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Relationship of Body Mass Index With Total Mortality, Cardiovascular Mortality, and Myocardial Infarction After Coronary Revascularization: Evidence From a Meta-analysis

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Abstract

Objective: To investigate the relationship of body mass index (BMI) with total mortality, cardiovascular (CV) mortality, and myocardial infarction (MI) after coronary revascularization procedures (coronary artery bypass grafting [CABG] and percutaneous coronary intervention [PCI]).

Patients and Methods: Systematic search of studies was conducted using PubMed, CINAHL, Cochran CENTRAL, Scopus, and the Web of Science databases. We identified studies reporting the rate of MI, CV mortality, and total mortality among coronary artery disease patients' postcoronary revascularization procedures in various BMI categories: less than 20 (underweight), 20-24.9 (normal reference), 25-29.9 (overweight), 30-34.9 (obese), and 35 or more (severely obese). Event rates were compared using a random effects model assuming interstudy heterogeneity.

Results: A total of 36 studies (12 CABG; 26 PCI) were selected for final analyses. The risk of total mortality (relative risk [RR], 2.59; 95% CI, 2.09-3.21), CV mortality (RR, 2.67; 95% CI, 1.63-4.39), and MI (RR, 1.79; 95% CI, 1.28-2.50) was highest among patients with low BMI at the end of a mean follow-up period of 1.7 years. The risk of CV mortality was lowest among overweight patients (RR, 0.81; 95% CI, 0.68-0.95). Increasing degree of adiposity as assessed by BMI had a neutral effect on the risk of MI for overweight (RR, 0.92; 95% CI, 0.84-1.01), obese (RR, 0.99; 95% CI, 0.85-1.15), and severely obese (RR, 0.93; 95% CI, 0.78-1.11) patients.

Conclusion: After coronary artery disease revascularization procedures (PCI and CABG), the risk of total mortality, CV mortality, and MI was highest among underweight patients as defined by low BMI and CV mortality was lowest among overweight patients.

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Obesity is a global epidemic and is associated with multiple cardiovascular (CV) diseases (CVDs).[1-3] One-third of adult Americans suffer from obesity, and its prevalence has continued to increase over the past few decades.[4] Obesity has been established as an independent risk factor for coronary artery disease (CAD).[5,6] Because of the high prevalence of CAD, overweight and obese patients more frequently undergo revascularization procedures—percutaneous coronary intervention (PCI) and/or coronary artery bypass graft (CABG) operation. Results from different population-based registries and databases have reported the prevalence of overweight and obesity to be as high as 70% among patients undergoing revascularization procedures.[7] Various postoperative risk stratification systems have described obesity as a risk factor for worse clinical outcomes after CAD revascularization operation due to the increased rate of postoperative wound infection, longer hospital stay, and higher postoperative mortality among obese patients.[8-10] The CABG operation is often postponed in obese patients because of presumed poor postprocedural outcomes in this subset of patients. However, recent studies have indicated a protective effect of obesity and reported lower mortality and morbidity among obese patients than among normal-weight patients.[11-14] This

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phenomenon has been referred to as the *obesity paradox*.

Because of contradictory results in various studies describing the association between body mass index (BMI; calculated as the weight in kilograms divided by the height in meters squared) and all-cause mortality, it is not clear whether the obesity paradox exists for patients undergoing PCI, CABG, or both. Furthermore, the risks of CV mortality and myocardial infarction (MI) among patients undergoing coronary revascularization procedures are not fully understood. In the present study, we systematically review the available evidence examining the association between the most commonly used anthropometric parameter to assess the degree of adiposity, namely, the BMI, with all-cause mortality, CV mortality, and MI in patients with established CAD undergoing PCI or CABG.

METHODS

Study Design

Meta-analysis was performed in accordance with the Meta-Analysis of Observational Studies in Epidemiology (MOOSE) guidelines.[15] A checklist of each of the MOOSE criteria and how they were handled in our study is contained in the Supplemental Appendix Table (available online at http://www.mayoclinicproceedings.org).

Data Sources

We systematically searched PubMed, CINAHL, Cochran CENTRAL, Scopus, and Web of Science databases for all studies that reported total mortality, CV mortality, and CVD events on the basis of body weight or other estimates of fat distribution. All relevant combinations of the following keywords related to body mass (eg, body mass index, body weight, obesity, overweight, and central obesity), total mortality and CVD outcomes (eg, cardiac death, CV death, mortality, and revascularization), and presence of CAD (MI, CABG, CAD, cardiac disease, PCI, balloon angioplasty, coronary stent) were included for database search. The search was conducted from the inception of these databases to July 31, 2013. Studies in English, German, Spanish, and French were selected.

Study Selection

Clinical studies were included if the studies met the following inclusion criteria: (1) studies that included patients with CAD (identified on the basis of a history of PCI, CABG, or MI) at baseline—those studies in which CAD was identified on the basis of results of noninvasive tests or history were not included; (2) studies that reported measures of mortality and CVD events (infarction/MI rates, total mortality rates, and CV mortality rates) based on BMI.

The most common estimate of adiposity was BMI, so we identified only those studies in which events were expressed with respect to BMI. There was inconsistency across studies in the classification of patient sample on the basis of BMI, with various studies reporting outcomes with different BMI cutoffs. Therefore, we classified the patient sample into the following groups: the low-BMI group—BMI lower than 20 kg/m^2; the normal-BMI group—BMI similar or close to 20 to 24.9 kg/m^2; the overweight group—BMI similar or close to 25 to 29.9 kg/m^2; the obese group—BMI similar or close to 30 to 34.9 kg/m^2; and the severely obese group—BMI equal to or more than 35 kg/m^2.

Data Extraction

Two independent reviewers (A.S. and A.V.) screened the titles and abstracts for relevance. Discrepancies between reviewers were discussed until consensus was reached. The articles of selected titles/abstracts were reviewed for inclusion and authors were contacted if additional data were needed. Using the above-mentioned selection criteria, these 2 reviewers independently determined the articles to be included and excluded, and data from the relevant articles were extracted using predefined extraction forms. Any disagreements in data extraction were discussed until consensus was reached. Events were added for studies that reported the outcome separately for patients with BMI 35 to 39.9 and for patients with BMI 40 or more and pooled as severe obese ($\geq$35).

Statistical Analyses

The statistical analyses were performed according to recommendations from the Cochrane Collaboration using Review Manager (version 5.2, The Nordic Cochrane Center, The Cochrane Collaboration, 2012). A random effects model with inverse variance weighting was used to calculate pooled relative risks (RRs) and 95% CI. We assessed the 3 outcomes—total mortality, CV mortality, and MI (or reinfarction for