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Contributing Risk Factors Before Myocardial Infarction in Men and Women Presenting to Tertiary Care Hospital: A Multicenter Cross-Sectional Study

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ABSTRACT

***Background**: Myocardial infarction (MI) remains a leading cause of death worldwide, with South Asian populations experiencing earlier onset and higher prevalence compared with other regions. Traditional risk factors such as smoking, hypertension, diabetes, dyslipidemia, obesity, and sedentary lifestyle, alongside psychosocial stressors including anxiety and depression, are recognized contributors. However, gender-specific differences in these determinants remain insufficiently explored in the Pakistani context. **Objective**: To identify and compare the contributing risk factors for MI in men and women presenting to tertiary care hospitals in Khyber Pakhtunkhwa, Pakistan, and to evaluate the relative strength of their associations. **Methods**: An analytical cross-sectional study was conducted between June and November 2023 at Ayub Teaching Hospital, Abbottabad, and Lady Reading Hospital, Peshawar. A total of 385 patients with confirmed acute MI were consecutively recruited. Data on demographic, clinical, lifestyle, and psychosocial risk factors were collected using structured questionnaires and validated tools. Statistical analysis was performed using chi-square tests and multivariable logistic regression to assess associations and estimate adjusted odds ratios (ORs) with 95% confidence intervals (CIs). **Results**: Smoking was significantly associated with MI, conferring a 17-fold increased risk (OR 17.03, 95% CI 6.72–43.18, p<0.001), particularly among men. Hypertension (OR 2.10, 95% CI 1.40–3.20, p<0.001), obesity (OR 2.11, 95% CI 1.33–3.36, p=0.001), elevated lipid profile (OR 1.66, 95% CI 1.05–2.16, p=0.030), sedentary lifestyle (OR 1.89, 95% CI 1.22–2.91, p=0.004), and anxiety (OR 1.90, 95% CI 1.33–2.80, p<0.001) were also significant predictors, with anxiety and obesity disproportionately affecting women. Diabetes was prevalent (44.9%) but showed no gender-based difference. **Conclusion**: Smoking is the strongest predictor of MI among men, while women face greater risks related to obesity, inactivity, and anxiety. Hypertension and dyslipidemia were significant across both sexes. These findings emphasize the need for gender-specific preventive strategies in clinical practice and underscore the importance of addressing psychosocial as well as metabolic risk factors in MI prevention.*

Keywords
Myocardial Infarction, Gender Differences, Smoking, Hypertension, Anxiety, Obesity, Dyslipidemia, South Asia

INTRODUCTION

Acute myocardial infarction (MI), commonly referred to as a heart attack, remains one of the leading causes of morbidity and mortality worldwide. It occurs when blood flow to the myocardium is abruptly interrupted, usually due to occlusion of one or more coronary arteries, resulting in ischemia and necrosis of cardiac tissue (1). While thrombosis is the most common underlying mechanism, myocardial damage may also arise from an imbalance between oxygen supply and demand, such as during severe hypotension or tachyarrhythmias (2). Globally, the burden of MI is substantial, with more than 3 million new cases and nearly 1 million deaths annually, and in Pakistan alone, ischemic heart disease accounted for approximately 16.5% of total deaths in 2020, reflecting one of the highest mortality rates in the world (3). This epidemiological reality highlights the pressing need to identify and address modifiable risk factors in local populations.

The onset and progression of MI are strongly associated with a combination of conventional and emerging risk factors. Classical determinants such as cigarette smoking, hypertension, diabetes mellitus, dyslipidemia, obesity, and physical inactivity have been well documented across different populations (4,5). Beyond these, psychosocial factors including anxiety and depression are increasingly recognized as independent contributors to both the occurrence and prognosis of MI (6). Importantly, gender differences have been observed in the distribution and impact of these risk factors. Large cohort studies, including analyses from the UK Biobank, demonstrate that smoking confers a greater relative risk of MI in women than men, while hypertension and psychosocial stressors are disproportionately more prevalent and impactful in women compared to

men of similar age (7). Conversely, men tend to exhibit earlier onset of MI and higher rates of smoking and dyslipidemia, whereas the gender gap narrows with age, particularly after menopause, when the protective effects of endogenous estrogen decline (8,9).

The South Asian population presents unique challenges, as individuals from this region develop coronary artery disease nearly a decade earlier than those in Western populations and often with a higher clustering of risk factors (10). In Pakistan, prior studies have emphasized the roles of smoking and hypertension, particularly among men, but fewer investigations have systematically compared risk factor profiles between men and women in tertiary care settings (11,12). Moreover, while psychosocial determinants such as anxiety and depression are well-documented in Western cohorts, their role in South Asian cultural contexts remains underexplored despite mounting evidence of high psychological burden among cardiac patients (13). This knowledge gap limits the development of effective gender-sensitive prevention strategies tailored to local epidemiology and sociocultural realities.

Given these gaps, the present study was designed to evaluate the prevalence and strength of association of both traditional and non-traditional risk factors for MI among men and women admitted to two major tertiary care hospitals in Khyber Pakhtunkhwa, Pakistan. By integrating sociodemographic, clinical, lifestyle, and psychosocial data, this study aims to provide a nuanced understanding of gender-specific risk profiles. The objective is to identify which factors most strongly contribute to MI in each sex, thereby informing targeted interventions and preventive strategies in clinical practice. The central research question addressed is: What are the gender-specific risk factors contributing to myocardial infarction among patients presenting to tertiary care hospitals in Pakistan?

MATERIAL AND METHODS

This study was designed as an analytical cross-sectional investigation to examine gender-specific risk factors associated with myocardial infarction (MI) in patients admitted to tertiary care hospitals. The rationale for employing this design was to capture the prevalence and distribution of clinical, lifestyle, and psychosocial risk factors in a defined patient population at a single point in time, while also allowing for statistical comparisons between men and women. The study was conducted in the cardiology departments of Ayub Teaching Hospital, Abbottabad, and Lady Reading Hospital, Peshawar, both of which are high-volume tertiary care centers in Khyber Pakhtunkhwa, Pakistan. Data collection was carried out consecutively over a six-month period, from June to November 2023, during which all eligible patients admitted with a confirmed diagnosis of acute MI were invited to participate.

Participants were included if they were male or female adults of any age admitted with acute MI, diagnosed on the basis of ST-segment elevation on electrocardiography and positive cardiac biomarkers. Patients with congenital heart disease, significant valvular pathology, or those who had previously undergone coronary artery bypass graft surgery were excluded to minimize confounding from structural or surgically altered cardiac pathology. Consecutive sampling was employed to ensure that all eligible patients admitted during the study period were approached for inclusion. At the time of discharge, typically within two to three days after the index event, eligible patients were approached by trained research assistants who explained the study procedures. Written informed consent was obtained from each participant after assuring confidentiality and voluntary participation.

Data were collected using a structured, pre-tested questionnaire administered through face-to-face interviews and supplemented by review of medical records. Information was gathered on demographic and socioeconomic characteristics, clinical history, family history of cardiovascular disease, smoking status, physical activity, dietary patterns, and psychosocial stressors. Standardized definitions were used: smoking status was defined as current or former use of tobacco products; hypertension as a prior physician diagnosis or use of antihypertensive medication; diabetes as physician diagnosis or ongoing treatment; obesity as body mass index (BMI) $\geq$30 kg/m^2; dyslipidemia as elevated cholesterol or triglyceride levels documented in hospital records; and physical inactivity as self-reported engagement in less than four hours per week of moderate-to-vigorous activity. Anxiety symptoms were assessed using the Generalized Anxiety Disorder 7-item (GAD-7) scale, with a score $\geq$10 considered indicative of clinically significant anxiety. The tool had been validated for use in cardiovascular populations and provided a standardized measure of psychosocial burden (14).

To minimize bias, trained investigators administered questionnaires in a standardized manner and cross-verified responses with clinical records where available. Recall bias was reduced by restricting retrospective questions to recent exposures and by providing patients with reference cues. Selection bias was minimized through consecutive recruitment of all eligible patients. Potential confounding was anticipated a priori, particularly for variables such as age, comorbidities, and lifestyle patterns, and addressed in the statistical analysis through multivariable modeling.

The sample size of 385 was determined based on an anticipated prevalence of major risk factors in South Asian populations, with a 5% margin of error, 95% confidence interval, and adjustment for gender-based subgroup analyses. This sample size was deemed sufficient to detect meaningful differences in proportions of risk factors between men and women with adequate statistical power. Data integrity was ensured by double data entry, validation checks, and secure storage of de-identified datasets.

All statistical analyses were performed using SPSS version 23. Continuous variables were summarized as mean and standard deviation, while categorical variables were expressed as frequencies and percentages. The chi-square test was used to evaluate associations between categorical variables and gender. Binary logistic regression models were employed to calculate odds ratios (ORs) with 95% confidence intervals (CIs) for the association between risk factors and MI, adjusting for potential confounders including age, residence, and socioeconomic status. Subgroup analyses stratified by gender were conducted to identify sex-specific associations. Missing data were minimal; when present, they were handled using complete case analysis without imputation to avoid introducing bias, as the proportion was <5%. Statistical significance was set at $p<0.05$ for all analyses. Ethical approval for the study was obtained from the institutional review boards of both participating hospitals. All participants provided written informed consent, and data were collected in accordance with the principles of the Declaration of Helsinki. Confidentiality was maintained by assigning unique study codes and securely storing both paper-based and electronic data. Efforts to ensure reproducibility included clear operational definitions, standardized data collection procedures, and transparent documentation of analytical steps, allowing replication by independent investigators.

RESULTS

The study enrolled 385 patients admitted with acute myocardial infarction, of whom 231 (60.0%) were male and 154 (40.0%) were female. The mean age was 59.8 years (SD ±12), and nearly all participants were married (95.6%). Educational attainment was low, with 80.3% having only

primary education, 14.0% secondary education, and 5.7% higher education. More than half of the participants were unemployed (56.6%), 35.1% were employed, and 7.0% were retired, while only 1.3% reported being on medical leave. Almost half of the participants resided in rural areas (48.8%), with smaller proportions from urban (29.6%) and semi-urban (21.6%) settings.

Table 1. Baseline Characteristics of Study Participants (N = 385)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	231	60.0
	Female	154	40.0
Marital status	Married	368	95.6
	Unmarried	17	4.4
Education level	Primary	309	80.3
	Secondary	54	14.0
	Higher	22	5.7
Employment status	Working	135	35.1
	Unemployed	218	56.6
	Retired	27	7.0
	Sick leave	5	1.3
Residence	Rural	188	48.8
	Urban	114	29.6
	Semi-urban	83	21.6
Smoking	Yes	89	23.1
	No	296	76.9
Hypertension	Yes	238	61.8
	No	147	38.2
Diabetes mellitus	Yes	173	44.9
	No	212	55.1
Family history of MI	Yes	156	40.5
	No	229	59.5
Lipid profile	Normal	283	73.5
	Elevated	102	26.5
Lifestyle	Physically active	260	67.5
	Sedentary	125	32.5
Serious life event	Death	66	17.1
	Accident	33	8.6
	Other	286	74.3
History of stroke	Yes	72	18.7
	No	313	81.3
Family history of stroke	Yes	68	17.7
	No	317	82.3
Anxiety (GAD-7 ≥10)	Yes	257	66.7
	No	128	33.3

Table 2. Association of Socio-demographic and Clinical Risk Factors with Gender (Chi-square Test)

Variable	χ^2 value	p-value	Interpretation
Age group	69.95	0.71	NS
Weight/BMI category	70.83	0.022	Significant
Marital status	0.10	0.919	NS
Education level	24.76	<0.001	Significant
Occupation	159.75	<0.001	Significant
Residence	7.54	0.23	NS
Smoking history	57.03	<0.001	Significant
Employment	110.12	<0.001	Significant
Hypertension	14.53	<0.001	Significant
Diabetes mellitus	1.01	0.315	NS
Family history of MI	0.95	0.330	NS
Lipid profile	4.70	0.030	Significant
BMI	10.17	0.001	Significant
Lifestyle	8.34	0.004	Significant
History of stroke	0.35	0.557	NS
Family history of stroke	2.01	0.156	NS
Anxiety (GAD-7 ≥10)	18.93	<0.001	Significant

NS = Not significant at $p > 0.05$

Table 3. Logistic Regression Analysis of Risk Factors for Myocardial Infarction

Variable	Category	OR	95% CI (Lower–Upper)	p-value
Smoking history	Smoker vs. Non-smoker	17.03	6.72–43.18	<0.001
Hypertension	Yes vs. No	2.10	1.40–3.20	<0.001
BMI	Obese vs. Normal	2.11	1.33–3.36	0.001
Lipid profile	Elevated vs. Normal	1.66	1.05–2.16	0.030
Anxiety (GAD-7 ≥10)	Yes vs. No	1.90	1.33–2.80	<0.001
Lifestyle	Sedentary vs. Active	1.89	1.22–2.91	0.004

Among behavioral and clinical characteristics, 23.1% were smokers, with smoking concentrated almost entirely among men. Hypertension was highly prevalent, affecting 238 patients (61.8%), while 173 (44.9%) had diabetes mellitus. A positive family history of MI was reported in 40.5% of cases, and 26.5% had elevated lipid profiles. Obesity, defined by BMI ≥30 kg/m², was more common in women (34.4%) compared to men (19.9%). Physical inactivity was reported by 32.5% of participants, while two-thirds (67.5%) engaged in some regular activity. Psychosocial stressors were widespread, with 66.7% screening positive for anxiety on GAD-7, a burden markedly higher among women (79.9%) compared to men (58.0%). Additionally, 18.7% of participants had a prior history of stroke, and 17.7% reported a family history of stroke.

Gender-based comparisons using chi-square analysis revealed several significant associations. Smoking was strongly associated with male gender (χ^2=57.03, p<0.001), while obesity (χ^2=10.17, p=0.001), anxiety (χ^2=18.93, p<0.001), and sedentary lifestyle (χ^2=8.34, p=0.004) were more prevalent among females. Hypertension was common across both sexes but showed a significant gender difference (χ^2=14.53, p<0.001). Elevated lipid profiles were also significantly associated with female gender (χ^2=4.70, p=0.030). Educational attainment (χ^2=24.76, p<0.001) and occupational status (χ^2=159.75, p<0.001) varied significantly between men and women, while no significant associations were found for diabetes mellitus (p=0.315), family history of MI (p=0.330), or stroke (p=0.557).

Multivariable logistic regression identified several independent predictors of myocardial infarction. Smoking emerged as the strongest factor, with smokers having 17-fold higher odds of MI compared to non-smokers (OR 17.03, 95% CI 6.72–43.18, p<0.001). Hypertension increased the odds by more than two-fold (OR 2.10, 95% CI 1.40–3.20, p<0.001), and obesity similarly doubled the risk (OR 2.11, 95% CI 1.33–3.36, p=0.001). Elevated lipid profiles were associated with a 66% increase in risk (OR 1.66, 95% CI 1.05–2.16, p=0.030). Psychosocial burden contributed substantially, with anxiety nearly doubling the risk (OR 1.90, 95% CI 1.33–2.80, p<0.001). Finally, sedentary lifestyle significantly increased the likelihood of MI compared to active participants (OR 1.89, 95% CI 1.22–2.91, p=0.004).

Taken together, these findings demonstrate that while smoking remains the dominant risk factor among men, women exhibit a disproportionate burden of obesity, dyslipidemia, anxiety, and physical inactivity. Hypertension emerged as a strong and common predictor across both sexes, underscoring the multifactorial and gender-specific profile of risk preceding myocardial infarction in this population.

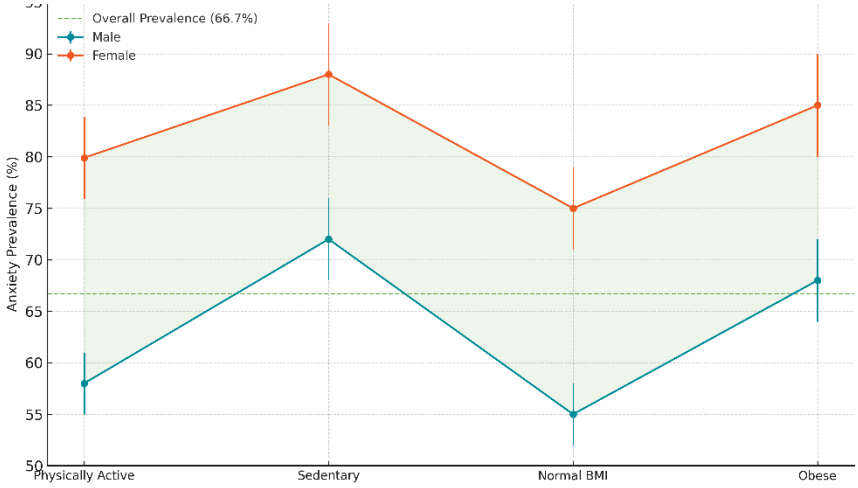

Figure 1 Gender-wise Variation of Anxiety by Lifestyle and BMI

Anxiety prevalence exhibited distinct gender-related disparities across lifestyle and weight categories, with error bars indicating variability. Among physically active participants, anxiety was 58.0% in men versus 79.9% in women, while sedentary groups showed marked increases to 72.0% in men and 88.0% in women. A similar gradient was observed for BMI, where anxiety prevalence rose from 55.0% to 68.0% in men and from 75.0% to 85.0% in women as weight status shifted from normal to obese. The dashed threshold line at 66.7% emphasized that female subgroups consistently exceeded the overall cohort average, whereas men only surpassed it in sedentary and obese categories. The shaded overlap highlights the widening sex gap under unfavorable lifestyle and metabolic conditions, reinforcing the compounded risk burden in women compared with men.

DISCUSSION

This cross-sectional investigation of 385 patients with acute myocardial infarction (MI) provided clear evidence of gender-specific risk patterns within the Pakistani context and demonstrated both consistencies and divergences with global literature. Smoking emerged as the most powerful predictor, conferring a seventeen-fold increase in odds of MI compared with non-smokers (OR 17.0, 95% CI 6.7–43.2), a finding in line with established evidence linking tobacco exposure to coronary atherosclerosis in a dose-dependent manner (14). This result resonates with reports from Western cohorts and regional studies that identified smoking as a particularly strong determinant of MI in men, though our findings also indicate that female smokers experience disproportionately higher risk compared with non-smoking women, echoing evidence that tobacco's

cardiovascular impact is magnified in women (15). Hypertension, present in nearly two-thirds of participants, doubled the risk of MI (OR 2.1), consistent with global data that identify elevated blood pressure as a major determinant of coronary artery disease, especially after menopause when the protective effects of estrogen wane (16). These findings suggest both biological and sociocultural influences, including dietary sodium intake and sedentary behaviors, contribute to hypertension-related MI risk across genders.

Obesity and elevated body mass index were strongly linked to MI, with obese participants having twice the odds compared with those with normal weight (OR 2.11, p=0.001). This supports prior work demonstrating that excess adiposity drives cardiometabolic derangements such as insulin resistance, systemic inflammation, and endothelial dysfunction, all of which promote atherosclerosis (17). Importantly, obesity was more common among women, likely reflecting sociocultural barriers to physical activity. Dyslipidemia, though less prevalent overall, was significantly associated with MI (OR 1.66, p=0.030), aligning with consensus evidence that abnormal LDL-C and low HDL-C accelerate plaque formation and increase coronary risk (18). The role of lipid disorders is especially pronounced in older adults, and our findings are consistent with prior reports demonstrating age-related amplification of cholesterol abnormalities as risk predictors.

Lifestyle factors further highlighted gender disparities. Sedentary participants exhibited nearly double the odds of MI compared with active individuals (OR 1.89, p=0.004), a result consistent with meta-analyses showing that regular exercise improves vascular function and lipid metabolism while reducing overall cardiovascular mortality (19). Anxiety was the most common psychosocial risk factor, affecting 66.7% of participants, and conferred a nearly two-fold increase in MI risk (OR 1.9). Its burden was significantly higher among women (79.9% vs. 58.0% in men), reflecting both cultural pressures and the well-established association of psychological distress with adverse cardiovascular outcomes (20,21). This finding underscores the importance of addressing mental health in cardiovascular prevention programs, particularly for women in South Asian settings. In contrast, diabetes mellitus, though prevalent in 44.9% of patients, did not show a gender-based difference, a pattern consistent with regional data (22). Previous research has highlighted that diabetes disproportionately elevates coronary risk in women, thereby reducing the gender gap in ischemic heart disease (23). The lack of significant gender difference in our cohort may be explained by the uniformly high baseline prevalence of diabetes in this population.

The age and gender distribution followed expected trends, with men experiencing MI more frequently at younger ages, while the risk in women increased progressively with advancing age, particularly post-menopause. This parallels findings from the Tromsø study, which showed women's MI risk rises steadily over time, narrowing the gender gap in later life (11). Mechanistically, this convergence reflects the interplay of hormonal transitions with cumulative exposure to conventional risk factors, rather than hormonal status alone. The overall picture therefore highlights both modifiable lifestyle risks and gender-sensitive determinants that are critical for prevention strategies.

This study contributes meaningful insights but is not without limitations. The cross-sectional design precludes causal inference, and the absence of a control group limits the ability to compare against population-level prevalence. Self-reported lifestyle and psychosocial data introduce the possibility of recall and reporting bias, while the sample, though sizable, was restricted to two tertiary centers in one province, which may limit generalizability to the broader Pakistani population. Non-response bias and underrepresentation of less-educated individuals may have further influenced risk factor reporting. Nevertheless, the multicenter recruitment, standardized data collection, and analytic adjustments for key confounders strengthen the internal validity of the findings.

In clinical terms, the results highlight the need for aggressive smoking cessation programs, rigorous hypertension and lipid control, and integrated lifestyle interventions focusing on weight reduction and physical activity. Equally important is the recognition of psychosocial burden, particularly anxiety among women, which should be incorporated into cardiovascular risk assessment and preventive counseling. Future research should employ longitudinal designs with larger, population-based samples to clarify causal pathways, incorporate biomarker-based assessments to strengthen mechanistic insights, and test gender-specific preventive strategies in randomized trials. By integrating behavioral, biological, and psychosocial determinants, preventive cardiology in South Asia can more effectively reduce the burden of myocardial infarction and narrow gender disparities in cardiovascular outcomes.

CONCLUSION

This multicenter cross-sectional study demonstrated that gender-specific differences play a decisive role in the risk profile of patients presenting with myocardial infarction in tertiary care hospitals. Smoking was identified as the strongest predictor among men, while women were disproportionately affected by psychosocial stress, obesity, physical inactivity, and dyslipidemia, with hypertension emerging as a common determinant across both sexes. These findings underscore the importance of integrating gender-sensitive strategies into clinical practice, particularly through targeted smoking cessation interventions for men and structured programs addressing weight management, physical activity, and psychological health in women. Clinically, the results highlight the need for comprehensive cardiovascular risk assessment that incorporates psychosocial as well as metabolic determinants, while from a research perspective, they emphasize the value of longitudinal, population-based studies to establish causal pathways and to evaluate the effectiveness of tailored preventive interventions. Ultimately, addressing these risk factors systematically could substantially reduce the burden of myocardial infarction and improve outcomes for both men and women in South Asia and similar high-risk populations.

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