

Lecture Notes in Civil Engineering

Anurag Varma
Vikas Chand Sharma
Elena Tarsi *Editors*

Proceedings of the 2nd International Conference on Trends in Architecture and Construction

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Preface

Proceedings of the 2nd International Conference on Trends in Architecture and Construction (ICTAC-2024) brought together a global assembly of scholars, practitioners, and educators to delve into pivotal issues shaping our built environment. This volume presents a curated selection of peer-reviewed papers stemming from the conference, centering on four foundational parts: Sustainable Cities and Communities, Innovative Architectural Design, Construction Technologies, and Architecture Education in the Digital Age.

Sustainable Cities and Communities

This track explores diverse approaches to creating sustainable cities. Papers examine the role of heritage management (Target 11.3) and traditional architecture in achieving Sustainable Development Goals (SDGs). Green infrastructure is another focus, with research on the impact of urban green spaces and vertical green walls on public health and well-being. Additionally, the track delves into participatory planning strategies, including citizen involvement in nature integration and fostering sustainable urban environments. Sustainable transportation is addressed through studies on transit-oriented development and its impact on public spaces. Other explored themes include urban sprawl, community development (community gardens, floating communities), and infrastructure planning.

Innovative Architectural Design

This part explores the expanding boundaries of architectural design. Papers investigate new analytical tools for design evaluation and delve into the future of vernacular architecture. The concept of interactive architecture is explored, while other contributions examine the impact of building form on energy efficiency. This track

also showcases innovative design solutions for specific needs, such as post-disaster shelters and inclusive urban spaces. By showcasing a range of innovative design approaches, this part highlights the profession's capacity to address contemporary challenges and shape the future of the built environment.

Construction Technologies

This part delves into advancements and innovations shaping the construction industry. Papers explore the potential of sustainable materials like waste-based concrete and recycled materials. Research also examines the use of natural materials like bamboo and mud in construction. Other contributions explore advancements in construction management and structural analysis. By showcasing a range of innovative technologies and materials, this part highlights the industry's commitment to sustainability, efficiency, and resilience.

Architecture Education in the Digital Age

This part explores the evolving landscape of architectural education in the face of rapid technological advancements. Papers examine the potential of artificial intelligence as a design tool and explore the integration of human-centered design into the curriculum. Other contributions explore innovative pedagogical approaches, such as a focus on social and climate justice and the integration of digital tools. Additionally, research addresses the importance of user experience and energy efficiency in architectural education.

Sustainability emerged as a focal point at ICTAC-2024, reflecting the pressing environmental imperatives of our time. The conference deliberated on strategies for architects and construction professionals to integrate sustainable practices into urban planning, design, and construction processes, thus nurturing a more conscientious built landscape. Technological advancements also took center stage, with discussions ranging from the utilization of artificial intelligence and digital tools in design workflows to the incorporation of cutting-edge materials and methodologies. ICTAC-2024 offered insights into how technology is reshaping the architectural domain, holding promise for enhanced efficiency, optimization, and the emergence of novel design paradigms. Crucially, the conference underscored the importance of equipping future architects with the requisite skills to navigate a rapidly evolving world. Papers delved into innovative pedagogical strategies that harness digital tools to empower students in addressing societal and environmental challenges.

ICTAC-2024 garnered participation from a diverse array of voices across 15 countries. Over 350 abstracts and 269 full-length papers were submitted, reflecting the vibrant international interest in the conference. This proceeding brings together the expertise of established researchers, practitioners, academicians, and emerging doctoral scholars through 84 rigorously peer-reviewed submissions. Each paper benefited from the in-depth scrutiny of three Technical Committee members, ensuring the quality and relevance of the presented research. The presented research offers a multifaceted perspective on the evolving architectural landscape, shedding light on the challenges and opportunities that lie ahead.

The editors extend their sincere gratitude to all those who contributed to the success of the conference and the publication process: our scientific partners, the international advisory board, the scientific and organizing committees, the reviewers, and the Springer publication team. We also express our gratitude to the esteemed keynote speakers, authors, and participants for their invaluable insights and contributions. Additionally, we extend our appreciation to our collaborating universities, UNIFI and XJTLU, and Council of Architecture, GOI, for their invaluable support in facilitating ICTAC-2024.

Mohali, India
Mohali, India
Florence, Italy

Anurag Varma
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A Recent Critical History of Urban Green for Psychological Wellbeing and Physical Health



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Abstract The idea that the city, with its overall structure, spaces, infrastructures, and environment, could play an essential role in its inhabitants' psychological wellbeing and physical health is a relatively recent emerging concept directly connected to the growing awareness on urban health issues. In particular, the green open space of the city has changed perception in this sense due to medical developments on the one hand and social changes on the other. Public open spaces, squares, gardens, and boulevards were mainly created as an element of urban decoration and for certain socialisation functions, but since the nineteenth century, they have started to be thought of as tools to ensure hygiene standards in the modern city. Urban green and health have long gone their separate ways, whereas, since the rise of industrialisation, have increasingly been conceived as interconnected, playing a crucial role in urban policies for the improvement of citizen's wellbeing. Through the critical analysis of medical and urban literature connected to urban green spaces and health, this contribution investigates the rise and growing potential of urban green spaces as crucial elements to improve the psychological and physical wellbeing of citizens, giving compelling proof of the urgent need of an effective contemporary strategy for sustainable and resilient cities and communities.

Keywords Urban history · Urban green spaces · Urban wellbeing

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1 Introduction

Over the years, there has been a substantial increase in interest in the topic of urban health, manifested not only in globally recognised institutions such as the World Health Organisation (WHO), which have launched projects such as The Healthy City, but also in national or international associations dedicated to the specific cause, such as the Big Cities Health Coalition or the Health City Institute. Many European Union projects, past and present, have invested in the topic, e.g. URBACT—Healthy Cities (2019–2022), URGE—Development of urban greenspaces to improve the quality of life in cities and urban regions (2001–2004) or, the most recent, Interreg Europe GREENHEALTH—Sustainable Protected Areas as a key value for human wellbeing (2023–2027). Publishing houses have dedicated entire series to the topic: Taylor & Francis has its Cities & Health series, The Lancet promoted the Shaping Cities for Health project, The Guardian opened the Health in Cities section, magazines such as Built Environment have been publishing more or less specific articles on the subject for years, not to mention the large number of articles, documents, reports and books of all kinds that can now be found in online database on the subject.

In the vast literature produced by dedicated institutes or scholars, the theme of urban health is often intertwined with that of the environment and, in particular, with that of ‘green’ in its various types and nuances. The latter, from being a quantitative standard, a ‘simple’ garden area or park, now plays an increasingly relevant role in the life of the city and its citizens, becoming an active tool to improve wellbeing. This paper looks at how the debate on urban health has evolved over the years through the journals and, in particular, how urban ‘green’, in its various forms, has become an increasingly significant and demonstrable element for healthier cities since the nineteenth century.

2 Methodology

The research is based on a literature review of online databases and a critical revision of the results. Considering the topic of the article ‘A recent critical history of urban green for psychological wellbeing and physical health’, the search included health and urban themes and health-related and urban-related databases. The medical databases chosen were Pubmed (Medline) (185 articles) and Excerpta Medica Database (Embase) (59 articles), in which the keywords selected were: ‘urban park, health’, ‘residential greenness, health’, ‘air pollution, green, health’, ‘gardening, health’, ‘biodiversity, health’, with a time range from 2020 to 2024. The medical studies were purposely chosen with a recent timeframe because ‘recent medical works’ are necessarily based on valuable earlier research, the more updated in terms of findings; there is no reason to use out-of-date medical studies. All the medical articles found following the above criteria were organised by thematic relevance, selecting systematic reviews and meta-analyses in particular because

these can provide a comprehensive and critical picture of the more recent discoveries. In parallel, more generic databases were also used: Jstore.org (151 articles), Cambridge.org (25 articles), Nature.com (26 articles), Tandfonline.com (30 articles), Researchgate.net (28), and Academia.edu (57 articles), in which interests were specified concerning: ‘urban planning’, ‘built and construction’ and ‘architecture’. The keywords ‘urban green’, ‘public health’, and ‘design’ linked by and/or/not were also used for searches in all databases. Since searches in the urban field are less bound to the most recent studies than those in the medical field, only the relevance parameter was adopted in the generic databases, and there was no predefined time range. Out of all the articles identified as ‘relevant’, only 34 were used and analysed. The different number of articles found in medical and urban fields is relatively small, considering that in the medical field are important only the more recent results, whereas in the urban field even earlier articles are valid and need to be considered. The selection of articles is based on topics that have been identified as vital floor for discussion and exchange between the two disciplines. Although publications on the subject ‘green, urban health’ existed even in the 1960s, the search of all databases revealed a growth in publications and interest, distributed fairly equally, from 2019, the start of the COVID-19 pandemic. The bibliographical references found in the individual online articles inevitably and gradually enriched research for this article, building organically parallel bibliographical paths. All the bibliographical references selected were then critically re-organised to investigate continuities and discontinuities concerning the past and present themes of urban green and human health. Bridges and overlaps between urban and health-related themes were freely constructed.

3 Amount of Green: From Park to Green Neighbourhood

3.1 Park Movement

During the mid-nineteenth century, the city municipality tried to respond to the urban crises by creating large parks to serve the citizens, designed not just for recreational purposes but also for health purposes; this phenomenon is known as the Park Movement. ‘The public park movement, which began in the 1830s, sprang mainly out of a desire to improve health in the over-crowded conditions of the rapidly growing industrial towns’ [1]. The period between 1885 and 1994 saw the opening of many public parks, and ‘The primary motivation for the provision of parks within existing built-up areas and in expanding suburbs was the concern for the population’s health. [...] The perceived benefits of open spaces were not restricted to improving the nation’s physical health; they were thought to increase moral [and psychological] health too’ [2]. Alongside the growing interest in citizens’ health, there was also a growing interest in sport. This aspect can be recognised in the new layout of parks, which were much more oriented towards physical activity than the traditional ones; indeed, ‘closely linked to the issue of health came an increasing interest in sport; it

was a generally acknowledged fact that it was impossible to bring up healthy children unless they had systematic physical training' [3]. Parks in the nineteenth century were recognised as 'one of the most important, as it is one of the most virtuous, in the utilitarian sense, of our public institutions' [4]; this is well understood from a description of Victoria Park in London written for the *Gardeners' Chronicle* issue of 1896: 'If there are any still among us who doubt the educational, social, and sanitary advantage of such fine open spaces as this park and the adjoining common affords, one visit on a Saturday would surely suffice for their conversion. The ample open spaces, the well-furnished parks and gardens, with their supply of seats, are crowded with their thousands of happy men, women, and children in search of health, happiness, and the higher education of sweetness and light which close fellowship with nature at her best cannot fail to impart' [5]. Harriet Jordan's article 'Public Parks, 1885–1914' from 1994 remains among the most comprehensive references reconstructing the historical significance of the park and the objectives for human health that were attributed to it.

Since the late-nineteenth century intuition of the 'park movement', much progress has been made, and science has proven that parkland has a positive role and effectiveness on health-related issues. Two recent articles are significant in this regard, the one by Kathryn P Derose et al., entitled 'Effects of park-based interventions on health-related outcomes: A systematic review' from 2021 [6] and the systematic literature review by Dëshira D. Wallace et al., entitled 'The Effects of Park-Based Interventions on Health-Related Outcomes Among Youth: A Systematic Review' from 2022 [7]. The 2021 article specifically examines park-based initiatives to improve health outcomes, including both physical and mental health (reduced incidence of cardiovascular disease, diabetes, depression, some cancers and obesity), distinguishing between park-based interventions and person-based interventions (organised exercise programmes); this study examines 27 surveys, and the results indicate that park-based interventions generally lead to increased park use and physical activity, while the effects of exercise programmes—e.g. Person-based interventions—are more modest. This paper suggests that improving the park's structure and its services for people optimises health benefits, making their renovation in cities essential. The 2022 paper, on the other hand, makes a systematic review of 15 significant research studies from the 2020s, all conducted in heavily urbanised areas, including both person- and park-based studies, with the limitation of only considering case studies in Australia, Denmark, and the USA. These combined studies highlighted that interventions in public parks improve physical and mental health outcomes for children and adolescents, particularly their physical health, and further confirmed that parks are key spaces in the city by promoting more active lifestyles and more significant contact with nature, emphasising the importance of considering green spaces not only as recreational areas but as crucial elements in health promotion, especially in youth. Cheng Zhang's recent 2023 study 'Urban Park Systems on Public Health: Underlying Driving Mechanism and Planning Thinking' [8] explores in detail the role of urban parks in promoting public health, using quantitative analyses and experimental models to highlight the link between urban green spaces and various aspects of physical, psychological, and social health. This specific park research is presented with

an analysis of data collected through questionnaires and interviews with residents to assess the impact of parks on their health. The article discusses mechanisms of action, planning strategies, and recommendations for optimising the contribution of urban parks to public health.

3.2 Garden City and Green Neighbourhoods

The garden city is a relatively old concept and dates back to the late-nineteenth century, when London, in particular, had grown disproportionately in population and industrial activity, becoming unlivable. It is proposed to use the garden, the green areas, to improve the compromised urban conditions. Two articles of great interest refer to the subject in its early days: the text by Melanie L. Simo. 'John Claudius Loudon: On Planning and Design for the Garden Metropolis' of 1981, which presents John C. Loudon's work of 1829, and Norman Macfadyen's 'The Garden City and Public Health' of 1921, which presents the validity of the Garden City principles established by Ebenezer Howard in the second half of the nineteenth century.

In 1829, John Claudius Loudon had already tried to give a long-term answer to urban growth by publishing a 'Landscape and Architecture' Plan for London [9] to preserve the Hampstead Heath landscape and hundreds of acres of farmland in the London metropolitan area. The plan was entitled 'Hints for Breathing places'. It consisted of a series of concentric green areas or 'country zones' alternating with built-up areas surrounding the metropolis at one-mile intervals. 'The main concern of this plan was breathing places for public health and recreation in the London metropolis' [10].

Norman MacFadyen, a Medical Officer of Health for Letchworth, points out in his text 'The Garden City and Public Health' that the idea of the garden city proposed in the late-nineteenth century by the Garden City Movement was visionary in order to preserve itself from industrial turmoil and its health consequences. 'The new understanding of the nature of disease, [...] and the immensity of the problems which confront Society today, even to the understanding of the causes of industrial tumult and unrest [...] the immediate remedy suggested here is the establishment of Garden Cities. This is quite a definitive proposal, and it is necessary to define what a Garden City is. This has been done recently by the Garden City Association and is taken to mean: a town, planned for healthy living, organised for industry, or a size necessary to give a full measure of social life, but no larger, surrounded by a rural belt; the whole land being in public ownership. [...] The town must be planned for healthy living' [11].

'The town must be planned for healthy living [...] unless we deal with the great environmental causes which in large cities are continually producing disease in our midst, we shall still lose our thousands of infants every year, we shall still have our defective school children, and we shall still be ravaged by tuberculosis and other preventable diseases. [...] Our aim is to create that great city, and it must be done by taking the conditions of urban life and making them as rural as possible, combining

town with country life' [12]; to counteract the damage caused by industry 'The industry is the key to the whole immense problems of health, housing and transport. [...] claims of the health and wellbeing of the workers [...] In Letchworth [...] they walk or cycle to their work, [...]. In the evening, they are out in their gardens [...]. By this means they are able to preserve health' [13]; it served to give a human dimension to the metropolis 'we believe that the growth of huge cities must be checked. If this city must grow, we say it should be by the formation of the new daughter garden cities' [13]; it finally gave the city a 'green belt' that ensures fresher and cleaner air, 'The town must be surrounded by a rural belt. This belt of open country serves several purposes. It ensures that the town shall always have fresh air and a pure atmosphere. It also automatically restricts the size of the town' [14]. The idea that the garden city is a sanitary solution for the city returns throughout the twentieth century, 'in 1920 the Ministry of Health suggested that the relief of over-crowding in London could be accomplished by self-contained garden cities', as we read in Peter Batchelor's article, 'The Origin of the Garden City Concept of Urban Form' from 1969 [15]. Also strongly emphasising the 'healthy' value of garden city planning is the 1988 book, published by Cambridge, entitled *Welwyn Garden City: A Town Designed for Healthy Living* [16], which analysed Welwyn's garden city from the point of view of health benefits.

Even if the utopia of the garden city also had negative repercussions such as the American suburbs—anonymous urban centres bounded to the automobile and individual confinement—the garden city in its less extensive and more structured version, as a multitude of smaller 'satellite towns', with community spaces, served by public transport, as understood at the end of the nineteenth century, denounces principles that are still very valid for providing answers to the problems of the contemporary city. It is no coincidence, in fact, that Samuel Morley in his text *Healthy Garden Cities* in 2019 took up its principles and put them into a modern perspective [17] or that the famous Town and Country Planning Association produced a report in 2012 entitled 'Creating Garden Cities and Suburbs today' [18], still highlighting its potential. Furthermore, in 1986, the recognised World Health Organisation began promoting an initiative called *Healthy Cities* [19], showing how the city plays a significant role in health and emphasising how green space, in particular, can be an important variable in reducing traffic and pollution.

We find many recent health research studies that concretely measure the impact of green neighbourhoods on health, and the studies are diversified according to the type of population, children-adults-elderly, or for effects on physical and mental illnesses. Cheng-Yang Hu's 2021 article 'Residential Greenness and Birth Outcomes: A Systematic Review and Meta-analysis of Observational Studies' [20] examines through a systematic review and meta-analysis of 29 studies the association between residential greenness and some perinatal outcomes, the focus is on the impact that the presence of vegetation around women's homes during pregnancy can have on some indicators of neonatal health, such as birth weight, preterm birth and small for gestational age (i.e. intrauterine malnutrition). In the presence of moderate-to-high heterogeneity of the studies, the analysis shows a generally positive association

between higher residential green and better birth outcomes, with higher birth weight (7.99–15.35 g) and reduced risk of low birth weight (0.79 to 0.93 ODDS).

Some research is disease-specific, in particular, for example, a recent study in 2022 by Jean C. Bikomeye, with other researchers, ‘The Impact of Greenspace or Nature-based Interventions on Cardiovascular Health or Cancer-related Outcomes: A Systematic Review of Experimental Studies’ demonstrated the beneficial effect of greenery on cardiovascular disease and cancer patients [21]. The article explores the impact of green spaces and initiatives in these contexts—nature-based interventions—on cardiovascular and cancer-related outcomes through a systematic review of 31 articles. The author shows that such interventions have beneficial effects by reducing cardiovascular risk, positively affecting blood pressure, and improving cancer-related quality of life (QoL) and, more infrequently, other cardiovascular risk biomarkers. The article details health outcomes according to different green space interventions: forest bathing, green exercise, gardening and nature viewing, offering healthcare providers, institutions, and urban planners’ valuable tools to imagine and design healthier cities.

In the 2023 research ‘Residential Greenness for Mitigating Impacts of Extreme Heat Events on Depression and Supporting Mental Health’ [22], Ying Yang, with other scholars, through a systematic literature review, discovered that residential green spaces can provide an ecosystem that lowers environmental temperatures by reducing depressive episodes during extreme heat events, thus constituting an effective strategy for improving mental health in urban environments.

In recent years, there have been an increasing number of studies—with varying degrees of detail—investigating residences surrounded by greenery and they clearly show how living surrounded by greenery, as was ideally suggested by the garden city theorists, is beneficial for physical and mental health.

4 Green: Passive Versus Active

4.1 Green Cleans

The indiscriminate planning of the twentieth century has led to ever-increasing pollution in the city. Of the different types of environmental pollution, air pollution is undoubtedly among the most significant, causing increased cardiovascular mortality, respiratory problems, increased incidence of prematurity, and intrauterine growth retardation. Regardless of whether one interacts with it directly or not, green has been shown to have beneficial functions on health, among them the ability to clean the air. Many recent studies show its great potential to reduce pollution. The research by Danilo Junior and Pinto Moreira, with other scholars, entitled ‘The Effect of Urban Green Spaces on Reduction of Particulate Matter Concentration’ [23], demonstrates with an experiment how urban green areas help mitigate the effects of PM. The work compares the concentration of PM_{2.5} in two neighbouring locations in Rio de

Janeiro to test how vegetation cover can improve air quality. One is the entrance to the Rebouças Tunnel, and the other is the Botanical Garden of Rio de Janeiro, two differently polluted places. To this end, PM_{2.5} samples were taken from September 2017 to March 2018. The results found that Tunnel Rebouças has a higher concentration of PM_{2.5} in almost all samples. The Botanical Garden, which has more vegetation cover, has concentrations about 33% lower than the other area, providing better air quality. Green is a reducer of pollution and improves the quality of life (QoL) even without interaction with it.

Arnt Diener and Pierpaolo Mudu's study 'How Can Vegetation Protect Us from Air Pollution? A Critical Review on Green Spaces Mitigation Abilities for Air-borne Particles from a Public Health Perspective - with Implications for Urban Planning' of 2021 [24] examines the ability of green areas to mitigate air pollution, mainly suspended particulate matter (PM), from a public health perspective. It is based on a critical review of existing literature, highlighting three main mechanisms through which urban greenery can influence air quality: deposition, dispersion, and modification of pollutant particles. The analysis suggests that the mitigation effects of green areas are significant, varying according to size, context, and vegetation characteristics. Xiangzhoong Luo's very recent article 'Mapping the Global Distribution of C4 Vegetation using Observations and Optimality Theory' [25] demonstrates that not all plants are beneficial in the same way, and it becomes essential to choose plant species carefully in urban environments to optimise results. Also interesting in this respect is the 2023 Gong' study entitled 'Role of Urban Vegetation in Air Phytoremediation: Differences between Scientific Research and Environmental Management Perspectives' [26]. The article examines the role of urban vegetation in air phytoremediation, showing how it can effectively reduce concentrations of certain atmospheric pollutants, such as PM, NO_x, and SO₂, but not for O₃, which can even increase. Optimal plant species selection is essential to maximise the benefits of purifying urban air and minimise adverse effects, such as O₃ production.

In the history of gardens, selecting plant essences has been a very relevant issue in designing gardens, particularly therapeutic or botanical gardens. In the present, the presence and the choice of plants in urban green spaces are crucial. Indeed, more imaginative efforts should be made by planners, with the support of medical experts, to decide the best quantity of greenery, its position, and the typology of plants to optimise their effects on health. To highlight the contemporary trend that puts plants at the centre, Mancuso's books are interesting, among them, 'Plant Revolution. Plants have already invented our future' from 2017 [27], 'The Plant Nation' from 2019 [28], and 'The Plant of the World' from 2020 [29]. Stefano Mancuso's 2023 book 'Phytropolis, the Living City' is fascinating because it puts plants explicitly at the centre of urban redesign; for the author, the behaviour of plants is indispensable to our wellbeing. The author provides scientific investigations regarding the importance of plants in the city '[Le Corbusier] was right, biology is the new word in urban planning; what was wrong was to limit biology to the animal form only' [30].

4.2 Gardening

It is now well-known that greenery is all the more beneficial to health the more it interacts with the user who enjoys it. The theme of gardening and the active relationship with the garden, no longer seen as an element to be passively watched or walked through, has been proven in recent years by studies, but its roots are much older. The beneficial interaction attributed to the activity of gardening also depends on the amount of time the activity forces one to remain exposed to greenery; it has been shown that greenery is more beneficial the longer one remains exposed to it [31].

Stephen Constantine's text 'Amateur Gardening and Popular Recreation in the 19th and 20th Centuries' from 1981 gives an overview of the history of gardening activities, and it can be seen that in the nineteenth and twentieth centuries, gardening had become a real hobby in particular, and it was consolidated after the Second World War. Horticultural societies multiplied. It was a leisure activity that concerned rural areas or urban elites and did not include either a city idea (as it was for the garden city) or even large urban parts (as it was for the park), but much smaller plots of green space that were spread out on a residential scale. In the era of industrialisation and production, time devoted to leisure activities had negative connotations of idleness and vice. Some people, however, recognised its potential, 'In gardening lay a solution: a recreational activity requiring physical effort and some intelligence', and again 'The culture of flowers is one of the most delightful and healthful recreations to which man can devote the powers of his mind and body, wrote one in 1857 [...] Another writer talked of gardening as health-giving properties, both to body and mind' [32] or 'Gardening had something for everyone and seemed incapable of being criticised as a social activity. It was healthy, educational, productive and decorative' [33]. Informally in urban literature and without scientific evidence, gardening is already attributed to therapeutic benefits for body and mind, 'Moderately indulged in, the occupation is one of the most beneficial recreations known for mind and body. The mind insensibly relaxes its nervous tension by contact with the peaceful and regular operations of nature; habits of observation and reflection are induced and fostered, and new and healthy interests are imparted to life' [32].

The health benefits of gardening have become proven and evident in recent medical studies. The research by Masashi Soga, Kevin Gaston, and Yuichi Yamaurama, entitled 'Gardening is Beneficial for Health: A Meta-analysis' from 2016, shows growing evidence of the health benefits of gardening activity. The study 'has provided robust evidence for the positive effects of gardening' [34], with most of the case studies reviewed demonstrating a reduction in depression and anxiety, decreased body fat index, increased sense of satisfaction, quality of life, and sense of community. Yeji Yang's 2022 study 'The Multi-Sites Trial on the Effects of Therapeutic Gardening on Mental Health and Wellbeing' also demonstrates how five mental health variables—depression, anxiety, daily activities, quality of life, memory—'improved significantly over time as therapeutic gardening programmes progressed' [35], even under highly stressful conditions such as during the COVID pandemic period.

Jiayue Yun's 2023 literature review and meta-analysis, 'Effects of Horticultural Therapy on Health in the Elderly: A Review and Meta-analysis' [36], show a direct relationship between horticultural therapy and the health of older people, helping to reduce weight, abdominal circumference, and increased flexibility, reduced stress, decreased depression and loneliness, increased interpersonal skills, and increased fruit and vegetable consumption. Finally, Panțiru's 2024 study 'The Impact of Gardening on Wellbeing, Mental Health, and Quality of Life: An Umbrella Review and Meta-analysis' demonstrates a positive impact of a variety of gardening and horticultural activities on both mental health and wellbeing in the general population and vulnerable communities. The article examines the impact of gardening on mental and physical health, concluding that gardening activities have positive effects on various aspects of psychological wellbeing, but emphasises the need to consider these results with caution due to the heterogeneity and variable quality of the included studies. We read that 'Gardening activities lead to the adoption of healthy behavioural practices (e.g., increased fruit and vegetable consumption, and physical activity) that positively impact on several aspects of health and wellbeing. Because of gardening, proximity to nature infuses feelings of connectedness with nature, promoting positive affect, lifted mood, and tranquillity. Spending time outdoors in a relaxed atmosphere can make people more mindful of the present, gain emotional resilience and combat stress through greater vitality. Several studies have documented that spending time in nature triggers physiological responses that lower stress levels. According to the attention restoration theory, connectedness with nature replenishes cognitive resources, leading to improved concentration and attention. Community gardening also provides a safe and relaxed context for social interaction, which counteracts feelings of loneliness and social isolation, particularly among vulnerable groups such as people with pre-existing learning difficulties and mental health. It provides an opportunity for greater community cohesion and social connectedness, increasing one's network of social support. Further, gardening activities have direct physiological benefits in reducing blood pressure and obesity levels, thus reducing the risk of physical health disorders (e.g., vascular diseases, type 2 diabetes, and cancer)' [37].

These medical studies analysing the effects of gardening and horticulture provide sufficient evidence to suggest to planners and institutions not only to add greenery in cities but also to provide an active relationship with it to optimise the health benefits for citizens.

5 From Grass to Environment

5.1 *Urban Green Biodiversity*

Green has long been understood as a garden area, the space of a city park, a ‘standard’ to be met in order to compensate for built-up areas; over the years, the definition of green has been broadly enriched to become a much more complex element that encompasses more elements of the environment and the concept of biodiversity [38].

In the field of architecture, planning, and the city, the topic of green biodiversity—understood as the diversification of green species in a garden, park, urban and non-urban green environment—is heard but relatively recent. The issue of biodiversity began to emerge when human interventions dramatically reduced it; as we read, ‘Reductions in urban biodiversity have consequences for human wellbeing, reducing the benefits people can obtain from nature at individual and community levels’ [39].

Caroline Brown’s text ‘Biodiversity and Human Health: What Role for Nature in Healthy Urban Planning?’ from 2005 [40] shows how the issue of biodiversity began to become a concern for urban planners in the city’s construction, but how its application was not yet effective. In particular, a 2022 research paper by Xuancheng Zhao ‘Biodiversity in Urban Green Space: A Bibliometric Review on the Current Research Field and Its Prospect’, perhaps the most comprehensive bibliographic reconstruction on the topic, explains how research on urban green space biodiversity has seen two phases, an initial exploration of the topic between 1998 and 2012 and a more operational phase since 2012, with growth of research since 2009 [41]. The biodiversity of urban green spaces is an added value for city planning because it indirectly improves many other aspects ‘Urban green biodiversity plays an important role in maintaining ecosystem functions and enhancing human wellbeing, such as improving air quality, reducing noise, repairing polluted soil, providing food and raw materials for residents, etc.’ [41]. In addition, ‘urban green space has been proven to be a refuge for biodiversity. [...] The biodiversity of urban green space significantly affects the microenvironment of green space, such as soil carbon storage, soil temperature, soil moisture, green space biomass, etc. Urban green space also positively improves urban ecosystem functions, such as mitigating the heat island effect and regulating water runoff. In addition, urban green space can also effectively deal with the adverse effects and risks of climate change and reduce the disaster losses caused by extreme weather and climate events’ [42]. The theme of biodiversity responds to issues such as preserving the ecosystem, coping with climate change, and sustainability.

In 2017, in the article ‘Planning for the Future of Urban Biodiversity: A Global Review of City-Scale Initiatives’ by Charles H. Nilon and other scholars, a thorough analysis was made of a series of urban city plans and their approach to biodiversity. Based on the assumption that cities represent an opportunity to advance global biodiversity and sustainability goals, the study identified key elements used in urban planning documents by 40 cities in 25 countries to conserve biodiversity. ‘We wanted to understand how cities from a variety of ecological, political, and

economic contexts incorporated biodiversity and ecosystem services into planning' [43]. In the light of the findings of the surveys, it emerged that many more qualitative objectives—habitat conservation, air and water quality, cultural ecosystem services and ecological connectivity—have been adopted, and far fewer quantitative ones, which often determine the ineffectiveness of local biodiversity conservation.

In the medical field, there is a vast literature, more or less accurate, linking biodiversity and health benefits. Among the articles, John D. Potter's 2023 text 'A Perspective on Green, Blue, and Grey Spaces, Biodiversity, Microbiota, and Human Health' [44] explores how human disconnection from natural spaces (green and blue) and increased urbanisation (grey spaces) affect health, emphasising the health benefits of proximity to natural environments and the importance of biodiversity and plant microbiota in maintaining a balance in human health. The most recent 2024 study by Jake M. Robinson, with other researchers, entitled 'Biodiversity and Human Health: A Scoping Review and Examples of Underrepresented Linkages' [45], examines the complex relationships between biodiversity and human health, highlighting three specific areas that have been less explored: the impact of biodiversity on the health of indigenous peoples, the link between biodiversity and urban social equity, and the interaction between biodiversity and COVID-19. The review finds moderate evidence supporting the environment-microbiota-human health pathway and moderate-to-strong evidence for broader pathways linking nature to various health outcomes, from stress reduction to improved wellbeing and social cohesion. In sum, both emphasise the crucial value of biodiversity for human health, underlining the need for more research that recognises and integrates these connections.

Although less evident than the effects of greenery on pollution and gardening, research on biodiversity shows a correlation between the health of individuals and the preservation of natural variety in urban areas and that this is among the urban investments to be pursued.

6 Final Remarks

The subject of 'green' is a complex issue that has been studied from many points of view. The literature in this article has been chosen based on significant overlaps between urban and medical fields, trying to find points of contact where dialogue and comparison between the disciplines is already alive or can be opened. It has been an attempt to interpret, on the one hand, the methodology of measuring green effects on human health in medical studies and, on the other hand, the practical application of green solutions in urban studies. It is interesting to see a significant difference in methodologies when approaching 'green' by medical experts and urban planners. 'Green' for urban planners has a health value, but on a much more intuitive and theoretical level, while the medical perspective presents more accurate studies connected to results that green has on health. In medical accuracy and precision, some approximations, for example, in defining the green indexes, could lead to inaccurate

results. Similarly, urban planners often lack the support of objective medical evidence and risk not adopting optimal design solutions.

In order to have a perspective on successful multidisciplinary initiatives that connect green, health, and design, it is worth reading the contribution by Debra Gray, Denis Hewlett, Julie Hammon, and Stephanic Aburrow, *Re-Connecting with Nature: Exploring Nature—Based Interventions for Psychological Health and Wellbeing* [46], the text by Bettina Bikten and Giuseppe Barbiero *Biophilic Design: Nine Ways to Enhance Physical and Psychological Health and Wellbeing in Our Built Environments* [47], or the research by Aakriti Grover and R.B. Singh, *Strategic Plan for Urban Health and Wellbeing for Indian Megacities* [48].

‘Green’ is a tool that, if wisely used, has proven to have positive effects on human health—such as reduced cardiovascular morbidity, lower rate of eosinophilic asthma, lower presence of type 2 diabetes, improved pregnancy outcomes, reduced mortality rates, reduced psychiatric symptoms, such as unenthusiasm, tiredness, loneliness, depressed mood, or feeling of being angry. Moreover, green mitigates climate pollution, green spaces are pivotal in creating resilient urban ecosystems, urban green fosters social interaction and community cohesion, improves air quality, reduces the urban heat island effect, promotes a healthier lifestyle, encourages to stay outdoors, and get, sunlight exposure which is beneficial for physical and mental health. ‘Green’ should be implemented and integrated effectively by urban planners in urban design, but one should also be aware that it may also have potential drawbacks and limitations, such as high maintenance costs of green, the criminal misuse of the green areas if not used frequently, vegetation may expose people more to pesticides and herbicides and may be a disease vector of lyme disease or chikungunya fever, physical activity in green areas may increase risk of injuries or wrong choices of plants (for example those that produce ozone) may have detrimental effects [49].

Specific themes and concerns about ‘Green’—in both urban and medical literature—were found and selected in this study: (1) more or less extensive green exposure, (2) interaction or not with green, and (3) more or less enriched quality of green. It was suggested by medical studies that the greater the extension of green, the greater the benefits; urban planners have given different possible green responses on a small, medium, and large urban scale. Moreover, medical studies show that green improves health even if used passively, but obviously, it is more beneficial if it is possible to interact with it; urban planners and landscape architects have room for designing more or less interactive green areas. Last, urban studies consider green areas equipped in the most diverse ways, but medical studies demonstrate that greenery enriched with other elements of nature, i.e. water or animals, is undoubtedly much more complete, providing more stimuli for health balance. In recent years, urban planners have considered, more and more, no longer just greenery but ‘green infrastructure’, imagining connecting several parts of nature in the city into a proper urban system. Given the vast number of topics connected to ‘green’ discussed nowadays, the categories identified in this article—park, residential green, passive green, active green, and biodiversity—are thought to provide interesting common ground themes for debate between urban planners and medical experts to project and design

an effective contemporary multidisciplinary strategy for sustainable and resilient cities and communities.

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