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Review article

The impact of bariatric surgery on pulmonary function: a meta-analysis

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Abstract Morbid obesity may affect several body systems and cause ill effects to the cardiovascular, hepatobiliary, endocrine, and mental health systems. However, the impact on the pulmonary system and pulmonary function has been debated in the literature. A systematic review and meta-analysis for studies that have evaluated the impact of bariatric surgery on pulmonary function were pooled for this analysis. PubMed, Cochrane, and Embase databases were evaluated through September 31, 2016. They were used as the primary search engine for studies evaluating the impact pre– and post–bariatric surgery on pulmonary function. Pooled effect estimates were calculated using random-effects model. Twenty-three studies with 1013 participants were included in the final meta-analysis. Only 8 studies had intervention and control groups with different time points, but 15 studies had matched groups with different time points. Overall, pulmonary function score was significantly improved after bariatric surgery, with a pooled standardized mean difference of .59 (95% confidence interval: .46–.73). Heterogeneity test was performed by using Cochran's Q test ($I^2 = 46\%$; P heterogeneity = .10). Subgroup analysis and univariate meta-regression based on study quality, age, presurgery body mass index, postsurgery body mass index, study design, female patients only, study continent, asthmatic patients in the study, and the type of bariatric surgery confirmed no statistically significant difference among these groups (P value > .05 for all). A multivariate meta-regression model, which adjusted simultaneously for these same covariates, did not change the results (no statistically significant P .05). Assessment of publication bias was done visually and by Begg's rank correlation test and indicated the absence of publication bias (asymmetric shape was observed and $P = .34$). This meta-analysis shows that bariatric surgery significantly improved overall pulmonary functions score for morbid obesity. (Surg Obes Relat Dis 2017;∎:00–00.) © 2017 American Society for Metabolic and Bariatric Surgery. All rights reserved.

Keywords: Morbid obese; Bariatric surgery; Pulmonary function; Meta-analysis

The obesity epidemic is increasing worldwide both in developed and developing countries. For example, in 2008, it was documented that 1.4 billion adults were considered overweight [1]. Every second, the earth grows in population by 2.5 people, and 1 in 2.5 people will be obese or

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overweight [2]. In the United State alone, obesity has increased at an alarming rate and currently approximately 35.7% of the adult population was defined as obese between 2009 and 2010 [2]. Data from the Framingham heart study indicates that the incidence of obesity has increased by 20% in men and 25% in women in each decade [3]. Also, by looking at the U.S. healthcare expenditure, approximately 16.5% is spent annually on treating obesity and related comorbidities [4]. In 1998, the U.S. health system spent approximately $78.5 billion on obesity; 10 years later, this number had doubled to $147 billion [5].

Obesity has been associated with increased risk of incident asthma and a reduction in the compliance of the total respiratory system [6]. A study showed that obesity increased the odds of incident asthma by 50% [6]. In addition, the risk of respiratory problems increased further as weight increases. Obesity can affect the response to obstructive lung disease treatment [7]. It has been proven that obesity can affect several body systems, such as the cardiovascular and central nervous system, resulting in fatty liver, type 2 diabetes, depression, hypertension, dyslipidemia, and some forms of cancer [8,9]. Lately, researchers have given special attention to the effect of obesity on the respiratory system. It was found that the misdistribution of the fat mass is the determining force in the reduction on pulmonary function [10]. The real concern is, if obesity correlates with a reduction in respiratory function, what changes occur in respiratory function after weight reduction surgery?

To answer this question with concrete conclusions, a systematic review and meta-analysis for studies that evaluated the impact of bariatric surgery on pulmonary function were pooled for analysis. The objective of the present study is to evaluate the effect of weight reduction surgeries on pulmonary function. This will help health practitioners gain a better understanding of the magnitude of the effect, whether these effects are modified by important covariates (existence of heterogeneity).

Methods

Literature search

PubMed, Cochrane, and Embase, from the beginning of all databases to September 31, 2016 were used as the primary search engines for studies evaluating the impact pre– and post–bariatric surgery on pulmonary function. Suitable MeSH terms, Emtree terms and (tw), text word keyword, were used in the PubMed, Embase, and Cochrane searches (Appendix 1). Reference lists of selected articles were examined to ensure all relevant articles published through September 2016 were identified.

Study selection

Studies were considered in the meta-analysis if they met the following inclusion criteria: (1) quasiexperimental studies (1-group pretest–posttest) and observational studies (cohort, case control trials) conducted on morbid obesity; (2) patients were ≥18 years old with initial body mass index (BMI) ≥35 and had undergone bariatric surgery (all types); (3) pulmonary function tests pre- and postsurgery by using spirometry with at least a 3-month gap between the pre- and postmeasurement; and (4) sample size of ≥10 patients. Non-English articles were excluded. All titles and abstracts were screened, and potentially relevant articles were selected for full-text screening. The full-text screening was conducted independently by 2 authors (A.D., A.A.) and any disagreements were resolved by consultation with the senior author (T.E.). Meta-analyses of Observational Studies in Epidemiology (https://www.editorialmanager.com/jognn/account/MOOSE.pdf) guidelines were used. The quality of the included studies was evaluated using Newcastle-Ottawa Scale (NOS) [11].

Data extraction

The following information for each study was extracted: study characteristics (authors, publication year, country of origin, sample size, study design, continent, and months of follow up); participant characteristics (sex, age, smoking, asthmatic, chronic obstructive pulmonary disease, and sample size); characteristics of the intervention (bariatric surgery type, pre- and postsurgery BMI, waist circumference); characteristics of the outcome (forced expiratory volume in the first second [FEV_1], forced vital capacity [FVC], total lung capacity [TLC], functional residual capacity [FRC], expiratory reserve volume [ERV], and residual volume [RV], partial pressure of oxygen dissolved in the blood [PaO_2], and oxygen [O_2] saturation, and gas diffusing capacity that analyzed by diffusing capacity of the lung for carbon monoxide test [DLCO]). Two investigators conducted the data extraction independently (A.D., A.A.).

Data analysis

Comprehensive meta-analysis Version 3 (Biostat, Inc., Englewood, NJ, USA) was used to perform data analysis. In general, there are 2 statistical models in meta-analysis. First, the fixed-effect model assumes that effect size is sampled from fixed and common population [12]. However, the DerSimonian–Laird random-effects model assumes that effect size is sampled from a population of universal effect size. Therefore, the choice between these models was based on our understanding of the sampling frame among included studies in this meta-analysis [12]. Thus, a random-effects model was used in this study. Also, mean difference was used to show the effect size in this meta-analysis. However, studies assessed the same outcome (pulmonary function tests) but measured it in a variety of ways. Therefore, standardized mean difference (Cohen's D) was used for combining continuous data as a summary