Review Article



# A systematic review on the association between body mass index and autologous breast reconstruction

**Nicolai Lassen Frid, Elisabeth Lauritzen, Tine Engberg Damsgaard**

Department of Plastic Surgery and Burns Treatment, Rigshospitalet and Institute of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark

*Contributions:* (I) Conception and design: NL Frid, TE Damsgaard; (II) Administrative support: NL Frid, TE Damsgaard; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: NL Frid; (V) Data analysis and interpretation: NL Frid; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Nicolai Lassen Frid, MD. Department of Plastic Surgery and Burns Treatment, Rigshospitalet and Institute of Clinical Medicine, University of Copenhagen, Inge Lehmanns Vej 8, 2100 Copenhagen, Denmark. Email: Nicolai.Lassen.Frid.01@regionh.dk.

**Background:** The incidence of breast cancer is increasing, and the prevalence of obesity is rising. The aim of the study was to investigate the association between body mass index (BMI, kg/m$^2$) and postoperative complications at the recipient site among women who have had autologous breast reconstruction based on free abdominal flaps. Furthermore, the aim is to investigate whether there is a BMI threshold where autologous breast reconstruction may not be recommended.

**Methods:** Medline/PubMed and EMBASE via OVID were searched using relevant terms. The literature was assessed using the PRISMA guideline. All studies reporting recipient site complications after autologous breast reconstruction, using either deep inferior epigastric artery perforator flap, superficial inferior epigastric artery flap, muscle-sparing or free transverse rectus abdominis musculocutaneous (TRAM) flap were included. BMI was stratified according to World Health Organization (WHO) classification and furthermore defined as obese (BMI ≥30 kg/m$^2$) and non-obese (BMI <30 kg/m$^2$). Data regarding postoperative outcomes were combined for pooled analyses. Strengthening the reporting of observational studies in epidemiology (STROBE) statement was used for a combined quality and bias assessment.

**Results:** Twenty studies met the inclusion criteria, encompassing a total of 10,514 patients and 11,458 flaps. Pooled analyses showed significant increased minor- and major complication rates and loss of reconstruction when compared the obese to the non-obese group. Stratifying BMI according to WHO criteria revealed significantly higher odds ratio (OR) for minor complications for all groups of obesity when compared to the normal weight group. The risk of loss of reconstruction was significantly higher in the class III obese group when compared to the normal weight.

**Conclusions:** In the autologous breast reconstructive population, obese patients (BMI ≥30 kg/m$^2$) have an increased risk of both minor- and major complications, as well as loss of reconstruction when compared to the non-obese population (BMI <30 kg/m$^2$). Stratifying levels of obesity according to WHO's BMI criteria shows increased OR for minor complications in all groups. However, autologous breast reconstruction may still be a viable option for this population. This study may be limited due to the heterogeneity of the included flaps and the quality of the included studies.

**Keywords:** Breast reconstruction; body mass index (BMI); postoperative complications; autologous breast reconstruction

Received: 21 June 2023; Accepted: 13 October 2023; Published online: 03 November 2023.
doi: 10.21037/abs-23-46
**View this article at:** https://dx.doi.org/10.21037/abs-23-46

## Introduction

Breast cancer (BC) is the most common type of cancer in women worldwide (1,2). The incidence of BC is increasing in both the developed and the developing world (1,2). Furthermore, the prevalence of obesity is rising, which has been shown to have a negative prognostic impact on BC in women. Obesity is also a known risk factor for developing BC among postmenopausal women (3-8). Obesity increases the risk of venous thromboembolism and the obese population has a greater risk for surgical site infection and slower healing because of the reduced blood flow in fat tissue (9-12).

The treatment of BC has the highest priority. Due to significant improvement in diagnosis and surgical-, medical- and therapeutic treatment, BC is no longer the main cause of cancer death in Europe (2,13). Surgical intervention is the primary regional and local treatment, with breast conserving surgery (BCS), sentinel lymph node biopsy (SLNB) and mastectomy as some of the treatment modalities (14,15).

Body mass index (BMI) is one of the simplest measures for screening for obesity. It is limited due to the lack of distinguishing between excess body fat, muscle or bone mass, and not including factors such as sex and ethnicity. Compared to more precise ways to calculate body fat, as dual energy X-ray (DEXA) and magnetic resonance imaging (MRI), BMI has its advantages regarding cost efficiency, accessibility and internationally usage as initial screening of overweight and obesity for adults (16,17).

Decision to perform mastectomy depends on tumor and breast size, recurrence of tumor, presence of Breast Cancer (*BRCA*) gene mutation and type of carcinoma. In addition to the psychological and emotional distress the patient experiences, women undergoing mastectomy may also suffer psychosocial distress due to body image distortions.

Trends in a nationwide study in the United States, show rates of breast reconstruction in women undergoing mastectomy have increased from 11.6% in 1998 to 36.4% in 2011 (18). In Europe however, trends show lower rates of both immediate and delayed breast reconstruction in comparison to the total number of mastectomies, and a decrease in mastectomy rates (19,20). The advances in the surgical management of BC has led to a growing preference for a more conservative approach (21).

Health-related quality of life (HRQOL) outcomes comparing patients undergoing either mastectomy or mastectomy and immediate breast reconstruction, shows improved physical and social outcomes in the breast reconstructive group (22-25). Immediate and delayed breast reconstruction have shown improvements in both body image and sexual well-being, therefore alleviating some of the psychosocial challenges related to diagnosis and treatment (26,27).

Improvements in surgical techniques and the development of the free microvascular tissue flap have resulted in more advanced and complex reconstructive options (28). The addition of autologous breast reconstruction to tissue expander/implant-based/acellular matrix-assisted procedures, have provided the patient with a multitude of options for a more natural reconstruction in terms of shape, size and symmetry of the breast. Abdominal based autologous breast reconstruction includes; the pedicled or free transverse rectus abdominis musculocutaneous (TRAM) flap, muscle-sparing TRAM (msTRAM) flap, the free deep inferior epigastric perforator (DIEP) flap and the superficial inferior epigastric artery (SIEA) flap. BMI (kg/m$^2$) is among several important factors when planning surgery and in deciding the most suitable breast reconstruction for the individual patient.

This study aims to investigate the association between BMI and postoperative complications at the recipient site (i.e., the breast) among women undergoing autologous

### Highlight box

**Key findings**

- In the autologous breast reconstructive population, obese patients [body mass index (BMI) ≥30 kg/m$^2$] have an increased risk of both minor and major complications, as well as loss of reconstruction when compared to the non-obese population (BMI <30 kg/m$^2$).
- Stratifying levels of obesity according to World Health Organization (WHO)'s BMI criteria shows increased odds ratio for minor complications in all groups. Loss of reconstruction is drastically increased when BMI ≥40 kg/m$^2$.

**What is known and what is new?**

- Obesity is associated with increased complication rates.
- Despite the increased risk of minor complication in the obese groups, autologous breast reconstruction may still be a valid option for the obese population in selected cases.

**What is the implication, and what should change now?**

- Considering the high rates of complications among patients with a BMI exceeding 30 kg/m$^2$ who undergo breast reconstruction, it is advisable to provide thorough counselling about the risks and possible delay in reconstruction until weight loss has been achieved.

breast reconstruction with free abdominal-based flaps.

Immediate- and delayed breast reconstruction with TRAM, msTRAM, DIEP and SIEA flaps were reviewed. BMI were stratified by World Health Organization (WHO) classification investigating any statistical differences in complication rates among the BMI categories.

Based on complication rates, we sought to investigate if a possible BMI threshold for not recommending autologous breast reconstruction in the obese population.

Furthermore, the aim is to investigate differences between the obese and non-obese patients with respect to recipient site complications. We present this article in accordance with the PRISMA reporting checklist (29) (available at https://abs.amegroups.com/article/view/10.21037/abs-23-46/rc).

## Methods

### *Search strategy*

Adhering to the PRISMA guidelines, a systematic search of Medline via PubMed and EMBASE via OVID were performed in December 2020 and updated in September 2022. Databases were searched using the following keywords: "BMI" OR "Body Mass Index" AND "Mammaplast" OR "Breast reconstruction" OR "Autologous breast reconstruction" AND "DIEP" OR "Deep inferior epigastric perforator" OR "SIEA" OR "Superficial inferior epigastric artery" OR "TRAM" OR "Transverse rectus abdominis musculocutaneous" OR "Flap" OR "Surgical flaps" AND "Complication" OR "Postoperative" OR "Post operative" OR "Post operative complications" OR "Outcome" OR "Treatment outcome".

"Body Mass Index", "Mammaplasty", "Surgical flaps" and "treatment outcome" were used as Medical Subject Headings (MeSH) terms at the PubMed database.

### *Inclusion and exclusion criteria*

All studies, without date limitation, reporting recipient site complications after autologous breast reconstruction, using free abdominal flaps, either DIEP, msTRAM, TRAM and SIEA flaps and evaluating outcomes based on BMI were included.

Studies not specifying type of autologous breast reconstruction and/or if outcomes were only reported on donor-site were excluded (30). Also, studies not stratifying BMI according to WHO criteria or pairing in a BMI <30 and ≥30 kg/m$^2$ group were excluded (31,32).

BMI stratification was defined according to WHO classification; normal weight (BMI 18.5–24.9 kg/m$^2$), overweight (BMI 25–29.9 kg/m$^2$), class I obese (BMI 30–34.9 kg/m$^2$), class II obese (BMI 35–39.9 kg/m$^2$) and class III obese (BMI ≥40 kg/m$^2$). Furthermore, as obese (BMI ≥30 kg/m$^2$) and non-obese (BMI <30 kg/m$^2$) (33,34).

### *Outcome measures*

The primary outcome measures were grouped as 'minor complications', 'major complications' and 'loss of reconstruction'. Minor complications were classified as complications treated conservatively, and not requiring any surgical intervention. Major complications were defined as complications requiring surgical intervention in local or general anesthesia as well as loss of reconstruction. Loss of reconstruction was defined as the number of total flap failures.

In addition, patient demographics, timing of reconstructive procedure (immediate or delayed), staging, and follow-up periods were recorded.

Hematoma, partial flap loss, mastectomy skin loss (wound edge necrosis, marginal necrosis, mastectomy flap necrosis), thrombosis, revision, re-exploration and microsurgical were categorized as major complications.

If a study did not specify treatment of complications, and were not suitable for the definition of major complications, they were categorized as minor complications.

### *Study selection and data extraction*

One thousand one hundred and ninety-four studies were retrieved with 756 articles left after removing duplicates. Six hundred and seventeen were excluded after screening title and abstract, 119 papers were excluded after full text readthrough, leaving 20 studies to be included for analyses (*Figure 1*).

Data were extracted from the included studies according to BMI and predefined outcome measures. The authors agreed on the data extracted.

### *Statistical analysis*

Statistical analysis was performed using R version 1.2.5033 and Microsoft Excel 2010 version 16.40. Data were combined for pooled analysis. Data were both extracted as complication per breast and per woman. If a study did not report 1 of the 3 outcomes, it was excluded from the subgroup analysis. Categorical variables were summarized and compared using

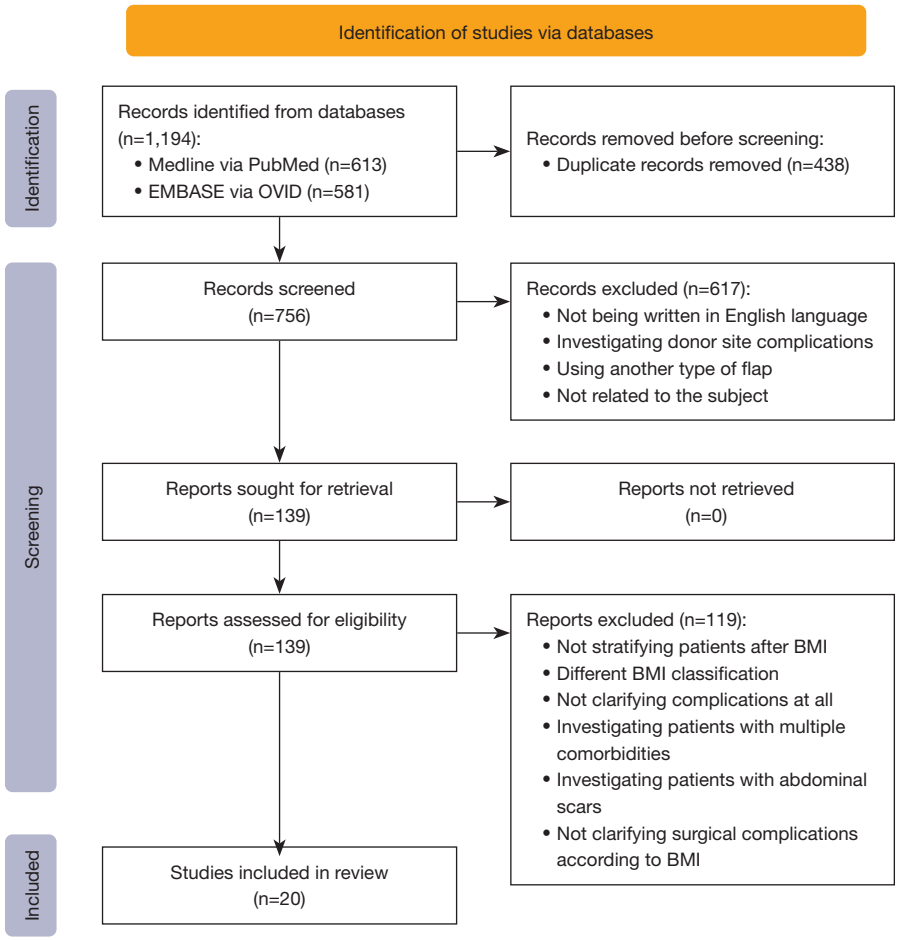


**Figure 1** PRISMA flow chart. BMI, body mass index.

Pearson's Chi-squared and Fisher's exact tests. Statistical significance was set at a P value of <0.05.

### *Risk of bias in individual studies and level of evidence*

Strengthening the reporting of observational studies in epidemiology (STROBE) statement was used for a combined quality and bias assessment of all included observational studies (35). The individual studies were assessed by the author within each domain and classified as sufficient (+) or insufficient (–). Based on the individual judgments, each study was given an overall risk of bias: low risk, moderate risk or serious risk.

Each of the included papers were rated according to the American Society of Plastic Surgeons (ASPS) Levels of Evidence Scale (36). The higher the level, the more reliable results and the more valid conclusions to be drawn from the paper.

## Results

### *Study characteristics*

Twenty studies with a total of 10,514 patients and 11,458 flaps were included for the analysis (*Table 1*).

Mean age was 50.7 years, stated in 18 papers, ranging from 45.3 to 53.6 years (37-53,55), and current smokers status varied from 0% to 15.2% (46,54). As for the timing of reconstruction, 1 study included delayed breast reconstruction (38), 16 included both immediate and delayed reconstruction and 3 studies did not specify the timing of reconstruction (54-56). One study stratified complications by BMI and immediate or delayed reconstruction (51).

Twenty studies (100%) reported the incidence of major complications and loss of reconstruction, 3 studies (15%) did not report minor complications (39,41,54).

Of the 20 included studies, 4 reported on unilateral breast

**Table 1** Summary of included studies and data

| Authors (year published, country/region, level) | Study design | No. patients/flaps (type of flap) | Summary of data included in WHO BMI classification | | | | | Summary of data included in BMI <30 *vs.* ≥30 kg/m$^2$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BMI (kg/m$^2$) | Women [breasts] | Minor | Major | Loss of reconstruction | BMI (kg/m$^2$) | Women [breasts] | Minor | Major | Loss of reconstruction |
| Patterson *et al.* (2022, USA, III) (37) | Rc | 219/306 [306 DIEP (132 unilateral, 174 bilateral)] | 30–34.9 | 125 [174] | 42 | 25 | 1 | ≥30 | 219 [306] | 83 | 55 | 3 |
| | | | 35–39.9 | 49 [69] | 17 | 15 | 1 | Total | 219 [306] | 83 | 55 | 3 |
| | | | ≥40 | 45 [63] | 24 | 15 | 1 | | | | | |
| | | | Total | 219 [306] | 83 | 55 | 3 | | | | | |
| Palve *et al.* (2022, Finland, III) (38) | Rc | 308/308 (308 DIEP (unilateral)] | <25 | 104 [104] | 13 | 16 | 0 | <30 | 246 [246] | 34 | 41 | 0 |
| | | | 25–29.9 | 142 [142] | 21 | 25 | 0 | ≥30 | 62 [62] | 17 | 11 | 0 |
| | | | Total | 246 [246] | 34 | 41 | 0 | Total | 308 [308] | 51 | 52 | 0 |
| Heidekrueger *et al.* (2021, Germany, III)† (39) | Rc | 3,911/4,561 (4,561 DIEP) | <25 | 1,817 [2,047] | NA | 189 | 36 | <30 | 3,227 [3,717] | NA | 345 | 71 |
| | | | 25–29.9 | 1,410 [1,670] | NA | 156 | 35 | ≥30 | 684 [844] | NA | 68 | 21 |
| | | | 30–34.9 | 516 [634] | NA | 50 | 17 | Total | 3,911 [4,561] | NA | 413 | 92 |
| | | | Total | 3,743 [4,351] | NA | 395 | 88 | | | | | |
| Cheng *et al.* (2021, Taiwan, III) (40) | Rc | 415/418 [381 DIEP, 20 SIEA, 17 TRAM (412 unilateral, 3 bilateral)] | 18.5–24.9 | 319 [321] | 45 | 35 | 3 | <30 | 415 [418] | 57 | 47 | 5 |
| | | | 25–29.9 | 96 [97] | 12 | 12 | 2 | Total | 415 [418] | 57 | 47 | 5 |
| | | | Total | 415 [418] | 57 | 47 | 5 | | | | | |
| Munder *et al.* (2020, Germany, III)† (41) | Rc | 1,124/1,274 [1,274 DIEP (974 unilateral, 150 bilateral)] | <25 | 502 | NA | 35 | 3 | <30 | 954 | NA | 105 | 7 |
| | | | 25–29.9 | 452 | NA | 70 | 4 | ≥30 | 170 | NA | 22 | 1 |
| | | | Total | 954 | NA | 105 | 7 | Total | 1124 | NA | 127 | 8 |
| Novak *et al.* (2020, USA, III) (42) | Rc | 66/123 [63 DIEP, 59 msTRAM, 1 TRAM (9 unilateral, 57 bilateral)] | | | NA | | | ≥30 | 66 [123] | 24 | 20 | 4 |
| | | | | | | | | Total | 66 [123] | 24 | 20 | 4 |
| Sultan *et al.* (2020, USA, III)† (43) | Rc | 71/71 (71 DIEP (unilateral)] | <25 | 30 [30] | 15 | 3 | 0 | <30 | 30 [30] | 15 | 3 | 0 |
| | | | Total | 30 [30] | 15 | 3 | 0 | Total | 30 [30] | 15 | 3 | 0 |
| Ochoa *et al.* (2019, USA, II)† (44) | Pcom | 73/130 [130 DIEP (16 unilateral, 57 bilateral)] | <25 | 23 [41] | 8 | 1 | 0 | <30 | 50 [88] | 18 | 4 | 0 |
| | | | 25–29.9 | 27 [47] | 10 | 3 | 0 | ≥30 | 23 [42] | 23 | 2 | 0 |
| | | | 30–34.9 | 15 [27] | 9 | 0 | 0 | Total | 73 [130] | 41 | 6 | 0 |
| | | | Total | 65 [115] | 27 | 4 | 0 | | | | | |
| O'neill *et al.* (2019, Canada, III)† (45) | Rc | 960/1,460 [1460 DIEP (460 unilateral, 500 bilateral)] | <25 | 243 [340] | 14 | 17 | 3 | <30 | 598 [887] | 46 | 42 | 6 |
| | | | 25–29.9 | 355 [547] | 32 | 25 | 3 | ≥30 | 362 [573] | 37 | 41 | 7 |
| | | | Total | 598 [887] | 46 | 42 | 6 | Total | 960 [1,460] | 83 | 83 | 13 |
| Chang *et al.* (2018, USA, IV) (46) | Pc | 72/115 [46 DIEP, 1 SIEA, 67 msTRAM, 1 TRAM (29 unilateral, 43 bilateral)] | | | NA | | | ≥30 | 72 [115] | 21 | 5 | 0 |
| | | | | | | | | Total | 72 [115] | 21 | 5 | 0 |
| Mani *et al.* (2016, England, III)† (47) | Rc | 171/171 [171 DIEP (unilateral)] | <25 | 58 [58] | 15 | 3 | 0 | <30 | 134 [134] | 35 | 9 | 1 |
| | | | 25–29.9 | 76 [76] | 20 | 6 | 1 | ≥30 | 37 [37] | 24 | 4 | 1 |
| | | | Total | 134 [134] | 35 | 9 | 1 | Total | 171 [171] | 59 | 13 | 2 |

**Table 1** *(continued)*

**Table 1** *(continued)*

| Authors (year published, country/region, level) | Study design | No. patients/flaps (type of flap) | Summary of data included in WHO BMI classification | | | | | Summary of data included in BMI <30 *vs.* ≥30 kg/m$^2$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BMI (kg/m$^2$) | Women [breasts] | Minor | Major | Loss of reconstruction | BMI (kg/m$^2$) | Women [breasts] | Minor | Major | Loss of reconstruction |
| Kantak *et al.* (2015, USA, III) (48) | Rc | 381/381 [381 DIEP (unilateral)] | | | NA | | | <30 | 291 [291] | 73 | 38 | 3 |
| | | | | | | | | ≥30 | 90 [90] | 29 | 21 | 2 |
| | | | | | | | | Total | 381 [381] | 102 | 59 | 5 |
| Ozturk *et al.* (2014, USA, III)† (49) | Rc-c | 182/264 [232 DIEP, 6 SIEA, 17 msTRAM, 9 TRAM (100 unilateral, 82 bilateral)] | <25 | 32 [42] | 2 | 5 | 0 | <30 | 119 [169] | 15 | 27 | 2 |
| | | | 25–29.9 | 87 [127] | 13 | 22 | 2 | ≥30 | 63 [95] | 28 | 18 | 1 |
| | | | Total | 119 [169] | 15 | 27 | 2 | Total | 182 [264] | 43 | 45 | 3 |
| Fischer *et al.* (2013, USA, III)† (50) | Rc | 812/1,258 [23,1% DIEP, 5,8% SIEA, 71,1% msTRAM (336 unilateral, 476 bilateral)] | 30–34.9 | 170 [273] | 97 | 3 | 1 | <30 | 540 [830] | 222 | 14 | 10 |
| | | | 35–39.9 | 56 [81] | 33 | 2 | 2 | ≥30 | 272 [428] | 152 | 10 | 7 |
| | | | ≥40 | 46 [74] | 22 | 5 | 4 | Total | 812 [1,258] | 374 | 24 | 17 |
| | | | Total | 272 [428] | 152 | 10 | 7 | | | | | |
| Garvey *et al.* (2012, USA, II) (51) | Rc | NA/548 (162 DIEP, 34 SIEA, 352 msTRAM) | | | NA | | | ≥30 | [548] | 125 | 156 | 8 |
| | | | | | | | | Total | [548] | 125 | 156 | 8 |
| Ochoa *et al.* (2012, USA III) (52) | Rc | 418/639 [639 DIEP (197 unilateral, 221 bilateral)] | <25 | 100 [141] | 24 | 12 | 0 | <30 | 253 [380] | 68 | 26 | 3 |
| | | | 25–29.9 | 153 [239] | 44 | 14 | 3 | ≥30 | 165 [259] | 68 | 12 | 3 |
| | | | 30–34.9 | 113 [181] | 42 | 11 | 3 | Total | 418 [639] | 136 | 38 | 6 |
| | | | 35–39.9 | 45 [68] | 25 | 1 | 0 | | | | | |
| | | | ≥40 | 7 [10] | 1 | 0 | 0 | | | | | |
| | | | Total | 418 [639] | 136 | 38 | 6 | | | | | |
| Jandali *et al.* (2011, USA, III)† (53) | Rc | 404/612 [141 DIEP, 42 SIEA, 431 msTRAM (194 unilateral, 210 bilateral)]‡ | ≥40 | 25 [42] | 11 | 6 | 8 | ≥30 | 25 [42] | 11 | 6 | 8 |
| | | | Total | 25 [42] | 11 | 6 | 8 | Total | 25 [42] | 11 | 6 | 8 |
| Seidenstuecker *et al.* (2011, Germany, IV) (54) | Pc-c | 558/624 [400 DIEP, 224 msTRAM (492 unilateral, 66 bilateral)] | | | NA | | | <30 | 479 [535] | NA | 22 | 2 |
| | | | | | | | | ≥30 | 79 [89] | NA | 13 | 3 |
| | | | | | | | | Total | 558 [624] | NA | 35 | 5 |
| Garvey *et al.* (2005, USA, III)† (55) | Rc | 71/80 [DIEP (62 unilateral, 9 bilateral)] | <25 | 33 [35] | 7 | 4 | 0 | <30 | 59 [65] | 13 | 12 | 3 |
| | | | 25–29.9 | 26 [30] | 6 | 8 | 3 | ≥30 | 12 [15] | 5 | 3 | 0 |
| | | | Total | 59 [65] | 13 | 12 | 3 | Total | 71 [80] | 18 | 15 | 3 |
| Chang *et al.* (2000, USA IV)† (56) | Pc | 718/936 [936 TRAM (76.7% unilateral, 23.3% bilateral)] | <25 | 442 | 46 | 64 | 0 | <30 | 654 | 76 | 113 | 4 |
| | | | 25–29.9 | 212 | 30 | 49 | 4 | ≥30 | 64 | 13 | 20 | 2 |
| | | | Total | 654 | 76 | 113 | 4 | Total | 718 | 89 | 133 | 6 |

Outcome comparison between BMI groups stratified according to 'WHO classification' and in '≥30 kg/m$^2$ (obese) and <30 kg/m$^2$ (non-obese)'. Outcome analyzed per woman and per breast. †, only data compatible to BMI classification excluded from study; ‡, the total number of flaps, as per the information drawn from the article, does not match the sum of the three different types of flaps as stated in the article. DIEP, deep inferior epigastric perforator; TRAM, transverse rectus abdominis musculocutaneous; msTRAM, muscle-sparing TRAM; SIEA, superficial inferior epigastric artery; BMI, body mass index; WHO, World Health Organization; Rc, retrospective cohort; Pcom, prospective comparative; Pc, prospective cohort; Rc-c, retrospective case-control; Pc-c, prospective case-control; NA, not applicable/not announced.

**Table 2** Risk of bias

| Study | Title and abstract | Introduction | Methods | Results | Discussion | Other information | Overall risk of bias |
|---|---|---|---|---|---|---|---|
| Patterson *et al.* (37), 2022 | + | + | – | – | + | – | Moderate |
| Palve *et al.* (38), 2022 | + | + | – | + | + | + | Moderate |
| Heidekrueger *et al.* (39), 2021 | + | + | – | – | + | + | Moderate |
| Cheng *et al.* (40), 2021 | + | + | – | – | + | + | Moderate |
| Munder *et al.* (41), 2020 | + | + | – | + | – | – | Moderate |
| Novak *et al.* (42), 2020 | + | + | – | + | + | + | Moderate |
| Sultan *et al.* (43), 2020 | + | + | – | – | – | + | Serious |
| Ochoa *et al.* (44), 2019 | + | + | – | + | + | + | Low |
| O'neill *et al.* (45), 2019 | + | + | – | + | + | + | Moderate |
| Chang *et al.* (46), 2018 | + | + | – | – | + | + | Serious |
| Mani *et al.* (47), 2016 | + | + | – | + | + | – | Moderate |
| Kantak *et al.* (48), 2015 | + | + | – | – | + | – | Moderate |
| Ozturk *et al.* (49), 2014 | + | + | – | + | + | + | Moderate |
| Fischer *et al.* (50), 2013 | + | + | – | + | + | + | Low |
| Garvej *et al.* (51), 2012 | + | + | – | + | + | + | Low |
| Ochoa *et al.* (52), 2012 | + | + | – | + | – | + | Moderate |
| Jandali *et al.* (53), 2011 | + | + | – | – | – | + | Serious |
| Seidenstuecker *et al.* (54), 2011 | + | + | – | – | – | + | Serious |
| Garvej *et al.* (55), 2005 | + | + | – | + | + | – | Moderate |
| Chang *et al.* (56), 2000 | + | + | – | + | – | – | Serious |

Studies are assessed as sufficient (+) or insufficient (–) within each domain.

reconstruction solely, and 16 comprised both unilateral and bilateral breast reconstruction. Two studies reported the stages of BC (40,55). Extraction of study parameters relating to pre- and postoperative radiation therapy, chemotherapy and hormone therapy was undertaken. Due to limited data availability and small cohort sizes, statistical analyses or trend assessments were not performed.

Follow-up was stated in 15 of 20 papers, ranging from 1 to 135 months (40,49).

### *Risk of bias and level of evidence*

The papers were ranked according to the level of evidence (36). The papers included were primarily of lower levels of evidence. Two studies were found to be level II. Fifteen studies corresponded to evidence level III, and three studies level IV (*Table 1*).

The majority of the included studies were retrospective studies and may therefore be prone to observer and recall bias. Methodological weakness was found in all 20 studies, primarily due to lack of description of potential bias and study size calculation. Three studies were considered to have a low risk of bias, 12 studies were considered to have moderate risk of bias and five studies were identified to have a serious risk of bias (*Table 2*).

### *Analyses*

#### Analysis of complications comparing obese (BMI ≥30 kg/m$^2$) *vs.* non-obese (BMI <30 kg/m$^2$) patients

In the obese/non-obese comparison, 18 studies were included for analysis per breast and 19 studies per woman (*Table 3*).

The obese group had statistically significant higher

**Table 3** Pooled outcome measurements

| BMI (kg/m$^2$) | Breasts/ women, n (%) | Minor | | | Major | | | Loss of reconstruction | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N (%)[†] | Odds ratio (95% CI) | P value | N (%) | Odds ratio (95% CI) | P value | N (%) | Odds ratio (95% CI) | P value |
| <30 | | | | | | | | | | |
| Breasts | 7,817 (68.2) | 596 (16.7) | NA | NA | 630 (8.1) | NA | NA | 106 (1.4) | NA | NA |
| Women | 8,049 (76.6) | 672 (19.8) | | | 848 (10.5) | | | 117 (1.5) | | |
| ≥30 | | | | | | | | | | |
| Breasts | 3,641 (31.8) | 647 (23.9) | 1.6 (1.4–1.8) | $3.3\times10^{-59}$* | 445 (12.2) | 1.6 (1.4–1.8) | $1.4\times10^{-12}$* | 68 (1.9) | 1.4 (1.0–1.9) | 0.045* |
| Women | 2,465 (23.4) | 535 (34.9) | 2.2 (1.9–2.5) | $1.0\times10^{-73}$* | 331 (13.4) | 1.3 (1.1–1.5) | $7.9\times10^{-5}$* | 63 (2.6) | 1.8 (1.3–2.4) | $3.2\times10^{-4}$* |
| Total | | | | | | | | | | |
| Breasts | 11,458 | 1,243 (19.8) | 1.2 (1.1–1.4) | $2.1\times10^{-4}$* | 1,075 (9.4) | 1.2 (1.1–1.3) | $1.6\times10^{-3}$* | 174 (1.5) | 1.1 (0.9–1.4) | 0.38 |
| Women | 10,514 | 1,207 (24.5) | 1.3 (1.2–1.5) | $5.6\times10^{-7}$* | 1,179 (11.2) | 1.1 (0.9–1.2) | 0.15 | 180 (1.7) | 1.2 (0.9–1.5) | 0.18 |

≥30 kg/m$^2$ (obese) compared with <30 kg/m$^2$ (non-obese) per breast and women with odds ratios and P values. [†], the percentages reflect calculations based on the sum of patients or breasts from the included articles that report on minor complications, rather than the overall total. *, P value <0.05. BMI, body mass index; CI, confidence interval; NA, not applicable/not announced.

odds ratio (OR) of minor complications (OR, 1.6), major complications (OR, 1.6) and loss of reconstruction (OR, 1.4) in the analysis per breast.

When comparing complications per woman, OR for minor complications (OR, 2.2), major complications (OR, 1.3) and loss of reconstructions (OR, 1.8) were significantly higher for the obese group.

### Analysis of complications per breast according to WHO BMI classification

The overweight (BMI 25–29.9 kg/m$^2$), class I (BMI 30–34.9 kg/m$^2$), class II (BMI 35–39.9 kg/m$^2$) and class III obese (BMI ≥40 kg/m$^2$) groups were compared to the normal weight group (BMI 18.5–24.9 kg/m$^2$). Thirteen studies were included for analysis according to WHO's BMI classification per breast (*Table 4*). Significant higher OR of minor complications were found in the class I (OR, 2.8), class II (OR, 3.6), and class III obese (OR, 3.0).

Analyzing major complications, the class I group had significant lower OR of major complications (OR, 0.7). OR major complications (OR, 1.6) and loss of reconstruction (OR, 2.9) were significant higher in the class III group (*Table 4*).

### Analysis of complications per woman according to WHO BMI classification

Fifteen studies were included for analysis according to WHO's BMI classification per woman (*Table 4*). The analysis per woman showed similar significant OR for the three outcome measurements. Significant higher OR of minor complications were found in the class I (OR, 5.2), class II (OR, 6.3) and class III obese (OR, 5.6). The class I group had significant higher OR of loss of reconstruction (OR, 1.9). The overweight group showed significant higher OR of major complications (OR, 1.3) and loss of reconstruction (OR, 1.6). Similar to the per breast analysis, the class III obese group showed significant higher OR for major complications (OR, 2.3) and loss of reconstruction (OR, 4.9) (*Table 4*).

## Discussion

This systematic review investigated the association between BMI and postoperative complications at the recipient site after autologous breast reconstruction based on free abdominal-based flaps.

A total of 10,514 patients and 11,458 flaps were included in 4 subgroup analyses. The complications were analyzed per breast and per woman. The total number of breasts and women varied within the different BMI groups, but pooled data showed similar results analyzing complications per breast and per woman.

In the obese group analyses yielded significantly higher complication rates for all three outcomes when compared to the non-obese group. Our results are comparable to previous studies reporting increased risk

**Table 4** Pooled outcome measurements

| BMI (kg/m$^2$) | Breasts/ women, n (%) | Minor | | | Major | | | Loss of reconstruction | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N (%)[†] | Odds ratio (95% CI) | P value | N (%) | Odds ratio (95% CI) | P value | N (%) | Odds ratio (95% CI) | P value |
| <25 | | | | | | | | | | |
| Breasts | 3,159 (40.0) | 143 (11.7) | NA | NA | 285 (9.0) | NA | NA | 42 (1.3) | NA | NA |
| Women | 3,703 (46.6) | 189 (13.7) | | | 384 (10.4) | | | 45 (1.2) | | |
| 25–29.9 | | | | | | | | | | |
| Breasts | 2,975 (38.0) | 158 (10.5) | 0.9 (0.7–1.2) | 0.62 | 271 (9.1) | 1.0 (0.8–1.2) | 0.94 | 49 (1.6) | 1.2 (0.8–1.9) | 0.36 |
| Women | 3,036 (38.2) | 188 (16.0) | 1.2 (0.9–1.5) | 0.18 | 390 (12.8) | 1.3 (1.1–1.5) | $1.7\times10^{-3}$* | 57 (1.9) | 1.6 (1.1–2.3) | 0.03* |
| 30–34.9 | | | | | | | | | | |
| Breasts | 1,289 (16.5) | 190 (14.7) | 2.8 (2.2–3.5) | $8.8\times10^{-17}$* | 89 (6.9) | 0.7 (0.6–0.9) | 0.025* | 22 (1.7) | 1.3 (0.8–2.2) | 0.4 |
| Women | 939 (11.8) | 190 (20.2) | 5.2 (4.0–6.6) | $3.1\times10^{-41}$* | 89 (9.5) | 0.9 (0.7–1.2) | 0.42 | 22 (2.3) | 1.9 (1.2–3.3) | 0.015* |
| 35–39.9 | | | | | | | | | | |
| Breasts | 218 (2.8) | 75 (34.4) | 3.6 (2.6–4.9) | $8.7\times10^{-15}$* | 18 (8.3) | 0.9 (0.6–1.5) | 0.8 | 3 (1.4) | 1.0 (0.3–3.4) | 0.76 |
| Women | 150 (1.9) | 75 (50.0) | 6.3 (4.4–9.0) | $1.8\times10^{-27}$* | 18 (12.0) | 1.2 (0.7–2.0) | 0.6 | 3 (2.0) | 1.7 (0.5–5.4) | 0.43 |
| ≥40 | | | | | | | | | | |
| Breasts | 189 (2.4) | 58 (30.7) | 3.0 (2.1–4.3) | $7.2\times10^{-10}$* | 26 (13.8) | 1.6 (1.0–2.5) | 0.04* | 7 (3.7) | 2.9 (1.3–6.4) | 0.018* |
| Women | 123 (1.5) | 58 (47.2) | 5.6 (3.8–8.3) | $1.6\times10^{-20}$* | 26 (21.1) | 2.3 (1.5–3.6) | $2.6\times10^{-4}$* | 7 (5.7) | 4.9 (2.2–11.1) | $1.2\times10^{-3}$* |
| Total | | | | | | | | | | |
| Breasts | 7,830 | 624 (17.9) | 1.5 (1.2–1.8) | $9.5\times10^{-5}$* | 689 (8.8) | 1.0 (0.8–1.1) | 0.74 | 123 (1.6) | 1.2 (0.8–1.7) | 0.39 |
| Women | 7,951 | 700 (10.3) | 1.7 (1.5–2.1) | $6.5\times10^{-10}$* | 907 (11.4) | 1.1 (0.9–1.3) | 0.1 | 134 (1.7) | 1.4 (1.0–2.0) | 0.06 |

WHO BMI classification per breast and women with odds ratios and P values. Odds ratio and P value for each BMI group is compared/ in relation to BMI <25 kg/m$^2$. [†], the percentages reflect calculations based on the sum of patients or breasts from the included articles that report on minor complications, rather than the overall total. *, P value <0.05. BMI, body mass index; CI, confidence interval; NA, not applicable/not announced; WHO, World Health Organization.

of overall complications (47,57,58), minor complications (4,49,51,52,55,57), major complications (54), and loss of reconstruction (53).

Comparing the normal weight group to the three obesity classes defined by WHO, each group showed significant higher risk of minor complications. Results are comparable to previously reported complication rates (41,45,49,50,53,58-60).

The overweight and class III obesity groups both showed significant higher risk of loss of reconstruction. These results are similar to Jandali *et al.*'s report on class III obesity group having significantly higher rates of loss of reconstruction and total major complications (53).

However, not all studies report this correlation. Ochoa *et al.* found no statistical difference in major complications or total flap failure, when comparing overweight, class I, class II and class III obese patients with the normal weight group in 418 patients and 639 flaps (52).

Though obesity and increased minor complication rates are associated, this study shows that major complications and total flap failures in the overweight and obese groups remains equal to the normal weight group. Risk of loss of reconstruction was significant higher for the class III obese group, indicating that patients with BMI ≥40 kg/m$^2$ are not candidates for an autologous breast reconstruction (*Figure 2*).

In the population with BMI between ≥30 and <40 kg/m$^2$, obesity may not be a contraindication for autologous breast reconstruction with DIEP, SIEA, msTRAM or TRAM flaps.

However, a weight loss prior to reconstructive surgery

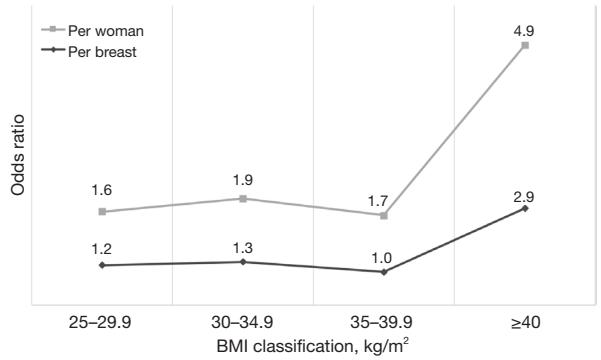


**Figure 2** Odds ratio loss of reconstruction. WHO BMI classification per breast and women. WHO, World Health Organization; BMI, body mass index.

should be recommended to obese patients optimizing safety and minimizing the increased risk of complications. It has previously been reported that preoperative weight loss facilitates reconstruction and improves outcomes in obese patients following a breast reconstruction (49,61). The class III obese had significantly higher complication rates on all three outcome measurements, indicating a need for a more specific BMI threshold before surgery.

Balancing risks of complications to the positive effect on quality of life as reported in previous studies (44,62-64), an autologous breast reconstruction may still be the best option despite the risk of minor complications in selected patient cases.

### *Strengths and limitations*

This systematic review included a large patient population, allowing comprehensive analyses of the correlation between BMI and postoperative complications, in addition analysis of BMI subgroups and postoperative complication were chosen to give a more precise correlation of the effect of the different BMI groups. All analyses were conducted both per patient and per breast. Classifying BMI according to WHO provides a more nuanced insight into different weight groups and a more precise analysis of BMI threshold for breast reconstruction. This study may be limited due to the heterogeneity of the included flaps and included studies, both regarding designs, definition of complications and the quality and evidence level. Moreover, results have not been adjusted for the effects of immediate/delayed or unilateral/bilateral reconstructions, age or smoking, which may limit the conclusions to be drawn from this systematic review. Insufficient information about the management of flap complications from the included studies may have resulted in incorrect subgroup complication classification by the authors.

## Conclusions

This review finds that BMI has an effect on the incidence of postoperative complications at the recipient site after autologous breast reconstruction.

The obese population (BMI ≥30 kg/m$^2$) has an increased risk of both minor and major complications and loss of reconstruction compared to the non-obese population.

Grouping BMI according to WHO classification, risks of minor complications are increased in all obesity classes (BMI 30–34.9, BMI 35–39.9 and BMI ≥40 kg/m$^2$). Despite the increased risk of minor complication in the obese groups, autologous breast reconstruction may still be the best option for this population in selected cases.

Overall, this study indicates a BMI ≤40 kg/m$^2$ as surgical threshold for autologous breast reconstruction based on free abdominal flaps, where the risk of loss of reconstruction is drastically increased. Considering the high rates of complications among patients with a BMI exceeding 30 kg/m$^2$ who undergo breast reconstruction, it is advisable to provide thorough counselling about the risks and possible delay in reconstruction until weight loss has been achieved.

Further studies on a higher level of evidence are needed to investigate the impact of BMI on autologous breast reconstruction, as well as the effect of immediate or delayed reconstruction on complications.

## Acknowledgments

Our abstract was accepted for presentation at the 11th EURAPS Research Counsil meeting, Stockholm, Sweden, which took place between the 24th and 25th of May 2023.
*Funding:* None.

## Footnote

*Reporting Checklist:* The authors have completed the PRISMA reporting checklist. Available at https://abs.amegroups.com/article/view/10.21037/abs-23-46/rc

*Peer Review File:* Available at https://abs.amegroups.com/

article/view/10.21037/abs-23-46/prf

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://abs.amegroups.com/article/view/10.21037/abs-23-46/coif). T.E.D. serves as an unpaid editorial board member of *Annals of Breast Surgery* from July 2023 to June 2025. The other authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring the questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.



## References

1. WHO - Breast cancer: prevention and control [Internet]. [cited 2021 Nov 15]. Available online: https://www.who.int/news-room/fact-sheets/detail/breast-cancer
2. WHO: Global Cancer Observatory [Internet]. [cited 2021 Nov 15]. Available online: https://gco.iarc.fr/
3. Cleary MP, Grossmann ME. Minireview: Obesity and breast cancer: the estrogen connection. Endocrinology 2009;150:2537-42.
4. Rao S, Stolle EC, Sher S, et al. A multiple logistic regression analysis of complications following microsurgical breast reconstruction. Gland Surg 2014;3:226-31.
5. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. Metabolism 2019;92:6-10.
6. Després JP, Lemieux I. Abdominal obesity and metabolic syndrome. Nature 2006;444:881-7.
7. Klasen J, Junger A, Hartmann B, et al. Increased body mass index and peri-operative risk in patients undergoing non-cardiac surgery. Obes Surg 2004;14:275-81.
8. Stein PD, Beemath A, Olson RE. Obesity as a risk factor in venous thromboembolism. Am J Med 2005;118:978-80.
9. Bamgbade OA, Rutter TW, Nafiu OO, et al. Postoperative complications in obese and nonobese patients. World J Surg 2007;31:556-60; discussion 561.
10. Lutsey PL, Zakai NA. Epidemiology and prevention of venous thromboembolism. Nat Rev Cardiol 2023;20:248-62.
11. Pierpont YN, Dinh TP, Salas RE, et al. Obesity and surgical wound healing: a current review. ISRN Obes 2014;2014:638936.
12. Byrne TK. Complications of surgery for obesity. Surg Clin North Am 2001;81:1181-93, vii-viii.
13. Carioli G, Malvezzi M, Rodriguez T, et al. Trends and predictions to 2020 in breast cancer mortality in Europe. Breast 2017;36:89-95.
14. Ahmad A. Breast Cancer Statistics: Recent Trends. Adv Exp Med Biol 2019;1152:1-7.
15. McDonald ES, Clark AS, Tchou J, et al. Clinical Diagnosis and Management of Breast Cancer. J Nucl Med 2016;57 Suppl 1:9S-16S.
16. Lesser GT. Issues in body fatness measurement. Arch Intern Med 2009;169:636.
17. Romero-Corral A, Somers VK, Sierra-Johnson J, et al. Accuracy of body mass index in diagnosing obesity in the adult general population. Int J Obes (Lond) 2008;32:959-66.
18. Kummerow KL, Du L, Penson DF, et al. Nationwide trends in mastectomy for early-stage breast cancer. JAMA Surg 2015;150:9-16.
19. Giunta RE, Hansson E, Andresen C, et al. ESPRAS Survey on Breast Reconstruction in Europe. Handchir Mikrochir Plast Chir 2021;53:340-8.
20. Garcia-Etienne CA, Tomatis M, Heil J, et al. Mastectomy trends for early-stage breast cancer: a report from the EUSOMA multi-institutional European database. Eur J Cancer 2012;48:1947-56.
21. Keelan S, Flanagan M, Hill ADK. Evolving Trends in Surgical Management of Breast Cancer: An Analysis of 30 Years of Practice Changing Papers. Front Oncol 2021;11:622621.
22. Winters ZE, Benson JR, Pusic AL. A systematic review of the clinical evidence to guide treatment recommendations in breast reconstruction based on patient- reported outcome measures and health-related quality of life. Ann Surg 2010;252:929-42.
23. Guyomard V, Leinster S, Wilkinson M. Systematic review of studies of patients' satisfaction with breast reconstruction after mastectomy. Breast 2007;16:547-67.
24. Lee C, Sunu C, Pignone M. Patient-reported outcomes of breast reconstruction after mastectomy: a systematic

 

review. J Am Coll Surg 2009;209:123-33.
25. Zehra S, Doyle F, Barry M, et al. Health-related quality of life following breast reconstruction compared to total mastectomy and breast-conserving surgery among breast cancer survivors: a systematic review and meta-analysis. Breast Cancer 2020;27:534-66.
26. Ewertz M, Jensen AB. Late effects of breast cancer treatment and potentials for rehabilitation. Acta Oncol 2011;50:187-93.
27. Zhong T, Hu J, Bagher S, et al. A Comparison of Psychological Response, Body Image, Sexuality, and Quality of Life between Immediate and Delayed Autologous Tissue Breast Reconstruction: A Prospective Long-Term Outcome Study. Plast Reconstr Surg 2016;138:772-80.
28. Chang EI. Latest Advancements in Autologous Breast Reconstruction. Plast Reconstr Surg 2021;147:111e-122e.
29. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev 2021;10:89.
30. Yezhelyev M, Duggal CS, Carlson GW, et al. Complications of latissimus dorsi flap breast reconstruction in overweight and obese patients. Ann Plast Surg 2013;70:557-62.
31. McAllister P, Teo I, Chin K, et al. Bilateral Breast Reconstruction with Abdominal Free Flaps: A Single Centre, Single Surgeon Retrospective Review of 55 Consecutive Patients. Plast Surg Int 2016;2016:6085624.
32. Canizares O, Mayo J, Soto E, et al. Optimizing Efficiency in Deep Inferior Epigastric Perforator Flap Breast Reconstruction. Ann Plast Surg 2015;75:186-92.
33. WHO BMI classification [Internet]. [cited 2021 Oct 10]. Available online: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
34. WHO - Body Mass Index [Internet]. [cited 2021 Oct 10]. Available online: https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi
35. STROBE Statement [Internet]. STROBE Checklist: cohort; case-control; and cross-sectional studies (combined). [cited 2021 Dec 11]. Available online: https://www.strobe-statement.org/index.php?id=strobe-home
36. Sullivan D, Chung KC, Eaves FF 3rd, et al. The level of evidence pyramid: indicating levels of evidence in Plastic and Reconstructive Surgery articles. Plast Reconstr Surg 2011;128:311-4.
37. Patterson CW, Palines PA, Bartow MJ, et al. Stratification of Surgical Risk in DIEP Breast Reconstruction Based on Classification of Obesity. J Reconstr Microsurg 2022;38:1-9.
38. Palve J, Luukkaala T, Kääriäinen M. Is there any difference in perioperative characteristics or postoperative complications between overweight, normal-weight and obese patients in delayed DIEP reconstructions? J Plast Surg Hand Surg 2022;56:236-41.
39. Heidekrueger PI, Fritschen U, Moellhoff N, et al. Impact of body mass index on free DIEP flap breast reconstruction: A multicenter cohort study. J Plast Reconstr Aesthet Surg 2021;74:1718-24.
40. Cheng MH, Koide S, Chen C, Lin YL. Comparisons Between Normal Body Mass Index and Overweight Patients Who Underwent Unilateral Microsurgical Breast Reconstructions. Ann Surg Oncol 2021;28:353-62.
41. Munder B, Andree C, Witzel C, et al. The DIEP Flap as Well-established Method of Choice for Autologous Breast Reconstruction with a Low Complication Rate - Retrospective Single-centre 10-Year Experience. Geburtshilfe Frauenheilkd 2020;80:628-38.
42. Novak MD, Blough JT, Abraham JT, et al. Breast Reconstruction in Obese Patients: The Fat Grafted Latissimus versus Abdominal Free Tissue Transfer. Plast Reconstr Surg Glob Open 2020;8:e2668.
43. Sultan SM, Seth AK, Lamelas AM, et al. Bipedicle-Conjoined Deep Inferior Epigastric Perforator Flaps for Unilateral Breast Reconstruction in Overweight and Obese Patients: Do the Benefits Outweigh the Risks? J Reconstr Microsurg 2020;36:346-52.
44. Ochoa O, Garza R 3rd, Pisano S, et al. Prospective Longitudinal Patient-Reported Satisfaction and Health-Related Quality of Life following DIEP Flap Breast Reconstruction: Relationship with Body Mass Index. Plast Reconstr Surg 2019;143:1589-600.
45. O'Neill AC, Sebastiampillai S, Zhong T, et al. Increasing body mass index increases complications but not failure rates in microvascular breast reconstruction: A retrospective cohort study. J Plast Reconstr Aesthet Surg 2019;72:1518-24.
46. Chang EI, Liu J. Prospective Evaluation of Obese Patients Undergoing Autologous Abdominal Free Flap Breast Reconstruction. Plast Reconstr Surg 2018;142:120e-5e.
47. Mani M, Wang T, Harris P, et al. Breast reconstruction with the deep inferior epigastric perforator flap is a reliable alternative in slim patients. Microsurgery 2016;36:552-8.
48. Kantak NA, Koolen PG, Martin C, et al. Are patients with low body mass index candidates for deep inferior epigastric perforator flaps for unilateral breast reconstruction?

 

Microsurgery 2015;35:421-7.
49. Ozturk CN, Kundu N, Bernard S, et al. Breast reconstruction with abdominal-based free flaps in high body mass index population: postoperative complications and impact of weight loss. Ann Plast Surg 2014;72:13-22.
50. Fischer JP, Nelson JA, Sieber B, et al. Free tissue transfer in the obese patient: an outcome and cost analysis in 1258 consecutive abdominally based reconstructions. Plast Reconstr Surg 2013;131:681e-692e.
51. Garvey PB, Villa MT, Rozanski AT, et al. The advantages of free abdominal-based flaps over implants for breast reconstruction in obese patients. Plast Reconstr Surg 2012;130:991-1000.
52. Ochoa O, Chrysopoulo M, Nastala C, et al. Abdominal wall stability and flap complications after deep inferior epigastric perforator flap breast reconstruction: does body mass index make a difference? Analysis of 418 patients and 639 flaps. Plast Reconstr Surg 2012;130:21e-33e.
53. Jandali S, Nelson JA, Sonnad SS, et al. Breast reconstruction with free tissue transfer from the abdomen in the morbidly obese. Plast Reconstr Surg 2011;127:2206-13.
54. Seidenstuecker K, Munder B, Mahajan AL, et al. Morbidity of microsurgical breast reconstruction in patients with comorbid conditions. Plast Reconstr Surg 2011;127:1086-92.
55. Garvey PB, Buchel EW, Pockaj BA, et al. The deep inferior epigastric perforator flap for breast reconstruction in overweight and obese patients. Plast Reconstr Surg 2005;115:447-57.
56. Chang DW, Wang B, Robb GL, et al. Effect of obesity on flap and donor-site complications in free transverse rectus abdominis myocutaneous flap breast reconstruction. Plast Reconstr Surg 2000;105:1640-8.
57. Schaverien MV, Mcculley SJ. Effect of obesity on outcomes of free autologous breast reconstruction: a meta-analysis. Microsurgery 2014;34:484-97.
58. Mehrara BJ, Santoro TD, Arcilla E, et al. Complications after microvascular breast reconstruction: experience with 1195 flaps. Plast Reconstr Surg 2006;118:1100-9.
59. Duraes EF, Schwarz G, Durand P, et al. Complications Following Abdominal-Based Free Flap Breast Reconstruction: Is a 30 days Complication Rate Representative? Aesthetic Plast Surg 2015;39:694-9.
60. Beugels J, Hoekstra LT, Tuinder SM, et al. Complications in unilateral versus bilateral deep inferior epigastric artery perforator flap breast reconstructions: A multicentre study. J Plast Reconstr Aesthet Surg 2016;69:1291-8.
61. Larson KE, Ozturk CN, Kundu N, et al. Achieving patient satisfaction in abdominally based free flap breast reconstruction: correlation with body mass index subgroups and weight loss. Plast Reconstr Surg 2014;133:763-73.
62. Boczar D, Huayllani MT, Forte AJ, et al. Microsurgical Breast Reconstruction in the Obese Patient Using Abdominal Flaps: Complication Profile and Patient Satisfaction. Ann Plast Surg 2020;84:S361-3.
63. Atisha DM, Alderman AK, Kuhn LE, et al. The impact of obesity on patient satisfaction with breast reconstruction. Plast Reconstr Surg 2008;121:1893-9.
64. Klement KA, Hijjawi JB, LoGiudice JA, et al. Microsurgical Breast Reconstruction in the Obese: A Better Option Than Tissue Expander/Implant Reconstruction? Plast Reconstr Surg 2019;144:539-46.

doi: 10.21037/abs-23-46
**Cite this article as:** Frid NL, Lauritzen E, Damsgaard TE. A systematic review on the association between body mass index and autologous breast reconstruction. Ann Breast Surg 2024;8:18.

 