The Heart Surgery Forum #2015-1458
19 (5), 2016 [Epub October 2016]
doi: 10.1532/hsf.1458 Online address: http://journal.hsforum.com

Effect of Body Mass Index on Mortality and Morbidity in Patients Undergoing Coronary Artery Bypass Grafting Surgery

Serkan Akarsu, MD, İrem İris Kan, MD, Tolunay Sevingil, MD, Mustafa Tok, MD

Department of Cardiovascular Surgery, Uludağ University Faculty of Medicine, Bursa, Turkey

ABSTRACT

Background: This study aims to investigate the effect of body mass index (BMI) on mortality and morbidity in patients undergoing coronary artery bypass grafting (CABG) surgery.

Methods: We retrospectively evaluated the medical records of 403 patients undergoing coronary artery bypass surgery in our center. The patients were divided into 5 groups according to their BMI values. Preoperative demographic characteristics, operative data, and postoperative complications during the six-month follow-up period were compared between the groups.

Results: There were no statistically significant differences between the groups except the coexistence of peripheral artery disease (P = .009), ejection fraction (P = .021) and chronic obstructive pulmonary disease (P = .044). There were no statistically significant differences between the groups in terms of postoperative complications. No relationship was found between postoperative complications and the implemented surgical procedures. An overall 30-day mortality rate of 1.48% was observed, and the six-month mortality rate was 1.7%.

Conclusion: According to this study, obesity does not lead to an increased risk of mortality and other adverse outcomes after CABG surgery. However, obesity may prolong hospital stay and increase the cost of CABG operation.

INTRODUCTION

Cardiac diseases are among the most critical health problems around the world. Obesity is a well-known major risk factor for ischemic heart disease. The relationship between coronary artery bypass grafting (CABG) surgery and obesity has become an important topic of discussion due to the increasing incidence of obesity and knowledge about its effects. Because of its association with diabetes mellitus (DM), hypertension (HT), and coronary artery disease (CAD), obesity results in diminished quality of life, leading to reduced life expectancy and increased morbidity. The leading cause of death in our country is cardiovascular disease, at 39.9%, with CAD the most common form of this disease [Tüik 2008].

Obesity is simply defined as a marked increase in the amount of body fat, and it consequently increases the risk of medical illness and early death. For obesity in clinical practice, the terms body weight and BMI are used. According to the World Health Organization (WHO), approximately 400 million individuals are obese and 1.6 billion are overweight, globally [WHO 2008]. Obesity is a risk factor for DM, HT, stroke, certain types of cancer, and ischemic heart disease [Berchtold 1981]. Obesity is associated with a 50-100% increased risk of morbidity, mortality, and reduced life expectancy in the same age group, compared with non-obese patients [Fontaine 2003].

The relationship between CABG surgery and obesity has become a major topic of discussion. BMI is not included as one of the risk factors in the EuroSCORE calculation, which is widely used to determine mortality rate [Nashef 1999]. In the Society of Thoracic Surgeons scoring system, height and weight are included as parameters [Anderson 1994]. In this study, the effects of BMI on CABG surgery were retrospectively evaluated in a population of patients undergoing CABG surgery.

PATIENTS AND METHODS

In the Department of Cardiovascular Surgery of Uludağ University Medical Faculty, patients who underwent isolated CABG were analyzed retrospectively. A total of 403 patients were selected for this study and placed into five different groups based on BMI scores. BMI was calculated using the Quetelet formula [Garrow 1985], and the groups were identified as described by the WHO. The variability of the effect of BMI on mortality, morbidity, length of hospital stay, and the effects of postoperative complications were compared.

The following complications were recorded in patients during hospitalization and at six-month follow-up: postoperative atrial fibrillation, pleural effusion, saphenous vein graft site infection, mediastinitis, sepsis, new renal failure, gastrointestinal bleeding, postoperative congestive heart failure, respiratory failure, postoperative myocardial infarction, stroke, and pericardial effusion.

Statistical Analysis

In this study, descriptive statistics of continuous and discrete variables are represented as median (minimum-maximum) values, and categorical variables are expressed as a percentage of the total. For between-group comparisons of continuous and discrete variables, the Kruskal-Wallis test and the Mann-Whitney U test were used, and categorical variables were compared between groups using Pearson chi-square test. Analysis was performed using Statistical Package

Received November 17, 2015; received in revised form September 26, 2016; accepted September 27, 2016.

Correspondence: Mustafa Tok, MD, Department of Cardiovascular Surgery, Uludağ University Faculty of Medicine, Görükle, Bursa, Turkey 16059; +90-532-4140617; fax: +90-224-2952319 (e-mail: mustafatok@uludag.edu.tr).

Table 1. Risk Characteristics of Patients

	All cases n = 403	Group 1 BMI <20 n = 10 (2.5%)	Group 2 BMI 20-24.99 n = 94 (23.3%)	Group 3 BMI 25-29.99 n = 195 (48.4%)	Group 4 BMI 30-34.99 n = 89 (22.1%)	Group 5 BMI >35 n = 15 (3.7%)	*P*
Male	318 (78.9%)	9 (90%)	75 (79.8%)	156 (80%)	67 (75.3%)	11 (73.3%)	.753
Age	28-83 (61)	46-77 (69)	38-82 (62)	37-82 (62)	28-78 (59)	46-83 (56)	.026*
CCS	1 (0-4)	2 (0-3)	2 (0-4)	1 (0-4)	1 (0-4)	2 (1-3)	.869
HT	275 (68.2%)	5 (50%)	60 (63.8%)	134 (68.7%)	66 (74.2%)	10 (66.7%)	.426
MI history	146 (36.2%)	4 (40%)	36 (38.3%)	72 (36.9%)	30 (33.7%)	4 (26.7%)	.892
Family history	46 (11.4%)	1 (10%)	9 (9.6%)	23 (11.8%)	13 (14.6%)	0 (0)	.526
Hyperlipidemia	193 (47.9%)	4 (40%)	35 (37.2%)	96 (49.2%)	49 (55.1%)	9 (60%)	.117
LDL	126 (49-400)	130.5 (65-149)	120 (66-233)	131 (49-400)	119.5 (57-250)	135 (73-189)	.248
HDL	39 (17-82)	39.5 (34-60)	40 (25-64)	39 (19-72)	39 (17-82)	36 (26-57)	.760
Total Cholesterol	197 (101-439)	200 (128-232)	184 (111-323)	201.5 (101-439)	186 (118-323)	201 (111-296)	.607
Triglyceride	159 (56-645)	139 (105-238)	138 (56-400)	161.5 (58-554)	164.5 (76-645)	169 (79-268)	.415
CVE History	27 (6.7%)	1 (10%)	7 (7.4%)	14 (7.2%)	4 (4.5%)	1 (6.7%)	.906
PAD	33 (8.2%)	1 (10%)	16 (17%)	9 (4.6%)	6 (6.7%)	1 (6.7%)	.009*
CHF	14 (3.5%)	0	6 (6.4%)	5 (2.6%)	1 (1.1%)	2 (13.3%)	**
LVEF <35	27 (6.7%)	0	13 (13.8%)	11 (5.6%)	2 (2.2%)	1 (6.7%)	.021*
COPD	23 (5.7%)	1 (10%)	4 (4.3%)	7 (3.6%)	8 (9.0%)	3 (20.0%)	.044*
Diabetes Mellitus	139 (34.5%)	3 (30%)	32 (34%)	56 (28.7%)	41 (46.1%)	7 (46.7%)	.055
CRF	17 (4.2%)	1 (10%)	5 (5.3%)	7 (3.6%)	4 (4.5%)	0	**
Urea	34 (14-200)	39 (20-200)	34.5 (14-186)	34 (16-152)	34 (17-96)	32 (20-45)	.577
Creatinine	0.9 (0.5-13)	0.95 (0.8-3.3)	1.0 (0.5-0.6)	1.0 (0.6-13)	0.9 (0.6-6.5)	0.9 (0.7-1.5)	.385
Creatinine Clearance (MDRD)	80.16 (4.07-157.13)	79.99 (19.64-110.4)	80.72 (5.27-143.75)	80.11 (4.07-157.13)	79.95 (9.77-131.96)	92.36 (51.3-127.2)	.619
Smoking	152 (37.7%)	4 (40%)	38 (40.4%)	71 (36.4%)	32 (36%)	7 (46.7%)	.896
(packet x year)	30 (2-100)	45 (38-60)	30 (7-100)	30 (2-90)	30 (6-80)	40 (20-70)	.132
GID	16 (4%)	1 (10%)	3 (3.2%)	5 (2.6%)	7 (7.9%)	0	**
Previous CABG	8 (2.0%)	0	6 (%6.4)	2 (1.0%)	0	0	**

BMI indicates body mass index; CABG, coronary artery bypass surgery; CCS, Canadian Cardiovascular Society Angina Score; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CRF, chronic renal failure; CVE, cerebrovascular event; GID, gastrointestinal disease; HT, hypertension; LVEF, left ventricular ejection fraction; MDRD, modification of renal disease; MI, myocardial infarction; PAD, peripheral arterial disease.

*$P < .05$ indicates statistically significant; **not calculated statistically; cross-national comparisons of variables related to BMI groups are given in Table 4.

for Social Sciences version 13 for Windows (SPSS, Chicago, IL, USA) and $P < .05$ was considered statistically significant. A binary logistic regression model was used to analyze risk factors for mortality.

RESULTS

The preoperative risk characteristics of the patients are compared in Table 1. Peripheral artery disease was diagnosed in 33 cases (8.2%), and the difference between the groups was statistically significant ($P = .009$). Between the groups, only group 2 (n = 16, 17%) and group 3 (n = 9, 4.6%) showed a statistically significant difference ($P < .001$) (Table 4). The patients' operative data are specified in Table 2, and no statistically significant difference was found between the groups. Postoperative data are also shown in Table 2 and only postoperative body temperature values were significantly different between the groups ($P = .037$). Table 3 classifies complications occurring within the six-month postoperative period that dictated a need for additional treatment in patients.

In our study, of the 403 patients included, seven of them died within the six-month follow-up period, and the mortality rate reached 1.7%. The early mortality (within 1 month) ratio in all groups was found to be 1.48. In the comparison of pairs of groups, or subgroup analysis, there was no difference between the groups' mortality rates. Risk factors associated

Table 2. Operative and Postoperative Data

	All Cases	Group 1 BMI <20	Group 2 BMI 20-24.99	Group 3 BMI 25-29.99	Group 4 BMI 30-34.99	Group 5 BMI >35	*P*
Anesthesia time, min	295 (125-510)	325 (210-410)	285 (180-495)	285 (125-510)	300 (152-495)	310 (210-382)	.125
Surgical time, min	225 (60-455)	257.5 (120-335)	221.5 (110-455)	220 (60-425)	230 (95-430)	235 (140-305)	.122
CPB time, min	82 (15-303)	73 (28-115)	90 (55-160)	82 (15-276)	81 (28-303)	90 (69-143)	.509
Cross-clamp time, min	46 (12-161)	33 28-134)	42 (12-86)	49.5 (18-161)	46 (25-125)	48 (32-76)	.614
Blood transfusions, unit	2 (0-16)	3 (0-6)	2 (0-16)	2 (0-6)	2 (0-5)	2 (0-5)	.123
Postoperative temperature, °C	35.0 (30.8-36.7)	34.5 (32.4-36.0)	34.7 (31.7-36.3)	35.0 (30.8-36.7)	35.0 (32.4-36.5)	35.0 (33.0-36.6)	.037*
Postoperative hematocrit	30 (18-42)	27 (20-32)	30 (18-41)	30 (20-42)	30 (23-39)	30 (22-38)	.241
Postoperative blood transfusions	1 (0-17)	3 (0-12)	1 (0-8)	1 (0-17)	1 (0-10)	2 (0-6)	.445
Intensive care unit length of stay, h	24 (6-456)	27 (18-96)	24 (6-168)	24 (14-180)	24 (16-456)	24 (18-288)	.446
Length of hospital stay, d	6 (0-113)	7.5 (3-18)	6 (0-17)	6 (3-113)	6 (1-23)	6 (4-18)	.442

CPB indicates cardiopulmonary bypass.
*$P < .05$ indicates statistically significant

with mortality, such as HT, MI, HL, DM, congestive heart failure, cerebrovascular disease, EF, coronary artery bypass surgery, hospital stay, and BMI were evaluated by binary logistic regression (Table 5). Only off-pump coronary artery bypass grafting (OPCAB) surgery was found to be statistically significant ($P = .049$).

DISCUSSION

Many studies have been conducted to determine risk factors for surgical patients. The success of surgery, if possible, eliminates these factors to some extent, or at least takes measures against them.

Obesity has reached alarming proportions in the western world, and the associated DM, HT, and CAD are associated with morbidity, including reduced life expectancy, and lead to diminished quality of life and increased healthcare costs [Potapov 2003]. Weight gain in adulthood is expected to be one of the most significant determinants of cardiovascular risk factors. Studies conducted on the effects of obesity are in agreement that it is associated with poor clinical outcome, and obesity is considered to be an independent cardiovascular risk factor [Hubert 1983]. The purpose of this study was to evaluate the relationship between BMI and postoperative results, complication rates, and 30-day mortality rates in patients undergoing CABG.

In the early 1980s, the Framingham Heart Study identified obesity as a risk factor for CAD [Hubert 1983]. In the study, BMI was associated with a significant increase in the frequency of all coronary risk factors. In a detailed evaluation of treatment modalities and a study of mortality and BMI in patients with CAD, patients with obesity were admitted for CAD earlier compared with normal weight patients, people who have been shown to undergo more aggressive treatment [Oreopoulos 2009]. Based on these observations, in almost all international publications for primary prevention of cardiovascular disease in overweight and obese patients, weight loss is recommended [De Backer 2003].

In a study performed on 2440 patients, Stamou et al [Stamou 2011] reported an important finding in which obese patients were younger than patients with normal and lower BMI. They found that the earlier trend of development of CAD in these patients compared with patients with normal BMI might necessitate surgical revascularization. In our study, we reached a similar conclusion. Compared to the age of patients in groups 4 and 5, mean ages of 56 and 59, respectively, were found, but there was no statistically significant difference between the groups.

Morbidity and mortality after surgical interventions are influenced by different preoperative factors. Paradoxically, recent studies in patients with obesity with CAD who underwent CABG, compared with their weaker counterparts, suggest that obesity has resulted in better outcomes [Birkmeyer 1998]. Gruberg et al [Gruberg 2005] identified this obesity paradox: a protective relationship that has shown that being underweight is clinically worse than being obese.

Obesity was not associated with increased risk of postoperative complications in a large prospective series of 11,101 patients who underwent CABG [Stamou 2011].

According to Perrotta et al [Perrotta 2007], low BMI is associated with increased morbidity and mortality after CABG, although obesity is associated with postoperative complications and length of hospital stay.

Increased mortality associated with low BMI can be explained in two different ways: the first is the obesity paradox and the other is fragility syndrome. The paradoxical pathophysiology of obesity is associated with low systemic vascular resistance in obese patients compared to weak patients with higher plasma renin activity [Lavie 2009]. Fragility has been shown to be associated with increased cardiovascular disease.

Table 3. Postoperative Complications

	All Cases	Group 1 BMI <20	Group 2 BMI 20-24.99	Group 3 BMI 25-29.99	Group 4 BMI 30-34.99	Group 5 BMI >35	*P*
Atrial fibrillation, n (%)	32 (7.9)	0	5 (5.3)	22 (11.3)	5 (5.6)	0	.154
Pleural effusion, n (%)	31 (7.7)	0	6 (6.4)	19 (9.7)	5 (5.6)	1 (6.7)	.596
Saphenous vein graft site infection, n (%)	34 (8.4)	0	7 (7.4)	13 (6.7)	12 (13.5)	2 (13.3)	.264
Mediastinitis, n (%)	22 (5.5)	0	3 (3.2)	8 (4.1)	8 (9)	3 (20)	**
Sepsis, n (%)	2 (0.5)	0	0	0	1 (1.1)	1 (6.7)	**
New renal failure, n (%)	8 (2)	1 (10)	1 (1.1)	4 (2.1)	2 (2.2)	0	**
Gastrointestinal bleeding, n (%)	3 (0.7)	1 (10)	0	2 (1)	0	0	**
Postoperative CHF, n (%)	6 (1.5)	0	2 (2.1)	3 (1.5)	1 (1.1)	0	**
Respiratory failure, n (%)	10 (2.5)	0	3 (3.2)	4 (2.1)	1 (1.1)	2 (13.3)	**
Postoperative MI, n (%)	6 (1.5)	0	2 (2.1)	2 (1)	1 (1.1)	1 (6.7)	**
Stroke, n (%)	3 (0.7)	0	1 (1.1)	2 (1)	0	0	**
Pericardial effusion, n (%)	4 (1)	0	0	2 (1)	2 (2.2)	0	**

CHF indicates congestive heart failure; MI, myocardial infarction.
**Not calculated statistically; relevant cross-national comparisons of BMI groups of variables are given in Table 4.

Table 4. *P* Value Incalculable Statistical Postoperative Complications, BMI Binary Comparison between Groups

	Group 1-2	Group 1-3	Group 1-4	Group 1-5	Group 2-3	Group 2-4	Group 2-5	Group 3-4	Group 3-5	Group 4-5
Mediastinitis	1.00	1.00	1.00	.250	1.00	.181	.033 *	.168	.035 *	.195
New renal failure	.184	.223	.033 *	.400	1.00	.613	1.00	1.00	1.00	1.00
Sepsis	***	***	1.00	1.00	***	.486	.138	.313	.071	.269
Gastrointestinal bleeding	.096	.140	.101	.400	1.00	***	***	1.00	1.00	***
Postoperative CHF	1.00	1.00	1.00	***	.662	1.00	***	1.00	1.00	1.00
Respiratory failure	1.00	1.00	1.00	.500	.686	.621	.139	1.00	.061	.054
Postoperative MI	1.00	1.00	1.00	1.00	.598	1.00	.361	1.00	.200	.269
Stroke	1.00	1.00	***	***	1.00	1.00	1.00	1.00	1.00	***
Pericardial effusion	***	1.00	1.00	***	1.00	.235	***	.592	1.00	1.00

CHF indidates congestive heart failure; MI, myocardial infarction.
***The number of data is insufficient, and statistical calculations failed.

Fragility is a syndrome, and it can be explained by low activity levels, loss in weight, low energy, reduced walking speed, and reduced grip strength. High levels of circulating tumor necrosis factor and increased inflammation can cause myocardial dysfunction in patients with fragility [Fried 2008]. Correspondingly, Lavie et al showed that adipose tissue produces more tumor necrosis factor, which results in neutralization of the harmful effects of tumor necrosis factors on the myocardium. Thus obesity may have the potential anti-inflammatory effect [Lavie 1992; Atalan 2012].

BMI is currently not used in the existing scoring systems. Only the STS scoring system includes height and weight as a parameter [Anderson 1994]. The relationship between BMI and mortality in adult intensive care unit patients, in a study to examine BMI weak patients (BMI <18.5 kg/m²), was associated with high mortality. Severe overweight (BMI >30 kg/m²) to be protective in patients respective to moderate overweight showed no protective effect on mortality. In the same study, BMI was reported as a useful component for future scoring systems [Orgeas 2004]. Low body weight should be considered a risk factor for preoperative risk stratification scores in cardiac surgery [Potapov 2003].

Among patients undergoing CABG surgery, 20% to 30% are diabetic patients. In addition, in patients with obesity undergoing CABG surgery, a higher incidence of DM was found [Orhan 2004]. In our study, 34.5% of patients have

DM and there was no statistically significant difference between the groups ($P = .055$). However, for patients in group 4 (46.1%) and group 5 (46.7%) the incidence of DM was significantly higher.

The relationship between obesity and DM was examined in detail, as these factors are often associated with increased morbidity. But no effect on operative mortality was reported as suspicious [Nalysnyk 2003]. Obesity was defined by Birkmeyer et al [Birkmeyer 1998] as a risk factor for sternal wound infection. In some studies, obesity, DM, smoking, and CPB were identified as independent risk factors for mediastinitis after CABG [Oliveira 2011]. In our study, obese patients with superficial sternal wound infection and sternal dehiscence were more often in groups 4 and 5 than the other groups, but this difference was not statistically significant. Among all patients, sternal wound infection was found in 5.5% of patients, whereas this rate was 9% in group 4, and 20% in group 5.

Postoperative wound infections usually cause morbidity, mortality, and extra costs. Our incidence of wound infection was 8.4%. At the same time, in groups 4 and 5, this ratio stood at 13.3% and 13.5%, respectively, but the difference was not statistically significant ($P = .264$).

As a result of reduced fatty tissue microcirculation for diabetic patients in the obese patient group, wound healing may be delayed due to the lack of tissue perfusion and possible infection, and this prolongs the duration of their hospital stay. For the postoperative period in patients with DM, a more aggressive treatment of hyperglycemia and avoiding use of the bilateral internal mammarian artery can reduce sternal wound infection in patients with obesity.

Obesity has a negative impact on respiratory function, exercise capacity, blood gas measurements, and complication rates of CABG surgery during the postoperative period [Moulton 1996]. On the other hand, anesthetic drugs are released from adipose tissue, and patients with a high BMI with low vital capacity prolong the need for mechanical ventilation.

Time on a ventilator increased in patients with moderate-to-severe obesity, but there were no statistically significant differences between the groups. In obese patients, it is a known fact that a restrictive effect on the increase in the lungs and the chest wall prevent the rib cage from being used actively. Among all of our patients, the respiratory failure rate was 2.5% during the postoperative period, whereas it was 13.3% for group 5 patients.

Atrial fibrillation was seen with high BMI in some publications, although no significant difference was detected in our study ($P = .154$) [Youn 2007].

Although there is no difference between the groups evaluated in the study, surgery ($P = .122$), cross-clamp ($P = .614$) and CPB times ($P = .509$) were longer in patients with obesity, but this difference was not statistically significant.

Shirzad et al [Shirzad 2009] found that after CABG, there was a higher risk of the development of gastrointestinal complications in overweight patients compared to normal patients, but in our study we did not find any data supporting this effect. In our findings, the GIS complication rate was 0.7%.

In our study the intensive care unit stay was 24 hours in all patients and there was no difference between the groups ($P = .446$). Similarly, length of hospital stay for all patients was six days, and there was no significant difference between the groups ($P = .442$).

Table 5. Logistic Regression Analysis of Risk Factors for Mortality

Risk factors	Coefficient	SE	P	Odds ratio = Exp(B)
HT(1)	3.012	1.590	.058	20.329
MI(1)	-1.688	1.016	.097	.185
DM			.546	
DM(1)	-.996	1.153	.388	.369
DM(2)	-.879	1.089	.419	.415
COPD(1)	-.344	1.522	.821	.709
CHF(1)	-.857	1.947	.660	.424
CVD(1)	.719	1.420	.613	2.053
HL(1)	-1.363	.936	.145	.256
EF	-.051	.042	.225	.950
OPCAB	-2.332	1.182	.049*	.097
HOSP	.001	.088	.988	1.001
BMI_GROUP			.069	
BMI_GROUP(1)	-2.827	1.406	.044	.059
BMI_GROUP(2)	-4.838	1.670	.004	.008
BMI_GROUP(3)	-3.092	1.514	.041	.045
BMI_GROUP(4)	-1.384	1.749	.429	.250
Constant	-3.213	2.293	.161	.040

HT indicates hypertension; MI, myocardial infarction; DM, diabetes mellitus; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; CVD, cerebrovascular disease; HL, hyperlipidemia; EF, ejection fraction; OPCAB, off-pump coronary artery bypass surgery; HOSP, hospital stay; BMI: body mass index.
*$P < .05$ indicates statistically significant.

We compared complications consisting of groups of patients based on either the OPCAB or CPB operation method, but did not find statistically significant results. In overweight patients, saphenous vein site infection rates were 16.4% and 8.8% for CPB and OPCAB, respectively ($P = .360$). Mediastinitis in obese patients occurred in 28.6% of those operated on with CPB, and 12.5% in patients operated with OPCAB ($P = .569$). Saphenous vein graft site infection rates were 28.6% in patients operated on with CPB and were significantly higher than in those who underwent OPCAB procedure ($P = .200$).

Conclusion

Despite the expectation of an increased risk of mortality and permanent morbidity in obese patients undergoing CABG surgery, these risks do not seem to vary from those of normal weight. CABG surgery can be performed safely in obese and morbidly obese patients [Shirzad 2009]. This might be attributable to the belief of physicians and nurses that morbidly obese patients are at higher risk, and perhaps they show more attention to these patients in the perioperative period. Unfortunately, this information is not available in our database. Obesity prolongs hospital stay and increases the cost of CABG with non-routine treatments. There is a need for the evaluation of more extensive results from a series related to this issue. The results of this study were collected from relatively short-term postoperative patients. Additional surveys with long-term follow-up, including preoperative risk factors associated with BMI, will be possible with future studies.

REFERENCES

Anderson RP. 1994. First publications from the Society of Thoracic Surgeons National Database. Ann Thoracic Surg 57:6-7.

Atalan N, Fazlioğulları O, Kunt AT, et al. 2012. Effect of body mass index on early morbidity and mortality after isolated coronary artery bypass graft surgery. J Cardiothorac Vasc Anesth 26:813-17.

Berchtold P, Jorgens V, Finke C, Berger M. 1981. Epidemiology of obesity and hypertension. Int J Obes 5:1-7.

Birkmeyer NJ, Charlesworth DC, Hernandez F, et al. 1998. Obesity and risk of adverse outcomes associated with coronary artery bypass surgery. Circulation 97:1689-94.

De Backer G, Ambrosioni E, Borch-Johnsen K, et al. 2003. European guidelines on cardiovascular disease prevention in clinical practice: third joint task force of European and other societies on cardiovascular disease prevention in clinical practice. Eur J Cardiovasc Prev Rehabil 10:10.

Fontaine KR, Redden DT, Wang C, et al. 2003. Years of life lost due to obesity. JAMA 289:187.

Fried LP, Tangen CM, Walston J, et al. 2008. Frailty in older adults: Evidence for a phenotype. J Gerontol A Biol Sci Med Sci 56:146-56.

Garrow JS, Webster J. 1985. Quetelet's index as a measure of fatness. Int J Obes 9:147.

Gruberg L, Mercado N, Milo S, et al. 2005. Impact of BMI on the outcome of patients with multi vessel disease randomized to either CABG or stenting in the ARTS trial: the obesity paradox? Am J Cardiol 95:439-44.

Hubert HB, Feinleib M, Mc Namara PM, Castelli WP. 1983. Obesity as an independent risk factor for cardiovascular disease: a 26 year follow up of participants in the Framingham Heart study. Circulation 67:968-77.

Lavie CJ, Ventura HO, Messerli FH. 1992. Left ventricular hypertrophy. Its relationship to obesity and hypertension. Postgrad Med 91:131-43.

Lavie CJ, Milani RV, Ventura HO. 2009. Obesity and cardiovascular disease risk factor, paradox, and impact of weight loss. J Am Coll Cardiol 53:1925-32.

Moulton M, Creswell L, Mackey ME, Cox JL, Rosenbloom M. 1996. Obesity is not a risk factor for significant adverse outcomes after cardiac surgery. Circulation 94:87-92.

Nalysnyk L, Fahrbach K, Reynolds MW, Zhao SZ, Ross S. 2003. Adverse events in coronary artery bypass graft trials: asystematic review and analysis. Heart 89:767-72.

Nashef SA, Roques F, Michel P, Gauducheau E, Lemeshow S, Salamon R. 1999. European system for cardiac operative risk evaluation (EuroSCORE). Eur J Cardiothorac Surg 16:9-13.

Oliveira B, Soares EF, Santos CA, et al. 2011. Risk factors for mediastinitis after coronary artery bypass grafting surgery. Rev Bras Cir Cardiovasc 26:27-35.

Oreopoulos A, Mc Alister FA, Zadeh KK, et al. 2009. The relationship between body mass index, treatment and mortality in patients with established coronary artery disease. Eur Heart J 30:2584-92.

Orgeas MG, Troch G, Azoulay E, et al. 2004. Body mass index. An additional prognostic factor in ICU patients. Intensive Care Med 30:437-43.

Orhan G, Biçer Y, Aka SA, et al. 2004. Coronary artery bypass graft operations can be performed safely in obese patients. Eur J Cardiothorac Surg 25:212-7.

Perrotta S, Nilsson F, Brandrup-Wognsen G, et al. 2007. Body mass index and outcome after coronary artery bypass surgery. J Cardiovasc Surg 48:239.

Potapov EV, Loebe M, Anker S, et al. 2003. Impact of body mass index on outcome in patients after coronary artery bypass grafting with and without valve surgery. Eur Heart J 24:1933-41.

Shirzad M, Karimi A, Armadi SH, et al. 2009. Effects of body mass index on early outcome of coronary artery bypass surgery. Minerva Chir 64:17-23.

Stamou SC, Nussbaum M, Stiegel RM, et al. 2011. Effect of body mass index on outcomes after cardiac surgery: is there an obesity paradox? Ann Thorac Surg 91:42.

Tüik. 2008. Death Statistics. ISBN 978-975-19-4660-7, 25.

World Health Organization. 2008. Global strategy on diet, physical activity, and health. Available at: http://whqlibdoc.who.int/publications/2009/9789241597418.html. Accessed October 10, 2012.

Youn YN, Kwak YL, Yoo KJ. 2007. Can the EuroSCORE predict the early and mid-term mortality after off-pump coronary artery bypass grafting? Ann Thorac Surg 83:2111–7.