

## Original Research Article

# Impact of body mass index on outcome of adult cardiac surgery

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## ABSTRACT

**Background:** The objectives of study were to determine the incidence of overweight and obesity in adult cardiac surgical patients, and to evaluate the impact of BMI on outcome from cardiac surgery.

**Methods:** Retrospective observational analysis of data of adult cardiac surgery at Queen Alia heart institute (QAHI) in the period of time between September 2023 and February 2024. Patients' data were recorded and analysed. Patients were divided in categories according to the world health organisation (WHO) body mass index (BMI) classification. The WHO BMI categories were compared regarding their pre-operative, intra-operative and post-operative characteristics. Recovery parameters such as extubation time, length of ICU stay, length of hospitalisation and mortality were also compared between normal weight, overweight and obesity categories. Ethical committee approval obtained.

**Results:** Data from 141 adult cardiac surgical patients was analysed. Male patients were 115 (81.56%) and female patients were 26 (18.44%) with a male to female ratio of 4.4. Mean age of patients was 56.66 (SD 10.26). Majority of patients were obese (39%) and overweight (34%). The incidence of diabetes in the normal weight category was 41.7%; while in the overweight category it increased to 58.4% and reached 60% in the obese category. The incidence of hypertension (75% in the overweight and 76.4% in the obese categories) increased with the increase of the BMI. Obese category had prolonged mean duration of hospitalisation (13 days); however, lower rates of re-opening and mortality.

**Conclusions:** Most of the adult cardiac surgical patients in this study are obese and overweight. The overweight and obese patients had higher rates of hypertension, diabetes and ischaemic heart disease. Longer hospitalisation and lower mortality rates were noted in patients with higher BMI.

**Keywords:** BMI, Cardiac, Diabetes, Hypertension, ICU, Mortality

## INTRODUCTION

Obesity is a global pandemic. According to the world obesity atlas 2023 report, 38% of the global population are currently either overweight or obese.<sup>1</sup> The World Obesity Federation predicts that around one billion people globally, including 1 in 5 women and 1 in 7 men, will be living with obesity by 2030.<sup>2</sup> In Jordan (where this study

is conducted), the national centre of diabetes, endocrinology, and genetics in Amman, Jordan estimated that 44.2% of men and 47.8% of women were determined to be obese in 2017.<sup>3</sup>

The WHO definitions of weight are: underweight if BMI is less than 18.5, normal weight range if BMI is 18.5 to <25, overweight (pre-obesity) as BMI >25 kg/m<sup>2</sup> and

obesity if BMI >30 kg/m<sup>2</sup>. Overweight and obesity are also described as abnormal or excessive fat accumulation that is associated with increased health risk. Obesity is frequently subdivided into categories: class 1: BMI of 30 to <35, class 2: BMI of 35 to <40, class 3: BMI of 40 or higher. Class 3 obesity is sometimes categorized as “morbid or extreme” obesity.<sup>4</sup>

Obesity is a major independent risk factor for cardiovascular disease, such as hypertension, type 2 diabetes mellitus, dyslipidaemia, coronary heart disease, atrial fibrillation, stroke and heart failure.<sup>5</sup> Traditionally, obesity has been considered as a significant risk factor for patients undergoing cardiac surgery.<sup>6</sup> Obesity may have an impact on outcome of cardiac surgery; it is assumed that obesity increases the risk of postoperative morbidity and mortality.<sup>7</sup> However, recently many studies have described a paradox between obesity and better survival on population undergoing cardiac interventions.<sup>8</sup> In this observational study, we aim to explore the prevalence of overweight and obesity among cardiac surgical patients, their comorbidities and the impact of BMI on intra-operative and post-operative outcomes.

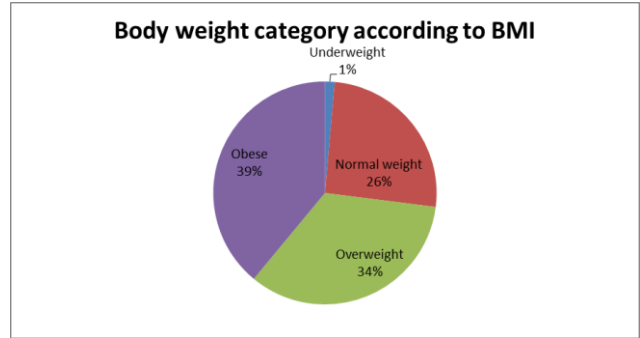
**METHODS**

Retrospective observational analysis of data of adult cardiac surgical patients presented for cardiac surgery at QAHI in the period of time between September 2023 and February 2024. The procedure of the study included data collection from patients’ files and hospitals’ computer system using Google forms which was followed by data tabulation and analysis on Microsoft excel. Patients’ demographic data and peri-operative characteristics were recorded and analysed. Patients were divided in categories according to WHO BMI classification. Patients from different categories were compared regarding their comorbidities, intra-operative variables, post-operative recovery characteristics (including extubation time, ICU stay and hospitalisation time), complications and mortality. Statistical analysis performed using Microsoft excel. Ethical committee approval obtained.

Inclusion criteria for this study are adult patients (age >18 years) and major cardiac surgery (coronary, valve, aorta or combined). Exclusion criteria included paediatric cardiac surgeries and minor procedures (pacemaker lead insertion, pericardial drain insertion or wound debridement).

**RESULTS**

Data from 141 adult cardiac surgical patients was analysed. Male patients were 115 (81.56%) and female patients were 26 (18.44%) with a male to female ratio of 4.4. Mean age of patients was 56.66 (Standard deviation (σ)=10.26). Majority of patients are either obese (39%) or overweight (36%). The normal weight category was 26% and the underweight category was 1.4% (Figure 1). The demographic data of patients are presented in Table 1.



**Figure 1: Distribution of patients according to BMI.**

**Table 1: Demographic data of patients.**

| Variables           | N (%)       |
|---------------------|-------------|
| Mean age (in years) | 56.7        |
| Male                | 115 (81.56) |
| Female              | 26 (18.44)  |
| Hypertensive        | 75          |
| Diabetic            | 53.9        |
| Underweight         | 2 (1.4)     |
| Normal weight       | 36 (25.6)   |
| Overweight          | 48 (34)     |
| Obese               | 55 (39)     |

The overall incidence of diabetes was 53.9%; however, this correlated with the BMI of the patients as the incidence of diabetes increased with the increase of the BMI. The Incidence of diabetes in the normal weight category was 41.7%; while in the overweight category it increased to 58.4% and reached 60% in the obese category. There was also an increase in the incidence of diabetes with the increase in the class of obesity, as this incidence was 54.8% in class 1, 63.6% in class 2 and 66.7% in class 3. Similarly, the incidence of hypertension increased with the increase of the BMI. The Incidence of hypertension in the normal weight category was 69.5%; while in the overweight category the incidence of hypertension was 75% and in the obese category of patients it was 76.4%. The incidence of other diseases such as cerebrovascular accidents, renal and thyroid diseases was also higher in the overweight and obese categories (Table 2).

Regarding intra-operative characteristics, the duration of cardiopulmonary bypass (CPB) increased with the increase of the BMI. The underweight category patients spent 85 minutes as CPB duration; while the overweight category had an average of 104.9 minutes CPB duration and the obese had 109.7 minutes. Regarding post-operative mechanical ventilation; the overall average intubation time was 16 hours. The duration of mechanical ventilation was significantly prolonged in patients with class 3 (severe) obesity. The average ICU length of stay was between 4 and 5 days in all categories; ICU stay ranged from 2 to 28 days. Interestingly, it was less in the obese category when compared with normal weight category. Hospital stays ranged from 4 days to 55 days. The overall average hospital length of stay was 12 days

and it was longest in the obese category (13 days) (Figure 2). The overall mortality rate was 14.2% and was higher in

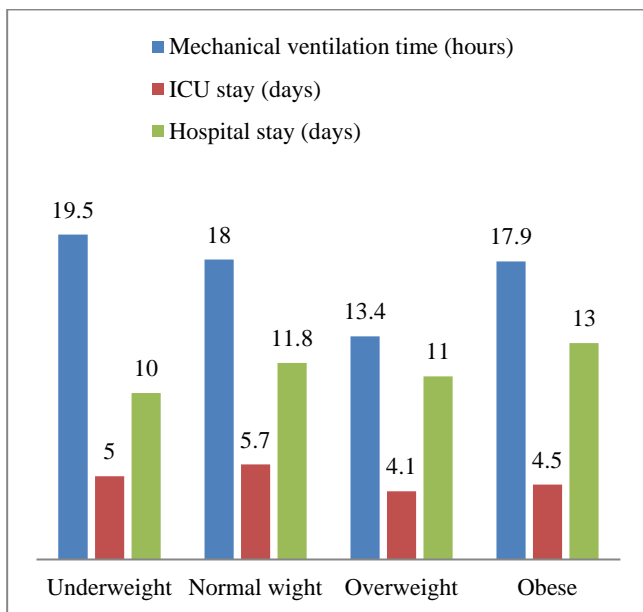
the normal weight category (13.9%) than the overweight (10.4%) and obese (9.1%) categories (Table 3).

**Table 2: Preoperative patients' characteristics.**

| Variables              | BMI (kg/m <sup>2</sup> ) | N (%)            | DM, N (%)        | HTN, N (%)        | IHD, N (%)        | CVA, N (%)     | Thyroid disease, N (%) | Renal disease, N (%) |
|------------------------|--------------------------|------------------|------------------|-------------------|-------------------|----------------|------------------------|----------------------|
| <b>Weight category</b> |                          |                  |                  |                   |                   |                |                        |                      |
| Underweight            | <18.5                    | 2 (1.4)          | 0 (0)            | 1 (50)            | 1 (50)            | 0 (0)          | 0 (0)                  | 0 (0)                |
| Normal weight          | 18.5-25                  | 36 (25.6)        | 15 (41.7)        | 25 (69.5)         | 28 (77.8)         | 1 (2.8)        | 0 (0)                  | 1 (2.8)              |
| Overweight             | 25-30                    | 48 (34)          | 28 (58.4)        | 36 (75)           | 41 (85.4)         | 1 (2.1)        | 1 (2.1)                | 1 (2.1)              |
| <b>Obese</b>           | <b>&gt;30</b>            | <b>55 (39)</b>   | <b>33 (60)</b>   | <b>42 (76.4)</b>  | <b>44 (80)</b>    | <b>0 (0)</b>   | <b>2 (3.6)</b>         | <b>3 (5.5)</b>       |
| Class 1                | 30-35                    | 42 (29.8)        | 23 (54.8)        | 33 (78.6)         | 35 (83.3)         | 0 (0)          | 1 (2.4)                | 2 (4.8)              |
| Class2                 | 35-40                    | 11 (7.8)         | 7 (63.6)         | 8 (72.7)          | 10 (90.9)         | 0 (0)          | 0 (0)                  | 1 (9.1)              |
| Class 3                | >40                      | 3 (2.1)          | 2 (66.7)         | 2 (66.7)          | 3 (100)           | 0 (0)          | 0 (0)                  | 0 (0)                |
| <b>Total</b>           |                          | <b>141 (100)</b> | <b>76 (53.9)</b> | <b>104 (73.8)</b> | <b>114 (80.9)</b> | <b>2 (1.4)</b> | <b>3 (2.1)</b>         | <b>5 (3.5)</b>       |

**Table 3: Intra-operative and post-operative patients' characteristics.**

| Variables              | BMI (kg/m <sup>2</sup> ) | N (%)            | Average CPB time (minutes) | Average postop. intubation (hours) | Average ICU stay (days) | Average hospital stays (days) | Reopening, N (%) | Mortality, N (%) |
|------------------------|--------------------------|------------------|----------------------------|------------------------------------|-------------------------|-------------------------------|------------------|------------------|
| <b>Weight category</b> |                          |                  |                            |                                    |                         |                               |                  |                  |
| Underweight            | <18.5                    | 2 (1.4)          | 85                         | 19.5                               | 5                       | 10                            | 1 (50)           | 0 (0)            |
| Normal weight          | 18.5-25                  | 36 (25.6)        | 106.3                      | 18                                 | 5.7                     | 11.8                          | 5 (13.9)         | 5 (13.9)         |
| Overweight             | 25-30                    | 48 (34)          | 104.9                      | 13.4                               | 4.1                     | 11                            | 7 (14.6)         | 5 (10.4)         |
| <b>Obese</b>           | <b>&gt;30</b>            | <b>55 (39)</b>   | <b>109.7</b>               | <b>17.9</b>                        | <b>4.5</b>              | <b>13</b>                     | <b>7 (12.7)</b>  | <b>5 (9.1)</b>   |
| Class 1                | 30-35                    | 42 (29.8)        | 108.3                      | 18.3                               | 4.6                     | 13.4                          | 6 (14.3)         | 3 (7.1)          |
| Class2                 | 35-40                    | 11 (7.8)         | 123.4                      | 14.6                               | 4.3                     | 12.7                          | 1 (9.1)          | 2 (18.2)         |
| Class 3                | >40                      | 3 (2.1)          | 90.4                       | 22.4                               | 4                       | 9                             | 0 (0)            | 0 (0)            |
| <b>Total</b>           |                          | <b>141 (100)</b> | <b>107.2</b>               | <b>16</b>                          | <b>4.7</b>              | <b>12</b>                     | <b>27 (19.1)</b> | <b>20 (14.2)</b> |



**Figure 2: Comparison of postoperative recovery between different BMI categories.**

**DISCUSSION**

Most of the patients presented for cardiac surgery in this study are in the overweight (34%) and obese categories (39%), with only 25.6% in the normal weight and 1.4% in the underweight categories. This might reflect the overall national distribution of body weight categories in the country. Several national and international studies reported high incidence of overweight and obesity among the national and global populations. Chooi et al reported that approximately one third of the global population is now classified as overweight or obese.<sup>9</sup> A national survey reported an incidence of obesity of 28.1% for men and 53.1% for women.<sup>10</sup> Obesity is not just a cosmetic concern. It is a health issue that increases the risk of many chronic medical diseases such as diabetes, hypertension and ischaemic heart disease. In our study, the incidence of diabetes was 41.7% in the normal BMI category and increased to 58.4% in the overweight category and 60% in the obese category of patients. Moreover, the prevalence of diabetes also increased with the increased severity of obesity and reached 66.7% in the extremely obese (class 3) patients. The close relationship between obesity and

diabetes lead to the term ‘diabesity’, which was coined by Sims et al in the 1970s.<sup>11</sup> The risk of type 2 diabetes increases linearly with an increase in BMI. Similar association was found between BMI and hypertension in our study. The Incidence of hypertension in the normal weight category of cardiac surgical patients was 69.5%; while in the overweight category the incidence of hypertension increased to 75% and in the obese category of cardiac surgical patients it reached a high of 76.4%. The relationship between excess adiposity and increased blood pressure is well established, and it is estimated that obesity accounts for 65-78% of cases of the primary hypertension.<sup>12</sup>

Regarding the effect of BMI on intra-operative characteristics we compared the CPB time in patients with different BMI categories. There was an increase in CPB duration with an increase in BMI. This might represent more difficult surgery in the obese population. Recent focus on epicardial fat (epicardial adipose tissue thickness) is noted. In an observational study by Kaya et al they reported that increased volume of epicardial adipose tissue is associated with extensive coronary lesions in patients undergoing coronary artery bypass grafting.<sup>13</sup> Correlation between epicardial adipose tissue thickness and surgical complications was reported by Mirdamadi et al as they found that cut-off value for adipose tissue thickness for predicting in-ICU complication was 6.5 mm with sensitivity of 65.9% and specificity of 58.8%.<sup>14</sup>

Postop overall average duration of mechanical ventilation was 16 hours (mechanical ventilation duration ranged from 4 hours to 168 hours). The extreme obesity (class 3) category had a prolonged intubation time of 22.4 hours. The overall length of hospitalisation was 12 days; however, the obese category spent 1 day more in hospital (mean 13 days). Interestingly, lower mortality rate was noted in the obese category of cardiac surgical patients, they also had lower rates of re-openings after surgery. This ‘obesity paradox’ was demonstrated in studies by Johnson et al and Jiang et al with no clear physiological explanation for these controversial finding.<sup>15,16</sup> More research is needed to clarify the ‘obesity paradox’ in the cardiac surgery.

### Limitations

Limitations of this research are the retrospective observational nature, the limited number of participants and the fact that it is a single centre study.

### CONCLUSION

The majority of adult cardiac surgical patients are in the obese and overweight categories. Comorbidities such as diabetes, hypertension and ischaemic heart disease were higher in the overweight and obese categories. Patients with high BMI had lower mortality rates.

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