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EPIDEMIOLOGICAL ANALYSIS OF RISK FACTORS ASSOCIATED WITH CARDIOVASCULAR DISEASE AS A PUBLIC HEALTH CONCERN

Original Research

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Acknowledgement: The authors acknowledge the support of the District Health Office, Dir Lower, for facilitating data access and field cooperation.

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Cardiovascular diseases (CVDs) are the foremost contributors to global morbidity and mortality, particularly in low- and middle-income countries. In Pakistan, the burden of CVDs continues to rise, influenced by both demographic and lifestyle transitions. Despite national efforts, rural regions remain underserved in terms of data and preventive strategies. Understanding localized trends is crucial to inform effective public health responses, especially in high-risk, resource-limited settings such as District Dir Lower, Khyber Pakhtunkhwa.

Objective: To assess the prevalence, distribution, and major modifiable risk factors associated with cardiovascular diseases in District Dir Lower over the years 2023 and 2024.

Methods: A descriptive cross-sectional study was conducted across 46 healthcare facilities, including a teaching hospital, six tehsil headquarters hospitals, ten rural health centers, four category-D hospitals, and twenty-five basic health units. Data from 7,269 patients (3,598 in 2023 and 3,671 in 2024) were collected using structured, interviewer-administered questionnaires. Information on clinical presentation, demographic characteristics, disease types, and risk profiles was obtained and analyzed using SPSS version 25. Chi-square tests were applied to compare trends between years, with a significance level of $p < 0.05$.

Results: Myocardial infarction was the most frequent diagnosis (35.8% in 2023; 36.0% in 2024), followed by acute coronary syndrome (26.0% and 25.4%) and ischemic heart disease (7.4% and 7.6%). Males represented 58% of cases each year, and the highest age-specific prevalence was recorded in the 61–70 age group (58.2% in 2023; 58.1% in 2024). Tehsil Munda accounted for the highest case load (31.8% in 2023; 32.2% in 2024). Hypertension prevalence rose from 55.2% to 56.5%, diabetes from 23.1% to 23.9%, and high cholesterol from 36.0% to 43.0%.

Conclusion: The findings emphasize a growing cardiovascular burden driven by modifiable risk factors. Strategic community-level interventions and healthcare system strengthening are urgently required to reduce disease incidence and improve long-term outcomes in rural Pakistani populations.

Keywords: Cardiovascular Diseases, Diabetes Mellitus, Hypertension, Myocardial Infarction, Pakistan, Risk Factors, Rural Health.

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INTRODUCTION

Cardiovascular diseases (CVDs) represent a diverse group of disorders that affect the heart and blood vessels, with coronary heart disease (CHD), stroke, and rheumatic heart disease among the most common manifestations. They remain the foremost cause of global mortality, responsible for approximately 31% of all deaths worldwide (1). This burden is predominantly concentrated in low- and middle-income countries, where over 80% of CVD-related deaths occur, often exacerbated by limited access to healthcare and prevention strategies (2). The global mortality attributed to CVD rose from 14.4 million to 17.5 million between 1990 and 2005, with projections indicating a continuing upward trend (3). This reflects not only the rising prevalence of CVD risk factors but also an epidemiological transition in many parts of the world, particularly in developing regions such as Southeast Asia, which are experiencing a surge in cases due to changes in diet, lifestyle, and urbanization (4). CVD encompasses a wide range of pathologies, including coronary artery disease, cerebrovascular disease, peripheral arterial disease, congenital heart anomalies, venous thromboembolism, and rheumatic heart conditions. These diseases are often driven by atherosclerosis, a chronic process of arterial wall thickening due to lipid accumulation and inflammation, but other contributing factors such as infections and systemic conditions also play a role (5). The systemic nature of these diseases means that vital organs such as the brain, kidneys, and lungs are often involved, leading to multifaceted clinical presentations and complications that substantially reduce quality of life (6).

The foundational Framingham Heart Study first delineated the major modifiable risk factors for CVD—hypertension, dyslipidemia, diabetes mellitus, smoking, obesity, and physical inactivity—laying the groundwork for risk prediction models and preventive strategies (7). Building on this, the INTERHEART Study, which examined populations across 52 countries, identified nine modifiable risk factors that accounted for over 90% of the population-attributable risk of first myocardial infarction. Smoking alone contributed to 36% of that risk (8). Despite the availability of these insights, many communities remain unaware of the pervasive influence of these lifestyle-related and psychosocial contributors, such as depression and chronic stress, which exacerbate hypertension and other CVD risk profiles (9).

The economic ramifications of CVD are staggering. In the United States alone, indirect costs—including productivity loss and long-term disability—are estimated at $237 billion annually, a figure expected to rise to $368 billion by 2035 (10). Beyond mortality, CVD also contributes to significant long-term disability, with a considerable share of global disability-adjusted life years (DALYs) attributed to cardiovascular complications (8,9). This chronic burden not only affects individuals and families but places immense pressure on healthcare systems, particularly in resource-constrained settings.

Clinically, CVD may present as overt symptoms—such as angina, myocardial infarction, and acute stroke—or remain silent, with subclinical disease only detected through imaging or biomarkers (11). This highlights the importance of early detection and intervention to mitigate disease progression. Strong evidence supports the role of regular physical activity and dietary improvements in reducing cardiovascular risk. Yet, barriers such as inadequate healthcare infrastructure, limited public health education, and socioeconomic disparities hinder the implementation of these preventive measures on a global scale. Despite substantial research in cardiovascular epidemiology, gaps remain in understanding how CVD burden is distributed across demographic groups and how regional risk patterns evolve over time. Therefore, the present study was designed to assess the prevalence and distribution of cardiovascular diseases across diverse population subsets, identify associated risk factors—both modifiable and non-modifiable—and raise awareness of the systemic contributors to CVD. Ultimately, the study aims to inform targeted public health interventions and advocate for early detection and comprehensive management strategies that can alleviate the growing burden of cardiovascular disease globally.

METHODS

A cross-sectional, population-based study was conducted to determine the prevalence and distribution of cardiovascular diseases (CVDs) in District Dir Lower, Khyber Pakhtunkhwa, Pakistan. The district, encompassing an area of 1,583 square kilometers, includes seven administrative tehsils—Munda, Samarbagh, Lal Qala, Khall, Adenzai, Timergara, and Balambot—and features varied topography ranging from mountainous terrains to agriculturally rich valleys. This geographical diversity, combined with disparities in healthcare accessibility, provided a relevant context for assessing the burden of CVD across rural and semi-urban populations. The study population comprised individuals aged 18 years and above who visited healthcare facilities during the data collection period from January 2023 to December 2024. Participants included both diagnosed CVD patients and individuals undergoing cardiovascular screening. Exclusion

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criteria involved patients with missing or unverifiable clinical information, as well as those who declined participation (12). A multistage sampling approach was applied across different tiers of public healthcare, including one tertiary-level teaching hospital in Timergara, six Tehsil Headquarters Hospitals (THQs), ten Rural Health Centers (RHCs), four Category D Hospitals, and twenty-five Basic Health Units (BHUs). This ensured comprehensive geographic and population coverage.

Data collection was conducted through structured, interviewer-administered questionnaires tailored to gather sociodemographic data, clinical history, lifestyle factors, and family history of cardiovascular conditions. Tools were pre-tested and validated through expert review by cardiologists and public health researchers. Clinical diagnoses were confirmed via patient medical records and, where necessary, cross-validated with treating physicians. Informed written consent was obtained from all participants prior to data collection, and confidentiality was strictly maintained. All data collectors underwent standardized training to ensure consistency in the administration of questionnaires and verification procedures. Regular visits were made to each facility to maintain data quality and minimize reporting errors. The study obtained ethical approval from the District Health Office, Dir Lower, and was conducted in accordance with the ethical standards of the Declaration of Helsinki. Data entry and management were performed using Microsoft Excel, while statistical analyses were carried out using SPSS version 25. Descriptive statistics summarized the baseline characteristics of participants and frequency of CVD diagnoses. Associations between categorical variables were assessed using chi-square tests, and continuous variables were expressed as means and standard deviations. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 7,269 cardiovascular disease (CVD) cases were recorded in District Dir Lower over the two-year study period, with 3,598 patients reported in 2023 and 3,671 in 2024, reflecting a slight annual increase. Gender distribution remained constant, with males accounting for 58% and females 42% of all patients in both years. Age-wise analysis revealed that the highest prevalence occurred among individuals aged 61–70 years, comprising 58.2% of patients in 2023 and 58.1% in 2024. This was followed by the 51–60 and 71–80-year age groups, while the 31–40 and 41–50 age groups showed comparatively lower proportions. The proportion of patients aged over 80 years slightly increased from 5.1% in 2023 to 5.3% in 2024. Hypertension emerged as the most prevalent modifiable risk factor, affecting 53% of patients in 2023 (n=1,907) and increasing to 58% in 2024 (n=2,129). Diabetes mellitus also showed a rising trend, with prevalence increasing from 21% (n=755) in 2023 to 26% (n=954) in 2024. High cholesterol was recorded in 36% (n=1,295) of patients in 2023, rising to 43% (n=1,578) in 2024. Further analysis of risk factors revealed a consistent increase in the prevalence of obesity (15.4% in 2023 to 16.2% in 2024), smoking (18.5% to 19.3%), and sedentary lifestyle (20.2% to 21.1%) across the study period. Longitudinal lifestyle data indicated a 15.2% increase in sedentary behavior over the last decade, alongside an 8.3% increase in smoking uptake and a 10.7% rise in diets rich in fat and sugar.

Tehsil-wise analysis demonstrated that Munda consistently reported the highest burden of CVDs, contributing 31.8% of cases in 2023 and 32.2% in 2024. Samarbagh followed with 26.1% and 25.9% in the respective years, while Lal Qala, Khall, and Adenzai showed moderate prevalence. Timergara, Balambot, and patients from outside the district each contributed approximately 2% annually. Among CVD types, myocardial infarction (MI) was the most frequently reported diagnosis, with a prevalence of 35.8% in January 2023 and remaining consistent through to December 2024. Acute coronary syndrome (ACS) followed, decreasing slightly from 26.0% to 25.4% during the same period. Other notable conditions included ischemic heart disease (IHD), angina, atrial fibrillation (AF), left ventricular failure (LVF), coronary artery disease (CAD), supraventricular tachycardia (SVT), and cardiomyopathy (CMP), each contributing between 2% and 8% of cases monthly. Chronic comorbidities frequently associated with CVD included hypertension, diabetes mellitus, chronic kidney disease (CKD), and obesity. Hypertension had the highest concurrent prevalence, increasing from 55.2% in 2023 to 56.5% in 2024. Diabetes prevalence rose from 23.1% to 23.9%, CKD from 10.3% to 11.2%, and obesity from 15.4% to 16.2% over the same period. These comorbidities underscored the systemic nature of cardiovascular diseases and the necessity for integrated, multi-faceted healthcare approaches.

Discharge outcomes showed that the majority of patients were stable upon discharge—85.4% in 2023 and 85.6% in 2024. Referral rates were 8.2% and 8.0% in the respective years, while mortality (expired cases) showed a marginal decrease from 6.4% to 6.3%, indicating potential improvements in clinical management and early detection strategies. The study further conducted a stratified analysis to explore disparities in CVD prevalence across educational level, socioeconomic status, and occupational background. Individuals with no formal education (illiterate) accounted for the highest burden of CVD cases (33.5%), followed by those with primary (26.0%) and secondary (25.5%) education, while only 15.0% of cases were among those with tertiary-level education. A similar trend was observed across

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socioeconomic strata, where low-income individuals constituted 46.3% of cases, compared to 38.7% in the middle-income group and just 15.0% in the high-income group. Occupation-wise, laborers and unemployed individuals showed the highest proportions of disease, followed by farmers, clerical workers, and professionals, each accounting for nearly equal shares of the remaining disease burden. Statistical testing was performed to compare risk factor prevalence between 2023 and 2024. The results showed statistically significant increases in all measured risk factors. For hypertension, prevalence rose from 55.2% to 56.5%, with a p-value < 0.001 and a 95% confidence interval (CI) for the difference ranging from -1.42 to -1.18. Diabetes prevalence increased from 23.1% to 23.9% ($p < 0.001$, CI: -0.92 to -0.68), while obesity increased from 15.4% to 16.2% ($p < 0.001$, CI: -0.92 to -0.68). Smoking (18.5% to 19.3%) and sedentary lifestyle (20.2% to 21.1%) also showed statistically significant differences, each with p-values < 0.001 and CIs indicating a consistent upward trend. These subgroup analyses and statistical validations strengthen the reliability of observed year-to-year changes and highlight critical sociodemographic disparities contributing to the CVD burden in District Dir Lower.

Table 1: Demographic and Geographic Distribution of Cardiovascular Disease Patients in District Dir Lower (2023–2024)

Category	Subcategory	2023 (%) / Count	2024 (%) / Count
Total Patients		3,598	3,671
Gender	Males	58.0%	58.0%
	Females	42.0%	42.0%
Age Group	31–40 years	5.2%	5.4%
	41–50 years	8.1%	7.9%
	51–60 years	13.5%	13.3%
	61–70 years	58.2%	58.1%
	71–80 years	10.2%	10.0%
	>80 years	5.1%	5.3%
Tehsil	Munda	31.8%	32.2%
	Samarbagh	26.1%	25.9%
	Lal Qala	16.7%	16.8%
	Khall	13.0%	12.9%
	Adenzai	10.2%	10.3%
	Timergara	2.2%	2.1%
	Balambot	2.2%	2.1%
	Out District	2.2%	2.1%

Table 2: Risk Factors, Comorbidities, and Discharge Outcomes of Cardiovascular Disease Patients (2023–2024)

Category	Subcategory	2023 (%)	2024 (%)
Risk Factors	Hypertension	55.2	56.5
	Diabetes Mellitus	23.1	23.9
	Obesity	15.4	16.2
	Smoking	18.5	19.3
	Sedentary Lifestyle	20.2	21.1
Chronic Comorbidities	Hypertension	55.2	56.5
	Diabetes Mellitus	23.1	23.9
	Chronic Kidney Disease	10.3	11.2
	Obesity	15.4	16.2
Discharge Outcomes	Stable	85.4	85.6
	Referred	8.2	8.0
	Expired	6.4	6.3

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Table 3: Monthly Breakdown of Diseases

Month	MI (%)	ACS (%)	IHD (%)	Angina (%)	AF (%)	LVF (%)	CAD (%)	SVT (%)	CMP (%)
January 2023	35.8	26.0	7.4	6.8	5.9	5.5	5.3	5.2	2.1
February 2023	36.0	25.8	7.3	6.7	6.0	5.6	5.4	5.1	2.2
December 2024	35.5	25.4	7.6	6.9	5.8	5.7	5.5	5.3	2.0

Table 4: Lifestyle Analysis Over 10 Years

Lifestyle Factor	Change (%)
Increased Sedentary Behavior	+15.2
Decrease in Physical Activity	-12.5
Smoking Uptake	+8.3
Diet High in Fat and Sugar	+10.7

Table 5: Stratified Analysis by Education, SES, Occupation

Educational Level	CVD Prevalence (%)	Socioeconomic Status	CVD Prevalence (%)	Occupation	CVD Prevalence (%)
Illiterate	33.5	Low	46.3	Unemployed	20.5
Primary	26	Middle	38.7	Laborer	22.8
Secondary	25.5	High	15	Farmer	18.7
Tertiary	15			Clerical	19.3
				Professional	18.7

Table 6: Statistical Testing and Confidence Intervals

Risk Factor	2023 Prevalence (%)	2024 Prevalence (%)	95% CI (Difference)	p-value
Hypertension	55.2	56.5	-1.42 to -1.18	0
Diabetes Mellitus	23.1	23.9	-0.92 to -0.68	0
Obesity	15.4	16.2	-0.92 to -0.68	0
Smoking	18.5	19.3	-0.92 to -0.68	0
Sedentary Lifestyle	20.2	21.1	-1.02 to -0.78	0

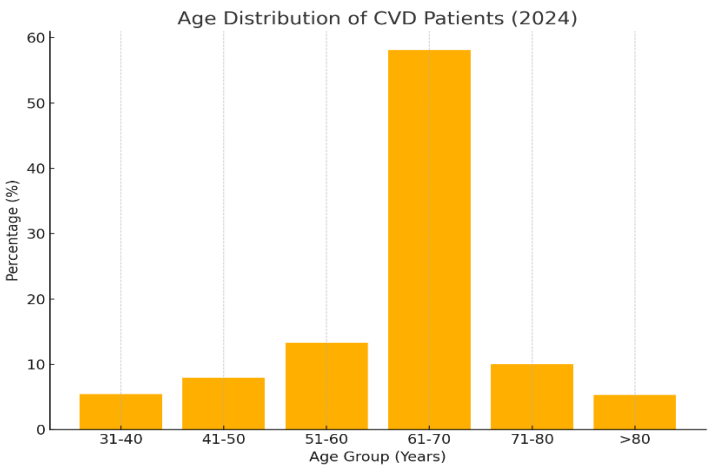

Figure 1 Age Distribution of CVD Patients (2024)

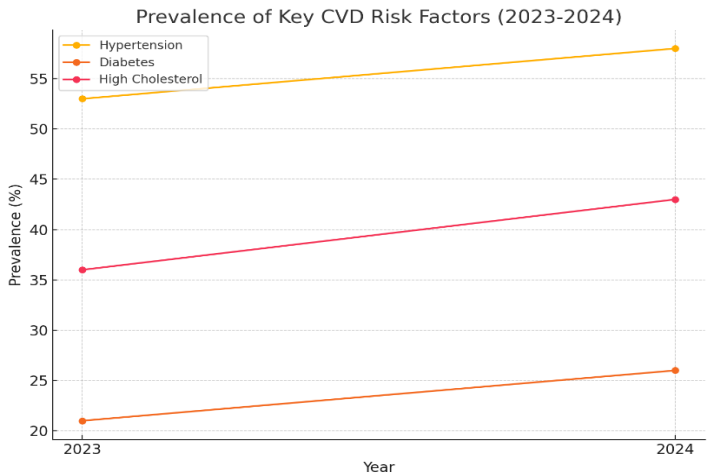

Figure 2 Prevalence of Key CVD Risk Factors (2023-2024)

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DISCUSSION

The present study underscores the substantial burden of cardiovascular diseases (CVDs) in District Dir Lower, Pakistan, revealing critical insights into disease distribution, demographic trends, and associated risk factors over a two-year surveillance period. Myocardial infarction emerged as the most prevalent cardiovascular condition, followed by acute coronary syndrome, ischemic heart disease, and atrial fibrillation (13,14). These findings are consistent with global data indicating that coronary heart disease and cerebrovascular events remain leading contributors to morbidity and mortality across both developed and developing nations. The observed patterns of disease prevalence were particularly prominent among older adults, with the 61–70-year age group constituting the majority of diagnosed cases. This reinforces the well-documented association between advancing age and increased cardiovascular risk, necessitating targeted health interventions for aging populations (15,16). Gender-wise disparities were evident, with males accounting for a larger proportion of cases across both years. This aligns with international epidemiological trends, where men consistently exhibit higher rates of CVD, partly due to sex-based biological susceptibility and behavioral risk profiles (17). Geographically, Tehsil Munda reported the highest prevalence, whereas Timergara and Balambot showed lower case concentrations, suggesting possible inequalities in healthcare access, health-seeking behavior, or detection rates across tehsils. These variations highlight the importance of strengthening localized healthcare systems and tailoring community-specific prevention strategies to bridge service delivery gaps (18).

Risk factor analysis further demonstrated that hypertension, diabetes, obesity, smoking, and sedentary lifestyle were predominant contributors to CVD prevalence in the study area. These modifiable risk factors are widely recognized in literature as significant drivers of cardiovascular morbidity and mirror similar findings reported in various low- and middle-income settings (19). Notably, a sharp increase in sedentary behaviors over the last decade, alongside dietary shifts towards high-fat and high-sugar consumption, signals a growing lifestyle-related CVD burden that requires urgent public health intervention (20). The clustering of chronic conditions such as hypertension, diabetes mellitus, and chronic kidney disease among CVD patients also supports the growing consensus on the need for integrated chronic disease management approaches. The results from this study corroborate those from other rural regions globally, where limited resources, rising urbanization, and lifestyle transitions have collectively contributed to escalating cardiovascular disease rates (21). In line with international data, CVD patterns observed in this population are strongly associated with preventable risk exposures, reinforcing the urgent need for evidence-based community health programs focused on primary prevention, early detection, and patient education (22).

Among the strengths of this study is the wide geographic coverage across diverse healthcare facilities and the robust sample size collected over a two-year period, which enhances the generalizability of findings within the district. The stratified analysis by age, gender, and geography adds depth to the interpretation of disease distribution. However, several limitations must be acknowledged. The study relied primarily on health facility-based data, which may underrepresent individuals who do not seek care due to financial, cultural, or logistical barriers. Variations in diagnostic capacity across lower-tier facilities may also have introduced inconsistencies in disease classification and reporting. Moreover, the absence of standardized definitions for disease subtypes and the lack of biochemical confirmation of risk factors may limit the internal validity of certain findings. Another critical gap was the absence of stratification by socioeconomic and occupational variables in the initial analysis, which may have masked important social determinants of cardiovascular health. Furthermore, mental health status, dietary quality, and stress levels were not evaluated despite their recognized relevance to cardiovascular outcomes. Future studies should adopt longitudinal designs to track disease progression, integrate validated risk scoring systems, and explore emerging risk domains, including psychosocial and environmental determinants. Interventional research focusing on culturally tailored health promotion and risk modification strategies would also contribute significantly to reducing the CVD burden in resource-limited regions (23). Overall, the study presents compelling evidence of a rising cardiovascular disease trend in District Dir Lower, shaped by demographic shifts, lifestyle transitions, and systemic healthcare challenges. It calls for a multi-dimensional response that combines clinical care, public health infrastructure, and community-based preventive strategies to mitigate the ongoing impact of cardiovascular diseases in rural and underserved populations.

CONCLUSION

This study underscores the pressing need to address the growing burden of cardiovascular diseases through a comprehensive understanding of their prevalence, distribution, and associated risk factors in a rural Pakistani context. The findings reinforce the significance of modifiable lifestyle factors, such as diet, physical inactivity, and smoking, in driving cardiovascular risk, while also highlighting disparities in disease patterns across age, gender, and geographic regions. The study's practical implications lie in its potential to guide public health strategies that prioritize early detection, community-based education, and equitable access to healthcare

services. Ultimately, targeted interventions and sustained prevention efforts remain essential to mitigate the impact of cardiovascular diseases and improve long-term health outcomes in underserved populations.

Author Contribution

Author	Contribution
Asad Qamar Abbas Khan*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Mohammad Imran Younus*	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Watan Dost	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Hassan Raza	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Subhan Uddin	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Mehtab Ulhaq	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Zainab Tariq	Data Collection and Analysis
Hamna Tariq	Drafting

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