RESEARCH PAPER

Quantitative Assessment of Modifiable and Non-Modifiable Risk Factors Associated With Cardiovascular Disease in Adult Patients: A Clinical Pharmacy Perspective

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ABSTRACT

Objective: To quantitatively assess the prevalence and independent contribution of modifiable and non-modifiable risk factors associated with cardiovascular disease (CVD) among adult patients, with emphasis on clinical pharmacy implications for risk stratification and preventive care.

Methods: A prospective observational study was conducted over 15 months in the outpatient department of a tertiary care hospital. A total of 252 adults were recruited through stratified random sampling. Data on demographic characteristics, clinical parameters, and lifestyle-related risk factors were collected using a validated data collection tool. Cardiovascular risk was estimated using the Framingham Risk Score. Statistical analyses included chi-square test, independent t-test, and multivariate logistic regression, with significance set at $P < 0.05$.

Results: A substantial burden of cardiometabolic risk factors was identified, with high prevalence of diabetes mellitus (89.3%), hypertension (78.6%), obesity (71.4%), and physical inactivity (79.4%). Significant associations were observed between cardiovascular risk and physical inactivity (χ^2=52.1), hypertension (χ^2=48.2), diabetes mellitus (χ^2=9.6), dyslipidaemia (χ^2=8.9), and smoking (χ^2=4.7) ($P<0.05$). Patients classified as high risk demonstrated significantly elevated systolic blood pressure, fasting glucose, and total cholesterol levels ($P<0.01$). Multivariate analysis confirmed physical inactivity (OR=6.6) and hypertension (OR=5.9) as the most influential independent predictors of cardiovascular risk.

Conclusion: Cardiovascular risk in the study population is predominantly driven by modifiable metabolic and behavioural determinants. These findings highlight the critical role of clinical pharmacists in implementing targeted interventions, including medication therapy management, adherence optimization, and patient-centered education, to mitigate risk and improve cardiovascular outcomes .

Keywords: Cardiovascular disease; Risk factors; Hypertension; Diabetes mellitus; Physical inactivity; Dyslipidaemia; Framingham Risk Score; Clinical pharmacy; Medication therapy management; Preventive cardiology.

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INTRODUCTION

Cardiovascular diseases (CVDs) remain the leading cause of global morbidity and mortality, accounting for a substantial proportion of premature deaths, particularly in low- and middle-income countries undergoing rapid epidemiological transition and urbanization [1,2]. Recent global burden estimates indicate a continued rise in cardiometabolic disorders, driven by demographic shifts, sedentary lifestyles, and increasing prevalence of metabolic risk factors [2]. Early identification and effective management of these determinants are central to reducing disease burden and improving long-term outcomes.

CVD development is inherently multifactorial, involving an interplay between non-modifiable factors such as age, sex, and genetic predisposition, and modifiable factors including hypertension, diabetes mellitus, dyslipidaemia, obesity, tobacco use, and physical inactivity [3,4]. Contemporary evidence demonstrates that a large proportion of cardiovascular events can be attributed to modifiable risk factors, highlighting their critical role as targets for

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preventive interventions [5]. In particular, physical inactivity and poorly controlled hypertension have emerged as dominant contributors to cardiovascular risk in diverse populations [6,7].

The clustering of cardiometabolic abnormalities further amplifies cardiovascular risk through interconnected pathophysiological mechanisms, including insulin resistance, endothelial dysfunction, oxidative stress, and chronic low-grade inflammation [7,8]. This synergistic interaction accelerates atherosclerotic progression and increases the likelihood of adverse cardiovascular events. Despite advances in pharmacotherapy and the availability of evidence-based guidelines, real-world control of cardiovascular risk factors remains suboptimal. Factors such as poor medication adherence, therapeutic inertia, inadequate risk assessment, and limited patient awareness continue to hinder optimal disease management [9,10].

In this context, clinical pharmacists play a pivotal role in bridging these gaps through medication therapy management, risk factor screening, patient education, and pharmacovigilance. Pharmacist-led interventions have been shown to significantly improve blood pressure control, glycaemic outcomes, and overall cardiovascular risk profiles in recent interventional studies [11–13]. However, there remains a need for context-specific data evaluating the relative contribution of modifiable and non-modifiable risk factors and their implications for clinical pharmacy practice, particularly in resource-limited settings.

Therefore, the present study aims to quantitatively assess the prevalence and independent contribution of modifiable and non-modifiable cardiovascular risk factors among adult patients, with a specific focus on their implications for risk stratification and clinical pharmacy-driven preventive strategies.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted over a period of 15 months (January 2025–March 2026) in the outpatient department of a tertiary care teaching hospital. The study setting enabled inclusion of a representative ambulatory population and facilitated real-world cardiovascular risk assessment.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee (St. Peter’s Institute of Pharmaceutical Sciences; IEC No: St. Peter’s IEC/2025/I/11). The study adhered to the Declaration of Helsinki and ICMR guidelines. Written informed consent was obtained from all participants, and confidentiality of patient data was maintained.

Study Population

Adults aged ≥18 years with established or potential risk of cardiovascular disease were included. Pregnant women, terminally ill patients, and those unwilling to participate were excluded.

Sample Size and Sampling Technique

Sample size was calculated using a standard prevalence-based formula with 95% confidence interval and 5% margin of error. Stratified random sampling was employed to ensure representative distribution across demographic and clinical categories.

Data Collection

Data were collected using a pre-validated case record form. Variables included demographic characteristics, family history, and major cardiovascular risk factors. Modifiable risk factors assessed were hypertension, diabetes mellitus, dyslipidaemia, obesity, smoking, alcohol use, and physical inactivity. Medication history was reviewed to identify therapy-related risk contributors.

Operational Definitions

Hypertension was defined as blood pressure ≥140/90 mmHg or use of antihypertensive therapy. Diabetes mellitus was defined as fasting glucose ≥126 mg/dL, random glucose ≥200 mg/dL, or ongoing treatment. Dyslipidaemia was defined based on abnormal lipid parameters or lipid-lowering therapy. Obesity was defined as BMI ≥25 kg/m² (Asian criteria). Physical inactivity was defined as <150 minutes of moderate activity per week.

Outcome Measures

The primary outcome was cardiovascular risk stratification using the Framingham Risk Score (FRS). Patients were categorized into low (<10%), moderate (10–20%), and high (>20%) risk groups.

Statistical Analysis

Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± SD and categorical variables as frequencies and percentages. Associations were assessed using chi-square test and independent t-test. Multivariate logistic regression was performed to identify independent predictors, with results reported as odds ratios (OR) and 95% confidence intervals (CI). A P-value <0.05 was considered statistically significant.

Clinical Pharmacy Involvement

Clinical pharmacists participates in data collection, medication review and identification of drug-related problems. Interventions focused on medication therapy assessment, adherence evaluation, and risk factor identification, strengthening the clinical applicability of the study.

RESULTS

Overview of Study Findings

This study evaluated the distribution and clinical relevance of modifiable and non-modifiable cardiovascular risk factors among adult patients in a tertiary care setting. Risk stratification using the Framingham Risk Score enabled categorization into clinically relevant groups, supporting comparative analysis of demographic and risk-related variables.

Baseline Characteristics of Study Population

A total of 252 patients were included, with a mean age of 52.3 ± 11.5 years, indicating a predominance of middle-aged individuals. The majority of participants (54.4%) were aged 46–60 years, followed by 23.8% aged >60 years, while younger adults (18–30 years) constituted only 1.6% of the cohort.

Gender distribution was equal (50% male, 50% female), minimizing sex-related bias. A family history of diabetes mellitus was reported in 67.5% of participants, suggesting a substantial hereditary contribution to the observed cardiometabolic risk profile.

Table 1 Demographic Characteristics and Family History Profile of the Study Population (N=252

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	4	1.6%
	31–45	51	20.2%
	46–60	137	54.4%
	>60	60	23.8%
Gender	Male	126	50.0%
	Female	126	50.0%
Family history of DM	Yes	170	67.5%
	No	82	32.5%

The predominance of individuals in the 46–60 years age group indicates clustering within a higher-risk demographic segment. The high prevalence of family history further suggests a potential interaction between genetic predisposition and modifiable risk factors.

The distribution of demographic variables is further illustrated in Figure 1, which shows the age group distribution among the study population. The graphical presentation clearly demonstrates the predominance of the middle-aged group, reinforcing the findings observed in the tabulated data.

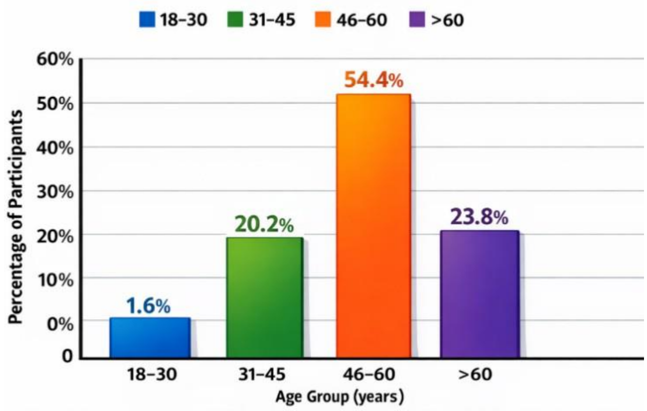

Figure 1 Illustrates the Age Distribution of Study Population

Prevalence of Modifiable and Non-Modifiable Risk Factors

A high burden of cardiometabolic and behavioural risk factors was observed in the study population. Diabetes mellitus was the most prevalent condition (89.3%), followed by hypertension (78.6%) and physical inactivity (79.4%). Obesity was present in 71.4% of participants, indicating a substantial contribution of excess body weight to cardiovascular risk.

Behavioural risk factors included alcohol use (31.7%) and smoking (23.4%). Dyslipidaemia was identified in 24.2% of patients, representing the least prevalent metabolic factor within the cohort.

Table 2: Distribution of Cardiovascular Risk Factors

Risk Factor	Category	Frequency (n)	Percentage (%)
Hypertension (HTN)	Present	198	78.6%
	Absent	54	21.4%
Diabetes Mellitus (DM)	Present	225	89.3%
	Absent	27	10.7%
Dyslipidaemia	Present	61	24.2%
	Absent	191	75.8%
Obesity (BMI ≥25 kg/m²)	Present	180	71.4%
	Absent	72	28.6%
Smoking	Yes	59	23.4%
	No	193	76.6%
Alcohol Use	Yes	80	31.7%
	No	172	68.3%
Physical Inactivity	Yes	200	79.4%
	No	52	20.6%

The observed pattern indicates clustering of metabolic risk factors, particularly diabetes mellitus and hypertension, alongside a high prevalence of physical inactivity. This distribution reflects the combined influence of metabolic and lifestyle determinants on cardiovascular risk within the study population.

Association between Risk Factors and Cardiovascular Risk

Chi-square analysis demonstrated significant associations between major risk factors and cardiovascular risk stratification based on the Framingham Risk Score (Table 3). Physical inactivity showed the strongest association ($\chi^2 = 52.1$, $P < 0.001$), followed by hypertension ($\chi^2 = 48.2$, $P < 0.001$), indicating their dominant contribution to elevated cardiovascular risk.

Diabetes mellitus ($\chi^2 = 9.6$, $P = 0.002$) and dyslipidaemia ($\chi^2 = 8.9$, $P = 0.003$) were also significantly associated, reflecting the role of metabolic abnormalities. Smoking demonstrated a weaker but statistically significant association ($\chi^2 = 4.7$, $P = 0.03$).

Table 3: Association between Risk Factors and Cardiovascular Risk (Chi-square Test)

Variable	Category	CVD Risk Present (n)	CVD Risk Absent (n)	χ² Value	P-value
Hypertension	Yes	168	30	48.2	**<0.001***

Diabetes	Yes	192	33	9.6	**0.002 ***
Dyslipidaemia	Yes	55	6	8.9	**0.003**
Smoking	Yes	50	9	4.7	**0.03***
Physical inactivity	Yes	180	20	52.1	**<0.001***

All variables showed statistically significant associations (*P* < 0.05), confirming that these relationships are unlikely due to chance. The higher χ^2 values for physical inactivity and hypertension indicate stronger effects compared to other factors (Figure 2).

Overall, the findings highlight that both lifestyle and metabolic factors contribute to cardiovascular risk, with modifiable determinants playing a major role.

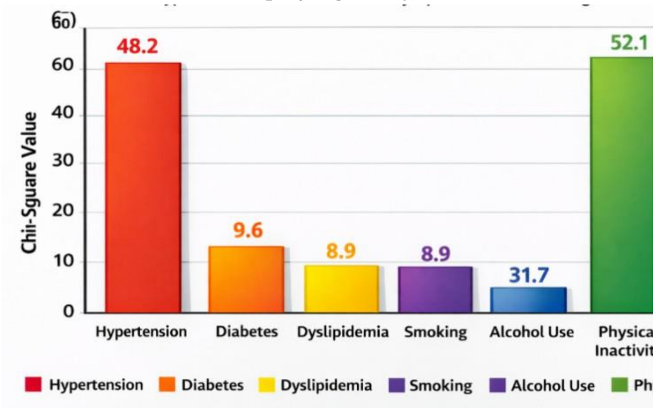

Figure 2. Comparative Strength of Association between Risk Factors and Cardiovascular Risk Based on Chi-square Values

Comparison of Clinical and Biochemical Parameters

Independent *t*-test analysis revealed significant differences in clinical and biochemical parameters between patients with and without cardiovascular risk (Table 4). Systolic blood pressure was significantly higher in the risk group (142.8 ± 17.6 mmHg) compared to the non-risk group (118.5 ± 12.4 mmHg; *t* = 9.52, *P* < 0.001). Similarly, diastolic blood pressure was elevated (87.6 ± 9.4 vs. 75.8 ± 7.9 mmHg; *P* = 0.001).

Fasting blood glucose levels were significantly greater in the risk group (162.4 ± 46.8 mg/dL vs. 112.6 ± 30.5 mg/dL; *P* = 0.002), along with total cholesterol (206.7 ± 35.9 mg/dL vs. 170.2 ± 28.7 mg/dL; *P* < 0.001).

Table 4: Comparison of Clinical Parameters (Independent t-test)

Variable	CVD Risk Group (Mean ± SD)	Non-Risk Group (Mean ± SD)	t-value	P-value
Systolic BP (mmHg)	142.8 ± 17.6	118.5 ± 12.4	9.52	**<0.001**
Diastolic BP (mmHg)	87.6 ± 9.4	75.8 ± 7.9	8.21	**0.001***
Fasting glucose (mg/dL)	162.4 ± 46.8	112.6 ± 30.5	7.38	**0.002***
Total cholesterol (mg/dL)	206.7 ± 35.9	170.2 ± 28.7	6.94	**<0.001**

All parameters showed statistically significant differences (*P* < 0.05), with higher values observed in the cardiovascular risk group. Blood pressure parameters demonstrated the greatest separation between groups, followed by glucose and cholesterol levels (Figure 3).

These findings indicate that both hemodynamic and metabolic factors are markedly elevated in high-risk individuals and contribute to cardiovascular risk stratification.

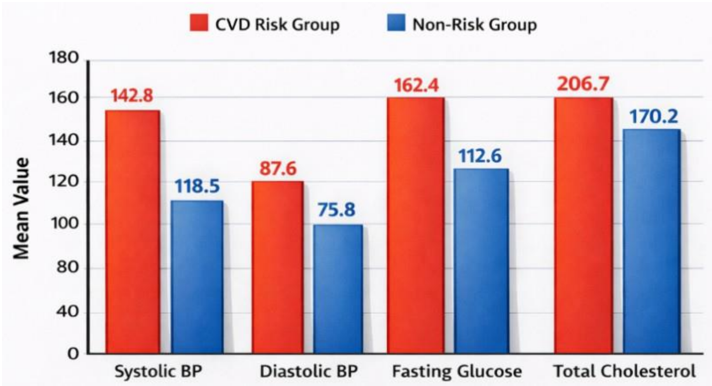

Figure 3. Comparative Analysis of Mean Clinical Parameters between Cardiovascular Risk Groups

Multivariate Logistic Regression Analysis

Multivariate logistic regression identified independent predictors of cardiovascular risk after adjustment for confounders (Table 5). Physical inactivity showed the strongest association (OR = 6.6; 95% CI: 3.5–12.4; *P* < 0.001), followed by hypertension (OR = 5.9; 95% CI: 3.2–10.8; *P* < 0.001).

Dyslipidaemia (OR = 3.4; 95% CI: 1.6–7.1; *P* = 0.001) and diabetes mellitus (OR = 2.7; 95% CI: 1.4–5.3; *P* = 0.003) were also significant predictors. Smoking demonstrated a moderate but significant association (OR = 2.2; 95% CI: 1.1–4.2; *P* = 0.02).

Table 5: Independent Predictors of Cardiovascular Risk

Variable	Odds Ratio (OR)	95% CI	P-value
Hypertension	5.9	3.2 – 10.8	**<0.001**
Dyslipidaemia	3.4	1.6 – 7.1	**0.001**
Diabetes Mellitus	2.7	1.4 – 5.3	**0.003***

Smoking	2.2	1.1 – 4.2	**0.02***
Physical inactivity	6.6	3.5 – 12.4	**<0.001**

All variables remained statistically significant ($P < 0.05$), with confidence intervals not crossing unity, confirming independent associations. Physical inactivity and hypertension showed the highest effect sizes, while diabetes, dyslipidaemia, and smoking contributed moderate but significant effects (Figure 4).

These findings indicate that both lifestyle and metabolic factors independently influence cardiovascular risk.

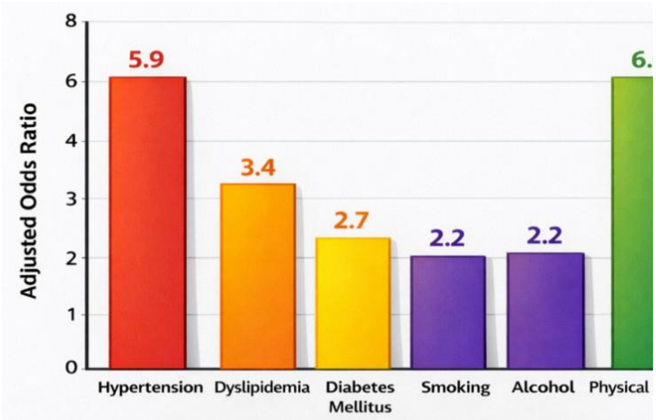

Figure 4. Adjusted Odds Ratios for Independent Predictors of Cardiovascular Risk

DISCUSSION

Cardiovascular disease remains a major public health concern, particularly in populations undergoing epidemiological transition. The present findings demonstrate a high burden of clustered cardiometabolic and behavioural risk factors (Table 2), supporting the multifactorial nature of cardiovascular risk. The coexistence of hypertension, diabetes, and physical inactivity reflects interconnected mechanisms such as metabolic dysregulation and endothelial dysfunction that accelerate atherosclerosis [16,17].

The demographic profile (Table 1, Figure 1) showed a predominance of individuals aged 46–60 years, indicating concentration within a high-risk age group. This is consistent with evidence that cumulative exposure to metabolic risk factors increases cardiovascular susceptibility with age [18]. The high prevalence of family history of diabetes (Table 1) further suggests a genetic predisposition interacting with lifestyle determinants [19].

A substantial burden of modifiable risk factors was observed (Table 2), particularly hypertension and diabetes, aligning with reports from South Asian populations [16,20]. Physical inactivity (Table 2) emerged as a key behavioural determinant, contributing to impaired glucose metabolism and vascular dysfunction [21]. Although dyslipidaemia showed lower prevalence (Table 2), its significant association with cardiovascular risk (Table 3) highlights its clinical importance and possible underdiagnosis [22].

The association analysis (Table 3, Figure 3) demonstrated that physical inactivity and hypertension had the strongest relationships with cardiovascular risk, indicating a synergistic effect of sedentary behaviour and hemodynamic stress on vascular damage [23]. Diabetes mellitus and dyslipidaemia (Table 3) also showed significant associations, supporting their roles in atherogenesis [22,24], while smoking showed a moderate but significant effect [25].

Significant differences in clinical and biochemical parameters (Table 4, Figure 4) indicate marked metabolic and hemodynamic imbalance among high-risk individuals. Elevated blood pressure, fasting glucose, and cholesterol levels (Table 4) reflect poor disease control and increased atherogenic burden [23,24], reinforcing their importance in cardiovascular risk stratification.

Multivariate analysis (Table 5, Figure 5) identified physical inactivity and hypertension as the strongest independent predictors of cardiovascular risk, indicating the dominant role of modifiable factors. The independent contributions of diabetes, dyslipidaemia, and smoking (Table 5) further confirm the multifactorial etiology of cardiovascular disease [22–25]. The consistency of effect sizes and statistical significance supports the robustness of these findings.

From a clinical pharmacy perspective, the findings emphasize the importance of pharmacist-led interventions targeting modifiable risk factors (Table 2) and key predictors (Table 5). Clinical pharmacists play a critical role in medication therapy management, adherence monitoring, and patient counselling. Evidence suggests that pharmacist-led interventions improve blood pressure control, glycaemic outcomes, and overall cardiovascular risk [26,27]. Additionally, pharmacists contribute to pharmacovigilance and rational drug use, particularly in patients with multiple comorbidities [28].

However, certain limitations should be considered. The hospital-based design may limit generalizability, and the cross-sectional nature restricts causal inference. The relatively lower prevalence of dyslipidaemia (Table 2) suggests potential gaps in screening practices. Future research should focus on longitudinal and interventional studies to evaluate long-term outcomes and the effectiveness of pharmacist-led strategies. Integration of digital health tools may further enhance risk prediction and patient-centered care.

CONCLUSION

This study demonstrates a substantial burden of cardiovascular risk factors among adult patients, with a predominance of modifiable determinants such as hypertension, diabetes mellitus, obesity, and physical inactivity. Among these, physical inactivity and hypertension emerged as the strongest independent predictors of cardiovascular risk.

The findings highlight that cardiovascular risk is largely driven by modifiable lifestyle and metabolic factors, underscoring the need for early risk identification and targeted intervention. Integration of clinical pharmacy services, including medication therapy management, patient counselling, and adherence optimization, can significantly contribute to risk reduction and improved clinical outcomes. A multidisciplinary, pharmacist-led approach is essential to enhance preventive care and reduce long-term cardiovascular morbidity.

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AUTHOR CONTRIBUTIONS

K. Visalakshi contributed to study design, data collection, analysis, and manuscript preparation. The supervising author provided conceptual guidance, critically reviewed the manuscript, and approved the final version. All authors meet authorship criteria and are accountable for the work.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this study.

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