https://doi.org/10.29309/TPMJ/2026.33.02.9178 www.theprofesional.com

ORIGINAL ARTICLE

The impact of metabolic syndrome on morbidity in patients undergoing Coronary Artery Bypass Graft (CABG) surgery.

Muhammad Farooq Ahmad[1], Muhammad Hussnain Raza[2], Riaz ul Haq[3], Muhammad Mujahid[4], Sidra Masood[5], Muneeza Dilpazeer[6]

ABSTRACT… Objective: To compare the post-operative morbidity in patients undergoing coronary artery bypass graft surgery with versus without metabolic syndrome. **Study Design:** This study was a quasi-experimental study. **Setting:** Department of Cardiac Surgery, Faisalabad Institute of Cardiology Faisalabad. **Period:** 30/03/2022 to 29/03/2023 (12 month study). **Methods:** The present study involved 200 both male and female patients aged 30-65 years undergoing coronary artery bypass grafting assimilated into two equal groups containing 100 cases for each group i.e. with and without metabolic syndrome. Standard departmental protocols were adopted to manage these cases. Outcome variables were mean intubation time, mean ICU and hospital stay duration, as well as post-operative atrial fibrillation, respiratory complications and wound infection which were noted and compared between the groups. **Results:** The average age of the study participants was 51.4 ± 9.4 years, with a male predominance of 7:1. Among them, 60.5% had hypertension, and 35.5% were diagnosed with diabetes. When comparing outcomes between groups, patients with metabolic syndrome experienced significantly longer intubation times (21.35 ± 2.70 vs. 16.35 ± 1.70 hours; p=0.001), prolonged ICU stays (63.85 ± 7.81 vs. 50.38 ± 4.38 hours; p=0.001), and extended hospital stays (9.70 ± 1.92 vs. 7.17 ± 1.78 days; p=0.001) compared to those without it. Additionally, the incidence of postoperative atrial fibrillation (19.0% vs. 2.0%; p=0.001), respiratory complications (16.0% vs. 0.0%; p=0.001), and wound infections (20.0% vs. 3.0%; p=0.001) was remarkably higher among CABG recipients diagnosed with metabolic syndrome. **Conclusion:** Among patients undergoing CABG, the presence of metabolic syndrome was linked to increased post-operative morbidity, including prolonged intubation time, extended ICU and hospital stays, and a higher risk of atrial fibrillation, respiratory complications, and wound infections, irrespective of age, gender, and diabetic status. This underscores the need for routine metabolic syndrome screening in CABG candidates to enable early detection and proactive management, ultimately improving patient outcomes.

Key words: Coronary Artery Bypass Graft, Metabolic Syndrome, Post-Operative Morbidity.

Article Citation: Ahmad MF, Raza MH, Riaz ul Haq, Mujahid M, Masood S, Dilpazeer M. The impact of metabolic syndrome on morbidity in patients undergoing Coronary Artery Bypass Graft (CABG) surgery. Professional Med J 2026; 33(02):203-212.
https://doi.org/10.29309/TPMJ/2026.33.02.9178

INTRODUCTION

Metabolic syndrome (MetS) includes multiple metabolic dysfunctions, such as central obesity, insulin resistance, high triglyceride levels, decreased HDL cholesterol, and hypertension.[1] The underlying mechanism linking these cardiovascular risk factors is insulin resistance, which serves as a defining feature of MetS and plays a crucial role as a causative factor in subjects undergoing CABG.[2] As metabolic syndrome (MetS) encompasses various cardiovascular risk factors, it has been linked to an increased incidence of morbidity in the early postoperative stage of CABG. Given this elevated risk, MetS should be an essential consideration in the preoperative evaluation of patients undergoing CABG. With a preventability rate of 40% to 50%, metabolic syndrome is a modifiable condition that is often overlooked and left untreated, potentially exacerbating outcomes in CABG patients.[3] It has been suggested that insulin resistance significantly contributes to the increased occurrence of ischemic events in MetS patients, though the exact mechanisms and related processes remain to be fully understood.[4] MetS has been reported to have a global prevalence of approximately 11% to 40%.[5,6] Metabolic syndrome is associated with chronic inflammation, characterized by increased adipocytokine levels, including interleukin-6, tumor necrosis factor-alpha, and C-reactive protein, along with elevated free fatty acids that contribute

1. MD, MS (Cardiac Surgery), Senior Registrar, FIC, Faisalabad.
2. MBBS, MS (Cardiac Surgery), Senior Registrar, WIC, Wazirabad.
3. MBBS, MS (Cardiac Surgery), Senior Registrar, SMBZAN Institute of Cardiology, Quetta.
4. MBBS, FCPS (Cardiac Surgery), Senior Registrar, PIC, Lahore.
5. MBBS, WMO, FIC, Faisalabad.
6. MBBS, FCPS (CT) Paeds Medicine ER Specialist, Children Life Specialist, (CLF) Quetta.

Correspondence Address:
Dr. Muhammad Farooq Ahmad
FIC, Faisalabad.
dr.farooqgill@gmail.com

Article received on:
17/02/2025
Date of revision:
15/09/2025
Accepted for publication:
22/09/2025

to endothelial dysfunction and vasoconstriction. This condition is also regarded as a form of low-grade inflammation, marked by increased levels of circulating inflammatory cytokines. Patients with MetS exhibit reduced plasma adiponectin levels and elevated leptin and resistin levels. While leptin and resistin enhance immune system activity, adiponectin counteracts inflammation in the vascular wall by inhibiting the nuclear factor kappa B pathway.[7] The chronic pro-inflammatory condition seen in MetS patients may worsen the systemic inflammatory response triggered by cardiopulmonary bypass (CPB) and surgical trauma, increasing the risk of complications both during and after surgery.[8]

As a key component of MetS, abdominal obesity contributes to metabolic imbalances that heighten susceptibility to type 2 diabetes and CVD.[9] It has been recognized as a predictor of unfavorable outcomes after cardiovascular procedures, and recent findings suggest its association with both short- and long-term mortality and morbidity following CABG surgery.[10] various trial did not find such relationship.[11] MetS is diagnosed when at least three of the five criteria established by NCEP ATP III are met. The modified NCEP ATP III criteria are more applicable to the Asian population, as they consider ethnic-specific waist circumference values.[12,13]

METHODS

This comparative cross-sectional study was carried out in the Cardiac Surgery Department at Faisalabad Institute of Cardiology, a well-equipped tertiary care center specializing in cardiac procedures. 200 patients who underwent CABG surgery from 30-03-2022 to 29-03-2023 were included in the study. Approval was obtained from the hospital's ethical review committee (19/DME/FIC/FSD), and no conflicts of interest were reported. As part of the preoperative evaluation, systolic and diastolic blood pressure, waist circumference (cm), triglyceride levels, fasting blood glucose, and high-density lipoprotein levels were measured and recorded during admission to the cardiac surgery unit. Both male and female patients between 40 to 70 years of age with serum creatinine level of less than 1.2 undergoing elective CABG surgery were included. The study excluded patients undergoing redo surgeries, those with an eGFR below 60 ml/min, and individuals with a LVEF<30%. Patients were interviewed, explained and counseled about the procedure of the study. They were admitted in cardiac surgery ward.

TABLE

The modified criteria NCEP ATP III for metabolic syndrome

Measure (any 3 of 5 constitute diagnosis of metabolic syndrome)	Categorical Cutpoints
Elevated waist circumference*†	≥102 cm (≥40 inches) in men
	≥88 cm (≥35 inches) in women
Elevated triglycerides	≥150 mg/dL (1.7 mmol/L)
	Or
	On drug treatment for elevated triglycerides‡
Reduced HDL-C	<40 mg/dL (1.03 mmol/L) in men
	<50 mg/dL (1.3 mmol/L) in women
	Or
	On drug treatment for reduced HDL-C‡
Elevated blood pressure	≥130 mm Hg systolic blood pressure
	Or
	≥85 mm Hg diastolic blood pressure
	Or
	On antihypertensive drug treatment in a patient with a history of hypertension
Elevated fasting glucose	≥100 mg/dL
	Or
	On drug treatment for elevated glucose

*To measure waist circumference, locate top of right iliac crest. Place a measuring tape in a horizontal plane around abdomen at level of iliac crest. Before reading tape measure, ensure that tape is snug but does not compress the skin and is parallel to floor. Measurement is made at the end of a normal expiration.

†Some US adults of non-Asian origin (eg, white, black, Hispanic) with marginally increased waist circumference (eg, 94-101 cm [37-39 inches] in men and 80-87 cm [31-34 inches] in women) may have strong genetic contribution to insulin resistance and should benefit from changes in lifestyle habits, similar to men with categorical increases in waist circumference. Lower waist circumference cutpoint (eg, ≥90 cm [35 inches] in men and ≥80 cm [31 inches] in women) appears to be appropriate for Asian Americans.

‡Fibrates and nicotinic acid are the most commonly used drugs for elevated TG and reduced HDL-C. Patients taking one of these drugs are presumed to have high TG and low HDL.

As described by NCEP ATP III, the modified criteria

will be used. According to which at least three of the five criteria will have to be met for the diagnosis of Metabolic Syndrome.
The patients divided into two groups
Study Group (with metabolic syndrome)
Control Group (without metabolic syndrome)

Surgery performed utilizing standard techniques of median sternotomy, arterial and venous grafts harvesting, pericardiotomy, heparinization, cannulation, cardiopulmonary bypass, hypothermia, aortic cross clamping and ante grade cold blood cardioplegia. Required number of grafts will be anastomosed, rewarming, removal of cross clamp, restoration of normal sinus rhythm, weaning off CPB, protamine administration, placements of pacing wires and drains, hemostasis and chest closure. Patients shifted to ICU.

Postoperative outcome in term of prolonged intubation time, prolonged ICU stay (Hours), prolonged hospital stay (Days), atrial fibrillations, pulmonary complications and wound infections were recorded.

RESULTS
Patients were aged between 33 and 65 years, of 51.4 ± 9.4 years was computed as mean + sd. Most of the cases i.e. 61.5% (n=123) belonged to the 45 years and older age group. There were 175 (87.5%) males and 25 (12.5%) females. Ratio between male to female patients was of 7:1. 121 (60.5%) patients were hypertensive and 71 (35.5%) patients were diabetic as given in Table-I.
The subgroup analysis demonstrated that there was no inherent bias between the groups in study, as differences in mean age (p = 0.881), age subgroup distribution (p = 0.884), gender (p = 0.831), and hypertensive status (p = 0.885) were statistically insignificant. However, diabetes was significantly more common among MetS patients (57.0% vs. 14.0%; p < 0.001), Table-II.

The intubation time ranged from 13-25 hours with a mean of 18.85±3.37 hours while the length of ICU stay ranged from 44-75 hours with a mean of 57.12±9.25 hours. Length of hospital stay ranged from 5-14 days with a mean of 8.43±2.24 days. Post-operative atrial fibrillation was noted in 21 (10.5%) patients while respiratory complications and wound infection were encountered in 16 (8.0%) and 23 (11.5%) patients respectively. The mean intubation time (21.35±2.70 vs. 16.35±1.70 hours; p < 0.001), ICU stay duration (63.85±7.81 vs. 50.38±4.38 hours; p < 0.001), and total hospital stay (9.70±1.92 vs. 7.17±1.78 days; p < 0.001) were all remarkably longer in subjects with MetS compared to those without it. Similarly, patients with metabolic syndrome who underwent CABG exhibited a significantly higher occurrence of postoperative atrial fibrillation (19.0% vs. 2.0%; p < 0.001), respiratory complications (16.0% vs. 0.0%; p < 0.001), and wound infections (20.0% vs. 3.0%; p < 0.001), as shown in Table-III. Upon stratification, an equally significant difference was observed between the groups across multiple subgroups classified by gender, age, hypertension, and diabetic status, as presented in Tables-IV–IX.

TABLE-I

Demographic and Clinical Profile of the Study Cohort

Characteristics	Participants n=200
Age (years)	51.4±9.4
<45 years	77 (38.5%)
≥45 years	123 (61.5%)
Gender	
Male	175 (87.5%)
Female	25 (12.5%)
Hypertension	
Yes	121 (60.5%)
No	79 (39.5%)
Diabetes	
Yes	71 (35.5%)
No	129 (64.5%)

TABLE-II

Baseline characteristics of the study groups n=200

Characteristics	Without MetS n=100	With MetS n=100	P-Value
Age (years)	51.5±9.1	51.3±9.8	0.881
<55 years	38 (38.0%)	39 (39.0%)	0.884
≥55 years	62 (62.0%)	61 (61.0%)	
Gender			
Male	87 (87.0%)	88 (88.0%)	0.831
Female	13 (13.0%)	12 (12.0%)	
Hypertension			
Yes	60 (60.0%)	61 (61.0%)	0.885
No	40 (40.0%)	39 (39.0%)	
Diabetes			
Yes	14 (14.0%)	57 (57.0%)	<0.001*

*The chi-square test confirmed the observed difference as significant

TABLE-III

Comparison of various outcome measures between the study groups n=200

Outcome Measures	Without Mets n=100	With Mets n=100	P-Value
Mean Intubation Time (hours)	16.35±1.70	21.35±2.70	<0.001*
Mean Length of ICU Stay (hours)	50.38±4.38	63.85±7.81	<0.001*
Mean Length of Hospital Stay (days)	7.17±1.78	9.70±1.92	<0.001*
Post-Operative Atrial Fibrillation	2 (2.0%)	19 (19.0%)	<0.001*
Post-Operative Respiratory Complications	0 (0.0%)	16 (16.0%)	<0.001*
Post-Operative Wound Infection	3 (3.0%)	20 (20.0%)	<0.001*

* The observed difference was statistically significant on Independent sample t-test and chi-square test/Fisher's exact test

TABLE-IV

Comparison of mean intubation time (Hours) between the study groups across various subgroups n=200

Subgroups	Mean Intubation Time (Hours)		P-Value
	Without MetS n=100	With MetS n=100	
Age			
<55 years	16.32±1.73	21.10±2.74	<0.001*
≥55 years	16.37±1.69	21.51±2.68	<0.001*
Gender			
Male	16.32±1.75	21.33±2.71	<0.001*
Female	16.54±1.33	21.50±2.72	<0.001*
Hypertension			
Yes	16.25±1.72	21.36±2.76	<0.001*
No	16.50±1.68	21.33±2.63	<0.001*
Diabetes			
Yes	16.21±1.72	21.07±2.87	<0.001*
No	16.37±1.70	21.72±2.43	<0.001*

* The observed difference in mean intubation time (hours) was statistically significant on t- test

TABLE-V

Comparison of Mean Length of ICU Stay (Hours) between the study groups across various subgroups n=200

Subgroups	Mean ICU Stay (Hours)		P-Value
	Without MetS n=100	With MetS n=100	
Age			
<55 years	50.13±4.52	63.74±8.56	<0.001*
≥55 years	50.53±4.33	63.92±7.36	<0.001*
Gender			
Male	50.32±4.43	63.75±7.99	<0.001*
Female	50.77±4.23	64.58±6.57	<0.001*
Hypertension			
Yes	50.48±4.54	63.77±7.55	<0.001*
No	50.23±4.19	63.97±8.30	<0.001*
Diabetes			
Yes	52.29±4.53	63.23±7.47	<0.001*
No	50.07±4.31	64.67±8.25	<0.001*

* The observed difference in mean length of ICU stay (hours) was statistically significant on t- test

TABLE-IV

Comparison of mean length of hospital stay (Days) between the study groups across various subgroups n=200

Subgroups	Mean Hospital Stay (Days)		P-Value
	Without MetS n=100	With MetS n=100	
Age			
<55 years	7.13±1.66	9.64±1.95	<0.001*
≥55 years	7.19±1.86	9.74±1.91	<0.001*
Gender			
Male	7.14±1.76	9.68±1.92	<0.001*
Female	7.38±1.94	9.83±1.99	0.005*
Hypertension			
Yes	7.23±1.88	9.80±1.91	<0.001*
No	7.08±1.62	9.54±1.93	<0.001*
Diabetes			
Yes	7.28±1.77	9.84±1.85	<0.001*
No	6.50±1.70	9.60±1.97	<0.001*

* The observed difference in mean length of hospital stay (days) was statistically significant on t- test

TABLE-IIV

Comparison of Post-Operative Atrial Fibrillation between the Study Groups across Various Subgroups n=200

Subgroups	Post-Operative Atrial Fibrillation		P-Value
	Without MetS n=100	With MetS n=100	
Age			
<55 years	1/38 (2.6%)	7/39 (17.9%)	0.050*
≥55 years	1/62 (1.6%)	12/61 (19.7%)	0.001*
Gender			
Male	2/87 (2.3%)	17/88 (19.3%)	<0.001*
Female	0/13 (0.0%)	2/12 (16.7%)	0.220
Hypertension			
Yes	2/60 (3.3%)	12/61 (19.7%)	0.008*
No	0/40 (0.0%)	7/39 (17.9%)	0.005*
Diabetes			
Yes	1/14 (7.1%)	11/57 (19.3%)	0.437
No	1/86 (1.2%)	8/43 (18.6%)	0.001*

* The observed difference was significant on Fisher's exact test

TABLE-VIII

Comparison of post-operative respiratory complications between the study groups across various subgroups n=200

Subgroups	Post-Operative Respiratory Complications		P-Value
	Without MetS n=100	With MetS n=100	
Age			
<55 years	0/38 (0.0%)	6/39 (15.4%)	0.025*
≥55 years	0/62 (0.0%)	10/61 (16.4%)	0.001*
Gender			
Male	0/87 (0.0%)	14/88 (15.9%)	<0.001*
Female	0/13 (0.0%)	2/12 (16.7%)	0.220
Hypertension			
Yes	0/60 (0.0%)	11/61 (18.0%)	0.001*
No	0/40 (0.0%)	5/39 (12.8%)	0.026*
Diabetes			
Yes	0/14 (0.0%)	9/57 (15.8%)	0.189
No	0/86 (0.0%)	7/43 (16.3%)	<0.001*

* The observed difference was significant on Fisher's exact test

TABLE-IX

Comparison of post-operative wound infection between the study groups across various subgroups n=200

Subgroups	Post-Operative Wound Infection		P-Value
	Without MetS n=100	With MetS n=100	
Age			
<55 years	1/38 (2.6%)	8/39 (20.5%)	0.029*
≥55 years	2/62 (3.2%)	12/61 (19.7%)	0.004*
Gender			
Male	2/87 (3.2%)	17/88 (19.3%)	<0.001*
Female	1/13 (7.7%)	3/12 (25.0%)	0.322
Hypertension			
Yes	2/60 (3.3%)	12/61 (19.7%)	0.008*
No	1/40 (2.5%)	8/39 (20.5%)	0.014*
Diabetes			
Yes	1/14 (7.1%)	12/57 (21.1%)	0.441
No	2/86 (2.3%)	8/43 (18.6%)	0.002*

* The observed difference was significant on Fisher's exact test

DISCUSSION

Coronary artery bypass grafting (CABG) continues to be the preferred method for multivessel coronary revascularization.[14,15] Despite advancements in percutaneous coronary interventions and medical therapy, CABG continues to be a major contributor in treatment in patients diagnosed with CVD.[15] CABG has been made much safe and more acceptable by major advancements. Continuous research into various methods, approaches and medical interventions has made cardiac surgery mush safe and less invasive for future.[14,15] The rate of early versus late complications and risk factors associated with patients undergoing CABG has been attempted by many researchers. Among them are DM and COPD, number of type of graft, stroke, gender, age, serum procalcitonin level, addition, and chronic kidney disease, transfusion of blood products, ejection fraction and kind of technique (on-pump vs. off-pump).[16,17,18] In South Asia, MetS represents a significant health concern that needs urgent therapeutic and preventive actions.[19,20,21] In South Asia, paradoxically prevalence of MetS is equal between non-obese and obese populations.[19] In this region, the increased prevalence of MetS is related with increasing incidence of premature cardiovascular disease, diabetes and hypertension.[21,22] Clinicians face patients meeting diagnostic criteria for MetS in routine practice; these criteria include hypertension,central obesity, atherogenic dyslipidemia, and hyperglycemia.[23] Irrespective of variation in its definition, metabolic syndrome is related with adverse outcomes in patients undergoing non-cardiac and cardiac surgery.[23,24,25] Few recent studies reported that presence of MetS was associated with higher likelihood of post-operative complications in patients undergoing CABG and advocated that such patients should be considered as high risk.[10,11,26,27,28,29] However, the available research evidence was insufficient, and no relevant studies had been conducted on the local population, necessitating the present study.

The mean age of the patients undergoing CABG in this study was 51.4±9.4 years. Our observation is in line with that of another study[30] which observed similar mean age of 51.3±5.7 years among patients undergoing CABG at Choudhary Pervaiz Elahi Institute of Cardiology, Multan. In another local study[31] reported similar mean age of 51.6±10.3 years among such patients undergoing CABG at Punjab Institute of Cardiology, Lahore. Similar mean age has already been reported in a number of other local studies[32,33,34] which observed it to be 53.6±10.2 years, 55.3±9.6 years and 54.5±3.4 years respectively. In another study[35] a comparable mean age has been observed in Indian patients undergoing CABG which reported it to be 52.±11.2 years and another study[36] reported it to be 53.7±9.5 years. A similar trial[37] in Bangladesh reported comparable mean age of 54.8±2.5 years among such patients while another trial[38] reported it to be 53.4±8.9 years in Nepal.

This observed mean age in the present study matches with statistics reported by other studies conducted in local as well as other populations in south-east Asia. However in comparison with western population, this mean age is quite younger while some studies[39,40] observed much higher mean age at the time of CABG and reported it to be 67.1±10.1 years and 66.1±9.9 years respectively. Another study[41] also reported higher mean age of 67.3±9.1 years among Chinese such patients. This difference in the mean age can be attributable to geographical as well as life style and genetic factors associated with coronary artery disease. It implies public health measures in this regard to increase the public awareness about this aspect to reduce the burden of disease and delay its development as much as possible.

We observed that there was a male predominance among patients undergoing CABG with a male predominance to female. In another similar study[32] reported alike predominance of males with male to female ratio of 7.2:1. Observations in this study are in line with that of another trial[42] as well, who stated similar male predominance with male to female ratio of 6.2:1 in patients undergoing CABG. Comparable male predominance with male to female ratio of 6.2:1 has also been reported in another study.[33] Some other studies[35,36] described comparable predominance of male patients with male to female ratio of 7.1:1 and 7.9:1 respectively in Indian CABG patients. Another study[43] observed it to be 7.3:1 among Italian such patients.

In the present study, among patients undergoing CABG, 60.5% patients were hypertensive and 35.5% patients were diabetic. A similar frequency of hypertension (83.0%) and diabetes (38.0%) has also been observed in another trial[44] among patients undergoing CABG. Another study[33] observed similar frequency of hypertension and diabetes among such patients at Chaudhary Pervaiz Elahi Institute of Cardiology Multan and reported it to be 47.0% and 36.3% respectively. Another local study[32] reported comparable frequency of 46.0% and 36.0% for hypertension and diabetes respectively among patients undergoing CABG at Punjab Institute of Cardiology, Lahore. Our observation is also in line with that another study[35] which reported similar frequency of hypertension (76.1%) and diabetes (38.1%) in Indian such patients. Another Indian study[36] reported similar frequency of hypertension (71.6%) and diabetes (37.5%) among patients undergoing cardiac bypass surgery. Similar distribution has also been reported by another study[37] which reported the frequency of hypertension and diabetes to be 81.3% and 34.1% respectively in Bangladesh. Another study[40] also observed similar frequency of hypertension (76.1%) and diabetes (32.6%) in American patients undergoing cardiac bypass surgery. Our results are also in line with a Chinese study[41] which reported similar frequency of 78.4% for hypertension and 31.2% for diabetes among patients undergoing CABG.

Thus middle aged males with hypertension and diabetes contributed major share of patients undergoing CABG in the present study.

Patients diagnosed with metabolic syndrome experienced significantly longer intubation periods (21.35±2.70 vs. 16.35±1.70 hours), extended ICU stays (63.85±7.81 vs. 50.38±4.38 hours), and prolonged hospitalization (9.70±1.92 vs. 7.17±1.78 days), with statistical tests confirming p-values below 0.001 in each case. Similarly, they had a markedly higher incidence of post-operative atrial fibrillation (19.0% vs. 2.0%), respiratory complications (16.0% vs. 0.0%), and wound infections (20.0% vs. 3.0%), all reaching statistical significance at p<0.001. Subgroup analysis indicated that these differences remained significant across stratifications based on age, sex, hypertension, and diabetes.

A similar study[45] supports our findings, as it assessed operative morbidity in 40 Indonesian CABG patients with metabolic syndrome, compared to 34 patients without it. Their results demonstrated a significantly prolonged mean intubation time (30.2±4.4 vs. 16.4±4.2 hours; p < 0.001) and longer hospital stays (9.44±1.50 vs. 7.31±1.13 days; p < 0.001) in the metabolic syndrome group. The study also reported a notably higher wound infection rate (20.5% vs. 2.9%; p < 0.001) among these patients.

Another study[29] investigated 11,021 CABG cases in the USA, identifying 3,881 (35.2%) as having metabolic syndrome. Their study highlighted a significantly prolonged mean intubation period (30.9±93.8 vs. 24.6±81.1 hours; p<0.001), an extended ICU stay (68.50±150.2 vs. 55.3±105.1 hours; p<0.001), and a longer hospitalization duration (7.3±6.3 vs. 6.3±5.2 days; p<0.001) among patients with metabolic syndrome compared to those without.

A study[46] on Chinese CABG patients reported that individuals with metabolic syndrome had extended intubation times (18.23±22.63 vs. 15.86±24.17 hours) and ICU stays (60.33±67.79 vs. 48.26±38.29 hours), with the differences reaching statistical significance at a 99.9% confidence level (p<0.001).

Another study[10] on American CABG patients, observed significantly longer ICU stays (2.3±4.3 vs. 1.9±2.8 days) and hospital stays (8.3±7.8 vs. 6.6±6.0 days), with statistical testing confirming p<0.003 for both outcomes. Similarly, a study[3] on Chinese patients found that those with metabolic syndrome had a significantly increased intubation duration (19.53±34.45 vs. 15.86±24.17 hours) and ICU stay (61.11±82.09 vs. 48.26±38.29 hours), with p-values indicating highly significant differences (p<0.001).

Another study[11] analyzed Turkish CABG patients and found that those with metabolic syndrome had significantly prolonged ICU stays (2.6±0.8 vs. 2.1±0.3 days) and hospital stays (7.9±2.7

vs. 7.1±1.1 days), with p-values demonstrating strong statistical significance ($p<0.001$). The study also highlighted a significantly higher frequency of atrial fibrillation (15.0% vs. 9.3%; $p<0.05$) and wound infections (30.0% vs. 4.7%; $p<0.001$). Similarly, another study[24] identified elevated rates of atrial fibrillation (20.3% vs. 4.5%; $p=0.005$), wound infections (21.9% vs. 3.4%; $p<0.001$), and pulmonary complications (17.2% vs. 3.4%; $p<0.001$) in patients with metabolic syndrome undergoing CABG.

Another study[26] on Iranian patients undergoing CABG, noted a significantly higher frequency of atrial fibrillation in the metabolic syndrome group (15.0% vs. 2.9%), with statistical evaluation yielding $p<0.05$.

This study is the first of its kind conducted in the local population and adds to the limited international literature on the topic. The study's strengths include a robust sample size of 200 cases and strict exclusion criteria. Additionally, we stratified the data to minimize the influence of confounding factors. Our results indicate that among CABG patients, metabolic syndrome was linked to increased post-operative morbidity, including prolonged intubation duration, extended ICU and hospital stays, and a higher risk of atrial fibrillation, respiratory complications, and wound infections. These associations were observed regardless of patient age, gender, or hypertensive and diabetic status. This validates our initial hypothesis, confirming that metabolic syndrome contributes to higher post-operative morbidity in coronary heart disease patients undergoing CABG. Based on these findings, we recommend that metabolic syndrome screening be incorporated into routine preoperative assessment for CABG candidates to facilitate timely intervention and improve surgical outcomes.

One key limitation of this study was the short follow-up period. A longer follow-up would have allowed for a more comprehensive evaluation of long-term outcomes such as the need for repeat surgery and mortality, providing a clearer picture of the prognostic impact of metabolic syndrome. Future research addressing this aspect is essential.

CONCLUSION

In the present study, we observed that among patients undergoing CABG, the presence of metabolic syndrome was linked to increased post-operative morbidity, including prolonged intubation time, extended ICU and hospital stays, and a higher risk of atrial fibrillation, respiratory complications, and wound infections, irrespective of age, gender, and diabetic status. This underscores the need for routine metabolic syndrome screening in CABG candidates to enable early detection and proactive management, ultimately improving patient outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SOURCE OF FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Mendrick DL, Diehl AM, Topor LS, Dietert RR, Will Y, Merrill MAL, et al. **Metabolic syndrome and associated diseases.** Toxicological Sciences. 2018; 162(1):36-42.
2. Ormazabal V, Nair S, Elfeky O, Aguayo C, Salomon C. Zuñiga FA. **Association between insulin resistance and the development of cardiovascular disease.** CardiovascDiabetol. 2018; 17(1):1-14.
3. Ao H, Xu F, Wang X, Tang X, Zheng Z, Hu, S. **Effects of metabolic syndrome with or without obesity on outcomes after coronary artery bypass graft. A cohort and 5-year study.** PloS One. 2015; 10(2):e0117671.
4. Pino AD, DeFronzo RA. **Insulin resistance and atherosclerosis: Implications for insulin-sensitizing agents.** Endocr Rev. 2019; 40(6):1447-67.
5. Elabbassi WN, Haddad HA. **The epidemic of the metabolic syndrome.** Saudi Med J. 2005; 26(3):373-75.
6. Ranasinghe P, Mathangasinghe Y, Jayawardena R, Hills AP, Misra A. **Prevalence and trends of metabolic syndrome among adults in the asia-pacific region: A systematic review.** BMC Public Health. 2017; 17(1):1-9.
7. Francisco V, Pino J, Campos-Cabaleiro V, Ruiz-Fernandez C, Mera A, Gonzalez-Gay MA, et al. **Obesity and immune system: Role for leptin.** Front. Physiol. 2018; 9:640.
8. Fathima Paruk, Chausse JM. **Monitoring the post surgery inflammatory host response.** J Emerg Crit Care Med. 2019; 3:47.
9. Brede S, Serfling G, Klement J, Schmid SM, Lehnert H. **Clinical scenario of the metabolic syndrome.** Visc Med. 2016; 32(5):336-41.

10. Brackbill ML, Sytsma CS, Sykes K. **Perioperative outcomes of coronary artery bypass grafting: Effects of metabolic syndrome and patient's sex.** Am J Critical Care. 2009; 18(5):468-73.
11. Ozyazicioglu A, Yalcinkaya SERHAT, Vural AH, Yumun G, Bozkurt Ö. **Effects of metabolic syndrome on early mortality and morbidity in coronary artery bypass graft patients.** J Int Med Res. 2010; 38(1):202-07.
12. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. **Diagnosis and management of the metabolic syndrome: An American Heart Association/ National Heart, Lung, and Blood Institute scientific statement.** Circulation. 2005; 112(17):2735-52.
13. Moy FM, Bulgiba A. **The modified NCEP ATP III criteria maybe better than the IDF criteria in diagnosing Metabolic Syndrome among Malays in Kuala Lumpur.** BMC Public Health. 2010; 10(1):1-6.
14. Elbardissi AW, Aranki SF, Sheng S, Obrien SM, Greenberg CC, Gammie JS. **Trends in isolated coronary artery bypass grafting: An analysis of the society of thoracic surgeons adult cardiac surgery database.** J ThoracCardiovasc Surg. 2012;143(2):273-81.
15. Kodia K, Patel S, Weber MP, Luc JG, Choi JH, Maynes EJ, et al. **Graft patency after open versus endoscopic saphenous vein harvest in coronary artery bypass grafting surgery: A systematic review and meta-analysis.** Ann Cardiothorac Surg. 2018;7(5):586-97.
16. Myers WO, Blackstone EH, Davis K, Foster ED, Kaiser GC. **CASS registry: Long term surgical survival.** J Am Coll Cardiol. 2014;33(2):488-98.
17. Abramov D, Tamariz MG, Sever JY, Christakis GT, Bhatnagar G, Heenan AL, et al. **The influence of gender on the outcome of coronary artery bypass surgery.** Ann Thorac Surg. 2017;70(3):800-05.
18. Brandrup-wognsen G, Berggren H, Hartford M, Hjalmarson A, Karlsson T, Herlitz J. **Female sex is associated with increased mortality and morbidity early, but not late, after coronary artery bypasses grafting.** Eur Heart J. 2019;17(9):1426-31.
19. Gupta A, Gupta R, Sarna M, Rastogi S, Gupta V, Kothari K. **Prevalence of diabetes, impaired fasting glucose and insulin resistance syndrome in an urban Indian population.** Diabetes Res Clin Pract. 2003;61(1): 69-76.
20. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, Das AK, et al. **High prevalence of diabetes and impaired glucose tolerance in India: National urban diabetes survey.** Diabetologia. 2001;44(9):1094-1101.
21. Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V. **Metabolic syndrome in urban Asian Indian adults: A population study using modified ATP III criteria.** Diabetes Res Clin Pract. 2003;60(3):199-204.
22. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, et al. **Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management.** JAPI. 2009;57(2):163-70.
23. Kostapanos M, Florentin M, Elisaf M, Mikhailidis D. **Hemostatic factors and the metabolic syndrome.** Curr Vasc Pharmacol. 2014;11(6):880-905.
24. Echahidi N, Mohty D, Pibarot P, Despres J, Ohara G, Champagne J, et al. **Obesity and metabolic syndrome are independent risk factors for atrial fibrillation after coronary artery bypass graft surgery.** Circulation. 2007; 116(Suppl-11):1213-9.
25. Moebus S, Balijepalli C, Losch C, Gores L, Von stritzky B, Bramlage P, et al. **Age- and sex-specific prevalence and ten-year risk for cardiovascular disease of all 16 risk factor combinations of the metabolic syndrome - a cross-sectional study.** Cardiovasc Diabetol. 2010;9(1):34.
26. Ardeshiri M, Faritus Z, Ojaghi-Haghighi Z, Bakhshandeh H, Kargar F, Aghili R. **Impact of metabolic syndrome on mortality and morbidity after coronary artery bypass grafting surgery.** Res Cardiovasc Med. 2014; 3(3):e20270.
27. Moeinipour A, Hoseinikhah H, Morovatdar N, Ghorbanzadeh A, Akbari M, Mirshahpanah M, et al. **Outcomes of on-pump coronary artery bypass grafting in patients with metabolic syndrome in Mashhad, Iran.** J Cardio-Thorac Med. 2017; 5(3):187-91.
28. Chen S, Li J, Li Q, Qiu Z, Wu X, Chen L. **Metabolic syndrome increases operative mortality in patients with impaired left ventricular systolic function who undergo coronary artery bypass grafting: A retrospective observational study.** BMC Cardiovasc Disord. 2019; 19(1):1-9.
29. Zapata D, Halkos M, Binongo J, Puskas J, Guyton R, Lattouf O. **Effects and outcomes of cardiac surgery in patients with cardiometabolic syndrome.** J Cardiac Surg. 2020; 35(4):794-800.
30. Gilani SRA, Hussain G, Ahmad N, Baig MAR, Zaman H. **Comparison of post-operative atelectasis in patients undergoing coronary artery bypass grafting with and without pre-operative incentive spirometry.** J. Postgrad. Med. Inst. 2016; 30(2):169-72.
31. Iqbal J, Ghaffar A, Shahbaz A, Abid AR. **Stroke after coronary artery bypass surgery with and without cardiopulmonary bypass.** J. Ayub Med. Coll. Abbott. 2014; 26(2):123-28.
32. Abid AR, Farogh A, Naqshband MS, Akhtar RP, Khan JS. **Hospital outcome of coronary artery bypass grafting and coronary endarterectomy.** Asian Cardiovasc. Thoracic Ann. 2009; 17(1):59-63.
33. Sher-i-Murtaza M, Baig MAR, Raheel HMA. **Early outcome of coronary artery bypass graft surgery in patients with significant Left Main Stem stenosis at a tertiary cardiac care center.** Pak. J. Med. Sci. 2015; 31(4):909-14.
34. Rana MA, Batool U, Khan S, Akbar MT, Haider I, Khan MK. **Gender based difference in quality of life after phase ii cardiac rehabilitation in patients with coronary artery bypass graft surgery.** Rehabil. J. 2019; 3(2):131-36.
35. Kumar R, Hote MP, Sharma G, Thakur B, Airan B. **Comparison of outcome in male and female indian patients undergoing Cabg, activity levels and quality of life: One year follow-up study.** Am. J. Thoracic Cardiovasc. Surg. 2017; 2(2):29-34.
36. Kasliwal RR, Kulshreshtha A, Agrawal S, Bansal M, Trehan N. **Prevalence of cardiovascular risk factors in Indian patients undergoing coronary artery bypass surgery.** JAPI. 2006;54:371-75.

37. Ranjan R, Adhikary D, Saha H, Mandal S, Saha SK, Adhikary AB. **Outcome of CABG with or without coronary endarterectomy in Bangladesh: A retrospective cohort study.**Bangladesh Heart J. 2017; 32(2):77-84.
38. Jaiswal LS, Prasad JN, Shah P, Pandit N. **Establishing cardiac surgery in Eastern Nepal: Early results.** J Nepal Health Res Council. 2018; 16(3):257-63.
39. Leyva F, Qiu T, Evison F, Christoforou C, McNulty D, Ludman P, et al. **Clinical outcomes and costs of cardiac revascularisation in England and New York state.** Open Heart J. 2018; 5(1):e000704.
40. Moazzami K, Dolmatova E, Maher J, Gerula C, Sambol J, Klapholz M, et al. **In-hospital outcomes and complications of coronary artery bypass grafting in the United States between 2008 and 2012.** J. Cardiothorac Vasc. Anesth. 2017; 31(1):19-25.
41. Zheng J, Cheng J, Wang T, Zhang Q, Xiao X. **Does HbA1c level have clinical implications in diabetic patients undergoing coronary artery bypass grafting?** A systematic review and meta-analysis. Int J Endocr. 2017; 1537213.
42. Azam H, Baksh A, Khalid ZR. **Stroke after coronary artery bypass grafting; a single centre study.** Pak. Heart J. 2017; 50(3):175-79.
43. Nicolini F, Fortuna D, Contini GA, Pacini D, Gabbieri D, Zussa C, et al. **The impact of age on clinical outcomes of coronary artery bypass grafting: long-term results of a real-world registry.** BioMed Res Int.2017; (1):1-11.
44. Dar MI, Dar AH, Almani K, Mannan A, Khan AQ, Rizwani GH, et al. **Coronary artery bypass surgery in old age group: is age itself a barrier?** J. Pak. Med. Assoc. 2009; 59(9):587-89.
45. Lubis MIP, Marshal A, Pohan DP. **Comparison of postoperative morbidity and mortality between patients with or without metabolic syndrome who underwent coronary artery bypass grafting (CABG) at Haji Adam Malik General Hospital Medan.** Int J Curr Res. 2020; 12(12):15087-090.
46. Wang L, Qian X, Wang M, Tang X, Ao H. **Which factor is the most effective one in metabolic Sydrome on the outcomes after coronary artery bypass graft surgery? A cohort study of 5 Years.** J Cardiothorac Surg. 2018; 13(1):1-8.

AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Farooq Ahmad:** Manuscript writing, Data collection.
2	**Muhammad Hussnain Raza:** Data entry.
3	**Riaz ul Haq:** Data analysis.
4	**Muhammad Mujahid:** Revisions.
5	**Sidra Masood:** Study design.
6	**Muneeza Dilpazeer:** References.