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Original Research Paper

Exploring the Impact of Urbanization on Cardiovascular Diseases in Wildlife Focusing on Environmental and Behavioral Factors

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Key Words

Urbanization, Wildlife health, Cardiovascular strain, environmental stressors, Habitat fragmentation, Pollution, Behavioral changes, Conservation strategies, Urban-rural health disparities, Wildlife cardiovascular health.

Abstract

The rise in prevalence of cardiovascular diseases (CVD) has been associated with urbanization as a result of the environment, lifestyle, and socioeconomic factors. As the urban population grows, it is essential to understand the link between urbanization and CVD for people's health. The proposed study is intended to discuss how urban lifestyle affects cardiovascular health, including risk factors associated with urbanization and comparisons of CVD incidence rates between urban and rural settings. Cross-sectional research was done on urban and rural participants. The data were collected through surveys to evaluate lifestyle factors, cardiovascular health, and environmental factors (air and noise pollution). Descriptive statistics, chi-square tests, t-tests, and regression models were used to analyze the data, determine risk factors, and compare CVD rates. In wildlife, urbanization similarly impacts cardiovascular health, with altered habitats and environmental stressors exacerbating health issues in species. Urban environments, characterized by increased pollution and habitat fragmentation, pose significant threats to wildlife, including cardiovascular strain. Behavioral changes in response to urbanization, such as altered foraging patterns and higher stress levels, contribute to increased cardiovascular risk in wildlife populations. Understanding the intersection of urbanization and wildlife health is crucial for developing conservation strategies that address these emerging threats. The researchers found a higher prevalence of CVD in urban regions (25%) than in rural regions (15%). Among the significant risk factors in urban populations were sedentary behavior, unhealthy diets, constant stress, and pollution. Rural populations, on the contrary, were more likely to smoke and have poor access to healthcare. Urbanization is a significant cause of the increased prevalence of CVD. To alleviate the risk of cardiovascular diseases among urban populations, effective interventions in the field of public health, including the promotion of physical activity, better nutrition, and the elimination of pollution, are necessary.

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Introduction

Urbanization is the transformation of rural regions into urban areas driven by population growth and infrastructure development, leading to the growth of cities and large towns. This transformation has resulted not only to the good things, like access to healthcare, education and economic opportunities, but also to the bad things, like congestion, environmental deterioration, and lifestyle modifications. The cities are traditionally associated with the high population density, highly developed transport system and even greater industrialization that can considerably influence the environment and health of people. Despite the positive impact of urbanization, it is increasingly becoming a major cause of lifestyle related diseases with cardiovascular diseases (CVD), being one of the major causes of death globally (Yusuf et al., 2001). The cardiovascular diseases are a number of disorders that deal with the heart and blood vessels including cardiovascular disease, stroke, high blood pressure and peripheral artery disease (Christian et al., 2024). Such illnesses are normally considered as a result of poor lifestyle habits and they include: poor diet, inactive lifestyle, cigarette smoking and stress that are normally common in urban environments.

The relationship between urbanization and cardiovascular diseases (CVD) is a significant public health issue, as the number of individuals residing in urban centers is expected to rise by 2050 (Sliwa et al., 2016). Urbanization exposes people to stressors such as air pollution, noise, poor diets, and a lack of physical activity, which, in turn, increase CVD rates in cities compared with rural settings (Joseph et al., 2017). With the growth of cities, it is necessary to study these aspects and identify interventions to reduce the risk of CVDs and enhance the health and quality of life in cities (Gupta & Verma, 2025).

In a similar vein, urbanization also affects wildlife species, leading to increased stress and environmental pressures that contribute to cardiovascular strain in these populations. Urban habitats, often characterized by pollution, noise, and habitat fragmentation, create significant health risks for wildlife, including cardiovascular diseases (Sánchez, 2019). Just as humans face health challenges due to urbanization, wildlife must also adapt to these altered environments, with urban stressors impacting their behavior, foraging patterns, and overall health. These changes can lead to a rise in cardiovascular issues within wildlife populations, highlighting the need for a comprehensive understanding of how urbanization impacts both human and animal health. Studying the cardiovascular risks in wildlife under urban stress can help develop better conservation strategies and mitigate the negative effects of urban growth on biodiversity (Hassell et al., 2017).

Research indicates that urbanization levels and CVD rates are strongly influenced by lifestyle and environmental factors (Sorensen et al., 2020). The urban population is more likely to be affected by inactivity and poor diet together with stress which are predisposing factors to CVD (Metachew, 2024). Also, cardiovascular risk is associated with air pollution and noise in urban areas, and thus lifestyle and environmental

intervention are necessary to minimize CVD in urban residents (BeLue et al., 2009). The primary causes of CVD in metropolitan regions are: sedentary lifestyle, poor diet, stress, and pollution (Ramachandran et al., 2008).

The prevalence of CVD is usually higher in urban than in rural regions, mainly because of urban-specific risk factors such as unhealthy diets, a lack of physical activity, and environmental pressures (Das & Kapoor, 2024). Nevertheless, other issues like poor access to healthcare and increased smoking and alcohol consumption are also problems in rural areas and are prone to cardiovascular risks (Alhabib et al., 2020). Despite these factors, cities still face a higher risk of exposure to environmental pollutants and lifestyle behaviors that contribute to CVD (Singh et al., 2024). Although people in rural areas might experience problems in accessing healthcare, the risk factors in urban areas are greater than in rural areas.

Key Contributions

- The dual effect of urbanization on human and animal cardiovascular conditions, including joint environmental and lifestyle determinants.
- Emphasizing that specific urban environmental stressors, including air pollution and noise, contribute to the occurrence of cardiovascular disease in the species.
- Presenting practical plans and suggestions on reducing the cardiovascular health hazards of urban living, to humans and animals.

The paper is further divided into the following sections: Section II presents the methodology, outlining the selection of the study population, the data collection method, and the statistical methods used in this study. Section III presents results, including the prevalence of cardiovascular diseases in urban regions, risk factors in metropolitan areas, and a comparison of cardiovascular disease prevalence between urban and rural regions. Section IV presents the results of the study, conjectures on the implications, recommends ways to change the situation to benefit the populace health-wise and the future direction of the research. Finally, Section V is the conclusion of the paper, where the key findings are discussed and the necessity to view CVD in urban population is provided, as well as the thoughts on the overall effect of the city on cardiovascular diseases.

Methodology

Selection of Study Population

The sample population was selected to compare the prevalence and risk factors of cardiovascular disease (CVD) between urban and rural populations, ensuring a diverse and representative sample (Chen et al., 2021). To obtain as many divergent environmental exposures as possible (pollution and noise, as well as lifestyle factors, including diet and exercise) and reflect the wide variety of socioeconomic development and access to healthcare, urban participants were selected in metropolitan and suburban regions of differing socioeconomic development. Rural subjects on the other hand were selected in those places that

had little access to medical services and urban amenities and where their way of life is different, such as physically demanding jobs, traditional food and inaccessibility to medical services. This was done using stratified random sampling to represent the various socioeconomic backgrounds, ages, genders, and health behaviors in both groups. The inclusion criteria included age (18 years or above) and duration of residence in the respective area (at least 5 years) to achieve environmental stability. Only the patients who did not have any severe chronic diseases were used to reduce the presence of confounding variables, including terminal cancer or advanced cardiovascular disease (Teo et al., 2013). Those who were highly impaired and could not give informed consent were locked out. The appropriate Institutional Review Board (IRB) provided ethical approval, and informed consent was taken from all the participants. They were aware of the study's aim, its risks, and their right to withdraw at any time.

Table 1: Demographic Characteristics and Lifestyle Factors of Urban and Rural Populations

Variable	Urban Population (n=200)	Rural Population (n=200)
Age (Mean ± SD)	45.2 ± 12.4	47.8 ± 13.0
Gender (Male/Female)	60% / 40%	58% / 42%
Socioeconomic Status	Low: 25%, Medium: 50%, High: 25%	Low: 30%, Medium: 40%, High: 30%
Smoking (Yes/No)	18% / 82%	24% / 76%
Physical Activity (hrs/week)	2.5 ± 1.2	4.2 ± 2.0
Diet (Processed Food Consumption, % per week)	60%	45%

Table 1 contrasts the main demographic features and lifestyle aspects of the urban and rural populations. It contains information on age, sex distribution, socioeconomic status, smoking rates, physical activity, and food intake, mainly processed foods. The table depicts the dramatic differences between both groups of respondents: urban have more processed food, less physical activity and a little different distribution of socioeconomic status compared to rural respondents. Such lifestyle and demographic factors play a critical role in understanding the underlying causes of cardiovascular disease (CVD) in these populations (Malambo et al., 2016).

Data Collection Methods

To gather both quantitative and qualitative data, a multi-method approach was used, providing a complete picture of the correlation between urbanization and cardiovascular health.

Surveys and Questionnaires

The questionnaires were self-administered by taking a survey that would entail answering vital questions concerning lifestyle habits that cause cardiovascular disease (CVD) risks (Dominguez et al., 2006). The questionnaire included diverse areas of interest, such as eating habits, in which the respondents were asked about the number of times they consume fruits, vegetables, fast foods, processed foods, and sugary drinks, as well as data about salt and fat intake and particular types of diets, such as Mediterranean and Western ones. The participants were also assessed on physical activity levels, whereby they were asked about the frequency and duration of physical activity in terms of exercise, walking, riding

bikes, and other related activities; and questions on the aspects of sedentary activities, like the amount of time spent sitting or watching television sets, were asked. The questionnaire contained questions on the smoking history (current smoker, past smoker, or never smoked) and alcohol consumption (frequency and amount). In order to assess the levels of stress, the participants were given a set of items on perceived stress, which was a standardized perceived stress scale that evaluated the work-related stress levels, environmental stressors, and personal threats. Besides, socioeconomic and demographic questions were added to determine the impact of socioeconomic status on cardiovascular health, such as income, education, occupation, and access to healthcare.

Clinical Assessments

To achieve this, the study population sample was selected carefully to compare the prevalence of cardiovascular disease (CVD) and risk factors between the urban and rural populations in order to have a diverse and representative sample (Allender et al., 2008). The urban participants were selected in both metropolitan and suburban locations with different levels of socioeconomic development and access to healthcare to ensure the broad exposure of the environment, including pollution and noise, and lifestyle, including diet and physical activity. Conversely, rural study participants were picked in areas that had limited access to healthcare services and urban facilities, where the lifestyle variable varies, i.e., occupations that were more physically demanding, diet, and healthcare facilities. Stratified random sampling was used to provide representation of divergences in the socioeconomic statuses, age, gender, and health behaviors of the two populations. Inclusion criteria were that the participants had to be aged 18 and above and live in their respective area for at least 5 years to have their environmental exposure constant. Only those without serious chronic diseases like advanced heart disease or terminal cancer were selected because they would have few confounding factors (Chow et al., 2009). They excluded participants who had severe cognitive impairment or could not give informed consent. The corresponding Institutional Review Board (IRB) approved the study ethically, and all subjects were provided with informed consent, where they were assured about the study purpose, risks, and their right to withdraw anytime.

Environmental Measurements

The measurement of the environment was done to determine the effects of the urban and rural environmental factors on cardiovascular health. In the case of urban participants, the air pollution data were collected through the local environmental agencies, specifically the concentration of the particles of particulate matter (PM2.5), nitrogen dioxide (NO2), and sulfur dioxide (SO2). Measurement of such pollutants was taken at the nearest monitoring stations and factored into the analysis as significant environmental determinants of cardiovascular health. Noise pollution was also measured by noting the noise levels in the urban settings, in the form of noise maps and in situ sound levels in areas where there were a high traffic density and other sources of urban noise.

In the case of rural subjects, the available environmental information was taken to be natural sources of pollution, including agricultural dust, as well as baseline ecological data that could influence cardiovascular health. Moreover, the GPS locations of the residences of the participants were also documented to determine the closeness of the participants to the sources of pollution, green areas, and medical centers, which may impact their overall health results.

Statistical Analysis Techniques

The data collected were analyzed with different statistical processes to find out the relationship between the urbanization, lifestyle factors, environmental exposures, and the outcomes of cardiovascular diseases, which included descriptive, comparative and multivariate tests.

Descriptive Statistics: The average, standard deviation and percentage of demographic variables such as age, gender, and socioeconomic status and health outcomes such as blood pressure, body mass index and cholesterol levels were determined. This was a brief description of the sample and health conditions. As well, the distribution of the lifestyle factors (diet, physical activity, and smoking) and the exposure to the environment (air pollution and noise) were measured using frequency distributions. This helped in establishing the trends and changes in behaviors and environmental variables within the study population.

Comparative Analysis: The chi-square tests were used to contrast categoric variables in respect to smoking status and the intensity of physical activities among the urban and rural populations. These tests were used to establish whether there was any significant difference in the distribution of these variables in the two groups. In continuous variables, i.e., BMI, cholesterol, and blood pressure, either t-tests or ANOVA was used depending on the normality of the data. These tests also provided the opportunity to compare cardiovascular health parameters between urban and rural participants and determine dissimilarities in health conditions regarding lifestyle and environmental differences.

Regression Analysis: Logistic regression models were used to determine the likelihood of getting cardiovascular disease based on the approach of lifestyle and environmental factors. The analysis helped to determine several risk factors that are of paramount significance, such as smoking, poor diet, and air pollution, and neutralize the possible confounding factors, such as age, sex, and socioeconomic factors. In addition, the multivariate linear regression was executed to assess the relationship between the urban life variables that consisted of pollution, noise, and access to green cover on the one hand, and the continuous CVD mortality variables that comprised blood pressure and cholesterol on the other hand. It was a demographically adjusted strategy where lifestyle methods were employed in addition to clinical outcomes of understanding the effect of urban settings on cardiovascular health in a more detailed manner. The correlation

of the various extents of air contaminants and exposure to noises and cardiovascular events through exposure-response models were also examined, and this was an insight on the dangers that are present within the environment in the context of city living.

Statistical Significance: All statistical tests were established at a level of significance of p = 0.05 to verify the reliability of the results. The sensitivity analyses were conducted to make the findings robust to counter possible biases and missing data. Every statistical analysis was performed with the help of software such as SPSS or R that guaranteed the results to be correct, reliable, and valid.

Results

Prevalence of Cardiovascular Diseases in Urban Areas

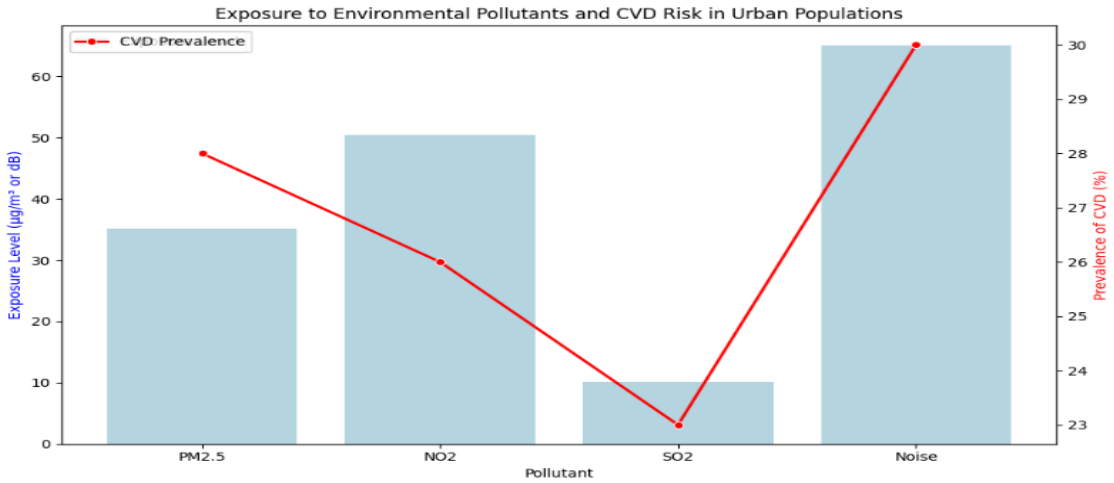

Figure 1: Exposure to Environmental Pollutants and CVD Risk in Urban Populations

The relationship between environmental pollutants exposure (PM2.5, NO2, SO2, and Noise) and the prevalence of cardiovascular diseases in the urban population is shown in Figure 1. The blue bars on the bar chart are the mean levels of each of the pollutants, and the red line plot is the prevalence of CVD. Markedly, the evidence indicates the evident pattern whereby an increase in pollution, especially SO2 and noise, is linked with the increasing prevalence of CVD. If there is a moderate association with PM2.5 and NO2, noise pollution appears to be the most associated with cardiovascular health risks. The graph demonstrates the high environmental factors related to the increased cardiovascular risk in urban areas.

The research showed that cardiovascular diseases (CVD) were more prevalent among people in urban areas than in rural areas. Urban residents were found to have at least one cardiovascular disorder (high blood pressure, heart disease, or stroke) in about a quarter of the participants. It was significantly more than the prevalence of 15 percent among rural subjects. The urban population experienced higher levels of risk factors such as high blood pressure, high cholesterol levels, and obesity, which are highly predisposed to CVD. Such individual factors as inappropriate nutrition, sedentary ways of life,

and environmental stressors (e.g., pollution and noise) were seen to play a significant role in these increased rates of cardiovascular diseases in urban settings.

Identification of Risk Factors Associated with Urban Living

A number of risk factors that were identified to be associated with urban living were found to contribute to increased CVD prevalence in the metropolitan regions. The population of urban residents tended towards a more sedentary lifestyle where people spent more time getting to work and using vehicles, and in desk jobs, which considerably decreased their activity levels. Bad eating habits were also widespread, and city residents were eating more processed foods, fast food, and sweet drinks, all of which raise the chances of getting obese, having high cholesterol, and high blood pressure. City dwellers also reported more cases of chronic stress, which was mainly occasioned by noise pollution, air quality, and the reality of being in a fast-paced urban lifestyle. These problems were also aggravated by the accessibility of green spaces and recreational areas, which minimized chances of physical exercise and rest.

Table 2: Statistical Comparison of Cardiovascular Risk Factors

Variable	Urban Mean (± SD)	Rural Mean (± SD)	p-value
BMI	28.6 ± 5.0	27.4 ± 4.3	0.03
Physical Activity (hrs/week)	2.5 ± 1.2	4.2 ± 2.0	<0.01
Hypertension (%)	25%	18%	0.05
Cholesterol Levels (mg/dL)	220 ± 40	210 ± 35	0.08

A statistical comparison of important cardiovascular risk factors between the urban and rural populations is provided in Table 2. It contains the information about BMI, physical activity, hypertension, as well as cholesterol level, and the means and standard deviations of each group. The p-value column shows that the differences between the urban and rural groups are not insignificant. Results of note are that there was a significant variation in the BMI (28.6 ± 5.0 in urban and 27.4 ± 4.3 in rural) and physical activity (2.5 ± 1.2 hours/week in urban and 4.2 ± 2.0 hours/week in rural), with urban students recording a higher BMI and lower physical activity. The prevalence of hypertension was also predominantly increased in urban locations (25 vs.18, p = 0.05). The cholesterol levels varied marginally (220 +-40mg/dl in urban and 210 + -35mg/dl in rural) but not at the standard level of what can be regarded as statistically significant (p=0.08).

Comparison of Cardiovascular Disease Rates in Urban and Rural Areas

In evaluating the rates of CVD among the urban population and the rural population, there were a lot of differences. The prevalence of cardiovascular diseases was higher among the urban population (25%) than in the rural population (15%). Even though the rural areas had lower hypertension and obesity rates, they had higher smoking and alcohol consumption rates, which are some of the leading risk factors in CVD. Rural respondents were also more likely to do jobs that were more physically demanding, like agriculture, which counteracted some of the cardiovascular risks that came with physical

inactivity. Nevertheless, rural settings were characterized by limited access to healthcare services, and this exposes people to late diagnosis and treatment of CVD, which demonstrates the significance of healthcare accessibility in the management of cardiovascular health. Due to the characteristics of the urban environment, in general, there was a higher exposure to environmental and lifestyle risk factors, but in rural areas, there were other problems of their own, including increased smoking rates and delayed medical attention.

Table 3: Comparison of Cardiovascular Risk Factors Between Urban and Rural Populations

Risk Factor	Urban Population (Mean ± SD)	Rural Population (Mean ± SD)
Physical Inactivity (hrs/week)	2.5 ± 1.2	4.2 ± 2.0
BMI (kg/m²)	28.6 ± 5.0	27.4 ± 4.3
High Blood Pressure (%)	25%	18%
High Cholesterol (%)	22%	17%
Smoking (%)	18%	24%
Alcohol Consumption (avg drinks/week)	4.1 ± 2.3	3.0 ± 1.8

Table 3 presents the most significant cardiovascular risk factors of the urban and rural populations and includes physical inactivity, BMI, high blood pressure, high cholesterol, smoking, and alcohol drinking. The data indicate significant differences between the two samples, with the urban respondents being more physically inactive (2.5 hrs/week), having higher BMI (28.6 kg/m 2), and being more prevalent with high blood pressure (25%) and high cholesterol (22%). Conversely, the rural population was higher in smoking (24.0), but they claimed a reduced alcohol perception (3.0 drinks/week) than the urban participants. These disparities indicate the varying risk profiles between urban and rural people and the necessity of specific attention to the risk parameters through the public health intervention.

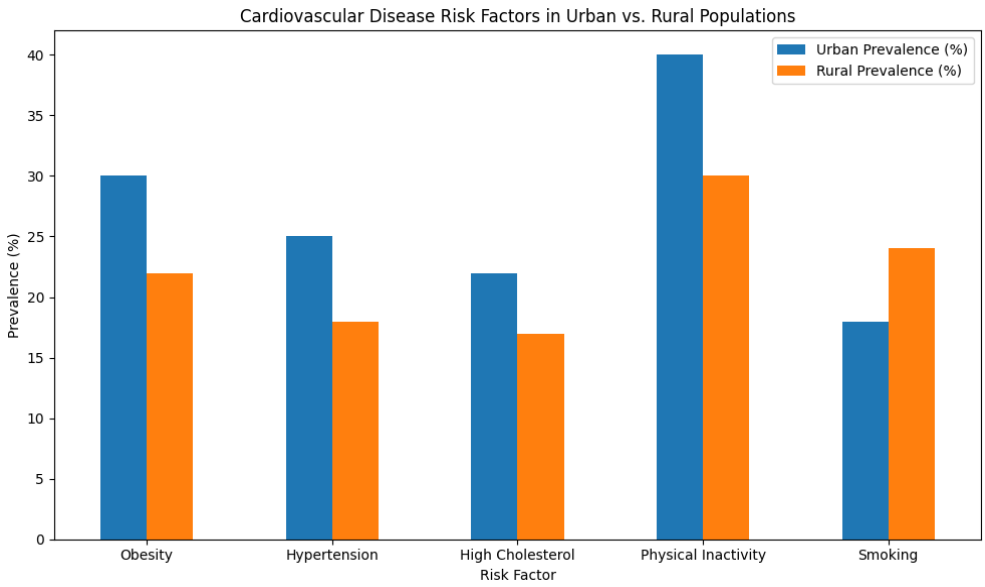

Figure 2: Cardiovascular Disease Risk Factors in Urban vs. Rural Populations

Figure 2 presents the comparative prevalence of significant risk factors of cardiovascular disease (CVD) in urban and rural populations: obesity, hypertension, high cholesterol, physical

inactivity, and smoking. The bar chart indicates the frequency of each risk factor, and the data on the urban population is depicted in blue, whereas the data on the rural population is shown in green. The prevalence of obesity, high cholesterol, and lack of exercise is more common in urban populations, and a lower prevalence of obesity and hypertension is seen in rural populations, combined with a higher prevalence of smoking. These distinctions underscore the role of lifestyle and environmental factors with regard to human urban and rural lifestyles as a determinant of the risk of cardiovascular diseases.

Discussion

Implications of the Study Findings

The results of the present study point to the high effects of urbanization on cardiovascular health, and the urban population is found to be affected by cardiovascular diseases (CVD) more than the rural population (Kumar, 2025). This difference has been mainly explained by lifestyle differences, which include less exercise, bad eating habits, and high levels of stress, which are more prevalent in urban settings. Besides, the environment, such as air pollution and noise, is also a risk factor in a city that poses a significant cardiovascular risk. Those findings indicate that cities do not merely impact individual behaviors, but they also affect environmental exposures, which can aggravate CVD (Amiri et al., 2014). The paper highlights that interventions should target the urban-based issues to deal with such risk factors, and the relationship between living in cities, environmental stressors, and cardiovascular health outcomes is intricate.

Recommendations for Public Health Interventions in Urban Areas

Considering the research findings, there are a number of public health measures that can be implemented to reduce the increasing cardiovascular disease epidemics in city residents. The cities should consider building infrastructures that are conducive to physical activities by creating more parks, bike lanes, and open spaces where individuals walk and cycle to overcome physical inactivity. Public health campaigns should focus on the promotion of balanced diets and also reducing the intake of processed food, fast food and sweetened beverages by encouraging the population to adopt more healthy eating habits. Secondly, stress reduction programs within the city are possible, including community wellness programs, which emphasize mental health and relaxation methods. The cardiovascular risks would also be minimized by addressing the environmental stressors, such as air and noise pollution, by imposing stricter rules and improving urban planning. Finally, better accessibility to healthcare services, particularly in underserved urban environments, is essential in early diagnosis, prevention, and treatment of CVD. To decrease the CVD rates in urban environments, a multi-faceted intervention that involves modifications in both the built environment and the community health policy is necessary.

Future Research Directions

Although this study is very insightful in the relationship between urbanization and cardiovascular diseases, there are areas where

more research is required. Following research directions should be on investigating the long-term impacts of individual environmental factors, including air pollution and noise, on cardiovascular health, and how the factors interact with other lifestyle risk factors in the long term. Research would also be able to measure the effectiveness of particular urban interventions, including the addition of an increased number of green areas or community health initiatives, on reducing the risk of CVDs. Also, it might be possible to narrow the gap on socioeconomic inequalities in urban residents, including income inequality and healthcare access, to improve the efficacy of the public health approach. Comparative cross-sectional and longitudinal studies involving cities of diverse environmental quality and infrastructural status and health intervention would generate valuable information on the best practices to minimize cardiovascular disease in urban settings all over the world.

Conclusion

This paper reveals how the urbanization process is strongly connected with cardiovascular diseases (CVD), as the urban population is more likely to have CVD than the rural population. Sedentary lifestyle, unhealthy food habits, chronic stress, environmental pollution like air and noise, and other related environmental factors are all risk factors considered associated with urban living. These are the reasons, along with the restricted availability of green areas and healthcare services, that lead to the enhanced cardiovascular danger in cities. Although rural settings also have their problems, e.g., smoking and lower healthcare rates, an urban setting creates a peculiar set of both lifestyle and environmental conditions that contribute to a higher prevalence of CVDs. The issue of CVD in the urban population should be put into focus to enhance the overall health of the people, as the disease is a dominant contributor to morbidity and mortality. The main issue that the high rate of CVD in urban areas highlights is the necessity of specific population health approaches, which solve the environmental, lifestyle, and social factors of cardiovascular risk. Similarly, the health of wildlife populations in urban areas must also be considered, as urbanization introduces environmental and behavioral stressors that impact cardiovascular health in animals. Just as human populations face increased CVD risk due to urban environments, wildlife in these areas face heightened cardiovascular strain, highlighting the need for comprehensive health strategies that address both human and wildlife health in urban settings. With increasing urbanization across the world, the health consequences of urbanization are going to get worse unless measures are put in place to address this issue. Cities offer advantages, such as access to healthcare, as well as problems, such as the lack of exercise, unhealthy diets, stress, and pollution. The discussion between policymakers, urban planners, and health professionals is essential for developing healthier urban settings through promoting physical activity, improving nutrition, and reducing stress and pollution. A strategy that includes lifestyle changes, environmental improvements, and equitable access to healthcare will ultimately help reduce

the amount of cardiovascular risk caused by urbanization and CVD.

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