Vol. 4 No. 4 (2025)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Jamil et al - 2025

Gender Based Association of Cardiovascular Risk Factors and Cardiac Biomarkers in Patients

Bishama Jamil
M.Phil (Biochemistry), University of Lahore, Lahore, Pakistan. bishamabiochem@gmail.com
Roha Umer
MS (Total quality management), Lecturer, Lahore Medical & Dental College, Lahore, Pakistan. rohashahid158@gmail.com
Afshan Tariq
BS MLT, National Institute of Health, Islamabad. Pakistan.afshantariq537@gmail.com
Abdul Ali Khan
Master in Biology, New Mexico Highlands University, Las Vegas, New Mexico, United States of America. abdulalik210@gmail.com
Zainab Yousaf*
MPhil (Human Genetics & Molecular biology), B.S.C (Hons) MLT, Lab Manager, Farooq Hospital Westwood, Lahore, Pakistan. zainabyousaf527@gmail.com

Author Details

Keywords:
Cardiovascular Disease, Cardiovascular Risk Factors, Cardiac Biomarker

Received on 11 June, 2025
Accepted on 21 Aug, 2025
Published on 02 Sept, 2025

Corresponding E-mails & Authors*:
Zainab Yousaf
zainabyousaf527@gmail.com

Abstract

Background: Cardiovascular disease remains the leading global cause of morbidity and mortality. Although conventional risk factors are well established, the role of gender in shaping cardiovascular risk and biomarker expression among younger populations is less clear. Objective: This study aimed to evaluate gender-based associations of conventional cardiovascular risk factors and cardiac biomarkers in patients presenting with chest pain. Methods: A cross-sectional study was conducted on 100 patients (60 males, 40 females) aged 18–60 years. Demographic data, lifestyle factors, and medical history were recorded. Serum levels of high-sensitivity C-reactive protein, high-sensitivity troponin-I, N-terminal pro–B-type natriuretic peptide, creatine

phosphokinase, creatine kinase-MB, and lactate dehydrogenase were measured. Associations between gender, risk factors (physical activity, hypertension, smoking, diabetes mellitus), and biomarker levels were analyzed using chi-square tests. Results: Elevated levels of various biomarkers were observed across participants, with wide inter-individual variability. However, no statistically significant associations were found between gender and biomarker expression (CPK p=0.077, CK-MB p=0.110, LDH p=0.259, hs-cTnI p=0.672, hs-CRP p=0.409, NT-proBNP p=0.539). Similarly, no significant correlations were identified between biomarkers and physical activity, hypertension, smoking, or diabetes mellitus (all $p > 0.05$). Conclusion: In this study, cardiac biomarker elevations were not significantly influenced by gender or conventional cardiovascular risk factors. These findings suggest that biomarker changes may reflect subclinical myocardial stress or injury beyond the explanatory scope of traditional risk factors.

INTRODUCTION

Cardiovascular disease (CVD) is the predominant cause of morbidity and mortality globally, responsible for approximately one-third of all annual fatalities and placing a significant strain on healthcare systems and economies (1). In the past, CVD has been regarded as a disease of middle-aged and elderly individuals, with clinical symptoms such as myocardial infarction, stroke, or heart failure manifesting later in life (2). Recent study has shown that the pathophysiological mechanisms contributing to these clinical consequences, including atherosclerosis and cardiac remodeling, initiate significantly earlier, frequently during adolescence and young adulthood. This stage of life constitutes a crucial interval during which uncontrolled exposure to modifiable risk factors might hasten the progression to clinical illness (3).

Young adulthood is marked by a dynamic interaction of biological, behavioral, and social health variables. This stage of life often involves the beginning of lifestyle-related issues like smoking, drinking, eating poorly, and engaging in less physical exercise (4). Metabolic problems such as obesity, dyslipidemia (5), poor glucose regulation (6), increased blood pressure, and variation in hemoglobin levels (7) may initially manifest in young adults, predisposing them to future cardiovascular events (5). Significantly, these exposures and situations do not impact all individuals evenly. Sex and gender are crucial in determining risk profiles, affecting both the prevalence and consequences of these characteristics. Biological sex differences, including hormonal impacts, adipose distribution, and vascular reactivity, interact with gendered behaviors and societal roles to establish divergent cardiovascular risk trends for males and females (8).

Research indicates that young males and females display significant disparities in the incidence and aggregation of conventional cardiovascular risk factors. Such as smoking and alcohol consumption are typically more prevalent among males, but trends of overweight and obesity differ by location but generally rise similarly in both genders (5, 8). Blood pressure and lipid profiles exhibit sex-related differences, with men more prone to higher systolic blood pressure and unfavorable lipid ratios in early adulthood (9). In contrast, women may benefit from the preventive effects of endogenous estrogens during their reproductive years, postponing the manifestation of overt CVD relative to men (10). Despite these general trends, a limited number of studies have rigorously assessed sex and gender specific risk profiles in young adult populations, especially in low- and middle-income countries where early preventative measures could produce substantial long-term advantages.

Circulating biomarkers of stress and cardiovascular injury, in addition to conventional risk factors, have become beneficial tools for identifying subclinical disease processes prior to the manifestation of clinical symptoms. High-sensitivity C-reactive protein (hs-CRP) functions as an indicator of systemic inflammation (11) and has been reliably linked to the risk of atherosclerotic CVD. High-sensitivity cardiac troponin (hs-cTnI) identifies subtle myocardial injury, even without evident ischemia episodes, and offers prognostic insights across diverse populations. N-terminal pro–B-type natriuretic peptide (NT-proBNP) indicates hemodynamic stress and neurohormonal activation, providing insight into subclinical cardiac dysfunction (12).

Additional enzymatic biomarkers, such as lactate dehydrogenase (LDH), creatine phosphokinase (CPK), and its cardiac-specific isoenzyme CK-MB, are altered in CVD and offer further diagnostic and prognostic information. Cardiac troponins are regarded as the gold standard for diagnosing myocardial injury due to their enhanced sensitivity and specificity (13). However, CK-MB continues to be useful in identifying reinfarction when troponin levels are consistently elevated. Additionally, LDH may act as a supportive marker in resource-limited settings (14). Collectively, these biomarkers complement modern assays by providing insights into the timing, extent, and recurrence of myocardial damage.

Despite the increasing evidence, limited studies have thoroughly assessed the intersection of gender with traditional risk factors and biomarker profiles in young adults. Many studies primarily examine middle-aged or older populations, thus neglecting a crucial developmental phase during which interventions could significantly influence lifelong cardiovascular outcomes. Examining gender-based differences in risk factors and biomarker expression during young adulthood may reveal unique

pathophysiological pathways, identify vulnerable subgroups, and guide the development of targeted prevention strategies.

MATERIALS & METHODOLOGY

The study was a cross-sectional analysis conducted to evaluate the gender-based association of cardiovascular risk factors and cardiac biomarkers in patients. A total of 100 patients with chest pain were enrolled in this study through a non-probability sampling technique. The participants included both male and female patients aged between 18 and 60 years. Those have known CVD, chronic inflammatory or autoimmune disease, active infection within two weeks, pregnancy, or current uses of any medications known to affect cardiac biomarkers were excluded.

All participants provided informed consent before being included in the study, and their confidentiality was maintained throughout the research process. Data were collected using a standardized questionnaire that recorded demographic information, and relevant medical history. Approximately 3 milliliters of venous blood were drawn from each patient using a sterile technique and collected into clotted vaccutainers. The samples were then centrifuged at 3000 rpm for ten minutes to separate the serum, which was subsequently used for the analysis of cardiac biomarkers. The levels of hs-CRP, hs-cTnI, NT-proBNP, CPK, CKMB, and LDH were measured using an automated system, ensuring high sensitivity and specificity.

The study's data were analyzed using IBM SPSS software, version 25.0. Descriptive statistics were utilized to summarize the demographic characteristics of the participants, with mean and standard deviation calculated for continuous variables and frequencies and percentages for categorical variables. The association was assessed using a chi-square test, with a p-value of less than 0.05 considered statistically significant.

RESULTS

In this study, majority of the patients were males (n=60) as compared to females (n=40). The mean age (± standard deviation) of the patients was 51.99±8.650. The range of age was sixteen to sixty years. In this study, CVD risk factors were evaluated. Among the patients, 38 reported engaging in regular physical activity, 34 had hypertension, 25 were diagnosed with diabetes mellitus, and 56 were smokers.

The analysis of cardiac biomarkers demonstrated significant diversity among patients. The mean CPK level was 478.58 U/L (SD ±1167.05), with a range of 46 to 8830 U/L, whereas CK-MB averaged 39.83 U/L (SD ±58.73), with values ranging from 10 to 357 U/L. LDH levels exhibited a mean of 416.46 U/L (SD ±858.90), with a minimum of 51 U/L and a maximum of 5660 U/L. The hs-cTnI showed a mean concentration of 1.13 ng/ml (SD ±3.57), with a range from 0.001 to 24.94 ng/ml. The average hs-CRP was 23.51 mg/L (SD ±28.17), with values ranging from 0.1 to 142 mg/L, indicating an extensive spectrum of inflammatory state. NT-proBNP levels exhibited significant variability, with a mean of 179.98 pg/ml (SD ±928.30) and a range from 10 to 8943 pg/ml.

The association between cardiac biomarkers, gender, and clinical risk factors was evaluated by chi-square analysis. No statistically significant differences were detected between males and females for any biomarkers, including CPK (p=0.077), CK-MB (p=0.110), LDH (p=0.259), hs-cTnI (p=0.672), hs-CRP (p=0.409), and NT-proBNP (p=0.539). The results suggest that, in this study cohort, increases in cardiac biomarkers were not substantially affected by gender (Table 1)

TABLE 1: GENDER WISE DISTRIBUTION OF CARDIAC BIOMARKERS

Variables	Males (n=60)	Females (n=40)	Chi-square (p-value)
CPK (U/L)			
<190	22 (36.67%)	24 (60.0%)	0.077
>190	38 (63.33%)	16 (40.0%)	
CKMB (U/L)			
<25	27 (45.0%)	26 (65.0%)	0.110
>25	33 (55.0%)	14 (35.0%)	
LDH (U/L)			
<160	14 (23.34%)	07 (17.5%)	
160-320	22 (36.66%)	23 (57.5%)	0.259
>320	24 (40.0%)	10 (25.0%)	
hs-cTnI (ng/ml)			
<0.034	28 (46.66%)	22 (55.0%)	0.672
>0.034	32 (53.34%)	18 (45.0%)	
hs-CRP (mg/L)			
<5.0	24 (40.0%)	18 (45.0%)	0.409
>5.0	36 (60.0%)	22 (55.0%)	
NT pro BNP (pg/mL)			
<125	58 (96.66%)	38 (95.0%)	0.539
>125	02 (3.34%)	02 (5.0%)	

The chi-square analysis was conducted to evaluate the association between cardiac biomarkers and physical activity, hypertension, smoking, and diabetes mellitus. No

notable correlations were detected among any of the biomarkers (all p > 0.05). In CPK, increased levels (>190 U/L) were more prevalent in patients lacking physical activity and hypertension; however, these differences were not statistically significant (p=0.516 and p=0.518, respectively). Likewise, CK-MB levels exhibited no significant variation based on physical activity (p=0.274), hypertension (p=0.168), smoking (p=0.208), or diabetes mellitus (p=0.080). The distribution of LDH across categories (<160, 160–320, >320 U/L) exhibited no significant correlation with any of the risk factors (p-values 0.337–0.583). The hs-cTnI and hs-CRP, while higher in a considerable number of participants, exhibited no significant correlation with physical activity, hypertension, smoking, or diabetes (all p > 0.2). NT-proBNP levels consistently stayed below 125 pg/mL across all groups, exhibiting no significant correlation with any risk factor (p-values 0.208–0.734). These data indicate that, within the current cohort, increases in cardiac biomarkers were not influenced by traditional cardiovascular risk factors (Table 2).

TABLE 2: ASSOCIATION OF CARDIOVASCULAR RISK FACTORS AND CARDIAC BIOMARKERS

Variables	Physical activities		p-value	Hypertension		p-value	Smoking		p-value	Diabetes mellitus		Chi-square (p-value)
	No (n=62)	Yes (n=38)		No (n=66)	Yes (n=34)		No (n=44)	Yes (n=56)		No (n=75)	Yes (n=25)	
CPK (U/L)												
<190	11 (17.74%)	27 (71.05%)	0.516	15 (22.72%)	23 67.64%)	0.518	21 (47.72%)	17 (30.35%)	0.215	10 (13.33%)	22 (88.0%)	0.397
>190	51 (82.25%)	11 (28.94%)		51 (77.28%)	11 (32.35%)		23 (52.28%)	39 (69.64%)		65 (86.67%)	03 (12.0%)	
CKMB (U/L)												
<25	24 (38.70%)	18 (47.36%)	0.274	49 (74.24%)	17 (50.0%)	0.168	29 (65.91%)	38 (67.85%)	0.208	52 (69.33%)	15 (60.0%)	0.08
>25	38 (61.29%)	20 (52.63%)		17 (25.75%)	17 (50.0%)		15 (34.09%)	18 (32.15%)		23 (30.67%)	10 (40.0%)	
LDH (U/L)												

<160	11 (18.33%)	03 (7.89%)		11 (16.66%)	03 (8.82%)	0.583	07 (15.91%)	07 (12.5%)	0.396	09 (12.0%)	05 (20.0%)	0.337
160-320	37 (59.67%)	27 (71.05%)	0.392	42 (63.63%)	22 (64.70%)		26 (59.09%)	36 (64.28%)		50 (66.67%)	12 (48.0%)	
>320	14 (22.58%)	08 (21.05%)		13 (19.69%)	09 (26.47%)		11 (25.0%)	13 (23.21%)		16 (21.33%)	08 (32.0%)	
hs-cTnI (ng/ml)												
<0.034	33 (53.22%)	18 (47.36%)		38 (57.57%)	13 (38.23%)	0.839	23 (52.28%)	29 (51.78%)	0.840	36 (48.0%)	15 (60.0%)	0.862
>0.034	29 (46.77%)	20 (52.63%)	0.916	28 (42.42%)	21 (61.76%)		21 (47.72%)	27 (48.21%)		39 (52.0%)	10 (40.0%)	
hs-CRP (mg/L)												
<5.0	23 (37.09%)	19 (50.0%)		30 (45.45%)	12 (35.29%)	0.450	21 (47.72%)	21 (37.5%)	0.440	35 (46.67%)	07 (28.0%)	0.214
>5.0	39 (62.90%)	19 (50.0%)	0.290	36 (54.54%)	22 (64.71%)		23 (52.28%)	35 (62.5%)		40 (53.33%)	18 (72.0%)	

NT pro BNP (pg/mL)												
<125	60 (96.77%)	36 (94.73%)	0.470	64 (96.96%)	33 (97.05%)	0.208	42 (95.45%)	55 (98.21%)	0.734	73 (97.33%)	25 (100.0%)	0.336
>125	02 (3.22%)	02 (5.27%)		02 (3.03%)	01 (2.94%)		02 (4.54%)	01 (1.78%)		02 (2.67%)	-	

DISCUSSION

This study examined the correlation between gender, cardiovascular risk factors, and cardiac biomarkers in individuals with chest discomfort. The results indicated that while a considerable percentage of participants displayed aberrant biomarker levels, no statistically significant correlations were found with gender, physical activity, hypertension, smoking, or diabetes mellitus. The findings indicate that increases in cardiac biomarkers in this study may signify underlying myocardial stress or subclinical injury not entirely accounted for by traditional risk factors.

The results of this study align with other researches emphasizing the intricacy of cardiovascular pathophysiology, wherein biomarker expression frequently indicates processes that extend beyond conventional risk profiles (15-17). The hs-CRP, an indicator of systemic inflammation, is well-established as an independent predictor of atherosclerotic cardiovascular disease (18). In this study, hs-CRP levels were high in several patients but did not exhibit a significant correlation with smoking, hypertension, or diabetes, indicating the potential involvement of alternative inflammatory pathways independent of traditional risk factors that is consistent with other studies (18, 19). Likewise, hs-cTnI, which is highly specific for myocardial damage, exhibited varied increases throughout the sample, however not has substantial association with lifestyle or metabolic risk factors. This pattern may suggest subclinical ischemia or non-ischemic myocardial injury, including stress cardiomyopathy or microvascular dysfunction, which are not identified by conventional risk factor screening (20, 21).

The lack of significant gender disparities in biomarker expression contradicts previous findings (22, 23) that indicate gender-associated heterogeneity in cardiovascular risk and biomarker profiles. This study indicates that among symptomatic

individuals with chest discomfort, the differences may be less significant, or that biomarker increases might obscure the inherent gender-related variability. This may also indicate the limited sample size and single-center design, which could restrict the capacity to identify significant sex-based differences.

A significant observation is the considerable heterogeneity in biomarker concentrations, especially for CPK, LDH, and NT-proBNP. The significant standard deviations and extensive ranges observed signify considerable inter-individual variability (24). This may be ascribed to variables including discrepancies in the timing of presentation concerning symptom start, the existence of comorbidities that were not considered for in this study or individual variations in myocardial reactivity to stress. Increased NT-proBNP levels in certain participants despite the lack of evident heart failure underscore its potential role in detecting early hemodynamic stress (25) and necessitate additional investigation in broader populations.

The therapeutic implication of this study finding is that dependence exclusively on conventional risk variables may insufficiently reflect the extent of subclinical myocardial damage. The integration of biomarker evaluation may improve early risk categorization, particularly in resource-constrained environments lacking modern imaging technologies. The lack of substantial relationships in this study highlights the necessity for prudence in over interpreting isolated biomarker increases devoid of clinical context. This study is constrained by its cross-sectional methodology, low sample size, and single-center recruiting, thereby diminishing the generalizability of the findings. This study also did not assess long-term outcomes, hence restricting the capacity to ascertain the prognostic relevance of biomarker increases in this population.

CONCLUSION

This study identified no significant associations between cardiac biomarkers and gender or conventional cardiovascular risk factors in patients presenting with chest discomfort. The findings emphasize the prospective function of biomarkers in indicating subclinical cardiac stress, irrespective of traditional risk factors, and underscore the necessity for extensive, longitudinal investigations to clarify their diagnostic and prognostic value.

Conflicts of Interest: None

Funding Statement: None

REFERENCES

1. Naeem A, Abbas SH, Yousaf M, Ishtiaq A, Murtaza I. Global Impact and Strategies to Reduce the Mortality from Cardiovascular Diseases. Integrated Science for Sustainable Development Goal 3: Empowering Global Wellness Initiatives: Springer; 2024. p. 283-306.
2. Aïdoud A, Gana W, Poitau F, Debacq C, Leroy V, Nkodo JA, et al. High prevalence of geriatric conditions among older adults with cardiovascular disease. Journal of the American Heart Association. 2023;12(2):e026850.
3. Cojocaru PA, Țieranu ML, Piorescu MTL, Buciu IC, Belu AM, Cureraru SI, et al. Myocardical Infarction in Young Adults: Revisiting Risk Factors and Atherothrombotic Pathways. Medicina. 2025;61(9):1615.
4. Balwan WK, Kour S. Lifestyle Diseases: The Link between Modern Lifestyle and threat to public health. Saudi J Med Pharm Sci. 2021;7(4):179-84.
5. Silveira Rossi JL, Barbalho SM, Reverete de Araujo R, Bechara MD, Sloan KP, Sloan LA. Metabolic syndrome and cardiovascular diseases: Going beyond traditional risk factors. Diabetes/metabolism research and reviews. 2022;38(3):e3502.

6. Shahid O, Akhtar R, Jaffer M, Sadaf R, Yousaf Z, Rafiq F. Correlation of Glycated Hemoglobin and Fating Lipid Profile Among Type 2 Diabetes Patients. JAIMC: Journal of Allama Iqbal Medical College. 2025;23(2).
7. Azmat J, Waseem M, Dar YF, Ambreen S, Shafqat H. ROLE OF HEMOGLOBIN AND ITS IMPACT ON HUMAN HEALTH-A NARRATIVE REVIEW. Insights-Journal of Health and Rehabilitation. 2024;2(2 (Health & Allied)):231-7.
8. Regitz-Zagrosek V, Gebhard C. Gender medicine: effects of sex and gender on cardiovascular disease manifestation and outcomes. Nature Reviews Cardiology. 2023;20(4):236-47.
9. Zhernakova DV, Sinha T, Andreu-Sánchez S, Prins JR, Kurilshikov A, Balder J-W, et al. Age-dependent sex differences in cardiometabolic risk factors. Nature Cardiovascular Research. 2022;1(9):844-54.
10. Xiang D, Liu Y, Zhou S, Zhou E, Wang Y. Protective effects of estrogen on cardiovascular disease mediated by oxidative stress. Oxidative medicine and cellular longevity. 2021;2021(1):5523516.
11. Bhatty ET, Mustafa M, Rao M, Khan AU, Farooq U, Saeed HA, et al. Role of Inflammatory Biomarkers in early diagnosis of bacterial and aseptic meningitis. Journal of Health and Rehabilitation Research. 2024;4(3).
12. Jain V. COMPARISON BETWEEN BIOMARKERS HIGH-SENSITIVITY C-REACTIVE PROTEIN AND N-TERMINAL PROBRAIN NATRIURETIC PEPTIDE IN PATIENTS WITH MYOCARDIAL INFARCTION.
13. Lippi G, Lavie CJ, Sanchis-Gomar F. Detecting cardiac injury: the next generation of high-sensitivity cardiac troponins improving diagnostic outcomes. Clinical Chemistry and Laboratory Medicine (CCLM). 2025;63(10):1941-51.

14. Hansson E, Frodig I, Askling H, Kjellgren K, Wasek Sikdar F, Sanner M. Survey of Clinical properties of Biomarkers in Urgent Care: The Potential for Multiplex Testing Using Olink PEA. 2025.
15. Bhatnagar S, Jain M. Unveiling the role of biomarkers in cardiovascular risk assessment and prognosis. Cureus. 2024;16(1).
16. Nazir A, Nazir A, Afzaal U, Aman S, Sadiq SuR, Akah OZ, et al. Advancements in Biomarkers for Early Detection and Risk Stratification of Cardiovascular Diseases—A Literature Review. Health Science Reports. 2025;8(5):e70878.
17. Kogularasu S, Lin W-C, Lee Y-Y, Huang B-W, Chen Y-L, Chang-Chien G-P, et al. Advancements in electrochemical biosensing of cardiovascular disease biomarkers. Journal of Materials Chemistry B. 2024;12(26):6305-27.
18. Denegri A, Boriani G. High sensitivity C-reactive protein (hsCRP) and its implications in cardiovascular outcomes. Current Pharmaceutical Design. 2021;27(2):263-75.
19. Lian P-A, Xie F, Zhang W, Cheng S, Zhao Y-F, Li L, et al. Association of the atherogenic index of plasma and high-sensitivity C-reactive protein with incident cardiovascular disease: evidence from a national cohort of middle-aged and older Chinese adults. Frontiers in Endocrinology. 2025;16:1618157.
20. Tang Y, Ma X, Dong Z, Chen X, Yang S, Chen X, et al. Cardiac magnetic resonance visualization of the myocardial microstructure in non-ischemic cardiomyopathies. Cardiovascular Innovations and Applications. 2024;9(1):939.
21. Defilippis AP, Lidani KC, Nam Y, Trainor PJ, Johnson WC, Heckbert SR, et al. Risk factor associations with individual myocardial infarction subtypes and acute non-ischemic myocardial injury in the Multi-Ethnic Study of Atherosclerosis (MESA): Design and rationale. American heart journal. 2023;260:151-73.

22. Wu PY, Lee S-Y, Chang K-V, Chao C-T, Huang J-W, editors. Gender-related differences in chronic kidney disease-associated vascular calcification risk and potential risk mediators: a scoping review. Healthcare; 2021: MDPI.
23. Lewis K, Stroebel BM, Kanaya AM, Aouizerat B, Longoria KD, Flowers E. Metabolomic signatures in adults with metabolic syndrome indicate preclinical disruptions in pathways associated with high-density lipoprotein cholesterol, sugar alcohols. Cardiovascular Diabetology–Endocrinology Reports. 2025;11(1):11.
24. Chetran A, Costache AD, Ciongradi CI, Duca ST, Mitu O, Sorodoc V, et al. ECG and biomarker profile in patients with acute heart failure: a pilot study. Diagnostics. 2022;12(12):3037.
25. Licordari R, Correale M, Bonanno S, Beltrami M, Ciccarelli M, Micari A, et al. Beyond natriuretic peptides: unveiling the power of emerging biomarkers in heart failure. Biomolecules. 2024;14(3):309.