

Mini Review

Challenges and Opportunities in Preventing Cardiovascular Disease Within the Built Living Environment

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Abstract: Cardiovascular health is shaped not only by biological factors but also by the environments in which people live. Specifically, the built living environment, comprising human-made surroundings that form the backdrop for daily activities, has been associated with inhabitants' engagement in physical activities, dietary habits, social connections, as well as overall sense of safety and quality of life. This review explores the challenges and opportunities for preventing cardiovascular disease within the built living environment, from a public health perspective.

Keywords: environment; built environment; cardiovascular disease; metabolic disease; public health

1. Introduction

Cardiovascular health is influenced not only by biological factors, but also by the environments in which people live. Heart-related environmental stressors associated with human activities include, built environment, air and noise pollution, light disturbance at night and climate change.

Accumulating evidence during the past years suggest that the built living environment significantly influences cardiovascular health, as well as other related metabolic disorders, i.e., obesity, diabetes, hypertension and hypercholesterolemia, affecting factors like access to healthcare, lifestyle behaviors, stress levels, and exposure to environmental hazards [1]. Several pathophysiological mechanisms have been suggested, including the promotion of inflammation and oxidative stress, metabolic dysregulation, vascular injury, and hormonal imbalances. Additionally, increased chronic stress activates the hypothalamic-pituitary-adrenal axis, resulting in elevated cortisol and other stress hormones, which subsequently raise blood pressure, heart rate, and trigger arrhythmias [1].

Understanding the complex interactions between the environment and cardiovascular health can guide public health policies and interventions aimed at reducing the burden of cardiovascular diseases (CVD) globally. Particularly, the built living environment, which consists of human-made surroundings that shape the setting for daily activities, has been linked to inhabitants' movement and physical activity, dietary choices, social interactions, and overall safety and security [2].

In this review, challenges and opportunities in preventing cardiovascular disease within the built living environment, under the perspective of public health are presented and discussed.

2. Built Living Environment and Cardiovascular Disease Threats: Understanding the Problem

Built living environment refers to all human-made spaces in which people live, work, and recreate. This environment is defined by human-designed, constructed, and maintained structures and infrastructure, often with little consideration for the surrounding natural environment and other species that inhabit it. It includes residential buildings, like houses, apartments, and other forms of housing, infrastructure (roads, sidewalks, public transportation systems, etc.), public spaces, like parks, playgrounds, and other communal areas for public use and



enjoyment, commercial and industrial buildings, public and private institutions and public service facilities, like hospitals, universities, schools, government buildings, libraries, places of worship, recreational facilities that include sports complexes, gyms and pools, as well as cultural spaces such as theaters and museums, and green infrastructure (i.e., urban forests, community gardens, stormwater management systems, and other elements that integrate nature into the built environment) [2].

A number of studies published the past few years have revealed that the built environment includes physical elements that can substantially affect health-related lifestyle choices, i.e., nutrition and physical activity, as well access to health-promoting resources [1,3–5]. Easy access to nutritious food is a crucial component of a health-friendly built environment, directly influencing inhabitants' health and overall well-being. Accumulating research has shown that neighborhoods with grocery stores, farmers' markets, and other sources of fresh, nutritious foods enable individuals to make healthier dietary choices [3–5]. An analysis of retailer data within the vast U.S. food environment literature showed that a range of socio-ecological factors affect retailers' decision-making and their readiness to adopt marketing-mix and choice-architecture strategies aimed at encouraging healthier consumer choices and enhancing dietary quality. These factors include inconsistent training outcomes aimed at improving retailers' knowledge and skills, limited trust, differing perspectives on marketing-mix strategies, consumer demand and demographics, supplier and store management dynamics, and the influence of local and federal policies that support community health [3]. In a large-scale European cohort study that followed participants for 20-years (2002–2022), the ATTICA study, it was revealed that areas more extensively covered by green urban spaces and sports facilities were shown to have lower prevalence of CVD and related metabolic disorders, while greater density and availability of supermarkets and street markets were inversely related to cardiometabolic disorders' prevalence in both males and females. Furthermore, it was found that the positive impact of health-promoting built environment features on the prevalence of cardiometabolic disorders was more pronounced in males, while the preventive effect of food-related environmental factors was stronger in females [4]. One potential explanation for these findings could be related to behavioural, socioeconomic, cultural and biological differences in how males and females interact with their built environment and how they respond to health-promoting features and food-related factors.

It is now well appreciated and documented that urban planning should emphasize ensuring affordable, healthy food is accessible within walkable distances, promoting better nutrition and supporting the overall health of the community. In contrast, areas lacking these options, often referred to as “food deserts”, push residents towards processed and fast foods, increasing the risk of obesity, diabetes, and cardiovascular diseases. Since 2010s research has shown that “food deserts” significantly contribute to poor dietary habits, such as consuming processed foods high in salt, sugar, and unhealthy fats, leading to higher rates of obesity, diabetes, hypertension, hypercholesterolemia and, consequently, heart disease [6]. Additionally, food swamps, i.e., neighborhoods with an overabundance of fast-food outlets and convenience stores (also known as a corner store), have shown that encourage unhealthy eating habits. Thomas and Cankurt [7], performed a quasi-experimental study to investigate the impact of two different scenarios of food environments on food choices, i.e., a food environment lacking in healthy options and signals that promote healthier choices, contrasted with an environment rich in nutritious food options. The results indicated that participants in the second scenario were over four times more likely to choose healthy foods compared to those in the first scenario [7]. In another study conducted in 3108 counties in the US, geographically weighted regression models showed that food deserts exposure was positively associated with obesity and diabetes in some counties, while density of fast-food restaurants had positive association with both diseases in some other counties of western New York [8]. Therefore, scientific evidence support that built living environment is strongly associated with residents' food choices, and nutrition-related diseases.

Another major issue regarding the impact of the built living environment on health is its influence on opportunities for physical activity. Accumulating evidence shows that neighborhoods with sidewalks, parks, and recreational facilities encourage physical activity [2]. Based on a systematic literature search across several databases to identify studies exploring the associations between built environment characteristics, and physical activity levels, published between 2000 and 2022, Hoyer-Kruse et al. [9] revealed that access to parks and natural areas has been shown to encourage physical activity, reduce chronic stress, and improve overall well-being, all of which benefit heart health. Müller et al. [10] in a systematic review of 51 quantitative and 19 qualitative relevant studies, concluded that well-designed urban environments that prioritize pedestrian safety, reduce traffic congestion, and minimize noise pollution seems to enhance heart health by reducing stress and encouraging active lifestyles. On the contrast, dependence on cars and lack of public transit options can limit opportunities for active transport (e.g., walking or cycling), contributing to sedentary lifestyles.

Built environment has also been strongly associated with air pollution, because urban development, infrastructure, and transportation systems contribute to the generation and high concentration of pollutants. Dense

traffic, industrial activities, and the design of cities often lead to increased emissions of harmful substances like carbon dioxide, nitrogen oxides, and particulate matter (PM). Of the many components of ambient air pollution, PM is the strongest driver of cardiovascular risk and adverse heart outcomes [2]. Strong evidence suggests that excess mortality associated with particulate matter 2.5 mm (PM_{2.5}) exposure is 10- to 20-times higher than other hazardous air pollutants. Short-term exposures (i.e., even few hours/day) to high concentrations of PM_{2.5} have been associated with acute heart outcomes, such as myocardial infarction, likely because they trigger acute plaque rupture [11]. Animal models and in vitro experiments support the aforementioned epidemiological observations suggesting mechanisms of toxicity that include oxidative stress that triggers vascular endothelium dysfunction and inflammation [12–14].

3. Interconnection between Social and Built Environment

The impact of social component on human health has been acknowledged for decades, with low socio-economic status populations experiencing higher all-cause, and cause-specific (e.g., CVDs, cancer, infections) mortality rates. Additionally, the social and built environments are closely intertwined, frequently reinforcing each other in ways that can either promote or detract from heart health. Low-income neighborhoods are often marked by built environments that are less conducive to health, with fewer green spaces and parks, a higher concentration of fast-food outlets, and poorer air quality. These factors contribute to elevated rates of heart disease and other health issues.

Gentrification, which involves wealthier individuals moving into a previously lower-income neighborhood and driving urban renewal and redevelopment, is also a factor that impacts the built living environment. Relatively new research has shown that gentrification, while it can improve the built environment by adding amenities like parks and healthier food options, it can also displace long-term residents, leading to increased stress and loss of social networks, which negatively impact heart health [15].

Understanding and appreciating this interconnection between social and built environment is crucial for addressing various public health challenges, including those related to cardiovascular health.

4. Challenges and Opportunities in Preventing Cardiovascular Disease Within the Built Living Environment

Preventing CVD within the built living environment is a complex and challenging task (see Figure 1). To mitigate the impact of social and built environments on heart health, public health interventions and policies must address several factors, some of them having significant political cost and consequences.

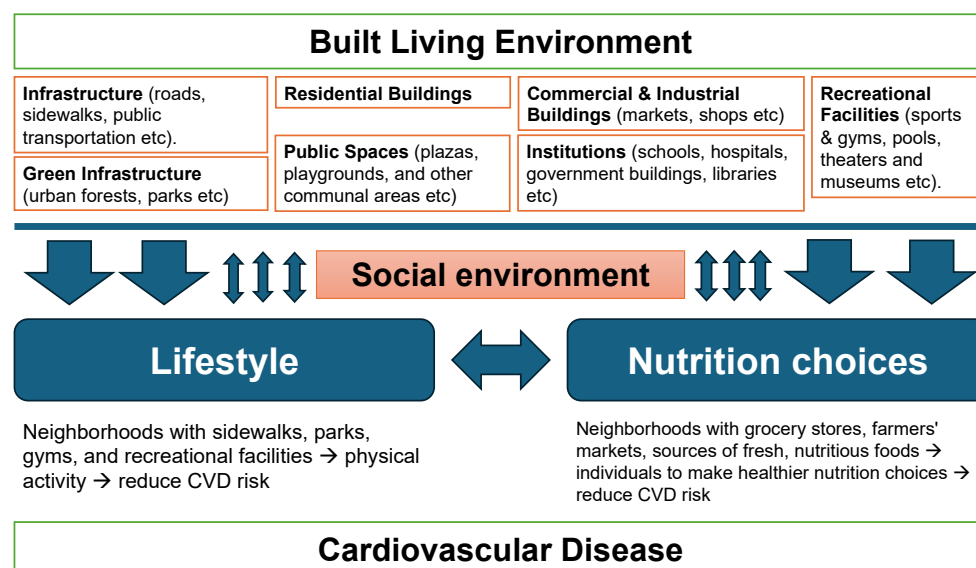


Figure 1. years after publication (preferably via an institutional or subject-based data repository or other data center), provided that the confidentiality of the participants can be protected and legal rights concerning proprietary data do not preclude their release. In instances where novel data were not generated or data remains inaccessible due to privacy or ethical considerations, a clear statement outlining these circumstances is mandatory.

Policymakers should prioritize developing strategies that go beyond providing physical access and consider social aspects of the environment in promoting healthy eating habits to improve public health and bolster the food security of communities. Affordable housing and economic development are another major issue. Investment in affordable housing to reduce stress and provide stability, are crucial for maintaining good cardiovascular health. Economic development initiatives that create jobs and increase income levels can also reduce the health disparities seen in lower socio-economic status communities. Urban planning and built zoning should be a major target, as both they promote walkable cities, accessible public transport, and green spaces. Implementing urban planning policies to limit the density of fast-food outlets and encourage grocery stores with healthy options, can lead to better, for heart health, food choices. Air quality regulations by strengthening environmental policies to reduce pollution and improve air quality, is also vital for protecting cardiovascular health, particularly in urban and industrial areas.

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Conflicts of Interest

The author declares no conflict of interest.

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