

The Effect of Urbanization-Related Built Environment on Global Cardiovascular Health

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ABSTRACT:

Background

This review focuses on the global significance of cardiovascular diseases (CVDs) and the determinants of a higher CVD risk. Due to the lack of existing reviews that have explored these determinants on an international scale, this review aims to examine the effect of urbanization, including neighborhood characteristics, air pollution, and fast food accessibility worldwide.

Methods

This literature review searched Google Scholar and Pubmed for academic articles published since 2015. This search was focused on original research that evaluated the correlation between neighborhood features, air pollution, and fast food on CVD risk, and the search ultimately concluded with five relevant articles which met specific inclusion and exclusion criteria.

Results

Violent crimes, noise pollution, and proximity to major roads were all associated with increased risk of CVD, with noise pollution and proximity to roads resulting in 225% and 286% increases in risk of CVD and myocardial infarction respectively. Increased air pollution was also associated with increased odds of CVD, as increasing NO₂ content by 10 parts per billion resulted in a diabetes odds increase of 16%. The correlation between fast-food restaurant proximity and CVD risk was inconclusive.

Discussion

Correlations between neighborhood features and air pollution with CVD risk are evident from the results, but this review is limited by its scope, considering two urban areas per correlation. It is in lawmakers' best interest to attempt to pass laws to lessen the effect of noise pollution and improve proximity to public transit, as these factors will help lessen CVD risk. Further research is required to explore these correlations on a larger, more global scale, and there is a need for more longitudinal studies concerning fast food and CVD risk.

INTRODUCTION:

Non-communicable diseases (NCDs) remain the leading cause of death across the world, and their global mortality rates are steadily increasing [1]. In this global health threat, cardiovascular diseases (CVDs) consistently play the biggest role, with overall cases doubling in the last 20 years [2]. The rising prevalence of CVDs not only results in more danger to public health, but it also has negative financial implications; according to the World Heart Federation's estimates, "the global cost of CVD will rise from roughly \$863 billion in 2010 to \$1044 billion in 2030" [2]. As the impact of CVDs remains a significant issue in our ever-changing world, it is important to better understand how health determinants may affect the risk of CVDs and how we may improve our strategies to address these diseases.

In recent scientific literature, several reviews have been conducted to help understand the determinants for CVDs in isolated groups, often citing lifestyle behaviors, access to healthcare, and financial situation as common areas for improvement [2, 3]. Therefore, these factors are important in assessing the risk for CVD in any population. However, few reviews have analyzed the determinants of CVDs on an multinational scale, comparing different populations in their respective environments. When looking on an international level, across nations and cultures worldwide, one trend is clear: the world continues to urbanize. As a result, the effects of urbanization require consideration and review in the realm of CVD risk.

Increased urbanization ultimately has several important implications concerning the risk of CVDs, these being notably increasing air pollution, noise pollution, and fast food accessibility and consumption. Due to these imminent trends, it is paramount to understand how these determinants affect CVD risk on an international basis. For instance, the rise in global urbanization is clear and predictable. According to the United Nations 2018 World Urbanization Prospects, 55% of the world's population already lives in urban areas, and by the year 2050, this number is estimated to rise to 68% of the world's population [4]. Increased urbanization follows suit with an increase in fast food restaurant density and consumption, as the proportion of fast-food related calories consumed by children and adolescents increased from 10.6% in 2009–2010 to 14.4% in 2017–2018 [5]. Increased urbanization also generally involves an increase in air and noise pollution [4]. Considering these effects will occur on a worldwide scale, the aim of this literature review is to fully assess the effect of the built environment on cardiovascular health on an international level; specifically, this review covers the worldwide effect of air pollution, infrastructure, and fast food on the risk of CVD.

METHODS:

In this literature review, Google Scholar and Pubmed were both searched for recent academic articles published in 2015 or later. Academic publications were deemed viable for review under the condition that they involved original research; inclusion criteria required a study design of investigation of quantitative correlation between exposures and outcomes.

Inclusion criteria also included exposures of measured or identified facets of built environment, including neighborhood factors, fast food accessibility, and air pollutant measures, along with outcomes of measured cardiovascular health. Exclusion criteria for this literature review excluded any design of comprehensive literature review papers associated with built environment and cardiovascular health. Key search terms were also used in each search engine's query—specifically, the terms built environment, fast food restaurant density, air pollution, cardiovascular disease, cardiovascular health, and CVD. Data was then obtained from a series of five relevant articles which matched the previous criteria, with a focus on the correlation between built environment and cardiovascular health on a global scale. Finally, the review considered other reputable sources to provide necessary background information about global trends and cardiovascular health.

RESULTS:

Neighborhood Characteristics and Infrastructure

One study carried out by Chum and O'Campo attempted to comprehensively investigate the link between neighborhood factors and cardiovascular diseases in Toronto, Canada discovering that—when adjusted for neighborhood income and environmental characteristics—their data suggest exposure to violent crimes, environmental noise, and proximity to major roads were associated with increased odds of CVDs [6]. Specifically, researchers were able to discover that individuals living in the quartile with the lowest rate of violent crime were on average 13% less at risk for myocardial infarction (MI) [6]. The researchers also discovered that respondents who reported “strongly agree” to being disturbed by noise at home were on average 225% more at risk of CVD while those who responded “disagree” were on average at 21% lower risk of CVD [6]. Furthermore, individuals living within 100m of a major road are on average 286% more at risk for MI [6]. In a different study, which investigated the effect of neighborhood walkability on hypertension and diabetes risk in Ontario, Canada, Howell et al. discovered that individuals living in the lowest walkability areas were 28% more at risk for hypertension and have 25% greater odds of having diabetes compared to those living in the highest walkability areas [7]. Moreover, in another study conducted by Lee et al. in Korea, a farther distance from public transit was associated with increased odds of heart attack [8], as the second farthest and farthest thirds from public transit were at a 41% and 22% greater risk of MI when compared to the group closest to public transit [8].

Air Pollution

Alongside walkability, Howell et al. also attempted to investigate the effect of traffic-related air pollution on hypertension and diabetes risk. The study discovered that traffic-related air pollution can predict the risk of hypertension and diabetes, associating higher traffic-related air pollution with higher odds of both diseases' risk; for every 10 parts per billion (p.p.b) unit increase in nitrogen oxide (NO₂), the odds of having hypertension increase by 2%,

and the odds of diabetes increase by 16% [7]. In another study conducted in the United Kingdom, Wang et al. discovered a 67% higher frequency of incident heart failure (HF) in the highest air pollution quintile when compared to the lowest air pollution quintile [9].

Fast Food

Poelman et al. attempted to analyze the correlation between fast-food restaurant density and risk of CVDs in the Netherlands [10]. In street network-based buffers of 500m, 1000m, and 3000m around residential addresses, the study discovered that the frequency of stroke, coronary heart disease (CHD) and HF was higher within 500m buffers with at least one fast-food restaurant, as well as within 1000m buffers [10]. In urban areas, individuals living in 500m buffers with 2 fast food restaurants are 6% more at risk of stroke, 13% more at risk of CHD, and 15% more at risk of HF [10]. However, in Korea, Lee et al. discovered that living in areas with high concentration of fast-food restaurants was associated with a decreased risk of stroke, as the second highest and highest fast food density thirds were 42% and 36% less at risk of stroke, even when accounting for multivariable analysis [8].

Table 1: Article Descriptions

Article	Purpose	Independent Variable	Dependent Variable
Cross-sectional associations between residential environmental exposures and cardiovascular diseases	Attempted to comprehensively investigate the link between various neighborhood factors and CVDs in Canada.	Violent crimes Housing requiring major repairs Traffic exposure Noise level perception Neighborhood socioeconomic status	Self-reported history of physician diagnosis of myocardial infarction (MI), angina, coronary heart disease (CHD), stroke, and congestive heart failure (CHF)
Interaction between neighborhood walkability and traffic-related air pollution on hypertension and diabetes: The CANHEART cohort	Attempted to investigate the effect of neighborhood walkability and traffic-related air pollution on hypertension and diabetes risk in Canada.	Walkability exposure Traffic-related air pollution	Hypertension Diagnosis Diabetes Diagnosis
Objectively Measured Built Environments and Cardiovascular Diseases in Middle-Aged and Older Korean	Attempted to assess the association between the built environment and CVDs.	Population density Fast-Food restaurant density Proximity to Public Facilities, Parks, and Public Transit	A self-reported history of a physician's diagnosis of conditions such as hypertension, diabetes, dyslipidemia, stroke, MI, or angina

Adults			
Joint exposure to various ambient air pollutants and incident heart failure: a prospective analysis in UK Biobank	Aimed to investigate the relationship between long-term exposure to ambient air pollutants and incidence of heart failure in the United Kingdom.	Air Pollution Exposures	Self-reported information and hospital inpatient records of prevalent heart failure and incident heart failure
Relations between the residential fast-food environment and the individual risk of cardiovascular diseases in the Netherlands: A nationwide follow-up study	To analyze the correlation between fast-food restaurant density and risk of CVDs in the Netherlands.	Fast-Food Outlet Density (FFD)	Incidence of CVD, CHD, stroke, and CHF

DISCUSSION:

Findings and Interpretations

After analyzing the data, it is apparent that the built environment does correlate with CVD risk. A primary aspect of an individual’s built environment is the residential neighborhood and its characteristics or infrastructure. In a study based in the urban environment of Toronto, Canada, researchers found that less exposure to crime was linked with a lower risk for MI [6]. In the same study, researchers also discovered that increased noise pollution and proximity to a major road was correlated with a significantly increased risk of CVD [6]. Another study based in Ontario, Canada also discovered that lower walkability was associated with higher odds of hypertension and diabetes [7]. In a different study, it was discovered that individuals living farthest away from public transit had a greater risk of MI in the urban Gyeonggi Province in South Korea [8]. These results all generally meet the expectations of current scientific literature regarding built environment and CVD risk, and they reaffirm the notion that built environment—across the world—is in fact a factor which has significant implications on cardiovascular health [11].

Air pollution was further found to be a driving force behind the risk of CVD in urban areas, with correlations confirmed on a worldwide basis by both studies in Ontario, Canada and the United Kingdom. In the Ontario-based study, even a miniscule increase in the ppb content of NO₂ was associated with a direct increase in odds of hypertension and the odds of diabetes, and in the United Kingdom, higher air pollution was linked with a significantly higher frequency of HF [7, 9]. These results confirm the existing literature that suggests that air pollution exposure is associated with cardiovascular disease risk [9].

The correlation between fast-food restaurant density and CVD risk was not nearly as straightforward. In the Netherlands, a study discovered that the proximity of one's residence to a fast-food restaurant was correlated with marginally increased risk of stroke, but a significantly higher risk of CHD and HF [10]. However, a study in Korea determined that living in an area with high concentration of fast-food restaurants was correlated at significantly lower risk of stroke, even when accounting for several other factors [8]. These conflicting results are surprising, as current scientific literature suggests that fast food's high saturated fat content can increase diabetes and obesity risk while its high salt content can raise blood pressure, thereby negatively impacting cardiovascular health [12]. While this trend holds true in the Dutch study, it may not hold entirely in the Korean study because fast-food density may not necessarily be associated with fast-food consumption among Koreans [8].

Implications and Limitations

As evidenced by the results, there is clearly a correlation between certain neighborhood factors and CVD and between air pollution and CVD. These correlations are evident among different populations on different continents, ranging from Canada, the United Kingdom, and Korea. It is safe to assume, therefore, that these correlations may be present on a global scale and require the attention of policymakers. When factoring the rapid rate of urban sprawl, many of these neighborhood factors will become more exaggerated over time [4]. Overall, these correlations may appear evident among two populations, but the claim that these correlations appear on a global scale is limited by the scope of the study, having only considered two urban populations per correlation. Furthermore, when considering fast food, it appears that fast-food restaurant density alone is not a substantial prerequisite for increased CVD risk among all populations, and again these claims are limited by the scope of the study. However, the findings of this review do not call into question the original belief that increased fast-food *consumption* is related to increased CVD risk [12].

One potential explanation for these correlations could be exercise as a mediating role. For example, in neighborhoods with lower crime rate and higher walkability, individuals would likely feel a greater propensity to exercise, which has been linked with improved cardiovascular health [13]. Pointing out such trends of which specific factors lead to a risk of CVD is nonetheless important, as it increases policymakers' and individuals' awareness of the risk factors behind CVD and allows for more efficient resource allocation, which can improve healthcare costs and facilitate research in specific areas.

Applications and Future Research

Considering the correlations between neighborhood factors and air pollution with heightened CVD risk, it is in legislators' best interest to attempt to curb the effect of these factors. For example, lawmakers can opt to bring about stricter laws regarding noise pollution and improving accessibility to public transit, which have a significant effect on citizens'

cardiovascular health. Policymakers may also find it in their best interest to invest in stricter environmental protection laws, especially concerning air pollution as our world continues to urbanize. Curtailing the effect of air pollution will significantly improve citizens' cardiovascular health, as long-term air pollutant exposure is a significant threat to public health worldwide [11].

Given the scope of this review, exploring the effect of neighborhood factors and air pollution in two urban areas each, further research is required to confirm claims that these correlations with CVD risk are in fact global trends. Potential grounds for future research would include a larger sample size of urban areas to consider, to better determine the worldwide presence of such trends. In addition, due to the unexpected finding regarding the correlation between fast-food and CVD, there is a need for further longitudinal studies attempting to explore the relationship between these two variables in the future.

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