

Review

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Review

Eco-Salute Infrastructure and Its Potentials for Health Promotion, Quality of Life and Well-Being in Urban Contexts: Conceptualization, Comparative Analysis and Review of Existing Evidence

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Abstract

This contribution introduces the novel concept of Eco-Salute Infrastructure in the Built Environment (ESI) as a framework for urban planning that focuses on promoting environmental health and improving human well-being. The ESI framework expands on previous concepts that explore the relationship between human well-being and urban design with the aim to create healthier cities and enhance people's quality of life. The paper presents existing evidence from research literature that supports the notion that ESI can foster human well-being in urban areas. Overall, implementing an ESI approach, which involves designing infrastructure and architecture that support active mobility and physical activity, creating appealing public spaces that encourage outdoor activities, and providing urban residents with increased access to high-quality, biodiverse green spaces, holds significant potential for enhancing human health and well-being in general and in the face of additional threats caused by the climate crisis. Further research is needed to provide more evidence for the health effects of ESI and to uncover synergies between human and environmental health in regards to urban design.

Keywords: eco-salute infrastructure; quality of life; urban planning; green space; one health; biodiversity

1. Introduction

According to The World Bank, over half of the world's population currently lives in cities, with this proportion projected to reach two-thirds by 2050 [1]. Increasing urbanisation comes with considerable risks and potentially harmful impacts on health and well-being of residents. Air and noise pollution, unhealthy lifestyles associated with urban living (e.g. physical inactivity), and climate change-related health risks (e.g. heat stress) are some of the most prominent health threats associated with urban environments [2]. Improving the quality of life of urban residents and making cities resilient in the face of increasing threats resulting from the climate crisis are key challenges [3], especially for urban planners. To effectively tackle these problems, a broader perspective than simply focusing on risk prevention measures or formal health care provision is required. It is becoming increasingly clear that the urban environment – the way cities and neighbourhoods are built and designed – can be a key influence on health-related behaviours and provide opportunities for stress reduction, in addition to mitigating health risks associated with living in modern cities to improve human well-being.

Although there are some existing concepts that address the relationship between urban design and human health or well-being (e.g. urban resilience, green infrastructure, social infrastructure), a

holistic approach that centres around improving human quality of life in urban environments through health-promoting design is lacking. Therefore, this paper aims to fill this gap by introducing the concept of *Eco-Salute Infrastructure (ESI)* in urban environments. ESI aims to improve well-being of urban residents through features of urban architecture and planning that promote and protect human and environmental health. It emphasises the implementation of biodiverse, natural elements in urban areas, the provision of attractive public spaces for recreation and mental wellness promotion, as well as the design of transport infrastructure that allows for physically active mobility. In this article, we give an overview of the current state of empirical findings on various pathways linking aspects of ESI with human health and well-being in urban environments and discuss the potential and limitations of ESI as a framework and in relation to other prominent concepts in urban planning. Compiled recommendations from the literature and conclusions from this paper may be relevant to urban planners and policy makers to aid them make decisions that promote greater well-being and quality of life in urban areas.

2. Eco-Salute Infrastructure

We propose the term “*Eco-Salute Infrastructure*” (ESI) to combine and describe a set of strategies, interventions and (man-made) features of public urban infrastructure that are designed and implemented in order to prioritise and foster human health and well-being in urban environments. This concept is derived from the Eco-Salute policy guidelines developed by the German Advisory Council for the Environment [4], though we specifically focus on the urban infrastructure and built environment components of this policy. The term “Eco-Salute” combines “eco”, which emphasises the integration of natural elements, and “salute”, which highlights the focus on facilitating good health. Central aspects of the eco-salute model and, specifically, eco-salute infrastructure are environment-related disease prevention and health promotion. This can be achieved by providing opportunities for residents to relax, socialize and engage in physical activity, while also reducing the exposure to harmful conditions that are prevalent in urban environments, such as air and noise pollution or heat stress. Nature-based solutions, such as biodiverse urban green spaces, are fundamental to this approach. Equally important are features and characteristics of grey spaces, such as walking and cycling infrastructure or sustainable building design. High biodiversity of urban spaces specifically is considered as a vital characteristic of ESI because it is essential for ecosystem functioning and thus the provision of ecosystem services that benefit human health [5]. The particular focus on improving health and well-being of urban residents through generating multiple health benefits with urban architecture and design is the key characteristic of the ESI framework. Simultaneously, through its emphasis on biodiversity, ESI intends to ensure and maximise the health of plants, animals, and microorganisms in urban areas, incorporating principles of One Health into urban planning (i.e. recognising the inter-dependencies between human and environmental health). This novel approach is introduced to expand on current concepts of health-related urban planning.

3. Evidence for Potentials of ESI for Human Health and Well-Being

We conducted a literature review to provide an overview of the different ways in which ESI can improve human health and well-being in urban areas. Due to the broadness of the topic, the approach of a narrative review was chosen. Publications were searched via scientific databases (Web of Science, PubMed) or identified through backward snowballing (i.e. looking up relevant references found in already identified research papers). A first search was conducted during July of 2023, and a second search was added in December of 2023. While the aim was to find (systematic, narrative, or scoping) reviews to provide a comprehensive assessment of the current state of research, relevant primary research papers were also included in the synthesis to illustrate the influence of ESI elements on human health and well-being. Building on a framework by Markevych and colleagues [6] describing the links between green space and health, elements and characteristics of ESI are presented according

to their potential to (1) reduce harm (i.e., reducing exposure to environmental stressors), (2) build capacities (build/strengthen resources), and (3) restore capacities (relaxation, stress reduction).

3.1. Reducing Harm

Features and elements of urban design can influence human health by reducing the exposure to environmental harms. Emerging pathways from the literature review are (1) urban heat stress, (2) air pollution, (3) noise pollution and, more recently, (4) light pollution in urban environments. These environmental hazards are not independent of each other, neither in terms of their sources – e.g. motorised transport is responsible for air as well as noise pollution – nor in terms of their health impacts – e.g. higher air pollution mediates the relationship between heat stress and mortality, and heat exacerbates the mortality effects of air pollution for some pollutants [7,8]. Thus, urban design strategies must be aware of all possible risk factors and develop solutions that mitigate, if possible, more than one of the stressors at a time.

3.1.1. Urban Heat Stress

The phenomenon of Urban Heat Islands, whereby higher temperatures are reached due to the absorption and retention of heat by urban grey infrastructure during the summer, presents a risk to human health, due to the increased likelihood of heat-related morbidity and mortality [9]. A recent estimate concerning 93 European cities states that approximately 4.3% of all premature deaths in summer can be attributed to Urban Heat Islands [10]. Urban trees and vegetation can have a cooling effect on their local environment through shading and evapotranspiration. A systematic literature review analysing 308 studies shows that green spaces in urban areas are on average cooler than non-green urban areas and that they improve human thermal comfort in these spaces [11]. There are differences in the cooling potential according to the type of green spaces (parks, urban forests, green roofs and walls, grassy areas, street trees, etc.), size of green spaces (with larger green spaces demonstrating a higher potential for cooling), the characteristics of green spaces (i.e. presence of water-bodies, vegetation cover, etc.), and species of trees or vegetation planted [11,12]. The authors of the aforementioned study on premature mortality due to heat calculate that around 1.84% of all summer deaths could be prevented if the tree cover in each respective city was increased to 30% [10]. Thus, providing more green space (in various forms) in urban areas could mitigate the negative health impacts associated with heat stress.

Special attention needs to be paid to urban areas with dense tree coverage at night, as they can trap heat under the canopy and thereby increase temperatures – a combination of tree shaded and grass covered areas is recommended in the design of urban green spaces to ensure optimal cooling effects at all times [11]. The structural, functional, and taxonomic composition and diversity of urban vegetation influences the potential for shading and temperature reduction [13]. Thus, prioritising the implementation of biodiverse urban green spaces could lead to better temperature regulation and therefore less heat-related morbidity.

3.1.2. Air Pollution

High levels of ambient air pollution (mainly in the form of high concentrations of small particulate matter PM₁₀ and PM_{2.5}, nitrogen dioxide NO₂, and ozone O₃ in the air), mostly caused by emissions from transportation in urban areas, can lead to considerable risks for human health [14]. An official report by the European Environmental Agency estimates, for example, that in the year 2020 around 238 000 premature deaths in Europe were attributable to air pollution in the form of exposure to PM_{2.5} above the levels recommended by the World Health Organisation [15]. Poor air quality increases the risk for asthma and other respiratory diseases [16], and exposure to polluted air is linked to increased risk of cardiovascular and other non-communicable diseases [17]. Generally, there are two ways in which vegetation can help improve air quality in urban settings: dispersion (e.g. by acting as a physical barrier between polluting sources and the receptor, or by inducing

changes in air flow) and deposition (pollutants are deposited on surfaces, thereby removing them from the air, Tomson et al., 2021). Some researchers add modification (changing the properties of pollutants to potentially make them less toxic or easier to dispose of) as a third mechanism [19]. While results often depend on the context, the precise local environmental characteristics and urban setting, the type and amount of vegetation examined, season, weather and wind conditions, etc., multiple reviews show that there is potential for air pollution control by a variety of different types of green spaces, such as trees, hedges, green walls, green screens and green roofs [18,19]. Biodiversity (in terms of taxonomic diversity, functional diversity, as well as abundance of vegetation) is generally positively associated with air pollution mitigation, though future research specifically in urban contexts is warranted [20]. A systematic review of 20 studies shows that there may be a positive effect of higher greenness on the relationship between air pollution and health, although the results are mixed [21].

There are circumstances in which urban vegetation can lead to an increase in poor air quality. One example is the planting of trees in street canyons, which has been shown to reduce air flow in most cases and therefore support the accumulation of air pollutants in these spaces [18]. Another example is the increased prevalence of pollen released by urban trees, which may lead to a higher prevalence of allergies among residents [22]. An ESI approach implies to reduce these potential harms by following specific recommendations, such as using low-pollen producing species, increasing biodiversity of planted species, and planning appropriate management strategies [23].

3.1.3. Noise Pollution

Another major contributor to health risks in modern cities is noise pollution. Increased noise exposure (e.g. from traffic noise) is associated with heightened risks for cardiovascular diseases and events (such as ischaemic heart disease or heart failure incidence and mortality) or sleep disturbances [24], and increased noise annoyance can lead to higher risks for anxiety, depression, and general mental health problems [25].

There are two ways in which urban vegetation can reduce the aforementioned health risks: by acting as a physical barrier between residents and the noise source as well as by reducing its negative impacts psychologically [26,27]. There is moderate evidence that urban green space can reduce noise annoyance [28], and therefore potentially mitigate associated adverse health risks. A study from 2021 could identify a reduction of annoyance from traffic and railway noise equivalent to between 3 dB - 6 dB due to the increase of residential greenery from "not much" to "a lot" [29]. Additionally, sounds that are associated with nature, such as birds and insects as well as water or wind, are known to be relaxing and positively affect stress recovery [30]. Consequently, if promoted in cities through biodiverse urban green spaces, they could potentially mitigate the negative stress effects of traffic noise, as an experimental study focusing on the perceived restorative powers of nature sounds recorded in local parks suggests [31]. Reduced noise exposure has been found to partially mediate the relationship between exposure to green space and non-accidental, cardiovascular and cerebrovascular mortality [32]. However, similar effects for noise pollution and high or low blood pressure risks could not be found [33], demonstrating a further need to examine the specific health benefits that can be achieved by reducing noise pollution through ESI.

3.1.4. Light Pollution

Besides air and noise pollution, another risk factor for human health that has received increasing attention in recent years is light pollution in urban environments, referring to artificial outdoor light, such as street lights or illuminated advertisements. The disruption of the natural circadian rhythm caused by light exposure at night time has been linked to various (mental) health problems, such as higher odds of depressive symptoms in adults [34] or psychosocial stress in children [35], though further studies are needed to establish causal effects more clearly and identify potential confounders [36].

Further research is needed on the one hand to establish the links between outdoor light at night and specific diseases and health problems, and on the other hand to test mitigation strategies [37]. A review of methods to reduce light pollution (and consequently avoid health risks associated with it) proposes several strategies that an ESI approach incorporates to promote the health of urban residents. These include an even distribution of outdoor lights, not too close to one another or nearby buildings, the utilisation of smart technology (e.g. motion sensors, timers, etc.) to ensure that the lights are only turned on when necessary, and keeping lights close to the ground [38].

3.2. Building Capacities

Implementing ESI can contribute to building social and physical capacities and to strengthening resources, such as the immune system. The following pathways are presented and discussed in the sections below: (1) encouraging physical activity, (2) facilitating contact with microbial diversity, (3) encouraging sun exposure/time spent outdoors, and (4) encouraging social interaction.

3.2.1. Encouraging Physical Activity

“Physical inactivity” (or insufficient physical activity) has been identified as one of the five leading risk factors for mortality, according to the WHO [39]. Being physically active compared to being inactive, is associated with numerous positive health outcomes, including a reduced risk of non-communicable diseases (such as cancer, diabetes and cardiovascular diseases) [40], improved bone health [41], reduced risks of dementia and cognitive decline [42,43] and reduced risk of depression [44,45]. Similar benefits are found when only examining active mobility (i.e. walking or cycling for transportation purposes, for example to commute): people who regularly walk or bike have lower all-cause mortality [46,47], report less psychological stress [48] and higher mental well-being [49].

Implementing an ESI approach could encourage residents to be more active, either through physical activity in their leisure time or by providing infrastructure that promotes active travel. Appropriate interventions to the built urban environment have been shown to be able to influence physical activity of residents: several reviews of existing evidence including results from longitudinal [50], experimental [51], or intervention studies [52] show that, overall, creating new walking, cycling or public transport infrastructure, as well as the provision of “quality parks” and playgrounds (e.g. with fitness equipment and lighting) has a positive effect on physical activity of different demographic groups (men, women, children, elderly). Improving existing infrastructure for walking or cycling (improving cross-walks and side-walks, providing bike parking opportunities) has a positive effect on active mobility behaviour. Features of the built environment for walking and cycling (well-maintained paths, cycling routes, providing bike parking facilities), higher street connectivity, accessible public transport and the presence of nearby destinations, such as shops, are consistently shown to be positively associated with active mobility behaviour [53–55], though this can vary between spatial scales, specific neighbourhoods, and individuals. Additionally, urban green spaces are an important feature associated with increased physical activity in urban environments [56,57]. The effects on physical activity can vary according to the type of green space, its quality, and the facilities available [56,58]. Well-maintained surroundings, facilities (playgrounds, outdoor gyms, etc.), amenities (e.g. benches, picnic tables, bike parking), absence of incivilities (litter, vandalism, drugs), and bird diversity are associated with a higher likelihood of participants having performed self-reported moderate-to-vigorous physical activity in urban green spaces [59], demonstrating that quality of urban environments matters in terms of their health-promoting potential.

3.2.2. Contact with Microbial Diversity

Another possible pathway through which ESI can benefit human health is the increased exposure to microbial diversity that is otherwise lost in modern urban environments characterised by concrete (or “grey”) areas [60,61]. Higher levels of residential greenness is associated with higher

microbial diversity in human skin, gut, and mouth [62] and exposure to biodiverse environments can increase diversity in the human microbiome [63], for example on the skin (and nose, depending on the individual; [64]). Microbiota (of different organs) influence various processes in the human body, including the immune system, the nervous system, and the endocrine system [65]. It is therefore theorised that exposure to greater microbial diversity (in the form of biodiverse urban green space) protects against the development of allergies, enhances gut and immune system health and, consequently, may even protect against cognitive diseases [60,61,66]. In recent studies, increased exposure to biodiversity for children has been linked to improved lung function [67] and an enrichment of commensal (“beneficial”) microbiota, including species associated with immune regulation, and a reduction in pathogenic bacteria on the skin [68,69]. Thus, providing biodiverse urban spaces, which is central to the ESI approach, could improve the health and well-being of urban residents by facilitating contact with greater microbial diversity.

3.2.3. Encouraging Sun Exposure/Time Spent Outside

Implementing a public infrastructure approach that aims to encourage residents to spend time outside of their homes can also help build capacities by harnessing the benefits associated with exposure to natural sunlight, which have been gaining more attention from researchers in recent years. In a systematic review on the topic of natural elements (including sun exposure) and mental health, Taniguchi et al. [70] only find evidence for positive associations between sun exposure and mental health, with seven out of seven identified studies demonstrating a range of benefits of more time spent exposed to sunlight, including lower lifetime risk of depression, less frequent use of antidepressants, greater self-reported happiness, in addition to a lack of sunlight leading to higher anxiety, worse depressive symptoms and an increased risk of developing depression. Insufficient sun exposure is linked to various (physical) health risks, e.g., increasing risks for all-cause mortality [71] and cardiovascular diseases [72]. In recent years, studies have shown an association between time spent outside in childhood and the risk of developing multiple sclerosis, with those who spent less time outdoors having higher odds of developing the disease [73,74]. A systematic overview of reviews and meta-analyses combining 47 different studies from seven different previous systematic reviews found evidence for a decreased risk of myopia in children with frequent exposure to outdoor light [75]. Moreover, ESI could reduce Vitamin D insufficiency or deficiency and the negative health risks associated with it by providing attractive public outdoor spaces. Studies have shown that higher levels of residential green space are associated with higher levels of Vitamin D in children [76] and higher odds of non-deficiency in older adults [77].

In addition to the mental and physical health benefits, there are also health risks associated with (too much intense) sun exposure and subsequent UV radiation. A comprehensive overview is given by Neale et al. [78], including a summary of risk of skin cancer, sunburn, inflammatory skin disorders and eye diseases. For example, in 2012 around 76% of melanomas globally could be attributed to excessive UV radiation exposure [79]. While comparable studies on the subject of the mitigation potential of urban green spaces are scarce, a systematic review concludes that 15 identified studies on the topic show that tree canopy can reduce exposure to solar radiation [11] - the capacity depends on the type of vegetation or tree species. Thus, urban green space could protect against the negative health effects of excessive UV-radiation by providing public spaces that reduce exposure, while still enabling the positive effects gained from social and physical activities outside.

3.2.4. Encouraging Social Interaction

Social relationships or social cohesion is another aspect of well-being and health that can be influenced by ESI. In general, easily accessible destinations and high walkability are features of the built environment that are consistently associated with good social relations at a local neighbourhood level, while high neighbourhood density is generally associated with lower social cohesion [80]. Consequently, especially in dense neighbourhoods, it is important to foster social cohesion through other elements of urban infrastructure in order to gain associated health benefits. Urban green spaces

as features of ESI provide areas for and encourage social interaction among residents [81,82]. Social relationships and (perceived) social cohesion can influence human health through various pathways, including social engagement, perceived and actual social support, social influence, access to information, and increased contact with others [83]. Multiple aspects of urban green spaces influence social interaction and feelings of social cohesion between residents. Some evidence suggests that higher presence of and closer proximity to green spaces is associated with higher social cohesion [84]. Amenities designed for diverse user groups, such as benches or playgrounds, in addition to well-maintained paths and well-lit areas, increase opportunities for social interaction between visitors. Regular and longer visits to green spaces are associated with higher social cohesion, and community engagement and co-management practices contribute to better social cohesion [84,85]. Loneliness and social isolation are negatively associated with multiple different health outcomes [86], including all-cause mortality [87]. Exposure to urban green spaces has been shown to reduce feelings of loneliness [88].

3.3. Restoring Capacities

Health-promoting urban design has the potential to restore capacities and improve mental health. The accessibility and visibility of nature-based solutions (i.e. natural elements in mainly urban environments) is associated with lower psychological stress [89]. Recent reviews on different types of green spaces and their impact on health confirm that while a few studies find neutral results, the majority of research finds positive effects of urban parks and other types of urban green spaces on restorative outcomes, including relaxation, “forgetting one’s worries”, and physiological stress [90,91]. Exposure to urban green spaces compared to non-green (or grey) urban areas, has generally been found to reduce (short-term) markers of physiological stress, such as heart rate or blood pressure [92] and green space exposure or interaction is associated positively with mental health in a majority of studies [56,93].

Additionally, attention has been given to biodiversity as one characteristic of urban green spaces that facilitates or enhances the restorative effects of such spaces. Biodiversity of green spaces in particular is associated with positive effects on perceived stress and restorative outcomes [90]. While Marselle and colleagues [94] conclude in their systematic review of 24 studies that the current body of evidence is not yet comprehensive enough to clearly characterise the relationship between biodiversity and mental health or well-being in urban spaces, there are some studies that support the notion that higher levels of plant or bird species richness in urban environments can lead to higher restorative potential [95,96], better psychological well-being [5,97] and better public mental health [98]. Higher perceived biodiversity has been identified as a predictor of subjective well-being [99] and positive emotions [100]. Lindemann-Matthies und Matthies [101] could show effects of plant diversity on lowering blood pressure. Interestingly, the decrease was strongest at medium levels of plant species richness. While the large heterogeneity in assessing and measuring urban green spaces [92] and biodiversity in particular [102] makes it difficult to generalise results, several systematic reviews have highlighted positive associations between biodiversity and different measures of (mental) health and well-being [103,104]. ESI may thus positively affect quality of life in urban areas by restoring capacities through exposure to biodiverse natural urban spaces.

4. Discussion

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

4.1. Potentials and Limits of ESI

As presented, a variety of health benefits can be derived from implementing ESI elements in urban areas that emphasises biodiverse urban green spaces, infrastructure that supports physically

active mobility and designing public spaces in a way that encourages residents to spend time outside. There are multiple benefits to introducing it as an urban planning concept: (1) ESI combines multiple essential elements, i.e. health promotion and infrastructure, creating a comprehensive concept for urban planners and public health officials alike. Addressing these fields simultaneously may foster the inter- and transdisciplinary work that is vital for the promotion of healthy urban living environments. (2) The concept refers to elements of the built environment that can be changed directly or implemented in a relatively short time frame. This is an important characteristic given the urgency of the climate crisis and its detrimental impacts on human health. (3) Additionally, the concept of ESI is open to integrate aspects beyond human well-being. By emphasising urban biodiversity, it recognises the importance of environmental health for human well-being and by providing diverse habitats for animals (e.g. birds), it offers a holistic perspective on the interconnectedness between human, animal, and environmental health, aligning with the One Health approach.

Given its focus on human well-being, the concept of ESI naturally also features some limitations: (1) It is specifically focussed on urban areas and thus does not refer to the impact of rural or less urbanised environments on human health and well-being, where strategies such as creating more walking infrastructure need to be paired with other interventions, e.g. better public transport, in order to be effective. Furthermore, its focus lies on tangible infrastructure and the physical environment. This leaves out important higher level infrastructure components, such as full-scale transportation networks or health-related services. (2) Additionally, the literature review and conceptualisation of ESI is Western-centric. Its application in other climate zones, other cultural settings and other conditions of the urban context may differ from what has been presented here. (3) ESI incorporates a limited understanding of infrastructure by focusing on tangible infrastructure. While this can be beneficial in terms of focussing on structural elements that can be directly changed to promote health and enhance preventive effects, it neglects the potential of non-tangible infrastructure (e.g., networks, services) to impact well-being.

4.2. Implications for a One Health Approach to Urban Planning

While our literature review focused specifically on benefits to human health, ESI additionally contributes to optimising environmental health in urban areas in line with the One Health approach. One Health is defined as a holistic concept that describes the interdependence of human, animal, and environmental health, advocating for transdisciplinary solutions. Implementing greater amounts of well-connected greenery in urban areas, even on a small scale, provides habitat for urban wildlife, contributing to biodiversity conservation [105]. In turn, urban green spaces may be more restorative and more conducive to physical activity for urban residents with (non-threatening) wildlife present [106,107], and measures of wildlife biodiversity are positively associated with some health indicators, such as bird species richness and mental health [108]. Interventions to the built environment that benefit human well-being, such as reducing light pollution, could improve health of urban wildlife as well [109]. These examples demonstrate a strong link between human and environmental health in urban areas. Although specific synergies and trade-offs in the relationship between the built environment, human and environmental health need to be further explored, studies to date show great potential for incorporating One Health ideas and principles into urban planning to address public health issues and environmental well-being comprehensively [30].

4.3. ESI in Relation to Other Prominent Concepts

In many respects, the framework of ESI adds to the current discussion on how urban environments can impact, and in particular benefit, human health. Table 1 presents a selection of prominent concepts associated with urban planning and human health, namely “Resilient Cities”, “Green Infrastructure”, and “Social Infrastructure”. While other concepts have been proposed, for example, the “New Urban Models” [110] or “Urban Ecological Infrastructure” [111], we focus on those that are widely used by policymakers and practitioners and established in scientific research.

While human health and well-being are considered in frameworks regarding *resilient cities* (e.g. “health and well-being” is one of the four main categories comprising a resilient city in the framework published by The Rockefeller Foundation), its primary functions are to “safeguard” human health and “minimalise vulnerability” by providing residents with reliable (formal healthcare) infrastructure and meeting their basic needs regarding housing, food, and financial stability [112]. Urban resilience research is mainly concerned with risk and disaster control in different fields related to urban planning (economic, environmental, etc.) [113] and with the prevention of harm, either through sudden shocks (economic, environmental) or gradual change (effects of the climate crisis; Bush & Doyon, 2019). However, ESI aims not only to prevent poor health and take risk prevention measures, but also to actively achieve good health and improve quality of life through features of urban planning that facilitate health behaviours, reduce exposure to stressors, and promote restoration.

Table 1. Characteristics of Selected Urban Planning Concepts.

Concept	Eco-Salute Infrastructure	Resilient Cities/Urban Resilience	(Urban) Green Infrastructure	Social Infrastructure
Definition	A set of strategies, interventions and (man-made) features of public urban infrastructure that are designed and implemented in order to promote human health and well-being in urban environments	“Resilient cities are cities that have the ability to absorb, recover and prepare for future shocks (economic, environmental, social & institutional)” [115] <i>Comment:</i> Diverse definitions; focused either on resilience in face of a specific risk or resilience of urban system in the face of all possible risks [116]	“A strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services” [117]	“Social infrastructure refers to the networks of spaces, facilities, institutions, and groups that create affordances for social connection” [118] “Social infrastructure refers to the physical places within the built environment where people can interact and connect

				with others in their community" [119]
Context	Concept for urban design/architecture (tangible infrastructure)	Concept for urban planning (tangible and non-tangible infrastructure); critical infrastructure	Concept for urban design/architecture (tangible infrastructure); sustainable urban management strategy	Concept for social aspects of infrastructure; tangible infrastructure included as long as it facilitates social interaction; non-tangible services are often focus
Examples	Biodiverse urban green space, attractive public outdoor spaces, cycling and walking infrastructure	Formal health care system, banking system, industries, stormwater infrastructure, civic organisations	Urban green space (parks, green walls/roofs, trees, etc.), green stormwater infrastructure	Recreational spaces (public parks, etc.), education, employment, health care system, public transportation system
Priorities & important dimensions	Improve human well-being, enhance quality of life in urban areas Simultaneously maximise environmental health (One Health approach) Achieved through biodiversity	Ensure cities are resilient against sudden shocks and threats (climate crisis, environmental, economic, etc.) Resilience in five dimensions: natural (ecosystems), economic (development), social, physical (infrastructure,	Climate change adaptation and mitigation [121] Improve ecosystem functioning and promote ecosystem services; promote societal well-being and health; protecting	Facilitate social interaction; improve community well-being "Social infrastructure provides essential societal resources that support individual and community well-being" [Goe and Green 2005, as cited in 123]

	y as a priority in urban planning	land use, etc.) and institutional (government, emergency response) [120]	biodiversit y; supporting developme nt of green economy; Multifuncti onality and connectivit y [122]	
Scale/ scope	Local/ neigh- bourhood/ city-wide application	City-wide application	Local/ neigh- bourhood/ city-wide application	Local/ neigh- bourhood/ city-wide/ regional application
How does health/ well- being fit into the concept?	Promotion of human health and well-being through urban design is central priority, while also maximi- sing environ- mental health	Health and well-being are one of four categories; functions are to “safeguard human life” & “deliver basic needs” [112]	Health and well-being are influenced by ecosystem services provided by green infrastructu re	Social interaction produces well-being <i>Comment:</i> Depending on definition: health- related/ care services

Note. ESI: Eco-Salute Infrastructure; GI: Green Infrastructure; UR: Urban Resilience; SI: Social Infrastructure.

ESI incorporates aspects of *green infrastructure* (GI) into a broader approach to improving human well-being through urban planning, but is more inclusive as a concept by also including other (“non-green”) design elements that benefit health, such as the provision of walkable paths and biking infrastructure to support active mobility. While biodiversity as a characteristic is sometimes emphasised in the conceptualisation of GI, it is not always a priority in the actual implementation [3]. Through its particular emphasis on biodiverse green spaces as health-promoting features in urban environments, ESI adds a dimension of quality to the GI concept, emphasising the active promotion of health rather than the mitigation of environmental harms and climate crisis adaptation. The benefits of GI for (mental) health and other “cultural ecosystem services” are recognised in research on GI benefits, but they are investigated less often than other types of services [124], demonstrating the need for focussing specifically on those aspects of well-being and quality of life in urban environments.

The term “social infrastructure” (SI) is sometimes utilised in similar ways to ESI here, i.e. it is defined in ways that emphasise and include public open (green) space [125], planning that supports walking and cycling [123], and infrastructural elements or spaces that enable social interaction [118,119]. However, there are many different definitions and understandings of SI, sometimes even contradictory [126], and the term broadly includes (non-tangible) services, such as education, public housing, formal healthcare services, etc. [123]. The variety of definitions with sometimes even contradicting meanings makes the use of the term less precise and may lead to misunderstandings. Thus, ESI may be a more appropriate term to ensure mutual understanding between different disciplines and sectors, as well as between scientists, policy makers, and urban planning practitioners. Additionally, focusing on “tangible” infrastructure, as a ESI approach does, ensures that health-promoting measures can be implemented directly by urban planners.

Overall, these concepts deal with urban planning and designing public infrastructure in a way that is beneficial to human health and well-being. They all have in common that they are (mainly) applied in urban contexts and aim to ensure human health through trans- and multidisciplinary approaches which are based on sound scientific evidence, addressing the challenges of tomorrow’s urban infrastructures, and taking into account sustainability goals [3,114]. However, they do not always consider improving human health and well-being directly as the main priority and fail to capture the full range of benefits that different scientific fields have proposed can be derived from designing urban environments in ways that promote and protect health. They differ in their approaches to achieving (higher) quality of life for urban residents and their potential for direct action, as well as in their potential to incorporate wider aspects of health in terms of a One Health perspective. The ESI framework is intended to complement, rather than replace, these models in the current discussion on how to make cities healthier and more sustainable (see Figure 1). Its core principle (implementing health-promoting and biodiverse urban architecture that prioritises improving human quality of life and well-being, while also maximising environmental health) distinguishes ESI from similar concepts and offers a unique perspective on the interactions between urban planning and public health.

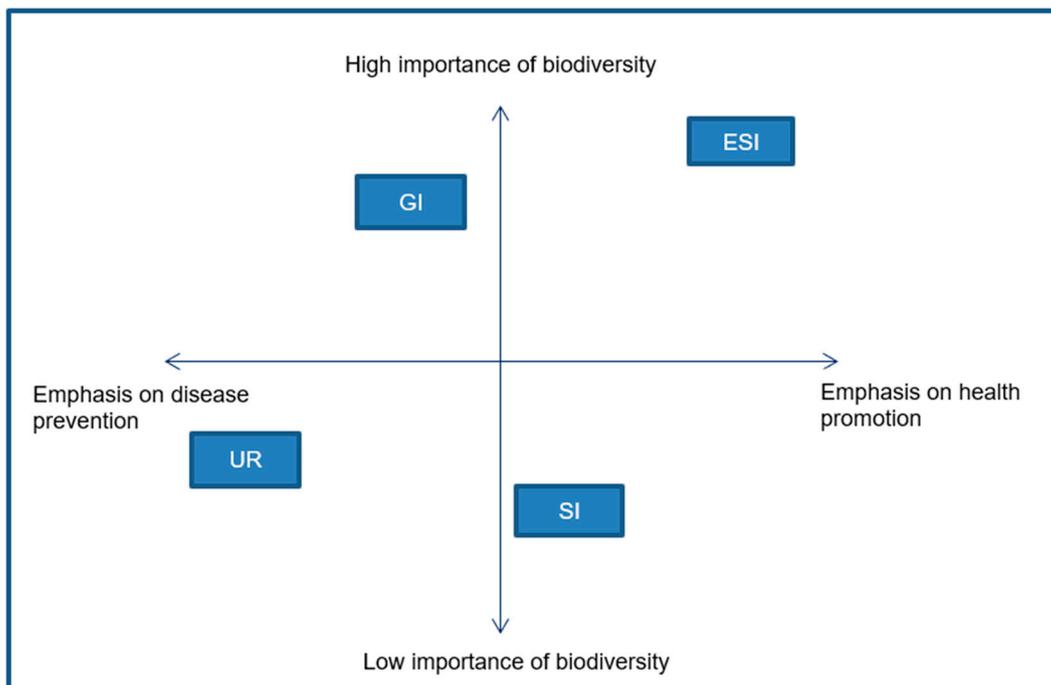


Figure 1. Selected Urban Planning Concepts in the dimensions of Health Orientation and Importance of Biodiversity. Note. Concepts related to health and urban planning in the dimensions of „health orientation“ and

„importance of biodiversity“. GI: Green Infrastructure, ESI: Eco-Salute Infrastructure, SI: Social Infrastructure, UR: Urban Resilience.

4.4. Implications for Urban Planning and Design

While generally more research is required, some implications for policy and practice can already be deduced. Multiple researchers highlight the need to involve more public health officials in urban planning [13,14], to ensure trans- and interdisciplinary insights and to make human and environmental well-being a driver of urban planning that should be considered in every decision.

Furthermore, it is essential to involve residents into the planning process and to consider local preferences when designing such spaces, since they can differ according to the demographic and cultural composition of the residential population [127,128], structural factors (e.g. city size) [129], individual health status of residents [130], as well as according to motivations for use [131]. Informing residents about renewal projects, making them aware of associated benefits for health and well-being and considering them as co-creators can be a vital strategy to increase usage and maximise positive health effects [132,133].

Generally, high perceived quality of green space is an important predictor of usage, for example, in terms of visit frequency [134–136]. People are more satisfied with urban green spaces and other infrastructure elements when they feel safe (i.e. have good lighting and visibility), are well maintained (e.g. not littered), have pleasing aesthetics (e.g. biodiverse vegetation and bird life) and amenities, such as playgrounds, workout equipment, but also benches and picnic tables [128,129,137].

Additionally, ESI interventions in urban environments should be evaluated in terms of their economic benefits regarding public health expenditure [13] in order to encourage more investment. They should also be monitored in terms of their actual ability to reduce harm in local conditions – for example mitigating air pollution [138] – and their impact on human health, to be able to learn and improve where necessary [110].

4.5. Directions for Future Research

Multiple reviews of the literature conclude that future studies need to adopt more comparable research designs and measurements to allow for a better synthesis of results regarding the effects of features of the urban environment on human health. This applies to research of impacts on health by green spaces [90], biodiversity [139], as well as the built environment [140]. In specific fields, such as research into the potential for air pollution mitigation, great context-dependency further complicates the generalisability of results [138]. Similarly, when assessing the restorative potential of built environment features, more research in real-world settings is needed to account for the complexity of urban environments [141]. Thus, future research should better characterise the types of spaces that are evaluated and be consistent in how relevant concepts are measured (e.g., biodiversity).

Instead of solely focusing on the presence or quantity of green spaces, more attention should be paid to the quality of urban green [9] and interventions to the built environment in general, allowing researchers to pinpoint more accurately which features or characteristics of urban design can maximise human health benefits, meaning that ESI approaches could be implemented more effectively. Biodiversity is one such feature that, while it is recognised as essential for the provision of important ecosystem services [20], needs to be studied more extensively (in urban areas) to create a more comprehensive evidence base regarding its benefits to human mental, physical, and social health at different levels [139].

Further uncovering and examining synergies between human well-being and environmental well-being (i.e. plants, urban wildlife, micro-organisms), using the One Health approach, could lead to more beneficial green space design [30]. Similarly, there is a need for evidence of the benefits of ESI for human health overall and to disentangle its impact for different population groups and contexts.

5. Conclusions

This paper has introduced ESI as a new framework for urban planning that prioritises human well-being, with the aim of creating healthier cities and improving people's quality of life. Although not systematic or exhaustive, recent research that supports the claim that ESI can improve human well-being in urban areas has been presented. The ESI framework has the potential to contribute to the current discussion on how to make (living in) urban areas healthier and more sustainable by expanding on previous concepts that address the interlinkages between human well-being, environmental health and urban design and by expanding the eco-salute policy guidelines developed by the German Advisory Council for the Environment [4]. However, more research is needed to establish a broader evidence base for the positive health effects. Additionally, research into synergies between environmental health and human well-being in urban areas would allow the ESI framework to be further refined. In general, implementing ESI, i.e. designing and building infrastructure as well as architecture that supports active mobility and physical activity, creating attractive public spaces that encourage people to spend time outside, and providing urban residents with (increased) access to high quality, biodiverse urban green spaces, seems to have great potential to improve human health and well-being.

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Abbreviations

The following abbreviations are used in this manuscript:

ESI	Eco-Salute Infrastructure
GI	Green Infrastructure
SI	Social Infrastructure

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