From Aesthetic Planting Design to Health-Oriented Planting Design: A Critical Review of the Paradigm Shift in Urban Green Space Planting Design

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Abstract

Growing evidence from environmental psychology, epidemiology, neuroscience, and landscape architecture has highlighted the contribution of urban green spaces to mental health and well-being, leading to a gradual shift in planting design from a purely aesthetic practice toward a health-oriented approach. Despite the expanding literature on nature–health relationships, a comprehensive framework explaining the dimensions of therapeutic planting design and the challenges of this emerging paradigm remains lacking. This study critically examines the theoretical foundations, empirical evidence, and transition challenges of therapeutic planting design and proposes a conceptual framework to evaluate and guide this shift. A critical review was conducted using the SALSA framework (Search, Appraisal, Synthesis, and Analysis). Literature was retrieved from Scopus, PubMed, Google Scholar, and SID. Of the 1,624 records initially identified, 80 studies published between 2015 and 2026 met the inclusion criteria, underwent quality appraisal, and were synthesized using Braun and Clarke's thematic analysis. The findings indicate that three major theoretical perspectives - Stress Reduction Theory, Attention Restoration Theory, and the Therapeutic Landscapes approach - constitute the conceptual foundations of health-oriented planting design. Thematic analysis further identified five key challenges: the tension between conventional visual aesthetics and multisensory, health-oriented aesthetics; the native–exotic plant dilemma; the misconception of a one size fits all healing garden; the research–practice gap; and the quantity–quality gap in urban green space planning. The findings demonstrate that urban planting design is undergoing a paradigm shift from a predominantly aesthetic approach toward a health-oriented one. The proposed five-level conceptual framework, the principal contribution of this study, conceptualizes this transition as a continuum from aesthetic planting to integrated health-oriented planting design and provides an evidence-informed basis for the design, evaluation, and policy development of urban green spaces.

Keywords: Attention Restoration Theory; Healing Garden; Medicinal and Aromatic Plants; Stress Reduction Theory; Therapeutic Landscape; Urban Planting Design.

1 .Introduction

Planting design, as one of the fundamental pillars of landscape architecture and green space planning, has consistently reflected how societies perceive the relationship between humans and nature (Fernandes et al., 2025). The evolution of this field is rooted in intellectual, cultural, and environmental transformations that have continuously redefined the objectives of landscapes across different historical periods. From the symbolic order of French formal gardens to the naturalistic composition of English landscape gardens, plant selection and arrangement have consistently been shaped by the dominant design paradigms of their time (Zgarbová, 2014). In recent decades, rapid urbanization, the growing prevalence of chronic diseases, and declining human contact with nature have driven a fundamental shift in urban planning and landscape architecture. The conventional perspective, which regarded plants primarily as aesthetic features and providers of shade, has gradually been replaced by a paradigm that recognizes vegetation as essential infrastructure for promoting public health and enhancing urban resilience (Dushkova & Ignatieva, 2020; Van den Bosch & Sang, 2017). Within the traditional paradigm, species selection was largely based on visual appeal, physical functionality, and maintenance costs (Ignatieva et al., 2020). However, this approach overlooked the multidimensional contributions of plants to psychological and social well-being (Bratman et al., 2019). Consequently, the transition from aesthetic planting

design to therapeutic planting design has emerged as one of the most significant paradigm shifts in the field, redefining the value of vegetation according to its capacity to support human health and well-being (Dushkova & Ignatieva, 2020; Van den Bosch & Sang, 2017). In this study, therapeutic planting design - and specifically the concept of "therapeutic" - refers to an evidence-based approach in which plants are selected, combined, and spatially organized to promote physical, psychological, and social health. This concept is fundamentally distinct from clinical treatment and direct medical interventions, instead operating within a preventive and health-promoting framework.

The foundation of this paradigm shift lies in the growing body of scientific evidence accumulated across public health, environmental psychology, and epidemiology. The World Health Organization (2023) has emphasized the role of green spaces in supporting health and highlighted the need to integrate them into urban policies. A global assessment of 199 nature-based solutions further confirmed their effectiveness in improving mental health and reducing urban vulnerability (Xie & Bulkeley, 2020), while an umbrella review demonstrated that green spaces contribute benefits beyond traditional ecosystem services through improvements in air quality and biodiversity (X. Wang et al., 2024). To explain the mechanisms through which nature influences human health, researchers have developed several complementary theoretical frameworks, including Stress Reduction Theory (Ulrich, 1984; Ulrich et al., 1991), Attention Restoration Theory (Kaplan & Kaplan, 1989; Kaplan, 1995) - with recent meta-analytic evidence indicating that the greatest cognitive restoration occurs after approximately 30 minutes of exposure to nature (Bell et al., 2025) - and the concept of therapeutic landscapes, which emphasizes the social and symbolic dimensions of place (Gesler, 1992; Williams, 2007). Collectively, these perspectives suggest that planting design can serve as an evidence-based instrument for promoting public health (Bratman et al., 2019; Markevych et al., 2017). Nevertheless, despite the breadth of available evidence, substantial disagreement remains regarding which planting characteristics - such as species type, density, diversity, and spatial structure - produce the greatest therapeutic benefits and how these findings should be translated into practical design guidelines. This gap between scientific evidence and design practice continues to generate significant challenges and barriers to implementation.

Despite the rapidly expanding evidence base, the transition from aesthetic to therapeutic planting design continues to face substantial barriers in practice. It has yet to become standard practice in many countries (Russo et al., 2026). One of the principal obstacles is the persistent gap between knowledge production and professional application, whereby implemented projects remain largely guided by traditional aesthetic criteria and short-term economic considerations while making limited use of evidence generated by the health sciences (Gutke Lunsjö, 2023; Krukar & Schultz, 2025; Motalebi, 2001). Another major challenge arises from the tension between aesthetic objectives and health-related performance in species selection. In many cases, resource-intensive exotic ornamental species are favored over resilient native species, reducing ecological sustainability while limiting the therapeutic and cultural values associated with indigenous vegetation (Ignatieva et al., 2020; Kazemi & Abbasi, 2018). Furthermore, the lack of evidence-based evaluation frameworks has resulted in design processes that rely heavily on the individual experience of designers (Marcus & Sachs, 2013; Paraskevopoulou & Kamperi, 2018). Institutional and policy barriers further complicate this transition, as concepts such as therapeutic gardens remain poorly represented within legal and regulatory frameworks (Russo et al., 2026). This situation persists despite longitudinal evidence demonstrating that access to high-quality green spaces is associated with reduced psychological distress among vulnerable populations (Galera et al., 2025), lower risks of cardiometabolic diseases (Yang et al., 2025), and reduced cardiovascular and respiratory mortality (Roscoe et al., 2022). Accordingly, the principal challenge is that most existing research has focused on measuring the health effects of green spaces while paying comparatively little attention to the implications of these findings for the planning, design, and management of urban green spaces. As a result, no comprehensive framework currently exists for translating scientific evidence into urban design strategies and policy. Therefore, the primary issue is not a lack of evidence but rather the absence of effective mechanisms for transferring knowledge into the design process.

These challenges are even more pronounced in developing countries, particularly Iran. Despite the growing number of studies examining the relationship between green spaces and health, this field has not yet been institutionalized within Iran's educational system, professional practice, or technical guidelines. A critical review of the domestic literature indicates that existing studies can be classified into four main categories: (1) evaluations of the healing potential of case studies, such as Razmara and Taghi Pour (2020), who compared Eram Garden with Azadi Park in Shiraz; (2) conceptual modeling studies, such as Nouri Horzvili et al. (2023), who developed a health landscape model based on perceptual mechanisms; (3) studies examining design impacts, such as Farvardin and Babakhani (2025), who demonstrated that design quality plays a more decisive role than the quantity of green space in promoting children's mental health; and (4) historical reinterpretation studies, including Taheri et al. (2021), who explored design guidelines for healing gardens for older adults, and Akbarzadeh and Adibi (2014), who reexamined the capacities of the Persian garden as a foundation for conceptualizing therapeutic gardens. Despite the scientific value of these studies, a critical analysis reveals that their primary emphasis has been on demonstrating why health matters, whereas how planting should be designed and how species should be selected based on scientific evidence have remained largely overlooked. This gap is particularly significant given

that Iran possesses more than 2,300 medicinal plant species (Hoseini et al., 2021; Owfi, 2020) and a long-standing tradition of traditional medicine, yet lacks coherent policy and technical frameworks for systematically integrating these resources into urban landscapes, an issue also highlighted by Shahvaran and Asadpour (2024). In other words, the principal challenge in Iran is not necessarily the lack of research but the absence of mechanisms for integrating scientific knowledge, education, and professional practice.

Accordingly, the primary gap in the existing literature lies not in the lack of scientific evidence demonstrating the importance of nature for human health, but in the absence of frameworks capable of translating fragmented research findings into evidence-based design principles, criteria, and strategies. In Iran, this gap is further exacerbated by the considerable disconnect between knowledge production, professional practice, and policymaking. Against this background, the novelty of this article lies not in providing a purely descriptive review, but in critically synthesizing theoretical and empirical evidence to develop the conceptual framework of the Urban Planting Design Spectrum: From Aesthetic to Therapeutic. This framework offers a practical mechanism for translating health evidence into design decisions and can serve as a foundation for developing evidence-based design guidelines, planning and evaluation criteria for urban green spaces, and health-oriented urban management policies. The primary objective of this article is to critically examine the paradigm shift from aesthetic planting design to therapeutic planting design and to elucidate its theoretical foundations, empirical evidence, and implementation challenges. The central research question is: On what theoretical foundations and empirical evidence has the perception of plants evolved from aesthetic elements to health-promoting components? To address this question, the article first critically reviews the relevant theoretical foundations and scientific evidence, then analyzes global and national challenges, subsequently presents the conceptual framework of the Urban Planting Design Spectrum, and concludes by discussing the study's conclusions, policy implications, and directions for future research.

2. Theoretical Foundations: How Does Nature - Particularly Planting Design - Influence Human Health?

Understanding the theoretical foundations underlying the effects of nature, and particularly planting design, on human health is a prerequisite for evidence-based design in healing gardens and therapeutic landscapes. These effects are explained through multiple physiological, cognitive, psychological, and social mechanisms, and no single theory can comprehensively account for all of these dimensions. Over the past decades, several major theoretical frameworks have been proposed to explain this relationship, each emphasizing a distinct underlying mechanism. Collectively, these theories not only provide the scientific foundation for the design of therapeutic green spaces but also offer practical criteria for selecting appropriate design elements. The three principal theoretical frameworks include Stress Reduction Theory (SRT), Attention Restoration Theory (ART), and the concept of Therapeutic Landscapes. Although these perspectives originate from different intellectual traditions - including psychology, evolutionary biology, and sociology - they converge on a common premise: nature, and particularly vegetation and green spaces, possesses inherent and multidimensional capacities to promote sustained improvements in human physical, psychological, and social well-being (Bratman et al., 2019; Markevych et al., 2017). Accordingly, the theoretical framework of this study draws upon these three complementary perspectives to explain the mechanisms through which planting design influences human health and to establish a comprehensive theoretical basis for health-oriented planting design.

Recent evidence further indicates that urban green spaces play a significant role in mitigating the adverse health effects of air pollution. A study by Gong et al. (2026), based on 13,629 myocardial infarction deaths in China, demonstrated that green spaces located within a 3,000 meter radius of residential areas can significantly reduce mortality risks associated with exposure to particulate matter (PM2.5 and PM10). These findings suggest that the therapeutic benefits of green spaces extend beyond direct psychological effects to include physiological protection against environmental pollutants. Likewise, Gan and Wang (2026) argued that the aromatic compounds released by plants - such as mint, honeysuckle, ginkgo, and calendula, all of which have long been recognized for their medicinal properties in traditional medicine - may contribute to stress reduction and cognitive enhancement through olfactory–neural pathways. Together, these findings further underscore the importance of integrating therapeutic green spaces into urban public health policies.

2.1. Stress Reduction Theory (SRT)

Stress Reduction Theory, developed by Roger Ulrich during the 1980s, represents one of the most influential theoretical frameworks for explaining the relationship between nature and human health. The theory is grounded in Ulrich's landmark empirical study (1984), which demonstrated that hospital patients whose rooms overlooked trees experienced shorter hospital stays, required fewer analgesics, and recovered more rapidly than patients whose windows faced a brick wall (Ulrich, 1984). This pioneering study is widely regarded as a milestone in research examining the health benefits of natural environments.

The central premise of Stress Reduction Theory is that, throughout human evolution, individuals developed rapid and adaptive physiological responses to natural environmental cues - such as flowing water, lush vegetation, and open landscapes - because these features historically signaled resource availability and protection from

potential threats. In contrast, densely built urban environments contain stimuli that are more likely to activate stress responses (Ulrich et al., 1991). According to this theory, exposure to a stressful environment triggers an immediate and largely automatic biological response that motivates individuals to withdraw from the stress-inducing setting and seek natural environments. This process facilitates positive emotional change, regulates the physiological consequences of stress, and restores depleted psychological and physiological resources.

Extensive empirical evidence supports Stress Reduction Theory. Numerous studies have demonstrated that exposure to natural environments can reduce blood pressure, decrease muscle tension, lower cortisol levels - the primary physiological marker of stress - and suppress sympathetic nervous system activity (Lee & Maheswaran, 2010). A field study conducted in New Delhi by Jha et al. (2026) found that visitors to urban parks consistently reported restorative benefits, including emotional calmness, improved mood, and recovery from mental fatigue. These findings suggest that the mechanisms proposed by Stress Reduction Theory are generalizable across diverse cultural and geographical contexts, including densely populated metropolitan areas in the Global South. Furthermore, a comprehensive review of 115 peer-reviewed studies reported that Nature-based Solutions (NbS) accounted for nearly 69% of the variance in perceived mental health outcomes (Morketo et al., 2025).

Despite its substantial empirical support, Stress Reduction Theory has been subject to several important criticisms. First, some scholars argue that the theory primarily emphasizes short-term physiological and emotional responses while paying comparatively limited attention to the cognitive, social, and contextual mechanisms that shape human experiences of nature. Recent systematic reviews indicate that although robust evidence exists for the short-term stress-reducing effects of natural environments, the mechanisms underlying their long-term contributions to mental health and psychological resilience remain insufficiently understood (Twohig-Bennett & Jones, 2018). Second, the theory's assumption of a relatively universal evolutionary response to natural environments may underestimate the influence of cultural background, social context, and individual characteristics on environmental perception. Emerging evidence suggests that the health benefits derived from nature are significantly moderated by factors such as accessibility, environmental quality, demographic characteristics, and social context (Joye & De Block, 2025). Third, much of the original empirical evidence supporting the theory was derived from laboratory experiments and short-term exposure studies, whereas recent research emphasizes the importance of investigating human experiences of nature within real-world urban environments and over extended periods (Bratman et al., 2019). Moreover, contemporary reviews indicate that the stress-reducing effects of nature depend not merely on the presence of green space but also on design quality, biodiversity, and the spatial characteristics of the environment (Wood et al., 2018).

From the perspective of urban planting design, Stress Reduction Theory suggests that the structure and quality of vegetation should be intentionally organized to facilitate both physiological and emotional restoration. Recent evidence indicates that the restorative potential of green spaces depends not only on the quantity of vegetation but also on structural diversity, accessibility, ecological quality, and the integration of green and blue infrastructure (Da et al., 2024). Accordingly, incorporating shade trees, multilayered vegetation, and dense planting arrangements can strengthen perceptions of comfort, safety, and refuge. Likewise, integrating water features with vegetation can enhance environmental perception, enrich multisensory experiences, reduce stress, and promote psychological well-being (Lee et al., 2022). Recent studies in environmental design further demonstrate that achieving an appropriate balance between open spaces offering broad visual prospects and semi-enclosed areas defined by vegetation represents one of the most effective strategies for enhancing psychological comfort, consistent with the Prospect–Refuge concept (Dosen & Ostwald, 2016). Furthermore, selecting plant species with natural growth forms, diverse textures, seasonal variation, and the capacity to provide shade and regulate microclimatic conditions can further strengthen the health-promoting benefits of green spaces (Elliott et al., 2020). Therefore, Stress Reduction Theory does not simply advocate increasing the quantity of urban green space; rather, it emphasizes the deliberate design of planting structure, the quality of sensory experiences, and the spatial organization of vegetation as fundamental strategies for promoting health and reducing stress among urban residents.

2.2. Attention Restoration Theory (ART)

Attention Restoration Theory, developed by Rachel Kaplan and Stephen Kaplan during the 1980s and 1990s, focuses on the cognitive benefits of nature and constitutes the second major pillar of the theoretical framework underlying this study (Kaplan & Kaplan, 1989; Kaplan, 1995). According to ART, human attention consists of two distinct forms: directed attention, which requires conscious mental effort to maintain focus on a specific task, and involuntary attention, which is automatically captured by intrinsically engaging environmental stimuli, such as scenic landscapes, the movement of leaves in the wind, or birdsong (Kaplan, 1995). Prolonged reliance on directed attention leads to attention fatigue, a condition characterized by reduced concentration, increased errors, irritability, and impaired problem-solving ability.

Kaplan (1995) proposed that natural environments restore depleted directed attention through four essential characteristics. The first is Being Away, referring to a psychological or physical sense of escape from routine demands and mentally taxing activities. The second is Extent, which denotes the richness and coherence of an

environment that creates a sense of immersion in something larger than oneself. The third is Soft Fascination, whereby natural elements effortlessly capture attention without requiring intensive cognitive processing, allowing directed attention to recover. The fourth is Compatibility, which reflects the degree to which an environment supports an individual's purposes, preferences, and intended activities (Kaplan, 1995).

A meta-analysis of 80 studies comprising 273 individual outcomes conducted by Bell et al. (2025) demonstrated that, compared with built environments, exposure to nature is generally associated with improved cognitive performance, with the greatest restorative effects occurring after approximately 30 minutes of exposure to natural settings. Nevertheless, empirical evidence supporting ART remains characterized by considerable heterogeneity. Bell et al. (2025) reported that approximately 35% of the reviewed studies yielded null findings, while only two cognitive domains - working memory and attentional control - consistently demonstrated significant benefits following exposure to nature. Furthermore, explicit induction of cognitive fatigue, a fundamental prerequisite of ART, was implemented in only 29% of the reviewed studies, suggesting that many investigations failed to operationalize one of the theory's core assumptions appropriately (Mangan, 2026). The urban biophilic approach examined by Lefosse et al. (2025) extends this perspective to a broader spatial scale, illustrating how urban design can facilitate meaningful human–nature interactions across multiple levels of the built environment (Lefosse et al., 2025).

Despite extensive empirical support, Attention Restoration Theory has recently been challenged on both conceptual and methodological grounds. Some researchers argue that the theory's four principal components - particularly Soft Fascination and Extent - lack sufficiently distinct conceptual boundaries, making empirical measurement and theoretical validation difficult. Moreover, recent studies indicate that the restorative effects of nature vary considerably according to individual characteristics, age, cultural background, environmental quality and complexity, duration and type of exposure, and the activities undertaken within natural settings. Consequently, it cannot be assumed that all natural environments, or all users, will experience identical cognitive benefits. Emerging evidence further suggests that the cognitive advantages associated with nature cannot be explained solely through attentional restoration. Complementary mechanisms, including stress reduction, emotional regulation, aesthetic experience, sense of place, and social interaction, also play significant roles in promoting psychological well-being. Accordingly, many scholars advocate considering ART alongside Stress Reduction Theory and biophilic approaches as complementary frameworks capable of providing a more comprehensive explanation of the health-promoting effects of nature (Bell et al., 2025; Bratman et al., 2019; Ohly et al., 2016). Nevertheless, ART remains one of the most influential theoretical foundations in contemporary landscape design.

These criticisms have important implications for planting design. They indicate that the effectiveness of green spaces depends less on the amount of vegetation than on the quality of its spatial organization and perceptual characteristics. Accordingly, planting design should achieve an appropriate balance among plant diversity, multilayered vegetation structure, spatial legibility, seasonal dynamics, and the sensory attributes of plants - including color, texture, movement, fragrance, and natural growth patterns - to foster soft fascination while minimizing unnecessary cognitive demands. Conversely, excessive complexity, visual clutter, or poorly organized vegetation may diminish the restorative capacity of natural environments. Therefore, the application of ART in planting design should extend beyond merely increasing per capita urban green space. Instead, it should promote the deliberate selection of plant species, thoughtful spatial organization, and the creation of rich perceptual and multisensory experiences that simultaneously support ecological integrity, aesthetic quality, and mental well-being. Within this framework, Attention Restoration Theory provides a robust theoretical foundation for evidence-based planting design in urban green spaces (Cameron et al., 2020; Hoyle et al., 2017; Jiang et al., 2014).

2.3. Therapeutic Landscapes: Social, Cultural, and Spatial Dimensions

The concept of Therapeutic Landscapes, first introduced by the health geographer Wilbert Gesler in 1992, constitutes the third major pillar of the theoretical framework underpinning this study (Gesler, 1992). Gesler coined this concept to address a fundamental question: why do certain places appear to possess a unique "healing sense of place"? Since its introduction, both the concept and its applications have evolved substantially, expanding beyond its original formulation.

Unlike Stress Reduction Theory and Attention Restoration Theory, which primarily emphasize biological, physiological, and cognitive mechanisms, the Therapeutic Landscapes framework focuses on the role of place in shaping meaning, identity, and social belonging (Bell et al., 2018; Gesler, 1992; Smyth, 2005). From this perspective, a healing garden derives its therapeutic value not only from its natural elements but also from the memories, symbolic meanings, and social interactions that emerge within it. A scoping review by Bell et al. (2018) demonstrated that the Therapeutic Landscapes concept has matured considerably, with its principal themes organized into four interrelated dimensions: material (nature, architecture, and infrastructure), social (social support, interaction networks, and sense of community), spiritual (meaning, purpose, and connection to something greater than oneself), and symbolic (cultural identity, history, and collective memory).

Winterbottom and Wagenfeld (2026) translated these dimensions into practical guidance for landscape architects and healthcare professionals, emphasizing participatory design, trauma-responsive design, and the

needs of diverse user groups, including neurodivergent individuals. In recent years, the Therapeutic Landscapes framework has further expanded through concepts such as Therapeutic Mobilities and Therapeutic Assemblage (Bell et al., 2018). Therapeutic Mobilities recognizes that healing experiences are not confined to fixed locations but may also emerge through movement and travel across different environments. Therapeutic Assemblage, in contrast, highlights the complex interactions among human and non-human actors - including plants, animals, physical objects, and technologies - in shaping therapeutic experiences.

A recent study by Xia et al. (2025) demonstrated that highly biodiverse natural areas surrounding cities can substantially enhance urban mental health by reducing travel barriers and improving accessibility. When appropriately planned, such environments may increase mental health benefits by as much as 49%. These findings suggest that therapeutic landscapes should not be limited to urban green spaces but should encompass broader networks of natural habitats within peri-urban and surrounding regions. Likewise, a study conducted by Jha et al. (2026) in New Delhi revealed that embodied experiences, including post-visit relaxation and thermal comfort, were stronger predictors of user satisfaction with urban green–blue spaces than visual aesthetics alone. This finding underscores the importance of incorporating multisensory and experiential dimensions into the design of therapeutic landscapes.

Despite its growing influence within health and landscape architecture research, the Therapeutic Landscapes framework has recently been subject to important conceptual and methodological critiques. First, scholars argue that the classical framework places excessive emphasis on the intrinsic qualities of place, whereas therapeutic experiences are better understood as dynamic outcomes arising from interactions among environmental characteristics, social, cultural, and economic contexts, and users' lived experiences. From this perspective, the therapeutic quality of a landscape depends not only on its natural features but also on spatial equity, equitable access, perceived safety, social relationships, and opportunities for public participation in the creation and use of space-dimensions that received relatively limited attention in earlier studies (Bell et al., 2018). Second, contemporary research indicates that much of the Therapeutic Landscapes literature continues to prioritize visual perception while giving comparatively less attention to embodied and multisensory experiences, including sound, fragrance, touch, thermal comfort, and movement through space. These dimensions are particularly important for older adults, children, patients, and neurodivergent individuals (Corazon et al., 2019; Jha et al., 2026). Furthermore, the emergence of concepts such as Therapeutic Mobilities and Therapeutic Assemblage suggests that the health benefits of nature arise not simply from occupying a particular place but from ongoing interactions among people, nature, technology, social relationships, memories, culture, and historical contexts, many of which are inherently qualitative. Consequently, many researchers contend that the Therapeutic Landscapes framework still lacks standardized and measurable indicators for assessing the therapeutic capacity of environments (Williams, 2007) and should evolve from a predominantly descriptive framework toward an evidence-based, measurable, and culturally responsive approach (Bell et al., 2018; Li et al., 2025; Winterbottom & Wagenfeld, 2026).

These developments have significant implications for planting design within landscape architecture. They suggest that creating a therapeutic landscape cannot be achieved merely by increasing vegetation cover or biodiversity; rather, the quality of users' experiences is of primary importance. Accordingly, planting design should not only fulfill ecological objectives but also foster multisensory experiences, social interaction, perceptions of safety, place identity, and emotional attachment. Employing multilayered vegetation, species exhibiting seasonal variation, diverse colors, textures, fragrances, and movement, together with carefully organized circulation routes, gathering spaces, semi-private areas, and opportunities for social interaction, can substantially strengthen the therapeutic qualities of landscapes. Plant selection should also reflect local cultural and climatic conditions as well as the needs of diverse user groups-including older adults, children, patients, and neurodivergent individuals-to promote spatial equity and ensure equal access to the health benefits of nature. Consequently, within contemporary landscape architecture, planting design is increasingly regarded not merely as an aesthetic intervention but as an integral component of evidence-based, health-oriented design, simultaneously addressing ecological, psychological, social, and cultural objectives while enhancing urban resilience and quality of life (Corazon et al., 2019; Hoyle et al., 2017; Winterbottom & Wagenfeld, 2026).

Despite their distinct theoretical foundations, all three frameworks emphasize the critical role of the quality of natural environments in promoting human health, although each approaches this relationship from a different perspective. These theories are fundamentally complementary rather than competing. Stress Reduction Theory focuses on physiological and biological mechanisms, Attention Restoration Theory explains cognitive restoration processes, and the Therapeutic Landscapes framework highlights the social, cultural, and symbolic dimensions of healing environments. Accordingly, only the integration of these three perspectives can provide a comprehensive theoretical foundation for health-oriented planting design. An effective healing garden should therefore simultaneously address all three dimensions. Ultimately, the transition from an aesthetic to a therapeutic paradigm in urban planting design requires the integrated application of these complementary theoretical frameworks throughout the design process.

3. Research Methodology

This study employed a critical review approach supported by a systematic search strategy. Unlike a conventional systematic review, which primarily synthesizes existing evidence, a critical review seeks to analyze, interpret, and, where appropriate, challenge the assumptions, methodologies, and conclusions of previous studies. The methodological framework was guided by the SALSA model - Search, Appraisal, Synthesis, and Analysis - which provides a structured approach for conducting critical literature reviews (Grant & Booth, 2009). This approach is particularly appropriate for investigating paradigm shifts because it facilitates not only the synthesis of existing knowledge but also the development of new theoretical perspectives through critical evaluation of the literature (Snyder, 2019).

3.1. Literature Search

The literature search included publications in both Persian and English. In addition, several studies originally published in Chinese, for which English abstracts were available, were also considered. English-language publications were retrieved from Scopus, selected for its comprehensive coverage of high-quality international journals; PubMed, which specializes in environmental health and medical research; and Google Scholar, which provides broad access to both peer-reviewed and gray literature. Persian-language studies were identified through the Scientific Information Database (SID) and Google Scholar. The combined use of these databases ensured both the breadth and depth of the literature search.

The search strategy was developed according to the objectives and thematic components of the study, and the search terms are presented in Table 1. Search syntax was adapted to the capabilities and limitations of each database as well as the language of the search. In Scopus, comprehensive search strings were applied within the TITLE–ABS–KEY field while restricting the publication period. PubMed employs a different indexing structure, allowing searches in titles and abstracts but not in author-defined keywords. Because Google Scholar imposes limitations on Boolean operators, nested expressions, and query length-particularly for Persian-language searches-advanced iterative ("crawling") searches were conducted by dividing complex search strategies into multiple smaller searches and subsequently merging the results. Furthermore, given the limited coverage of Persian-language publications in Google Scholar, SID was included to improve the retrieval of Persian scientific literature. Since SID does not support field-specific searches (e.g., TITLE–ABS–KEY) or advanced Boolean operators, an iterative search strategy was likewise employed.

The literature search was conducted within the TITLE–ABS–KEY fields for publications published between 2015 and 2026. This time frame was considered appropriate for examining recent paradigm shifts in planting design and therapeutic landscapes. To ensure adequate coverage of the foundational literature, several seminal publications predating this period-including the pioneering works of Ulrich, Kaplan and Kaplan, and Gesler - were deliberately incorporated into the final dataset (Gesler, 1992; Kaplan & Kaplan, 1989; Kaplan, 1995).

3.2. Inclusion and Exclusion Criteria

The initial search identified 925 records in Scopus, 207 in PubMed, 217 English-language records in Google Scholar, 161 Persian-language records in Google Scholar, and 114 Persian-language records in SID.

Table 1. Specialized Search Keywords Used in the Combined Literature Search Strategy.

No.	Language	Search Keywords
1	Persian	«باغ شفابخش»، «باغ درمانی»، «باغ حسی»، «منظر درمانی»، «فضای سبز درمانی»، «نظریه کاهش استرس»، «نظریه بازسازی توجه»، «فرضیه بیوفیلیا»، «تأثیر طبیعت بر سلامت»، «بازیابی توجه»، «گیاهان دارویی»، «منظر شهری»، «طراحی کاشت»، «فضای سبز شهری»، «معماری منظر»، «سلامت روان»، «بهزیستی»، «تجدید قوا»، «راه‌حل مبتنی بر طبیعت»، «طبیعت‌بنیاد»، «زیرساخت سبز»، «سلامتی شهری»، «بوم‌شناسی شهری»
2	English	Healing garden, Therapeutic garden, Sensory garden, Attention Restoration Theory, Stress Reduction Theory, Biophilia hypothesis, Medicinal plant, Urban landscape, Planting design, Mental health, Well-being, Nature-based solution, Urban health

After removing duplicate titles, 1,146 unique publications remained.

Screening of titles for relevance to the research topic, together with the exclusion of conference proceedings, reduced the dataset to 311 publications. Abstract screening further narrowed the sample to 121 studies that were selected for full-text assessment. Ultimately, 80 articles (Appendix Table 1) met the eligibility criteria and were included in the final analysis.

The inclusion criteria were as follows: (1) publication in high- or medium-quality journals indexed in ISI/Web of Science or Scopus ; (2) direct relevance to planting design and health or therapeutic environments; (3) use of transparent and assessable research methodologies; and (4) presentation of original empirical or theoretical findings rather than superficial reviews (Page et al., 2021).

The exclusion criteria included: (1) publications written exclusively in languages other than English or Persian without a reliable English translation; (2) studies conducted solely on animals or in non-urban environments; and

(3) conference papers lacking rigorous peer review, with the exception of proceedings from internationally recognized conferences.

3.3. Quality Assessment of Included Studies

Given the methodological diversity of the included literature, the studies were first classified into two broad methodological categories (Table 2). Quality assessment was then conducted using appraisal tools specifically matched to the methodological characteristics of each study type.

Systematic reviews and meta-analyses were evaluated using AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews), one of the most comprehensive instruments for assessing the methodological quality of evidence syntheses. Narrative reviews, scoping reviews, and conceptual or theoretical papers lacking the structured search procedures of systematic reviews were assessed using the SANRA (Scale for the Assessment of Narrative Review Articles), which was specifically developed to evaluate the quality, coherence, and scientific rigor of narrative review articles. Primary empirical studies employing quantitative, qualitative, or mixed-methods designs were appraised using the Mixed Methods Appraisal Tool (MMAT), selected for its unique ability to evaluate diverse research designs within a single integrated framework.

Table 2. Distribution of Study Types Included in the Review

A. Overall Classification of Studies Included in the Review		
Overall Category	Number	Percentage
Review studies (systematic, scoping, narrative, and umbrella reviews)	23	28.75%
Theoretical studies (theory development, conceptual framework development, and conceptual studies)	17	21.25%
Quantitative empirical studies (experimental, quasi-experimental, longitudinal, and cross-sectional studies)	22	27.50%
Qualitative empirical studies (phenomenological, ethnographic, and content analysis studies)	5	6.25%
Mixed-methods empirical studies (quantitative + qualitative)	5	6.25%
Methodological / Instrumental studies (tool development, guidelines, and methodological innovations)	8	10.00%
Total	80	100.00%
B. Subclassification of Studies Included in the Review		
1. Review Studies (n = 23)		
Subcategory	Number	Percentage of Total Studies
Systematic review	9	11.25%
Scoping review	4	5.00%
Narrative review	8	10.00%
Umbrella review	2	2.50%
2. Theoretical and Conceptual Studies (n = 17)		
Subcategory	Number	Percentage of Total Studies
Foundational theoretical studies	4	5.00%
Theoretical reference books	7	8.75%
Conceptual frameworks and theoretical modeling	6	7.50%
3. Quantitative Empirical Studies (n = 22)		
Subcategory	Number	Percentage of Total Studies
Experimental / intervention studies (including randomized controlled trials [RCTs] and quasi-experimental studies)	5	6.25%
Longitudinal studies	4	5.00%
Cross-sectional / survey studies	7	8.75%
Statistical modeling, machine learning, and data mining studies	6	7.50%
4. Qualitative Empirical Studies (n = 5)		

Subcategory	Number	Percentage of Total Studies
Phenomenological / ethnographic studies	2	2.50%
Content analysis / in-depth interview studies	3	3.75%
5. Mixed-Methods Empirical Studies (n = 5)		
Subcategory	Number	Percentage of Total Studies
Mixed-methods (quantitative + qualitative)	5	6.25%
6. Methodological / Instrumental Studies (n = 8)		
Subcategory	Number	Percentage of Total Studies
Tool / checklist development	3	3.75%
Design guidelines and recommendations	4	5.00%
Novel methodologies / analytical frameworks	1	1.25%
Note: The included studies were classified using a two-level framework to address methodological overlap and heterogeneity. The first level comprises four broad categories (review, theoretical, empirical, and methodological/instrumental studies), whereas the second level provides detailed methodological subcategories within each major category.		

This multi-tool appraisal strategy enabled a more rigorous and balanced evaluation of evidence across heterogeneous study designs. Based on these assessments, the included studies were classified into high, moderate, and low-quality categories. Approximately 86% of the studies Included were rated as either high or moderate quality (Table 3). Studies receiving low-quality ratings generally failed to satisfy stringent methodological criteria required by the appraisal instruments-such as protocol registration, comprehensive searches across multiple databases, provision of complete lists of included studies, or formal quality assessment of primary evidence. Nevertheless, detailed examination indicated that many of these studies still provided scientifically valuable and credible findings despite these methodological limitations. To enhance methodological transparency and reproducibility, the literature screening and selection process was documented using the PRISMA flow diagram (Figure 1)

Table 3. Quality Assessment of the Studies Included in the Review According to the Applied Appraisal Tools (Source: Authors)

Quality Appraisal Tool	High Quality	Moderate Quality	Low Quality	Total	Percentage
SANRA (Narrative reviews, theoretical studies, and books)	31	6	0	37	46.3%
MMAT (Empirical, mixed-methods, and methodological studies)	28	1	0	29	36.3%
AMSTAR 2 (Systematic reviews and meta-analyses)	3	0	11	14	17.5%
Total	62	7	11	80	100%
Note: To ensure consistency in reporting the quality assessment results, the scores obtained from the three appraisal instruments (SANRA, MMAT, and AMSTAR 2) were harmonized into three overall quality categories: high, moderate, and low. This classification was based on the numerical thresholds and critical appraisal criteria defined for each instrument and served as the basis for the final quality synthesis and analysis.					

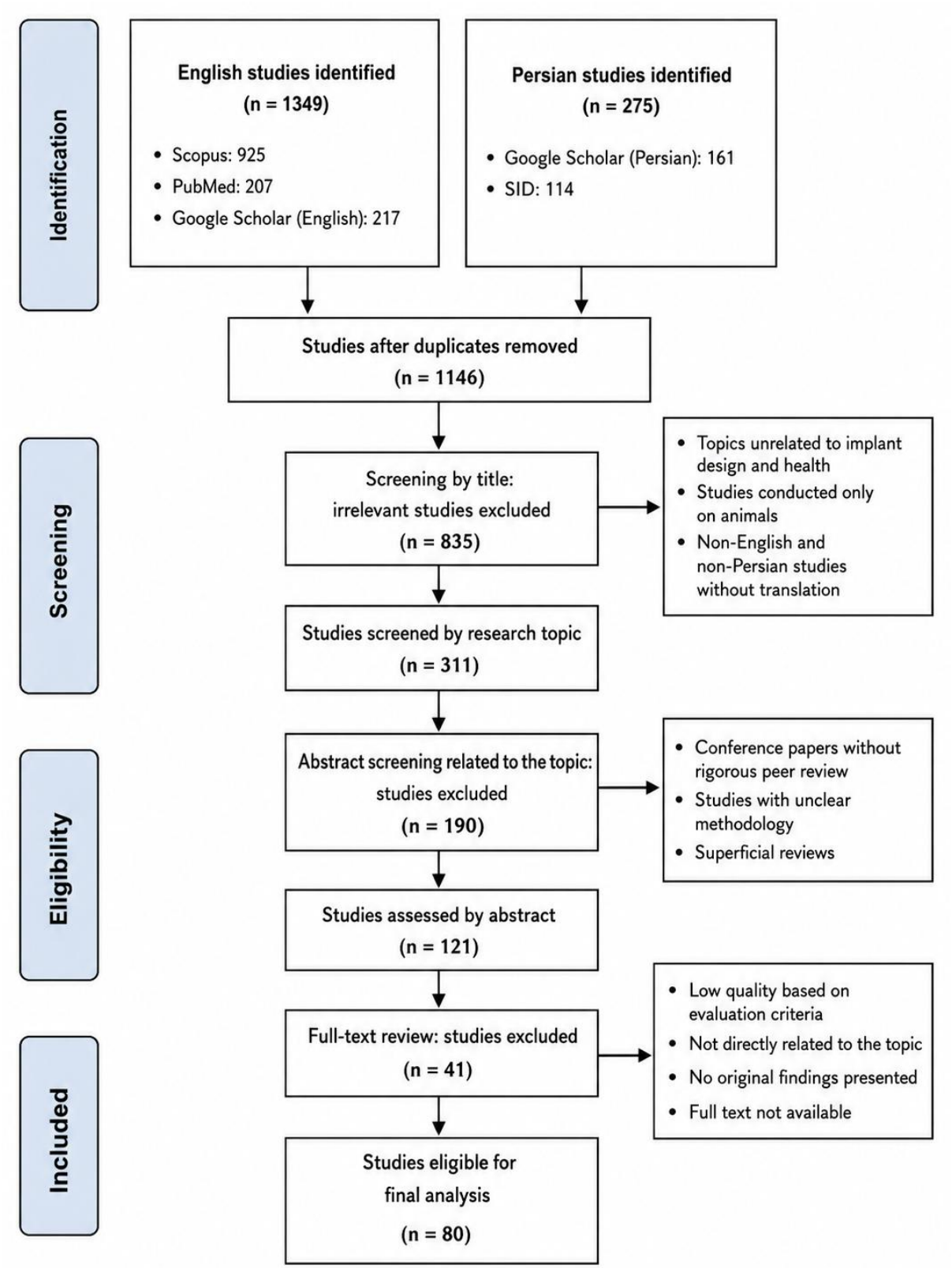

Figure 1. PRISMA Flow Diagram Illustrating the Identification, Screening, Eligibility Assessment, and Selection of Studies Included in the Review (Source: Authors)

3.4. Data Analysis

The selected studies were analyzed using the thematic analysis approach developed by Braun and Clarke (2006). The coding process was conducted iteratively until theoretical saturation was achieved, meaning that analysis of the later studies yielded no additional themes. Nevertheless, the remaining articles were also examined

to verify the stability and completeness of the conceptual framework, and no further themes emerged. Consequently, the final synthesis was based on all 80 included studies.

Initially, 72 preliminary codes were identified. Following iterative comparison, refinement, and clustering, these codes were organized into five overarching themes:

1. Theoretical foundations of therapeutic planting design (Stress Reduction Theory, Attention Restoration Theory, and Therapeutic Landscapes);
2. Empirical evidence and key indicators of the paradigm shift (including both quantitative and qualitative research);
3. Challenges and contradictions associated with the paradigm transition;
4. Practical and policy implications; and
5. Unintended consequences of therapeutic planting design.

Finally, the findings were synthesized into an integrated conceptual framework, referred to as the Urban Planting Design Spectrum, which provides a comprehensive model for understanding the transition from aesthetic planting toward evidence-based, health-oriented planting design.

4 .Findings: Empirical and Neuroscientific Evidence of the Paradigm Shift

This section presents the findings derived from the analysis of the 80 selected studies concerning the scientific evidence and key indicators of the paradigm shift. The findings are organized into four major themes: (1) evidence supporting the transition from the concept of general green space to specific landscape elements ; (2) evidence regarding the mediating pathways through which nature influences health; (3) evidence on sensory gardens and aromatic plants; and (4) neuroscientific evidence explaining the biological mechanisms underlying nature–health relationships.

4.1. Evidence for the Transition from General Green Space to Specific Landscape Elements

One of the most significant methodological developments in recent research has been the shift from measuring broad indicators of vegetation cover-such as NDVI (Normalized Difference Vegetation Index) or general green space[i]-to identifying specific landscape elements associated with mental health outcomes. A systematic review of 48 studies demonstrated that although general measures of vegetation cover failed to show significant associations with mental health in approximately 40% of the studies, specific landscape components, particularly urban parks (79% positive findings) and trees (63% positive findings), exhibited strong and consistent associations with mental health indicators (Sander et al., 2025).

This finding has important implications for urban planting design, suggesting that tree planting and the provision of parks-even at the neighborhood scale-are more effective in promoting mental health than simply increasing the overall amount of green space, such as extensive lawn coverage. Another meta-analysis reported that biodiversity within urban green spaces is positively associated with improved mental health. Green spaces characterized by high species diversity, seasonal dynamics, and naturalistic design elements provide greater support for psychological and physiological restoration than homogeneous or highly artificial environments (Tutova et al., 2025). In other words, the quality and structural characteristics of vegetation -including species diversity, tree form, and multilayered planting-are more influential than vegetation quantity alone.

More specifically, green space quality, reflected in factors such as the availability of recreational facilities, plant species diversity, variation in color and form, multisensory vegetation characteristics, and multilayered planting structures, appears to play a more important role than green space quantity, which is commonly measured using indicators such as per capita green space, vegetation density, or overall vegetation cover.

4.2. Evidence on Mediating Pathways: How Nature Influences Human Health

Recent studies have increasingly focused on identifying the causal pathways through which nature affects health rather than merely documenting statistical associations. A comprehensive review identified three principal mechanisms linking natural environments to human health: (1) reduction of air and noise pollution (physiological pathway); (2) promotion of physical activity (behavioral pathway); and (3) enhancement of social interaction (social pathway) (Tutova et al., 2025).

A meta-analysis employing Meta-Analytic Structural Equation Modeling (MASEM) across 51 studies with a weighted sample of 28,252 participants demonstrated a significant positive association between urban vegetation and residents' subjective well-being ($r = 0.322$, 95% CI = [0.219–0.417]). The analysis further identified physical activity as the strongest mediating mechanism (Chen et al., 2025). These findings indicate that planting design can indirectly improve health by facilitating walking, encouraging active mobility, and promoting everyday physical activity through interventions such as street tree planting and interconnected green corridors.

Horticultural Therapy, recognized as one of the most effective nature-based interventions, simultaneously operates through all three pathways-physiological, behavioral, and social. Tutova et al. (2025) reported that horticultural therapy not only enhances mental health but also contributes to increased physical activity, reduced oxidative stress, and improved social interaction, thereby helping reduce the mortality gap among individuals with severe mental disorders.

Moderating Variables: Recent evidence also demonstrates that the relationship between green space and mental health is neither linear nor uniform across populations. From a socioeconomic perspective, Galera et al. (2025) found that the protective effects of green space against psychological distress are substantially stronger among socioeconomically disadvantaged populations, suggesting that green infrastructure can function as an equalizing public health resource. However, unequal access to green spaces remains a major barrier in deprived neighborhoods.

Similarly, the conceptual framework proposed by Markevych et al. (2017) identifies three interrelated mediating pathways - harm mitigation, capacity restoration, and behavioral capacity building - all of which are strongly influenced by lifestyle characteristics and neighborhood opportunities.

Contextual factors, including perceived safety, sensory quality, and thermal comfort, also function as important moderators. Jha et al. (2026) demonstrated that embodied experiences, particularly feelings of relaxation and thermal comfort, were stronger predictors of restorative outcomes than visual aesthetics alone. Furthermore, perceived environmental quality, including cleanliness and safety, significantly enhanced or diminished the restorative effects of green spaces.

At the psychological level, Yoshida et al. (2022) reported that place attachment was the strongest predictor of well-being ($\beta = 0.35$), indicating that nature promotes mental health partly by strengthening individuals' emotional attachment to place.

Collectively, these findings suggest that the paradigm shift from aesthetic to therapeutic planting design requires a context-sensitive and user-centered approach that addresses social inequalities, behavioral pathways, perceptual qualities, and identity-related psychological dimensions in order to promote environmental justice and urban health.

4.3. Evidence on Sensory Gardens and the Therapeutic Role of Aromatic Plants

Among the human senses, olfaction has the strongest connection with memory and emotion, making it a fundamental component of sensory and healing garden design. Wang et al. (2025) demonstrated that aromatic plants influence human health through three complementary pathways: physiological, psychological, and social. Volatile compounds released by plants - such as linalool in lavender and menthol in mint - interact with the limbic system, the brain's emotional processing center, thereby reducing anxiety and improving mood.

A case study of six urban sensory gardens in Poland found that their therapeutic potential ranged between 46% and 66%. Among the 73 respondents, 62 participants (85%) expressed a preference for using rainwater and graywater for irrigation, reflecting strong public awareness of water scarcity and support for ecologically sustainable management practices. The study also revealed that lavender and mint evoked the strongest positive autobiographical memories associated with home, family, and childhood. These findings suggest that selecting aromatic plants for urban planting design should consider not only their ecological characteristics but also their cultural significance, memory-evoking capacity, and therapeutic sensory qualities (Krzeptowska-Moszkowicz et al., 2022).

A bibliometric analysis of 229 publications on aromatic plants in therapeutic environments in China demonstrated that research in this field has expanded rapidly, with a clear shift from descriptive studies toward experimental and effectiveness-oriented investigations (Li et al., 2024). Aromatic species such as lavender, rosemary, mint, and sage, owing to their distinctive fragrances, colors, textures, and medicinal properties, play an indispensable role in the design of healing and sensory gardens (Shahrajabian, 2022).

4.4. Neuroscientific Evidence: The Brain's Response to Nature

Recent advances in neuroimaging technologies, particularly functional magnetic resonance imaging (fMRI), have provided new insights into the neural mechanisms through which natural environments influence human health. One neuroimaging study demonstrated that natural soundscapes capture attention, reduce distraction, and increase parasympathetic nervous system activity, thereby facilitating physiological relaxation (Cuthbert et al., 2020).

Neuroscientific research has further shown that exposure to green environments throughout different stages of life is associated with structural changes in brain regions involved in stress regulation - including the amygdala and prefrontal cortex - as well as cognitive control processes (Sander et al., 2025). Likewise, Bratman et al. (2015) demonstrated through an fMRI experiment that a 50-minute walk in a natural environment significantly reduced activity in the subgenual prefrontal cortex (sgPFC), a brain region associated with rumination, whereas an equivalent walk in an urban environment produced no comparable effect (Bratman et al., 2015). Collectively, these findings demonstrate that the health benefits of nature are not merely subjective perceptions or psychological beliefs but are supported by robust neurobiological evidence, establishing nature exposure as a scientifically credible public health intervention (Bratman et al., 2019).

Recent research has also focused on translating empirical evidence into practical decision-support tools for designers and policymakers. One notable example is HEAL (Health Effect Assessment of Landscape), a machine learning–based framework developed using data from five major metropolitan areas in the United States. HEAL predicts the effects of neighborhood green-space morphology on the prevalence of non-communicable diseases - including cardiovascular disease, stroke, chronic obstructive pulmonary disease, diabetes, poor mental health, and

physical inactivity - with predictive accuracies exceeding 93% across multiple disease categories. The tool evaluates alternative green-space design scenarios, including verdancy, fragmentation, connectedness, aggregation, and green-space configuration, before implementation, enabling policymakers to compare potential health outcomes and make evidence-informed planning decisions (H. Wang et al., 2024). This development illustrates how emerging artificial intelligence technologies can be used to predict the public health impacts of green space design before implementation.

5. Discussion: A Critical Analysis of the Assumptions and Challenges Underlying the Paradigm Shift

This section critically examines the five fundamental assumptions identified across the reviewed literature that have historically underpinned the aesthetic planting paradigm. It also evaluates the limitations and challenges associated with the emerging therapeutic paradigm, with the aim of providing a balanced and evidence-based interpretation of this transition. These assumptions are not treated as hypotheses to be tested; rather, they are considered foundational paradigms deeply embedded in landscape architecture and urban planning theory and practice.

5.1. Challenging the First Assumption: "Beauty Is Equivalent to Better Design"

A central assumption of the aesthetic paradigm is that the more aesthetically pleasing a plant or planting composition is - in terms of color, form, symmetry, harmony, and visual attractiveness - the more suitable it is for urban landscapes. This assumption is rooted in the Western aesthetic tradition, from Plato to Kant, in which beauty has historically been associated with goodness and perfection. However, accumulating scientific evidence indicates that visual beauty alone is a comparatively weak predictor of mental health when compared with other sensory dimensions, including smell, sound, texture, and biodiversity. Multisensory experiences integrating vision, olfaction, hearing, touch, and even taste exert substantially greater influences on human well-being than purely visual experiences (Wang et al., 2025).

Moreover, an exclusive emphasis on visual aesthetics often promotes homogeneous planting schemes, such as extensive lawns or orderly rows of a single tree species, which provide limited biodiversity and relatively poor sensory stimulation. Tutova et al. (2025) further demonstrated that environments characterized by greater biodiversity and natural ecological complexity generate stronger health-promoting effects than landscapes designed primarily for visual attractiveness.

These findings challenge the traditional assumption that beauty alone should guide plant selection. Instead, therapeutic efficacy should be recognized as an equally important and independent design criterion. Consequently, the longstanding dichotomy between aesthetics and function requires reconsideration. The findings of this review support the concept of a multisensory, health-oriented aesthetic, in which beauty is understood not solely through visual perception but through the integrated stimulation of multiple senses and their measurable contributions to human health (Dushkova & Ignatieva, 2020).

5.2. Challenging the Second Assumption: "Exotic Plants Are Superior to Native Species"

Another prevailing assumption within the aesthetic paradigm is that exotic or imported plant species are inherently preferable because of their novelty and visual appeal. This preference has historical roots in colonial horticulture and the global exchange of ornamental plants. From a therapeutic perspective, however, native species offer several important advantages: (1) greater adaptation to local climatic conditions, reducing irrigation and maintenance requirements; (2) support for native biodiversity and pollinator communities; and (3) reinforcement of sense of place and cultural identity, both of which contribute significantly to psychological well-being (Goda et al., 2025; Hagaman, 2024; Kazemi & Abbasi, 2018; Tutova et al., 2025).

Tuna et al. (2020) identified 80 native medicinal and aromatic species among 189 documented species in Malatya, Türkiye that met landscape planting design criteria. Their findings indicate that native flora possesses considerable potential for landscape applications but remains underutilized because of insufficient documentation regarding aesthetic characteristics and ecological performance (Kazemi & Abbasi, 2018).

Accordingly, prioritizing exotic species is not only ecologically unsustainable but may also reduce therapeutic effectiveness. Native plants are synchronized with local pollinators and regional seasonal rhythms, enabling users to experience a more authentic and meaningful connection with local nature (Ignatieva et al., 2020). This sense of authenticity and place attachment has itself been identified as an important mechanism for reducing stress and promoting well-being (Townsend et al., 2018; Yoshida et al., 2022). In Iran, native species such as Damask rose (Rosa damascena), Shirazi thyme (Zataria multiflora), and sage (Salvia spp.) are not only climatically adapted but also deeply embedded within Persian cultural traditions and collective memory, thereby enhancing users' emotional attachment and psychological comfort (Akbarzadeh & Adibi, 2014).

5.3. Challenging the Third Assumption: "A Healing Garden Works Equally Well for Everyone"

Many healing garden guidelines implicitly assume that a single design can effectively serve all users regardless of age, gender, cultural background, medical condition, or life experience. This assumption reflects the traditional medical model of "one size fits all" (Gesler, 1992).

Evidence increasingly demonstrates that therapeutic preferences vary considerably among user groups. Individuals with post-traumatic stress disorder (PTSD), for example, often prefer enclosed spaces with dense

vegetation that provide security (Thomas et al., 2024), whereas individuals experiencing depression may benefit more from open, sunlit environments offering broad visual prospect (Li et al., 2025). Older adults frequently prefer tactile vegetation and gently scented plants (Huang & Yuan, 2024), while children respond more positively to brightly colored plants and playful forms (Sheng et al., 2024). Similarly, green spaces within psychiatric healthcare facilities should accommodate users with different therapeutic needs throughout various stages of recovery. User-sensitive and multifunctional design has therefore been recognized as an effective strategy for reconciling diverse preferences while creating truly therapeutic environments (Schmid et al., 2024).

A recent study adopting Ingold's Dwelling Perspective further argues that therapeutic landscapes should not be understood as static natural settings but as relational epistemology co-produced through continuous interactions among humans, non-human organisms, and the surrounding landscape (Zhang & Sun, 2025).

These findings indicate that healing gardens should be designed using a user-centered and context-sensitive approach. Flexible spatial organization - including active horticultural therapy areas, quiet contemplative spaces, and multisensory zones - allows therapeutic environments to accommodate diverse user needs (Sillmann et al., 2024). Iranian studies similarly demonstrate the importance of tailoring healing gardens to specific populations, including older adults, children, and military veterans (Farvardin & Bababkhani, 2025; Taheri & Ghasemi Sichani, 2021; Taheri & Shabani, 2022). Consequently, robust Post-Occupancy Evaluation (POE) frameworks are essential for assessing therapeutic effectiveness across different user groups (Carroll et al., 2024).

5.4. Challenging the Fourth Assumption: "Existing Scientific Evidence Is Sufficient to Change Policy"

Another assumption that is rarely questioned is that the current body of scientific evidence demonstrating the therapeutic benefits of green spaces is, by itself, sufficient to transform urban policies and planning regulations. In reality, a substantial gap remains between scientific knowledge and policy implementation (Russo et al., 2026).

Comprehensive reviews indicate that the implementation of Nature-based Solutions (NbS) continues to face significant barriers, including science–policy gaps, the absence of standardized evaluation frameworks, and governance challenges (Bayulken et al., 2021). Consequently, even when scientific evidence is compelling, policymakers may remain reluctant to adopt innovative approaches because of financial constraints, political pressures, limited technical guidance, or insufficient awareness (Diep & McPhearson, 2025; Zarei & Shahab, 2025). Resistance to evidence-based innovation therefore often reflects structural, institutional, economic, and political constraints rather than weaknesses in the scientific evidence itself.

This challenge is particularly evident in Iran. Despite possessing more than 2,300 medicinal plant species and a long tradition of herbal medicine, the country currently lacks an integrated legal and policy framework governing the application of medicinal plants within urban landscapes. Existing regulations primarily focus on conserving historical and traditional gardens rather than establishing standards for therapeutic landscapes or medicinal plant gardens within urban green infrastructure (Kazemi & Abbasi, 2018).

These findings suggest that although sufficient scientific evidence exists to support a paradigm shift, that evidence must be translated into practical policy guidelines, measurable standards, and evidence-based planning frameworks. Capacity building and professional education for policymakers and urban managers are equally essential if the therapeutic value of health-oriented planting design is to be fully recognized and implemented (Russo et al., 2026).

5.5. Challenging the Fifth Assumption: "Quantity Is More Important Than Quality"

A further assumption of the aesthetic paradigm is that simply increasing the quantity of green space - through larger park areas, more trees, or greater vegetation cover - is sufficient to improve public health. However, accumulating evidence indicates that the quality of vegetation, including its structure, diversity, layering, morphology, and perceived biodiversity, plays a far more decisive role.

First, the relationship between vegetation quantity and mental health is not linear. Wang et al. (2024) identified an inverse U-shaped relationship between NDVI and mental health in Wuhan, with benefits increasing up to approximately NDVI = 0.25 before subsequently declining, indicating that greater vegetation cover does not necessarily produce greater health benefits (Z. Wang et al., 2024). Similarly, research has shown that not all green spaces provide equivalent health outcomes; rather, accessible, usable, and well-designed public green spaces maximize both health benefits and urban greening objectives (Cao et al., 2025).

Second, vegetation quality strongly influences attentional restoration and stress reduction. Using immersive virtual reality, Li et al. (2024) demonstrated that vegetation richness, structural complexity, and color significantly enhanced environmental preference and perceived restoration, with color exerting the strongest influence (β = 2.55). Nevertheless, moderate environmental complexity produced the most favorable restorative outcomes, whereas excessive simultaneous complexity diminished benefits because of diminishing interactive effects (Hao et al., 2024; Li & Zhang, 2024).

Third, perceived biodiversity has emerged as a key mediating mechanism. Using structural equation modeling, Uebel et al. (2025) demonstrated that users' visual and auditory perceptions of biodiversity were stronger determinants of mental health than biodiversity itself. Likewise, an experimental virtual reality study found that street green spaces characterized by unrestricted access, open layouts, random planting arrangements, and high species diversity generated substantially greater restorative potential than enclosed spaces with limited

accessibility, highly ordered layouts, and low diversity (Baniadam et al., 2025). Plant diversity itself represents one dimension of environmental quality, while spatial organization and user perception function as complementary mechanisms through which restorative benefits are realized.

These conclusions are supported by several systematic reviews. Xu et al. (2025), synthesizing evidence from 22 studies, found that natural landscape components - particularly vegetation diversity and water features - consistently promoted mental health, whereas the influence of spatial characteristics such as accessibility depended heavily on design quality and long-term maintenance. Similarly, Wang et al. (2024) identified six fundamental indicators of green-space morphology - size, shape, fragmentation, connectivity, aggregation, and diversity - highlighting that spatial configuration is as important as the overall quantity of green space (Huaqing Wang et al., 2024).

These findings demonstrate that simple quantitative indicators, such as per capita green space, are insufficient for evaluating the health effects of vegetation. Consistent with recent Iranian research (Farvardin & Bababkhani, 2025), landscape architects, urban greening professionals, and planners should shift their emphasis from increasing the amount of green space toward improving its structural quality through multilayered vegetation, species diversity, seasonal variation, naturalistic planting design, and therapeutic functionality. This transition from quantity to quality represents one of the defining characteristics of the paradigm shift from aesthetic to therapeutic planting design.

Overall, the critical analysis of these five assumptions indicates that the transition from aesthetic planting design to health-oriented planting design should not be understood as a simple replacement of one paradigm by another. Rather, it represents a gradual, multidimensional, and evolutionary process. The findings of this review demonstrate that many of the traditional dichotomies within landscape architecture - including aesthetics versus function, native versus exotic species, quantity versus quality, and standardization versus personalization - are better interpreted as continua rather than mutually exclusive alternatives.

In addition to these issues, one of the major themes emerging from the reviewed studies concerns the unintended consequences associated with the expansion of therapeutic planting design. These include potential negative outcomes and social inequalities arising from the development of urban green spaces, such as green gentrification[ii], unequal access, biological risks (including plant toxicity and allergies), and social exclusion. These challenges highlight the importance of adopting equitable, inclusive, and context-sensitive approaches when implementing health-oriented landscape interventions.

6. Conceptual Framework: The Spectrum of Urban Planting Design from Aesthetic to Health-Oriented

Based on the synthesis of the studies included in this review (Table 4), an Urban Planting Design Spectrum is proposed (Figure 2). Rather than representing discrete categories, the spectrum illustrates a progressive continuum of five paradigms, each characterized by distinct design objectives, plant selection criteria, and performance indicators. Together, these paradigms reflect the ongoing transition from conventional aesthetic planting toward evidence-based, health-oriented planting design.

Level 1. Aesthetic Planting Design

Primary objective: Visual aesthetics (color, form, texture, composition, and visual harmony)

Plant selection criteria: Attractive flowers, foliage, fruits, and plant form

Success indicators: Users' visual satisfaction, typically assessed through perception surveys.

Typical examples: Traditional French formal gardens characterized by symmetrical rows of a single tree species; English picturesque gardens dominated by expansive lawns and informal planting compositions (Ignatieva et al., 2020); and aesthetical plantings in highway interchanges, roundabout central islands, and urban boulevards, where the principal objective is environmental beautification through visual stimulation.

Level 2. Functional–Aesthetic Planting Design

Primary objective: Integration of aesthetic quality with environmental functions, including shade provision, urban cooling, air pollution mitigation, and noise reduction

Plant selection criteria: Visual attractiveness combined with drought tolerance and low irrigation requirements

Success indicators: Reduced water consumption, enhanced biodiversity, improved visual quality, and increased recreational usability

Typical examples: Xeriscape gardens, conventional urban parks such as Laleh Park and Shahr Park (a historic urban park) in Tehran, extensive green roofs (Caser et al., 2017), and the National Botanical Garden of Iran[iii], where planting design not only provides aesthetic value but also accommodates recreational functions while contributing to urban microclimate regulation.

Table 4. Relationship Between the Selected Studies and the Five Levels of the Proposed Conceptual Framework for Urban Planting Design

Framework Level	Primary Implications for Planting Design	Key Studies
Level 1: Aesthetic Planting Design	Emphasis on color, form, texture, spatial composition, and visual attractiveness as the primary criteria for plant selection.	Zgarbová (2014); Ignatieva et al. (2020); Fernandes et al. (2025)
Level 2: Functional–Aesthetic Planting Design	Integration of ecosystem services, climate resilience, water conservation, native plant selection, and ecological performance alongside landscape aesthetics.	Van den Bosch & Sang (2017); Dushkova & Ignatieva (2020); Caser et al. (2017); Xie & Bulkeley (2020); Wang et al. (2024); Tuna et al. (2020); Kazemi & Abbasi (2018); Aćimović & Zheljazkov (2026); Owfi (2020); Hoseini et al. (2021)
Level 3: Multisensory Therapeutic Planting Design	Utilization of fragrance, color, texture, sound, and multisensory experiences to reduce stress, improve mood, and promote mental well-being.	Wang et al. (2025); Krzeptowska-Moszkowicz et al. (2022); Li et al. (2024); Shahrajabian et al. (2021, 2022); Huang & Yuan (2024); Sheng et al. (2024); Thomas et al. (2024); Sillmann et al. (2024); Abu Bakar & Aziz (2024); Capolongo et al. (2023); Carroll et al. (2024); Schmid et al. (2024)
Level 4: Cognitive–Restorative Planting Design	Design informed by attention restoration, cognitive fatigue reduction, soft fascination, moderate visual complexity, seasonal diversity, and positive cognitive stimulation.	Ulrich (1984); Ulrich et al. (1991); Kaplan & Kaplan (1989); Kaplan (1995); Bell et al. (2025); Bratman et al. (2015, 2019); Li (2022); Cuthbert et al. (2020); Hao et al. (2024); Li & Zhang (2024); Sander et al. (2025); Xu et al. (2025); Uebel et al. (2025)
Level 5: Integrated Health-Oriented Planting Design	Simultaneous integration of physical, mental, social, and ecological health; evidence-based design; health impact assessment; and health-oriented planning and policymaking.	Gesler (1992); Williams (2007); Markevych et al. (2017); Bratman et al. (2019); World Health Organization (2023); Galera et al. (2025); Yang et al. (2025); Roscoe et al. (2022); Chen et al. (2025); Cao et al. (2025); Tutova et al. (2025); Wang et al. (2024a); Wang et al. (2024b); Baniadam et al. (2025); Russo et al. (2026); Bayulken et al. (2021); Diep & McPhearson (2025); Zarei & Shahab (2025); Fry et al. (2025); Rebecchi et al. (2023)
Cross-Level Studies	Studies addressing more than one framework level simultaneously and serving as conceptual links among planting design, health, place identity, evaluation, and policymaking.	Gutke Lunsjö (2023); Krukar & Schultz (2025); Marcus & Sachs (2013); Paraskevopoulou & Kamperi (2018); Paraskevopoulou et al. (2018); Goda et al. (2025); Hagaman (2024); Townsend et al. (2018); Yoshida et al. (2022); Zhang & Sun (2025)

Level 3. Sensory–Therapeutic Planting Design

Primary objective: Stimulation of the five human senses - particularly olfaction and touch - to reduce stress and promote psychological restoration

Plant selection criteria: Fragrance, tactile qualities, calming colors, and scientifically validated stress-reducing properties

Success indicators: Reduced cortisol levels, improved mood, and enhanced attentional capacity

Typical examples: Sensory gardens in hospitals and rehabilitation centers (Dushkova & Ignatieva, 2020), particularly within healthcare campuses possessing extensive outdoor green spaces, as well as traditional Persian gardens characterized by aromatic flowers and flowing water features designed to stimulate and enrich multisensory experiences.

Figure 2. Conceptual Framework of the Study (Source: Authors)

Level 4. Cognitive–Restorative Planting Design

Primary objective: Restoration of directed attention and enhancement of cognitive performance

Plant selection criteria: Soft fascination generated through gentle movement in the wind, seasonal change, diverse vegetation textures, and visually rich yet cognitively manageable planting compositions

Success indicators: Improved performance on cognitive tasks and reduced attentional fatigue (Bell et al., 2025)

Typical examples**:** Contemplation gardens, healing gardens in hospitals and rehabilitation facilities, and restorative landscapes that emphasize attention restoration and stress reduction based on established psychological theories without requiring active public engagement.

Level 5. Integrated Health-Oriented Planting Design

Primary objective: Simultaneous promotion of physical, psychological, social, and ecological health

Plant selection criteria: Integration of the criteria from Levels 1–4 together with biodiversity, medicinal value, user safety, accessibility, and inclusivity

Success indicators: A combination of quantitative physiological measures (e.g., cortisol concentration, blood pressure, and heart rate variability) and qualitative indicators (e.g., user satisfaction, place attachment, and social interaction) (Galera et al., 2025; Yang et al., 2025)

Typical examples: Participatory healing gardens, health-oriented urban parks, and integrated hospital landscapes that explicitly address environmental justice, community engagement, ecological sustainability, and public health objectives.

It should be emphasized that the proposed framework is not intended as a prescriptive model applicable to all landscape projects. Rather, it serves as a flexible conceptual guide that synthesizes evidence-based principles of health-oriented planting design. Depending on landscape type, project scale, design objectives, environmental context, and user characteristics, these principles may be selectively applied and weighted differently. Accordingly, the distinction among healing gardens, urban parks, neighborhood green spaces, and other landscape types lies not in fundamentally different planting design principles but in the manner in which these principles are prioritized, combined, and implemented.

Furthermore, the proposed framework has the potential to evolve into a practical evaluation and benchmarking tool for future research and professional practice. Such a tool could assess and compare urban green-space projects using indicators including biodiversity, sensory quality, responsiveness to user needs, the extent to which scientific evidence informs design decisions, and contributions to public health objectives. By providing standardized assessment criteria, this framework could help bridge the longstanding gap between academic research, landscape architectural practice, and urban policymaking, thereby facilitating the broader implementation of evidence-based, health-oriented planting design.

7 .Conclusion

Using a critical review approach guided by the SALSA framework, this study examined the paradigm shift in planting design from a predominantly aesthetic approach toward a health-oriented perspective. The critical synthesis and analysis of 80 selected studies demonstrate that contemporary landscape architecture and environmental health literature increasingly recognizes plants as more than ornamental elements, positioning them as integral components that contribute to the promotion of physical, psychological, and social well-being. The findings further indicate that Stress Reduction Theory, Attention Restoration Theory, and the Therapeutic Landscapes framework each explain complementary mechanisms underlying human–nature interactions. Their integration provides a more comprehensive theoretical foundation for understanding the role of planting design in promoting health. Accordingly, this study argues that the transition from aesthetic planting design to health-oriented planting design cannot be achieved simply by incorporating isolated therapeutic features. Rather, it requires a fundamental redefinition of design objectives through the integration of scientific evidence with landscape architectural principles and the coordinated organization of ecological, sensory, functional, and social characteristics within a unified conceptual framework.

The analysis further demonstrates that health outcomes are influenced more strongly by the quality of planting design than by the quantity of green space. Characteristics such as species diversity, spatial organization, vegetation structure, multisensory qualities, biodiversity, and opportunities for social use play substantially greater roles than green-space area alone. Moreover, the synthesized evidence indicates that planting design promotes health through interconnected physiological, cognitive, psychological, and social mechanisms, although the magnitude of these effects depends on user characteristics, cultural context, environmental conditions, and design quality. The critical evaluation of the literature also revealed a persistent gap between advances in scientific knowledge and prevailing approaches to the design and management of urban green spaces, highlighting the urgent need to move from experience-based toward evidence-based planting design.

In response to the central research question, this review proposes a five-level conceptual framework that explains the transition from aesthetic to health-oriented planting design. Representing the principal contribution of this study, the framework integrates the three major theoretical perspectives with contemporary empirical evidence to conceptualize health-oriented planting design as an evolutionary continuum, ranging from purely

aesthetic landscapes to fully integrated health-oriented environments. Unlike conventional binary classifications that distinguish only between aesthetic and therapeutic landscapes, the proposed framework recognizes that urban green-space projects may occupy different levels of health-oriented maturity depending on their objectives, scale, user groups, and contextual conditions. Consequently, the framework should be understood not as a prescriptive design model but as a conceptual tool to support evidence-based design, evaluation, and decision-making across diverse types of green infrastructure.

The findings also have important implications for urban policy and landscape management. Integrating health-oriented criteria alongside conventional ecological and aesthetic indicators into the design and evaluation of urban green spaces has the potential to substantially enhance their effectiveness. The proposed framework further highlights the importance of developing evidence-based assessment systems, promoting the use of native and medicinal plant species adapted to local climatic conditions, encouraging interdisciplinary collaboration among landscape architects, healthcare professionals, and urban planners, and addressing environmental justice by ensuring equitable access to high-quality green spaces. These recommendations are particularly relevant for hospitals, rehabilitation centers, schools, urban parks, and other public open spaces, where evidence-based planting design can contribute directly to public health and well-being.

Several limitations should be acknowledged. The reviewed studies exhibited considerable methodological heterogeneity, employed diverse health outcome measures, and were limited to publications in Persian and English, introducing the possibility of language and publication bias. Furthermore, despite the application of transparent selection criteria and systematic thematic analysis, the interpretive nature of critical review methodology inevitably involves a degree of researcher judgment. Accordingly, future research should focus on empirically validating the proposed conceptual framework, developing standardized tools for evaluating health-oriented planting design, conducting longitudinal and intervention-based studies, and investigating the therapeutic potential of native plant species and the principles of traditional Persian gardens and landscapes.

Overall, the findings of this critical review demonstrate that health-oriented planting design represents far more than a change in plant selection; it reflects a fundamental transformation in the philosophy of urban landscape planning and design. This paradigm shift repositions landscape architecture from the creation of aesthetically attractive spaces toward the design of environments that simultaneously promote public health, environmental justice, biodiversity, and urban resilience. From this perspective, the conceptual framework proposed in this study provides a foundation for future research, the development of evidence-based evaluation tools, and informed decision-making in health-oriented planting design.

Author Contributions

All authors contributed to the conception, design, and preparation of the manuscript. During manuscript preparation, ChatGPT (OpenAI, GPT-5.5) was used solely for editing the Persian text, improving readability, refining the linguistic structure and academic writing style, and improving the presentation of Figures 1 and 2. The study design, literature selection, critical analysis, interpretation of the findings, development of the conceptual framework, and all scientific conclusions were carried out exclusively by the authors, who assume full responsibility for the accuracy, originality, and integrity of the manuscript.

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Conflict of Interest

The authors declare that they have no competing interests or conflicts of interest related to this study.

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Appendices

Appendix Table 1 – List of the 80 Studies Included in the Review

Row	Source (Author, Year)	Study Type	Quality Level	General Topic	Main Results
1	Abu Bakar & Aziz (2024)	Systematic Review	Moderate	Role of sensory elements in therapeutic landscapes	Four aspects of health (physiological, psychological, social, socio-ecological), with physiological being the most important.
2	Aćimović & Zheljazkov (2026)	Narrative Review	High	Alternative applications of Helichrysum species in phytoremediation and urban horticulture	Drought-tolerant, suitable for green roofs; produces essential oil free of heavy metals.

3	Bahrami et al. (2026)	Design Guideline/Recommendation	High	Designing a medicinal plant garden in Kerman	Provides planting design for native species, phytoremediation, and zoning based on medicinal plant types.
4	Baniadam et al. (2025)	Experimental/Quasi-experimental with VR	High	Effect of streetscape vegetation design on mental restoration	Unrestricted conditions, random arrangement, and high diversity yield greater restoration.
5	Bayulken et al. (2021)	Systematic Review	Low	Nature-based solutions for greening cities during crises	Need for further research on predictive learning, retrospection, and community participation.
6	Bell, L.J. et al. (2025)	Systematic Review + Meta-analysis	Low	Effect of nature exposure duration on attention restoration	Approximately 30 minutes yields the greatest difference; small effect size, high heterogeneity.
7	Bell, S.L. et al. (2018)	Scoping Review	High	Evolution of therapeutic landscapes towards healthy spaces and places	Identifies strengths, weaknesses, knowledge gaps, and future directions.
8	Bratman et al. (2015)	Experimental/RCT with random assignment	High	Effect of nature walking on affect and cognition	Reduces anxiety, rumination, and negative affect; improves working memory.
9	Bratman et al. (2019)	Conceptual/Theoretical Framework	High	Nature and mental health from an ecosystem service perspective	Proposes a conceptual model to integrate mental health into ecosystem service assessments.
10	Cao et al. (2025)	Statistical Modelling/Machine Learning	High	Nonlinear health benefits of public green space	Active public green space has a positive effect; baseline thresholds 12.4% and 36.3%, optimal 18% and 45% for active public green space and its ratio to total public green space, respectively.
11	Capolongo et al. (2023)	Theoretical Reference Book	High	Therapeutic landscape design, methods, and strategies	Emphasises outdoor spaces for Alzheimer's patients, children, and biophilic design.
12	Chen et al. (2025)	Systematic Review + Meta-analysis	Low	Impact of urban green space on subjective well-being	Positive correlation r = 0.322; mediating roles of social cohesion, air pollution, and physical activity.
13	Cooper Marcus & Valente (2015)	Design Guideline/Recommendation	High	Design processes of healing gardens	Use of evidence-based design and post-occupancy evaluation; case study of three Californian gardens for cancer patients.
14	Diep & McPhearson (2025)	Conceptual/Theoretical Framework	High	Four levers for urban adaptation with nature-based solutions	Knowledge production, incentive policies, budget access, regulatory mechanisms.
15	Din et al. (2023)	Narrative Review	High	Benefits of healing gardens for children in healthcare facilities	Need for evidence-based guidelines for policymakers.
16	Dushkova & Ignatieva (2020)	Narrative Review	High	New trends in urban environmental health research	Healing gardens and therapeutic landscapes as nature-based solutions.
17	Fernandes et al. (2025)	Systematic Review	Low	Planting design for resilient and liveable cities	Increasing publications since 2016; focus on aesthetics and ecology; climate change is a hot topic.
18	Fry et al. (2025)	Systematic Review	Low	Effect of place-based nature interventions on human health	Limited evidence; community-engaged park projects better; crime reduction on vacant land.
19	Galera et al. (2025)	Longitudinal Study	High	Neighbourhood green space and psychological distress with socioeconomic inequality	Lack of green space associated with higher distress; high green space more beneficial for disadvantaged groups.
20	Gan & Wang (2026)	Conceptual/Theoretical Framework	Moderate	Transforming urban parks into comprehensive health-promoting spaces	Role of aromatic plant molecules; 20-minute park visits increase well-being.
21	Gesler (1992)	Foundational Theory	High	Therapeutic landscapes in new cultural geography	Introduces the concept of therapeutic landscapes and their connection to health.
22	Gray et al. (2024)	Mixed-Methods (Quantitative + Qualitative)	High	Community gardening for vulnerable populations	Four themes: connection to self, others, place, and purpose; increased satisfaction, health, and social connection.
23	Guo et al. (2023)	Cross-sectional/ Survey	High	Landscape elements needed for hospital healing spaces	Need for safe, quiet, private environments; differences between adolescents and the elderly.
24	Gwedla et al. (2024)	Cross-sectional/ Survey (Floristic)	High	Health clinic gardens as social-ecological systems	631 species; 55% native in natural micro-gardens; potential for ecosystem services.
25	Hao et al. (2024)	Experimental (Factorial Design with VR)	High	Effect of structural, species, and colour diversity on preference and perceived restoration	Colour has the greatest effect (2.55×); moderate complexity is best.

26	He et al. (2022)	Cross-sectional/ Survey (Field)	Moderate	Therapeutic landscape design based on the five senses theory	High plant diversity and user satisfaction; shortcomings: simple structure and lack of wetland plants.
27	Ignatieva et al. (2020)	Narrative Review	High	Urban lawns and nature-based solutions	Need for native, resilient alternatives to globalised lawns.
28	Jha et al. (2026)	Statistical Modelling/Machine Learning (SHAP)	High	Urban blue-green spaces and everyday well-being	More than 40% visit three times a week; thermal comfort and adequate seating are important.
29	Kaleta et al. (2025)	Systematic Review (Systematic Review of Reviews)	Low	Nature-based interventions (NBIs)	13 intervention categories; 11 moderating factors (social, physical activity, age, duration, etc.).
30	Kaplan & Kaplan (1989)	Theoretical Reference Book	High	Experience of nature from a psychological perspective	Foundational theory for Attention Restoration Theory (ART).
31	Kaplan (1995)	Foundational Theory	High	Restorative benefits of nature; integrative framework	Introduces Attention Restoration Theory (ART) and the role of nature.
32	Kazemi & Abbasi (2018)	Narrative Review	High	Challenges of domesticating native plants for Iran's urban green spaces	Highlights the potential of native plants and adaptation challenges.
33	Kearns & Milligan (2020)	Foundational Theory	High	Theoretical development of therapeutic landscapes	Reviews 119 articles; three main themes; emphasis on maintaining the tripartite foundation.
34	Krzeptowska-Moszkowicz et al. (2022)	Cross-sectional/ Survey	High	Urban sensory gardens with aromatic herbs and their effect on memory and well-being	Almost all respondents associated smells with personal memories; preference for ecological solutions.
35	Laiyi (2024)	Narrative Review	High	Healing gardens from an Eastern garden perspective	Combines Western perspectives with traditional Chinese concepts.
36	Lefosse et al. (2025)	Conceptual/Theoretical Framework	High	Biophilic urbanism across different scales	Evidence-based maps to improve liveability through nature.
37	Li, H. et al. (2026)	Statistical Modelling	High	Impact of green space quantity and quality across geographic contexts on mental health	Mediating pathways: physical activity, social interaction, and psychological stress.
38	Li, Q. (2022)	Narrative Review	Moderate	Effects of forest environment (Shinrin-yoku) on health	10 positive effects including increased natural killer cells, reduced blood pressure, stress, and improved sleep.
39	Lin, W. et al. (2023)	Experimental/Quasi-experimental	High	Sky-leaf-trunk (SLT) ratio in canopy landscapes and restorative effects	Appropriate combination of elements reduces stress and restores attention.
40	Lin, X. et al. (2025)	Cross-sectional/ Survey (analysis of 1000+ species)	High	Plant characteristics and planning strategies for herbal gardens	Analysis of over 1000 species; provides design principles based on ecological diversity, health, and safety.
41	Marcus & Sachs (2013)	Theoretical Reference Book	High	Evidence-based therapeutic landscapes for healing gardens	Provides guidelines based on evidence and user participation.
42	Markevych et al. (2017)	Conceptual/Theoretical Framework	High	Pathways linking green space to health	Three domains: harm mitigation, capacity restoration, and capacity building.
43	Mooney (2019)	Theoretical Reference Book	High	Planting design and connecting people and place	Integrates planting design art with human responses to nature.
44	Mossabir et al. (2021)	Scoping Review	High	Therapeutic landscape experiences in everyday community geographies	Reviews 45 studies; role of everyday places as sanctuaries, anchors, and resonances.
45	Owfi (2020)	Theoretical Reference Book	Moderate	Natural products and botanical medicines of Iran	Introduces the diversity of medicinal plants and their traditional uses.
46	Paraskevopoulou & Kamperi (2018)	Systematic Review	Low	Healing garden design in hospitals and pre-/post-occupancy research	Lack of research and differing design recommendations.

47	Paraskevopoulou et al. (2018)	Experimental (with biosensors)	High	Effect of seasonal colour change in planting on psychotic patients	Seasonal colour change in tree canopies generates strong positive emotions; recommends deciduous trees.
48	Pimentel et al. (2024)	Systematic Review	High	Recommendations for implementing therapeutic gardens	Seven-step framework for setup and monitoring.
49	Rebecchi et al. (2023)	Content Analysis/In-depth Interviews (Qualitative Case Study)	High	Evaluating the impact of healing gardens on physicians and nurses	Positive effects on satisfaction, relaxation, and willingness to work.
50	Russo et al. (2026)	Narrative Review	High	Nature-based solutions in urban regeneration	Three domains: typology, governance, and methodology (GIS, multi-criteria decision-making).
51	Sander et al. (2025)	Narrative Review	High	Natural vs. built urban elements and brain health	Parks and trees show the strongest positive associations; general green space often non-significant.
52	Schmid et al. (2024)	Mixed-Methods (Quantitative + Qualitative)	High	Greenspaces in psychiatric clinics and patient perceptions	Multi-functional green spaces contribute to relaxation, connection with nature, and social interaction.
53	Shahrajabian (2022)	Narrative Review	Moderate	Traditional medicinal plants for stress and anxiety during the COVID-19 pandemic	Role of plants in managing stress and improving mental health.
54	Sheng et al. (2024)	Statistical Modelling	High	Role of plant colour and familiarity on children's mood	Colour richness, familiarity, and proportion of non-green parts have positive effects; gender differences.
55	Sillmann et al. (2024)	Narrative Review	Moderate	Therapeutic gardens: historical context, foundations, and landscaping	Review of supportive, restorative, and healing garden theories; design based on user needs.
56	Smyth (2005)	Foundational Theory	High	Medical geography: therapeutic places, spaces, and networks	Therapeutic spaces regulate behaviour and exclude some; need for spaces of resistance.
57	Taheri et al. (2021)	Systematic Review	Low	Systematic review of therapeutic landscape literature with emphasis on health dimensions	Greater attention to non-physical dimensions and personal-social perceptions.
58	Taufer et al. (2025)	Narrative Review	High	Psychological and physiological responses to natural smells	Natural odours reduce stress, increase relaxation and well-being.
59	Thomas et al. (2024)	Cross-sectional/ Survey (Online)	High	Preferences of military personnel for therapeutic garden design elements	Preference for fences, gates, private boundaries, and direct views in fenced areas.
60	Townsend et al. (2018)	Theoretical Reference Book Chapter	High	Therapeutic landscapes, restorative environments, place attachment, and well-being	Evolutionary connection with nature; need to restore this relationship in the Anthropocene.
61	Tuna et al. (2020)	Cross-sectional/ Survey (Floristic)	High	Integration of medicinal and aromatic plants into urban landscapes	Identified 189 medicinal species; 80 species usable in design.
62	Tutova et al. (2025)	Narrative Review	High	Restorative gardens in urban green infrastructure and the role of horticultural therapy	Therapeutic gardens as ecosystem services; need for multi-dimensional design.
63	Uebel et al. (2025)	Statistical Modelling	High	Natural soundscapes and mental health through capacity-building pathways	Perceived biodiversity, perceived restoration, perceived stress reduction, and awe mediate the effects.
64	Ulrich (1984)	Experimental (Historical Cohort Study)	High	Effect of window view on recovery from surgery	Patients with natural views had shorter hospital stays and less medication.
65	Ulrich et al. (1991)	Experimental (Laboratory with 120 subjects)	High	Stress reduction during exposure to natural and urban environments	Faster and more complete recovery in nature, with reduced stress and high attention/positive affect.
66	Van den Bosch & Sang (2017)	Systematic Review (Systematic Review of Reviews)	Low	Nature-based solutions for public health	Strong evidence for mood improvement and heat reduction; mediating cardiovascular diseases.

67	Wang, C. et al. (2025)	Narrative Review	High	Plant smellscape and its connection to human well-being	Three pathways: physiological, psychological, and social; need for equitable planning.
68	Wang, H. et al. (2024a)	Systematic Review	Low	Green space morphology and health	Six characteristics (size, shape, fragmentation, connectivity, aggregation, diversity); need for prospective studies.
69	Wang, H. et al. (2024b)	Tool Development	High	Development of the HEAL tool for assessing health effects of green space design	Machine-learning-based tool with high accuracy for predicting non-communicable diseases.
70	Wang, M. et al. (2023)	Systematic Review	High	Effect of horticultural therapy on older adults	21 studies; improvements in physical, mental, and social health, and quality of life.
71	Wang, Q. & Tzortzi (2023)	Design Guideline/Recommendation	High	Design guidelines for healing gardens in general hospitals	Methodology based on case studies and questionnaires.
72	Wang, X. et al. (2024)	Umbrella Review	High	Green and blue spaces and human health	Reduces mortality, cardiovascular disease, diabetes, and improves mental health.
73	Wang, Z. et al. (2024)	Cross-sectional/ Survey (Non-linear Analysis)	High	Non-linear relationships between urban green space and mental health	Inverse U-shaped relationship; optimal NDVI ≈ 0.25 and distance 0.24 km.
74	Williams (2007)	Theoretical Reference Book	High	Therapeutic landscapes (book)	Theoretical and methodological review.
75	World Health Organization (2023)	Guideline/Recommendation (Policy Report)	High	Assessing the value of urban green and blue spaces for health	Provides qualitative and quantitative approaches for valuation.
76	Xia et al. (2025)	Statistical Modelling (Global analysis of 9,034 cities)	High	Biodiversity-rich recreational areas near cities as a mental health solution	Over 96% of cities have access; cost-effective in developed regions.
77	Xu et al. (2025)	Systematic Review	High	Urban green space quality and mental health	Natural elements (plant diversity and water) are positive; amenities depend on design.
78	Yoshida et al. (2022)	Statistical Modelling	High	Intangible contributions of nature to well-being via place attachment and social capital	Nature enhances well-being by increasing place attachment and social relationships.
79	Zarei & Shahab (2025)	Systematic Review + Bibliometric Analysis	Low	Nature-based solutions in urban green infrastructure	Success factors: spatial equity, governance integration, financial and technical capacity.
80	Zhang et al. (2024)	Narrative Review	High	Effect of natural space on human health and well-being	Physical and mental improvements, even with short-term exposure to nature.

Notes

[i] Composite and undifferentiated green cover metrics that integrate various types of nature into a single concept.

[ii] Green gentrification denotes the unintended outcome of urban greening projects, whereby rising property values facilitate the displacement of low-income residents.

[iii] The research potential of this type of green space should also not be disregarded