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Review

Associations Between Urban Green Space Quality and Mental Wellbeing: Systematic Review

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Abstract: With the rapidity of urbanisation, concerns about citizens' mental wellbeing issues are on the rise, and simultaneously, the issue of land use conflicts is becoming increasingly prominent. As a nature-based solution, the role of urban green space has been continually emphasised in the past decade. In urban areas facing scarce land resources, improving the quality of green spaces appears to be an important approach. This review aimed to systematically elaborate the studies regarding the associations between urban green space (UGS) qualities and mental wellbeing, following the Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Twenty-two articles were included, and most of them had a cross-sectional design. From the analysis of the data, it emerged that the definition of the quality of green space is heterogeneous. Natural elements, particularly vegetation diversity and water features, consistently showed positive associations with mental wellbeing, while the effects of spatial features like accessibility showed mixed results. The impact of facilities and amenities appeared more complex, with their benefits heavily dependent on the design and maintenance. More evidence is needed to determine the mental wellbeing benefits of maintenance and the development of facilities and amenities for UGSs. In addition, the assessment of mental wellbeing relied on various self-reported scales, with different scales targeting different aspects. Instrumental measurements were rarely employed. Future research should employ more rigorous experimental methods and standardised quality assessment tools.

Keywords: urban green spaces; quality; mental wellbeing; mental health benefits

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1. Introduction

By 2050, more than two-thirds of the world's population will live in urban areas [1]. Although celebrated for fostering economic growth and technological advancement, unfortunately, the witnessed rapid pace of urbanisation has undeniably unleashed a myriad of detrimental factors which have not only diminished the existence of green spaces but also exerted a negative impact on residents' mental wellbeing [2,3].

As remnant patches or introduced patches in cities, urban green spaces (UGSs) have acquired substantial attention for their associations with mental wellbeing, with plenty of studies proving the psychological benefits of exposure to nature within urban environments [4–7]. Plenty of studies have suggested that mere exposure to green spaces is

sufficient to confer mental health benefits [8–11]. Existing studies have also attempted to elucidate the pathways through which residents benefit from UGSs by exploring the underlying mechanisms. The prevailing theory posits that UGSs benefit mental wellbeing via three key pathways: recreation, physical activities, and social connections [12,13]. In such studies, the general greenness, size, or accessibility are usually used for the measurement of the existence of green spaces [14].

On the other hand, emerging evidence indicates that the quality of the green spaces may be a crucial factor influencing the extent of these relationships [15]. For example, ecosystem diversity can enhance health and wellbeing, but pollen may pose risks to human health [16]. Amenities and facilities in the parks also significantly attract residents to UGSs, making the construction of green areas more utilitarian [17]. In addition, maintaining cleanliness and safety in the park is also a crucial aspect of enhancing its appeal, requiring effective management, renovation, and maintenance [18–20].

Moreover, healthy and high-quality UGSs not only benefit residents' health, but are also important in enhancing the quality of life, controlling pollution, regulating the climate, and providing other ecosystem services [21,22]. However, it is relatively difficult to plan idealised UGSs in urban areas due to various land cover and land use restrictions [23]. Therefore, creating multi-functional UGSs of a high quality is essential in the construction of future sustainable cities, which aligns with the United Nations Millennium Development Goals [24], which means that studying green spaces' qualities has practical implications for urban planning.

Currently, articles pertaining to the quality of green spaces are in the exploratory phase. There exists a notable gap in the understanding of how different qualities mainly contribute to the mental health outcomes associated with these spaces. The definition of UGS quality itself remains inconsistent, giving rise to various interpretations and an uneven hierarchy of quality standards. Thus, performing a statistical review of the existing relevant studies can be instrumental in elucidating the current research gaps and potential avenues for future endeavours. This approach aids in the establishment of an assessment framework for UGS quality, contributing to the refinement of urban planning strategies and policies that optimise the mental health impact of green spaces in our cities. In this framework, the present systematic review aimed to achieve the following:

(a) Identify and categorise all qualities of UGSs that have been investigated in previous primary studies;

(b) Examine the associations between different UGS qualities and mental health outcomes.

2. Materials and Methods

This systematic review of the studies investigating the association of the UGS quality with mental wellbeing was conducted following the updated Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [25]. The predefined protocol was registered on the PROSPERO (CRD42023462427) website: http://www.crd.york.ac.uk/prospero/ (accessed on 11 February 2025). We searched the Web of Science (WOS) Core Collection and MEDLINE databases via the WOS platform, as well as the PubMed, Scopus, and Cochrane Library databases for all the English publications starting from 2013 to capture the latest progress in this topic. The starting point of 2013 was chosen to ensure the inclusion of the most recent studies, reflecting the rapid development in research on the UGS quality and mental wellbeing, as well as the increasing refinement of measurement methodologies in this field [26]. We limited our search to research articles, including early-access articles up to 2025 using an article type filter if available. We did not apply any restrictions regarding geographical regions or study populations to maintain a comprehensive overview of the research topic. Additional eligible studies were identified

through the reference list checking of included articles, the citation tracking of key papers, and consultation with field experts.

2.1. Search Strategy

The search strategy (detailed search history in Supplementary Materials S1) was developed through an iterative process of pilot searches in the WOS Core Collection by all authors, considering the theme and the purpose of this review. After finalising the most comprehensive and suitable strategy, we adapted and applied it to other databases. Our strategy was a combination of three relevant parts including mental wellbeing outcomes and green space quality and urban green space terms. Firstly, we simultaneously employed both general mental health terminology and specific terms related to psychological health issues for the mental wellbeing outcomes, including the following: mental health OR mental wellbeing OR psychological health OR psychological wellbeing OR mental state OR mental disorder* OR mental illness OR mood OR happiness OR emotion* OR depress* OR anxi* OR stress OR cognitive function* OR restoration OR recovery OR resilience OR psychological benefit* OR mental benefit* [6,15,27]. Secondly, multiple synonyms for green space quality were used to capture the "quality", including the following: "green space quality" OR "quality of green space*" OR "spatial feature*" OR "spatial character*" OR "landscape pattern*" OR "vegetation cover*" OR NDVI OR accessibility OR facility* OR amenit* OR maintenance OR safety feature*. Thirdly, green space types were limited to urban settings by describing UGSs, including the following terms: urban green space* OR urban park* OR urban garden* OR urban green infrastructure* OR city park* OR city garden* OR municipal park* OR community garden* OR neighbourhood green* OR urban forest*.

2.2. Eligibility Criteria

As inclusion criteria, we considered only articles published in English. Regarding publication types, we included only research articles and excluded reviews, letters to the editor, comments, editorials, recommendations, and all other document types unintentionally retrieved during the database search.

The PICOTS criteria drafted to address the primary search aim were the following:

- P (Patients): All the urban residents who can obtain access to the UGS. However, studies specifically targeting minors were excluded because studies targeting minors are usually conducted with data or survey results provided by parents or teachers as proxies.
- I (Interventions): Exposure to UGSs with different aspects of quality. The definition of quality refers to features or characteristics that can impact the experiential aspects of users' park utilisation, including but not limited to the spatial features (e.g., the size, accessibility, landscape patterns index, etc.), nature elements (e.g., blue elements inside green spaces, the tree canopy, biodiversity, etc.), and the existence and maintenance of facilities and amenities (e.g., playgrounds, sport fields/courts, walking paths/trails, etc.) [28]. In assessing the quality, blue elements within these green spaces were considered as criteria. Exclusions encompassed studies specifically targeting blue spaces, studies on a comparison between urban and rural green spaces, studies on the remote viewing of urban green spaces through windows, vertical greenery, or UGSs not fully accessible to the public, and studies relying solely on methods of photographic or virtual reality or recorded soundtracks. Studies specifically focusing on the area of green spaces or accessibility were excluded because usually the area is a measurement of quantity and accessibility is a measurement of environmental justice if they exist independently. In addition, studies which only used subjective

quality measurements such as perceptions and the satisfaction of participants were also excluded for the reason of logical uncertainty between the interventions and outcomes.

- O (Outcomes): The general mental wellbeing status or specific psychological terms such as depression, anxiety, and stress, which are recognised as fundamental indicators of mental wellbeing. In contrast, studies addressing specific emotional states such as loneliness, self-esteem, and calmness were excluded because emotions represent transient, context-specific experiences rather than comprehensive indicators of mental wellbeing. This distinction ensured that the included studies aligned with the scope of the mental wellbeing assessment and avoided overly fragmented outcomes that may deviate from the research objectives.
- S (Study Design): All types of original studies, including cross-sectional studies, case-crossover studies, retrospective cohort studies, prospective cohort studies, quasi-experimental studies, before–after studies, and ecological studies, with the full text available, written in English, and published between 2013 and 2024 (including early-access publications for 2025).

2.3. Study Selection

The records retrieved from database searches and additional eligible studies were imported into EndNote 21 for management (Version 21.5.0.18513, copyright 1998–2024, Clarivate Analytic, Philadelphia, PA, USA). After the duplications were removed, the title/abstract screening of the first 100 articles was completed by the first author (ZX) and a co-author (SM) independently and in parallel, strictly following the Eligibility Criteria. A discussion with the senior reviewer (ST) was engaged in to resolve disagreements and reach a consensus. Once a consistent understanding of the criteria was achieved, the remaining title and abstract screening was completed by the first author (ZX) under the guidance of the senior reviewer (ST), ensuring adherence to the agreed criteria. The selection of the full-text articles was completed by ZX, ST, and AG. The reason for exclusion was recorded. Disagreements and indeterminacy were resolved by discussions. There was no inter-rater reliability testing due to the refinement and improvement of the search criteria, which were applied to the entire process. The protocols were updated and applied to the final screening process.

2.4. Quality Assessment and Data Extraction

Data were extracted from eligible articles into Google Sheets. The form included the author; year of publication; study location; study design; population description; measurements of quality; measurement instrument; mental wellbeing outcomes; outcome instrument; the moderator, mediator, and covariates; statistical methods; and key findings.

The assessment of the methodological quality of the included studies was carried out using a modified version of the Criteria for Quality Assessment of the Studies originally proposed by Gascon et al. in 2015 [6]. This framework was chosen as it aligned closely with the specific requirements of this review. To better suit the context of this study, three items (No. 7, No. 9, and No. 11) within the original framework were adjusted, ensuring that the criteria remained appropriate for the studies included. Details of the adapted criteria are provided in Table S6.

3. Results

In the initial search, 3813 articles were identified in five databases, with 12 articles from websites and 21 articles found by citation searching. A total of 1006 duplicates were removed, and 2840 articles were included for abstract and title screening. One hundred

and seventy-five articles were selected for full-text screening, and twenty-two articles from 21 studies were included (Figure 1).

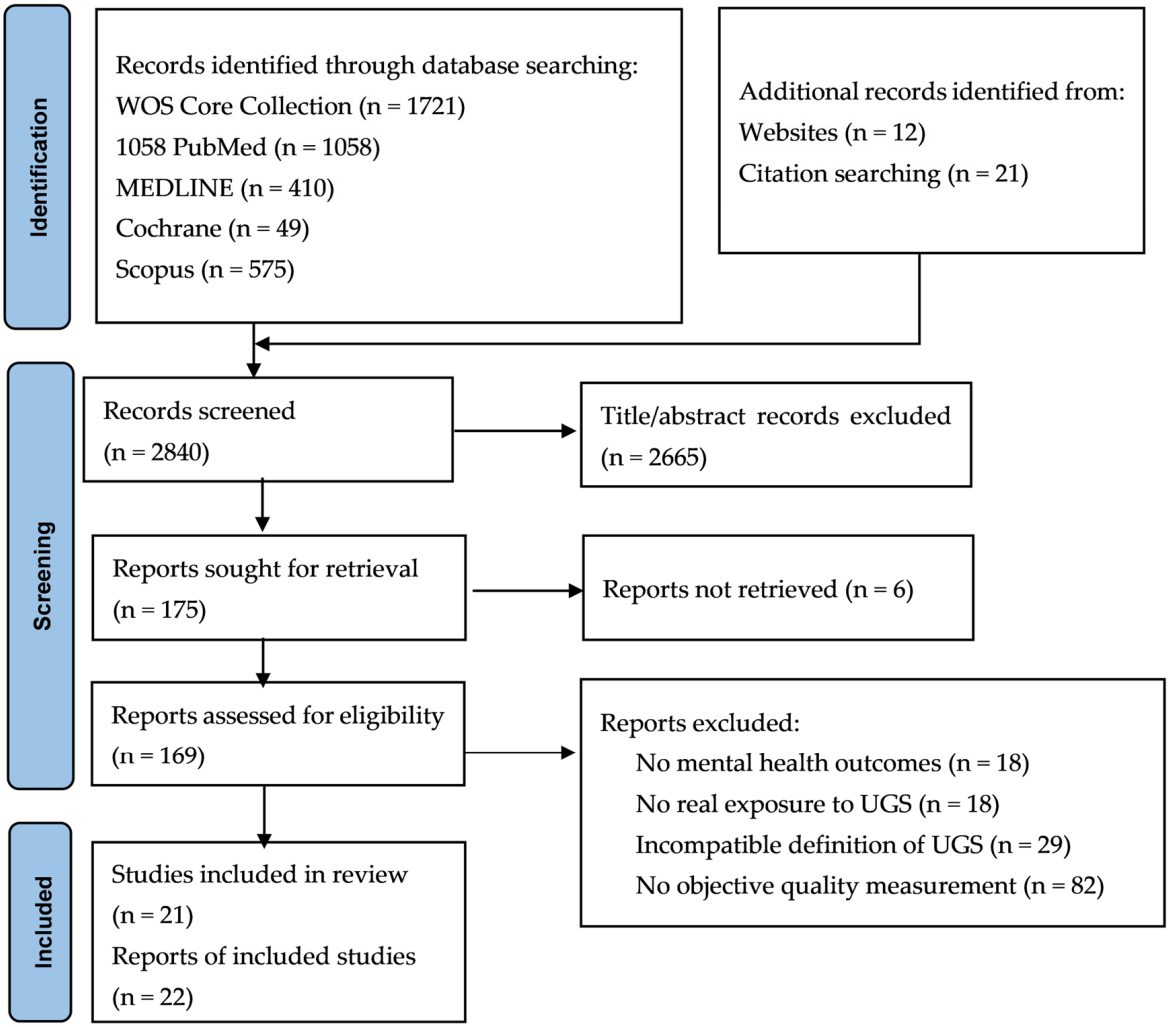

Figure 1. PRISMA flow diagram.

3.1. Study Characteristics

The key characteristics are shown in Table 1. The 22 articles published from 2017 to 2024 were conducted mainly in mainland China (n = 11) and the United Kingdom (n = 3), followed by Taiwan (n = 2), Hong Kong (n = 1), Australia (n = 1), Turkey (n = 1), Guyana (n = 1), and Pakistan (n = 1). One study was carried out in four European countries (the United Kingdom, the Netherlands, Spain, and Lithuania) [29]. The study populations comprised varying sample sizes, ranging from 30 to 3771. Most of the studies included general populations or adult populations. Three studies exclusively included the elderly [30–32], two articles on which belonged to the same study explicitly excluding students [33,34]. Four of the selected studies were quasi-experimental studies [35–38]. One study employed a longitudinal design [32]. The remaining 18 studies were cross-sectional. Additionally, the sample sizes were relatively small and with similar characteristics, ranging from 33 to 80 participants, reflecting the controlled nature of experimental settings. On the contrary, the other studies usually included larger samples, with sizes ranging from 30 to 3771 participants, depending on the study scope and design (Table 1).

Table 1. Main characteristics of the studies on the urban green space (UGS) quality and mental wellbeing.

No.	Author	Year	Location	Study Design	Population Description	Moderator, Mediator, and Covariates	Statistical Methods
1	Abdul et al. [39]	2022	Peshawar, Pakistan	Cross-sectional	n = 200	Covariates: sociodemographic information	Chi-Square Tests
2	Cameron et al. [40]	2020	Sheffield, UK	Cross-sectional	n = 259	Covariates: sociodemographic information	Mixed-Effects Modelling
3	Chang et al. [30]	2020	Taichung, China	Cross-sectional	n = 769 age > 55	Mediator: place attachment; covariates: sociodemographic information	Structural Equation Models
4	Chu et al. [31]	2021	Taipei, China	Cross-sectional	n = 380 age > 55	Moderator: environmental perception, outdoor leisure; covariates: sociodemographic information	Hierarchical Linear Models
5	Deng et al. [35]	2020	Chengdu, China	Quasi-experimental	n = 60 age: 19–24	-	Repeated Measures ANOVA, Wilcoxon Signed-Rank Test
6	Dobbinson et al. [36]	2020	Melbourne, Australia	Quasi-experimental	n = 1670 median age: 34–37	-	Cluster-Level Analysis, Independent Sample *t*-Test
7	Duzenli et al. [41]	2017	Trabzon, Turkey	Cross-sectional	n = 375	-	One-Way ANOVA
8	Fisher et al. [42]	2021	Georgetown, Guyana	Cross-sectional	n = 478 age > 18	Moderator: blue spaces and green spaces; covariates: sociodemographic information on gender and age	Bivariate General Linear Mixed-Effect Models
9	Huang et al. [37]	2021	Fuzhou, China	Quasi-experimental	n = 33 age: 22–28	-	Kruskal–Wallis (K–W) Tests
10	Knight et al. [43]	2022	Greater London, UK	Cross-sectional	n = 1606 age > 16	Covariates: sociodemographic information	Fixed-Effects Regression Models
11	Li et al. [44]	2023	Shanghai, China	Cross-sectional	n = 478 without underlying medical conditions	Covariates: sociodemographic information	Ordered Logit Models

Table 1. *Cont.*

No.	Author	Year	Location	Study Design	Population Description	Moderator, Mediator, and Covariates	Statistical Methods
12	Liu et al. [32]	2023	Hong Kong, China	Longitudinal	n = 2081 age $\geq$ 65 without known dementia or another psychiatric disorder	Covariates: sociodemographic information	Latent Growth Curve Modelling
13	Meng et al. [45]	2024	Chengdu, China	Cross-sectional	n = 1124 age > 18	Covariates: sociodemographic information	Multilevel Linear Models
14	Ruijsbroek et al. [29]	2017	Stoke-on-Trent, UK; Doetinchem, Netherlands; Barcelona, Spain; and Kaunas, Lithuania	Cross-sectional	n = 3771 age = 18–75	Mediators: social cohesion, neighbourhood attachment, social contacts; covariates: sociodemographic information, neighbourhood socioeconomic status, cities	Multilevel Linear Models, Logistic Regression Models
15	Wan et al. [46]	2024	Chengdu, China	Cross-sectional	n = 135	Mediators: environmental preferences	Stepwise Regression Analysis, Path Analysis
16	Wang et al. [47]	2022	Shanghai, China	Cross-sectional	n = 496 age > 18	Mediator: use of parks; covariates: sociodemographic information	Multilevel Regression Models
17	Wang et al. [33]	2021	Guangzhou, China	Cross-sectional	n = 1003 age > 18 and not student	Mediators: PM 2.5, NO_2, perceived pollution, stress, life satisfaction, physical activity, social cohesion; covariates: sociodemographic information, neighbourhood deprivation index	Structural Equation Models, Parallel Mediation Models
18	Wang et al. [34]	2022	Guangzhou, China	Cross-sectional	n = 1003 age > 18 and not student	Moderator: blue space and green space indicators; covariates: sociodemographic information	Multilevel Linear Regression Models
19	Wood et al. [48]	2018	Bradford, UK	Cross-sectional	n = 128 age > 18	Moderator: use of the parks; covariates: sociodemographic information	Multilevel Linear Regression Models

Table 1. *Cont.*

No.	Author	Year	Location	Study Design	Population Description	Moderator, Mediator, and Covariates	Statistical Methods
20	Xu et al. [38]	2024	Nanjing, China	Quasi-experimental	n = 80 university students age: 19–25	-	One-Way ANOVA, Paired Sample *t*-Test, Multiple Linear Regression Models
21	Xu et al. [49]	2022	Fuzhou, China	Cross-sectional	n = 30 age > 18	Covariates: sociodemographic information	General Linear Models
22	Zhang et al. [50]	2022	Nanjing, China	Cross-sectional	n = 1984 age > 18	Mediator: physical activity, mental stress, environmental stressors, social cohesion	Multivariate Linear Regression Models, Multiple-Mediation Models

3.2. Quality Assessment

The quality assessment of the included studies was conducted using 11 criteria, with the total scores converted to percentages and categorised as poor (<40%), fair (40–60%), good (61–80%), or excellent (>80%). Among the twenty-two included studies, three studies (13.6%) were rated excellent [32,37,38], thirteen studies (59.1%) were rated as good, five studies (22.7%) were rated as fair, and one study (4.5%) was rated as poor [29]. No studies were categorised as very poor-quality. The detailed scoring can be found in Table S7.

3.3. Mental Wellbeing Outcomes

The selected studies reported a series of mental wellbeing outcomes (Table 2). The reviewed studies showed diverse methods of mental wellbeing measurement. The general mental wellbeing was frequently measured [33,39,43,44,50], commonly using standardised scales such as the World Health Organization-Five Well-Being Index (WHO-5) and General Health Questionnaire-12 (GHQ-12). The emotion status was another major focus, including the general emotional status ([39,41] and positive/negative emotions [36,40,42,49], mainly measured using the Positive and Negative Affect Schedule (PANAS). Depression was also a common measurement [29,31,32,34,47], usually evaluated using the Mental Health Inventory-5 (MHI-5) or Geriatric Depression Scale-15 (GDS-15). Attention restoration was another important mental wellbeing measurement, which appeared in several studies ([37,38,45,46,48] using the Perceived Restorativeness Scale (PRS) developed by Hatig et al. [51]. Stress and anxiety were also evaluated by several studies [29,34,37,39,42,49], while some studies considered life satisfaction as a measurement [31,43]. Most studies relied on psychological measurements, while some studies incorporated physiological indicators. For example, Deng et al. (2020) measured blood pressure, pulse rate, and electroencephalogram (EEG) data [35], while Huang et al. (2021) employed a wearable sensing device called an ErgoLAB (including measurements of the electrodermal activity (EDA), facial electromyography (EMG), a respiration sensor (RESP), measurements of the skin temperature (SKT), and photoplethysmography (PPG)), providing more objective assessment methods [37].

Table 2. Main characteristics and results of the studies on urban green space (UGS) qualities' benefits on wellbeing outcomes.

No.	Measurements of Quality	Measurement Instrument	Combined with Subjective Measurements	Mental Wellbeing Outcomes	Outcome Instrument	Effects
Spatial Features						
1	Accessibility, spatial layout	Environmental audit	Perception and satisfaction measured by Likert scales	Stress reduction, emotional wellbeing, perception of overall wellbeing	Self-developed Likert scale	(+)
3	Green coverage, spatial layout	Environmental audit (EAPRS)	Perception and satisfaction measured by Likert scales	PERMA model	Self-developed Likert scale	(+) (-)
4	Accessibility	Environmental audits (NGST)	Environmental perception measured by Neighbourhood Open Space (NOS) scale	Life satisfaction, depression	SWLS, GDS-15	(+)
9	Openness, topography	Environmental audit		Stress recovery, attention restoration	ErgoLAB (electrodermal activity, facial electromyography, respiration sensor, skin temperature (SKT), photoplethysmography), PRS	(+) (○)
11	Accessibility	Official database		General mental wellbeing	Self-developed Likert scale	(+) (-) (○)
12	Accessibility, terrain slope	Environmental audit (POST)		Depression	GDS-15	(+) (○)
15	Site area	Environmental audit, GIS analysis	Perception and satisfaction measured by Likert scales	Attention restoration	Self-developed Likert scale	(+)
16	Accessibility	Environmental audit	Perception and satisfaction measured by Likert scales	Depression	MHI-5	(○)
22	Accessibility, NDVI	GIS analysis	Perception measured by Likert scales	General mental wellbeing	WHO-5	(+) (○)

Table 2. *Cont.*

No.	Measurements of Quality	Measurement Instrument	Combined with Subjective Measurements	Mental Wellbeing Outcomes	Outcome Instrument	Effects
Nature Elements						
1	Plant richness and distribution	Environmental audit	Perception and satisfaction measured by Likert scales	Stress reduction, emotional wellbeing, perception of overall wellbeing	Self-developed Likert scale	(+)
2	Avian diversity, habitat diversity	Avian survey, habitat survey	Perceived biodiversity measured by Likert scales	Positive emotion	Self-developed Likert scale, ReQoL-10	(+)
3	Plant diversity, landscape diversity, landscape maintenance	Environmental audit (EAPRS)	Perception and satisfaction measured by Likert scales	PERMA model	Self-developed Likert scale	(+)
4	Nature features (quality of grass, trees, and flower beds), maintenance of natural features	Environmental audit (NGST)	Environmental perception measured by Neighbourhood Open Space (NOS) scale	Life satisfaction, depression	SWLS, GDS-15	(○)
5	Green elements (lawn, bamboo forest, view of forest in distance, bushes, and flowers), blue elements (lake, stream, still pond, waterfall), mixed ecological areas, wetlands, topography	GIS analysis, environmental audit		Mood states, attention restoration	PRS, POMS, electronic blood pressure monitor (blood pressure, pulse rate), NeuroSky MindWave (electroencephalogram)	(+)
7	Plant materials (variety, appropriate species, colour and fragrance, avoidance of toxic plants), waterscape (types and quality), natural view	Environmental audit	Perception and satisfaction measured by Likert scales	Emotional status	Self-developed Likert scale, types of activities (positive and negative)	(+)
8	Avian diversity	Avian survey		Positive and negative emotions, anxiety	PANAS, STAI	(○)

Table 2. *Cont.*

No.	Measurements of Quality	Measurement Instrument	Combined with Subjective Measurements	Mental Wellbeing Outcomes	Outcome Instrument	Effects
9	Plant richness, water landscape	Environmental audit		Stress recovery, attention restoration	ErgoLAB (electrodermal activity, facial electromyography, respiration sensor, skin temperature (SKT), photoplethysmography), PRS	(+)
11	Open lawns, blue spaces	Official database		General mental wellbeing	Self-developed Likert scale	(+) (-) (○)
13	Avian diversity, plant diversity, habitat diversity, water features	Environmental audit	Perception of biodiversity measured by self-developed Likert scale	Attention restoration	PRS	(+) (○)
15	Plant configuration	Environmental audit, GIS analysis	Perception and satisfaction measured by Likert scales	Attention restoration	Self-developed Likert scale	(+)
16	Aesthetics—natural features (trees, vegetation)	Environmental audit	Perception and satisfaction measured by Likert scales	Depression	MHI-5	(+)
19	Biodiversity (plant, avian, butterfly/bee, habitat)	Environmental audit		Attention restoration	Self-developed Likert scale	(+)
20	Vegetation coverage, plant diversity, plant colour	Environmental audit	Perception measured by Likert scales	Attention restoration	PRS, FS-14	(+)
21	Avian diversity	Avian survey		Positive and negative emotions, anxiety	PANAS, STAI	(○)
22	Green space visibility	GIS analysis	Perception measured by Likert scales	General mental wellbeing	WHO-5	(+)

Table 2. *Cont.*

No.	Measurements of Quality	Measurement Instrument	Combined with Subjective Measurements	Mental Wellbeing Outcomes	Outcome Instrument	Effects
Facilities and Amenities						
1	Jogging tracks, sitting areas, streetlights, parking areas	Environmental audit	Perception and satisfaction measured by Likert scales	Stress reduction, emotional wellbeing, perception of overall wellbeing	Self-developed Likert scale	(+) (-)
3	Trails and paths, signage, seating areas, drinking and sanitation facilities, fitness equipment, shelter/pavilion, lighting facilities, etc. (including maintenance and convenience)	Environmental audits (EAPRS)	Perception and satisfaction measured by Likert scales	PERMA model	Self-developed Likert scale	(+)
4	Recreation (playgrounds, sports courts), facilities (benches, rubbish bins), incivilities (drinking, noise), usability (suitability for walking and playing)	Environmental audits (NGST)	Environmental perception measured by NOS scale	Life satisfaction, depression	SWLS, GDS-15	(-) (○)
5	Landscape constructions (pavilions, corridors, viewing platforms), roads and pavements (wooden walkways, flagstone paths), garden facilities (poetry wall, lamps, decorative openwork windows), convenient facilities (benches, trash bins, drinking fountains)	GIS analysis, environmental audit		Mood states, attention restoration	PRS, POMS, electronic blood pressure monitor (blood pressure, pulse rate), NeuroSky MindWave (electroencephalogram)	(+)

Table 2. *Cont.*

No.	Measurements of Quality	Measurement Instrument	Combined with Subjective Measurements	Mental Wellbeing Outcomes	Outcome Instrument	Effects
6	Refurbishments of amenities: playground, shade, paths, sporting facilities, fitness equipment, sitting and picnic areas, dog off-lead area, planned refurbishments	Environmental audit	Perception measured by intercept survey	Positive and negative emotions	PANAS	(○)
7	Furniture (sitting equipment, coverings, bins, signboards), enclosed bounded areas, lighting, parking, maintenance, access (parking, paths, barrier-free designs)	Environmental audit	Perception and satisfaction measured by Likert scales	Emotional status	Self-developed Likert scale, types of activities (positive and negative)	(+)
9	Road network, cultural landscape	Environmental audit		Stress recovery, attention restoration	ErgoLAB (electrodermal activity, facial electromyography, respiration sensor, skin temperature (SKT), photoplethysmography), PRS	(+)
11	Sports facilities	Official database		General mental wellbeing	Self-developed Likert scale	(+)
12	Types of facilities, shade, bench quality	Environmental audit (POST)		Depression	GDS-15	(○)
15	Walking comfort, facility accessibility (benches, rubbish bins, sport equipment, shade), site safety	Environmental audit, GIS analysis	Perception and satisfaction measured by Likert scales	Attention restoration	Self-developed Likert scale	(+)

Table 2. *Cont.*

No.	Measurements of Quality	Measurement Instrument	Combined with Subjective Measurements	Mental Wellbeing Outcomes	Outcome Instrument	Effects
16	Aesthetics—non-natural features (decorative water features, public artworks, lighting for aesthetics), recreational facilities (playgrounds, sports courts, fitness equipment), usability (walking paths, bench availability, activity space), incivilities (litter count, graffiti presence, noise level)	Environmental audit	Perception and satisfaction measured by Likert scales	Depression	MHI-5	(+) (-) (○)
19	Site facilities (benches, rubbish bins, lighting, and maintenance)	Environmental audit (NEST)		Attention restoration	Self-developed Likert scale	(○)
20	Rest facilities, walking paths, spatial privacy, cleanliness, noise level	Environmental audit	Perception measured by Likert scales	Attention restoration	PRS, FS-14	(+) (○)
Combination						
10	Accessibility to Sites of Importance for Nature Conservation	Official database		Life satisfaction, general mental wellbeing	Life Satisfaction Scale, GHQ-12	(+)
14	Fraction of visible gardens, size of garden, garden arrangement, trees, size of green space, size of blue space	Environmental audit	Perception and satisfaction measured by Likert scales	Nervousness, depression	MHI-5	(+) (○)

Table 2. *Cont.*

No.	Measurements of Quality	Measurement Instrument	Combined with Subjective Measurements	Mental Wellbeing Outcomes	Outcome Instrument	Effects
17	Accessibility, maintenance, variation, naturalness, colourfulness, clear arrangement, shelter, cleanliness, safety, general impression	GIS analysis	Perception and satisfaction measured by Likert scales	General mental wellbeing	WHO-5	(+) (○)
18	Accessibility, maintenance, variation, naturalness, colourfulness, clear arrangement, shelter, cleanliness, safety, general impression	GIS analysis	Perception and satisfaction measured by Likert scales	Depression, anxiety	SCL-90	(+)

Notes: 1. Environmental audit tools: EAPRS: Environment Assessment of Public Recreation Scale; NGST: Neighbourhood Green Space Tool; POST: Public Open Space Tool; NEST: Natural Environment Scoring Tool; NOS scale: Neighbourhood Open Space scale. 2. Scales for mental wellbeing: PERMA model: positive emotion, engagement, relationship, meaning, accomplishment; SWLS: Satisfaction with Life Scale; GDS-15: Geriatric Depression Scale-15; PRS: Perceived Restorativeness Scale; MHI-5: Mental Health Inventory-5; WHO-5: 5-item World Health Organization-Five Well-Being Index; ReQoL-10: 10-item Recovering Quality of Life Questionnaire; POMS: Profile of Mood States; PANAS: Positive and Negative Affect Schedule; STAI: State Trait Anxiety Inventory; FS-14: Chalder Fatigue Scale; GHQ-12: 12-item short form of General Health Questionnaire; SCL-90: Symptom Checklist-90. 3. Effects: (+): evidence of protective associations; (-): evidence of risk associations; (○): insignificant associations.

3.4. Quality of Urban Green Spaces Outcomes

The measurement of the quality of green spaces was divided into three domains, including spatial features, natural elements, and facilities and amenities. The studies which comprehensively considered the above domains but did not describe their conclusions according to specific indicators instead of using an overall evaluation were classified as the combination group (Table 2).

3.4.1. Spatial Features

Studies including the spatial features of UGSs employed a variety of measurement instruments. Environmental audits were the most commonly used tools used to conduct an evaluation of green spaces' accessibility, spatial layout, and design features [30,31,37,39,46]. Standardised quantitative tools such as the Neighbourhood Green Space Tool (NGST), the Public Open Space Tool (POST), and the Environment Assessment of Public Recreation Scale (EAPRS) provided a structured framework to measure the quality of UGSs [30–32]. The audits were often complemented by geographic information system (GIS) analyses to measure features like the green coverage and the size of the UGS [46,50]. Most of the studies combined these with subjective measurements to capture user perceptions and experiences. Perceptions and satisfaction measured by Likert scales were commonly employed [30,31,39,46,47,50].

Accessibility was the most commonly measured quality, but its effects were not entirely consistent across studies. For example, high accessibility was linked to reduced stress, less depression, and enhanced life satisfaction through improved convenience and increased recreational opportunities [31,39,44]. However, some studies found no significant association between accessibility and mental health outcomes [47]. Meanwhile, the benefits of accessibility were often mediated by environmental perceptions and the quality of interactions with the UGS [31,50]. Comprehensive parks located farther away (>3 km) provided stronger positive impacts on wellbeing than nearby smaller parks, indicating that the type and scale of accessibility also influenced outcomes [44]. Similarly, larger green and blue spaces offered greater restorative potential compared to smaller ones, by providing diverse recreational opportunities and a sense of immersion [46]. The green coverage and a rational spatial layout were associated with reductions in environmental stressors such as noise and pollution, and improvements in user satisfaction were achieved by providing increased physical activity opportunities [30,50]. The topography showed a notable impact, with uneven terrain contributing to stress recovery and attention restoration [37]. However, this kind of impact was not applicable for the elderly [32]. Openness was found to have negligible effects, with no significant differences observed between open and enclosed spaces in terms of mental health outcomes [37].

3.4.2. Natural Elements

Similarly to spatial features, the measurement of nature elements in UGSs primarily relied on environmental audits carried out by the researchers [30,31,37–39,41,45–48]. Different standardised tools such as the EAPRS, NGST, and The Natural Environment Scoring Tool (NEST) were applied to measure different indicators for quality assessment [30,31,48]. Specialised ecological surveys were conducted in several studies according to the study content. Avian surveys were carried out to measure the bird species diversity and abundance [40,42,49], sometimes combined with habitat surveys to better understand the ecological complexity [40]. Additionally, GIS analysis was a common, more objective method for the measurement of nature elements [35,46,50]. Many studies combined these methods with subjective measurements using perception- and satisfaction-based Likert scales to capture residents' perceptions of the biodiversity and natural features. This combination of objective and subjective mea-

surements provided comprehensive insights into how natural elements influence mental wellbeing, with several studies revealing that the perceived biodiversity often mediated the psychological benefits of these elements [30,31,38–41,45–47,50].

Analysis of the 16 studies indicated that natural elements contributed to mental wellbeing through multiple pathways, with their effects varying according to the element type and quality. The most extensively investigated aspect was biodiversity (11 studies). Most of the studies showed that plant diversity and species richness generally showed positive associations with mental wellbeing [30,37,39,45,46], especially in terms of stress reduction and attention restoration. However, the relationship between avian diversity and wellbeing benefits appears complex. Studies on the avian diversity yielded mixed results [40,42,45,48,49]. Notably, several studies found that the perceived biodiversity often indicated stronger associations with mental health outcomes than actual biodiversity measures [40,45]. Water features were found to be another significant contributor to restoration [35,41,44,45]. Different types of water bodies seemed to offer distinct functions: dynamic features (streams, waterfalls) enhanced stress reduction and attention focusing, while still water (lakes, ponds) promoted meditation and emotional stability [35,46]. Notably, spaces integrating both green and blue elements demonstrated enhanced restorative potential compared to those with single elements [35,37]. The aesthetic quality and maintenance of natural elements were also important aspects [46,47,50]. Well-maintained vegetation with diverse colours and spatial arrangements enhanced the restorative potential [30,38,46], while poor maintenance decreased these benefits [39]. However, neither the quality nor maintenance of nature features showed significant effects on mental wellbeing in the study by Chu et al. (2021) [31]. Additionally, the visibility and accessibility of these natural elements significantly influenced their effectiveness in promoting mental wellbeing [50].

3.4.3. Facilities and Amenities

The measurement of facilities and amenities in UGSs also used systematic diversity in its methodology. Unsurprisingly, environmental audits were the main assessment tool as well [30,31,35,38,39,41,46–48]. These audits evaluated various characteristics of facilities and amenities, such as walking paths, seating areas, recreational facilities, and supporting amenities. Specialised audit tools (EAPRS, POST, NEST) were employed to provide standardised frameworks for the assessment [30,32,48]. Some studies used planned refurbishment assessments and GIS analysis to evaluate the spatial distribution and usability of facilities and amenities [35,36,46]. Subjective measurements were commonly used to capture users' perception and satisfaction using self-developed Likert scales [30,39,41,46,47].

Diverse relationships were found between facilities and amenities in UGSs and mental wellbeing. Walking-related facilities were the primary focus (seven studies). Well-maintained walking paths and comfortable pedestrian infrastructure indicated positive associations with attention restoration and stress reduction [30,39,46]. However, it is interesting that the effects were moderated by the design quality, with studies finding that road networks near UGSs could increase stress levels and reduce the restorative potential [37]. The walking comfort and pathway accessibility significantly influenced the perceived restoration benefits [38,46]. Recreational and rest facilities indicated mixed effects. Some studies found that sports facilities were positively associated with mental wellbeing [30,44]; others reported negative correlations, particularly when facilities generated noise or crowding [47]. Rest facilities, including benches and sitting areas, showed more consistent positive effects, although their impact was often affected by the quality and maintenance [32,39,41]. Meanwhile, improvements of the facilities, including playgrounds, shade structures, and sporting facilities, increased park usage, but the results remained inconsistent [30,36,44]. Notably, the effects of facilities and amenities may not increase the mental wellbeing of the

elderly [31,32,47]. In addition, adequate lighting, safety features, and general maintenance significantly increased the mental wellbeing benefits [41,46,47]. Conversely, incivilities and poor maintenance decreased the mental wellbeing benefits [31,47]. Cultural landscape elements and non-natural aesthetic features contributed positively to attention restoration [35,37], while spatial privacy and environmental cleanliness did not showed significant effects on wellbeing outcomes [38].

3.4.4. Combination

These studies employed different measurement methods. The studies used official databases [43], environmental audits [29], or GIS analyses [33,34], usually combined with perception measurements using Likert scales [29,33,34].

The combined assessment of multiple UGS qualities demonstrated the overall effects of the UGS quality on mental wellbeing. The studies found that high-quality ecological spaces (recognised as Sites of Importance for Nature Conservation in the UK) significantly contributed to life satisfaction and general mental wellbeing, showing stronger effects than those of ordinary open spaces [43]. The overall quality including the visibility and arrangement of green and blue spaces indicated varying associations with psychological outcomes, but with these relationships only being significant in specific urban areas [29]. Additionally, the street-view green space quality (SVG-Quality) influenced mental wellbeing through indirect pathways. Although not showing significant direct effects, higher quality UGSs indirectly improved mental wellbeing by enhancing social cohesion, promoting physical activity, and reducing stress [33]. Similar comprehensive quality assessments revealed significant improvements in depression and anxiety symptoms [34].

4. Discussion

4.1. Mental Wellbeing

Due to the increasing prevalence of mental health issues, there has been a growing awareness of and emphasis on mental health in recent years, especially following the lockdowns resulting from the COVID-19 pandemic [3,52]. Existing evidence has indicated the general benefits of urban green spaces (UGSs) on mental health. By encouraging residents to engage in physical or social activities, UGSs have the potential to reduce stress and enhance emotional restoration, which is consistent with the widely accepted theory [53].

This systematic review revealed several key methodological patterns in mental wellbeing assessments. Self-reported psychological scales were the primary method for assessing mental health, focusing on general wellbeing, positive and negative emotions, and attention restoration, as well as anxiety and depression. The diversity in outcome measures reflected both advantages and limitations in current research approaches. Although comprehensive in scope, ranging from general wellbeing to specific conditions like depression and anxiety, this variation creates challenges in cross-study comparisons and meta-analyses, especially since there were 22 studies considered. The predominant reliance on self-reported measures, though pragmatic for large-scale studies, raises concerns about response bias and the objectivity of the findings. There were only two studies incorporating physiological indicators such as the blood pressure, heart rate, and electroencephalograms [35,37]. This highlights a significant methodological gap in current research, which limits the integration of objective measurements which may capture the immediate physiological responses to UGS exposure to better measure mental wellbeing promotion, particularly in terms of stress reduction and attention restoration processes. Although there has been a recent emergence of experimental studies measuring physiological responses to UGSs in laboratory settings, these studies predominantly rely on simulated green environments (VR devices, pictures,

or soundtracks) as experimental interventions [54,55]. The portability of wearable devices, however, makes the objective measurement of mental wellbeing possible in real UGSs, suggesting potential directions for a future research methodology.

4.2. Quality of Urban Green Spaces

Overall, various aspects of the UGS quality are associated with mental health benefits. Our analysis identified distinct patterns in how different aspects of quality domains contribute to mental wellbeing outcomes. The findings demonstrated complex and sometimes counterintuitive relationships between the quality and mental health benefits.

Within the domain of spatial features, accessibility was the most common quality considered in the studies. Remarkably, the included studies showed that the accessibility of UGSs exhibited a certain level of inconsistency in its benefits to mental health. For example, the results showed that distant comprehensive parks sometimes provided stronger benefits than proximate smaller ones, which was inconsistent with the general understanding and challenged traditional accessibility-based planning approaches [44]. This could be attributed to variations in the measurement scales used for assessing accessibility across different studies [56]. In terms of spatial patterns, it seems that a more complex spatial structure appears to imply higher green space quality [37,57], although the evidence supporting this notion is not yet sufficient. This suggests the necessity of reconsidering how we conceptualise and measure accessibility and usability in urban planning, because different UGSs cater to diverse user groups with varying usage patterns, influenced by individual preferences.

The variety of natural elements was also considered an important aspect in enhancing the quality of UGSs. The assessment of natural elements provided the most consistent evidence for mental health benefits, particularly through the assessment of vegetation diversity and water features. An increase in the plant richness, blue space elements, and tree quantities in UGSs can effectively contribute to the mental health of participants [30,35,37–41,46–48]. The biophilia hypothesis suggests that human beings inherently have a natural inclination to establish connections with nature and other living entities: connecting to nature features potentially provided emotional support and mood restoration [58,59]. However, the studies specifically focusing on avian diversity showed inconsistent results [40,42,45,49]. The notable disparity between the effects of the perceived versus actual biodiversity raises important questions about the measurement validity and the role of user perceptions [40,45]. This finding suggests that both objective quality metrics and subjective experiences should be considered in UGS planning. Compared to trees, shrubs exhibited negative mental health effects [44]. This could be attributed to the difficulties shrubs cause for accessibility or the impression of disorder and insecurity associated with dense and tangled shrubbery. There is limited evidence regarding the impact of vegetation types, necessitating further research.

The analysis of facilities and amenities showed complex trade-offs in the UGS quality. Walking-related facilities, the most extensively studied amenity type, demonstrated particularly nuanced effects. While well-maintained walking paths and comfortable pedestrian infrastructure generally showed positive associations with attention restoration and stress reduction, their benefits were dependent on the design context [30,35,37,39,46,47]. Notably, the finding that road networks near UGSs could increase stress levels and reduce the restorative potential highlights the critical importance of careful infrastructure planning and integration with the surrounding environment [37]. The impacts of recreational and rest facilities presented an interesting paradox in the UGS quality. On the one hand, some studies found that sports facilities were positively associated with mental wellbeing; on the other hand, the others reported negative correlations when these facilities generated noise or crowding, especially for the elderly, suggesting that the benefits of recreational amenities

may be offset by their potential mental wellbeing benefits [30,31,36,44,47]. Regarding other facilities, benches and sitting areas demonstrated more consistently positive effects, though their impact was strongly moderated by the maintenance quality. Supporting amenities and maintenance were crucial mediating factors. The significant positive effects of adequate lighting and safety features underscore the importance of creating environments that feel secure and welcoming. Similarly, the negative impact of incivilities and poor maintenance on mental wellbeing benefits highlights the critical role of ongoing facility management. [30,31,38,39,41,46] These contrasting findings emphasise the necessity of considering both the direct functional benefits of facilities and their potential indirect effects on the overall user experience. Comprehensive quality assessments further illuminated the interconnected nature of these domains. The identification of indirect pathways, including social cohesion and physical activity, suggests that high-quality UGSs influence mental wellbeing through multiple mechanisms. This complexity emphasises the need for integrated assessment approaches that can capture both the direct and indirect effects of the UGS quality on mental health outcomes [29,33,34,43].

4.3. Limitations

In this study, we conducted a relatively comprehensive review of the association of the UGS quality with mental health. Although our final sample of 22 studies might appear relatively small, this limited number reflects the rigorous inclusion criteria, focusing specifically on the quality measurements of UGSs and their direct impacts on mental wellbeing outcomes. Many studies were excluded because they either examined only the quantity of green spaces or evaluated only the perception and satisfaction for quality measurements. This selective approach, while reducing our sample size, was necessary to ensure a focused analysis of quality–wellbeing relationships. Additionally, the included studies showed considerable heterogeneity in their measurements and mental wellbeing outcome assessments, making the comparisons challenging. The predominant use of cross-sectional designs (18 out of 22 studies) limits our ability to establish causal relationships between the UGS quality and mental health outcomes. Furthermore, while recent years have seen an emergence of experimental studies measuring physiological responses to green space exposure in laboratory settings, these studies predominantly rely on simulated green environments as experimental interventions, suggesting a need for more field-based experimental research examining real-world interactions with UGSs. Lastly, this review only included English-language publications, which may have excluded potentially relevant studies in other languages. Although the preliminary search suggested that eligible studies in non-English languages were extremely scarce, future research may consider expanding the language inclusion criteria due to the explosive growth of this topic all over the world. This review also excluded studies focusing on minors, as many of these studies assess mental wellbeing through parental or guardian proxy reports instead of direct self-reports from the participants. Although this approach ensured consistency in measurements across the included studies, it may limit the applicability of our findings to minors. Future research could address this gap by including objective assessments of the mental wellbeing of minors.

5. Conclusions

Although the research field of the health benefits of green spaces is thriving, the quantity of research on UGS quality and mental wellbeing remains limited. The definition of the quality of green spaces was heterogeneous. Our findings demonstrate that natural elements, particularly vegetation diversity and water features, consistently showed positive associations with mental wellbeing, while the effects of spatial features like accessibility

showed mixed results. The impact of facilities and amenities appeared more complex, with their benefits heavily dependent on the design quality and maintenance. Most current evidence comes from cross-sectional studies using varied quality measurements, suggesting a need for more standardised approaches and longitudinal research to better understand the causal relationships between the urban green space quality and mental health outcomes.

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