sustainability

Review

Health Impacts of Urban Environmental Parameters: A Review of Air Pollution, Heat, Noise, Green Spaces and Mobility

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Abstract: This literature review examines the relationship between the urban environment and human health, focusing on five key parameters: air pollution, extreme temperatures, noise, green spaces, and urban mobility. A systematic review was conducted using indexed scientific databases (Scopus, Web of Science, and PubMed) and technical reports, following predefined search terms and exclusion criteria. A total of 131 publications were selected and analyzed. The study highlights the negative health effects of air pollution, heat, and noise—particularly on the respiratory, cardiovascular, nervous, and reproductive systems—especially in vulnerable populations including older adults, children, pregnant women, individuals with chronic illnesses, and those living in socioeconomically disadvantaged areas. In contrast, green spaces and sustainable mobility have shown beneficial impacts, including improvements in mental health, increased physical activity, and indirect benefits as they contribute to reducing air pollution, urban heat, and noise. Among all parameters, air pollution emerges as the most extensively studied and regulated, while significant research gaps persist in the fields of urban mobility and noise pollution. Furthermore, regulatory development remains limited across all parameters analyzed, highlighting the need for more comprehensive and consistent policy frameworks. Based on the evidence, three key urban strategies are proposed: renaturalizing cities, promoting sustainable mobility, and implementing data-driven management and educational tools. These actions are essential to create healthier, more resilient, and sustainable urban environments.

Keywords: morbidity; mortality; hospital admissions; urban design; public health

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1. Introduction

Human health and the environment are deeply interconnected through complex interactions that directly impact our quality of life. Natural environments not only provide essential resources for life, such as clean air and potable water, but also act as barriers against diseases and adverse conditions. However, global climate change introduces unprecedented challenges: from extreme weather events, such as heat waves, floods, and droughts, to the spread of emerging diseases transmitted by vectors, among others. The World Health Organization (WHO) estimates that 23% of world mortality is attributable to environmental factors [1]. In terms of the global population, this figure accounts for 12.6 million deaths annually, distributed unevenly across the planet; in Europe, it is estimated to be 1.4 million [1].

Nowadays, the city is one of the most typical habitats for human development. In fact, the 21st century has witnessed an accelerated demographic transition that has redefined global configurations, bringing with it a phenomenon of historic proportions: the continuous and pronounced growth of cities. In this context, the United Nations estimates that by 2050, 68% of the world's population will live in cities [2]. This rapid growth, while reflecting the dynamism and innovation associated with urban life, also presents considerable challenges, particularly concerning the interaction between the environment and human health. Cities act as microcosms where human activities, infrastructure, pollution, access to services, and biodiversity converge in a complex manner.

Initially, the authors wanted to consider a wide range of environmental factors for analysis. However, to maintain a focused approach, only those with the strongest scientific evidence and development were selected. In this context, factors such as air pollution, high temperatures, noise, mobility, and access to green spaces were selected as key determinants of urban health and well-being. Therefore, the main aim of this article is to analyze the impact of urban environment on the health of the population, based on a literature review. Five urban parameters were studied: air pollution, high temperatures, and noise, which negatively affect health; and green spaces and urban mobility, which have a positive influence on public health. Additionally, this review aims to highlight knowledge gaps related to this topic, with the goal of defining future research directions.

The scope of our review is focused on Europe. Therefore, comparisons were primarily limited to regions with similar regulatory, economic, and climatic conditions, ensuring greater consistency when analyzing the relationship between environmental indicators and health outcomes.

2. Materials and Methods

The literature review covers the following topics: on the one hand, studies providing evidence on how environmental factors—such as air pollution, high temperatures, and urban noise—negatively affect human health, have been reviewed; on the other hand, the literature on the positive contributions of urban design elements—such as green spaces and mobility—to public health has also been assessed. As health indicators, the following have been considered and extracted from the literature: (i) impacts on physical health (various systems of the human body); (ii) impacts on mental health; (iii) increased associated mortality; and (iv) hospital admissions. Figure 1 presents a graphical summary of the analysis conducted.

The present systematic review has been based on the PRISMA methodology [3]. Specific search terms ("keywords") were used, organized into three categories: (i) city and health: health, public health, diseases, mortality, morbidity; (ii) environment: environment, urban environment, city, green areas, urban; and (iii) parameters: air pollution, high temperatures/heatwaves, noise, green spaces, and urban mobility. These keywords have been combined with Boolean operators (AND, OR).

The reviewed sources were (i) indexed scientific publications (academic articles, scientific studies, and systematic reviews in online bibliographic repositories such as PubMed, Medline, ScienceDirect, Scopus, and Web of Science and (ii) European/WHO technical reports. The searches were limited to the last 25 years (2000–2024).

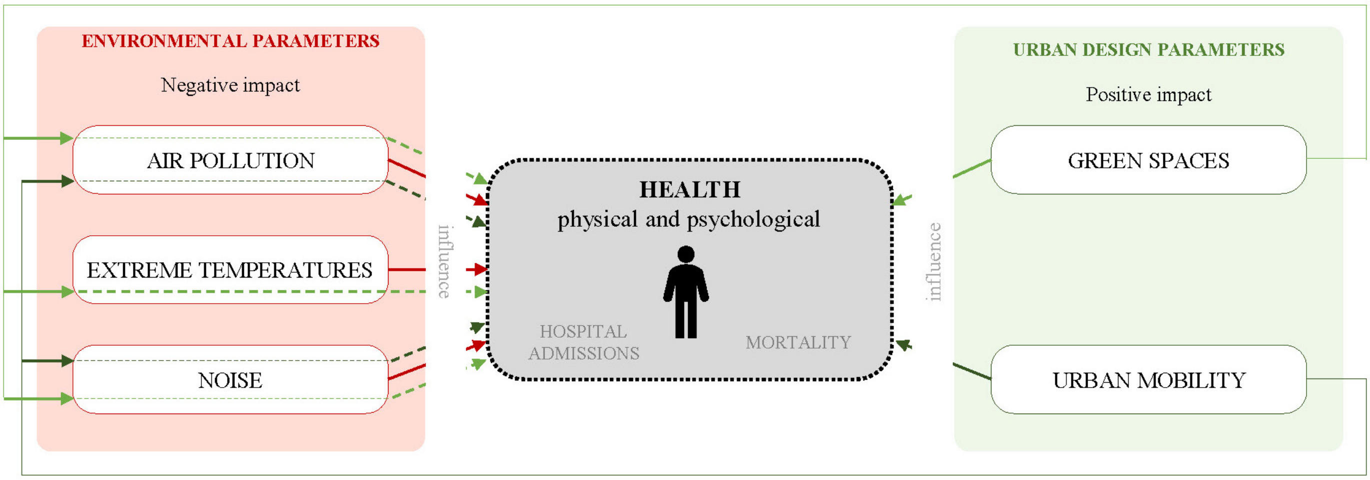

Figure 1. Flow chart with the parameters analyzed and the relationships and indicators considered in this review.

After the initial searches, the exclusion criteria were established for discarding publications:

A. Removal of duplicates
B. Unavailability or incomprehension: publications that are inaccessible due to unavailability, language barriers, or incomprehensibility, as well as those removed due to plagiarism, are excluded.
C. Thematic relevance: publications that analyze the impacts of the studied parameters on other fields but do not specifically focus on health were excluded.
D. Type of results: studies reporting exclusively qualitative outcomes were excluded to maintain consistency in the assessment of health impacts across the different parameters. This criterion prioritizes studies that report quantifiable outcomes (e.g., morbidity rates, mortality rates, hospital admissions), facilitating comparative synthesis and supporting data-driven urban planning and health policy development.

A total of 341 publications were obtained in the initial search. After removing duplicates (n = 24), a screening process was carried out in which 174 publications were excluded for failing to meet the exclusion criteria. During this selection process, 317 titles and keywords, 194 abstracts, and 155 full-text publications were reviewed. Finally, the analysis was conducted on a total of 143 publications, distributed across the different topics: general concepts (n = 2), air pollution (n = 54), extreme temperatures (n = 20), noise (n = 10), green spaces (n = 28), urban mobility (n = 12), vulnerable populations (n = 8), strategies (n = 3), and future research (n = 6). Figure 2 summarizes the process of selection and filtering of publications.

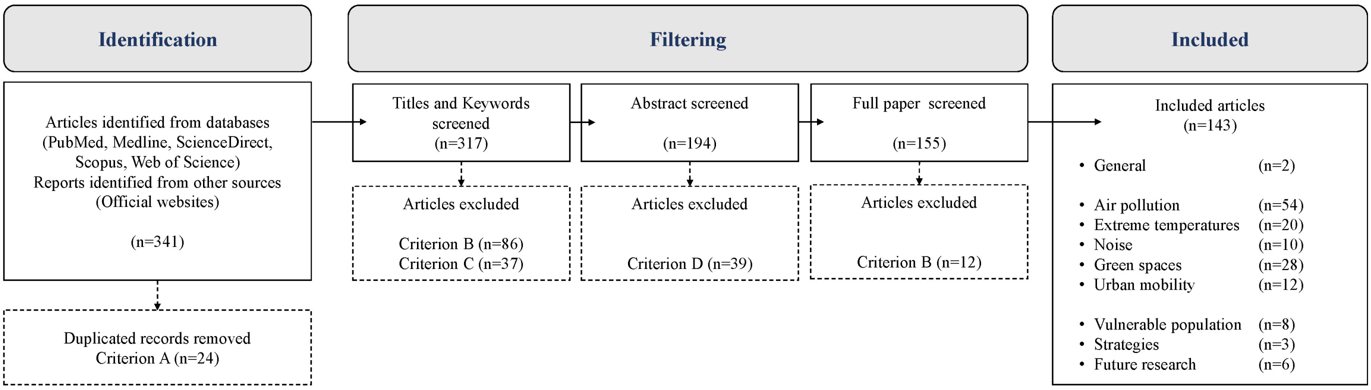

Figure 2. Development of the publications' selection process.

3. Results

3.1. Negative Impact of Environmental Parameters on Health

Environmental parameters have a direct and negative impact on people's health, affecting both their physical and mental health. Table 1 summarized these impacts.

3.1.1. Air Pollution

Air pollution is defined as the presence of pollutants in the air (such as nitrogen oxides, sulfur dioxide, ozone, carbon monoxide, benzene, heavy metals, and particulate matter) that are hazardous to human health and the environment. Climate change increases the concentration of atmospheric pollutants due to phenomena like heat waves or droughts. The World Health Organization (WHO) estimates that 4.2 million people die annually due to air pollution, with high mortality rates from lung cancer, chronic obstructive pulmonary disease (COPD), strokes, and ischemic heart disease [4]. In Europe, air pollution causes the death of 370,000 people each year [5].

Exposure to air pollutants primarily affects the respiratory system, due to the increased risk of respiratory infections, cystic fibrosis, emphysema, and lung cancer [6–8]. Suspended particulate matters (PMs) are associated with oxidative stress that can lead to carcinogenesis, teratogenesis, and mutagenesis [9]. Additionally, the smaller ones ($PM_{2.5}$), can also cause imbalances in intracellular calcium and inflammatory processes that may result in apoptosis, necrosis [10], and chronic inflammation [11]. In children and young people, during their growth stages, exposure to polluted air is associated with chronic respiratory diseases, including COPD, asthma, and complications in lung development [12,13].

Air pollution is also harmful to the cardiovascular system through disruption of the nervous system balance (contributing to vascular plaque instability and arrhythmias), causing endothelial dysfunction and a pro-coagulant state, affecting the vascular endothelium, causing inflammation and oxidative stress, as well as causing arrhythmias, ischemia, hypertension, and atherosclerosis [7].

In fact, among the specific mortality associated with air pollution, two-thirds are due to cardiovascular diseases [7,10,11]. Studies have estimated that 5% of myocardial infarctions can be attributed to short-term exposures to $PM_{2.5}$, increasing the relative risk by 2.5% for every 10 $\mu g/m^3$ increase in these particles' concentration (adult population, Europe) [14]. Prolonged exposure to pollutants has also been found to be particularly harmful, triggering severe cardiovascular effects after an average of 5–7 days of exposure [7].

Pollutants can enter the central nervous system either directly through the bloodstream or via the olfactory, eye mucosa, affecting neurons and causing damage through mechanisms such as oxidative stress and neuroinflammation [15,16]. The brain is particularly susceptible to oxidative stress due to its high metabolic activity; therefore, the presence of metals in the air can catalyze the production of reactive oxygen species, contributing to neurodegeneration [17,18]. Other studies have demonstrated a relationship between air pollution and increased mortality and morbidity rates from stroke [15,19]. Additionally, chronic exposure to pollution has been associated with declines in cognitive function in older adults [20,21] and the development of depressive behaviors [22]. Furthermore, there is evidence that pollution exacerbates neurodegenerative diseases like Alzheimer's and Parkinson's through mechanisms such as protein aggregation and oxidative stress [23,24].

The influence of air pollution on the reproductive system and pregnancy outcomes is becoming an increasingly important field of study, particularly in terms of decreasing fertility [25,26] and increasing birthing complications [27]. Concerning fertility, numerous studies indicate that female infertility, although influenced by factors such as delayed motherhood, is significantly affected by environmental pollutants [28,29]. Additionally, sperm quality can also be compromised by air pollution, as evidenced by studies linking abnormalities in sperm morphology with periods of high pollution [30,31]. Moreover, air pollution has a negative impact on in vitro fertility treatments, reducing pregnancy rates [28,32,33]. Regarding the fetus, the mechanisms by which pollutants affect the reproductive system include altering the placental exchange, impacting umbilical blood flow and the transport of oxygen and essential nutrients for fetal growth and development [34,35]. Complications associated with pregnancy and fetal development influenced by pollution include preterm births [36] and low birth weight, with studies showing a relationship between these outcomes and high levels of pollutants such as SO_2 and PM [7,34]. Air pollution has also been linked to an increased risk of miscarriage and infant mortality, with studies associating high levels of NO_2 and SO_2 with these tragic outcomes [37,38]. After birth, adverse effects such as cleft palate, cleft lip, and congenital heart defects have been observed in newborns exposed to high levels of pollutants like O_3 [39,40] and a decrease in respiratory volume by up to 2.7% with a 10 $\mu g/m^3$ increase in NO_2 concentration (children at 4.5 years of age, Spain) [41].

Regarding the excretory system, although research in these areas is less extensive, emerging evidence suggests that pollutants, especially metals present in suspended particulate matter (PM), can cause kidney damage, including tubular dysfunction, reduced glomerular filtration rate, and an increased risk of kidney stones and renal cancer [10]. Furthermore, the ingestion of air pollutants through aerophagia can directly impact the digestive system, with studies linking exposure to nitrogen dioxide (NO_2) to an increased risk of developing ulcers and cancer in this system in older individuals [42].

Concerning the immune system, studies focus on analyzing how exposure to air pollution is increasingly triggering a variety of allergies [43].

Hospital admissions for respiratory diseases can increase between 0.35% and 0.80% with a 10 $\mu g/m^3$ increase in PM_{10} levels [44,45], and for $PM_{2.5}$, the increase in admissions for respiratory causes is 0.53%, reaching 1.23% after 5 days of exposure [46]. For specific diseases, hospitalization rates also increase: asthma admissions have seen a 0.68% increase after 4 days of exposure to $PM_{2.5}$ (adult population, 30 US cities) [46]; COPD admissions have seen increases of 3.88% and 3.58% after exposure to PM_{10} and $PM_{2.5}$, respectively (adult population, 30 US cities) [46]. The O_3 also impacts hospital admissions (children) for respiratory diseases, with an increased risk between 2% and 7% after two days of exposure to various maximum concentrations (adult population, New York State) [47]. On the other hand, NO_2 is associated with a 1.82% increase in general emergency room admissions for each 10 $\mu g/m^3$ increase in its concentration, highlighting its impact on respiratory and cardiovascular diseases (adult population, Beijing, China) [48]. Finally, SO_2 has also been shown to increase the risk of admission for cardiovascular and respiratory diseases, with a significant increase in hospital admissions ranging from 1.82% to 6.88% for every 10 $\mu g/m^3$ increase in its average concentration (adult population, Beijing, China) [48].

Regarding associated mortality, different studies have shown a significant correlation between air pollution and increased mortality in urban areas. Prolonged exposure to fine particles ($PM_{2.5}$) is associated with a 6% increase in mortality from cardiovascular and respiratory diseases for each 10 $\mu g/m^3$ rise in $PM_{2.5}$ levels (adult population, data from 211 county units in the 51 US metropolitan areas during the 1980s and 1990s) [49]. Similarly, long-term exposure to nitrogen dioxide (NO_2) and fine particles is linked to a 5% increase in mortality from natural causes for each 10 $\mu g/m^3$ rise in NO_2 concentration [50]. These findings are consistent with studies associating $PM_{2.5}$ with a 7% increase in overall mortality for every 5 $\mu g/m^3$ increase (adult population, data from 22 European cohort studies, which created a total study population of 367,251 participants) [51].

3.1.2. High Temperature

Rising temperatures, especially in summer, are a growing challenge affecting both the environment and public health. Heatwaves, which are increasing in frequency and intensity due to climate change, can have significant impacts on health, agriculture, and ecology. The World Health Organization established that between 2000 and 2016, the number of people exposed to heatwaves increased by about 125 million worldwide, putting a large part of the population at risk [52]. This rise in summer temperatures is particularly exacerbated in urban areas due to the Urban Heat Island (UHI) phenomenon [53]. Regions like Southern Europe have seen a rise in global temperatures, and this trend is expected to continue [54].

The most common effect of high temperatures on the body is heatstroke [55] or hyperthermia, resulting in a range of severe symptoms such as confusion, dizziness, nausea, red and hot skin, rapid pulse, and loss of consciousness, as well as minor ailments like cramps or dehydration [56]. In addition to these effects, the cardiovascular system is affected by high temperatures, leading to increased heart rate and blood pressure. This can be especially problematic for individuals with pre-existing or chronic heart diseases [57].

Moreover, high temperatures significantly impact sleep quality, causing difficulty falling asleep and less restorative sleep, leading to long-term negative health consequences [58]. This can also affect cognitive function and mental performance, decreasing attention, memory, and decision-making ability during periods of extreme heat [59].

Regarding increased hospital admissions, several studies suggest that while daily maximum temperatures are more closely linked to deaths during heatwaves, it is the minimum temperatures during summer that better explain hospital admissions [60,61], as they indicate a longer exposure to heat. These hospital admissions are mostly associated with older adults, particularly those over 75, who are one of the most vulnerable groups to high temperatures [62].

Studies conducted in Northern Europe, such as one in Finland that evaluated the summer months of 2001–2017, found positive associations between heatwave days and admissions for myocardial infarction and cerebrovascular diseases [62]. Another study conducted in England with data from the hot summer of 2019 found an acute increase in hospital admissions, but the specific causes of these admissions could not be determined [63].

Another way to estimate the impact of the heat on human health is by the number of calls to ambulance services. During heatwaves, these calls also rise. A study in England found that the total number of heat-related symptomatic calls significantly increased (between 3.3 and 11.5% depending on the area) during the two heat episodes of 2003 [64]. Another study in Brisbane (Australia) concluded that the heatwaves occurring between 2000 and 2007 resulted in 18.8% (95% confidence interval (CI): 6.5%, 32.5%) more total ambulance attendances [65]. Additionally, another study in Sydney showed that during the 2011 heatwave, there was an increase in emergency service calls [66].

Regarding mortality, in the last two decades, several extreme heat events have been studied in relation to the excess mortality attributed to high temperatures: inAugust 2003, Europe experienced a massive heatwave that caused 50,000 additional deaths across the continent [67], hitting France particularly hard, where nearly 15,000 additional deaths were recorded in Paris alone between August 1 and 20 [68];during the summer of 2022, an estimated 61,672 heat-related deaths (95% CI: 37,643–86,807) occurred in Europe between May 30 and September 4 [69]. Many of these deaths are caused by the effects of O_3, the concentration of which increases with rising temperatures [70,71].

3.1.3. Noise

An increasingly recognized environmental issue is noise pollution, which refers to the presence of noise or vibrations in the environment that cause discomfort, risk, or harm to people, both auditory and non-auditory, affecting their activities [72]. This type of pollution, primarily caused by vehicular traffic, industrial activities, construction, and nightlife disturbances, has become a significant concern in modern cities [73].

Regarding auditory damage, exposure to intense noise (from 85 dB) can cause hearing loss due to the loss of sensory cells in the cochlea, which do not regenerate [72]. This condition can severely impact the ability to understand speech in everyday situations, affecting cognitive performance and increasing the risk of accidents and falls [72,74]. It is important to note that these high noise levels are not very common in cities, as they are more related to industrial areas.

The European Environment Agency estimates that prolonged exposure to environmental noise causes 12,000 premature deaths and contributes to 48,000 new cases of ischemic heart disease annually in Europe. Additionally, 22 million people suffer from chronic high-intensity annoyance, and 6.5 million people experience severe chronic sleep disturbances in Europe [75]. The most severe effects of noise on health, such as those affecting the heart and circulatory system and leading to premature mortality, are triggered by long-term physiological stress reactions and a reduction in sleep quality [72], and impact the metabolic system [76].

Noise can cause responses from both the endocrine system and the autonomic nervous system, affecting the cardiovascular system and becoming a risk factor for cardiovascular diseases. These effects begin to be observed with long-term daily exposure to noise levels above 65 dB or acute exposure to noise levels above 80–85 dB [77]. Acute noise exposure activates nervous and hormonal responses, leading to temporary increases in blood pressure, heart rate, and vasoconstriction [77]. In this regard, a study published in June 2009 [78] measured blood pressure and individual noise exposure simultaneously in a sample of 60 young adults (30 men and 30 women) and used linear mixed-effects regression models to evaluate the relationship. The study found that environmental noise exposure above 55 dBA may be associated with elevated ambulatory blood pressure, although the study is limited by its small sample size. The results suggest a possible gender difference, as the increase in blood pressure was higher in women than in men.

In the specific case of children, although noise levels generated by transport sources are usually very low to cause physical damage to the ear, it is well established that if exposure is prolonged and exceeds certain levels, noise can cause non-auditory health effects such as sleep disturbances, cardiovascular damage, stress, stroke, metabolic disorders, and cognitive impairment [72,79,80]. Specifically, in the school environment, one study found that exposure to traffic noise outside schools was associated with slower development of working memory and increased inattentiveness [81].

Table 1. Summary of the effect of the environmental parameters on the human body.

Parameter	Respiratory System	Cardiovascular System	Nervous System	Reproductive System	Excretory System	Others
Air pollution	Respiratory infections, cystic fibrosis, emphysema, and lung cancer [6–8]. Carcinogenesis, teratogenesis, and mutagenesis [9]. Intracellular calcium and inflammatory processes that may result in apoptosis or necrosis [10]. COPD, asthma, and complications in lung development in children [12,13].	Myocardial infarctions [14]. Endothelial dysfunction, platelet activation, and systemic inflammation, which are associated with a wide range of cardiovascular diseases, such as arrhythmias, ischemia, hypertension, and atherosclerosis [7].	Oxidative stress and neuroinflammation [15,16]. Stroke [15,19]. Neurodegeneration [29,30,35,36]. Declines in cognitive function in older adults [20,21].	Decreased fertility [37,38,40,41]. Decreased sperm quality [30,31]. Increased birthing complications [7,34]. Reducing pregnancy rates in the in vitro treatments [28,32,33]. Altering the placental exchange, impacting umbilical blood flow and the transport of oxygen and essential nutrients for fetal growth and development [34,35]. Cleft palate, cleft lip, and congenital heart defects have been observed in newborns exposed to high levels of pollutants like O_3 [39,40]. Decrease in respiratory volume by up to 2.7% with a 10 $\mu g/m^3$ increase in NO_2 concentration (children at 4.5 years of age) [41].	Kidney damage, including tubular dysfunction, reduced glomerular filtration rate, and an increased risk of kidney stones and renal cancer [10]. Developing ulcers and cancer in this system in older individuals [42].	Depressive behaviors [22]. Increasingly triggering a variety of allergies [43].
High temperatures	-	Heat stroke, cardiovascular problems and decompensation [55]. Increased heart rate and blood pressure [57].	-	-	-	Confusion, dizziness, nausea, red and hot skin, rapid pulse, and loss of consciousness, as well as minor ailments like cramps or dehydration [56]. Impact sleep quality, causing difficulty falling asleep and less restorative sleep, leading to long-term negative health consequences [58]. Mental performance, decreasing attention, memory, and decision-making ability during periods of extreme heat [59].
Noise	-	Temporary increases in blood pressure, heart rate, and vasoconstriction (above 65 dB) [77].	-	-	-	Loss of sensory cells in the cochlea, which do not regenerate (>85 dB) [72].

3.2. Positive Impact of Urban Design Parameters on Health

Urban design parameters impact directly and indirectly (through their collaboration in the improvement of environmental parameters) on the health of citizens. Table 2 summarizes these impacts.

3.2.1. Green Spaces

Firstly, green spaces have a direct impact on public health, as they can positively impact human well-being and reduce population morbidity [82]. Having green spaces in cities has a favorable impact on people's mental health, particularly for those who reside nearby. Recent research indicates that spending at least 120 min per week in natural environments is associated with significantly better health and well-being [83].

Numerous studies have shown that exposure to natural settings is associated with reduced stress [84,85], anxiety and depression [86,87], as the presence of vegetation and the tranquility provided by these spaces help calm the mind and improve mood [88,89], fostering social interactions, especially among older adults [90] and children [91,92].

Additionally, green spaces encourage physical activities [93], which various studies link to reduced obesity [94] and lower risks associated with diabetes (type 2) [95]. Along this line, studies conducted in China and Canada have found associations between green spaces and a reduction in cardiovascular mortality in urban populations [96,97]. Two recent studies conducted in Miami (FL, USA) among the population aged over 65 years found that high levels of green surface in neighborhoods were associated with a significant 20% reduction in stroke probabilities [98] and a strong inverse association with substantial reductions in the probabilities of various heart diseases as neighborhood green surface increased, suggesting that green spaces benefit cardiovascular health by mediating these risk factors [99].

Secondly, vegetation and green spaces have been shown to reduce atmospheric pollutant concentrations, particularly particulate matter (PM), varying based on scale, context, and vegetation characteristics. It has been estimated that urban vegetation coverage could decrease primary PM_{10} concentrations by 10% by increasing vegetation coverage from 3.5% to 16.5% in an urban area [100]. In Barcelona, a study examined the environmental benefits provided by the city's urban forests using the UFORE (Urban Forest Effects) model, finding that the 1,419,823 trees distributed across various land uses, such as urban forests, residential areas, and natural zones, removed approximately 305.6 tons of pollutants in 2008 [101]. Another environmental study conducted in Fuenlabrada (Madrid) using the same UFORE model, where 9.2% of its territory is covered by urban trees and green areas occupy 22.5% of the territory, estimated that in 2002, urban trees removed a total of 7969 kg of air pollutants [102]. This reduction in pollutants improves the health of the inhabitants and reduces hospital admissions related to air pollution. A study conducted in different US cities found that the population in city areas with more green space had 1.68% less hospital admissions than the downtown population, linking these results to a reduction in PM_{10} [103]. Similarly, a study conducted in Wuhan (China) found that in areas with low green space, each 10 $\mu m/m^3$ increase in $PM_{2.5}$ was associated with a 0.99% increase in total hospitalizations for cardiovascular diseases, while in areas with more green space, the increase in hospitalizations for cardiovascular diseases was 0.45% [104]. According to an Australian study, neighborhoods with more diverse green spaces had a 37% lower hospitalization rate for heart disease and stroke than those with less access to these areas [105].

Finally, green spaces contribute to reducing urban temperatures, as well. A recent study conducted in Australia found that increasing urban vegetation coverage in central Melbourne from 15% to 33% could reduce heat-related mortality rates by between 5%

and 28% [106]. Similarly, a study conducted in a Chinese city showed that having green spaces scattered throughout the city with distances of at most 800 m between them reduced urban temperatures, which was associated with a reduction in cardiovascular diseases in the population related to high temperature [107]. Along this line, a study conducted in 93 European cities (including nine Spanish cities: Bilbao, Barcelona, Palma de Mallorca, Madrid, Seville, Malaga, Valencia, Murcia, and Alicante) with data from 2015, concluded that 2644 premature deaths (equivalent to 1.84% of all summer deaths and approximately 39.5% of deaths attributable to UHI effects) could be prevented by increasing city tree cover to 30% [108]. However, during extreme events like heatwaves, although vegetation provides certain cooling advantages, its capacity to substantially mitigate extreme heat remains limited [109].

Regarding the influence that nature has on reducing urban noise, natural barriers can disperse and mitigate traffic noise, improving environmental quality and the livability of urban spaces [110], but there are not yet enough scientific studies that demonstrate this quantitatively.

3.2.2. Sustainable Urban Mobility

High-quality and sustainable urban mobility can positively impact human well-being and population health through direct and indirect means (improving environmental parameters).

Despite the scientific evidence, a large proportion of adults do not engage in sufficient physical activity to gain health benefits, increasing the risk of developing or exacerbating certain diseases such as type 2 diabetes, cardiovascular diseases, and some types of cancer [111]. Walking daily improves flexibility, strength, and endurance in the legs and promotes blood flow, helping to prevent edema and varicose veins and reducing the risk of osteoporosis and fractures. It can also improve the lipid profile by increasing levels of cholesterol (HDL) [112]. In fact, walking at least 30 min a day for five days a week increases life expectancy and reduces cardiovascular risk by up to 11% [113].

Although the willingness to engage in physical activity is influenced by numerous social and psychological factors, the availability, accessibility, and spatial configuration of public spaces play a crucial facilitating role. In this review, sports and transportation facilities are considered part of urban design, as they are integrated into the physical layout of the city and influence population behavior. This classification follows a widely accepted approach in the urban health literature, which frames parks, pedestrian areas, and transportation infrastructure as structural determinants of active lifestyles and equitable access to health-promoting environments [114].

Along this line, an international study in 14 cities found that cities with better walking and cycling infrastructure have populations with higher cardiovascular health indicators [115]. Another study found that interventions in the built environment that improve accessibility and safety for pedestrians and cyclists can increase weekly physical activity minutes per person by 16%, resulting in significant improvements in cardiovascular health and obesity rates [116]. The WHO recommends at least 150 to 300 min of moderate to vigorous-intensity aerobic physical activity per week for all adults [117]. To achieve this ratio, it encourages countries to adopt global guidelines to develop national policies that promote physical activity and mobility with the goal of reducing physical inactivity by 15% by 2030 [117].

Regarding mental health, commuting by bicycle or walking, compared to driving, is associated with lower stress levels and better psychological well-being [118]. Another study examining the impact of train commute duration on passenger stress found that longer travel times were associated with higher cortisol levels (a physiological stress marker), reduced ability to maintain focus on tasks requiring attention, and increased perceived stress among travelers [119].

In relation to the influence that urban mobility has on environmental parameters, interventions such as the one carried out in Pontevedra (Spain) is an example. The city council pedestrianized the streets in the historic center and those narrower than 10 m, widened sidewalks on streets wider than 10 m, set a maximum speed limit of 30 km/h, developed bicycle lanes, and installed free parking areas on the urban periphery. Therefore, after these interventions, the motor vehicle traffic was reduced by 30.1% in the city and 70% in the city center, show that walking has increased by 67% and emissions have been reduced to 500 kg of CO_2 per person per year [120].

Sustainable urban mobility policies have a significant impact on reducing urban noise, which in turn greatly improves the quality of life in urban areas. On the one hand, promoting the use of public transportation, cycling, and walking, through appropriate infrastructure, reduces the number of private vehicles on the roads and, therefore, noise [121]. Moreover, the promotion of electric vehicles results in a significant reduction in noise, as they are significantly quieter than internal combustion ones [122]. Furthermore, the incorporation of natural barriers and the strategic layout of roads can help disperse and mitigate traffic noise, thereby improving environmental quality and the livability of urban spaces [110].

To conclude the Results section, Figure 3 provides a conceptual summary that visually synthesizes the relationships between urban environmental parameters and their health impacts.

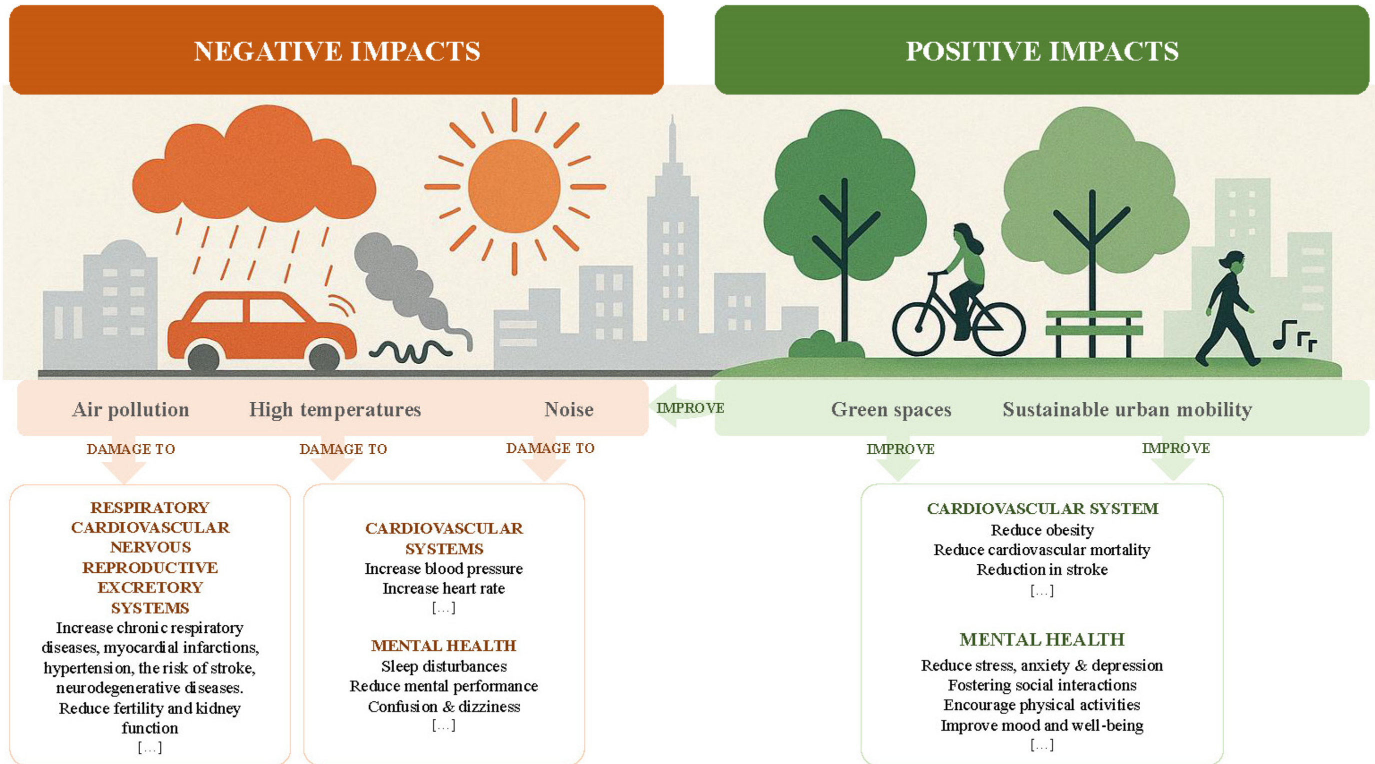

Figure 3. Conceptual overview of the relationships between environmental parameters and health outcomes.

Table 2. Summary of the direct and indirect impacts of urban design parameters in health.

Parameter	Direct Impact	Indirect		
		Air Pollution	**High Temperatures**	**Noise**
Green areas	Reduced stress [84,85]. Reduced anxiety and depression [86,87]. Improved mood [88,89]. Fostering social interactions, especially among older adults [90] and children [91,92]. Encourage physical activities [93]; therefore, reducing obesity [94] and lowering risks associated with type 2 diabetes [95]. Reduced cardiovascular mortality [96,97]. Reduction in stroke [98].	Decrease primary PM_{10} concentrations by 10% by increasing vegetation coverage from 3.5% to 16.5% in an urban area [100]. Population in city areas with more green space had 1.68% fewer hospital admissions than the downtown population, linking these results to a reduction in PM_{10} (21 major US cities) [103]. Each 10 $\mu m/m^3$ increase in $PM_{2.5}$ was associated with a 0.99% increase in total hospitalizations for cardiovascular diseases, while in areas with more green space, the increase in hospitalizations for cardiovascular diseases was 0.45% (Wuhan, China) [104].	Increasing urban vegetation coverage from 15% to 33% could reduce heat-related mortality rates by between 5% and 28% (Central Melbourne, Australia) [106]. 2644 premature deaths could be prevented by increasing city tree cover to 30% (93 European cities) [108].	Natural barriers can disperse and mitigate traffic noise, improving environmental quality and the livability of urban spaces [110].
Sustainable urban mobility	Can increase weekly physical activity minutes per person by more than 16%, leading to notable improvements in cardiovascular health and reduced obesity [116]. Lower stress levels and better psychological well-being [118].	Reducing CO_2 emissions: the motor vehicle traffic was reduced by 30.1% in the city and 70% in the city center, show that walking has increased by 67% and emissions have been reduced to 500 kg of CO_2 per person per year (Pontevedra, Spain) [120].	-	Reduces the number of private vehicles on the roads and, therefore, noise [121]. Promotion of electric and autonomous vehicles offers a notable reduction in noise, as these vehicles are much quieter than internal combustion vehicles [122].

4. Discussion

This literature review compiles the main findings on how air pollution, extreme temperatures, urban noise, green spaces, and urban mobility affect citizens' health. The presented studies show that these parameters have a significant impact on health, ones in a negative (air pollution, extreme temperatures, and urban noise) and others (green spaces and urban mobility) in a positive way. This classification (negative and positive impacts) does not imply that environmental factors are exclusively harmful or that urban design elements are purely beneficial. Instead, the review is structured to reflect the predominant direction of health impacts reported in the majority of the literature.

On the one hand, this literature review reveals that air pollution is the parameter most studied in relation to its impact on health (41% of the articles reviewed), followed by green spaces (23% of the papers reviewed). On the other hand, significant research gaps have been identified in relation to noise and urban mobility, with significantly fewer studies analyzing their influence on people's health.

Regarding regulations, air pollution stands as the one with the most extensive regulatory development among all parameters analyzed. At the international level, the WHO developed the Global Air Quality Guidelines in 2021 [123], with the general aim of providing health-based quantitative recommendations for air quality, expressed as long- or short-term concentrations of a range of key atmospheric pollutants. Exceeding the air quality guideline levels is associated with significant public health risks. These guidelines are not mandatory; however, they offer countries an evidence-based tool that can be used to inform legislation and policies. The European Union (EU) also sets air quality standards for different air pollutants through the Directive 2008/50/EC [124]. Table 3 shows a comparison of air quality standards established by both regulations.

Table 3. Air quality standards according to European regulations and WHO guidelines.

Pollutant	European Regulation [124]	WHO Guidelines [123]
Sulfur dioxide (SO_2)	125 $\mu g/m^3$ 24-h concentration	40 $\mu g/m^3$ 24-h concentration (i.e., 3–4 exceedance days per year)
Nitrogen dioxide (NO_2)	40 $\mu g/m^3$ annual concentration	10 $\mu g/m^3$ annual concentration 25 μg/m3 24-h concentration (i.e., 3–4 exceedance days per year)
Ozone (O_3)	120 $\mu g/m^3$ 24-h concentration	100 $\mu g/m^3$ 8-h concentration (i.e., 3–4 exceedance days per year)
Carbon monoxide (CO)	10 $\mu g/m^3$ 24-h concentration	4 $\mu g/m^3$ 24-h concentration (i.e., 3–4 exceedance days per year)
Particulate matter (PM_{10} y $PM_{2.5}$)	PM_{10}: 40 $\mu g/m^3$ annual concentration $PM_{2.5}$: 20 $\mu g/m^3$ annual concentration	PM_{10}: 15 $\mu g/m^3$ annual concentration 45 $\mu g/m^3$ 24-h concentration (i.e., 3–4 exceedance days per year) $PM_{2.5}$: 5 $\mu g/m^3$ annual concentration 15 $\mu g/m^3$ 24-h concentration (i.e., 3–4 exceedance days per year)
Metals (Pb, As, Cd, Ni)	Pb: 10 $\mu g/m^3$; As: 6 ng/m^3; Cd: 5 ng/m^3; Ni: 20 ng/m^3	-
Organic gases (C_6H_6, B(a)P)	C_6H_6: 5 $\mu g/m^3$	-

However, when it comes to the regulation of green spaces—despite being a widely studied topic—the situation is different. There is no international consensus or established regulatory standard that defines a minimum ratio of green spaces in cities. Currently, it is worth mentioning the 3-30-300 rule [125], which has recently been proposed as a planning guideline to promote access to urban greenery and vegetation coverage at multiple scales. This rule establishes three ratios: (i) The ability to see at least three trees from home, emphasizing the importance of neighborhood-level vegetation:being able to see trees from one's residence can provide a more pleasant environment and a sense of connection to nature, even without direct access to a park. (ii) Thirty percent of tree canopy coverage in the neighborhood. a minimum level of tree canopy in the neighborhood significantly contributes to reducing the urban heat island effect, improving air quality, and providing shade and recreational spaces. (iii) A distance of 300 m to a park:proximity to parks and larger green areas allows people easy access to recreational spaces, sports, and outdoor activities.

In relation to urban noise, something similar occurs, where there is no consensus on its regulation. After our review, it can be suggested that regulatory policies should prioritize the non-auditory effects of noise on health, promoting ambitious strategies to ensure values below 65 dBA.

Regulation regarding noise and mobility in Europe is also more limited compared to air quality regulation, although the health impacts of noise pollution and urban mobility patterns are increasingly recognized. This difference can be attributed partly to the historical trajectory of evidence. The adverse health effects of air pollution were documented earlier and with stronger quantitative data, leading to earlier regulatory action. In contrast, evidence regarding noise and mobility impacts has emerged more recently and often presents greater challenges in measurement and standardization across diverse urban contexts. Furthermore, regulating noise and mobility typically requires profound transformations in urban infrastructure and transportation systems, which can face substantial political, economic, and social resistance.

In addition, it is important to highlight that the health effects of the studied environmental parameters are especially notable in vulnerable populations, which are [126–132]: people over 65, children, women (especially pregnant women), people with chronic illnesses, people overexposed to the environment (outdoor workers, those who exercise outdoors, inhabitants of the most deprived and congested urban areas, etc.), households in energy poverty or with limited economic resources, and people living in energy-inefficient buildings.

Among all the parameters analyzed, specific solutions targeting vulnerable groups were found only in relation to high temperatures and some cities have already implemented actions such as the establishment of cooling centers during heatwaves. For the other environmental parameters, there is a lack of specific actions addressing the needs of vulnerable populations.

After assessing all the research, three lines of action could be developed in the urban environment for their improvement and, consequently, for the improvement of people's health:

- The first action is to *renaturalize cities*. This involves transforming unused urban spaces, such as courtyards or squares, into green areas and parks, promoting green roofs, reducing the use of asphalt and concrete, and implementing sustainable drainage systems. Additionally, it encourages planting trees, developing river parks, and creating green corridors for pedestrians and cyclists. It is essential to select tree species that are appropriate for the local climate, avoiding issues like allergies or excessive water demands, and promoting biodiversity to enhance ecological resilience.

- For example, the Montreal (Canada) case study where the 3-30-300 rule is evaluated [133].
- The second action is to *promote sustainable mobility*. This can be achieved by encouraging active transportation through the concept of "15-min cities," where essential services are within walking or cycling distance. It also includes pedestrianizing streets, developing bicycle lanes, reducing speed for traffic in some urban zones, investing in efficient and sustainable public transport, improving traffic management, and promoting the use of sustainable vehicles. This can be supported by offering incentives for the purchase of electric vehicles, developing charging infrastructure, and establishing low-emission zones with restrictions for polluting vehicles.
- For Example, the Plan Vélo in Paris, which has implemented more than 1000 km of bike lanes, has achieved a significant reduction in car use and an improvement in active mobility in the city [134]. And the superblock plan in Barcelona, an innovative urban planning and transport strategy aimed at reclaiming public space for people, has reduced motorized traffic and improved both health and urban quality of life [135].
- The third action focuses on *promoting management and education tools*. This includes the development of a geographic information system (GIS)-based tool, to diagnose specific urban problems and apply solutions effectively. It also involves monitoring air pollution and temperatures to evaluate and adjust the implemented measures. Promoting epidemiological studies to assess the impact of these actions on public health is also crucial. Finally, educating and raising awareness among all stakeholders, from policymakers to citizens, about the benefits of these measures for public health is essential for their success.

In addition to quantifying the influence of different parameters on public health impact, another objective of the study was to draw attention to the need for further research on this topic, which involves an advance in the study of underexplored variables such as blue spaces [136], urban morphology [137,138], land use [139,140], and local climate zones [141].

Future research could expand this review by analyzing other environmental parameters that negatively impact human health. In particular, light pollution warrants an urgent study due to its growing prevalence in urban areas and its associations with sleep disorders, circadian rhythm disruption, and mental health issues. Water management is also particularly relevant, especially in coastal cities, where significant knowledge gaps remain. Other urban design elements—such as the three-dimensional spatial morphology of cities, two-dimensional land use patterns, and the organization of spaces for production and daily living—could also be explored for their effects on the urban environment and public health.

Moreover, it would be valuable for future research to address this issue through a holistic and interdisciplinary approach (involving policymakers, urban planners, physicians, sociologists, psychologists, etc.) that integrates both qualitative and quantitative evidence and includes more diverse regions in terms of climate, social, and economic contexts at a global level. Furthermore, to better understand the impact of heatwaves and air pollution on health indicators (such as mortality and morbidity), future research could compare results from rural areas and cities.

5. Conclusions

Urban environment plays a crucial role in people's health, directly influencing their physical and mental well-being. This article presents a literature review with the aim of illustrating the influence that air pollution, extreme temperatures, noise, green spaces, and urban mobility have on human health in urban environments.

Among all the parameters analyzed, air pollution is the one with the greatest number of studies on its impact on health, which has led to greater knowledge of its effects on the different systems of the human body. Particularly noteworthy are its repercussions on the respiratory, cardiovascular, and reproductive systems. In contrast, this review of the literature reveals important gaps in research on other factors such as urban mobility and noise. In terms of regulation, although progress has been made in the development of standards, it is essential to continue strengthening them and raising their level of stringency.

Urban design plays a crucial role in improving urban environments, with green spaces and sustainable urban mobility being key elements to improving these parameters. It has been demonstrated that cities that prioritize the creation of parks, gardens and green corridors, along with the development of sustainable transportation networks, experience improvements in air quality, reductions in temperatures, and noise mitigation. These interventions not only transform the urban landscape, but also directly contribute to the physical and mental well-being of citizens.

Moving forward, urban planners, public health officials, and policymakers must collaborate to adopt an integrated approach that embeds health equity, climate justice, and intersectionality into urban development. Special consideration should be given to vulnerable populations who often face the compounded effects of environmental hazards and social inequities. Designing cities that are not only greener and quieter, but also more just and inclusive is essential to building healthier, more resilient communities in the face of climate and public health challenges.

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