Greenspace and Cardiovascular Disease: The grass is not always greener

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ABSTRACT

Background: Environmental factors have been associated with cardiovascular disease prevalence. The amount of greenspace is one of those factors that has been studied.
Objective: Greenspace has many nuanced effects on cardiovascular disease. The purpose of this study was to look at current literature on greenspace and cardiovascular disease and see what are the consistent and inconsistent correlations.
Methods: A review of recently published articles was conducted and data and experimental methods to correlate greenspace and cardiovascular disease were compared.
Results: This showed that type of greenspace (for example, trees) and additional pollutants such (for example, particulate matter) had a bearing on the correlation between the amount of greenspace and amount of cardiovascular disease. The vulnerability of the population being affected also had a correlation with the results.
Conclusion: Further research is necessary to look into the nuances of greenspace variables rather than simply conclude that all increases in greenspace is beneficial to cardiovascular health.

INTRODUCTION

Cardiovascular disease is the number one cause of mortality worldwide [1]. Hypertension, hypercholesterolemia, chronic kidney disease, obesity, smoking, male gender, older age, and hereditary diseases “are risk factors that increase the likelihood of cardiovascular disease” [1]. Normally physicians treat individual patients with these risk factors to reduce these chances of developing major cardiac events. However, it is becoming increasingly recognized that factors beyond the control of the individual patient or physician play a large role in cardiovascular disease progression[2].

These other factors are social determinants of health and require changes in public policies or resources to address. They include poverty, access to health insurance, food security, access to quality nutrition, educational level, stressors from discrimination and racism, and environmental factors. Most of these factors are consistently more prevalent among persons of lower socio economic status [2].

The amount of greenspace in a neighborhood has been shown to correlate with the level of cardiovascular health [3]. However, unlike other social determinants of health, there is variability in greenspace within each strata of socio economic status. Lack of greenspace is not

restricted to the poor but may have more negative impacts on the disadvantaged [4]. This makes the analysis of greenspace effects more complicated. Questions have been raised about whether all greenspace is equal and whether more greenspace leads to better cardiovascular health directly or through associated factors such as pollution [5]. Also newer technology has been adopted with street view cameras coupled with artificial and machine learning to evaluate thousands of more residential neighborhoods than have been done in the past [6].

The aim of this study is to review the latest literature on greenspace to understand how to most effectively target greenspace for cardiovascular risk reduction.

METHODS

A narrative review was done on articles from PubMed. The keywords used centered around green space and cardiovascular disease.

Inclusion criteria were articles that were published within the last year, had access to full documents, and had greenspace as the exposure and cardiovascular disease as the outcome. Exclusion criteria were articles published more than one year prior to the search, articles that did not have free access, those that addressed non-cardiac greenspace health benefits exclusively. Other review articles, editorials, or case studies were excluded.
Each article was evaluated to see how specifically the greenspace was measured (aerial or streetview) and the particular cardiac parameters were measured.

RESULTS

Ten peer-reviewed articles met the inclusion criteria upon search and PubMed. They give various details regarding greenspace as follows.

Chen et. al. used google street view cameras and deep learning techniques to correlate with major adverse cardiovascular events (MACE). They studied 49,887 people living in Northeastern Ohio in a retrospective cohort study. They created a tree-sky index and a pavement index as well as house and building indexes based on the google images. They were able to show that per a 1 unit increase in pavement index (meaning more sidewalks), there was a 9 percent decrease in MACE. They showed a tree-sky index increase of one unit was associated with a five percent decrease in MACE risk. They showed no difference with grass index (non-tree green space and cardiovascular risk reduction) [7].

Zhou et. al. studied seventy-six people in China who wore body cameras for five days. They had

electronic questionnaires, physical exams, and laboratory tests to evaluate cardiac and pulmonary functions. They also measured particulate matter exposure in the air (PM 2.5). They were able to show that if they controlled for variations in PM 2.5 exposure, they would increase greenspace and did not show a correlation with cardiovascular events. But, they were able to show a reduction in total cholesterol and atherogenic coefficient from more greenspace despite controlling for PM 2.5 exposure[8].

Caryl et. al. studied 377,817 UK participants over fourteen years. They found that tree canopy showed the best correlation with cardiac protection. Water features in a green space also showed some benefit. Having sports facilities in the greenspace actually showed a higher risk of cardiovascular events. Grass by itself or “any park exposure” did not show a correlation with cardiovascular health[9].

James et.al. used deep learning analysis of street view imagery to correlate with the Nurses’ health study. They had 350 million street view images analyzed by the deep learning models and correlated them to the cardiovascular events in this population of 88,788 nurses between 200 and 2018.They were able to show lower cardiovascular events with visible tree cover but not with visible grass or turf grass [10].

Chuai, X. et.al. took normalized difference vegetation index (NDVI) and exposures to PM2.5 to correlate with data from CHARLS 2014 and 2015 data in China. They showed green space exposure was associated with lower cardiovascular disease and that greenspace exposure also correlated with lower exposure to PM2.5. They concluded that green space effects occur linked to reduction in air pollution [11].
Chu, Z. et.al. specifically evaluated major adverse cardiovascular events one year after hospital discharge following an acute cardiovascular event. They showed that more greenspace within 1000 meters of the home can decrease PM2.5 exposure and reduce the incidence of major cardiovascular events. They conclude the mechanism of greenspace improvement of cardiovascular risk is directly related to greenspace reduction of particulate matter exposure (PM2.5)[12].

Pescador-Jimenez et. al. studied 6795 participants in the MESA (Multi-Ethnic Study of Atherosclerosis) trial which had 19 years of followup. They analyzed street view technology and deep learning to identify different types of greenspaces. They found more effect of greenspace benefits in those of lower socioeconomic status. They also found that there was no association with tree cover in this group [13].

Riggs et. al. studied 624 adults in Louisville, Kentucky. They measured leaf area index and Normalized Difference Vegetation Index (NDVI) as markers of greenspace. They found more

greenspace was associated with more interleukin 4 and less B cells, natural killer cells, and monocytes. They could not find consistent results associated with greenspace and other inflammatory markers [14].

Thovinakere, N. et.al. studied 295 adults in the UK who had a new cardiovascular diagnosis. They were looking for predictable factors that were associated with new increased physical activity after the new cardiac diagnosis. Among factors associated with more physical activity was greenspace access [15].

Mouli, S. et.al. studied green space visits in various U.S. cities (nine) and made comparisons of green space availability and actual green space usage. They showed greater greenspace utilization of the available greenspace in suburban areas vs urban areas. They also showed that areas with warmer environments such as Houston, Atlanta, and Phoenix, had more limited greenspace engagement than those with more seasonal variation represented by New York, Chicago, and Los Angeles. [16].

DISCUSSION

Previous literature supports the idea that more greenspace is associated with cardiovascular risk reduction. The present review highlights articles that point out nuances in greenspace, namely how it is measured, what type of greenspace is advantageous, how it is utilized, and the possible mechanisms by which it improves cardiovascular situations.

Most of the included articles in this study point out that using NDVI has been supplanted by street level cameras. The ability to evaluate a large number of images and evaluate patterns has been dependent on artificial intelligence and machine learning. This was not previously possible.
Almost all the articles that look at the type of greenspace overwhelmingly favor tree cover as a positive factor for mitigating cardiovascular risk while grass either increases or negates this advantage. The notable exception is the article by Pescador-Jimenez et.al. which found better results with fields, flowers and plants rather than trees for all cause mortality[13].

Utilization of greenspace was assumed in most articles and not specifically tested except in the article by Mouli et.al. Interestingly they found that greenspace even when equivalent in suburban and urban areas was more utilized in suburban areas. Whether this correlates with socioeconomic status or income was not measured. They also found it was more utilized in areas that had more distinct seasons [16].

The mechanisms as to why greenspace positively affects cardiovascular health have been theorized in all the papers of this study [7-16]. Riggs et al. directly measured cytokines and immune cells to explain this [14]. Other articles refer to the same issue of inflammation, psychological well being, and opportunity to exercise as reasons for the benefit of green space. However, several of the articles suggest particulate matter from air pollution may be a mechanism why greenspace increases, especially with trees rather than grass is beneficial as the former may block pollution [7-12].

The association of particulate matter and worsening of cardiovascular disease has been established in many different scenarios with various research[17-19]. This includes even in very specific settings such as with breast cancer cardiac toxicity from chemotherapy and oil spills that worsen particulate matter and increase cardiovascular events [20,21].

Ultimately my study shows the limitations with current knowledge of greenspace and how best to modify it for cardiovascular benefits. Simply increasing the greenspace in a polluted area may allow more pollution to spread unless the vegetation such as trees can stop the pollution. Simply increasing trees in an area without higher risk populations with other cardiovascular stressors may not improve the outcomes. Simply increasing green space in urban areas without pollution may not be helpful. Crowded urban spaces also have people of high socioeconomic status that are at the higher end of the social gradient for healthcare. More studies are needed to see whether they benefit from greenspace or whether the benefit is limited to those who are already with multiple other risks.

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