
Green Spaces and Elderly Well-being in Urban Planning: A Survey

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Abstract

This survey explores the interdisciplinary study of urban planning and public health, emphasizing the integration of green spaces to enhance the mental health and well-being of elderly populations. It highlights the necessity of incorporating ecological, social, and economic factors into urban design to create sustainable environments conducive to mental health, particularly for older adults. The survey systematically examines the role of green spaces in promoting mental health, urban planning strategies, public health implications, and challenges to implementation. Key findings underscore the importance of addressing socioeconomic disparities and accessibility barriers, urban density constraints, and the need for interdisciplinary collaboration. Case studies from cities like Copenhagen, Tokyo, New York, and Singapore illustrate successful integration practices, offering insights into innovative design and implementation techniques. Future research directions emphasize refining methodologies, expanding research scopes, and assessing long-term impacts and causal relationships to optimize green space design and accessibility. By leveraging interdisciplinary approaches and innovative strategies, urban planners can develop inclusive and health-promoting environments that significantly enhance the quality of life for elderly urban residents.

1 Introduction

1.1 Interdisciplinary Nature of Urban Planning and Public Health

The intersection of urban planning and public health is crucial for enhancing the well-being of elderly populations. This interdisciplinary approach integrates ecological, social, and economic factors to create sustainable urban environments that promote mental health and overall well-being [1]. The strategic incorporation of greenery in urban landscapes has been shown to improve mental health outcomes for older adults by providing restorative environments that aid physiological stress recovery [2].

Adopting a transdisciplinary framework in urban planning is essential for addressing the complex interdependencies among biodiversity, health, and climate change [3]. Innovative methodologies, such as those assessing urban visual appeal, underscore the necessity of linking urban planning with public health to enhance elderly well-being [4]. Historically, streetscape designs have been directed at improving health outcomes, necessitating a renewed focus on the subjective experiences of urban residents and user-centered planning approaches.

The morphology of urban green spaces is vital for preserving natural habitats and contributing to the mental health of urban residents, including the elderly [5]. Theoretical perspectives from climate economics, which link environmental stressors to mental health outcomes, further emphasize the importance of incorporating ecological considerations into urban planning [6]. Frameworks categorizing strategies to enhance access to green spaces, while ensuring physical distancing, are critical in urban planning and public health policies aimed at supporting elderly populations [7].

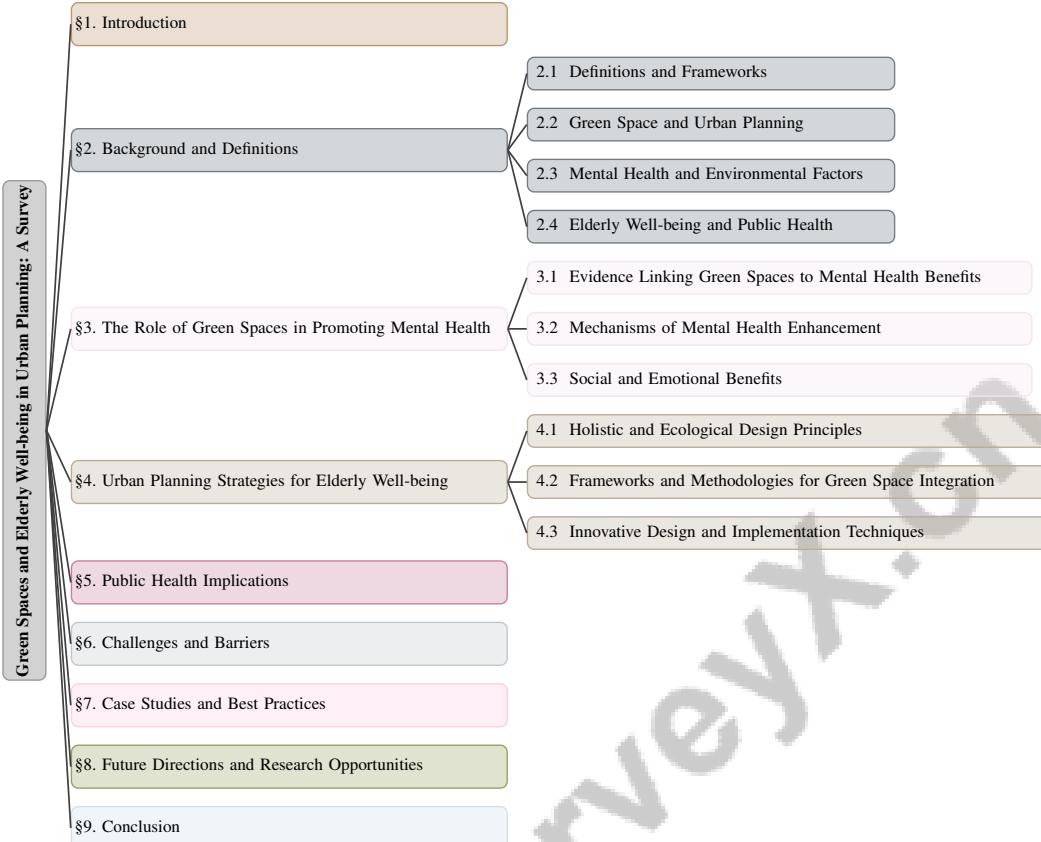


Figure 1: chapter structure

Understanding mechanisms of social exclusion is crucial, as urban green spaces significantly foster social inclusion and community cohesion [8]. Furthermore, categorizing urban greenspace use based on socioeconomic status reveals disparities that must be addressed through collaborative urban planning and public health efforts [7]. The survey introduces a framework linking biodiversity and psychological well-being with individual characteristics, suggesting that the benefits of biodiversity are not universally applicable [9]. This interdisciplinary approach is essential for developing informed strategies to enhance the quality of life for older adults, utilizing open data and collaborative frameworks [6].

1.2 Structure of the Survey

This survey systematically examines the role of green spaces in promoting mental health and well-being among elderly populations in urban environments. It begins with an introduction that establishes the interdisciplinary nature of urban planning and public health, highlighting their collective impact on enhancing elderly well-being. The subsequent background and definitions section provides foundational understanding of key concepts such as green space, urban planning, mental health, and elderly well-being, paving the way for further discussions.

The core of the survey is divided into thematic sections. The first major section explores the role of green spaces in promoting mental health, presenting evidence of their benefits and discussing mechanisms through which they enhance mental well-being. This is followed by a section on urban planning strategies, examining various design principles, frameworks, and innovative techniques for integrating green spaces into urban settings.

The survey then addresses the public health implications of integrating green spaces into urban planning, emphasizing their potential to enhance residents' quality of life, reduce healthcare costs, and mitigate environmental challenges. It notes that the benefits of urban green spaces (UGS) are not uniformly distributed, particularly highlighting how targeted greening strategies can promote

social inclusion for marginalized groups, including the elderly with dementia and individuals from underprivileged neighborhoods. Additionally, it underscores the importance of collaboration between public and private sectors in developing effective inclusion strategies that leverage health benefits associated with high-quality urban green spaces [5, 8]. The discussion of challenges and barriers to implementation, including socioeconomic and accessibility issues, urban density constraints, and the necessity for interdisciplinary collaboration, provides a realistic perspective on the complexities involved.

To exemplify best practices in urban green space integration, the survey features detailed case studies from cities such as Copenhagen, Tokyo, New York, and Singapore, showcasing successful strategies for enhancing social inclusion, promoting public health, and improving urban living environments through thoughtful design and implementation of green spaces [10, 11, 8, 12, 13]. Finally, the survey concludes by identifying future research directions, emphasizing the need to refine methodologies, integrate interdisciplinary approaches, and assess long-term impacts to further enhance the design and accessibility of green spaces for the elderly. The following sections are organized as shown in Figure 1.

2 Background and Definitions

2.1 Definitions and Frameworks

The impact of green spaces on elderly well-being necessitates precise definitions and frameworks. Green space exposure, the interaction between individuals and urban green environments, significantly affects older adults' mental health [5]. The quality of these spaces is crucial, as varied exposure measures can lead to different health outcomes, necessitating thorough evaluations.

Bronfenbrenner's ecological theory offers a foundational framework for understanding mental health determinants in public health research, emphasizing the complex interplay of environmental systems influencing mental health. This theory aids in examining how interactions among social, physical, and psychological environments affect well-being, highlighting the role of natural settings, such as wildlife encounters, in enhancing mental health outcomes [14, 15]. Biodiversity in urban green spaces, including species like birds and plants, contributes to psychological well-being by providing experiences that extend beyond physical health benefits [9].

The COVID-19 pandemic underscored the necessity for access to parks and green spaces for mental and physical health. Nature-facilitated physical activity has proven benefits in mitigating pandemic-related adverse effects, such as obesity and cardiovascular disease. Park closures during the pandemic disproportionately affected vulnerable populations, stressing the need for equitable green space access to promote resilience [16, 17, 15]. Disparities in green space access, often influenced by socioeconomic factors, significantly impact urban populations' health and well-being.

Understanding physiological stress recovery mechanisms facilitated by urban green spaces is essential for designing spaces that offer immediate stress relief and enhance long-term mental health for the elderly. Incorporating wildlife encounters, known to contribute to well-being experiences, can create ecologically rich, socially inclusive spaces. Addressing barriers such as physical limitations is crucial, and innovative approaches like augmented soundscapes may replicate outdoor restorative benefits for those in care facilities, supporting psychological health [18, 15].

2.2 Green Space and Urban Planning

Integrating green spaces into urban planning enhances urban areas' environmental and social dynamics, significantly impacting community well-being and mental health [1]. Urban green spaces mitigate outdoor heat stress and address global inequalities, underscoring their critical role in urban environments [3]. Effective planning requires a comprehensive approach incorporating ecological, social, and economic dimensions to foster sustainable development [19].

Recent literature emphasizes the need for sustainable urban green space patterns and strategies. Zou et al. highlight the importance of enhancing urban green spaces' aesthetic and ecological functionality [20]. In Thessaloniki, a green space deficit negatively impacts residents' quality of life, necessitating multiscale intervention planning [21].

Innovative tools, such as street view imagery for human perception data collection, provide valuable insights for urban planners. These tools facilitate incorporating public preferences into green space design, ensuring they meet diverse urban populations' needs [22]. AI-aided design processes, as discussed by Chen, enable rapid, effective landscape space generation, overcoming traditional method limitations [23].

The COVID-19 pandemic further underscored the importance of accessible urban green spaces, as shelter-in-place orders limited physical activity options and exacerbated green space accessibility disparities. This situation highlights the necessity for urban planning policies prioritizing equitable green space access, particularly in high-density cities like Kuala Lumpur and Penang [24].

Public preferences for urban green spaces, including cleanliness, maintenance, and biodiversity, are critical in urban planning. Studies in Lisbon, Porto, and Évora demonstrate how these preferences influence green space design and management, aligning with community needs [25]. The relationship between urban green space and happiness, explored by Kwon et al., suggests that green spaces contribute to well-being alongside economic factors like GDP, with varying impacts based on a country's wealth [10].

Assessing urban green space quality is vital for understanding health implications. The RECITAL tool, developed by Knobel et al., offers a quality assessment method emphasizing local user experiences over expert evaluations, providing a nuanced understanding of green space quality. This approach aligns with addressing perceived neighborhood quality, as highlighted by Muller et al., crucial for effectively integrating green spaces into urban planning [26]. The importance of urban greenery in enhancing living environments and resident health is reinforced by Zhang et al., underscoring the role of green spaces in urban planning [13].

2.3 Mental Health and Environmental Factors

The relationship between environmental factors and mental health is increasingly recognized in urban planning and public health. Green spaces, as a pivotal environmental element, are consistently linked to enhanced mental well-being. Streetscapes enriched with green spaces correlate with improved health outcomes, emphasizing compact urban environments' role in fostering mental health [27]. Natural elements, such as greenery and sky, significantly influence mental health, with oppressive cityscapes potentially impeding access to these beneficial elements [28].

Environmental stressors, such as light pollution, complicate urban mental health. Light pollution disrupts sleep patterns and exacerbates mental health issues, highlighting environmental factors' multifaceted impact on human health [29]. Urban decay, characterized by neglect signs like abandoned buildings and litter, contributes to mental health challenges, reinforcing the need for well-maintained urban environments [30].

The availability of green spaces inversely correlates with depression incidence, with studies showing increased green space exposure alleviates depressive symptoms [31]. This relationship underscores integrating green spaces into urban planning as a strategy to address mental health issues. The psychological benefits of urban biodiversity and nature experiences are well-documented, revealing positive associations between exposure to diverse natural environments and enhanced mental well-being [9].

Technological advancements offer new methodologies for assessing mental health concerning environmental factors. Natural Language Processing (NLP) application to analyze sentiment in TripAdvisor reviews provides insights into perceived urban green space quality, facilitating a deeper understanding of their mental health impact [11]. Integrating social media data, such as tweets, into mental health assessments enables neighborhood-level mental health outcome predictions, addressing the challenge of accurately capturing local mental health conditions [32].

2.4 Elderly Well-being and Public Health

The intersection of elderly well-being and public health is increasingly recognized, particularly in urban environments where green space integration plays a pivotal role. Urban green spaces provide restorative environments alleviating depression and mental health issues prevalent among older adults [12]. These spaces promote social inclusion by offering interaction opportunities, often limited for the elderly due to unequal green space access [8].

Disparities in green space availability and quality between cities in the Global North and South significantly impact elderly well-being, with the Global South often experiencing lower cooling capacities and benefits [3]. Socioeconomic factors compound this disparity, as lower-income neighborhoods, despite having more greenery, often suffer from reduced sky visibility, negatively affecting environmental quality and elderly residents' well-being [28].

Understanding the complex interactions between urban features and health outcomes is crucial. For instance, the lack of comprehensive knowledge regarding urban features' influence on cancer prevalence highlights the need for integrated urban health strategies [33]. Integrating green spaces into urban planning can mitigate such health issues by enhancing environmental quality and providing spaces for physical activity and social interaction, vital for elderly well-being [12].

3 The Role of Green Spaces in Promoting Mental Health

3.1 Evidence Linking Green Spaces to Mental Health Benefits

Extensive research underscores the positive impact of green spaces on mental health, particularly for elderly populations. A significant inverse relationship exists between green space availability and antidepressant prescriptions, indicating that increased access to these areas correlates with improved mental health outcomes [34]. Urban green spaces contribute to stress reduction and overall well-being [2]. The influence of streetscape greenery on mental well-being is notable, with stronger mediation effects compared to the Normalized Difference Vegetation Index (NDVI) [1], highlighting the crucial role of greenery in urban environments.

Regression analyses reveal that urban green space, alongside GDP, significantly accounts for happiness levels in developed nations, emphasizing the essential contribution of green spaces to overall well-being [10]. Prolonged exposure to urban green spaces is linked to enhanced physical and mental well-being among the elderly [7]. For older adults experiencing depression, the restorative and social benefits of green spaces are particularly valuable, with augmented spatial soundscapes proposed to simulate these benefits in environments lacking direct access [18].

Geographic disparities in urban visual appeal, influenced by AI-generated ratings, suggest that improving visual aesthetics through green spaces could mitigate these disparities and bolster mental health outcomes [4]. The application of Generative Adversarial Networks (GANs) to visualize urban design improvements underscores the potential of green spaces to transform areas with poor health outcomes into healthier environments [27]. Exposure to green spaces significantly reduces depression risk, with a notable buffer distance of 510 meters for this association [31]. Systematic evaluations of urban street quality perceptions further underscore the mental health advantages of green spaces [26], and urban green spaces mitigate heat stress, correlating with improved mental health outcomes for the elderly [3].

3.2 Mechanisms of Mental Health Enhancement

Green spaces enhance mental health through complex environmental, social, and psychological mechanisms. A primary pathway is stress reduction; exposure to natural settings promotes physiological and psychological recovery from stress. Urban greenery lowers stress levels by creating restorative environments conducive to relaxation and mental rejuvenation [1]. This effect is amplified by improved air quality and reduced noise pollution associated with green spaces, contributing to a more tranquil urban experience.

Physical activity is another significant mediator; accessible and appealing green spaces encourage activities such as walking, jogging, and cycling, positively affecting mental well-being. Regular physical activity in green settings enhances physical health and improves mood while alleviating symptoms of depression and anxiety [1]. Thus, integrating green spaces into urban planning promotes healthier lifestyles among residents.

Social interaction and cohesion are critical components of the mental health benefits derived from green spaces. These areas act as communal hubs, facilitating social activities that foster a sense of community and belonging. The social interactions enabled by green spaces enhance support networks crucial for mental health, particularly among elderly individuals facing social isolation [1]. Advanced methodologies, such as Bayesian geoadaptive quantile regression (BQR), elucidate the

complex interplay of these mechanisms by exploring non-linear associations between green space and mental health indicators [34]. Additionally, language-based assessments derived from social media provide innovative insights into mental health conditions like depression and anxiety, offering real-time evaluations of the mental health impacts of green spaces at the community level [35].

As illustrated in Figure 2, this figure categorizes the diverse mechanisms through which green spaces enhance mental health into environmental, social and psychological, and physical activity pathways. Each category highlights specific benefits such as stress reduction, improved air quality, social interaction, and regular exercise, underscoring the multifaceted role of green spaces in promoting mental well-being. The studies depicted in the figure examine various methodologies and tools employed to understand and enhance mental health, including the use of Twitter data for mental health trend assessment, the analysis of temperature effects on helpline calls, and advanced techniques for simulating environmental conditions to study restorative benefits of green spaces [35, 36, 18].

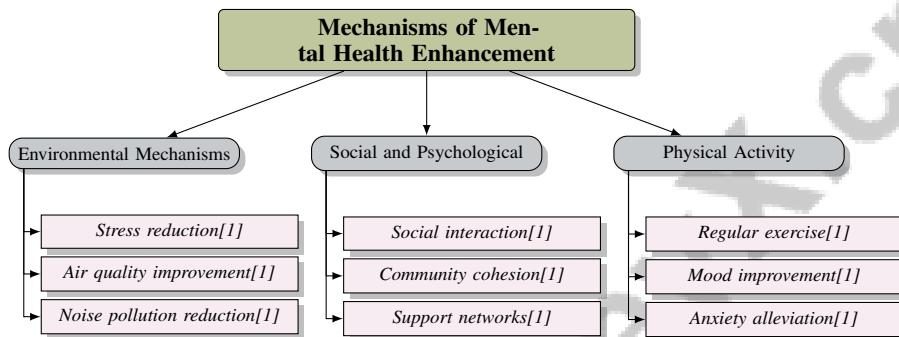


Figure 2: This figure illustrates the diverse mechanisms through which green spaces enhance mental health, categorized into environmental, social and psychological, and physical activity pathways. Each category highlights specific benefits such as stress reduction, improved air quality, social interaction, and regular exercise, underscoring the multifaceted role of green spaces in promoting mental well-being.

3.3 Social and Emotional Benefits

Green spaces offer significant social and emotional benefits, particularly for elderly populations in urban areas. These benefits encompass enhanced social interactions, a greater sense of community, and improved emotional well-being. Green spaces facilitate social engagement among residents, fostering community cohesion and reducing feelings of loneliness and isolation [8]. Such interactions are vital for elderly individuals, who may face barriers to social participation due to mobility limitations or lack of accessible communal areas.

Moreover, green spaces serve as venues for community activities, strengthening social networks and support systems. These gatherings not only encourage physical activity but also enhance psychological well-being by promoting a sense of belonging and community identity [1]. Emotionally, green spaces are linked to reduced stress and improved mood, contributing to overall mental health. Natural elements like trees, plants, and water features create calming environments that facilitate emotional recovery and relaxation [2]. This restorative effect is especially beneficial for the elderly, who may experience heightened stress and anxiety due to health concerns or social isolation.

Additionally, the aesthetic and sensory experiences provided by green spaces—such as the sounds of birds and the sight of greenery—evoke positive emotions and enhance life satisfaction [9]. These experiences enrich quality of life by offering respite from urban noise, allowing individuals to connect with nature and find emotional solace.

4 Urban Planning Strategies for Elderly Well-being

The increasing elderly population in urban areas demands strategic urban planning to enhance their well-being. This section explores strategies and principles for creating environments that support older adults' health and quality of life. By focusing on holistic and ecological design principles, we

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Holistic and Ecological Design Principles	Human-Centric Feedback Technology-Enhanced Planning	URSim[30] CVPUA[28]
Frameworks and Methodologies for Green Space Integration	Public Engagement and Perception Analytical and Evaluation Techniques	percept[22], UTMA[12] PFL-CRM[31], GVI-BPC[13], GVA[4]
Innovative Design and Implementation Techniques	Wireless Communication Deep Learning Applications	SWAS[37] GAN-SA[27], PSGDS[23], GDUIP[21]

Table 1: This table presents a comprehensive overview of various urban planning strategies and methodologies aimed at enhancing elderly well-being through green space integration. It categorizes the methods into three main areas: holistic and ecological design principles, frameworks and methodologies for green space integration, and innovative design and implementation techniques. Each category highlights specific features and methods, illustrating the diverse approaches employed to create age-friendly urban environments.

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identify strategies addressing this demographic's unique needs, setting the stage for discussions on frameworks and methodologies for integrating green spaces into urban settings. Table 2 provides a detailed summary of the strategies and methodologies explored in this section for integrating green spaces into urban planning to improve the well-being of the elderly. Additionally, Table 3 provides a comprehensive overview of the strategies and methodologies discussed in this section, emphasizing their role in integrating green spaces into urban planning to improve elderly well-being.

4.1 Holistic and Ecological Design Principles

Holistic and ecological design principles are crucial for urban environments that support elderly populations. These principles advocate for integrating natural and built environments to enhance ecological sustainability and human health. Green spaces play a critical role in urban development, promoting social inclusion and overall well-being. Access to urban green spaces (UGS) mitigates social exclusion for marginalized groups, including the elderly, fostering community cohesion and enhancing happiness by facilitating social interaction and recreational activities linked to improved mental and physical health outcomes [19, 10, 11, 8, 15].

A major urban planning challenge is the limited UGS access in densely populated areas, adversely affecting the elderly who rely on these spaces for well-being. This highlights the need for age-friendly urban designs, especially in high-density environments like Hong Kong, where perceptions of UGS influence health outcomes. Research shows perceived proximity to UGS correlates with increased visitation frequency and duration, suggesting that thoughtful design and management can enhance seniors' quality of life. Strategies promoting social inclusion within UGS can address marginalized groups' needs, including elderly individuals with dementia, fostering a more equitable urban landscape [10, 7, 8]. Holistic design principles advocate for inclusive spaces catering to diverse user needs, promoting accessibility and usability for all age groups, aligning with the necessity for age-friendly environments facilitating physical activity, social interaction, and mental well-being.

Figure 3 illustrates the hierarchical structure of holistic and ecological design principles, focusing on urban green spaces, age-friendly urban design, and innovative methodologies. This figure highlights the roles these principles play in enhancing social inclusion, accessibility, and data-driven urban planning, reinforcing the importance of integrating these elements into urban design strategies.

Innovative methodologies, such as the URSimulator framework, incorporate human perception feedback into urban renewal simulations, illustrating design principles enhancing urban environments [30]. This integration ensures urban planning meets ecological, aesthetic, and subjective resident experiences.

Additionally, computer vision-based pipelines for urban analysis inform housing policies by quantitatively assessing sky visibility and greenery, crucial for creating health-promoting urban spaces [28]. This technological approach supports holistic design by providing data-driven insights into urban environmental quality, enabling planners to make informed decisions that enhance residents' quality of life.

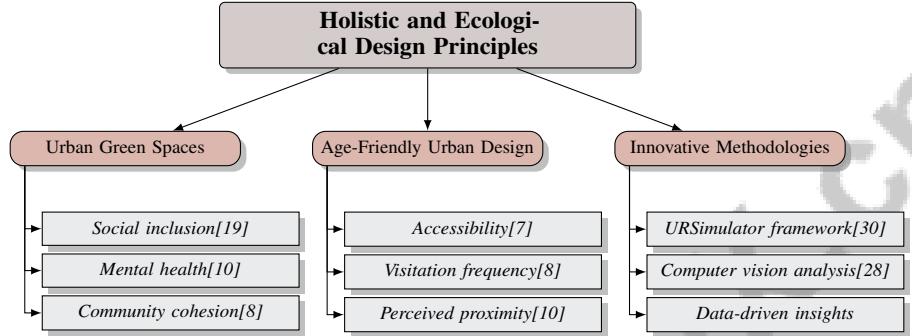


Figure 3: This figure illustrates the hierarchical structure of holistic and ecological design principles, focusing on urban green spaces, age-friendly urban design, and innovative methodologies, highlighting their roles in enhancing social inclusion, accessibility, and data-driven urban planning.

4.2 Frameworks and Methodologies for Green Space Integration

Integrating green spaces into urban environments requires addressing both ecological and social dimensions. The Green View Index Best Path Calculation (GVI-BPC) serves as a systematic framework for integrating urban greenery by evaluating the visual appeal and accessibility of green spaces [13]. This method emphasizes visual and aesthetic dimensions in urban planning, ensuring green spaces are functional and enhance the urban experience.

Technological innovations significantly influence modern urban planning methodologies. Mobile-friendly web applications enable users to rate street view images based on perceptions, incorporating citizen science into the planning process [22]. This participatory approach leverages public input to gather valuable urban environment data, fostering a more inclusive and democratic planning process. Additionally, advanced AI techniques, such as GPT-4, assess the visual appeal of urban environments through Google Street View images, complementing human evaluations and enhancing urban analysis accuracy and efficiency [4].

Research categorizing urban green space integration into urban green space planning, urban green infrastructure, urban ecosystem services, and urban habitat and biodiversity provides a structured framework for understanding the complex interactions between green spaces and their ecological and social functions [20]. These categories facilitate comprehensive analyses of green spaces' multifaceted roles in urban environments, guiding the development of targeted integration strategies.

Current methods for measuring urban green space are organized into five standards: population-ratio, area percentage, catchment area, facility specification, and local standards [24]. Each standard provides specific criteria for evaluating urban green space, ensuring planning efforts are tailored to local needs and conditions. This systematic approach allows for developing context-specific green space strategies responsive to each urban area's unique characteristics.

Incorporating multisensory elements into urban green space design is essential for enhancing well-being, as research highlights the importance of sensory experiences in public spaces [2]. This multisensory approach is crucial for creating environments that promote mental and physical health. The application of AI and NLP techniques for analyzing user reviews regarding urban green space quality assessments represents an innovative technological application in this context, offering valuable insights into public perceptions and preferences [12].

Frameworks categorizing urban green spaces based on cooling capacity and socio-economic factors influencing their development underscore the need to address global inequalities in urban planning [3]. These frameworks ensure green space integration considers both environmental benefits and social equity, promoting sustainable and inclusive urban development. The use of advanced statistical techniques, such as the penalized functional linear Cox regression model, to determine appropriate buffer distances for assessing the relationship between green space exposure and health outcomes exemplifies the integration of cutting-edge methodologies in urban planning [31].

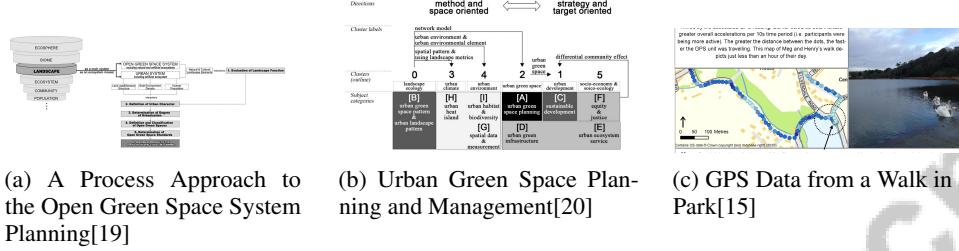


Figure 4: Examples of Frameworks and Methodologies for Green Space Integration

As illustrated in Figure 4, integrating green spaces is pivotal in urban planning strategies aimed at enhancing elderly well-being. Various frameworks and methodologies underscore the multifaceted approach required for effective green space integration. The first framework, "A Process Approach to the Open Green Space System Planning," presents a hierarchical flowchart guiding green space evaluation and planning from ecosystem levels to individual populations, emphasizing foundational biomes. The "Urban Green Space Planning and Management" framework offers a hierarchical classification system distinguishing method and space-oriented strategies from strategy and target-oriented ones, highlighting clusters such as urban climate and sustainable development. Lastly, "GPS Data from a Walk in a Park" exemplifies technology's role in understanding individual interactions with green spaces, using GPS data to map paths and speeds within a park. Collectively, these examples illustrate a comprehensive urban planning approach prioritizing green space integration to enhance elderly quality of life [19, 20, 15].

4.3 Innovative Design and Implementation Techniques

Innovative design and implementation techniques are essential for effectively integrating green spaces in urban areas, particularly in densely populated environments where traditional methods may be inadequate. One cutting-edge approach involves using deep learning in generative park space design, leveraging advanced algorithms to create design plans based on the topological relationships among landscape elements [23]. This AI-aided methodology allows for rapid generation of realistic landscape designs, providing urban planners with flexible tools to address dynamic urban needs.

In addition to deep learning, the application of image-to-image translation and image inpainting algorithms marks a significant advancement in urban intervention planning. These techniques produce photorealistic images that visualize potential urban transformations, offering a more immersive representation of proposed changes compared to traditional planning methods [21]. By providing clear visual contexts, these innovations facilitate stakeholder engagement and informed decision-making in urban planning.

Incorporating advanced technologies, such as Artificial Intelligence and Natural Language Processing, into urban planning significantly enhances the aesthetic and functional quality of urban green spaces. This integration not only improves the overall experience but also fosters sustainable and resilient urban environments by enabling data-driven decisions regarding future investments in urban green space. Emphasizing the morphological aspects of urban green spaces aids in preserving natural habitats and promoting effective spatial patterns that contribute to ecological balance within urban settings [20, 11]. As cities evolve, adopting innovative design and implementation techniques will be crucial for creating urban environments that are both ecologically sustainable and conducive to resident well-being.

As depicted in Figure 5, innovative design and implementation techniques are crucial for urban planning, particularly concerning the well-being of the elderly. The first example, "SensorTag: A

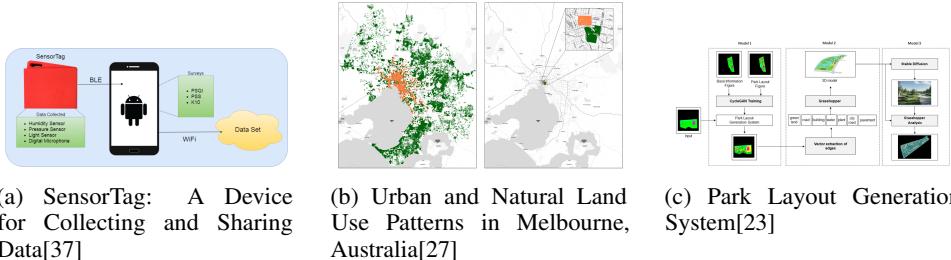


Figure 5: Examples of Innovative Design and Implementation Techniques

"Device for Collecting and Sharing Data," showcases a sophisticated data collection system utilizing Bluetooth Low Energy (BLE) technology to connect a SensorTag to a smartphone, enabling wellness data collection through established scales such as PSQI, PSS, and K10. This data is securely stored in a cloud server, facilitating comprehensive wellness assessments. The second example, "Urban and Natural Land Use Patterns in Melbourne, Australia," visually compares urban and natural land use, emphasizing the balance between developed and green spaces essential for promoting a healthy lifestyle among the elderly. Lastly, the "Park Layout Generation System" illustrates an advanced process for designing park layouts using multiple models, including 3D modeling and vector data analysis through Grasshopper, ensuring functional and aesthetically pleasing park designs. Together, these examples underscore the importance of integrating technology and thoughtful design in urban planning to enhance elderly quality of life [37, 27, 23].

Feature	Holistic and Ecological Design Principles	Frameworks and Methodologies for Green Space Integration	Innovative Design and Implementation Techniques
Design Focus	Inclusive Spaces	Visual Appeal	Generative Design
Technological Integration	Data-driven Insights	Citizen Science	Deep Learning
Social Impact	Social Inclusion	Democratic Planning	Stakeholder Engagement

Table 3: This table presents a comparative analysis of various urban planning strategies and methodologies aimed at enhancing the well-being of the elderly through green space integration. It highlights key features such as design focus, technological integration, and social impact across three main categories: holistic and ecological design principles, frameworks and methodologies for green space integration, and innovative design and implementation techniques. The table underscores the importance of inclusive and data-driven approaches in creating age-friendly urban environments.

5 Public Health Implications

5.1 Enhancing Quality of Life

Urban green spaces (UGS) are pivotal in enhancing the quality of life for the elderly by providing ecological, social, and mental health benefits. The inequitable distribution of UGS, often influenced by socioeconomic factors and urban policies, adversely affects the elderly's well-being [8]. Effective integration of green spaces into urban settings promotes physical activity, social interaction, and mental wellness, crucial for older adults. Proximity to UGS significantly encourages their utilization, positively impacting the elderly's quality of life. Urban planning that improves greenery access and sky visibility fosters restorative environments [13]. Initiatives that incorporate vegetation and community feedback during urban renewal processes enhance perceived safety and vibrancy, benefiting the elderly [30].

Technological advancements, such as AI-assisted urban design, facilitate dynamic planning that meets evolving population needs. These innovations enable real-time aesthetic evaluations and extensive dataset processing, essential for informed decision-making [12]. Social media reviews provide a cost-effective alternative to traditional assessments, enhancing public health interventions for older adults. The quality of UGS and the methodologies used to assess them significantly influence public health outcomes. Research shows that individuals with high nature-relatedness report positive well-being linked to perceived biodiversity, while those with low nature-relatedness may experience adverse effects [9]. Comprehensive evaluations of green space quality are necessary to cater to the diverse needs of urban residents.

5.2 Reducing Healthcare Costs

Thoughtful design and integration of urban green spaces can substantially reduce healthcare costs by promoting preventive health measures and enhancing overall well-being. UGS serve as natural interventions that decrease the prevalence of chronic diseases and mental health disorders, major contributors to healthcare expenditures. By fostering environments that encourage physical activity and social interaction, green spaces help mitigate lifestyle-related diseases such as obesity, cardiovascular issues, and depression, thus alleviating financial burdens on healthcare systems [1]. Research links green spaces to reduced stress levels and improved mental health, crucial for preventing costly mental health interventions [2]. Accessible and well-maintained green spaces can decrease reliance on medical treatments by providing natural settings conducive to therapeutic activities and stress relief [18]. This preventive strategy aligns with public health initiatives aimed at reducing long-term healthcare costs through community wellness programs.

The economic benefits of green spaces extend beyond direct healthcare savings. By enhancing urban aesthetics and livability, green spaces can boost property values and attract investments, contributing to urban economic vitality [4]. Increased property values and economic activity related to well-integrated green spaces can generate additional tax revenues for reinvestment into public health and infrastructure improvements. Incorporating advanced technologies, such as AI and data analytics, into the planning and management of urban green spaces can further optimize health benefits and cost-effectiveness [11]. These technologies provide insights into user preferences and health outcomes, enabling urban planners to design green spaces that maximize health benefits while minimizing maintenance costs, ensuring sustainable urban development.

5.3 Addressing Environmental and Climate Challenges

Integrating green spaces in urban environments strategically addresses environmental and climate challenges associated with rapid urbanization and climate change. Green spaces act as critical infrastructures that mitigate urbanization's adverse effects, such as heat islands, air pollution, and biodiversity loss, enhancing climate resilience and environmental sustainability [19]. Increasing urban greenery effectively lowers ambient temperatures and improves air quality, essential for adapting to climate change impacts. Urbanization often fragments natural habitats and diminishes biodiversity, exacerbating climate change effects. Incorporating green spaces into urban planning aids in preserving and restoring ecosystems, providing habitats for diverse species, and promoting ecological balance. This ecological integration fosters biodiversity, vital for maintaining ecosystem health and resilience, and enhances urban carbon sequestration, playing a crucial role in reducing greenhouse gas emissions [38, 8].

Furthermore, green spaces are instrumental in managing stormwater and mitigating flood risks in urban areas. By facilitating natural water infiltration, they alleviate pressure on drainage systems, reducing flooding likelihood during extreme weather events. This function is particularly vital in the context of climate change, as rising temperatures and increased extreme weather events pose significant threats to human health and ecosystem stability. Enhanced management and expansion of urban green infrastructure can mitigate these adverse effects, promoting better health outcomes and resilience against climate change, particularly in regions with pronounced disparities in access to such resources [3, 38]. The social and economic benefits of green spaces also contribute to climate adaptation and mitigation efforts. By providing cooling effects that lower outdoor temperatures, green spaces enhance urban livability. This reduction in heat stress improves resident comfort and decreases air conditioning demand, leading to lower carbon emissions. However, research indicates stark global inequality in the cooling capacity of urban green spaces, particularly between Global North and South cities, with the latter experiencing significantly less cooling benefit. Expanding and optimizing green spaces can enhance outdoor cooling adaptation, foster social cohesion, and contribute to climate change mitigation efforts [11, 3, 10]. Additionally, the aesthetic and recreational value of green spaces enhances community resilience by promoting social cohesion and well-being, essential for adapting to climate-related stresses.

6 Challenges and Barriers

The development and accessibility of urban green spaces (UGS) are hindered by socioeconomic and accessibility barriers, disproportionately affecting marginalized groups such as the elderly, individuals

with mental health challenges, and residents of underprivileged neighborhoods. These barriers limit access to restorative environments, necessitating targeted urban greening strategies to promote social equity and inclusion [16, 8]. Addressing these challenges is crucial for understanding urban density and design limitations that complicate green space integration.

6.1 Socioeconomic and Accessibility Barriers

Socioeconomic and accessibility barriers significantly impede UGS development and utilization, affecting mental health benefits for vulnerable populations. In the Global South, these challenges are exacerbated by socioeconomic factors that hinder UGS development and maintenance [3]. The scarcity of quality green spaces and societal resistance to integrating marginalized groups into shared environments further aggravate these issues [8]. Older adults and blue-collar workers are particularly vulnerable to mental health impacts from commuting, highlighting the need for accessible UGS [39]. Urban renewal efforts often fail to adequately assess human perceptions, creating barriers to effective planning and equitable green space distribution [30].

High urbanization rates and land scarcity exacerbate inequalities in green space access, as inconsistent planning guidelines hinder standardized practices. In cities like Kuala Lumpur and Penang, rapid urban development pressures prevent meeting the National Urbanization Policy's green space targets, limiting recreational opportunities and undermining social equity for marginalized groups [19, 11, 24, 8, 20]. Localized assessments are necessary to understand diverse urban preferences and needs, with park closures during events like the COVID-19 pandemic further accentuating health disparities.

Urban density and safety concerns restrict green space utilization, compounded by biases in subjective evaluations and inconsistent quality of volunteered street view imagery. Emphasizing UGS quality over quantity necessitates comprehensive assessments that incorporate diverse community experiences to promote inclusivity and equitable access [11, 26, 8]. The lack of reliable global medical datasets for mental health assessments and universally applicable methods for measuring green space impact complicates UGS evaluation on well-being.

6.2 Urban Density and Design Limitations

Urban density and design limitations present significant challenges for integrating green spaces in densely populated areas, where land availability is restricted. Innovative solutions are required to navigate these spatial constraints, as existing methods may not adapt well to high-density settings [21]. Advanced methodologies like the Green View Index demand substantial computational resources, limiting their scalability in larger urban areas [13]. Efficient techniques are needed to address extensive urban landscapes without sacrificing accuracy.

AI-driven assessments of urban visual appeal face challenges in densely populated settings, as models may struggle to capture contextual nuances influencing human evaluations [4]. Integrating human-centered approaches in urban planning ensures residents' subjective experiences are considered. Predictive models assessing mental health risks, such as depression and anxiety, are hindered by the multifaceted nature of these conditions, complicating urban environment design for mental well-being [40].

6.3 Interdisciplinary Collaboration

Implementing green spaces in urban environments requires interdisciplinary collaboration across urban planning, public health, environmental science, and social sciences. This collaboration integrates diverse perspectives and expertise, creating urban environments that are ecologically sustainable and conducive to resident well-being [8]. Understanding ecological, social, and economic factors influencing urban environments is essential for integrating green spaces. Collaboration among urban planners, ecologists, public health experts, and community stakeholders devises innovative solutions for green space implementation [3]. This approach ensures green spaces meet diverse urban population needs, promoting inclusivity and equity in natural environment access.

Interdisciplinary collaboration enhances the capacity to address global inequalities in green space provision, facilitating knowledge sharing and best practices across contexts and regions. Leveraging various disciplines' strengths, urban planners develop strategies adaptable to local conditions while aligning with broader sustainability goals [3]. This approach not only improves green space initiatives'

effectiveness but also fosters resilience in urban communities by promoting social cohesion and environmental stewardship.

Integrating advanced technologies, such as AI and data analytics, into urban planning processes benefits from interdisciplinary collaboration. These technologies provide insights into user preferences and environmental impacts, designing green spaces that maximize health benefits and sustainability [11]. Combining technological innovations with human-centered design principles, interdisciplinary teams create urban environments that are functional and aesthetically pleasing.

7 Case Studies and Best Practices

7.1 Urban Park Development in Copenhagen

Copenhagen exemplifies effective urban park integration, enhancing ecological resilience and quality of life through multifunctional green spaces. These initiatives align with sustainability and climate adaptation goals, addressing urban heat islands and biodiversity while ensuring access for marginalized communities. Leveraging AI to gauge public sentiment on green spaces informs strategic investments, fostering a resilient urban environment [19, 11, 3, 8, 12]. Participatory planning processes engage community stakeholders, ensuring parks cater to diverse needs, including those of the elderly and individuals with mental health challenges. Collaboration between public and private sectors strengthens social cohesion and ownership, contributing to equity [11, 12, 8, 15].

Copenhagen's parks support varied activities, integrating natural habitats, recreational facilities, and educational resources. The city's commitment to cleanliness and safety enhances park appeal, promoting public health and well-being, particularly for vulnerable populations. Citizen feedback platforms like TripAdvisor offer insights into public perceptions, justifying investments in inclusive green spaces [4, 7, 11, 8, 12]. Innovative infrastructure such as rain gardens and green roofs not only improve aesthetics but also contribute to climate resilience by managing stormwater, reducing flood risks, and enhancing air quality, serving as models for cities aiming to balance ecological and social objectives [20, 11, 19, 12].

7.2 Community Gardens in Tokyo

Tokyo's community gardens significantly enhance elderly well-being by providing spaces for physical activity and social interaction, combating isolation and improving mental health [7, 10, 11, 8, 15]. These gardens transform underutilized spaces, addressing urban density challenges and creating accessible environments for gardening, fostering a sense of purpose and enhancing quality of life [8]. They promote social cohesion by facilitating intergenerational interactions and cultural exchange, strengthening social networks and emotional well-being [8]. The therapeutic effects of engaging with nature in these gardens alleviate depression and anxiety symptoms, underscoring their importance in urban planning for elderly mental health [2].

7.3 Green Roofs and Vertical Gardens in New York

New York City exemplifies innovative greening strategies with green roofs and vertical gardens, addressing space constraints while enhancing urban biodiversity and mitigating heat effects [20, 11]. Green roofs improve air quality and energy efficiency, contributing to health and well-being in high-density areas [3]. Vertical gardens transform facades into green spaces, promoting biodiversity and aesthetic appeal [9]. These infrastructures offer urban agriculture, community engagement, and educational opportunities, fostering social inclusion and environmental stewardship, particularly for marginalized groups [10, 8].

7.4 Innovative Green Spaces in Singapore

Singapore's innovative green spaces model sustainable urban planning and ecological resilience. Vertical greenery systems, like the Supertree Grove, provide aesthetic and recreational benefits while improving urban green space quality through AI-driven sentiment analysis [11, 12]. Green roofs and rooftop gardens enhance biodiversity and mitigate the heat island effect, promoting social well-being and aligning with global trends for happier communities [20, 10, 8]. Interconnected park connectors

and nature trails facilitate access to green spaces, enhancing recreational opportunities and ecological corridors, promoting urban biodiversity and inclusivity [11, 8, 15]. Singapore’s holistic approach balances ecological and social benefits, creating a livable and resilient urban environment.

8 Future Directions and Research Opportunities

Addressing the challenges and opportunities in urban green space research requires innovative methodologies and a broader scope, particularly at the intersection of green spaces and mental health. This section proposes strategies to refine research methods and expand the research landscape, laying the groundwork for optimizing urban green spaces to improve well-being across diverse populations. Figure 6 illustrates the future directions and research opportunities in urban green space studies, emphasizing methodological refinements, interdisciplinary integrations, long-term impact assessments, and enhancements in green space design and accessibility. By integrating these insights, researchers can better navigate the complexities of urban environments and their effects on mental health.

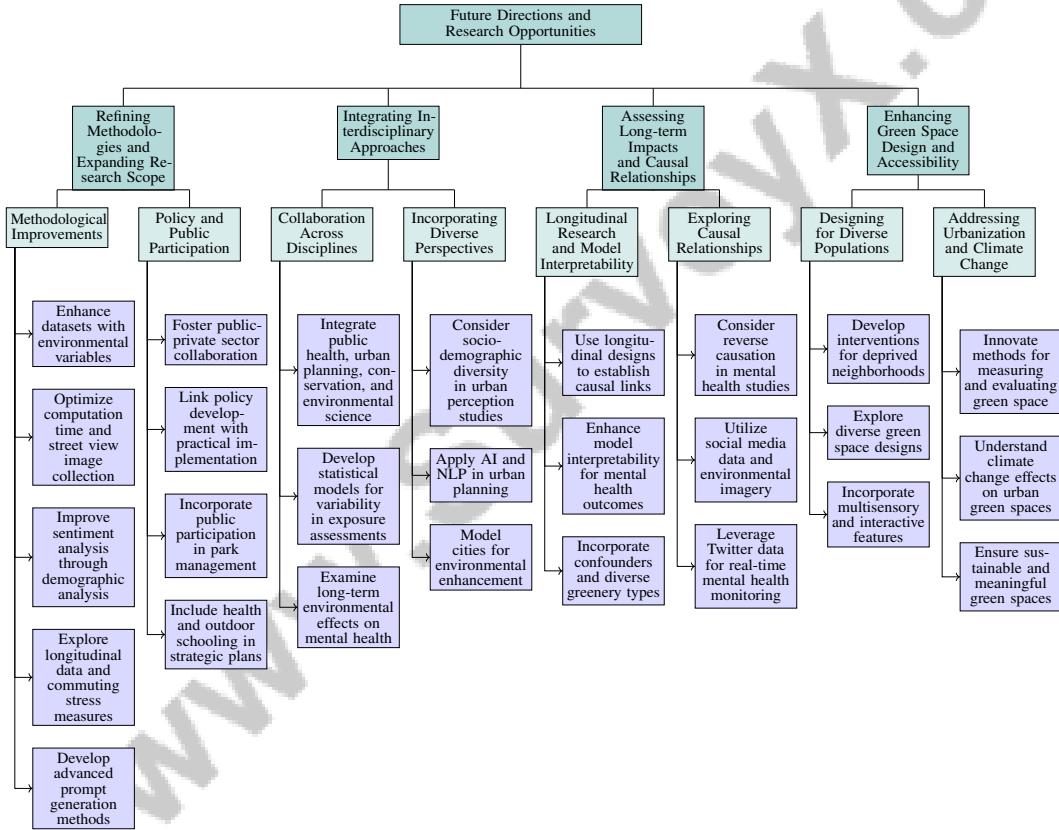


Figure 6: This figure illustrates the future directions and research opportunities in urban green space studies, emphasizing methodological refinements, interdisciplinary integrations, long-term impact assessments, and enhancements in green space design and accessibility.

8.1 Refining Methodologies and Expanding Research Scope

The evolution of urban environments necessitates refined methodologies and broader research scopes to effectively address the integration of green spaces and their mental health impacts. Future research should enhance datasets by incorporating environmental variables that affect urban living, significantly benefiting elderly well-being [28]. Policies fostering collaboration between public and private sectors are crucial for improving urban green space accessibility, emphasizing the need for research linking policy development with practical implementation [8]. Investigating public participation in park

management and incorporating themes like health and outdoor schooling into strategic plans ensures green spaces' relevance and benefits for diverse urban populations [41].

Methodological improvements should focus on optimizing computation time and enhancing street view image collection, essential for studying urban greenery and visual appeal [13]. Demographic analysis of reviewers can provide deeper insights into sentiment across user groups, improving sentiment analysis accuracy for urban green spaces [11]. Longitudinal data exploration and commuting stress measures can offer a comprehensive view of the dynamics between commute times and mental health, enriching our understanding of urban living conditions [39]. Expanding datasets and developing advanced prompt generation methods can refine urban planning methodologies, ensuring responsiveness to human perceptions and needs [30].

8.2 Integrating Interdisciplinary Approaches

Interdisciplinary approaches are essential for understanding the complex interactions between urban environments and public health outcomes. By integrating public health, urban planning, conservation, and environmental science, researchers can develop comprehensive studies on the health benefits of urban biodiversity [38]. This collaboration is vital for addressing the multifaceted challenges of urbanization and climate change, synthesizing diverse perspectives and methodologies.

Future research should develop statistical models accounting for variability in exposure assessments, such as buffer distance selection, crucial for evaluating urban green spaces' health impacts [31]. Examining long-term environmental effects on mental health and the mechanisms influencing well-being will benefit from interdisciplinary collaboration [36]. Such research provides insights into urban features' interactions and their mental health implications [33].

Incorporating diverse socio-demographic groups in urban perception studies enhances research outcomes. Considering various communities' perspectives helps develop inclusive urban planning strategies addressing all residents' needs [26]. AI and NLP applications in urban planning present new opportunities for assessing urban green space quality, modeling cities seeking environmental enhancement [12].

8.3 Assessing Long-term Impacts and Causal Relationships

Understanding long-term impacts and causal relationships between urban green spaces and mental health outcomes is crucial. The complexity of urban environments requires robust methodologies to unravel interactions between environmental features and mental well-being. Longitudinal research designs are valuable, enabling observation of changes over time and establishing causal links between green space exposure and mental health benefits [34].

Enhancing model interpretability for predicting mental health outcomes, such as depression and anxiety, is crucial for understanding environmental features' contributions. Future research should improve model interpretability, providing clearer insights into causal pathways through which green spaces influence mental health [40]. By incorporating additional confounders and exploring diverse greenery types, researchers can develop a nuanced understanding of green space characteristics' impacts on mental well-being [1].

Exploring causal relationships should consider reverse causation, where individuals with better mental health may seek green spaces. Addressing mental health assessment complexities requires advanced statistical methodologies and high-resolution datasets encompassing diverse factors influencing mental health outcomes. Recent studies highlight innovative approaches, like social media data and environmental imagery analysis, providing granular insights into mental health trends at local levels. For example, leveraging Twitter data facilitates real-time monitoring of mental health conditions across neighborhoods, while street-view image analysis reveals environmental correlates of depression and anxiety. These methodologies enhance mental health evaluations' precision and enable timely responses to societal events and policy changes, ultimately improving public health strategies [35, 32, 40, 14, 42]. Adopting these approaches provides valuable evidence to inform urban planning and public health policies aimed at maximizing green spaces' mental health benefits.

8.4 Enhancing Green Space Design and Accessibility

Enhancing green space design and accessibility for the elderly is crucial for maximizing health and well-being benefits. Future research should prioritize developing interventions tailored to deprived neighborhoods, where access to quality green spaces is limited [16]. Focusing on these areas addresses greenspace access disparities, ensuring all communities benefit from natural environments' mental and physical health advantages.

Research should explore diverse green space designs resonating with various populations, enhancing emotional connections to nature and improving species identification skills [9]. Designs can incorporate multisensory elements and interactive features engaging users of all ages, particularly the elderly, who may face mobility or sensory limitations. Integrating these elements creates inclusive environments fostering a deeper connection with nature and promoting well-being.

In developing countries, where urbanization pressures and climate change pose significant challenges, innovative methods for measuring and evaluating green space are essential [10]. These methods should consider local environmental conditions and cultural contexts, ensuring green spaces remain sustainable and meaningful to the communities they serve. Understanding climate change effects on urban green spaces is critical for designing resilient environments that can adapt to changing conditions and continue providing vital ecological and social benefits.

9 Conclusion

Green spaces play a pivotal role in urban planning, significantly contributing to the mental health and overall well-being of elderly populations. This survey underscores the necessity of a comprehensive, multi-faceted approach to the design and implementation of urban green spaces, which not only enhances urban sustainability but also addresses the mental health needs of older adults who are particularly susceptible to stress and isolation. The integration of green spaces within urban settings is vital for promoting ecological balance and providing substantial mental health benefits to the elderly.

The findings from this survey advocate for an integrated framework in urban green space research, emphasizing both strategic planning and methodological advancements. By focusing on the interplay between ecological systems and urban development, urban planners can align their efforts with public health policies aimed at improving the well-being of older residents. This interdisciplinary approach ensures that green spaces are designed to accommodate the diverse needs of urban populations, promoting inclusivity and equitable access to natural environments. Through such efforts, urban green spaces can become instrumental in fostering community cohesion and enhancing the quality of life for elderly individuals.

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