Isolated Coronary Artery Bypass Grafting in Obese Individuals

– A Propensity Matched Analysis of Outcomes –

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Background: There is conflicting data regarding the impact of obesity on morbidity and mortality in patients undergoing isolated coronary artery bypass grafting (CABG).

Methods and Results: Retrospective cohort analysis of patients who underwent CABG from January 1, 1995, through July 31, 2010 was performed. Patients were classified as obese or non-obese (body mass index ≥30.0 kg/m² and <30.0 kg/m², respectively). The primary outcome was in-hospital mortality. Secondary outcomes included postoperative respiratory failure, postoperative stroke, postoperative myocardial infarction, sternal and leg wound infections, postoperative atrial fibrillation, postoperative ventricular tachycardia, postoperative renal failure and length of hospital stay. Propensity-matched stepwise multivariable logistic regression was performed. Of 13,115 patients, 4,619 (35.2%) were obese. In the propensity-matched logistic regression models (n=8,442), obesity was not associated with postoperative mortality (odds ratio=1.13, 95% confidence interval 0.86–1.48). However, obesity was associated with postoperative respiratory failure, postoperative renal insufficiency, sternal wound infection, and leg wound infection. Obesity was also associated with a decreased risk of postoperative bleeding and re-operation from bleeding.

Conclusions: Obesity was associated with an increased risk of postoperative respiratory failure, postoperative renal failure, and surgical site infections. However, obesity was not associated with in-hospital mortality in patients undergoing CABG. (Circ J 2011; 75: 1378–1385)

Key Words: Coronary artery bypass grafting; Morbidity; Mortality; Obesity; Outcomes

Obesity is an increasingly prevalent chronic health condition that contributes significantly to morbidity and mortality.1 Obese individuals suffer from a higher incidence of diabetes mellitus, hypertension, and hyperlipidemia, and thus, they are at higher risk of coronary atherosclerosis.2–9 However, the impact of obesity on short- and long-term measures of morbidity and mortality in patients undergoing coronary artery bypass grafting (CABG) remains controversial, although it is often considered as a risk factor in patients undergoing CABG or percutaneous coronary intervention (PCI).10 Obesity has been associated with the development of coronary artery disease (CAD),11 post-procedural complications,11 prolonged hospital stay, an increased risk of 30-day re-admission to hospital after CABG12 and increased risk of saphenous vein graft occlusion.13 Although some authors have reported higher postoperative and mid-term mortality in obese14–17 and morbidly obese18,19 patients after CABG, others have failed to confirm this association.20–31 Obesity is considered as a predictor for post-cardiac surgery 30-day mortality in a risk stratification system devised by Parsonnet et al.18 Although several studies have demonstrated an increased cardiovascular risk in obese individuals, there is an increasing body of literature describing the obesity paradox, suggesting possible protection from adverse cardiovascular events in obese patients, including congestive heart failure (CHF).6,32–37 Some of these studies also suffer

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from selection bias since obese patients, on average, have a higher number of associated comorbidities, and the use of logistic regression analysis may not completely adjust for this selection bias. Similarly, although obesity may not impact mortality, it may be associated with an increased need for prolonged ventilation, risk of postoperative infections and length of hospital stay. Therefore, we sought to ascertain whether after propensity score matching to control for this selection bias obesity is associated with increased postoperative mortality or morbidity in patients undergoing isolated CABG.

### Methods

The study was a retrospective cohort analysis of consecutive patients who underwent CABG at the St. Luke’s Episcopal Hospital/Texas Heart Institute from January 1, 1995, through July 31, 2010. The institutional review board at St. Luke’s Episcopal Hospital approved the study protocol. Patients undergoing concomitant valve replacement surgery, aortic root replacement, or ventricular assist device placement were excluded. Recently, body mass index (BMI) was correlated with waist circumference as a surrogate of central obesity. Therefore, the study population (n=13,115) was divided into 2 groups based on BMI: obese (BMI $\geq 30.0$ kg/m$^2$; n=4,619, 35.2%), and non-obese (BMI $<30.0$ kg/m$^2$; n=8,496, 64.8%).

BMI was also evaluated across categories of obesity (ie, mild [BMI 30.0–34.9 kg/m$^2$], moderate [BMI 35.0–39.9 kg/m$^2$], and morbid [BMI $\geq 40$ kg/m$^2$] obesity.

#### Table 1. Preoperative Characteristics of Obese vs. Non-Obese Patients Undergoing Isolated CABG

<table>
<thead>
<tr>
<th></th>
<th>BMI ≥30 kg/m$^2$</th>
<th>BMI &lt;30 kg/m$^2$</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>4,619 (35.2)</td>
<td>8,496 (64.8)</td>
<td>0.0007</td>
</tr>
<tr>
<td>Males, n (%)</td>
<td>3,388 (73.4)</td>
<td>6,460 (76.0)</td>
<td></td>
</tr>
<tr>
<td>Mean BMI ± SD*</td>
<td>34.4±4.1</td>
<td>25.6±2.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean age (years) ± SD*</td>
<td>61.0±10.0</td>
<td>64.6±10.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>&gt;65 years, n (%)</td>
<td>1,666 (36.1)</td>
<td>4,329 (51.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Preoperative morbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NYHA functional class III-IV, n (%)</td>
<td>3,478 (75.3)</td>
<td>6,417 (75.3)</td>
<td>0.77</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>3,868 (83.7)</td>
<td>6,205 (73.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>2,105 (45.6)</td>
<td>2,643 (31.2)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Insulin-dependent diabetes mellitus, n (%)</td>
<td>617 (13.4)</td>
<td>681 (8.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Non-insulin-dependent diabetes mellitus, n (%)</td>
<td>1,488 (32.2)</td>
<td>19,62 (23.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Previous MI, n (%)</td>
<td>1,909 (41.3)</td>
<td>3,638 (42.8)</td>
<td>0.09</td>
</tr>
<tr>
<td>Preoperative renal insufficiency, n (%)</td>
<td>678 (14.7)</td>
<td>1,232 (14.5)</td>
<td>0.78</td>
</tr>
<tr>
<td>Preoperative pulmonary disease, n (%)</td>
<td>1,297 (28.1)</td>
<td>2,255 (26.8)</td>
<td>0.06</td>
</tr>
<tr>
<td>Smoking, n (%)</td>
<td>2,386 (51.7)</td>
<td>4,346 (51.2)</td>
<td>0.55</td>
</tr>
<tr>
<td>Peripheral arterial disease, n (%)</td>
<td>719 (15.6)</td>
<td>1,793 (21.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>History of congestive heart failure, n (%)</td>
<td>916 (19.8)</td>
<td>1,442 (17.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Unstable angina, n (%)</td>
<td>2,470 (53.5)</td>
<td>4,413 (51.9)</td>
<td>0.09</td>
</tr>
<tr>
<td>Urgent surgery, n (%)</td>
<td>937 (20.1)</td>
<td>1,782 (21.0)</td>
<td>0.35</td>
</tr>
<tr>
<td>Preoperative IABP, n (%)</td>
<td>209 (4.5)</td>
<td>388 (4.5)</td>
<td>0.91</td>
</tr>
<tr>
<td>Preoperative aspirin, n (%)</td>
<td>2,970 (64.7)</td>
<td>5,435 (64.3)</td>
<td>0.69</td>
</tr>
<tr>
<td>Preoperative β-blockers, n (%)</td>
<td>2,295 (50.0)</td>
<td>3,959 (46.9)</td>
<td>0.0006</td>
</tr>
<tr>
<td>Extent of CAD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-vessel, n (%)</td>
<td>567 (12.3)</td>
<td>1,002 (11.8)</td>
<td>0.63</td>
</tr>
<tr>
<td>2-vessel, n (%)</td>
<td>1,237 (26.8)</td>
<td>2,316 (27.3)</td>
<td></td>
</tr>
<tr>
<td>3-vessel, n (%)</td>
<td>2,641 (57.2)</td>
<td>4,885 (57.5)</td>
<td></td>
</tr>
<tr>
<td>Unknown, n (%)</td>
<td>174 (3.7)</td>
<td>293 (3.4)</td>
<td></td>
</tr>
<tr>
<td>No. of coronary bypass grafts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-vessel</td>
<td>276 (6.0)</td>
<td>549 (6.5)</td>
<td>0.74</td>
</tr>
<tr>
<td>2-vessel</td>
<td>688 (14.9)</td>
<td>1,230 (14.5)</td>
<td></td>
</tr>
<tr>
<td>3-vessel</td>
<td>1,738 (37.6)</td>
<td>3,143 (37.0)</td>
<td></td>
</tr>
<tr>
<td>4-vessel</td>
<td>1,424 (30.8)</td>
<td>2,668 (31.4)</td>
<td></td>
</tr>
<tr>
<td>5-vessel</td>
<td>493 (10.7)</td>
<td>906 (10.6)</td>
<td></td>
</tr>
<tr>
<td>Use of internal mammary artery</td>
<td>4,207 (91.1)</td>
<td>7,671 (90.3)</td>
<td>0.14</td>
</tr>
<tr>
<td>Total circulatory bypass time (min)</td>
<td>72.1±36.8</td>
<td>67.5±32.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Aortic clamp time (min)</td>
<td>41.7±23.5</td>
<td>39.5±21.2</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

CABG, coronary artery bypass grafting; BMI, body mass index; SD, standard deviation; NYHA, New York Heart Association; MI, myocardial infarction; IABP, intra-aortic balloon pump; CAD, coronary artery disease.
use, procedural details, and postoperative variables were obtained from the Texas Heart Institute Research Database (THIRDBase). The primary outcome was in-hospital mortality, defined as death during hospitalization for CABG surgery.

Secondary outcomes of interest included postoperative respiratory failure (failure to extubate in the 24 h after CABG surgery), postoperative renal insufficiency, postoperative ischemic stroke, postoperative myocardial infarction (MI), infections, postoperative atrial fibrillation (AF), postoperative atrial flutter (AFL), postoperative ventricular tachycardia (VT), and length of hospital stay. Postoperative renal insufficiency was defined as the occurrence of acute tubular necrosis, acute interstitial nephritis, postoperative anuria, or any increase in serum creatinine deemed clinically significant by the treating physician. Postoperative MI was defined as the appearance of new Q waves on ECG, increased levels of creatine kinase-MB isoenzyme (>5% of upper limit of normal), a new regional wall motion abnormality (other than paradoxical septal motion) on the echocardiogram, or the presence of MI at autopsy. Ischemic stroke was defined as clinical evidence of a focal neurologic deficit along with a radiologic defect on computed tomogram or magnetic resonance imaging scan of the brain. Postoperative AF and AFL were defined as the occurrence of fibrillation or flutter of any duration during the hospitalization for the index surgery deemed to be clinically significant by the treating physician. Postoperative VT was defined as sustained (≥30 s or requiring intervention for termination) or non-sustained (≤6 beats or <30 s) VT during hospitalization for the index surgery. All patients were on continuous telemetry throughout their hospital stay, and any episodes of AF, AFL, or VT were included in the analysis.

All statistical analyses were performed using SAS statistical software (SAS Institute, Cary, NC, USA). The 2 patient groups were compared in terms of the presence of preoperative risk factors. Differences between groups were evaluated by chi-square test for discrete variables and independent samples Student’s t-test for continuous variables. A stepwise multivariable logistic regression model was subsequently used to control for potential confounders and to ascertain which variables were independently associated with primary or secondary outcomes. All preoperative variables, as described in Table 1, were used in the multivariable logistic regression model.

Since it could be argued that, in general, obese patients are sicker than non-obese patients, we also performed propensity score analyses to minimize this selection bias. Propensity scores were estimated for each patient using unconditional logistic regression to determine the predicted probability. Obese and non-obese patients were matched 1 to 1 on the basis of variables described below. All predictor variables were then entered in a multivariate step-wise logistic regression model to determine whether obesity was associated with postoperative mortality as well as secondary outcomes. All the P values described are 2-sided and a P<0.05 was considered statistically significant.

### Results

Of the 13,115 patients who underwent CABG surgery during the study period, 4,619 (35.2%) were categorized as obese (BMI ≥30 kg/m²). The proportion of patients who were mild, moderate or morbidly obese was 23.2%, 8.4% and 3.6%, respectively.

Table 1 is a comparison of the preoperative characteristics of obese vs. non-obese patients. The majority of patients in the obese (73.4%) and non-obese (76.0%) groups were male. Patients in the obese group were younger and had a higher prevalence of hypertension, diabetes mellitus, history of CHF, and a trend towards higher prevalence of pulmonary disease. On the other hand, the non-obese group had a higher proportion of patients with peripheral arterial disease (PAD) and transient ischemic attacks (TIAs). A higher proportion of patients in the obese group were on preoperative β-blockers. Table 1 also shows the comparison of the extent of CAD, as well as the extent of surgical revascularization, between the 2 groups. There were no differences in terms of number of vessels involved (P value for trend=0.63) and the number of vessels grafted (P value for trend=0.74). The internal mam-

### Table 2. Baseline Characteristics of Obese and Non-Obese Patients After Propensity-Score Matching

<table>
<thead>
<tr>
<th></th>
<th>≥30 kg/m²</th>
<th>&lt;30 kg/m²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>4,221</td>
<td>4,221</td>
<td></td>
</tr>
<tr>
<td>Males, n (%)</td>
<td>3,219 (76.3)</td>
<td>3,184 (75.4)</td>
<td>0.38</td>
</tr>
<tr>
<td>&gt;65 years, n (%)</td>
<td>1,544 (36.6)</td>
<td>1,565 (37.1)</td>
<td>0.63</td>
</tr>
<tr>
<td>Preoperative NYHA class III or IV</td>
<td>3,160 (74.9)</td>
<td>3,191 (75.6)</td>
<td>0.43</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>3,529 (83.6)</td>
<td>3,549 (84.1)</td>
<td>0.55</td>
</tr>
<tr>
<td>Insulin-dependent diabetes mellitus, n (%)</td>
<td>396 (9.4)</td>
<td>391 (9.3)</td>
<td>0.85</td>
</tr>
<tr>
<td>Previous MI, n (%)</td>
<td>1,720 (40.8)</td>
<td>1,744 (41.3)</td>
<td>0.59</td>
</tr>
<tr>
<td>Preoperative renal insufficiency, n (%)</td>
<td>563 (13.3)</td>
<td>580 (13.7)</td>
<td>0.59</td>
</tr>
<tr>
<td>Preoperative pulmonary disease, n (%)</td>
<td>1,107 (26.2)</td>
<td>1,139 (27.0)</td>
<td>0.43</td>
</tr>
<tr>
<td>Smoking, n (%)</td>
<td>2,192 (51.9)</td>
<td>2,214 (52.5)</td>
<td>0.63</td>
</tr>
<tr>
<td>Peripheral arterial disease, n (%)</td>
<td>605 (14.3)</td>
<td>637 (15.1)</td>
<td>0.32</td>
</tr>
<tr>
<td>Previous transient ischemic attack, n (%)</td>
<td>117 (2.8)</td>
<td>138 (3.3)</td>
<td>0.18</td>
</tr>
<tr>
<td>Previous cerebrovascular accident, n (%)</td>
<td>236 (5.6)</td>
<td>251 (5.9)</td>
<td>0.48</td>
</tr>
<tr>
<td>History of congestive heart failure, n (%)</td>
<td>707 (16.8)</td>
<td>710 (16.8)</td>
<td>0.93</td>
</tr>
<tr>
<td>Unstable angina, n (%)</td>
<td>2,250 (53.3)</td>
<td>2,202 (52.2)</td>
<td>0.29</td>
</tr>
<tr>
<td>Urgent surgery, n (%)</td>
<td>836 (19.8)</td>
<td>823 (19.5)</td>
<td>0.72</td>
</tr>
<tr>
<td>Preoperative IABP, n (%)</td>
<td>176 (4.2)</td>
<td>166 (3.9)</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Abbreviations see in Table 1.
Outcome After Isolated CABG in Obese Individuals

mary artery was used in equivalent proportions of patients in the obese (91.1%) and non-obese (90.3%) groups (P=0.14). Obese patients had overall longer cardiopulmonary bypass time (72.1±36.8 vs. 67.5±32.7 min, P<0.0001) and aortic clamp time (41.7±23.5 vs. 39.3±21.2 min, P<0.0001) than the non-obese patients.

Baseline demographic and comorbid variables of interest after propensity-score matching are shown in Table 2: male gender, old age (>65 years), preoperative New York Heart Association (NYHA) class III or IV, hypertension, diabetes mellitus, prior MI, preoperative renal insufficiency, pulmonary disease, smoking, PAD, TIA, stroke, CHF, unstable angina, urgent surgery and preoperative use of intraoperative balloon pumping (IABP). Our propensity-score matching for these variables yielded a total of 8,442 patients (n=4,221 in each of the obese and non-obese groups).

A total of 448 patients died during the index hospitalization: 137/4,619 (2.97%) obese patients compared with 311/8,496 (3.66%) non-obese patients. Table 3 provides details of the multivariate logistic regression analysis for predictors of postoperative mortality in both unmatched analyses as well as after propensity-score matching. Old age, male gender, urgent or emergent surgery and preoperative comorbidities (renal insufficiency, CHF, need for IABP, PAD, prior MI and NYHA class III–IV symptoms at the time of CABG) were all associated with a significantly increased risk of post-

<table>
<thead>
<tr>
<th>Table 3. Independent Predictors of In-Hospital Mortality in Patients Undergoing Isolated CABG After Multivariate Logistic Regression Analyses (Results Presented Both With And Without Propensity-Score Matching)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
</tr>
<tr>
<td><strong>OR (95%CI)</strong></td>
</tr>
<tr>
<td>Obesity</td>
</tr>
<tr>
<td>Age &gt;65 years</td>
</tr>
<tr>
<td>Female gender</td>
</tr>
<tr>
<td>Urgent or emergent surgery</td>
</tr>
<tr>
<td>Preoperative renal insufficiency</td>
</tr>
<tr>
<td>Preoperative congestive heart failure</td>
</tr>
<tr>
<td>Need for preoperative IABP</td>
</tr>
<tr>
<td>Preoperative peripheral arterial disease</td>
</tr>
<tr>
<td>Prior MI</td>
</tr>
<tr>
<td>Preoperative NYHA class III-IV</td>
</tr>
</tbody>
</table>

OR, odds ratio; CI, confidence interval. Other abbreviations see in Table 1.
operative mortality. Obesity was not associated with in-hospital mortality in the fully adjusted analyses after propensity-matching (odds ratio [OR] 1.13; 95% confidence interval [CI] 0.86–1.48).

We also analyzed the association between obesity and postoperative mortality across the various ranges of BMI (ie, <30.0, 30.0–34.9, 35.0–39.9 and ≥40 kg/m²) and the respective mortality rates are shown in the Figure. Obesity was not associated with an increase in mortality across the different BMI ranges (mortality rate in BMI range <30.0, 30.0–34.9, 35.0–39.9 and ≥40 kg/m² was 3.7%, 2.9%, 3.3%, and 3.0%, respectively [P for trend =0.19]).

The association between obesity and secondary outcomes of postoperative morbidity after logistic regression analyses (both with and without propensity-score matching) is presented in Table 4. Obesity was significantly associated with increased risk of postoperative respiratory failure (OR 1.51; 95% CI 1.32–1.72), sternal wound infections (OR 2.12; 95% CI 1.74–2.60), leg wound infections (OR 1.78; 95% CI 1.31–2.40) and postoperative renal insufficiency (OR 1.48; 95% CI 1.25–1.74). Obesity was also associated with a higher risk for postoperative VT (OR 1.16; 95% CI 1.07–1.34) before propensity matching, but this risk was not significant after propensity matching (OR 1.13; 95% CI 0.94–1.34). Patients in the obese group also had lower odds for postoperative stroke (2.1% vs. 2.9%; OR 0.77; 95% CI 0.60–0.98) before propensity matching, but this difference was not significant after propensity score matching (OR 0.85, 95% CI 0.63–1.14). Obese patients were at lower risk for postoperative bleeding (OR 0.81, 95% CI 0.71–0.92), and re-operation for postoperative bleeding complications (OR 0.76; 95% CI 0.61–0.94) compared with non-obese patients. There were no significant differences between the 2 groups in terms of length of hospitalization, postoperative atrial arrhythmias (AF, AFL), postoperative MI and need for IABP in the postoperative period.

### Table 4. Postoperative Secondary Outcomes in Obese vs. Non-Obese Patients Undergoing Isolated CABG After Logistic Regression Analyses (Results Presented Both With And Without Propensity-Score Matching)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>≥30 kg/m²</th>
<th>&lt;30 kg/m²</th>
<th>Without propensity matching</th>
<th>OR (95%CI)</th>
<th>Propensity matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative respiratory failure</td>
<td>794 (17.2)</td>
<td>1,126 (13.2)</td>
<td>1.42 (1.27–1.58)</td>
<td>1.51 (1.32–1.72)</td>
<td></td>
</tr>
<tr>
<td>Postoperative atrial fibrillation</td>
<td>970 (21.0)</td>
<td>1,897 (22.3)</td>
<td>1.04 (0.95–1.15)</td>
<td>1.06 (0.95–1.18)</td>
<td></td>
</tr>
<tr>
<td>Postoperative atrial flutter</td>
<td>294 (6.4)</td>
<td>541 (6.4)</td>
<td>1.13 (0.97–1.31)</td>
<td>1.09 (0.91–1.31)</td>
<td></td>
</tr>
<tr>
<td>Postoperative ventricular tachycardia</td>
<td>349 (7.6)</td>
<td>566 (6.7)</td>
<td>1.16 (1.07–1.34)</td>
<td>1.13 (0.94–1.34)</td>
<td></td>
</tr>
<tr>
<td>Sternal wound infection</td>
<td>342 (7.4)</td>
<td>318 (3.7)</td>
<td>2.01 (1.71–2.37)</td>
<td>2.12 (1.74–2.60)</td>
<td></td>
</tr>
<tr>
<td>Leg wound infection</td>
<td>136 (2.9)</td>
<td>145 (1.7)</td>
<td>1.96 (1.53–2.50)</td>
<td>1.78 (1.31–2.40)</td>
<td></td>
</tr>
<tr>
<td>Postoperative sepsis</td>
<td>91 (2.0)</td>
<td>146 (1.7)</td>
<td>1.14 (0.86–1.50)</td>
<td>1.39 (0.98–1.96)</td>
<td></td>
</tr>
<tr>
<td>Postoperative stroke</td>
<td>97 (2.1)</td>
<td>250 (2.9)</td>
<td>0.77 (0.60–0.98)</td>
<td>0.85 (0.63–1.14)</td>
<td></td>
</tr>
<tr>
<td>Postoperative MI</td>
<td>180 (3.9)</td>
<td>286 (3.4)</td>
<td>1.60 (0.96–1.40)</td>
<td>1.16 (0.92–1.46)</td>
<td></td>
</tr>
<tr>
<td>Postoperative renal insufficiency</td>
<td>481 (10.4)</td>
<td>640 (7.5)</td>
<td>1.43 (1.24–1.64)</td>
<td>1.48 (1.25–1.74)</td>
<td></td>
</tr>
<tr>
<td>Postoperative bleeding</td>
<td>590 (12.8)</td>
<td>1,352 (15.9)</td>
<td>0.78 (0.70–0.88)</td>
<td>0.81 (0.71–0.92)</td>
<td></td>
</tr>
<tr>
<td>Re-operation for bleeding</td>
<td>176 (3.8)</td>
<td>434 (5.1)</td>
<td>0.76 (0.63–0.91)</td>
<td>0.76 (0.61–0.94)</td>
<td></td>
</tr>
<tr>
<td>Postoperative IABP</td>
<td>238 (5.1)</td>
<td>434 (5.1)</td>
<td>1.00 (0.84–1.19)</td>
<td>1.02 (0.82–1.26)</td>
<td></td>
</tr>
<tr>
<td>Mean length of hospital stay (days ± SD)</td>
<td>11.1±8.8</td>
<td>10.7±9.7</td>
<td>1.07 (0.96–1.20)</td>
<td>1.09 (0.95–1.25)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations see in Tables 1, 3.

### Discussion

This retrospective propensity-matched analysis of patients undergoing isolated CABG showed no significant increase in postoperative mortality in obese patients. However, there was a higher incidence of postoperative complications, including secondary outcomes of postoperative respiratory failure, surgical site infections, and postoperative renal insufficiency. An interesting finding was the decreased odds for postoperative bleeding and decreased need for re-operation due to bleeding in obese patients undergoing CABG.

Traditionally, obesity has been viewed as a risk factor for postoperative mortality in patients undergoing CABG. Several studies in the past have explored this potential association with mixed results. Some studies found a higher incidence of mortality in the postoperative and mid-term follow-up after CABG in obese patients, whereas others did not find this association. There are reports of increased operative mortality in morbidly obese individuals. In a recent systematic review, Oreopoulos et al reported a lower mortality in obese patients undergoing CABG. We did not find a significant association between obesity and early postoperative mortality, even after accounting for selection bias by performing propensity-score matching. In addition, we did not find any association between obesity and postoperative mortality across various cut-offs of BMI as a measure of the severity of obesity. Several factors may contribute to this finding in our study, including the expertise of the surgical team, a high level of perioperative care, a high volume of cardiac surgeries performed at the study institution, as well as residual confounding from variables not included in our logistic regression models.

Obesity has been consistently reported as an independent risk factor for surgical site infections both at the sternum and the superficial femoral vein harvest site. Rates of deep sternal wound infections between 0.5% and 14.2% have been reported around the world. OR of 2.1–11.0 have been reported in obese patients for sternal wound infection. Our data are consistent with the prevailing literature and likely reflect a multifactorial process due to prolonged operative times, higher incidence of renal insufficiency, as well as diabetes mellitus in obese patients. Similarly, harvest site surgical infection rates of 2.4–4.5% have been described in various reports, and therefore, our study corroborates the
Table 2

variables (tiary-care referral center and may have been affected by refer-
analysis. Our results represent the experience of a single, ter-
interpreting the clinical outcomes presented in the current
isolation (and the absence of aortic clamp times in patients undergoing
for re-operation for bleeding complications in obese patients, leading to an apparent decrease in the need
for re-operation due to bleeding in obese individuals. This association has
been described previously, but the reason remains largely unexplored.21,25,58
Although not proven, it may be related to
the procoagulant state seen in metabolic syndrome and obe-
sity characterized by higher levels of clotting factors (fibrino-
gen, tissue factor and Factor VII), inhibition of fibrinolytic
pathways (increased plasminogen activator inhibitor-1 and
decreased tissue plasminogen activator activity) and greater
platelet aggregability due to the presence of hyperlipidemia
and the endothelial dysfunction that is frequently encountered
in obese patients.59,60,62
These characteristics of obesity could explain both the decreased incidence of bleeding complications and the decreased need for re-operation from bleeding
complication in obese patients, although the possibility that the treating surgeons may have a higher threshold for returning
obese patients to the operating room compared with non-
obese patients, leading to an apparent decrease in the need
for re-operation for bleeding complications in obese patients,
cannot be completely ruled out.

Table 1

baseline risk factors and demographic variables by perform-
ing propensity-score matching (Table 2). Since propensity-
score matching is also performed on known variables, there
remains the possibility of confounding unaccounted for by
propensity matching. Another potential limitation is the use
of BMI as a surrogate marker for obesity. BMI may not be
the best measure of body fat content and truncal obesity.
Waist circumference or the waist-to-hip ratio may be a better
measure of obesity,54 but these data were not available in our
database. This may in part be responsible for the lack of asso-
ciation between obesity and the primary outcome of postop-
erative mortality. Other limitations inherent to retrospective
chart review include the possibility of incomplete data cap-
ture and a dependency on previously recorded data in the
chart, where the quality may be limited by systematic or
recorder bias. However, the use of trained chart abstractors
with written definitions of each variable and outcomes, very
strict quality standards, and data checks maintained by the
database used for our analyses may reduce this bias. The
strengths of the current analyses include the strict quality
standards maintained by the THIRDBase and the large num-
ber of patients undergoing CAGB used in our analyses (one
of the largest reported series), as well as carefully carried out
regression and propensity-score matched analyses.

In this retrospective propensity-matched cohort analysis, obesity was associated with a higher perioperative mor-
bidity, including respiratory failure, renal insufficiency and
higher risk of surgical site infections. However, obesity was
not associated with early (in-hospital) mortality in patients
undergoing isolated CAGB. Obese patients were found to
have lower odds for postoperative bleeding and the need
for re-operation for bleeding, a finding that needs further explo-
ration.

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Disclosures

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Outcome After Isolated CABG in Obese Individuals


