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Approach to Weight Loss Patient's Post Bariatric Surgery

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Abstract: ***Approach to obesity management includes lifestyle changes, pharmacotherapy, and bariatric surgery when indicated. Bariatric surgery is one of the most effective tools for achieving clinically significant weight reduction, with different procedures leading to varying degree of weight loss. Bariatric surgery is a safe and effective option for those who do not achieve durable weight loss with non - surgical methods. There is a potential role of pharmacotherapy in combination with bariatric surgery to prevent weight recurrence.***

Keywords: obesity, weight, bariatric surgery, body mass index (BMI)

1. Introduction

Obesity is defined by the World Health Organization (WHO) as an abnormal or excessive fat accumulation that presents a risk to health, commonly classified by the body mass index (BMI): Underweight < 18.5%; normal weight 18.5% - 24.9%; overweight 25% - 29.9%; obese class I 30% - 34.9%; obese class II 35% - 39.9%; obese class III >40 %. [1 - 4] BMI is simple to calculate, but it does have its limitations where factors such as age, muscle mass and ethnicity can influence its relationship with body fat. [1 - 4] Other measures such as skinfold thickness, waist circumference and waist - to - hip ratio are increasingly used to assess an individual's risk of obesity related conditions such as type 2 diabetes mellitus and cardiovascular disease. [1 - 4] In response to the expanding weight problem, there has been an increased focus on weight loss for improving clinical outcomes in morbidly obese patients. Major medical disorders that are directly induced or exacerbated by obesity. [5, 6] Obesity is associated with osteoarthritis, insulin - resistant diabetes mellitus, obstructive sleep apnea, dyslipidemia and secondary coronary artery disease, hypertension and a group of miscellaneous disorders, including gastroesophageal reflux disease, cardiovascular disease, asthma and deep vein thrombosis, increased risk of endometrial, breast, pancreatic, prostate and colon cancer. [5, 6] Unfortunately, the average weight loss reported to be achieved by medical weight loss programs is neither sufficient nor durable enough to be an adequate treatment for morbid obesity. [7, 8] According to WHO, obesity has reached epidemic proportions worldwide, with approximately 1.9 billion overweight and 650 million obese adults. [9 - 11] Purnell explains the physiology of body weight regulation, focusing on the communication between the brain, gastrointestinal system, and fat tissue. The dysregulation of this system can lead to obesity and its associated with health complication. [9]

Obesity is a complex, multifactorial disease that occurs through interaction between genetic predisposition and the environment. The genetic contributes to weight through syndromic, monogenic, and polygenic causes. The leptin - melanocortin hypothalamic pathway is a core mechanistic pathway regulating appetite. Environmental changes (ultra - processed food, sleep changes, medications, parental exposures) has driven the more recent obesity epidemic. [9 - 12] Bariatric surgical procedures reduce caloric intake by modifying the anatomy of the gastrointestinal tract. These operations are classified as either restrictive or malabsorptive. Restrictive procedures limit intake by creating a small gastric reservoir with a narrow outlet to delay emptying. Malabsorptive procedures bypass vary. [13]

2. Updates on surgical and procedural interventions for obesity

1) Sleeve gastrectomy (SG)

This restrictive procedure involves resection of a large segment of the stomach, leaving a narrow gastric remnant and intact segments of the intestine. Resection of the gastric fundus restricts the ability of the residual stomach to stretch and nearly eliminates the production of ghrelin (a foregut peptide hormone implicated in regulating food intake and body weight), and a reduce a risk of death. [14 - 19] SG can yield excess weight loss of up to 70% within one year, which is maintained to at least three years. [20] SG increases remission rates of diabetes (86%), hypertension (82%), dyslipidemia (83%) and sleep apnea (91%). SG has a low mortality rate and its most serious complication is leakage, which occurs in 2–3% of patients. [21] Others include strictures (4%) and gastro - oesophageal reflux. [22]

2) Roux - en - Y gastric bypass (RYGB)

This procedure combines restrictive and malabsorptive components to facilitate weight loss. The stomach is restricted to a small pouch and the small intestine is divided and rerouted; the jejunum is anastomosed to the small gastric pouch (the Roux limb), whereas the proximal small intestine (including the duodenum) is further anastomosed distally, in the jejunum (the biliopancreatic limb). Food from the gastric pouch travels through the Roux limb into the common channel, where it mixes with biliopancreatic secretions for digestion; the shorter the common channel, the greater the malabsorptive effect. [14 - 19]

(RYGB) estimated weight loss of 73% within 1 - year, good long - term weight loss maintenance, and remission of comorbidities such as diabetes (95%), dyslipidaemia (80%), hypertension (81%) and sleep apnoea (95%). [20] 30 - day mortality rates are lower for the laparoscopic vs open approach (0.2% vs 2.1%, respectively). [23] Serious complications include anastomotic leaks (3–5%) and internal bowel herniation (3.1%) with the potential to lead to bowel obstruction and perforation. [24 - 26] Other complication includes malabsorption of dietary vitamins (particularly B - complex vitamin) and minerals. The vitamin B12 deficiency may induce myelopathy, degenerative of the posterior and lateral column and macrocytic anemia. [14 - 19] Thiamine deficiency can be induced by malabsorptive bariatric surgical procedures. It can also be seen in conjunction with excessive alcohol use and exists worldwide as consequence of major nutritional deficiency. The classic presentation of thiamine deficiency includes ataxia, nystagmus, and confusion (Wernicke's encephalopathy). Patient with thiamine deficiency may have distal sensorimotor polyneuropathy (Dry Beriberi) with or without cardiomyopathy (Wet Beriberi) and amnesia with confabulation but relatively normal cognition (Korsakoff's syndrome). [14 - 19] Prompt identification of thiamine deficiency in cases of Wernicke's encephalopathy and beriberi is critical; the rapid administration of intravenous thiamine may restore normal neurologic function and prevent irreversible damage. Investigation for other nutritional deficiencies should also be conducted. [14 - 19]

3) Adjustable Gastric Banding (ABS)

This purely restrictive procedure involves the placement of an adjustable band around the gastric entry to partition the stomach into two compartments. The adjustable band can be tightened or relaxed through an injectable saline - infusion port that is placed in the subcutaneous tissue. [14 - 19] Longitudinal assessment of bariatric surgery yield excess weight loss of up to 55% 2 years post - operatively, but also promotes the remission of diabetes (74%), hypertension (54%), dyslipidaemia (40%) and sleep apnoea (94%). [23] The Longitudinal Assessment of Bariatric Surgery consortium have reported no mortality at 30 days post - LABG (n=1, 198). [23] More common minor complications include oesophageal pouch dilatation (11%) and gastroesophageal reflux, whereas major complications include band slippage (7.9%) and erosion (<1%). [27 - 29]

4) Biliopancreatic diversion with a duodenal switch (BPD - DS)

This procedure includes a restrictive component (a sleeve gastrectomy), but it is primarily a malabsorptive procedure reserved for patients with severe obesity. A gastroileostomy with a very short common channel is constructed to maximize malabsorption; the mixture of food contents and biliopancreatic secretions is diverted to the distal segments of the small intestine. [14 - 19] BPD - DS Can yield excess weight loss of up to up to 73% with maintenance to over 8 years via both restrictive and malabsorptive mechanisms akin to RYGB, with significant effects on comorbidities such as type2 diabetes. ([28] Although mortality rates remain low (<1%), BPD - DS is a more complex procedure, with complications including perioperative anastomotic leaks (3–4%) and splenectomy (<1%), and later malnutrition (4%), internal bowel herniation and small bowel obstruction (2 - 7%). [30, 31]

Post - metabolic bariatric surgery and type 2 diabetes mellitus remission

Metabolic surgery is highly effective in obtaining significant improved quality of life and a reduced risk for other obesity - related and diabetes - related disorders, including microvascular disease, sleep apnea, fatty liver disease, and malignant diseases. [32 - 35] Comparable glycemic benefits of surgery have been observed in patients with lower initial BMIs <35 kg/m2. In the STAMPEDE trial, the antidiabetic effects of surgery were the same in patients with baseline BMIs higher and lower than 35 kg/m^2. [36 - 38]

Shah et al. [39] demonstrated a substantial benefit of RYGB in Indian patients with an initial BMI <35 kg/m2, and similar BMI - independent benefits of surgery have been established in meta - analyses. [39 - 41] As a result, current guidelines support the use of metabolic surgery in individuals with mild obesity and poorly controlled type 2 diabetes. [41 - 44] Although the antidiabetic effects of ABS appear less powerful than those of other metabolic operations, one study nonetheless demonstrated the ability of ABS to induce remission of type 2 diabetes mellitus, defined as fasting glucose <126 mg/dl and post - load glucose during a 2 - h oral glucose tolerance test <200 mg/dl, at least 2 days after cessation of antidiabetic medication, among overweight (BMI 25 to 30 kg/m2) individuals. [45] In some patients, the bariatric and metabolic effects of gastrointestinal surgery may diminish over time, with relapse of type 2 diabetes in patients who had initially achieved full remission. Even in these patients, however, the recurrent diabetes is generally far less severe, requires less intensive medication regimens, and is more easily controlled than before the metabolic surgery. Patients who are older, use insulin, regain weight, or have greater baseline waist circumference, longer diabetes duration, or poor preoperative glycemic control appear to be at highest risk for late postoperative diabetes recurrence. [46 - 48] Even in the setting of diabetes relapse, however, a legacy effect may exist. Finally, the effect of post - operative antidiabetic medications in patients whose diabetes failed to remit or recurred late after surgery is currently being examined (Canagliflozin vs. Placebo for Post Bariatric Patients with Persistent Type 2 Diabetes [CARAT]. [49] A courcoulas et al, demonstrate prospective randomized interventional data from the largest cohort of patients to date demonstrates that metabolic surgery improves glycemic control, diabetes - related comorbidities, and weight loss to a greater extent than medical/lifestyle intervention for up to three years after treatment, with minimal and generally tolerable adverse events. [50] The study show that surgery is more effective than medical therapy in the long - term control of type 2 diabetes. Our findings suggest that it might be possible to reduce the frequency of glycemic monitoring in patients who maintain at least five years of remission of type 2 diabetes although larger studies are needed to confirm this finding. Clinicians and policy makers should ensure that metabolic surgery is appropriately considered in the management of patients with obesity and type 2 diabetes. [51] A very long - term follow - up observational study of obese patients with type 2 diabetes, bariatric surgery was associated with more frequent diabetes remission and fewer complications than usual care. These

findings require confirmation in randomized trials. [52] Weight loss after bariatric surgery is strongly associated with initial Type 2 Diabetes remission; however, above a threshold of 20% total weight loss, rates of initial Type 2 Diabetes remission did not increase substantially. Achieving this threshold is also associated with initial remission even in patients who traditionally experience lower rates of remission, such as patients taking insulin. [53]

Post - metabolic bariatric surgery weight loss and prevalence of nonalcoholic steatohepatitis (NASH) remission

Bariatric - metabolic surgery was more effective than lifestyle intervention and best medical care as a treatment of nonalcoholic steatohepatitis in people with obesity, with or without type 2 diabetes. Roux - en - Y gastric bypass and sleeve gastrectomy had similar efficacy on nonalcoholic steatohepatitis, even though Roux - en - Y gastric bypass was generally more effective at improving glycemic control, lipid profile, insulin resistance, and weight loss. This finding might be explained by the existence of a threshold in the weight loss or degree of metabolic improvement that is necessary to resolve nonalcoholic steatohepatitis. [54] In fact, the probability of reaching the primary endpoint increased non - linearly above 20% weight reduction and further decreases in bodyweight above this threshold translated into less additional histological improvement. Resolution of nonalcoholic steatohepatitis was also associated with postoperative improvement of insulin resistance and triglyceride concentrations. [54] A threshold mechanism for changes in insulin resistance might explain the lower effect of further weight reduction above 20% and the lack of differences observed between Roux - en - Y gastric bypass and sleeve gastrectomy. [54] A study investigating the effect of weight loss achieved through diet and physical exercise on liver histological features was done in 293 people with nonalcoholic steatohepatitis. [55] nonalcoholic steatohepatitis resolution was reached in 25% of the participants and 19% had regression of liver fibrosis. [55] The 1 - year mean weight loss in the study was 4·6 kg (SD 3·2); however, only 10% had a weight loss of 10% or greater. [55] Comparatively, the mean weight loss in the lifestyle - intervention group of this study was 5·5% and only 27% achieved a weight reduction of at least 10%. These findings provide reassurance regarding the effectiveness of lifestyle modification in our study, thus providing an appropriate comparator for the related effectiveness of surgical therapy. Studies show that new anti - obesity medications (eg, tirzepatide or cagrilintide plus semaglutide) ([56, 57]) can achieve levels of weight loss close to 20% in some people, suggesting that these drugs might be more effective as a treatment of nonalcoholic steatohepatitis compared with lifestyle modification, as well as with pioglitazone and liraglutide, the drugs used in our study. Semaglutide achieved resolution of nonalcoholic steatohepatitis without fibrosis worsening in 59% of participants versus 17% in the placebo group in one trial. Importantly, however, there was no difference in previous studies between semaglitude and placebo in the downstaging of liver fibrosis, [58] despite the substantial weight loss achieved by this drug. This observation suggests that the net improvement of fibrosis achieved by surgery in our study might not be extrapolated to other forms of weight - loss interventions. The relative efficacy of newer anti - obesity drugs on nonalcoholic steatohepatitis and liver fibrosis will therefore require further investigation. [59] The Intention - to - treat analysis showed that in participants with a nonalcoholic fatty liver disease activity score of 4 or 5 or more, the probability of reaching the primary endpoint was 3–5 times higher with bariatric - metabolic surgery than with lifestyle modification. In this subgroup, the improvement of at least one stage of fibrosis in the per protocol analysis was almost double after both Roux - en - Y gastric bypass and sleeve gastrectomy than after lifestyle modification. The ability of surgery to control and even improve fibrosis associated with nonalcoholic steatohepatitis is of particular clinical relevance given that fibrosis is the main predictor of liver complications and cardiovascular mortality and morbidity in nonalcoholic steatohepatitis. [59, 60] The number of surgical complications in our study was similar after both surgical procedures. Several participants had gastroesophageal reflux after sleeve gastrectomy. Gastroesophageal reflux disease is a known complication of sleeve gastrectomy; [61] the high rate of gastroesophageal reflux disease in our study might partly be related to a more frequent use of postoperative diagnostic endoscopy compared with in usual clinical practice, which is a standard practice in postoperative assessment of patients undergoing sleeve gastrectomy at our centers. A cost - effectiveness analysis ([62] of bariatric - metabolic surgery in individuals with nonalcoholic steatohepatitis showed that surgery is cost - effective in all individuals with obesity and nonalcoholic steatohepatitis, regardless of fibrosis stage, making surgery a suitable approach for the treatment of this condition. Previous studies had shown efficacy of bariatric - metabolic surgery on nonalcoholic fatty liver disease. [63 - 65] there is a study supports these findings and also provides evidence that benefits of surgery extend to nonalcoholic steatohepatitis and liver fibrosis. The results have important implications for clinical practice. There are no existing mechanisms for prioritization of bariatric - metabolic surgery in most health - care systems and access to surgery is often based on a first - come - first - served basis. ([66] Other study supports prioritization of surgery in nonalcoholic steatohepatitis, especially in the presence of a high risk of liver - related morbidity and mortality. A study of 30 000 individuals with nonalcoholic fatty liver disease and BMI of 40 kg/m2 or more showed that bariatric surgery conferred a 49% lower risk of cardiovascular disease compared with non - surgical care. [67] Whether or not surgery could be used as a treatment of nonalcoholic steatohepatitis in patients who do not meet standard criteria for bariatric - metabolic surgery cannot be extrapolated from our study and warrants further and specific investigation. Our study is the first to compare three active treatments of nonalcoholic steatohepatitis and investigate the efficacy of bariatric - metabolic surgery in a randomized trial. Importantly, this study used preoperative and postoperative liver biopsy, which is the gold standard for assessment of nonalcoholic steatohepatitis related endpoints. [68] This study has several limitations. The FDA guidance [68] was published recommending the use of a nonalcoholic fatty liver disease activity score of at least 4 with at least 1 point each in inflammation and ballooning along with a Fibrosis staging scored (CRN) fibrosis score of 2–3 as essential inclusion criteria in nonalcoholic steatohepatitis trials. In the present study, we included people with a nonalcoholic fatty liver disease activity score of at least 3, and inflammation and ballooning scores in line with the most recent FDA guidance.

However, consistent with most nonalcoholic steatohepatitis trials published since 2021 that study included people with fibrosis stages [69 - 73] to investigate the effect of interventions according to the most recent FDA recommendations, we did a post - hoc analysis of the primary endpoint in participants with a nonalcoholic fatty liver disease activity score of 4 or at least 5. We also did subgroup analyses of results in participants with fibrosis stages 2 and 3, who accounted for more than 50% of all participants in our study. [54] In the aggregate, the results of these subgroup analyses show that differences between surgical and non - surgical treatment of nonalcoholic steatohepatitis are greater among participants with more severe fibrosis. This finding supports the robustness of the overall findings of our study and their clinical relevance in patients with more advanced stages of fibrosis. As the study did not control for baseline BMI and glycemic control, differences in bodyweight and diabetes severity at baseline could have, at least partly, influenced the response to treatment. [54] However, BMI and HbA1c levels were higher in the Roux - en - Y gastric bypass group, which would potentially bias results against rather than in favor of surgery, which was the most effective intervention. Another limitation is that the medications used reflect indications and drugs available in Italy for people with obesity and nonalcoholic steatohepatitis at the time the study was designed. [54] Novel antiobesity drugs might result in better nonalcoholic steatohepatitis outcomes than those we observed in the non - surgical group of our study, given their greater weight - loss potential. Future research should compare new anti - obesity drugs with other active drugs or bariatric - metabolic surgery. Another important limitation is that all participants in this study were White, meaning that the rates of nonalcoholic steatohepatitis resolution and other metabolic improvements observed in this trial might not be generalizable to other ethnic groups. [54]

Post - metabolic bariatric surgery associated with fewer cardiovascular mortality outcomes

Obesity is associated with an increase incidence of heart failure, myocardial infarction, stroke, and death. [74 - 76] Weight loss has become a standard recommendation for all patients with cardiovascular disease and coexisting obesity; however, randomized evidence to support this recommendation is limited. The largest trial to date investigating whether intentional weight loss reduces cardiovascular morbidity and mortality in overweight individuals with type 2 diabetes did not show a significant reduction in cardiovascular events. [77] However, the weight loss observed in this trial was modest, and it is not known whether greater levels of weight loss would lead to clear reductions in recurrent cardiovascular events and deaths. Several studies of overweight and obese patients with cardiovascular disease suggest an “obesity paradox,” whereby elevated body mass index may be associated with lower mortality and cardiovascular events. [78, 79] However, other studies have described a U - shaped relationship with respect to weight, with severe obesity being associated with increased risk of cardiovascular outcomes. [76] Although the relationship between obesity and cardiovascular outcomes is not well delineated, bariatric surgery, in addition to being the most effective weight loss treatment, is also known to resolve other cardiovascular risk factors, including the burden of recurrent cardiovascular disease in patients with obesity and previous heart disease. [80] Randomized clinical trials have revealed that bariatric surgery leads to consistent improvements in diabetes outcomes and cardiovascular risk factors in patients with diabetes and severe obesity. [81 - 83] However, such trials did not evaluate the effect of bariatric surgery on mortality and other major cardiovascular outcomes. Several observational studies have reported on the promising correlation between bariatric surgery and decreased cardiovascular outcomes. [32 - 85] Early studies of patients with severe obesity and type 2 diabetes undergoing bariatric surgery showed lower risks of macrovascular events in the surgery group, but confounding bias may have contributed to these results, and patients in these studies received procedures that are no longer common. [32] More recently, retrospective studies of patients with diabetes undergoing sleeve gastrectomy and Roux - en - Y gastric bypass have associated bariatric surgery with significantly lower incidence of incident major cardiovascular events after 8 years. [84, 85] More than 10 small randomized clinical trials have shown that metabolic surgery is superior to usual medical therapy for diabetes control and modifying cardiometabolic risk factors in patients with type 2 diabetes mellitus and obesity. [81 - 83, 86, 87] Furthermore, >30 large comparative cohort studies have consistently reported reduction in risk of mortality after metabolic surgery. [84, 85, 88] The majority of these Randomized clinical trials and large observational studies have only examined the favorable effects of Roux - en - Y gastric bypass (RYGB). Currently, sleeve gastrectomy (SG), a relatively new procedure, is the most commonly performed metabolic surgical procedure worldwide. [89 - 91] However, long - term data on efficacy of SG for macro - and microvascular complications of type 2 diabetes and mortality are limited. [92] Although cardiovascular and survival benefits of RYGB have been reported, the current study is among the first in the literature to show lower risk of coronary artery events, cerebrovascular events, heart failure, atrial fibrillation, nephropathy, and all case of mortality and mortality after SG compared with usual care. [92] The findings of this large retrospective study also provide evidence suggesting that RYGB in patients with obesity and type 2 diabetes may be associated with greater weight loss, better diabetes control, and lower risk of six - component coronary artery events, cerebrovascular events, heart failure, atrial fibrillation, nephropathy, and all case of mortality and mortality and nephropathy compared with SG. However, given the nature of the study, these data should be considered hypothesis generating and not conclusive. [92] Aristithes et al cohort study, demonstrated that bariatric surgery was associated with a significant lower incidence of coronary artery events, cerebrovascular events, heart failure, atrial fibrillation, nephropathy, and all case of mortality and mortality in patients with cardiovascular disease and severe obesity. These observed results apply to both patients with ischemic heart disease and heart failure. This study provides novel information and requires confirmation by a large scale randomize control trial, because effects of observational studies can be overestimated. [92]

Post - metabolic bariatric surgery and decrease incidence of cancer and mortality

Obesity and type 2 diabetes are both associated with increased cancer risk and cancer mortality. [94 - 99] In a study by Pearson - Stuttard et al. [99] an estimated 6% of all cancer cases worldwide in 2012 were attributable to the combined effects

of diabetes and overweight/ obesity. Additionally, the combination of diabetes and overweight/obesity contributed to as much as 25–40% of all liver cancer, esophageal adenocarcinoma, and endometrial cancer cases. Thus, the global pattern of increasing obesity and diabetes has led to an increased cancer prevalence. The causal link between obesity and 13 specific cancer types, referred to as obesity related, is well established. [100] In addition, some of these cancer types (i. e., liver, pancreatic, endometrial, colon and rectal, breast, bladder) have been suggested to be diabetes (mainly type 2) related. [101] However, at present, there is no clear consensus regarding which cancers are directly linked to type 2 diabetes. [102, 103] Obesity is a modifiable risk factor for type 2 diabetes and cancer, and bariatric surgery is the most effective intervention for substantial and sustained weight loss in patients with obesity. [104] Furthermore, the beneficial effects of bariatric surgery on type 2 diabetes are well described [81, 82] and the majority of patients with diabetes achieve short - term diabetes remission after bariatric surgery. Numerous observational and retrospective cohort studies of patients undergoing bariatric surgery have contributed to the understanding that intentional weight loss leads to reduced cancer risk and mortality in patients with obesity. [105 - 109] In a study by Ali Aminian et al, among adults with obesity, bariatric surgery compared with no surgery was associated with a significantly lower incidence of obesity - associated cancer and cancer - related mortality. [110] In conclusion, with increasing rates of obesity and diabetes worldwide, a greater emphasis on cancer prevention strategies is needed. Our results suggest that bariatric surgery may greatly reduce the risk of cancer among patients with obesity and diabetes. Moreover, durable diabetes remission seems imperative for cancer prevention in patients with obesity and diabetes. [111]

Post - metabolic bariatric surgery increases life expectancy

Lower mortality in association with bariatric surgery has also been observed in retrospective cohort studies, and a recent meta - analysis indicated 41% lower all - cause long - term ≥2 years mortality. [112] However, a recent retrospective study indicated that the relative risk of death remained higher among patients who underwent bariatric surgery than in the general background population. [113] Despite the beneficial effects of bariatric surgery, only a minority of eligible patients undergo such surgery. [114] It is recommended that patients considering bariatric surgery be given appropriate information to make an informed choice. [115] A major motivation to undergo bariatric surgery is to reduce the risks of deteriorating health and premature death. [116] However, the extent to which the reduced relative risk of death after bariatric surgery increases the life span in patients with obesity is unclear. [117] In 2007, our group provided prospectively collected data showing that mortality in a group of patients who underwent bariatric surgery was lower than in a matched control group of patients who were given usual care. [117] After an additional 13 years of follow - up, we now report that the difference in mortality persisted and that bariatric surgery was associated with a lower risk of death from both cardiovascular diseases and cancer. In addition, we show that life expectancy among patients with obesity who were given usual care was approximately 8 years shorter than in the general population, and this difference was decreased by bariatric surgery, which was associated with life expectancy that was approximately 3 years longer than that associated with usual care. The mean increase in life expectancy after an intervention used for prevention of an outcome is generally lowest in populations at average risk, higher in populations with an elevated risk, and greatest among persons with established disease. [118] When viewed in the context of life - years gained with a variety of interventions in populations at elevated risk, [118] the 3 - year mean prolongation of life after bariatric surgery in our study is large. However, the controlled Swedish Obese Subjects study at baseline includes persons who have an elevated risk of serious and potentially life - threatening diseases, as well as persons with established conditions, such as type 2 diabetes and hypertension. [117] Therefore, it is important to emphasize that the reported gain in life expectancy is for our entire study population and cannot be translated into a survival benefit for a particular patient or for other populations beyond the study participants. The 8 - year - shorter life expectancy in the control group than in the general Swedish population is within the range previously reported for persons with severe obesity relative to those of healthy weight. [119 - 121] Although life expectancy was longer in association with bariatric surgery, survival was still lower than in the general population. This finding is consonant with a recent report from the Nordic countries showing that overall mortality among patients who had undergone bariatric surgery remained higher than in the general population. [122] Possible explanations for the remaining higher mortality in the surgery group include the above - normal BMI even after bariatric surgery, irreversible effects of obesity - related metabolic dysfunction that may have begun processes that lead to atherosclerosis or microvascular disease, and surgical complications and other factors causing death (alcoholism, suicide, and trauma). More frequent occurrence of alcoholism, suicide, and trauma [123 - 125] and a larger number of related deaths have previously been observed among patients with obesity who undergo bariatric surgery than among those who do not undergo surgery. [126] In the controlled Swedish Obese Subjects study, we have found a higher risk of alcohol abuse, suicide and self - harm, and serious fall - related injuries among patients with obesity who have undergone bariatric surgery than among those who have not. [127 - 130] In conclusion bariatric surgery was associated with lower overall mortality than usual obesity care. In middle - aged patients with severe obesity, life expectancy was approximately 3 years longer among patients who underwent surgery than among those who received usual care. [131]

Post - Bariatric Weight Recurrence and Pharmacotherapy for Regain

Bariatric surgery is a powerful tool for weight management and treating obesity - related comorbidities. [131 - 133] Yet weight regain occurs frequently a few years after bariatric surgery and it is often associated with recurrence of metabolic complications. [134, 135] Rates of weight regain vary across studies owing, in part, to variability in the definition. [135] One study reported that people regained an average of 22.5% of their lost weight at 3 years after surgery and more than two - thirds of them had regained at least 20% of their lost weight by 5 years. [135] Data from the Swedish Obesity Study suggest that weight loss is greatest at 1 to 2 years after bariatric surgery and rates of weight regain level off after 8 to 10 years. Currently, there is not a standardized or consistently utilized definition for post - bariatric weight regain. [136]

3. Conclusion

Obesity is a growing major health problem in populations. The lifestyle modification and pharmacotherapy remain important but are limited in weight loss results. Bariatric surgery is safe, effective and underutilized for treating obesity and related complication. Weight loss more than ten percent is often recommended. Metabolic bariatric surgery can effectively treat disease like type 2 diabetes and nonalcoholic fatty liver disease, and greater weight loss leads to greater remission in some group. In addition to atherosclerotic and cardiovascular risk reduction. Metabolic bariatric surgery may decrease cancer risk and increase life expectancy for people with obesity. promotes weight loss by modifying the gastrointestinal tract to restrict food intake, induce malabsorption. Bariatric surgery is associated with numerus complications, including the malabsorption of dietary of vitamins and minerals. Malabsorption can be averted through nutritional supplementation and periodic monitoring for deficiencies. Many complications can occur without sustained supplementation, of vitamins and minerals that induced by malabsorption bariatric surgery

References

[1] World Health Organization. Obesity and overweight. Geneva: WHO, 2017.
[2] Huxley R, Mendis S, Zheleznyakov E, et al. Body mass index, waist circumference and waist: hip ratio as predictors of cardiovascular risk – a review of the literature. Eur J Clin Nutr 2010; 64: 16–22.
[3] De Koning L, Merchant AT, Pogue J, et al. Waist circumference and waist - to - hip ratio as predictors of cardiovascular events: meta - regression analysis of prospective studies. Eur Heart J 2007; 28: 850–6.
[4] Visscher TL, Seidell JC, Molarius A et al. A comparison of body mass index, waist - hip ratio and waist circumference as predictors of all - cause mortality among the elderly: the Rotterdam study. Int J Obes Relat Metab Disord 2001; 25: 1730–5.
[5] Ervin, R. B. Prevalence of metabolic syndrome among adults 20 years or age and over, by sex, age, race and ethnicity, and body mass index: United States, 2003–2006. Natl Health Stat. Report 13, 1–7 (2009).
[6] Hussain, Z. & Quigley, E. M. M. Gastrointestinal issues in the assessment and management of the obese patient. Gastroenterol. Hepatol.2007; 3 (7): 559–569.
[7] Laura P Svetkey, Victor J Stevens, Philip J Brantley. et al. Comparison of strategies for sustaining weightloss: the weight loss maintenance randomized controlled trial. JAMA.2008 12; 299, 1139–1148.
[8] Clifton, P. M. Dietary treatment for obesity. Nat. Clin. Pract. Gastroenterol. Hepatol.5, 672–681 (2008).
[9] Purnell JQ. What is Obesity? Definition as a Disease, with Implications for Care. Gastrenterol Clin North Am.2023 52 (2): 261 - 275.
[10] Ramya Sivasubramanian, Sonali Malhotra. Genetic Contributors to Obesity. gastroenterol Clin North Am. 2023; 52 (2): 323 - 332.
[11] Brownson RC, Boehmer TK, Luke DA. Declining rates of physical activity in the United States: what are the contributors? Annu Rev Public Health 2005; 26: 42143.
[12] Ledikwe JH, Blanck HM, Khan LK, et al. Dietary energy density is associated with energy intake and weight status in US adults. Am J Clin Nutr 2006; 83: 13628.
[13] Cope MB, Allison DB. Obesity: person and population. Obesity 2006; 14: Suppl 4: 156S159S.
[14] Bal B, Koch TR, Finelli FC, Sarr MG. Managing medical and surgical disorders after divided Roux - en - Y gastric bypass surgery. Nat Rev Gastroenterol Hepatol 2010; 7: 320 - 34.
[15] Buscaglia J, Faris J. Unsteady, unfocused, and unable to hear. Am J Med 2005; 118: 1215 - 7.
[16] DeMaria EJ. Bariatric surgery for morbid obesity. N Engl J Med 2007; 356: 2176 - 83.
[17] Kumar N. Neurologic presentations of nutritional deficiencies. Neurol Clin 2010; 28: 107 - 70.
[18] Sechi G, Serra A. Wernicke's encephalopathy: new clinical settings and recent advances in diagnosis and management. Lancet Neurol 2007; 6: 442 - 55.
[19] Toh B - H, van Driel IR, Gleeson PA. Pernicious anemia. N Engl J Med 1997; 337: 1441 - 8.
[20] Chang SH, Stoll CR, Song J et al. The effectiveness and risks of bariatric surgery: an updated systematic review and meta - analysis, 2003–2012. JAMA Surg 2014; 149: 275–87.
[21] Burgos AM, Braghetto I, Csendes A et al. Gastric leak after laparoscopic - sleeve gastrectomy for obesity. Obes Surg 2009; 19: 1672–7.
[22] Cottam D, Qureshi FG, Mattar SG et al. Laparoscopic sleeve gastrectomy as an initial weight - loss procedure for high - risk patients with morbid obesity. Surg Endosc 2006; 20: 859
[23] Longitudinal AOBSLABSC, Flum DR, Belle SH et al. Perioperative safety in the longitudinal assessment of bariatric surgery. N Engl J Med 2009; 361: 445–54.
[24] Fernandez AZ, DeMaria EJ, Tichansky DS et al. Experience with over 3, 000 open and laparoscopic bariatric procedures: multivariate analysis of factors related to leak and resultant mortality. Surg Endosc 2004; 18: 193–7.
[25] Ballesta C, Berindoague R, Cabrera M, et al. Management of anastomotic leaks after laparoscopic Roux - en - Y gastric bypass. Obes Surg 2008; 18: 623–30.
[26] Higa KD, Ho T, Boone KB. Internal hernias after laparoscopic Roux - en - Y gastric bypass: incidence, treatment and prevention. Obes Surg 2003; 13: 350–4.
[27] Merrouche M, Sabaté JM, Jouet P et al. Gastro - esophageal reflux and esophageal motility disorders in morbidly obese patients before and after bariatric surgery. Obes Surg 2007; 17: 894–900.
[28] Lee WK, Kim SM. Three - year experience of pouch dilatation and slippage management after laparoscopic adjustable gastric banding. Yonsei Med J 2014; 55: 149–56.
[29] Singhal R, Bryant C, Kitchen M et al. Band slippage and erosion after laparoscopic gastric banding: a meta - analysis. Surg Endosc 2010; 24: 2980–6.
[30] Hess DS, Hess DW. Biliopancreatic diversion with a duodenal switch. Obes Surg 1998; 8: 267–82.
[31] Sethi M, Chau E, Youn A et al. Long - term outcomes after biliopancreatic diversion with and without

duodenal switch: 2 - , 5 - , and 10 - year data. Surg Obes Relat Dis 2016; 12: 1697–705.
[32] Sjöström L, Gummesson A, Sjöström CD, et al. Effects of bariatric surgery on cancer incidence in obese patients in Sweden (Swedish Obese Subjects study): a prospective, controlled intervention trial. Lancet Oncol 2009; 10: 653–62.
[33] Sarkhosh K, Switzer NJ, El - Hadi M, et al. The impact of bariatric surgery on obstructive sleep apnea: a systematic review. Obes Surg 2013; 23: 414–23.
[34] Bower G, Toma T, Harling L, et al. Bariatric surgery and non - alcoholic fatty liver disease: a systematic review of liver biochemistry and his - tology. Obes Surg 2015; 25: 2280–9.
[35] Sjöström L, Peltonen M, Jacobson P, et al. Association of bariatric surgery with long - term remission of type 2 diabetes and with microvas - cular and macrovascular complications. JAMA 2014; 311: 2297–304.
[36] Schauer PR, Kashyap SR, Wolski K, et al. Bar - iatric surgery versus intensive medical therapy in obese patients with diabetes. N Engl J Med 2012; 366: 1567–76.
[37] Schauer PR, Bhatt DL, Kirwan JP, et al. Bar - iatric surgery versus intensive medical therapy for diabetes: 5 - year outcomes. N Engl J Med 2017; 376: 641–51.
[38] Schauer PR, Bhatt DL, Kirwan JP, et al. Bar - iatric surgery versus intensive medical therapy for diabetes: 3 - year outcomes. N Engl J Med 2014; 370: 2002–13.
[39] Shah SS, Todkar JS, Shah PS, Cummings DE. Diabetes remission and reduced cardiovascular risk after gastric bypass in Asian Indians with body mass index 35 kg/m^2. Surg Obes Relat Dis 2010; 6: 332–8.
[40] Panunzi S, De Gaetano A, Carnicelli A, et al. Predictors of remission of diabetes mellitus in severely obese individuals undergoing bariatric surgery: do BMI or procedure choice matter? A meta - analysis. Ann Surg 2015; 261: 459–67.
[41] Cummings DE, Cohen RV. Bariatric/metabolic surgery to treat type 2 diabetes in patients with a BMI <35 kg/m2. Diabetes Care 2016; 39: 924–33.
[42] Jensen MD, Ryan DH, Apovian CM, et al.2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. J Am Coll Cardiol 2014; 63: 2985–3023.
[43] Rubino F, Nathan DM, Eckel RH, et al. Metabolic surgery in the treatment algorithm for type 2 diabetes: a joint statement by international diabetes organizations. Diabetes Care 2016; 39: 861–77.
[44] Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient–2013 update: Cosponsored by American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery. Obesity (Silver Spring) 2013; 21 Suppl 1: S1–27.
[45] Wentworth JM, Playfair J, Laurie C, et al. Multidisciplinary diabetes care with and without bariatric surgery in overweight people: a rando - mised controlled trial. Lancet Diabetes Endocrinol 2014; 2: 545–52.
[46] Adams TD, Arterburn DE, Nathan DM, et al. Clinical outcomes of metabolic surgery: microvascular and macrovascular complications. Diabetes Care 2016; 39: 912–23.
[47] Panunzi S, De Gaetano A, Carnicelli A, Mingrone G. Predictors of remission of diabetes mellitus in severely obese individuals undergoing bariatric surgery: do BMI or procedure choice mat - ter? A meta - analysis. Ann Surg 2015; 261: 459–67.
[48] Arterburn DE, Bogart A, Sherwood NE, et al. A multisite study of long - term remission and relapse of type 2 diabetes mellitus following gastric bypass. Obes Surg 2013; 23: 93–102.
[49] Karim Kheniser , Sangeeta R Kashyap , Canagliflozin versus placebo for post - bariatric surgery patients with persistent type II diabetes: A randomized controlled trial (CARAT). Diabetes Obes Metab; . 2017; 19 (4): 609 - 610.
[50] John P Kirwan, Anita P courcoulas, David E Cummongs, et al, Diabetes Remission in the Alliance of Randomized Trials of Medicine Versus Metabolic Surgery in Type 2 Diabetes (ARMMS - T2D). Diabetes Care. 2022; 45 (7): 1574–1583.
[51] Mingrone, Geltrude, Panunzi, et al. Metabolic surgery versus conventional medical therapy in patients with type 2 diabetes: 10 - year follow - up of an open - label, single - centre, randomised controlled trial. The Lancet. 397, 10271,: 293 - 304.
[52] Bilal Bshir, Zohair Iqbal, Safwaan Aam, et al. Microvascular complications of obesity and diabetes - Role of bariatric surgery. Obes Rev.2023 (10): e13602
[53] Douglas Barthold, Elizabeth Brouwer, Lee J Barton. Minimum Threshold of Bariatric Surgical Weight Loss for Initial Diabetes Remission. diabetes Care 2022 Jan 1; 45 (1): 92 - 99
[54] Ornella Verrastro, Simona Panunzi, Lidia Castagneto - Gissey, et al. Bariatric - metabolic surgery versus lifestyle intervention plus best medical care in non - alcoholic steatohepatitis (BRAVES): a multicenter, open - label, randomized trial. Lancet 2023; 401: 1786 - 97
[55] Vilar - Gomez E, Martinez - Perez Y, Calzadilla - Bertot L, et al. Weight loss through lifestyle modification significantly reduces features of nonalcoholic steatohepatitis. Gastroenterology 2015; 149: 367–78.
[56] Jastreboff AM, Aronne LJ, Ahmad NN, et al. Tirzepatide once weekly for the treatment of obesity. N Engl J Med 2022; 387: 205–16.
[57] Enebo LB, Berthelsen KK, Kankam M, et al. Safety, tolerability, pharmacokinetics, and pharmacodynamics of concomitant administration of multiple doses of cagrilintide with semaglutide 2·4 mg for weight management: a randomized, controlled, phase 1b trial. Lancet 2021; 397: 1736–48.
[58] Newsome PN, Buchholtz K, Cusi K, et al. A placebo - controlled trial of subcutaneous semaglutide in nonalcoholic steatohepatitis. N Engl J Med 2021; 384: 1113–24.
[59] Taylor RS, Taylor RJ, Bayliss S, et al. Association between fibrosis stage and outcomes of patients with

nonalcoholic fatty liver disease: a systematic review and meta - analysis. Gastroenterology 2020; 158: 1611–25.
[60] Aminian A, Al - Kurd A, Wilson R, et al. Association of bariatric surgery with major adverse liver and cardiovascular outcomes in patients with biopsy - proven nonalcoholic steatohepatitis. JAMA 2021; 326: 2031–42.
[61] Genco A, Castagneto - Gissey L, Gualtieri L, et al. GORD and Barrett's esophagus after bariatric procedures: multicenter prospective study. Br J Surg 2021; 108: 1498–505.
[62] Klebanoff MJ, Corey KE, Chhatwal J, et al. Bariatric surgery for nonalcoholic steatohepatitis: a clinical and cost - effectiveness analysis. Hepatology 2017; 65: 1156–64.
[63] Burza MA, Romeo S, Kotronen A, et al. Long - term effect of bariatric surgery on liver enzymes in the Swedish Obese Subjects (SOS) study. PLoS One 2013; 8: e60495.
[64] Clark JM, Alkhuraishi AR, Solga SF, et al. Roux - en - Y gastric bypass improves liver histology in patients with non - alcoholic fatty liver disease. Obes Res 2005; 13: 1180–86.
[65] Taitano AA, Markow M, Finan JE, et al. Bariatric surgery improves histological features of nonalcoholic fatty liver disease and liver fibrosis. J Gastrointest Surg 2015; 19: 429–36, discussion 436–37.
[66] Rubino F, Cohen RV, Mingrone G, et al. Bariatric and metabolic surgery during and after the COVID - 19 pandemic: DSS recommendations for management of surgical candidates and postoperative patients and prioritization of access to surgery. Lancet Diabetes Endocrinol 2020; 8: 640–48.
[67] Elsaid MI, Li Y, Bridges JFP, et al. Association of bariatric surgery with cardiovascular outcomes in adults with severe obesity and nonalcoholic fatty liver disease. JAMA Netw Open 2022; 5: e2235003.
[68] US Food and Drug Administration. Noncirrhotic nonalcoholic steatohepatitis with liver fibrosis: developing drugs for treatment. Guidance for industry. September, 2022. https: //www.fda. gov/ regulatory - information/search - fda - guidance - documents/ noncirrhotic - nonalcoholic - steatohepatitis - liver - fibrosis - developing - drugs - treatment (accessed Jan 2, 2023).
[69] Younossi ZM, Golabi P, de Avila L, et al. The global epidemiology of NAFLD and NASH in patients with type 2 diabetes: a systematic review and meta - analysis. J Hepatol 2019; 71: 793–801.
[70] Quek J, Chan KE, Wong ZY, et al. Global prevalence of non - alcoholic fatty liver disease and non - alcoholic steatohepatitis in the overweight and obese population: a systematic review and meta - analysis. Lancet Gastroenterol Hepatol 2023; 8: 20–30.
[71] Kleiner DE, Brunt EM, Van Natta M, et al. Design and validation of a histological scoring system for nonalcoholic fatty liver disease. Hepatology 2005; 41: 1313–21.
[72] Francque SM, Bedossa P, Ratziu V, et al. A randomized, controlled trial of the pan - PPAR agonist lanifibranor in NASH. N Engl J Med 2021; 385: 1547–58.
[73] Newsome PN, Buchholtz K, Cusi K, et al. A placebo - controlled trial of subcutaneous semaglutide in nonalcoholic steatohepatitis. N Engl J Med 2021; 384: 1113–24.
[74] Steinberger J, Daniels SR; American Heart Association Atherosclerosis, Hypertension, and Obesity in the Young Committee (Council on Cardiovascular Disease in the Young); American Heart Association Diabetes Committee (Council on Nutrition, Physical Activity, and Metabolism). Obesity, insulin resistance, diabetes, and cardiovascular risk in children: an American Heart Association scientific statement from the Atherosclerosis, Hypertension, and Obesity in the Young Committee (Council on Cardiovascular Disease in the Young) and the Diabetes Committee (Council on Nutrition, Physical Activity, and Metabolism). Circulation.2003; 107: 1448–1453.
[75] Van Gaal LF, Mertens IL, De Block CE. Mechanisms linking obesity with cardiovascular disease. Nature.2006; 444: 875–880.
[76] Romero - Corral A, Montori VM, Somers VK, et al. Association of bodyweight with total mortality and with cardiovascular events in coronary artery disease: a systematic review of cohort studies. Lancet.2006.
[77] Wing RR, Bolin P, Brancati FL, et al. Cardiovascular effects of intensive lifestyle intervention in type 2 diabetes. N Engl J Med.2013; 369: 145–154.
[78] Lavie CJ, Alpert MA, Arena R, Mehra MR, Milani RV, Ventura HO. Impact of obesity and the obesity paradox on prevalence and prognosis in heart failure. JACC Hear Fail.2013.
[79] Lavie CJ, Milani R V., Ventura HO. Obesity and cardiovascular disease: risk factor, paradox, and impact of weight loss. J Am Coll Cardiol.2009.
[80] Vest AR, Heneghan HM, Agarwal S, et al. Bariatric surgery and cardiovascular outcomes: a systematic review. Heart.2012; 98: 1763–1777.
[81] Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes: 5 - year outcomes. N Engl J Med 2017; 376: 641–651.
[82] Mingrone G, Panunzi S, De Gaetano A, et al. Bariatric - metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 - year follow - up of an open - label, single center, randomized controlled trial. Lancet.2015; 386: 964–973.
[83] Ikramuddin S, Korner J, Lee WJ, et al. Lifestyle intervention and medical management with vs without Roux - en - Y gastric bypass and control of hemoglobin A1c, LDL cholesterol, and systolic blood pressure at 5 years in the Diabetes Surgery Study. JAMA.2018; 319: 266–278.
[84] Fisher DP, Johnson E, Haneuse S, et al. Association between bariatric surgery and macrovascular disease outcomes in patients with type 2 diabetes and severe obesity. JAMA.2018; 320: 1570–1582.
[85] Aminian A, Zajichek A, Arterburn DE, et al. Association of metabolic surgery with major adverse cardiovascular outcomes in patients with type 2 diabetes and obesity. JAMA 2019; 322: 1271–1282.

[86] Courcoulas AP, Gallagher JW, Neiberg RH, et al. Bariatric surgery vs lifestyle intervention for diabetes treatment: 5 - year outcomes from a randomized trial. J Clin Endocrinol Metab 2020; 105: 866–876.
[87] Cummings DE, Arterburn DE, Westbrook EO, et al. Gastric bypass surgery vs intensive lifestyle and medical intervention for type 2 diabetes: the CROSSROADS randomized controlled trial. Diabetologia 2016; 59: 945–953.
[88] Aminian A, NissenSE. Success (butunfinished) story of metabolic surgery. Diabetes Care 2020; 43: 1175–1177
[89] Aminian A, Aleassa EM, Bhatt DL, et al. Bariatric surgery is associated with a lower rate of death after myocardial infarction and stroke: a nationwide study. Diabetes Obes Metab 2019; 21: 2058–2067.
[90] AngrisaniL, SantonicolaA, IovinoP, etal. IFSO worldwide survey 2016: primary, endoluminal, and revisional procedures. Obes Surg 2018; 28: 3783–3794.
[91] English WJ, DeMaria EJ, Hutter MM, et al. American Society for Metabolic and Bariatric Surgery 2018 estimate of metabolic and bariatric procedures performed in the United States. Surg Obes Relat Dis 2020; 16: 457–463.
[92] Ali Aminian, Rickesha Wilson, Alexander Zajichek, et al. Cardiovascular Outcomes in Patients with Type 2 Diabetes and Obesity: Comparison of Gastric Bypass, Sleeve Gastrectomy, and Usual Care. Diabetes care 2021; 44: 2552 - 2563.
[93] Aristithes G Doumouras, Jorge A Wong, J Michael Paterson, et al. Bariatric Surgery and Cardiovascular Outcomes in Patients with Obesity and Cardiovascular Disease: A Population - Based Retrospective Cohort Study. Circulation.2021; 143: 1468 - 1480
[94] Hula Hrund Bjornsdottir, Araz Rawshani, Aidin Rawshani, et al. A national observation study of cancer incidence and mortality risks in type 2 diabetes compared to the background population over time. Sci Rep 2020; 10: 17376.
[95] Calle EE, Rodriguez C, Walker - Thurmond K, et al. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U. S. adults. N Engl J Med 2003; 348: 1625–1638.
[96] Carlsson LMS, Sjo€holm K, Jacobson P, et al. Life expectancy after bariatric surgery in the Swedish Obese Subjects study. N Engl J Med 2020; 383: 1535–1543.
[97] Zhou XH, Qiao Q, Zethelius B, et al.; DECODE Study Group. Diabetes, prediabetes and cancer mortality. Diabetologia 2010; 53: 1867–1876.
[98] Pearson - Stuttard J, Zhou B, Kontis V, Bentham J, et al. Worldwide burden of cancer attributable to diabetes and high body - mass index: a comparative risk assessment. Lancet Diabetes Endocrinol 2018; 6: e6–e15
[99] Pearson - Stuttard J, Zhou B, Kontis V, et al. Worldwide burden of cancer attributable to diabetes and high body - mass index: a comparative risk assessment. Lancet Diabetes Endocrinol 2018; 6: e6–e15.
[100] Lauby - Secretan B, Scoccianti C, Loomis D, et al. International Agency for Research on Cancer Handbook Working Group. Body fatness and cancer—viewpoint of the IARC Working Group. N Engl J Med 2016; 375: 794–798
[101] Giovannucci E, Harlan DM, Archer MC, et al. Diabetes and cancer: a consensus report. Diabetes Care 2010; 33: 1674–1685
[102] Ling S, Brown K, Miksza JK, et al. Association of type 2 diabetes with cancer: a meta - analysis with bias analysis for unmeasured confounding in 151 cohorts comprising 32 million people. Diabetes Care 2020; 43: 2313–2322.
[103] Ohkuma T, Peters SAE, Woodward M. Sex differences in the association between diabetes and cancer: a systematic review and meta - analysis of 121 cohorts including 20 million individuals and one million events. Diabetologia 2018; 61: 2140–2154.
[104] Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta - analysis. JAMA2004; 292: 1724–1737.
[105] Adams TD, Stroup AM, Gress RE, et al. Cancer incidence and mortality after gastric bypass surgery. Obesity (Silver Spring) 2009; 17: 796–802
[106] Schauer DP, Feigelson HS, Koebnick C, et al. Bariatric surgery and the risk of cancer in a large multisite cohort. Ann Surg 2019; 269: 95–101.
[107] Sjo€stro€m L, Gummesson A, Sjo€stro€m CD, et al.; Swedish Obese Subjects Study. Effects of bariatric surgery on cancer incidence in obese patients in Sweden (Swedish Obese Subjects study): a prospective, controlled intervention trial. Lancet Oncol 2009; 10: 653–662.
[108] TaubeM, PeltonenM, Sjo€holmK, et al. Association of bariatric surgery with skin cancer incidence in adults with obesity: a nonrandomized controlled trial. JAMA Dermatol 2020; 156: 38–43.
[109] Tee MC, Cao Y, Warnock GL, et al. Effect of bariatric surgery on oncologic outcomes: a systematic review and meta - analysis. Surg Endosc 2013; 27: 4449–4456
[110] Ali Aminian, Rickesha Wilson, Abbas Al - Kurd, et al. Association of Bariatric Surgery with Cancer Risk and Mortality in Adults with Obesity. JAMA.2022; 327 (24): 2423 - 2433.
[111] Kajsa Sjoholm, Lean M S Calsson, Markku Peltonen, etal. Response to Comment on Sjöholm et al. Association of Bariatric Surgery with Cancer Incidence in Patients With Obesity and Diabetes: Long - term Results From the Swedish Obese Subjects Study. diabetescare 2022; 45: 444 - 450
[112] Cardoso L, Rodrigues D, Gomes L, et al. Short - and long - term mortality after bariatric surgery: a systematic review and meta - analysis. Diabetes Obes Metab 2017; 19: 1223–32.
[113] Kauppila JH, Tao W, Santoni G, et al. Effects of obesity surgery on overall and disease - specific mortality in a 5 - country population - based study. Gastroenterology 2019; 157 (1): 119–127. e1.
[114] Westerveld D, Yang D. Through thick and thin: identifying barriers to bariatric surgery, weight loss maintenance, and tailoring obesity treatment for the future. Surg Res Pract 2016; 2016: 8616581.
[115] Arterburn DE, Courcoulas AP. Bariatric surgery for obesity and metabolic conditions in adults. BMJ 2014; 349: g3961.

[116] Brantley PJ, Waldo K, Matthews - Ewald MR, et al. Why patients seek bariatric surgery: does insurance coverage matter? Obes Surg 2014; 24: 961–4.
[117] Sjöström L, Narbro K, Sjöström CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl JMed 2007; 357: 741–52.
[118] Wright JC, Weinstein MC. Gains in life expectancy from medical interventions — standardizing data on outcomes. N Engl J Med 1998; 339: 380–6.
[119] Prospective Studies Collaboration. Body - mass index and cause - specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. Lancet 2009; 373: 1083–96.
[120] Fontaine KR, Redden DT, Wang C, et al. Years of life lost due to obesity. JAMA 2003; 289: 187–93.
[121] Bhaskaran K, Dos - Santos - Silva I, Leon DA, et al. Association of BMI with overall and cause - specific mortality: a population - based cohort study of 3·6 million adults in the UK. Lancet Diabetes Endocrinol 2018; 6: 944–53.
[122] Kauppila JH, Tao W, Santoni G, et al. Effects of obesity surgery on overall and disease - specific mortality in a 5 - country population - based study. Gastroenterology 2019; 157 (1): 119–127. e1.
[123] Castaneda D, Popov VB, Wander P, et al. Risk of suicide and self - harm is increased after bariatric surgery — a systematic review and meta - analysis. Obes Surg 2019; 29: 322–33.
[124] Azam H, Shahrestani S, Phan K. Alcohol use disorders before and after bariatric surgery: a systematic review and meta - analysis. Ann Transl Med 2018; 6: 148.
[125] Kanji S, Wong E, Akioyamen L, et al. Exploring pre - surgery and post - surgery substance use disorder and alcohol use disorder in bar iatric surgery: a qualitative scoping review. Int J Obes 2019; 43: 1659–74.
[126] Adams TD, Gress RE, Smith SC, et al. Long - term mortality after gastric bypass surgery. N Engl J Med 2007; 357: 753–61.
[127] Svensson PA, Anveden Å, Romeo S, et al. Alcohol consumption and alcohol problems after bariatric surgery in the Swedish Obese Subjects study. Obesity (Silver Spring) 2013; 21: 2444–51.
[128] Neovius M, Bruze G, Jacobson P, et al. Risk of suicide and non - fatal self - harm after bariatric surgery: results from two matched cohort studies. Lancet Diabetes Endocrinol 2018; 6: 197–207.
[129] Konttinen H, Sjöholm K, Jacobson P, et al. Prediction of suicide and nonfatal self - harm after bariatric surgery: a risk score based on sociodemographic factors, lifestyle behavior, and mental health: a non - randomized controlled trial. Ann Surg 2021 1; 274 (2): 339 - 345.
[130] Carlsson LMS, Sjöholm K, Ahlin S, et al. Long - term incidence of serious fall - related injuries after bariatric surgery in Swedish obese subjects. Int J Obes 2019; 43: 933–7.
[131] Lean M S Carlsson, Kajas Sjoholm, Peter Jacobson, et al, Life Expectancy after Bariatric Surgery in the Swedish Obese Subjects Study. N Engl J Med 2020; 383: 1535 - 1543.
[132] Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical ther - apy for diabetes– 3 - year outcomes. N Engl J Med 2014; 370: 2002 - 2013.
[133] Lee GK, Cha YM. Cardiovascular benefits of bariatric surgery. Trends Cardiovasc Med 2016; 26: 280 - 289.
[134] Velapati SR, Shah M, Kuchkuntla AR, et al. Weight regains after bariatric surgery: prevalence etiology, and treatment. Curr Nutr Rep 2018; 7: 329 - 334.
[135] King WC, Hinerman AS, Belle SH, et al. Comparison of the performance of common measures of weight regain after bariatric surgery for association with clinical outcomes. JAMA 2018; 320: 1560 - 1569.
[136] Voorwinde V, Steenhuis IHM, Janssen IMC, et al. Definitions of long - term weight regain and their associations with clinical outcomes. Obes Surg 2020; 30: 527 - 536.