



Major article

Influence of high body mass index on mortality and infectious outcomes in patients who underwent open gastrointestinal surgery: A meta-analysis



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Key Words:

Hospital-acquired infection
BMI

Background: The influence of high body mass index (BMI) on mortality and infectious outcomes of patients following open gastrointestinal surgery was unclear. This meta-analysis aimed to resolve this controversy.

Methods: PubMed and EMBASE were searched by 2 researchers. High and normal BMIs were defined as ≥ 25 and 18.5–24.99, respectively. Odds ratios (ORs) were calculated to compare the pooled effect sizes. The primary outcome was mortality. The secondary outcome was infectious outcomes, including surgical site, pulmonary infections, and urinary tract infections.

Results: Eleven eligible articles with 51,307 patients total were included. Compared with normal BMIs, high BMIs did not increase the risk of mortality (OR, 0.78; 95% confidence interval [CI], 0.58–1.06; $P = .12$). The secondary outcome indicated a significantly higher risk of infectious outcomes in high-BMI patients (OR, 1.34; 95% CI, 1.13–1.58; $P = .0007$). Among high-BMI patients, the risks of surgical site infections (OR, 1.75; 95% CI, 1.33–2.3; $P < .0001$) and pulmonary infections (OR, 1.2; 95% CI, 1.02–1.40; $P = .03$) increased significantly; urinary tract infections (OR, 1.10; 95% CI, 0.92–1.31; $P = .30$) did not show statistical difference.

Conclusions: High BMI was associated with higher risks of infectious outcomes, including surgical site infections and pulmonary infections after open gastrointestinal surgery, but no association was observed between high BMI and urinary tract infections.

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Body mass index (BMI), defined as weight (in kilograms)/height (in meters²),¹ is a simple, standard anthropometric index of a patient's nutritional status² that is widely used in hospitals. A high BMI, which is defined as a BMI > 25 , is gaining attention as an epidemic in developed countries. According to the World Health Organization (WHO) recent reports, 39% of adults aged 18 years and older were overweight in 2014, and 13% were obese.³ Open gastrointestinal surgery usually hinders or decreases a patient's nutritional intake. Vomiting, diarrhea, malabsorption before operation and insufficient nutrition following surgery could eventually

weaken the immune system and increase the risk of postoperative complications.

High-BMI patients are more likely to have thicker fat in their abdominal area, and might experience sagging skin and fat liquefaction after open gastrointestinal surgery. Additionally, a study⁴ has shown that more visceral fat is associated with significantly higher rates of postpancreatic surgery complications. Relating to these factors, there could be more postoperative infectious complications among high-BMI individuals undergoing gastrointestinal surgery, which could cause enormous economic losses to the patients and increase the length of the hospital stay.^{5–9} However, studies within the general surgery literature had mixed results with regard to postoperative outcomes associated with high BMI. Some studies showed an increased risk of mortality and infectious outcomes for high-BMI patients;^{10,11} the reasons included increased operative time and difficulty,⁷ whereas others failed to find this link^{5,8} and some studies even found that mortality of patients was lower in slightly to

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moderately high-BMI patients than normal-BMI patients, which indicated a viewpoint of the so-called obesity paradox.^{9,12,13} Therefore, it is necessary to reestimate the influence of high BMI on postoperative mortality and infectious outcomes.

The aim of our meta-analysis was to investigate the relationships between high BMI and mortality and infectious outcomes in patients who underwent open gastrointestinal surgery.

MATERIALS AND METHODS

Literature search strategy

The PubMed and EMBASE databases were searched from their earliest records to February 18, 2015. The following key words, Boolean operators, and medical subject headings (MeSH) terms (the asterisk symbol was used for truncation) were used: *BMI* OR *body mass index*, *postoperative complications* (MeSH terms) OR *infectious outcomes* OR *postoperative outcomes*, *digestive system surgical procedures* (MeSH terms) OR *gastrointestinal surgery* OR *gastric surgery* OR *intestinal surgery* OR *colon surgery*. Two reviewers scanned the titles and abstracts to find potentially appropriate articles. We also searched the reference lists of all the identified full-text articles to include as many relevant articles as possible. There were no type or language restrictions. We did not contact authors to obtain unpublished manuscripts.

Selection criteria

We scanned all titles and abstracts. The following criteria were used to select articles: human subjects; cohort design; BMI stratification was in accordance with the WHO definition with cut-points at underweight (<18.5), normal weight (18.5–24.99), overweight (25–29.99), and obese (≥ 30); patients did not use chemotherapy or radiotherapy; gastrointestinal surgery included gastric, duodenal, small intestine, colon, and nonperforated appendix surgery; and clear definitions and diagnoses of surgical site infection (SSI), pulmonary infection, and urinary tract infection (UTI).

Exposure definition

BMI was divided into 2 groups: normal BMI (18.5–24.99) and high BMI (≥ 25), based on our belief that compared with normal-BMI patients, high-BMI individuals may have higher risks of contracting nosocomial infections. Postoperative mortality and infectious outcomes were defined as occurring within 30 days after surgery. In this meta-analysis, we used mortality, infectious outcomes, SSI, pulmonary infection, and UTI as indicators to evaluate the pooled effects. Infectious outcomes contained all kinds of infections that occurred among the included patients in each research, not only the 3 infection sites mentioned above. SSI was defined in accordance with the Centers for Disease Control and Prevention,¹⁴ which included superficial, subcutaneous cellular tissue, and organ space infections. The pulmonary infections and UTI definitions were based clinical manifestations, laboratory tests, and imaging studies such as radiograph or chest computed tomography scans.¹⁵ Infection diagnosis was confirmed by patient medical records, doctor's office records, or telephone interviews with patients. This article followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.¹⁶

Data extraction

The data were extracted from each article by 2 reviewers (YHL and XHW) separately according to the selection criteria. Disagreements were resolved through discussion or by a third person (SHW).

The extracted data included the first author, publication year, study design, number of patients, number of female and male patients, patient age, type of surgery, observed population, and 2 BMI stratification criteria with the corresponding number of patients.

Risk of bias

The risk of bias was assessed using the Newcastle–Ottawa scale (NOS) by 2 independent reviewers (YHL and XHW). There were 3 dimensions that included selection, comparability, and exposure, and 8 items in the NOS. In selection dimension, there were 4 items assessing the representation and the selection methods of included individuals, the methods of determining exposure, and whether there were outcomes when research started. There was only 1 item about the comparability between exposed and unexposed groups in comparability dimension. In exposure dimension, 3 items were used in terms of whether the results were fully evaluated, whether the follow-up time was enough, and whether follow-up number was sufficient. The studies were evaluated regarding 3 major aspects: selection, comparability, and exposure worth 4, 2, and 3 stars, respectively. The highest possible score was 9 stars. Studies with more than 7 stars were considered high quality. Disagreements were resolved by discussion or via a third person (SHW). Overall, the agreement rate was 0.80.

Statistical analysis

We used Review Manager 5.2 (Cochrane Collaboration, London, United Kingdom) software to perform the data analysis. Odds ratios (ORs) were calculated to compare the pooled effect sizes. Heterogeneity was calculated using χ^2 and I^2 statistical testing methods. A low degree of heterogeneity was indicated by $P > .1$ or $I^2 < 25\%$; otherwise, $P < .1$ or $I^2 > 50\%$ indicated a moderate or high degree of heterogeneity. Fixed effects models were implemented when the heterogeneity was low and random effects models were used when heterogeneity was high. A funnel plot was used to visually test for publication bias. A sensitivity analysis was also performed to test the source of heterogeneity and the stability of the results. Because of different indicators assessed by each article, our research indexes included various number of articles depending on whether an individual study evaluated these items.

RESULTS

Search results

A total of 1,375 publications were identified by searching electronic databases and references, including 1,320 from PubMed, 33 from EMBASE, and 22 from reference lists. After removing duplicates, 1,282 articles remained. Then, 1,262 articles were excluded based on the selection criteria, including 49 reviews, 6 animal studies, 53 case reports, and another 1,154 articles that did not meet the inclusion criteria. The remaining 20 articles were assessed by reading the full texts. Of these, 11 articles were eligible and were assessed for quality using the NOS. Finally, 11 studies were included in the quantity analysis and meta-analysis. A flowchart of this process is provided in Figure 1.

Descriptions of the included studies

The primary study characteristics were cohort design; sample size range from 50–30,765; and publication year from 2004–2014. The surgery types included procedures for gastric cancer, Crohn's disease, nonperforated appendicitis, intestinal abnormalities, digestive tract abnormalities, and colon cancer. The BMI data were

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