional association and develop a stronger causal research agenda. Longitudinal cohort studies, natural experiments, quasi-experimental designs, and intervention studies are needed to examine whether changes in environmental exposure are followed by changes in mental-health and well-being outcomes over time. Future studies should also integrate objective environmental data, such as GIS, remote sensing, street-view images, spatial audits, and environmental sensors, with subjective environmental perception and momentary psychological assessments. Greater attention should be paid to the mechanisms linking environmental exposure to mental health, including social participation, restorative experience, perceived safety, environmental satisfaction, and sense of community. In addition, future research should examine subgroup heterogeneity by age, gender, income, health status, mobility limitation, housing tenure, and urban–rural context. Such work would help clarify not only whether the built environment is associated with older adults' mental health and well-being, but also under what conditions, through which mechanisms, and for which groups environmental interventions are most likely to support mental health.

6. Conclusions

This study systematically reviewed and synthesized empirical evidence on how the built environment is associated with older adults' mental health and well-being. Existing evidence indicates that the built environment is an important environmental condition

associated with older adults' mental health. Key dimensions include green and blue space exposure, access to neighborhood facilities and services, housing and living conditions, walkability and barrier-free environments, the internal composition of public open spaces and parks, and adverse environmental exposures such as road proximity and urbanization pressure. These factors are linked to both negative mental health outcomes, such as depression, anxiety, stress, psychological distress, and loneliness, and positive outcomes, such as life satisfaction, subjective well-being, and psychological well-being. These findings suggest that the built environment may serve as an important spatial context for healthy aging and community well-being.

The evidence also suggests that this relationship is complex and context-dependent. Green spaces, blue spaces, age-friendly neighborhood environments, high-quality public open spaces, and positive environmental perceptions more often act as protective factors. In contrast, road proximity, high-intensity urbanization exposure, adverse neighborhood change, non-vegetated park spaces, and poor housing conditions are more often associated with negative mental health outcomes. These associations do not operate through a single pathway. They are shaped by multiple environmental experiences and daily spatial processes. A small number of studies have also introduced machine learning and deep learning methods. XGBoost-SHAP can identify the relative importance of multidimensional neighborhood environmental factors, while fully convolutional neural networks can extract street-level green and blue space exposure from street-view images. These methods offer useful tools for examining non-linear relationships and fine-grained environmental exposure.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/buildings16122398/s1>. Table S1: Search Terms; Table S2: Methodological Quality Assessment Checklist (Final Version); Table S3: Characteristics of Reviewed Studies; Table S4: Studies with Non-Exclusive Older Adult Samples Included as Supplementary Evidence; Table S5: Item-Level Methodological Quality Assessment Results of the Included Studies. PRISMA 2020 Checklist. References [102–107] are cited in the supplementary materials.

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Data Availability Statement: The original questionnaire used and analyzed during the current study are available from Chunhong Wu (wuch0142@cau.ac.kr) upon reasonable request.

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

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