

The Prevalence Of Hyperglycemia In Non-Diabetic Patients In The Cardiac Intensive Care Unit (Icu) After Cardiac Surgery At Tertiary Care Hospitals Peshawar

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Abstract

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Background: Postoperative hyperglycemia is a well-documented risk factor for complications following cardiac surgery, even in patients without a prior history of diabetes. This study aimed to assess the prevalence of postoperative hyperglycemia in non-diabetic patients undergoing cardiac surgery. **Methods:** A total of 101 non-diabetic patients who underwent cardiac surgery were included in this observational study. Demographic, surgical, and glycemic data were collected and analyzed to identify patterns and potential risk factors associated with postoperative hyperglycemia. **Results:** Of the patients studied, 92.1% had normal preoperative glucose levels, yet 63.4% developed elevated or high glucose levels postoperatively. Patients who developed hyperglycemia were notably older (mean age 40.7 years) compared to those who maintained normal glucose levels (mean age 30.5 years), while body mass index (BMI) showed no significant difference

between groups. CABG was the most frequently performed procedure (58.4%). A progressive increase in BMI and weight was observed across age groups. **Conclusion:** The findings indicate that postoperative hyperglycemia is common in non-diabetic cardiac surgery patients, with older age identified as a significant risk factor. These results highlight the importance of routine glucose monitoring and early management in non-diabetic individuals to reduce the risk of adverse outcomes. Further research is

recommended to explore additional predictive factors and long-term effects of stress-induced hyperglycemia.

Introduction

Stress-induced hyperglycemia (SIH) is a frequent metabolic disturbance observed in hospitalized and surgical patients, even in those without a prior diagnosis of diabetes. Acute physiological stress triggers the release of catecholamines, cortisol, glucagon, and growth hormone, resulting in enhanced hepatic gluconeogenesis, reduced peripheral glucose uptake via GLUT-4 transporters, and impaired insulin secretion. This dysregulated metabolic state contributes to elevated circulating glucose levels that may worsen clinical outcomes, particularly among critically ill patients and those undergoing cardiac surgery (1,2).

Mounting evidence demonstrates that hyperglycemia exacerbates oxidative stress and inflammatory responses, both of which contribute to myocardial injury, endothelial dysfunction, and impaired tissue recovery. Although traditionally considered a transient epiphenomenon, SIH has shown independent associations with increased mortality, postoperative renal dysfunction, neurological injury, deep sternal wound infections, and arrhythmias after cardiac surgery. Importantly, even non-diabetic patients frequently develop significant postoperative hyperglycemia due to the profound inflammatory and metabolic burden imposed by cardiopulmonary bypass (CPB), anesthesia, surgical trauma, and increased catecholamine exposure (3,4).

As cardiac surgery volumes rise globally particularly for CABG, TAVR, and mitral valve interventions the identification and management of peri-operative hyperglycemia have become crucial to improving patient outcomes. Contemporary guidelines recommend maintaining intraoperative and postoperative glucose levels below 180 mg/dL; however, optimal glucose targets, timing of insulin initiation, and intensity of insulin therapy remain subjects of ongoing debate. Understanding the clinical significance of hyperglycemia in both diabetic and non-diabetic patients remain essential to reducing postoperative morbidity and mortality (5,6).

Several studies have consistently demonstrated that peri-operative hyperglycemia is a strong and independent predictor of adverse outcomes following cardiac surgery. Thiele et al. (2015) reported that higher admission blood glucose levels were significantly associated with increased mortality, postoperative renal failure, and stroke. Similarly, doesn't et al. (2005) observed that elevated intraoperative glucose levels during CPB independently predicted mortality and major complications in both diabetic and non-diabetic individuals. Additional findings from Donatella et al. (2008) highlighted that patient with metabolic syndrome experienced universal postoperative insulin resistance and significantly higher CPB-associated glucose elevations, indicating the enhanced vulnerability of high-risk metabolic phenotypes (7,8).

Pharmacological factors also influence postoperative glucose trends. Tien et al. (2016) demonstrated that dexamethasone administration significantly increased postoperative glucose levels in both diabetic and non-diabetic patients when compared with ondansetron. Beyond drug effects, multiple mechanisms—including inflammatory cytokine release, acute insulin resistance, and enhanced hepatic glucose output—contribute to postoperative hyperglycemia. Collectively, the literature underscores that peri-operative hyperglycemia is not merely a benign reflection of illness severity but a modifiable risk factor with clear implications for postoperative recovery (9).

Effective peri-operative glucose management has demonstrated substantial clinical benefits across diverse cardiac surgical populations. Continuous insulin infusion protocols have been linked with reduced deep sternal wound infections, shorter hospital stays, lower rates of recurrent ischemia, improved long-term survival, and decreased postoperative morbidity. Tight glucose regulation also mitigates oxidative

stress, reduces inflammatory burden, enhances immune function, and supports optimal wound healing. Emerging therapeutic options, such as GLP-1 receptor agonists, provide additional promise by improving glycemic stability with minimal hypoglycemia risk, suggesting expanding opportunities for safer and more effective peri-operative metabolic care (10).

Peri-operative hyperglycemia is a prevalent and clinically significant condition among cardiac surgery patients, irrespective of pre-existing diabetic status. The evidence strongly supports its role as an independent predictor of mortality, renal dysfunction, neurological complications, and postoperative infections. Surgical stress, CPB, inflammatory activation, and medication effects collectively contribute to the development of SIH, emphasizing the need for early recognition and targeted glycemic control. Optimizing peri-operative glucose management may improve patient outcomes, reduce postoperative complications, and enhance recovery following complex cardiac procedures. Continued research is essential to refine glucose targets and develop therapeutic strategies that maximize benefit while minimizing risks.

MATERIALS AND METHODS

This prospective observational study was conducted over a six-month period in the Cardiac Intensive Care Units (ICUs) of Hayatabad Medical Complex (HMC) and Peshawar General Hospital (PGH), both tertiary-care centers providing 24-hour multidisciplinary management for critically ill cardiac patients. The study aimed to determine the prevalence of postoperative hyperglycemia among non-diabetic individuals admitted to the cardiac ICU following cardiac surgery. A total of 101 non-diabetic patients aged above 15 years, recovering after various cardiac surgical procedures, were selected through convenient sampling, ensuring accessibility to the participants while maintaining a 90% confidence level and a 1% margin of error. Patients included were those with a confirmed non-diabetic status prior to surgery and admitted to the cardiac ICU after the procedure; both male and female individuals were eligible. Exclusion criteria comprised known diabetes mellitus, preoperative glucose-lowering medications, long-term steroid therapy, preoperative steroid use, emergency cardiac surgeries, refusal to participate, and age below 15 years. Institutional approval was obtained from the Research Committee of IQRA National University, as well as permissions from HMC (CRC) and PGH, after which data were collected using a structured questionnaire administered within the ICU setting (11).

RESULTS:

Demographic Analysis

The demographic analysis of 101 patients shows a strong male predominance (75.2%) and identifies the 36–50 years age group as the largest cohort (51.5%). A clear age-related trend is observed, with both BMI and weight increasing steadily across age groups from 19.2 kg/m² and 45.8 kg in the youngest group to 27.2 kg/m² and 70.8 kg in the oldest group while gender differences remain minimal. These findings indicate that age is the primary factor influencing anthropometric variation in this cardiac surgical population.

Table 1: Descriptive Statistics of Demographic information

Age Group	Gender	N	Mean Age	SD Age	Mean BMI	SD BMI	Mean Weight	SD Weight

16-25	Male	10	19.3	3.4	19.2	5.7	45.0	13.4
16-25	Female	3	19.7	1.5	19.2	0.4	48.0	5.3
26-35	Male	8	31.8	2.9	23.7	4.1	68.0	13.0
26-35	Female	6	33.0	6.1	22.3	6.0	57.7	22.3
36-50	Male	37	43.4	5.7	27.0	4.7	77.1	13.5
36-50	Female	15	43.6	4.9	27.1	6.4	67.9	18.5
51-75	Male	21	61.1	6.6	27.2	5.5	71.2	13.8
51-75	Female	1	58.0		25.0		58.0	

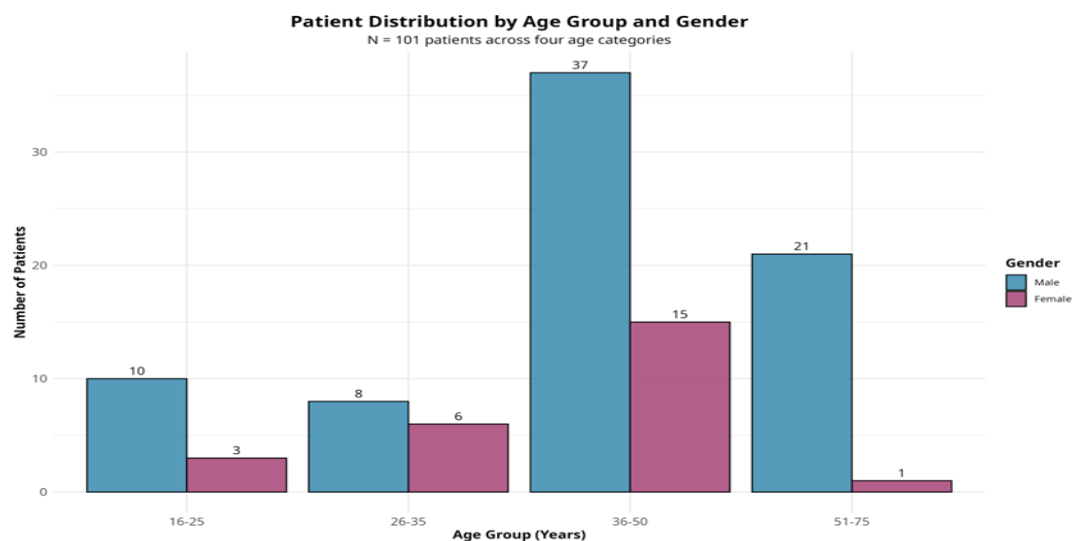


Figure 1 shows Patient Distribution by Age group and Gender

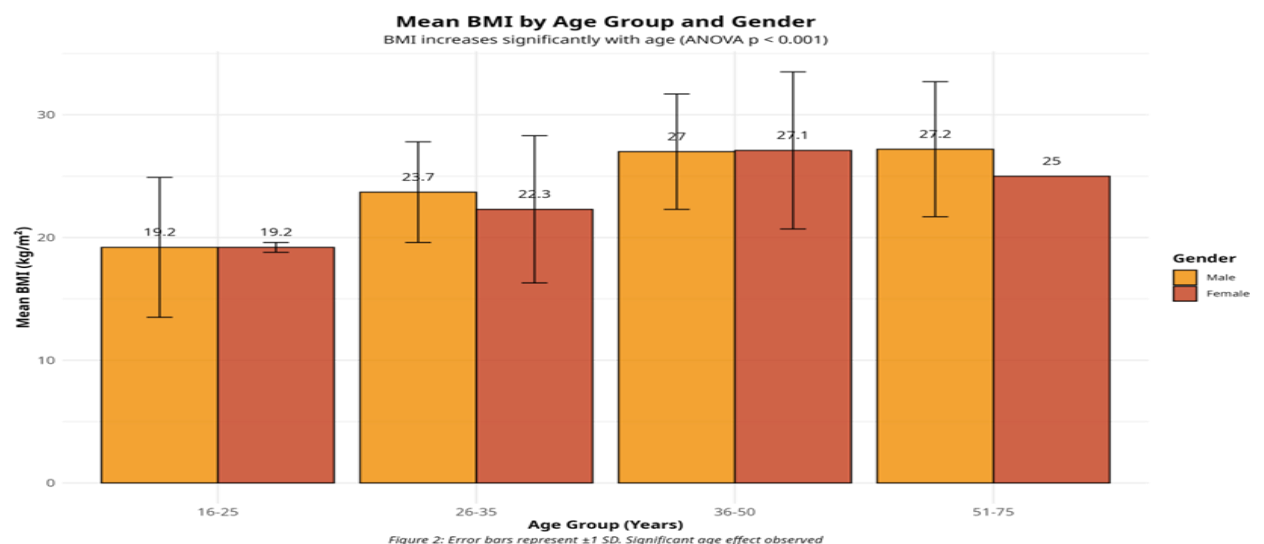


Figure 4.2 shows mean BMI by age group and gender

Surgery Type Analysis

The surgery type distribution shows a strong concentration toward Type 1 procedures, which account for over half of all surgeries (58.4%), while all other surgery types occur at much lower frequencies. Type 11 is the next most common but still represents only 7.9% of cases, and several specialized procedures, including DVR and MVR, were performed on just one or two patients. Patient characteristics vary across surgery categories, with BMI ranging from 20.1 kg/m² in Type 5 to 30.5 kg/m² in Type 14, and mean age spanning from 26 years in Type 6 to 53 years in MVR cases. Although surgery durations typically fall between 2.0 and 2.2 units, some types show shorter or longer times. Overall, the pattern indicates a facility highly experienced in Type 1 surgeries while still managing a diverse array of less frequent procedures.

Table 2: Frequency and Average of Surgical Procedures

Surgery Type	N	Percentage (%)	Mean Age	Mean BMI	Mean Duration
Type 1	59	58.4	48.2	27.1	2.2
Type 11	8	7.9	38.1	23.2	2.2
Type 6	5	5.0	26.0	24.1	1.8
Type 3	4	4.0	37.8	20.9	2.2
Type 4	4	4.0	35.2	20.9	2.5
Type 10	3	3.0	36.0	29.2	1.7
Type 14	3	3.0	38.7	30.5	2.0
Type 5	3	3.0	28.7	20.1	1.7
13	2	2.0	18.5	16.2	2.5
7	2	2.0	52.0	26.8	2.5
12	1	1.0	46.0	28.5	1.0
15	1	1.0	34.0	14.9	2.0
16	1	1.0	17.0	17.9	1.0
17	1	1.0	19.0	16.2	1.0
8	1	1.0	42.0	21.0	2.0

9	1	1.0	22.0	24.2	2.0
DVR	1	1.0	47.0	27.8	2.0
MVR	1	1.0	53.0	24.7	1.0

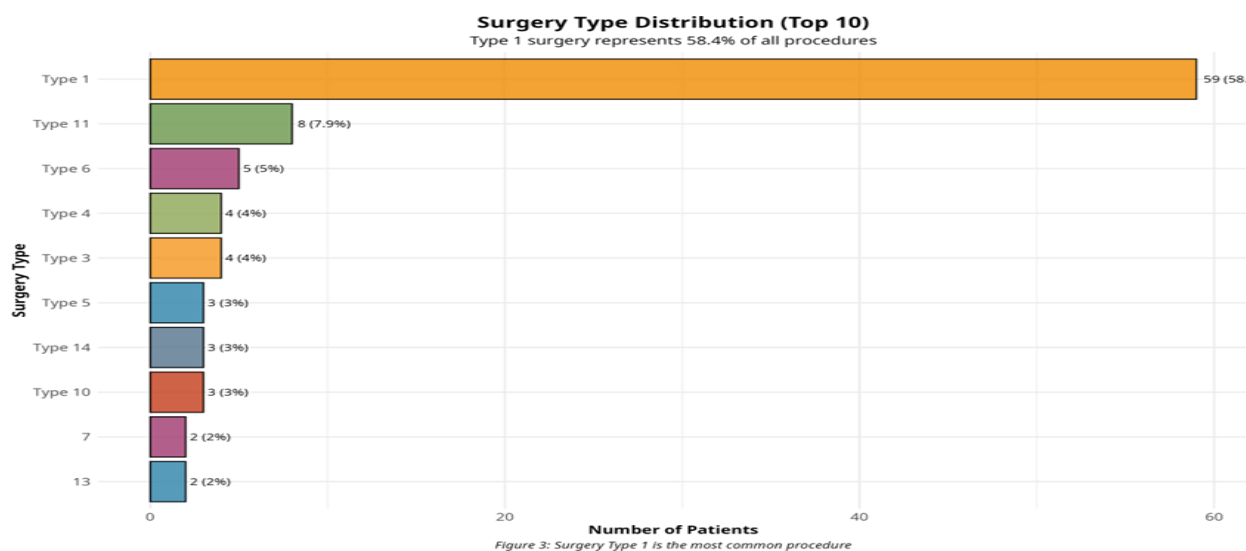


Figure 3: show Number of Patients by Surgery Distribution

Table 3 Various Surgical Procedure Key

TYPE	SURGICAL PROCEDURE
1	Coronary Artery Bypass Grafting (CABG)
2	Mitral Valve Replacement (MVR)
3	Double Valve Replacement (DVR)
4	Atrial Valve Replacement (AVR) and CABG
5	Vascular Surgery
6	Atrial Valve Replacement
7	LAD myotomy
8	Coarctation of Aorta
10	CABG and MVR
11	ASD Closure
12	VSD Closure
13	RA Myxoma Excision

Clinical Outcomes Analysis

The clinical outcomes analysis shows a significant rise in post-operative hyperglycemia despite most patients (92.1%) having normal pre-operative glucose levels. Only 8.6% of these patients maintained normal glucose post-operatively, while

the majority (63.4%) developed some form of hyperglycemia, including high levels above 220 mg/dl and severe elevations exceeding 300 mg/dl. Among patients who were already elevated pre-operatively, most progressed to higher levels after surgery. Those who developed high glucose post-operatively were generally older (mean age 40.7 years) compared to patients who maintained normal glucose (mean age 30.5 years), suggesting that surgical stress, suboptimal perioperative glucose management, and age-related metabolic factors may be contributing to poor glycemic outcomes.

Table 4: shows the blood Glucose Level changes from pre-operative to post-operative and their frequency, BMI, Average

Pre-Op BGL	Post-Op BGL	N	Percentage (%)	Mean Age	Mean BMI
Normal	220-280	40	39.6	40.7	25.1
Normal	Exceed 300	25	24.7	39.6	26.5
Normal	180-220	19	18.8	50.2	24.0
Normal	Less than 120	1	1.0	24	18.25
Normal	Normal	8	7.9	30.5	24.6
Elevated	220-280	5	5.0	57.6	29.7
Elevated	Normal	1	1.0	55.0	37.3
Elevated	220-280	1	1.0	59.0	21.8
Elevated	Exceed 300	1	1.0	46.0	20.0

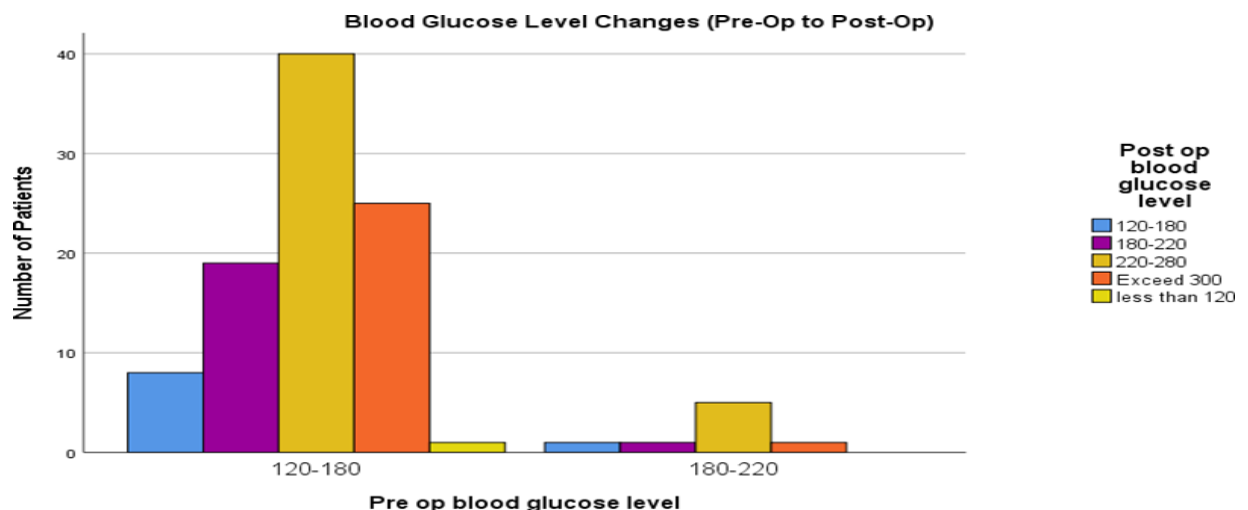


Figure 4 Show blood glucose level changes from Pre op to Post Op Clinical Outcomes Analysis

The statistical analysis confirmed strong and significant associations among key variables. A one-way ANOVA demonstrated highly significant BMI differences across age groups ($F = 9.638$, $p < 0.001$), with age accounting for about 23% of BMI variance. Post-hoc Tukey tests showed that the youngest group (16–25 years) had significantly lower BMI than the 36–50 and 51–75 age groups, while no difference was found between the two older groups, indicating BMI tends to plateau after age 35. Correlation analysis further supported these findings, revealing a moderate positive correlation between age and BMI ($r = 0.308$), a very strong correlation between weight and BMI ($r = 0.829$), and a moderate correlation between height and weight ($r = 0.506$), all statistically significant. These results collectively validate the observed age-related trends and anthropometric relationships.

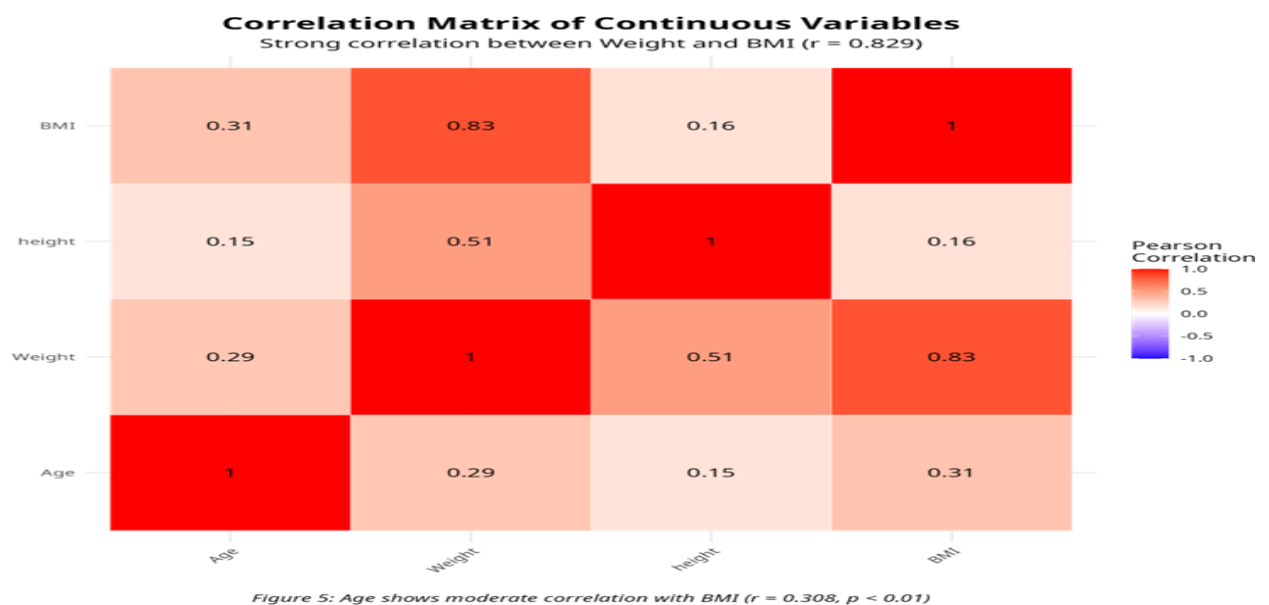


Figure 5 shows Moderate Correlation with BMI

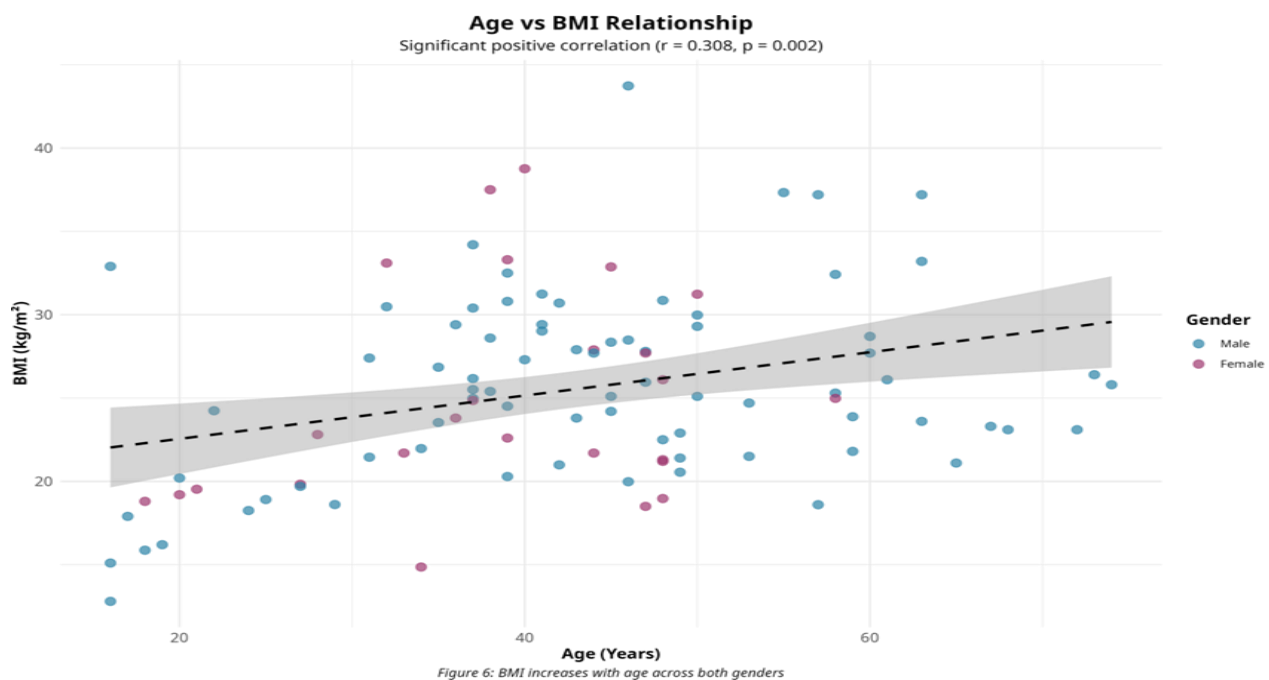


Figure 6 Shows Age vs BMI relationships

Correlation Matrix of Age, Weight, BMI and Post-op Glucose

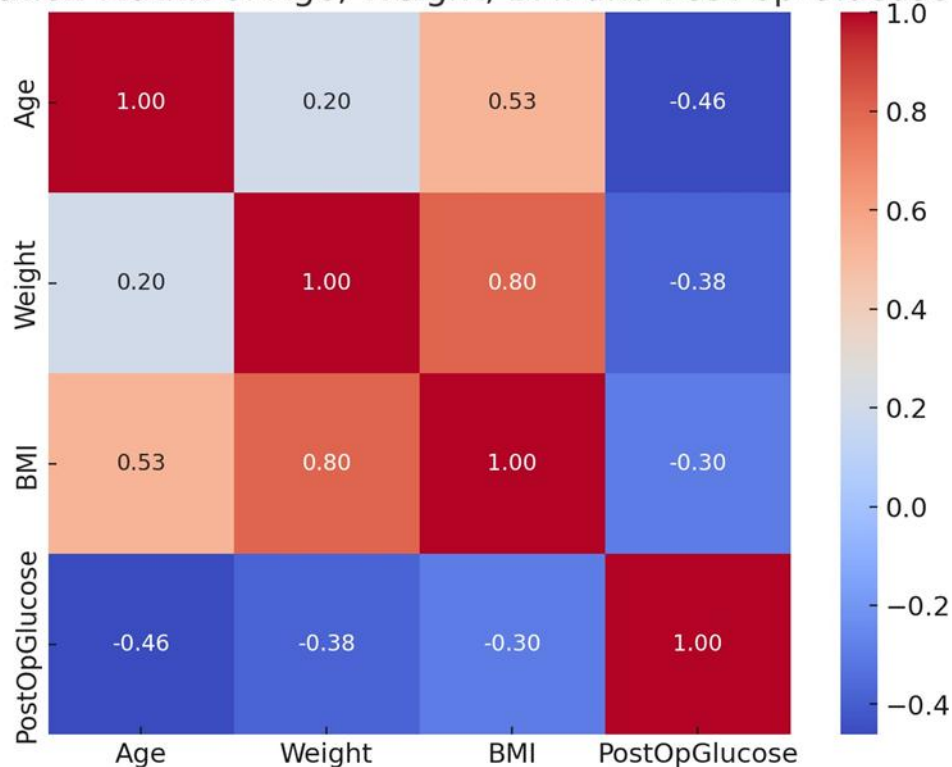


Figure 7 shows the correlation matrix of 8 patients who's hyperglycemic pre operatively with Age, Weight, BMI and Post-operative blood glucose level

Statistical Tests Analysis

The analysis leads to several key clinical recommendations aimed at improving surgical outcomes. The most urgent priority is strengthening perioperative glucose management, as 63.4% of patients with normal pre-operative glucose developed post-operative hyperglycemia. This requires more frequent glucose monitoring, standardized insulin protocols, and early endocrinology involvement, especially for severe cases. Age-related increases in BMI highlight the need for age- and BMI-based perioperative planning, including tailored nutritional assessment, modified anesthesia strategies, and closer post-operative monitoring for older patients. The strong predominance of Type 1 surgeries supports developing specialized care pathways and standardized protocols to enhance efficiency and safety. Furthermore, gender-specific risk assessments, improved data collection to reduce missing glucose values, BMI-based surgical risk stratification, and multidisciplinary care involving endocrinologists, nutritionists, and specialized nurses are recommended to optimize patient care.

DISCUSSION

Postoperative hyperglycemia is a well-recognized complication following cardiac surgery, even among patients without pre-existing diabetes. Stress-induced rises in glucose levels can impair immune function, delay wound healing, prolong ICU stay, and increase morbidity. The present study, conducted on 101 non-diabetic patients undergoing various cardiac surgeries in two tertiary care hospitals in Peshawar, highlights the substantial burden of postoperative hyperglycemia and its clinical implications. Data were collected in the cardiac ICUs of Hayatabad Medical Complex and Peshawar General Hospital over six months (12).

A key finding of this study is that although 92.1% of patients had normal preoperative glucose levels, ****63.4% developed postoperative hyperglycemia****, demonstrating

that metabolic stress triggered by cardiac surgery is a major contributor to glucose dysregulation. These findings are consistent with previous evidence. Das et al. reported perioperative hyperglycemia in approximately 80% of non-diabetic patients undergoing off-pump CABG in India. Similar to their observation that older patients were more affected, the current study also found that patients who developed high postoperative glucose were generally older (mean age 40.7 years) compared with those who maintained normal glucose (mean age 30.5 years) (13,14).

Garg et al. conducted a large retrospective study of 3658 cardiac surgery patients and found postoperative hyperglycemia in 39.72% of non-diabetics. They identified older age, male gender, and higher BMI as important risk factors. The current study aligns with their findings regarding age but differed in that BMI did not significantly vary between hyperglycemic and normoglycemic groups. This suggests that age-related metabolic stress may play a more dominant role in this population (15).

Duggan et al. emphasized that perioperative hyperglycemia arises from inflammatory and hormonal stress responses causing insulin resistance. They recommended glycemic targets of 140–180 mg/dL and standardized insulin protocols. The present study similarly demonstrated a high burden of stress-induced hyperglycemia, underscoring the need for improved perioperative glucose control strategies in non-diabetic cardiac surgery patients (16,17).

While Bahauddin et al. reported a high prevalence of diabetes (64%) among CABG patients in Peshawar and emphasized its association with complications, the current study shows that even non-diabetic patients are at substantial risk of hyperglycemia due to surgical stress. This highlights the need to manage both pre-existing diabetes and stress-induced hyperglycemia with equal vigilance (18,19).

Predictors of hyperglycemia reported in prior studies, such as those by Moorthy et al. and Bláha et al., include age, BMI, cross-clamp time, blood transfusion, and ethnicity. The Singaporean study by Moorthy et al. found hyperglycemia in 77.7% of non-diabetic patients, and like the present findings, age was a significant risk factor. Although BMI was an independent predictor in their cohort, BMI differences were minimal in the current sample. This suggests potential population-specific variations in metabolic response to surgical stress (20,21).

Several studies identified additional contributors to postoperative hyperglycemia. Sevuk et al. found that low hematocrit and blood transfusions increased hyperglycemia risk, while Tien et al. demonstrated that even a single antiemetic dose of dexamethasone significantly elevated glucose levels. Although the current study did not assess hematocrit, transfusions, or steroid use, its findings still revealed a substantial rate of postoperative glucose elevation, indicating that surgical stress alone is a strong driver of metabolic imbalance (22,23).

Other evidence, such as the findings of Vedantam et al. and Bellis et al., highlights that stress-induced hyperglycemia is particularly harmful in non-diabetic individuals due to mechanisms involving inflammation, oxidative stress, and endothelial dysfunction. These insights align with the present study, which documented frequent postoperative hyperglycemia despite normal preoperative glucose values in most patients, emphasizing the importance of early recognition and intervention (24,25).

The findings of Chen et al. showed worse outcomes in diabetic cardiac surgery patients, whereas the current study focused solely on non-diabetic individuals but still revealed a high incidence of postoperative hyperglycemia (26). This reinforces that stress-induced glucose elevation, even in the absence of chronic diabetes, warrants serious clinical attention. Similarly, the work of Thiele et al. and Jarvela et al. demonstrated associations between elevated postoperative glucose and increased mortality, infections, and neurologic complications. Although the present study did not assess outcomes such as mortality or stroke, its identification of high

postoperative glucose incidence indicates a significant risk that should be addressed proactively in clinical settings (27,28).

Overall, the current study's findings are consistent with global literature, highlighting that postoperative hyperglycemia is common, especially among older non-diabetic patients undergoing cardiac surgery. The present results reinforce the need for strict perioperative glucose monitoring, age-specific risk assessment, and early therapeutic strategies to prevent complications. They further emphasize the necessity of implementing standardized glucose management protocols in cardiac ICUs to minimize postoperative risks in both diabetic and non-diabetic populations (29,30).

CONCLUSION:

The study demonstrates that although 92.1% of non-diabetic cardiac surgery patients had normal preoperative glucose levels, 63.4% developed postoperative hyperglycemia, with older age emerging as the primary predictor while BMI showed minimal impact. These findings align with international evidence highlighting stress-induced hyperglycemia as a common and clinically significant postoperative issue. The results emphasize the need for improved glycemic monitoring and careful use of steroids, medications, and intraoperative maneuvers that may elevate glucose levels in hospitals across Pakistan and globally. However, the study is limited by its small sample size and the absence of key intraoperative variables such as corticosteroid use, inotropes, aortic cross-clamp time, blood transfusion, and CPB duration. Therefore, larger multicenter cohort studies are recommended to better evaluate intraoperative contributors to postoperative hyperglycemia and related complications.

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