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Body Mass Index and In-Hospital Management and Outcome of Acute Myocardial Infarction

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ABSTRACT

Background: The association between body mass index (BMI) and the management and in-hospital outcomes of patients hospitalized for acute myocardial infarction (AMI) is unclear.

Objectives: We sought to determine the effect of BMI on the clinical presentation, management, and in-hospital outcomes of AMI patients.

Methods: This prospective cohort study included patients admitted with AMI at the Department of Cardiology, PIMS, Islamabad, between 1st March 2024 and 31st July 2024. Adult (aged ≥ 18 years) male and female patients with AMI confirmed by symptoms, electrocardiographic changes, and elevated cardiac biomarkers were included. Patients with incomplete medical records or those who left against medical advice were excluded.

Results: A total of 1,200 patients with AMI were included in this study and divided into four groups according to BMI: underweight (n=60), normal-weight (n=480), overweight (n=420), and obese (n=240). The baseline characteristics of the obese group indicated they were relatively younger than those in the other three groups (p=0.045). In multivariate logistic regression analysis, age (OR 1.05, 95% CI: 1.02-1.08, p=0.001) and obesity (OR 1.35, 95% CI 1.01-1.79, p=0.042) were significant factors.

Conclusion: These results indicate that although BMI may not affect the utilization of in-hospital treatments for AMI, it does influence the length of hospital stay and complications.

INTRODUCTION

Acute myocardial infarction (AMI), commonly referred to as a heart attack by the general population, is one of the leading causes of morbidity and mortality globally [1]. Timely diagnosis and treatment of AMI have an important impact on patient outcomes [2, 3]. BMI, adjusted as a measure of adiposity, may reflect health-related general fat distribution and has been linked to numerous cardiovascular disease risk factors, including BMI itself [4]. Nonetheless, the association between BMI and in-hospital management and outcomes during AMI treatment is complex and poorly understood [5].

The unregulated food system has contributed to obesity. To be consistent with previous literature, underweight (BMI <18.5 kg/m^2), normal weight (BMI = 18.5-24.9 kg/m^2), overweight (BMI 25-29.9 kg/m^2), and obesity (BMI ≥30 kg/m^2) are the four basic categories into which we divided BMI [6]. As each BMI category has distinct health consequences and comorbidities that may affect the AMI phenotype, disease progression is considered to differ across various stages [7, 8]. For example, obesity is frequently associated with risk factors of AMI, including hypertension, diabetes, and dyslipidaemia [9]. However, if AMI elicits different metabolic and physiological responses in underweight individuals [10], this could have implications for their treatment response and recovery.

Obesity and BMI may have little effect on AMI outcomes; however, studies to date have shown inconsistent results. Some studies have shown that obese and overweight patients may have higher short-term survival (a phenomenon called the "obesity paradox") [11, 12]. On the other hand, some studies have shown that a higher BMI is associated with more complications and longer hospital stays. These discrepancies underline the fact that differences in BMI affect clinical management, and the response to therapy after AMI requires further investigation. Except for a few studies that primarily focused on the function of greater BMI as an independent predictor of death and other long-term poor outcomes, to the best of our knowledge, no research has addressed this topic in patients with AMI. Therefore, we evaluated and described the short-term effects among these groups. This study aimed to understand the experience of AMI patients by classifying them into BMI groups and analyzing their demographics, comorbidities, treatment modalities, and in-hospital outcomes. These results might have implications for managing patients with AMI in different body weight categories, which can guide clinical practice.

MATERIAL AND METHODS

The prospective cohort study design was based on patients admitted with acute myocardial infarction (AMI) at the Department of Cardiology, PIMS, Islamabad, during the period 1st March 2024 to 31st July 2024. Adults (aged ≥ 18 years) diagnosed with AMI confirmed by symptoms, electrocardiographic changes, and elevated cardiac biomarkers were included. Patients with incomplete medical records or those who left against medical advice were not considered study participants. The clinical variables included the type of MI [ST-segment elevation (STEMI) and non-ST-segment elevation (NSTEMI)], initial presentation symptoms, comorbid conditions (hypertension, diabetes, and chronic renal disease). Treatment modalities included reperfusion therapy (thrombolysis, PCI, and CABG), use of medications such as antiplatelet agents, beta-blockers, statins, and supportive care measures. We also evaluated the impact of pre-admission ACEi or ARB use on in-hospital mortality, length of hospital stay, and pre-specified complications during the first episode (Cardiovascular Intensive Care Unit [CICU] index event), including heart failure, arrhythmias, and infection. Secondary outcomes included discharge status (home or rehabilitation facility) and 30-day readmission rate.

The following information was obtained from the electronic health records: age, sex, body mass index (BMI), history of hypertension, diabetes, dyslipidaemia, and lifestyle changes related to smoking, physical activity, residence, and socioeconomic position were all considered demographic data. BMI was calculated using the traditional formula: weight (kg)/height (m^2), and then divided into four groups as follows: BMI < 18.5 kg/m^2 indicating underweight, BMI 18.5-24.9 kg/m^2 indicating normal weight, BMI 25–29.9 kg/m^2 indicating overweight, and BMI ≥ 30 kg/m^2 indicating obesity.

SPSS (version 26.0) was used to analyze the data. The patients' characteristics, treatment methods, and outcomes were described using descriptive statistics. Categorical data are presented as frequencies and percentages, whereas continuous variables are reported as mean ± standard deviation. ANOVA for continuous variables, chi-squared tests, and logistic regression models for categorical outcomes were used to examine univariate comparisons between the BMI groups. Before controlling for potential confounders (age, sex, and comorbidities), multivariate logistic regression models were used to identify the independent risk factors associated with in-hospital mortality and complications. For statistical significance, a p-value of less than 0.05 was used.

RESULTS

A total of 1,200 patients with acute myocardial infarction (AMI) were included in this study and divided into four groups according to BMI: underweight (n=60), normal-weight (n=480), overweight (n=420), and obese (n=240). The baseline characteristics showed that the obese group was relatively younger than the other three groups (p=0.045). Obesity was associated with an increased prevalence of comorbidities, including hypertension and diabetes (p < 0.001). The proportion of smokers was higher in the underweight group than in the other groups (58.3%, p=0.076). Obese patients had a higher percentage of chronic kidney disease compared to the non-obese group (p=0.022).

Table 1: Baseline Characteristics of Patients by BMI Category

Characteristic	Underweight (n=60)	Normal Weight (n=480)	Overweight (n=420)	Obese (n=240)	p-value
Age (years)	65.4 ± 10.2	62.3 ± 11.1	61.5 ± 10.8	60.9 ± 11.5	0.045
Male N (%)	32 (53.3)	293 (61.1%)	271 (64.5%)	141 (58.8%)	0.211
Female N (%)	28 (46.7%)	187 (38.9%)	149 (35.5%)	99 (41.3%)	
Hypertension N (%)	29 (48.3%)	261 (54.4%)	290 (69.1%)	190 (79.2%)	<0.001
Diabetes N (%)	5 (8.3%)	71 (14.8%)	121 (28.8%)	105 (43.8%)	<0.001
Smoking N (%)	35 (58.3%)	163 (33.9%)	123 (29.3%)	58 (24.2%)	0.076
Chronic Kidney Disease N (%)	5 (8.3%)	36 (7.5%)	51 (12.1%)	34 (14.2%)	0.022

A higher proportion of obese cases were recorded from urban localities (68.8%, p=0.034), and patients with lower education levels up to secondary school (21.7%, p=0.011), as shown in the demographic and socioeconomic status analysis. There was a significant difference in socioeconomic status between the different BMI groups, with a greater representation of middle-class patients among the obese (59.6%, p=0.029).

Regarding clinical presentation, among obese patients, STEMI was present in 63.3% (p=0.032), while NSTEMI was more commonly observed in other groups. There was no significant difference in initial systolic and diastolic blood pressures between BMI categories (both p > 0.05), but heart rate appeared lower among obese patients (p=0.038).

Across BMI groups, no statistically significant differences were observed in treatment modalities, including the use of thrombolysis, PCI, or CABG. Standard antiplatelet therapy was given to all patients. However, the use of beta-blockers and statins did not differ among the BMI categories. Importantly, obese patients required longer hospital stays (7.2 ± 2.9 days; p < 0.001) and showed higher rates of heart failure (20.4%, p=0.002) as well as infections (12.1%, p=0.007). The study found no difference in mortality rates or the occurrence of arrhythmias between groups.

Table 2: Demographic and Socioeconomic Characteristics by BMI Category

Characteristic	Underweight (n=60)	Normal Weight (n=480)	Overweight (n=420)	Obese (n=240)	p-value
Residence					
Urban N (%)	31 (51.7%)	285 (59.4%)	270 (64.3%)	165 (68.8%)	0.034
Rural N (%)	29 (48.3%)	195 (40.6%)	150 (35.7%)	75 (31.2%)	0.034
Education Level					
No Formal Education N (%)	3 (5.0%)	46 (9.6%)	61 (14.5%)	45 (18.8%)	0.002
Primary Education N (%)	8 (13.3%)	122 (25.4%)	125 (29.8%)	81 (33.8%)	0.012
Secondary Education N (%)	22 (36.7%)	167 (34.8%)	121 (28.8%)	62 (25.8%)	0.021
Tertiary Education N (%)	27 (45.0%)	145 (30.2%)	113 (26.9%)	52 (21.7%)	0.011
Socioeconomic Status					
Low N (%)	23 (38.3%)	143 (29.79%)	106 (25.2%)	46 (19.2%)	0.015
Middle N (%)	28 (46.7%)	245 (51.1%)	215 (51.2%)	143(59.6%)	0.029
High N (%)	9 (15.0%)	92 (19.2%)	99 (23.6%)	51 (51.3%)	0.671

In multivariate logistic regression analysis, age (OR 1.05, 95% CI: 1.02-1.08, p=0.001), obesity (OR 1.35, 95% CI 1.01-1.79, p=0.042), STEMI (OR 1.40, 95% CI 1.05-1.87, p=0.021), and heart failure (OR 1.50, 95% CI 1.12-2.02, p=0.006) were identified as independent predictors of in-hospital mortality. Gender, hypertension, and diabetes were not significant predictors of mortality.

Table 3: Clinical Presentation and AMI Type by BMI Category

Variable	Underweight (n=60)	Normal Weight (n=480)	Overweight (n=420)	Obese (n=240)	p-value
STEMI N (%)	32 (53.3%)	261 (54.4%)	248 (59.1%)	152 (63.3%)	0.032
NSTEMI N (%)	28 (46.7%)	219 (45.6%)	172 (40.9%)	88 (36.7%)	0.032
Initial SBP (mmHg)	135.2 ± 25.4	138.3 ± 27.2	140.5 ± 24.8	145.1 ± 26.3	0.089
Initial DBP (mmHg)	80.1 ± 12.3	82.4 ± 13.1	84.2 ± 14.5	85.5 ± 15.2	0.121
Heart Rate (bpm)	85.4 ± 18.2	82.3 ± 16.5	80.2 ± 17.4	78.5 ± 16.8	0.038

Table 4: Treatment Modalities by BMI Category

Treatment	Underweight (n=60)	Normal Weight (n=480)	Overweight (n=420)	Obese (n=240)	p-value
Thrombolysis N (%)	23 (38.3%)	248 (51.7%)	245 (58.3%)	123 (51.3%)	0.633
PCI N (%)	21 (35.0%)	214 (44.6%)	228 (54.3%)	112 (46.7%)	0.442
CABG N (%)	4 (6.7%)	21 (4.4%)	28 (6.7%)	14 (5.8)	0.789
Anti-platelets N (%)	60 (100%)	480 (100%)	420 (100%)	240 (100%)	
Beta-blockers N (%)	53 (88.4%)	465 (96.9%)	405 (96.4%)	230 (95.8%)	0.325
Statins N (%)	51 (85.0%)	458 (95.4%)	392 (93.3%)	225 (93.8%)	0.534

The study involving 1,200 patients with acute myocardial infarction (AMI) reveals significant associations between body mass index (BMI) categories and various clinical and demographic outcomes. The findings highlight that obese patients, who were relatively younger, had a higher prevalence of comorbidities such as hypertension, diabetes, and chronic kidney disease.

Table 5: In-Hospital Outcomes by BMI Category

Outcome	Underweight (n=60)	Normal Weight (n=480)	Overweight (n=420)	Obese (n=240)	p-value
Mortality N (%)	4 (6.7%)	19 (3.9%)	22 (5.2%)	15 (6.3%)	0.774
Length of Stay (days)	6.1 ± 2.5	5.4 ± 2.1	5.7 ± 2.4	7.2 ± 2.9	<0.001
Heart Failure N (%)	7 (11.7%)	57 (11.9%)	65 (15.5%)	49 (20.4%)	0.002
Arrhythmias N (%)	5 (8.3%)	49 (10.2%)	51 (12.1%)	37 (15.4%)	0.065
Infections N (%)	2 (3.3%)	26 (5.4%)	35 (8.3%)	29 (12.1%)	0.007

These patients also tended to be from urban areas and of lower educational levels, with a greater proportion classified as middle-class. Clinically, obese patients were more likely to present with STEMI, required longer hospital stays, and experienced higher rates of complications, including heart failure and infections. However, treatment modalities, including the use of thrombolysis, PCI, and CABG, were consistent across BMI groups, indicating fair access to care regardless of BMI. Notably, while obesity was associated with more complications, it did not impact mortality rates or arrhythmias, consistent with the "obesity paradox." Multivariate analysis identified age, obesity, STEMI, and heart failure as independent predictors of in-hospital mortality, underscoring the complexity of managing AMI in obese patients and the need for tailored interventions. In multivariate logistic regression analysis, age (OR 1.05, 95% CI: 1.02-1.08, p=0.001), obesity (OR 1.35, 95% CI 1.01-1.79, p=0.042), STEMI (OR 1.40, 95% CI 1.05-1.87, p=0.021), and heart failure (OR 1.50, 95% CI 1.12-2.02, p=0.006) were identified as independent predictors

Table 6: Multivariate Logistic Regression for Predictors of In-Hospital Mortality

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age	1.05	1.02-1.08	0.001
Male Gender	1.20	0.85-1.68	0.297
Hypertension	1.15	0.83-1.58	0.397
Diabetes	1.25	0.92-1.70	0.156
BMI (Obese vs. Normal)	1.35	1.01-1.79	0.042
STEMI	1.40	1.05-1.87	0.021
Heart Failure	1.50	1.12-2.02	0.006

of in-hospital mortality. Gender, hypertension, and diabetes were not significant predictors of mortality.

DISCUSSION

The present study was conducted to provide additional insight into body mass index (BMI) and in-hospital treatment patterns and outcomes for patients with AMI. A total of 1,200 patients were studied, divided into four groups according to BMI; differences between these subgroups in demographic, clinical, and outcome parameters were analyzed.

Obese patients presented at a younger age than those in the other BMI categories (p=0.045). These findings align with other studies that have demonstrated a higher incidence of cardiovascular events among younger individuals with higher BMI, who are at increased risk for cardiovascular events [13]. Obese patients also had a higher prevalence of hypertension and diabetes (p<0.001), consistent with literature linking obesity to these comorbid conditions [14]. The underweight group had the highest likelihood of smoking compared to any other BMI category (58.3%, p=0.076), a finding supported by other studies suggesting that lower BMIs are associated with higher smoking rates, potentially due to nicotine's appetite-suppressing effects [15].

After adjustment for age and sex, obese patients were more likely to live in urban areas (68.8%, p=0.034), and their socioeconomic status, as expressed by having a tertiary education, was lower than that of non-obese cases (21.7%, p=0.011). This finding is consistent with larger socioeconomic trends where obesity and overweight are inversely related to urbanization and education level [16]. In terms of socioeconomic status, we found that obese patients were more likely to belong to the middle-class group (59.6%, p=0.029), possibly reflecting the availability of calorie-rich but cheaper food products made widely available in towns and cities [17].

We found that STEMI was most commonly observed in obese patients (63.3%, p=0.032), whereas NSTEMI occurred more often among the underweight group, albeit with borderline significance. Previous studies have similarly observed a higher prevalence of STEMI in obese individuals, potentially due to greater arterial plaque burden and inflammation [18]. Mean blood pressures and heart rates at baseline were not significantly different across BMI categories, although resting heart rate was lower in obese patients (p=0.038). These results may suggest differential patterns of autonomic control and cardiac workload in different BMI groups [19].

The lack of statistically significant differences in the use of thrombolysis, PCI, and CABG across BMI groups indicates fair access to these important interventions regardless of patients' BMI. Additionally, all patients in our cohort received antiplatelet therapy, while the use of beta-blockers and statins did not significantly differ among CAD low, intermediate, and high probability categories, supporting compliance with contemporary AMI management guidelines [20].

Obese patients had longer hospital stays (7.2 ± 2.9 days, p<0.001) and higher incidence rates of heart failure (20.4%, p=0.002) and infections (12.1%, p=0.007). These findings are supported by previous studies that have demonstrated longer hospitalizations and higher complication rates in obese patients with AMI [21]. BMI groups were not significantly associated with either mortality rates or the development of arrhythmias, consistent with the "obesity paradox," in which short-term BMI-dependent survival may be superior despite increased complication rates [22].

Using multivariate logistic regression, age, obesity, STEMI, and heart failure were identified as independent predictors of in-hospital mortality. This is consistent with previous studies that emphasize the importance of age and pre-existing comorbid conditions in relation to mortality risk among patients discharged after an AMI [23]. Most importantly, obesity was identified as a strong predictor (OR 1.35, p=0.042), highlighting the importance of international management strategies to minimize risk factors in this subgroup.

CONCLUSION

These results indicate that although BMI may not affect the utilization of in-hospital treatments for AMI, it does affect the length of stay and complications. Given the longer hospitalizations and more in-hospital complications observed among obese patients, interventions to manage this high-risk population should be prioritized. Further studies are necessary to elucidate the potential mechanisms and to determine whether excessive BMI has any long-term consequences for AMI patients.

REFERENCES

1. World Health Organization. Cardiovascular Diseases (CVDs). Available at: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds).
2. Khera R, Dharmarajan K, Wang Y, Lin Z, Bernheim SM, Wang Y, et al. Association of the Hospital Readmissions Reduction Program With Mortality Among Medicare Beneficiaries Hospitalized for Acute Myocardial Infarction, Heart Failure, and Pneumonia. JAMA Netw Open. 2021;4(1). doi:10.1001/jamanetworkopen.2020.30985
3. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC Guidelines for the Management of Acute Myocardial Infarction in Patients Presenting With ST-Segment Elevation. Eur Heart J. 2018;39(2):119-77. doi:10.1093/eurheartj/ehx393
4. Jebb SA, Wells JC. Measuring Body Composition in Adults and Children. In: Handbook of Obesity. CRC Press; 2007. p. 19-43. doi:10.1201/9781420016691
5. Poirier P, Giles TD, Bray GA, Hong Y, Stern JS, Pi-Sunyer FX, et al. Obesity and Cardiovascular Disease: Pathophysiology, Evaluation, and Effect of Weight Loss. Arterioscler Thromb Vasc Biol. 2006;26(5):968-76. doi:10.1161/01.ATV.0000216787.85457.f
6. Nuttall FQ. Body Mass Index: Obesity, BMI, and Health: A Critical Review. Nutr Today. 2015;50(3):117. doi:10.1097/NT.0000000000000092
7. Huang Y, Cai X, Mai W, Li M, Hu Y, Xu D. Association Between Obesity and Short- and Long-Term Mortality in Patients With Acute Myocardial Infarction: A Systematic Review and Meta-Analysis. Clin Cardiol. 2021;44(5):590-602. doi:10.1002/clc.23577
8. Bozkurt B, Hershberger RE, Butler J, Grady KL, Heidenreich PA, Isler ML, et al. 2021 ACC/AHA Key Data Elements and Definitions for Heart Failure: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Data Standards (Writing Committee to Develop Clinical Data Standards for Heart Failure). J Am Coll Cardiol. 2021;77(17):2053-2150. doi:10.1016/j.jacc.2021.02.038
9. Powell-Wiley TM, Poirier P, Burke LE, Després JP, Gordon-Larsen P, Lavie CJ, et al. Obesity and Cardiovascular Disease: A Scientific Statement From the American Heart Association. Circulation. 2021;143(21). doi:10.1161/CIR.0000000000000973
10. Romero-Corral A, Somers VK, Sierra-Johnson J, Thomas RJ, Collazo-Clavell ML, Korinek J, et al. Accuracy of Body Mass Index in Diagnosing Obesity in the Adult General Population. Int J Obes. 2008;32(6):959-66. doi:10.1038/ijo.2008.11
11. De Schutter A, Lavie CJ, Milani RV, Ventura HO. The Impact of Obesity on Outcomes in Heart Failure With Preserved Ejection Fraction: A Systematic Review and Meta-Analysis. Prog Cardiovasc Dis. 2021;68:64-70. doi:10.1016/j.pcad.2021.05.002
12. Khan SS, Ning H, Wilkins JT, Allen N, Carnethon M, Berry JD, et al. Association of Body Mass Index With Lifetime Risk of Cardiovascular Disease and Compression of Morbidity. JAMA Cardiol. 2021;6(3):343-50. doi:10.1001/jamacardio.2020.5262
13. Angerås O, Albertsson P, Karason K, Råmunddal T, Matejka G, James SK. Evidence for Obesity Paradox in Patients With Acute Coronary Syndromes: A Report From the Swedish Coronary Angiography and Angioplasty Registry. Eur Heart J. 2013;34(5):345-53. doi:10.1093/eurheartj/ehs217
14. Lavie CJ, Milani RV, Ventura HO. Obesity and Cardiovascular Disease: Risk Factor, Paradox, and Impact of Weight Loss. J Am Coll Cardiol. 2009;53(21):1925-32. doi:10.1016/j.jacc.2008.12.068
15. Chiolero A, Faeh D, Paccaud F, Cornuz J. Consequences of Smoking for Body Weight, Body Fat Distribution, and Insulin Resistance. Am J Clin Nutr. 2008;87(4):801-9. doi:10.1093/ajcn/87.4.801
16. Drewnowski A, Specter SE. Poverty and Obesity: The Role of Energy Density and Energy Costs. Am J Clin Nutr. 2004;79(1):6-16. doi:10.1093/ajcn/79.1.6
17. Drewnowski A. Obesity and the Food Environment: Dietary Energy Density and Diet Costs. Am J Prev Med. 2004;27(3):154-62. doi:10.1016/j.amepre.2004.06.011
18. Neeland IJ, Poirier P, Després JP. Cardiovascular and Metabolic Heterogeneity of Obesity: Clinical Challenges and Implications for Management. Circulation. 2018;137(13):1391-406. doi:10.1161/CIRCULATIONAHA.117.029617
19. Grassi G, Dell'Oro R, Quarti-Trevano F, Scopelliti F, Seravalle G, Mancia G. Neuroadrenergic and Reflex Abnormalities in Hypertension and Their Implications in Treatment. J Hypertens. 2004;22(9):1711-4. doi:10.1097/00004872-200409000-00002
20. Amsterdam EA, Wenger NK, Brindis RG, Casey DE Jr, Ganiats TG, Holmes DR Jr, et al. 2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes. J Am Coll Cardiol. 2014;64(24). doi:10.1016/j.jacc.2014.09.017
21. Bucholz EM, Rathore SS, Gosch K, Schoenfeld A, Jones PG, Buchanan DM, et al. Effect of Obesity on Mortality and Procedural Complications in Percutaneous Coronary Intervention Among Patients With Acute Myocardial Infarction. J Am Coll Cardiol. 2014;64(11):1042-51. doi:10.1016/j.jacc.2014.06.1152
22. Oreopoulos A, Padwal R, Kalantar-Zadeh K, Fonarow GC, Norris CM, McAlister FA. Body Mass Index and Mortality in Heart Failure: A Meta-Analysis. Am Heart J. 2008;156(1):13-22. doi:10.1016/j.ahj.2008.02.014
23. Fox CS, Evans JC, Larson MG, Kannel WB, Levy D. The Association of Obesity With Cardiovascular Disease Mortality in the Framingham Heart Study. Ann Intern Med. 2004;140(1):24-32. doi:10.7326/0003-4819-140-1-200401060-00008