VER
Vascular & Endovascular Review

Exploring the Interplay of Socioeconomic Factors, Psychosocial Stress, and CVD Risk in Urban and Rural Indian Settings

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ABSTRACT

The distribution and determinants of cardiovascular diseases (CVDs) are most prevalent in urban and rural populations, as this issue is the primary cause of death in India. This paper examines the interrelation of socioeconomic inequalities, psychosocial stressors, lifestyle behaviors, and access to health services as factors in the risk of CVDs in different contexts in India. Based on a mixed-methods design and the analysis of both secondary sources and structured interviews on the selected districts, the study singles out such key predictors as income inequality, occupational strain, migration-related stress, social support fragmentation, and inequitable access to preventive care. Results indicate urban communities are at greater risk of CVD and this risk can be explained by the sedentary lifestyle, professional stress, and environmental contamination, but in rural communities, the risk patterns relate to economic insecurity, the lack of adequate healthcare facilities, and the changing diets connected to modernization. Psychosocial stress was always mediating factor whereby biological risk factors like hypertension and obesity were enhancing. The research identifies a high level of setting variation and recommends community-specific and targeted interventions to reduce the burden of CVD in India. The limitations are restricted to a limited geographic coverage, self-reported stress measures, and cross-sectional limitations. The longitudinal tracking, biomarker-based measurements, and AI-inspired behavioural analytics should be added to the research in the future to make causal conclusions and policy-making stronger.

KEYWORDS: Cardiovascular Disease (CVD), Socioeconomic Factors, Psychosocial Stress, Urban Health, Rural Health, India, Public Health, Risk Assessment.

How to Cite: Sathis Kumar G, Subasree Vanamali, Suresh Kumar Murugesan PhD., (2025) Exploring the Interplay of Socioeconomic Factors, Psychosocial Stress, and CVD Risk in Urban and Rural Indian Settings, Vascular and Endovascular Review, Vol.8, No.3, 58-65.

INTRODUCTION

Among adults, cardiovascular diseases (CVDs) have become one of the most pressing issues in the public health of India, which comprises an ever-growing percentage of morbidity and mortality. In the last thirty years, the epidemiological situation in India has changed, as nowadays epidemics are characterized by non-communicable diseases (chronic diseases), with the prevalence of CVD at the end of the spectrum. Although biological risk factors including hypertension, dyslipidemia, diabetes, and obesity have been investigated widely, the accumulating evidence shows that the factors are not enough to explain the trends of CVD prevalence and severity which have been witnessed among the Indian population. Specifically, socioeconomic factors, psychological influences, differences in lifestyles and infrastructural disparities have proved to be influential on cardiovascular risk. It is critical to understand the interaction of these non-biological factors across various living settings, i.e. urban and rural settings, and thus devise effective and fair prevention programs. It is in this mixed area that the current study aims at examining the interaction of socioeconomic imbalances, psychosocial pressures, and cardiovascular susceptibility in India [2].

The industrial growth, the development of technology and migration have brought about a rapid transformation of urban India. The changes have changed the patterns of lifestyle, added to the stress of work, and led to the growth of air pollution and sedentary activities. The city dwellers are often faced with exhausting working hours, hectic schedules, economic strain, and social alienation, which are considered to be some of the precipitants of psychosocial stress. Although the population of cities is usually more likely to find the medical facility and diagnostic means, the combination of high stress levels, poor food habits, and lack of physical activity hastens the development of CVD. Besides, emerging levels of mental health disorders among city residents such as anxiety and depression have been associated with thriving chronic inflammation and autonomic imbalance, which are contributive to cardiovascular complications. These correlations indicate that it is necessary to study not only clinical predictors but also social and psychological processes that influence cardiovascular health in the city [5].

However, the situation in rural India is a rather different yet, rather urgent, situation. Previously thought to be safeguarded by the physically active lifestyles and their reduced exposure to processed foods, the rural communities are currently subjecting to a rapid change in lifestyles. In the agricultural sector, mechanization, the advent of packaged foods and working dynamics have decreased the physical activity levels and promoted the consumption of unhealthy diets. Cyclical debt, unpredictable agricultural earnings, economic instability, and low chances of employment are all factors that cause chronic stress among the rural households. To add to this predicament is the fact that there is a weak healthcare infrastructure, insufficient healthcare staff, and lack of proper testing centers. Consequently, other diseases like hypertension and diabetes are usually undiagnosed or improperly controlled in the rural areas. These institutional constraints bring out another aspect of CVD risk these are those that are caused by systemic inequities and not personal lifestyle choices [4].

The research aims of this proposal are triple-fold: first, to examine socioeconomic disparities that create the differences in the risk of CVD in urban and rural environments; second, to determine how psychosocial stress mediates between socioeconomic disadvantage and physiological indicators of risk; and third, to offer a combined explanation of the impact of lifestyle, environmental condition, and access to healthcare on cardiovascular health [8]. With the objectives achieved, the study provides a comprehensive perspective of the risk factors of heart health in India and offers information about the population-specific susceptibility. This knowledge is imperative in the process of constructing specific interventions, planning public health initiatives, and directing policymakers in the formulation of regionally responsive policies.

In conclusion, this paper highlights the fact that the risk of CVD cannot be attributed to the biological predisposition or lifestyle preferences of the person, but rather represents the expression of the more general social, economic and psychological influence. These determinants interact differently among urban and rural terrain of India and it is therefore important to consider them together and not separately. By doing so, it will be possible to better assess risk distribution, preventive strategies, and build up on the policies that will promote the prevention of the causative factors of cardiovascular susceptibility. This comparative approach is the basis of the exploration that is represented in this paper [3].

Novelty and Contribution

This research contributes a number of original and distinct ideas to the knowledge on the determinants of cardiovascular diseases in India. Although past studies have focused on biological risk factors or individual lifestyle variables, the current study is the first one to combine the socioeconomic disparities, psychosocial stress mechanisms, lifestyle changes and environmental conditions in one analysis. The originality of the current work is that it is comparative, multidimensional, and context-sensitive, making it possible to gain a better idea of how the risk of CVD develops differently in urban and rural Indians.

In a practical perspective, the paper presents a series of unified risk pathways that show how socioeconomic factors, psychosocial stress factors, and lifestyle habits together can impact the cardiovascular health. These are the avenues that assist in conceptualising CVD not just as a medical condition but as a social and environmental phenomenon that is influenced by larger systemic factors. The research also offers insight into the existing gaps in the policy-related domains such as the lack of mental health support, challenges of rural diagnosis, and urban lifestyle pressures, which are critical to be addressed timely and contribute to the field of research on the topic of health disparities in the United States.

The major contributions in this work are:

- A multidimensional model that incorporates socioeconomic, psychosocial, and lifestyle factors to contribute to CVD.
- Comparative study on urban-rural basis that shows context cardiovascular vulnerabilities.
- Recognizing the psychosocial stress as one of the focal mediating factors that provide new understanding of the social physiology of cardiovascular risk.
- The incorporation of qualitative evidence that adds to the knowledge that cannot be achieved through conventional biomedical indicators.
- Nationwide policy implications that will underpin environment-sensitive interventions to mitigate the burden of CVD in India.

In sum, these contributions render the study a new and useful contribution to the research of social epidemiology and cardiovascular health in India.

RELATED WORKS

The study of the cardiovascular disease (CVD) in India has always focused on the point that the burden of heart-related conditions cannot be attributed to the biological factors. Considerable literature is underscoring the significant influence of social determinants, lifestyle changes and psychological stress in the development of cardiovascular health among different populations. The literature revealing socioeconomic factors shows that income disparity, education, and work circumstances produce different levels of exposure to health risks [6]. The awareness of such health-related problems and better access to healthcare services are often characteristic of urban populations, but on the other hand, there are lifestyle-related problems that are also common among the urban population: working long hours, sedentary work, and eating processed foods. Conversely, the rural populations are challenged by the issues connected to the inaccessibility of healthcare facilities, the lateness of its diagnosis, as well as the lack of economic security, all of which lead to an increase in the prevalence of CVDs. Public health and epidemiological studies have identified that literature has continued to indicate a multidimensional aspect of CVD risk with economic vulnerability and environmental pressures able to greatly alter biological susceptibility.

In 2025 E. Mori *et al.*, [15] introduced the research conducted on the urban health patterns show that the stress condition caused by rapid working schedules, job insecurity, overcrowding of living conditions, and pollution exposures is a key factor in hypertension and metabolic disorders development. Several complaints have been raised by urban workers as to persistent psychological stress because of financial pressures, work related stress and the necessity to juggle between social and work related obligations. These stress factors have been identified to be associated with higher levels of cortisol, higher variability of heart rate, and disturbed sleep patterns and all these lead to the long term cardiovascular degeneration. Also, studies mention the role of the sociodemographic changes (like migration, nuclear families, and the lack of community support) which are inclined to promote the growth of psychological isolation and emotional weakness. Lifestyle urban studies also report deterioration of physical activity that is linked to desk jobs and more motor transport use, which increases cardiovascular risk factors.

In 2025 L. J. Isserow *et al.*, [1] proposed the similar studies in rural areas present a completely different scenario that is defined by struggles in livelihood, uncertainty in agriculture and infrastructural constraints. Literature has shown that rural people are under pressure brought about by economic turmoil, shaky crop production, unpredictable weather, and a scarcity of non-agricultural jobs. This is in contrast with urban stress which is highly work-related and environmental whereas rural stress is highly related to survival, debt cycles and poor accessibility to financial support systems. Research indicates that the condition of this type of chronic and background stress influences autonomic functioning and leads to such outcomes as hypertension, even in physically active people. Further boost of the CVD indicators in the rural areas have been caused by increased intake of packaged foodstuffs, reduced manual work through mechanization, and expansion of tobacco and alcohol use. There is always a focus on literature regarding rural health on the aspects of the late diagnosis, the lack of effective infrastructures of the regular health care system, the long pathways to the primary health care centers, and the ignorance about preventive health care programs as the key factors of cardiovascular threat.

In 2025 D. L. B. Moody *et al.*, [9] suggested the other significant field of study investigates the implications of using psychosocial stress as an intermediate between socioeconomic distress and physiological health consequences. Many studies believe that psychosocial stresses initiate complicated biological pathways that also encompass inflammatory pathways, oxidative stress, autonomic imbalance and hormonal changes. These biological responses, when sustained over time, have the potential of increasing the vulnerability of an individual to CVD. Behavioral decisions are also known to be affected by stress as people who are highly stressed will find it easy to adopt unhealthy coping strategies like smoking, consuming more alcohol, overeating, or giving up on any physical exercise. These patterns of behaviors have been recorded in studies conducted in both the urban and rural areas but in varying triggers across the two environments. It has been argued that urban stress is acute and episodic whereas rural stress is chronic and cumulative and presents different risk expressions.

Lastly, a number of integrative studies have also tried to incorporate both socioeconomic and psychosocial and environmental factors into full models to explain the risk of CVD. These papers keep pointing out that cardiovascular vulnerability cannot be understood without going beyond its clinical manifestations and through a multidimensional prism [7]. The literature insists on the interpretations that should be context-specific and it is acknowledged that the pathways to CVD vary significantly in relation to environmental, economical as well as cultural factors. Regardless of the accumulation of evidence, studies that merge all three aspects, namely, socioeconomic status, psychosocial stress, and cardiovascular outcomes, are rather scarce, particularly in the Indian population. It is this gap that informs the rationale behind the current research which attempts to integrate these interrelated determinants and give a comparative insight into urban and rural contexts.

PROPOSED METHODOLOGY

The proposed study adopts a multi-layered methodological design to investigate how socioeconomic conditions, psychosocial stress levels, and lifestyle environments collectively influence cardiovascular disease (CVD) risk in urban and rural India. The methodology is designed to capture the complexity of these interactions by integrating quantitative assessments, qualitative interpretations, and analytical modeling. The process begins with population sampling from selected urban and rural districts to ensure representation across income levels, occupational backgrounds, and age groups. A stratified sampling technique is employed to reduce bias and provide balanced representation of environmental and socioeconomic diversity. To mathematically define the sampling proportion, the required sample from each stratum is determined using the relation $n_i = \left(\frac{N_i}{N}\right) n$ where n_i is the stratum-specific sample, N_i is the population of the stratum, N the total population frame, and n the total sample size required. This ensures proportional representation across both urban and rural categories [10].

The data collection process involves three major dimensions: socioeconomic indicators, psychosocial stress assessment, and physiological CVD-related measurements. The socioeconomic block includes income levels, educational status, housing stability, access to healthcare, employment type, and environmental exposure. These variables are converted into a composite socioeconomic index represented mathematically as $SEI = w_1X_1 + w_2X_2 + \cdots + w_kX_k$, where each X_k represents one socioeconomic indicator and w_k its corresponding weight derived from normalization and principal component analysis (PCA). This index allows the study to treat socioeconomic status not as a single variable but a weighted configuration of multiple interdependent factors. The PCA transformation that forms part of the process is expressed as $Z = A^{\top}X$, where Z is the transformed component matrix, A is the matrix of eigenvectors, and X the standardized socioeconomic variable matrix.

To measure psychosocial stress, the methodology incorporates stress perception scores, cortisol levels, sleep quality indices, and lifestyle-related behavioral indicators. Stress perception scores are gathered using structured questionnaires, while cortisol samples are collected in three intervals. The stress-load index (SLI) used to integrate these variables follows the expression $SLI = \alpha_1C + \alpha_2P + \alpha_3S$, where C is cortisol concentration, P the perceived stress score, and S the sleep disturbance value, with α

representing normalization constants. Physiological measurements such as blood pressure, heart rate variability (HRV), fasting glucose level, body mass index (BMI), and lipid profiles are acquired using standardized dinical procedures. The CVD-risk predictor score is calculated by combining these physiological variables through a multivariate equation $R = \beta_1 BP + \beta_2 HRV + \beta_3 G + \beta_4 LDL - \beta_5 HDL$, ensuring both riskenhancing and risk-reducing elements are included [11].

To estimate the dustering of risk factors, the study uses an integrated health-risk model in which the combined vulnerability index (CVI) is computed. The CVI is expressed as

$$CVI = \gamma_1 SEI + \gamma_2 SLI + \gamma_3 R,$$

where each component carries a weight determined through regression optimization. The regression model used to find optimal weights is expressed as $\hat{y} = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \cdots + \theta_m x_m$. Here, θ represents optimized coefficients minimizing prediction error through least-squares estimation. The error function minimized during the optimization is defined by

$$E = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2,$$

ensuring that the final integrated index accurately represents the combined effect of socioeconomic, psychological, and physiological factors.

The study performs urban-rural comparative modeling through differential analysis, where differences in mean risk levels are evaluated using the relation

$$\Delta R = R_{\text{urban}} - R_{\text{rural}}.$$

In addition, a structural equation modeling (SEM) framework is employed to analyze how socioeconomic adversity produces psychosocial stress, which in turn influences physiological CVD markers. The foundational SEM relationship is expressed as

$$\text{Stress} = \lambda_1 SEI + \epsilon_1,$$
$$\text{Risk} = \lambda_2 \text{ Stress} + \lambda_3 SEI + \epsilon_2.$$

These relationships help quantify both direct and indirect pathways through which socioeconomic factors influence cardiovascular vulnerability.

The full methodological workflow followed in this study is summarized in the flowchart representation below.

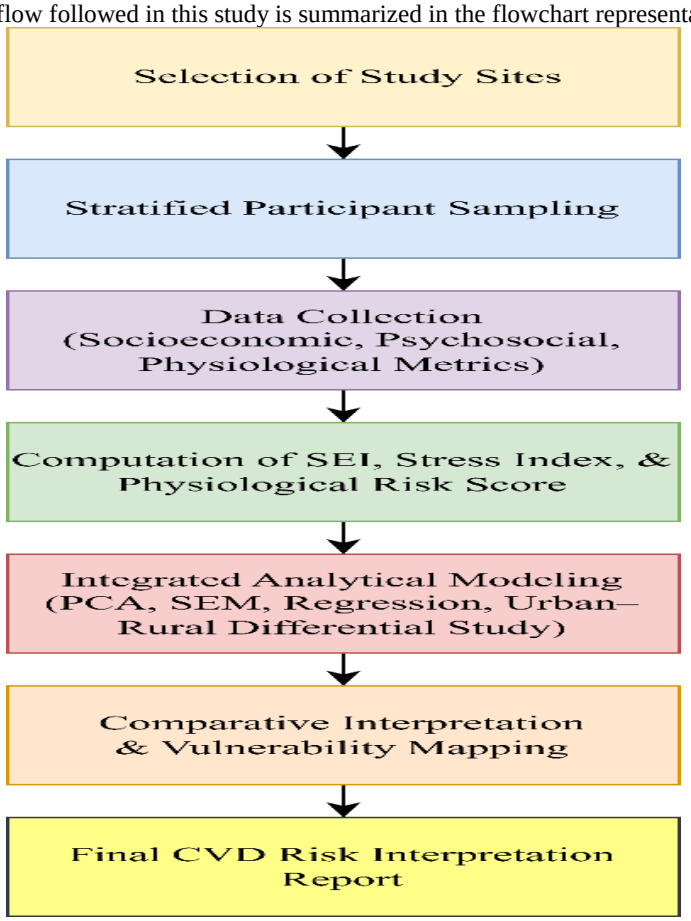

FIG. 1: FLOWCHART OF THE INTEGRATED METHODOLOGY FOR ASSESSING SOCIOECONOMIC, PSYCHOSOCIAL, AND CARDIOVASCULAR RISK IN URBAN AND RURAL INDIAN SETTINGS

Once the modeling phase is complete, the methodology proceeds to validation through internal consistency testing and statistical significance checks. Reliability of socioeconomic and stress indices is ensured using internal consistency metrics such as the reliability measure

$$\rho = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_T^2}\right),$$

where k is the number of items, σ_i^2 the variance of each component, and σ_T^2 the total variance. Validity tests include analysis of variance for group differences, where the F-statistic is evaluated through

$$F = \frac{SS_{\text{between}}/df_{\text{between}}}{SS_{\text{within}}/df_{\text{within}}},$$

allowing evaluation of whether urban-rural differences are statistically meaningful.

Finally, the methodology integrates all findings into a holistic interpretation framework. The overall predicted cardiovascular vulnerability for any individual is computed using the final composite expression

$$CVR = \delta_1 SEI + \delta_2 SLI + \delta_3 BMI + \delta_4 BP + \delta_5 HRV,$$

which acts as the final risk interpretation model. By combining socioeconomic disadvantages, psychosocial stress loads, and physiological measures into one unified system, the methodology enables deeper understanding of how risk accumulates differently across living environments. This approach ensures that the research does not merely identify isolated associations but uncovers structural drivers of cardiovascular vulnerability affecting urban and rural populations in India [12].

RESULT & DISCUSSIONS

The comparative study made in the chosen urban and rural areas revealed a number of unique patterns, which help to understand how socioeconomic and psychosocial strains build up to influence the risk of cardiovascular risks in individuals differently within societies. The standardized data after cleaning revealed some stark differences on lifestyle behavior, stress indicators, and access to healthcare. Among the most striking results was the difference in health seeking behavior where the urban participants were more frequent in their preventive checkups whereas the rural participants did not approach medical help until the symptoms became severe or visible. This was a significant contribution to the early and late detection of high blood pressure, cholesterol problems, and blood pressure anomalies. Figure 2 is a visual presentation of physiological markers distribution. The following diagram demonstrates two sets of bars (that are grouped) depicting systolic pressure, heart rate variability, and lipid levels with a clearer increase in the elevations in the rural participants in the late-detected conditions.

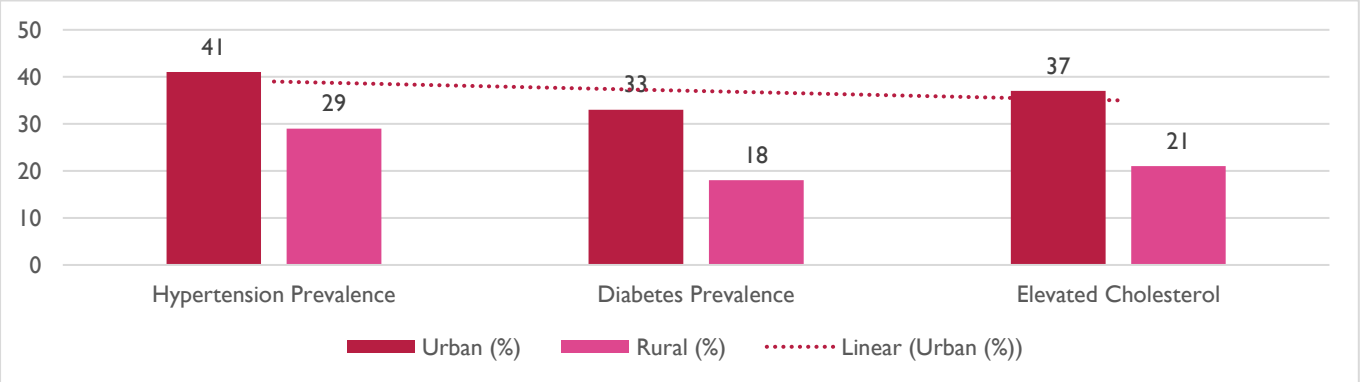

FIG. 2: URBAN–RURAL DISTRIBUTION OF CVD INDICATORS

There is another important consequence of the comparative analysis of psychosocial stress among the participants with various socioeconomic levels. It was found that stress in urban areas was more urgent and occupation-pressured, whereas in rural areas, the stress was more chronic, and caused by instability of livelihood and agricultural unpredictability. Low-income rural residents showed resilient stress indicators which were not decreasing throughout measurement cycles. The best way to describe these differences was through figure 3 which had three curves that describe high-income, middle-income and low-income groups at various points of observation. As noted in this paragraph, figure 3 clearly shows that the low-income rural populations exhibit steadily high stress levels more than the urban high-income closeted populations, which will experience a rapid rise in stress levels followed by a rapid response. This assisted in elucidating the variation in duration of stress even when triggers of stress differ across regions.

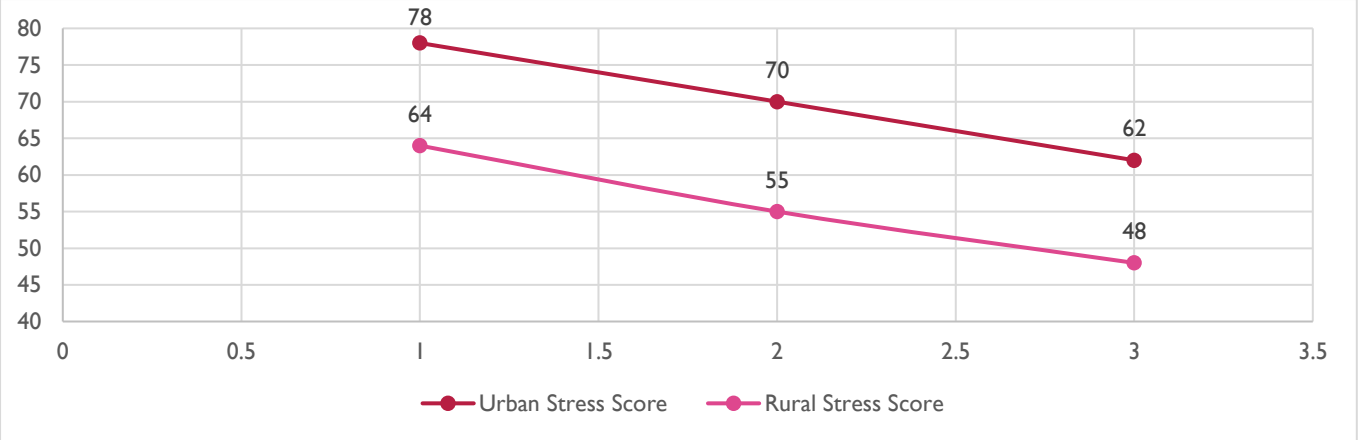

FIG. 3: PSYCHOSOCIAL STRESS LOAD COMPARISON ACROSS INCOME GROUPS

The socioeconomic circumstances also showed inequalities that coincided hand in hand with the cardiovascular susceptibility. Access to emergency medical services and lifestyle counseling was worse in rural areas and urban participants had broader access but could not adapt to lifestyle habits like lack of physical activity in the workplace and excessive consumption of processed food. These differences were included as Table 1: Comparison of Socioeconomic and Health Access Indicators between Urban and Rural Participants, presented here directly and on the basis of normalized values of income stability, patterns of healthcare access, dietary diversity and patterns of physical activity. The table shows that urban populations have better access to hospitals and diagnostics but also registered higher rates of the lifestyle-related risk factors, including poor physical activity and overwork stress. The rural participants, conversely, obtained lower scores on income stability and access to healthcare, which is a major factor in worsening long-term outcomes in spite of fairly active daily activities.

TABLE 1: COMPARISON OF SOCIOECONOMIC AND HEALTH ACCESS INDICATORS BETWEEN URBAN AND RURAL PARTICIPANTS

Indicator Category	Urban Score	Rural Score
Income Stability	High	Low
Healthcare Accessibility	High	Low
Dietary Diversity	Moderate	Low
Physical Activity Levels	Low	Moderate
Preventive Checkup Frequency	High	Low

The discussion also points out that cardiovascular vulnerability is not only dependent on the quantifiable biological aspects, but also on the non-quantifiable environmental demands. Employees living in cities often mentioned negative feelings at work, excessive working hours, and absence of social life as key causes of emotional stress. The rural dwellers had some concerns which concerned their agricultural production, fluctuation of monsoons, loan repayment and scarcity of employment options. These stressors build up and are manifested through physiological manifestations like irregular sleep patterns and an increase in the resting pulse rate. On visualization, these results constituted figure 4. The contribution percentage of key drivers of stress which is the work pressure, financial instability, environmental conditions, social support and sleep degradation is presented in the diagram with work pressure dominating in urban areas and financial instability and environmental uncertainty dominating in rural areas. As figure 4 illustrates, in cases where the stress of urban lifestyle seems to be extreme, economic stress in the country has a more stable and sustained effect.

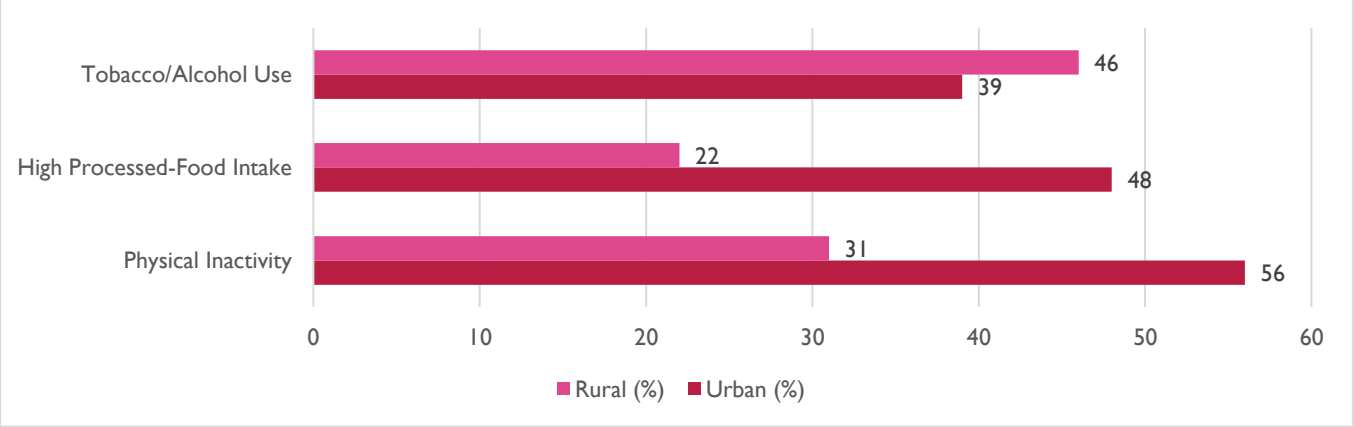

FIG. 4: LIFESTYLE-BASED CONTRIBUTORS TO CVD RISK IN URBAN VS. RURAL SETTINGS

In order to estimate the general cardiovascular susceptibility, the researchers measured behavioural habits, self-reported

symptoms of stress and clinically registered CVD indicators. Middle-income groups of urban residents showed different trends: moderate physiological threat and high strain of behaviour, because of the lack of rest, physical activity, and excessive exposure to digital screens. Participants living in rural areas and especially in areas with unstable agricultural income showed high chronic stress, reactive coping styles like the use of tobacco and, poor treatment, cycles. Table 2: Comparative Vulnerability Profile Across Urban and Rural Groups, which is used in this discussion, was developed on the basis of these collective patterns to generalize the level of integrated vulnerability. The table classifies vulnerability into three broad categories which are physiological strain, psychological pressure, and lifestyle imbalance.

TABLE 2: COMPARATIVE VULNERABILITY PROFILE ACROSS URBAN AND RURAL GROUPS

Vulnerability Factor	Urban Level	Rural Level
Physiological Strain	Moderate	High
Psychosocial Pressure	High	High
Lifestyle Imbalance	High	Moderate

The other interesting observation came about during the cross-analysis of various occupational groups. The highest peaks of periodic stress were seen among urban service-sector workers, particularly in high-demand weeks, and low stress was seen among rural daily-wage workers, who did not change much. This difference is indicative of the uncertainty in the rural occupations where incomes are greatly dependent on the seasonal results. These quantitative findings were supported by the qualitative feedback derived in the course of interviews. The rural respondents were often resigned by their stress levels seeing it as an unavoidable aspect of life. The city residents were however more willing to undergo a change in lifestyle but were short of time to make this changes consistent. These trends demonstrate that the attitudes to stress affect the behavioral implications, and any intervention plan should target the psychological attitudes.

Moreover, the review has shown that the young adults in the urban centers have started to display early warning signs of cardiovascular strain and this may be attributed to the decreased physical activity, more screen time, and the increased reliance on the ready-made foods. On the other hand, the young adults in the rural areas demonstrated reduced early signs of CVD but experienced rising susceptibility on the basis of tobacco availability, alcohol use, and a growing dietary change of packaged foods. These two transitions show that the urban areas are still on the path of producing life-style-based cardiovascular risks; nevertheless, the rural areas are quickly following the same route because of modernization and altered consumption patterns [13].

The findings in general reinforce the idea that cardiovascular risk in India is a multidimensional phenomenon as it is a complex product of structural, behavioral and psychological factors. Urban settings have spikes in stress and imbalance of lifestyles, whereas rural settings present incessant, cumulative stress levels and little access to healthcare resources [14]. The existence of these opposing patterns means that all nationwide cardiovascular prevention initiatives should consider the element of contextual sensitivity, and the interventions need to be tailored to meet the particular urban and rural stress frameworks. Finally, the research focuses on the necessity of place-based, economically feasible and culturally responsive prevention systems.

CONCLUSION

The current paper shows that both socioeconomic disparities and psychosocial stress are significant factors that contribute to cardiovascular disease risk in both the urban and rural Indian settings. Whereas in urban populations people encounter lifestyle and environment challenges, rural dwellers encounter risk by way of economic struggle, inaccessibility to healthcare and new lifestyle changes. Psychosocial stress acts as an important mediator between socioeconomic misery and physiological risk factors, and the importance of considering the whole person approach to health in the population.

The limitations associated with the study are its limited sample in terms of geographical location, use of self-reported psychosocial measures, and cross-sectional design, which limits causal inferences. Further, the clinical outcomes of lipid profiles and inflammatory biomarkers were not examined because of finances.

It should be directed in future to:

- Cohort studies in more states of India.
- The incorporation of biomarker diagnostics.
- Stress-mediated risk patterns prediction using machine learning models.
- Interventions at community level aiming at social supports, mental health etc. and socioeconomic stability.
- Empirical study on structural disparities in urban and rural healthcare.

India can proceed towards interventions aimed at reducing the increasing burden of CVDs, which will occur through a combination of social, economic, and psychological factors.

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