Critical review of bariatric surgery, medically supervised diets, and behavioural interventions for weight management in adults

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Abstract

Aims: Patient selection of weight management treatment option is often guided by a variety of factors. Currently, there is no comprehensive tool to facilitate informed decision-making for patients and clinicians. This article aims to synthesise evidence on the treatment effectiveness, health benefits, risks, and patient experiences of treatment options presently available at the Weight Management Clinic at The Ottawa Hospital (TOH), as a first step towards developing a decision aid.

Methods: Narrative and systematic reviews published in English between 1999 and 2014 were included that focused on one or more of the following weight management treatments in adults aged 18 years and over: roux-en-y gastric bypass (RYGB), sleeve gastrectomy (SG), medically supervised meal replacement, and behavioural or lifestyle intervention.

Results: Overall, bariatric surgeries have received the greatest research attention and have been associated not only with greater weight loss and health benefit but also with greater risks, complications, and financial cost. Dietary programmes demonstrated weight loss and health benefits to a lesser extent than with surgery but were associated with lower and shorter-term risks and complications. Behavioural and lifestyle interventions have been studied less yet have shown significant, albeit small, weight loss outcomes alone and in combination with dietary or surgical options; they also appear to be the lowest risk interventions. Patient experiences of weight management options are mixed and not well understood.

Conclusion: Further research is needed; however, this review identified some general trends related to weight loss outcomes, benefits, risks, and barriers for weight management options that have implications for shared treatment decision-making.

INTRODUCTION

Obesity is on the rise in Canada, affecting at least 18% of Canadians.[1] Individuals with obesity are at risk of and experience a number of health co-morbidities, reduced life expectancy, and poorer quality of life.[2–7] Persons in higher obesity classes, when considering the World Health Organization (WHO) classification of weight status (class I: body mass index (BMI) of 30–34.9 kg/m^2, class II: BMI of 35–39.9 kg/m^2; class III: BMI of >40 kg/m^2), experience lower quality of life and greater risk of co-morbidities[5,8] compared to those with lower BMI. From a public health standpoint, obesity is a costly condition.[6,9]

People seek out weight management programmes often with the primary goal of reducing their weight.[10] Reduction of body weight by 5%–7% has been shown to improve general health,[11] which supports weight management as a remedy for obesity. There exists a range of weight management options, including surgical, pharmacological, dietary and behavioural interventions, and approaches that combine multiple interventions. Many of these interventions can be sought in Canada, either commercially (e.g. dietary or behavioural programmes such as Weight Watchers) or through hospital-based programmes (e.g. bariatric surgery and medically supervised dietary programmes). Interventions vary in the benefits, risks and cost to the patient and in terms of contact required with health professionals.

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Well-established weight management interventions have undergone systematic reviews.[12] However, this information is not compiled across interventions or readily accessible to clinicians and patients making it more difficult for patients to gain a clear understanding of the risks and benefits of various treatments. It is also overly burdensome for clinicians with limited time and multiple demands to maintain up-to-date knowledge on the effectiveness and risks of various interventions.[13]

This gap hinders shared decision-making, a patient-centred approach that emphasises fully informing and engaging the patient in their health-care decisions.[14,15] It involves the patient and clinician sharing 'the best available evidence when faced with the task of making decisions and where patients are supported to consider options, to achieve informed preferences'.[16] Shared decision-making is associated with improved treatment outcomes and a reduction in medical costs.[15] It is considered especially useful for illnesses that are severe and chronic and when multiple treatment options are available with no obvious treatment choice,[17,18] making it well suited to the selection of a weight management treatment option. To support shared decision-making, patient decision aids have been developed that highlight patient preferences, values, and trade-offs of different treatment options.[19–22] Randomised controlled trials of decision aids have shown that utilising these tools led to patients feeling more informed and clear about personal values in relation to treatment, becoming more active in the decisional process, and less undecided about treatment.[19] Explicit presentation of treatment successes and associated risks also provided a more accurate understanding of risk. For instance, decision aid use was related to reduced selection of major elective invasive surgery compared to more conservative treatment options. Methods of value clarification in decision aids have also been examined, with the listing of pros and cons as the most commonly used, followed by prioritisation and rating scales.[23]

WEIGHT MANAGEMENT OPTIONS

Surgical interventions

A number of bariatric surgery procedures are currently in use including the roux-en-y gastric bypass (RYGB), sleeve gastrectomy (SG), adjustable gastric banding (AGB), and biliopancreatic diversion with or without duodenal switch. Of these, the RYGB is considered to be the 'gold standard', and the surgery is most commonly used in Canada and the United States.[24–26] The RYGB is an irreversible procedure, which leads to restriction of food intake and malabsorption of food consumed.[24] Typically done laproscopically, staples are used to first create a 15- to 30-mL gastric pouch. The jejunum, part of the small intestine, is then divided and connected to the gastric pouch, effectively bypassing sections of the small intestine. The SG was first introduced as the initial step in a staged approach to the RYGB and biliopancreatic diversion in 1988.[27] The SG leads to the restriction of food intake via the creation of a gastric sleeve but, unlike the RYGB, does not involve malabsorption as the small intestine remains fully intact. Although the RYGB is well researched and considered to be the standard of practice, in preliminary studies, the SG has yielded similar weight loss outcomes and, thus, may be performed in cases where the RYGB is contraindicated.[28]

Dietary-focused interventions

Most medically supervised dietary-focused programmes are based on the principle of caloric restriction, which over time is believed to result in weight loss due to the creation of an energy deficit.[6,29] The extent to which intake is restricted varies (e.g. low-calorie diet vs very low–calorie diet (VLCD)), as does the method of creating an energy deficit (e.g. diets that specifically restrict the intake of fat, carbohydrates, or both).[30] VLCDs are defined as intake of <800 kcal/day, whereas other diets focus on the proportion of protein versus carbohydrate intake while lowering overall calorie intake.[31] Ongoing medical supervision is necessary for programmes with greater restriction. Meal replacement drinks and food bars are also used as they are nutritionally balanced and assist patients in managing portion size. Many dietary interventions are combined with physical activity to maximise energy expenditure.[32]

Behavioural and lifestyle interventions

Behavioural and lifestyle interventions, which for the purposes of this article include behavioural interventions that extend beyond dietary-only programmes, are important components of weight management treatment as non-adherence to recommendations and other lifestyle factors (e.g. sedentary lifestyle and other health behaviours) are often significant barriers to weight management. Behavioural interventions are essential for long-term maintenance of weight loss and prevention of weight regain.[33] Most weight management interventions, be it surgical or dietary, involve some behavioural intervention where the individual is counselled regarding health behaviours that might support or hamper weight reduction.[34] Intervention to address psychosocial elements such as emotional issues that maintain dysfunctional eating may also be involved.[35] Behavioural modification programme components often include self-monitoring (i.e. tracking health behaviours) and stimulus control (i.e. managing the environment to alter behaviour).[36] Exercise training is another common component and goal in behavioural interventions.[37] Specific interventions used often include motivational interviewing and cognitive behavioural therapy.[6,38]

REVIEW OBJECTIVE

The objective of this article is to synthesise existing empirical knowledge on the treatment effectiveness, health benefits, risks, and patient experiences of those weight management options presently available at a hospital-based weight management programme in Ottawa, with the aim of facilitating the process of shared decision-making. This review is a synthesis of the literature and is not a systematic review. Two known decision aids for bariatric surgery and weight loss diets currently exist (e.g.

'should I have weight loss surgery?': http://www.healthwise.org). Each is a stand-alone decision aid and does not assist the patient and clinician in comparing various weight management options. A decision aid including the different weight management treatments and their unique benefits and risks would likely be helpful in facilitating shared decision-making. This review is a crucial first step in the development of a patient decision aid[39] to be used at this site and subsequently could be adapted for use at other similar programmes in Ontario and elsewhere.

METHODS

Inclusion–exclusion criteria and procedure

This review included previous reviews (systematic and non-systematic) related to weight management in adults aged 18 years and over, published in English, on one or more of the following treatments: RYGB, SG, dietary-focused interventions, and other behavioural and lifestyle interventions. These treatments were included as they are most relevant to the treatment options offered at The Ottawa Hospital (TOH). Treatments not included in the scope of this review included other bariatric surgery procedures, pharmacotherapy, commercial weight loss programmes, and nutritional supplements; these were excluded due to lack of evidence on effectiveness (e.g. nutritional supplements), lack of availability in Canada (e.g. pharmacotherapy), and incompatibility with hospital-based outpatient weight management programmes (e.g. AGB and commercial weight loss).[40] No limits were set in terms of behavioural and lifestyle interventions.

A search for relevant review articles was conducted in the following databases: Medline, Web of Science, Cochrane, and PsycInfo from 1999 to 2014. The following search terms were used: *weight loss, weight management, bariatric surgery, obesity treatment, roux-en-y, gastric sleeve, meal replacement, very low carbohydrate diet, very low energy diet, very low calorie diet, very low fat diet, lifestyle/behavioural program/intervention/treatment, patient experiences, patient expectations, patient costs*. Search terms were kept broad given the focus of this review on other reviews. A mix of systematic reviews, meta-analyses, and narrative reviews were included as identified by two researchers; a third researcher was also consulted to ensure that key articles were captured in the search.

Due to limited number of reviews related specifically to patient experiences and values in weight management, the literature search on this topic was expanded and considered non-review articles. Information from seven such articles was included to provide some preliminary knowledge on patient experiences of weight management treatments. Non-review literature was also consulted related to psychological outcomes to weight management treatments as these have also been less well researched.

The articles were reviewed according to topics for critical comparison across weight management options and included four broad areas: *weight loss, other health benefits, risks and barriers*, and *patient experiences*. The topic of *other health benefits* consisted of the literature related to *type 2 diabetes, cardiovascular risk factors, sleep apnoea*, and *psychosocial benefits.* The topic *risks and barriers* was further organised into *mortality and complications, possible negative outcomes, attrition and adherence*, and *financial cost to patient.* Topics considered to be important for treatment decision-making were generated from the existing literature about the treatment options themselves and also from patient preferences highlighted in the shared decision-making literature.

RESULTS

Results are organised according to the topic across the weight management options included in this review.

Weight loss

Bariatric surgery, dietary programme, and behavioural or lifestyle modification differ in the short-term percentage weight loss and long-term maintenance of weight loss. Method of reporting percentage weight loss was inconsistent across studies,[11,12] where bariatric surgery outcomes tended to be reported in percentage of excess body weight loss (EWL), while dietary and behavioural programme outcomes were reported in percentage of initial body weight loss (IWL). Other studies also utilised percentage reduction of BMI, change in BMI class, and change in kilograms or pounds. For the purposes of comparison, percentage EWL and IWL will be used in this article (refer to Table 1 for details).

When comparing bariatric surgeries to non-surgical interventions, reviews show greater weight loss with bariatric surgeries at 2 years and up to 8 years, particularly for RYGB.[92,93] Less is known about the weight loss outcomes for SG as compared to RYGB after 1–2 years.[12,24,28] Overall, evidence for EWL beyond 5 years post-surgery for both RYGB and SG is limited.

In terms of dietary programmes, VLCDs have received an abundance of research support,[31,46,55] and percentage IWL appears to plateau with VLCD between 2 and 5 years at 3%–6%.[46,51] Additionally, low-carbohydrate–high-protein (LCHP) diet appears to lead to greater IWL compared to low-fat diet (LFD) at 6 months.[29,47]

Reviews consistently demonstrate that weight loss in surgery and dietary programmes can be augmented and better maintained when combined with lifestyle and behavioural interventions.[32,55–59] This finding is particularly true when behavioural change also involves the bolstering of social support, such as that offered through a support group.[56,60]

In terms of behavioural and lifestyle modification alone, studies show significant results especially when programmes involve multiple components such as diet, exercise, and motivational enhancement.[6,13,38,48,53,54] In the context of dietary change, behavioural interventions specifically focusing on self-monitoring, relapse prevention, and prompting behavioural change lead to greater weight loss.[88] Mode of delivery for the behavioural intervention may affect weight loss and maintenance. Greater patient contact (face to face vs phone vs online)

Table 1

Benefits, risks, and other issues across weight management treatment option

Outcomes	Weight management treatment options		
	Surgical	**Dietary**	**Behavioural**
Weight loss	At 6 months RYGB 55%–62% ↓ EWL[41,42] SG 35%–60% ↓ EWL[24,41,43] At 1 year RYGB 51%–76% ↓ EWL[26,42] SG 63% ↓ EWL[44] At 3–5 years RYGB 53%–94% ↓ EWL[24,26,41,45] SG 61%–81% ↓ EWL[41] At 10 years RYGB 52% ↓ EWL[45]	At 6 months[29,46,47] Low-calorie diets 5%–9% ↓ IWL VLCD ↓ 16% IWL At 1 year VLCD showed greatest %IWL compared to other diets,[48] about 10%[46] Maintained with meal replacements 7%–8% ↓ IWL[49,50] At 4–5 years VLCD 3%–6% ↓ IWL[46,51]	At 1 year, 10% ↓ IWL[52] At 3 years, 5%–7% ↓ IWL[41,42] Better weight loss and maintenance with: Multi-component programmes[6,13,48,53,54] In-person contact with health provider as compared to telephone or online support[36] Dietitian counselling combined with physician monitoring more effective than physician care alone[34]
	Better weight loss maintenance when combined with behavioural intervention[32,55–59] or weight loss support group[56,60]		
Type 2 diabetes	At 1 year RYGB resolution of type 2 diabetes 41%–78%[26,42,61,62] SG 26%–64% resolution of type 2 diabetes[62] RYGB reduces risk of developing type 2 diabetes[61,63]	VLCD improves glucose control and reduces risk of developing type 2 diabetes[32] Inconsistent evidence for resolution of type 2 diabetes[59,64]	Improves glucose control in type 2 diabetes[65] No evidence for resolution of type 2 diabetes[65]
Cardiovascular risk factors	At 1 year RYGB 47%–60% improvement and 23%–88% resolution of hypertension; 29%–49% improvement and 60%–83% resolution of lipid disease[42] SG 7%–55% improvement and 15%–93% resolution of hypertension;[52] 42%–84% resolution or improvement of lipid disease[44] Improvement in cardiac structure, for example, left ventricular hypertrophy and reduction of left atrial size[66]	LCHP diet – improvement in lipid profiles and cardiovascular risk, more effective than low-fat diets[29] At 6 months, LCHP diet showed greater improvement in cardiovascular risk than LFD[29] At 5 years, improvement maintained LCHP diet[29] VLCD – improvement in hypertension[32]	At 3 years, improvement in hypertension and lipid levels[65,67,68]
	Reduced improvements over longer term; further study required to understand relationship between weight and hypertension[69]		
Sleep apnoea	RYGB 70% resolution, 32%–88% improvement[70] SG 39%–86% improvement or resolution[53,71]	VLCD – improvement in sleep apnoea[32]	No evidence
Psychosocial benefits	Improvements in disordered eating[35,57] including binge eating and purging behaviours,[57] chronic pain,[57] sexual satisfaction, depression, health-related quality of life,[57] self-esteem, occupational status[71]	VLCD – reduced binge eating symptoms; effect on other disordered eating (e.g. restrictive) not known[32] Dietary interventions in general: Improvement in body image, quality of life No change or improvement in depressive symptoms[72]	Improvement in eating behaviours,[35] cardiovascular fitness, muscle strength, lean body mass,[33] self-esteem, body image[73] Reduced knee pain and improved gait and physical functioning for programmes focusing on behaviour change for exercise and diet[74,75]

(Continued)

Table 1 (Continued)

Outcomes	Weight management treatment options		
	Surgical	**Dietary**	**Behavioural**
Mortality and complications	Mortality: RYGB 0.1%–0.5%;[26,42] SG 0.2%[52,76] RYGB re-operation rate 12%–19%[26] Major complications less frequent in SG (5%) compared to RYGB (11%)[77] RYGB complications[13,24,41,77–79] 14%–20% long-term complications 2% complications required hospitalisation, most common: anastomotic strictures, GI bleeding, internal hernias Bowel obstruction, anastomotic leak, sepsis, nutritional deficiencies, osteoporosis, stomach ulceration, gallstones, diarrhoea Iron deficiency 15% (vs 2% iron deficiency for non-surgical) SG complications[41,52,80] Rate 0%–24% SG short-term complications: anastomotic leak (2%–3%), dietary intolerance, stoma stenosis	LCHP diet – constipation (68%), headache (60%), halitosis (38%), muscle cramps (35%), diarrhoea (23%), general weakness (25%), skin rash (13%)[47] LFD – constipation (35%), headache (40%), halitosis (8%), muscle cramps (7%), diarrhoea (7%), general weakness (8%), no skin rash[47] Post diet risks are less known	Minor risks associated with exercise[37]
Possible negative outcomes	Risk of depression and suicidality (4.1/10,000 persons)[57,71] Loose skin (70%)[81] Long-term disordered eating and poorer food choices post-surgery[82] Dissatisfaction related to not meeting weight loss and benefit expectations[71,83,84] Feeling unprepared for extreme psychosocial and lifestyle changes post-surgery[85]	VLCD – during diet – VLCD – symptoms of depression and anxiety possible, especially when programme does not include behavioural component[86,87]	Not documented
Attrition and adherence to programmes	Missed appointments 65%–72%[82] Non-adherence to instructions 39%–57%[82] Retention in post-surgery behavioural management 80% at 1 year[58,82]	Across diets attrition of 29% at 1 year[46] VLCD 23% drop out[32] Meal replacement diets dropout lower than reduced calorie diets at 1 year[50] LCHP diet completion better than LFD[29,30]	Dropout at completion 16%[88] Completion rate of 50%–97%[65] Attrition related to difficulties with exercise component[89]
Financial cost to the patient	Average cost for surgical programme at TOH: CAD$300 for meal replacement drinks (3 weeks pre-surgery) CAD$60 for protein supplements (6 weeks post-surgery) CAD$60/month over patient's life, for nutritional supplements 4 weeks medical leave or unpaid time-off for surgery and recovery Minimum six appointments pre-surgery and 5-year follow-up	Average cost for VLCD with meal replacement drinks at TOH: CAD$800 for 6 weeks, or CAD$1,400 for 12 weeks, programme depending, for meal replacements drinks 26 weeks of group meetings and weekly medical appointments (3-h commitment per week)	Average cost for programme[a] at TOH: No specific monetary cost At least six appointments on monthly basis with dietitian and physician

(Continued)

Table 1 (Continued)

Outcomes	Weight management treatment options		
	Surgical	Dietary	Behavioural
	Appointments at TOH are covered under provincial health plan but are associated with other costs (e.g. time away from work, transportation, parking, and child care)		
Patient experience of treatment	RYGB (80%) greater satisfaction compared to other surgeries[90] Misconception of seeing bariatric surgery as a cure and preferring non-active role[90]	Common difficulties in LFD: controlling eating when hungry, motivation to eat healthily, using food as reward[91] Common preference in LFD: when patients were 'doing it on their own' and in research programme[91]	Limited knowledge

GI: gastrointestinal; EWL: excess body weight loss; IWL: initial body weight loss; LCHP: low-carbohydrate–high-protein; LFD: low-fat diet; RYGB: roux-en-y gastric bypass; SG: sleeve gastrectomy; VLCD: very low–calorie diet.
[a]Costs and appointments are approximates and may differ across patients.

seems to improve weight loss maintenance.[24,26,41,45] Delivery of multi-component programmes by dietitian and physician, versus physician alone, also led to improved outcomes.[34] The focus of content was also important. For instance, when the content was focused on behaviour modification rather than simply education, weight loss and maintenance was greater up to 1-year post-intervention.[36]

OTHER MEDICAL BENEFITS

Type 2 diabetes

Treatment of obesity has been shown to confer benefit to related health problems such as diabetes and hypertension. Prevention and resolution of diabetes post-RYGB were related to substantial and sustained weight loss (i.e. >33% total body weight, 30% BMI decrease from baseline, and >2–10 years). Bariatric surgeries are associated with the resolution of pre-surgical type 2 diabetes[26,42,61,62] and improvement in glucose control,[94] with extent being related to the amount of weight lost.[63] In terms of dietary programmes, those involving meal replacements appear to offer a promising strategy for management of type 2 diabetes rather than resolution of the condition,[40,95] by limiting food choices, controlling portion size, and caloric intake and also preventing macronutrient deficiencies.[95,96] In general, studies suggest that 10% IWL can lead to a positive effect on diabetes status, with combined dietary and behavioural approaches showing the best effect.[54] Resolution of diabetes after dietary or behavioural programmes has been studied less (refer to Table 1 for details).[48,94]

Cardiovascular risk factors

Improvement in specific cardiovascular disease risk factors has been found including for lifestyle interventions[67] but tends to be less significant than that of diabetes. Although the amount of improvement tends to relate to the amount of weight lost,[42,66] this relationship remains unclear.[31,32,97] More recent evidence suggests that improvements in hypertension and lipid disease may be dependent on reaching >5% IWL.[97–99] These findings would suggest that improvement in cardiovascular risk with behavioural modification does not require significant weight loss.[32]

Sleep apnoea

Sleep apnoea is another serious health condition that tends to remit after bariatric surgery.[70] Dietary programmes, namely, VLCD, also lead to improvements in sleep apnoea,[32] specific rates not identified. Evidence for improvement in sleep apnoea with behavioural or lifestyle interventions was not found.

Psychosocial benefits

Weight management treatment is also associated with positive changes in psychosocial factors (see Table 1 for details). In terms of bariatric surgeries, greater benefits have been found with participation in a post-surgical behavioural programme.[58] The literature, however, is mixed with regard to the impact of psychosocial factors on predicting post-surgical outcomes.[60,100] These reviews found that while personality factors do not independently predict post-operative weight loss, they may play an indirect role in both psychological and behavioural adjustment during the post-operative period. These reviews also concluded that aside from psychosocial predictors, pre-surgical BMI and pre-operative weight loss were negatively and positively associated with post-operative outcomes, respectively.[60,100]

There is also evidence in support of psychosocial benefits for both dietary and behavioural interventions; these benefits are related to the degree of weight loss.[32] Improvements in physical functioning found for behavioural programmes seem to be particularly related to the exercise component,[37] which also helps to prevent further weight gain.[33] Limited evidence exists related to the benefits for occupational functioning.

RISKS AND BARRIERS

Mortality and complications

In the case of surgery, laparoscopic procedures have been found to be safer than open bariatric surgery,[101] and most procedures are now conducted in this fashion. Clinics conducting a higher number of surgical procedures tend to have lower mortality and complication rates. The same is true for those centres certified as Bariatric Surgery Centers of Excellence as compared to uncertified surgical sites.[102] Risk is reduced with a surgeon volume of at least 25 cases per year.[103] It is also important to consider the types of complications that arise. For instance, RYGB complications include bowel obstruction, anastomotic leak, and sepsis. Less is known about complications for SG (see Table 1 for details). Although more is known about risks with surgical as compared to non-surgical treatments, a review did show surgical treatments (e.g. RYGB and SG) to pose a greater range of complications relative to non-surgical treatments.

In terms of dietary programmes, possible side effects of medically supervised VLCDs and LCHP diets are similar and seem most common during periods of rapid weight loss. Side effects are usually mild (e.g. fatigue, constipation, nausea, and diarrhoea) and can generally be well managed although there are more significant risks, such as increased risk of gallstones.[59] Diets involving restriction of carbohydrates and a focus on protein intake are known as ketogenic diets and are also associated with a range of side effects. Cholesterol and low-density lipoproteins were found to decrease with prolonged protein intake (see Table 1 for details).[47] Similar side effects and safety concerns were reported of a dietary regimen involving meal replacements.[49] Long-term issues with LCHP diets are less well known, and most studies on the effect of LCHP diets involve time frames of only 12 months. Risks associated with behavioural programmes are minor and, if any, typically linked to exercise.

Possible negative outcomes

Disordered eating has been noted after long-term follow-up post-surgery,[104] although may or may not be related to pre-surgery eating pathology.[57] Another possible post-surgical outcome involves increased risk of depression and suicidality.[105] Specifically, studies in the area of bariatric surgery have found that relative to the reduction in mortality rates associated with cardiovascular illness following weight loss surgery, the risk of death due to emotional causes tends to rise. Several researchers have found that suicide rates in bariatric surgery populations are significantly higher than that of the general population, with some studies citing that suicide attempts are as much as 73 times greater among post-surgical patients.[106,107] Some of the possible explanations for this statistic include the finding that bariatric surgery patients tend to have higher levels of pre-surgical psychopathology and/or personality characteristics that predispose them to suicide risk,[105] that post-surgical body image may not live up to pre-surgical expectations,[108] and that post-operative change in psychopharmacokinetics may alter the efficacy of psychotropic medications.[105] Research has shown that those on VLCD may be at greater risk of developing depressive symptoms than those undergoing RYGB.[32] Also for VLCD, binge eating symptoms were shown to be reduced, but restrictive or other disordered eating was not measured.[86,88]

Attrition and adherence to programmes

Attrition rates have been particular concerns for dietary programmes. In VLCDs, attrition rates appear to be higher in the follow-up phase rather than during the VLCD period.[49] However, for patients who dropped out of VLCD in the initial phase of the programme, reasons included distaste, poor adherence to the diet, and work schedule, rather than due to side effects of the diet. When combined with behavioural modification, attrition to VLCD was reduced.[32] Related to adherence to dietary regimen, satiety and appetite also play a role. This area is only beginning to be investigated in terms of how sensory signals change as carbohydrates are being restricted.[30] At this time, it is thought that protein has greater satiety effect and, thus, is a helpful feature of LCHP diets.[29,30] In general, there has been suboptimal reporting of attrition in weight loss interventions (see Table 1 for further details).[109] Consequently, although much has been studied with regard to the correlates of non-adherence and/or attrition, very little has been investigated in terms of the rates of attrition across various programmes.

Financial cost to the patient

In terms of barriers to using certain weight management programmes, cost may play an important role in surgical and dietary programmes. Surgical options require frequent appointments with multiple care providers, travel costs to medical appointments, financial cost of about 4 weeks' time away from work post-surgery, as well as the cost of vitamin and mineral supplement likely for the rest of the patient's life. The cost associated with the pre- and post-operative health care itself (i.e. physician visits, surgery, and hospital stay), however, is covered by the Ontario provincial health-care plan.

VLCDs also require the monitoring of physicians and likely other health providers during the diet period, a cost that is covered by provincial health plans in Canada but would typically cost around CAD$3,500 over 6 months in the United States. Liquid meal replacements are also used as part of a VLCD, as is done at TOH, and requires similar financial cost to the patient. Information on financial barriers of behavioural and lifestyle programmes are lacking, although it is likely that the cost is comparably lower than surgery and dietary programmes in the case of the programme being offered within the hospital setting (as compared to private or commercial programmes). Research has shown practical issues such as need to travel to a clinic, financial difficulties, and cost for treatment as related to attrition.[110]

PATIENT EXPERIENCES

Research on patient experiences relevant to treatment decision-making such as patient satisfaction, expectations, pre-weight loss reasons or assumptions, and patient values and preferences was

limited (see Table 1 for further details).[10] Patients may feel ambivalent about health needs and, as a result, be reluctant to seek or use relevant services.[111] Another patient experience is that of feeling personally responsible for the condition and feeling a sense of stigma and helplessness.[111]

With regard to patient goals and expectations prior to attempting weight loss, one study showed that realistic goals were not related to weight loss outcomes nor was receiving the treatment option that the patient preferred.[112] Other studies found a complex relationship between weight loss goal, effort, and distress,[113] such that patients tended to have unrealistically high weight loss goals and that this was unrelated to distress and only weakly related with behavioural efforts or weight outcomes. A systematic review of the literature on weight loss expectations and various outcomes also showed inconsistencies.[114] Overall, satisfaction appears to be related to the amount of weight loss and health benefits.[71]

In terms of dietary programmes, patient satisfaction has been linked to weight loss and improved health status,[115] which was also related to improved diet, increased physical activity, and improved body image. Some individuals reported preferring weight loss regimens that involved less monitoring.[91] In a review of bariatric surgery research, Coulman *et al*.[116] demonstrated that patient-reported outcomes are underused, leading to limited understanding about psychosocial issues, body image, and eating behaviours for patients post-surgery.

DISCUSSION

This review identified some general trends related to weight loss outcomes, benefits, risks, and barriers for weight management options. Overall, bariatric surgeries have received the greatest research attention; have been associated with the greatest weight loss and physical health benefit; and yet also come with greater risk, complications, and financial barriers to treatment. Dietary weight management programmes also tend to lead to significant weight loss and health benefits but to a lesser extent than surgery; they have fewer and short-term risks and complications. A more significant barrier for dietary programmes may be adherence to treatment. Behavioural and lifestyle interventions have received the least research attention, show mixed weight loss outcomes alone but significant results when in combination with dietary or surgical options, and are the lowest risk. Patient experiences of weight management options are mixed and not well understood.

Limitations of the review

As with any critical review, comparability of studies is a concern. This article reviewed existing reviews, for which, the quality of the reviews and studies included varied. For instance, no randomised control studies on SG and improvement of lipid disease have been published, and thus, the systematic review was based on case series and non-randomised trials.[44] This review is also limited to the types of treatments offered at TOH, which, although similar to many hospital-based weight management programmes in Ontario and elsewhere, did not include community-based commercial programmes, privately funded surgical procedures (i.e. AGB), or pharmacological options. Informed decision-making needs to take into account the availability and feasibility of treatment options, and thus, adaptation of any decision tool developed from these findings would be required for other sites.

Important limitations to the existing literature are inconsistencies in patient selection, duration of follow-up, and measurement of outcomes, in addition to limited data that permitted direct comparison of various treatment modalities. For instance, reviews did not consistently report sample BMIs which may lead to misleading conclusions about treatment options, as it is likely that individuals with BMI between 30 and 35 kg/m^2 vary from those with BMI > 40 kg/m^2. There are also important distinctions with regard to how weight loss is represented. Specifically, EWL takes into account the height and weight of the individual via the ideal body weight (as based on the Metropolitan Life Tables, 1979), while IWL does not. Thus, EWL numerically under-represents the amount of weight lost. Comparability across studies on behavioural and lifestyle modification can also be problematic, such that the type and content of behavioural interventions vary to a greater degree as compared to bariatric surgeries where procedures are protocol based. This variability may lead to difficulty in interpreting and synthesising outcomes from behavioural interventions, possibly deflating positive benefits. Notably, a review of outcomes for weight management treatments[93] collapsed all non-surgical options in their comparison. Research on surgical interventions may have also included behavioural interventions (via psychological and dietitian consultation), although this was rarely described. Another possible confound is whether differences in findings are a result of differences in health-care systems, patient populations, or the procedures themselves.[26] For instance, AGB studies originated in Europe, while RYGB tended to originate in the United States. Studies involving follow-up periods post-surgery tended to lack information regarding attrition at follow-up and for 10 years post-surgery.[117] Overall, most studies on weight loss outcomes focused on the first 3 years, which greatly limits our understanding of long-term consequences for decision-making.[118]

Implications for future research

Despite the understanding that multi-modal weight management treatments tend to be more effective than stand-alone treatments, the research literature has yet to reflect this as the bulk of studies and reviews focused on one treatment type alone. Certain studies have attempted to compare across treatment options[35] such as by examining the effect of surgical as compared to psychosocial programmes on disordered eating patterns. However, these studies neglected to address the behavioural changes that were likely

promoted within the surgical option. Research on patient experiences is seriously limited. Within studies focused on bariatric surgery, most research focused on psychosocial variables and how these factors predict weight loss outcomes. Most bariatric surgery studies focused on post-surgical variables rather than measuring other patient variables (e.g. goals, assumptions, and values) at the outset, which would be helpful in gaining a greater understanding of how patients make decisions regarding weight management. Along these lines, there remains a need to study psychological factors using controlled randomised trials to better understand how such factors might facilitate or constrain improvements in physical and mental health related to weight management.

Implications for shared decision-making

Based on existing knowledge on weight management options, treatment decision-making may be understood as trade-offs in known benefits, risks, and barriers, as well as match with patient preferences. Current evidence appears to be weighted towards weight loss and physiologically related outcomes, which may limit the extent to which psychosocial and patient experiences are factored into the decision-making process. Clinicians assisting patients in selecting a weight management option may clarify the state of evidence by highlighting the known advantages and disadvantages of each option, while informing the patient about results that are less certain. Furthermore, although the current review involves indirect comparison of various treatment modalities, this approach can still provide valuable insight with regard to the shared decision-making process. Clinicians should also be made aware that greater research is focused on bariatric surgeries, followed by dietary programmes, and thus, more is known about these options. The limited evidence does not necessarily mean that behavioural or lifestyle programmes are less suitable for patients, particularly when weighed against risks, complications, and cost. The nature of the evidence will likely fit with the decision aid for presenting and comparing the trade-offs of surgical, dietary, and behavioural and lifestyle interventions.

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CONFLICT OF INTEREST

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References

1. Twells LK, Gregory DM, Reddigan J, Midodzi WK. Current and predicted prevalence of obesity in Canada: A trend analysis. *CMAJ Open* 2014; 2: E18–26.
2. Alley DE, Chang VW. The changing relationship of obesity and disability, 1988-2004. *Journal of the American Medical Association* 2007; 298: 2020–7.
3. Faith MS, Butryn M, Wadden TA, Fabricatore A, Nguyen AM, Heymsfield SB. Evidence for prospective associations among depression and obesity in population-based studies. *Obesity Review* 2011; 12: e438–53.
4. Fontaine KR, Redden DT, Wang C, Westfall AO, Alison DB. Years of life lost due to obesity. *Journal of the American Medical Association* 2003; 289: 187–93.
5. Jia H, Lubetkin EI. The impact of obesity on health-related quality-of-life in the general adult US population. *Journal of Public Health* 2005; 27: 156–64.
6. Laddu D, Dow C, Hingle M, Thomson C, Going S. A review of evidence-based strategies to treat obesity in adults. *Nutrition in Clinical Practice* 2011; 26: 512–27.
7. Moore RH, Sarwer DB, Laenberg JA, Lane IB, Evans JL, Volger S *et al*. Relationship between sexual function and quality of life in obese persons seeking weight reduction. *Obesity* 2013; 21: 1966–74.
8. Mannucci E, Petroni ML, Villanova N, Rotella CM, Apolone G, Marchesini G. Clinical and psychological correlates of health-related quality of life in obese patients. *Health and Quality of Life Outcomes* 2010; 8: 90.
9. Withrow D, Alter DA. The economic burden of obesity worldwide: A systematic review of the direct costs of obesity. *Obesity Reviews* 2011; 12: 131–41.
10. Picot J, Jones J, Colquitt JL, Loveman E, Clegg AJ. Weight loss surgery for mild to moderate obesity: A systematic review and economic evaluation. *Obesity Surgery* 2012; 22: 1496–506.
11. Cummings S, Parham ES, Strain GW. Position of the American Dietetic Association: Weight management. *Journal of the American Dietetic Association* 2002; 102: 1145–55.
12. Padwal RS, Chang HJ, Klarenbach S, Sharma AM, Majumdar SR. Characteristics of the population eligible for and receiving publicly funded bariatric surgery in Canada. *International Journal of Equity in Health* 2012; 11: 54.
13. Kirk SFL, Penney TL, McHugh TLF, Sharma AM. Effective weight management practice: A review of the lifestyle intervention evidence. *Internal Journal of Obesity* 2012; 36: 178–85.
14. Stacey D, Legare F, Pouliot S, Kryworuchko J, Dunn S. Shared decision making models to inform an interprofessional perspective on decision making: A theory analysis. *Patient Education and Counseling* 2010; 80: 164–72.
15. Veroff D, Marr A, Wennberg DE. Enhanced support for shared decision making reduced costs of care for patients with preference-sensitive conditions. *Health Affairs* 2013; 32: 285–93.
16. Elwyn G, Frosch D, Thomson R, Joseph-Williams N, Lloyd A, Kinnersley P *et al*. Shared decision making: A model for clinical practice. *Journal of General Internal Medicine* 2012; 27: 1361–7.
17. Fraenkel L. Incorporating patients' preferences into medical decision making. *Medical Care Research and Review* 2013; 70: 80S–93S.
18. Mull-Engelmann M, Keller H, Donner-Banzhoff N, Krones T. Shared decision making in medicine: The influence of situational treatment factors. *Patient Education and Counseling* 2011; 82: 240–6.
19. Stacey D, Legare F, Col NF, Bennett CL, Barry MJ, Eden KB *et al*. Decision aids for people facing health treatment or screening decisions (Review). *The Cochrane Database of Systematic Reviews*. Epub ahead of print 28 January 2014. DOI: 10.1002/14651858. CD001431.pub4.
20. Legare F, Turcotte S, Stacey D, Ratte S, Kryworuchko J, Graham ID. Patients' perceptions of sharing in decisions: A systematic review of interventions to enhance shared decision making in routine clinical practice. *Patient* 2012; 5(1): 1–19.
21. Wu R, Boushey R, Potter B, Stacey D. The evaluation of a rectal cancer decision aid and the factors influencing its implementation in clinical practice. *BMC Surgery* 2014; 14(1): 16.
22. Yu CH, Stacey D, Sale J, Hall S, Kaplan D, Ivers N *et al*. Designing and evaluating an interprofessional shared decision-making and goal-setting decision aid for patients with diabetes in clinical care – Systematic decision aid development and study protocol. *Implementation Science* 2014; 9(1): 16.
23. Fagerlin A, Pignone M, Ahyankar P, Col N, Feldman-Stewart D *et al*. Clarifying values: An updated review. *BMC Medical Informatics and Decision Making* 2013; 13: S8.
24. Franco JVA, Ruiz PA, Palermo M, Gagner M. A review of studies comparing three laparoscopic procedures in bariatric surgery: Sleeve gastrectomy, roux-en-y gastric bypass and

adjustable gastric banding. *Obesity Surgery* 2011; 21: 1458–68.
25. Griffith PS, Birch DW, Sharma AM, Karmali S. Managing complications associated with laparoscopic Roux-en-Y gastric bypass for morbid obesity. *Canadian Journal of Surgery* 2012; 55: 329–36.
26. Tice JA, Karliner L, Walsh J, Peterson AJ, Feldman MD. Gastric banding or bypass? A systematic review comparing the two most popular bariatric procedures. *The American Journal of Medicine* 2008; 121: 885–93.
27. Tucker ON, Szomstein S, Rosenthal RJ. Indications for sleeve gastrectomy as a primary procedure for weight loss in the morbidly obese. *Journal of Gastrointestinal Surgery* 2008; 12: 662–7.
28. Padwal R, Klarenbach S, Wiebe N, Hazel M, Birch D, Karmali S *et al*. Bariatric surgery: A systematic review of the clinical and economic evidence. *Journal of General Internal Medicine* 2011; 28: 1183–94.
29. Hession M, Rolland C, Kulkarni U, Wise A, Broom J. Systematic review of randomized controlled trials of low-carbohydrate vs. low-fat/low-calorie diets in the management of obesity and its comorbidities. *Obesity Reviews* 2009; 10: 36–50.
30. Hite AH, Berkowitz VG, Berkowitz K. Low-carbohydrate diet review: Shifting the paradigm. *Nutrition in Clinical Practice* 2011; 26: 300–10.
31. Rolland C, Mavroeidi A, Johnston KL, Broom J. The effect of very low-calorie diets on renal and hepatic outcomes: A systematic review. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* 2013; 6: 393–401.
32. Mulholland Y, Nicokavoura E, Broom J, Rolland C. Very-low-energy diets and morbidity: A systematic review of longer-term evidence. *British Journal of Nutrition* 2012; 108: 832–51.
33. Soderlund A, Fischer A, Johansson T. Physical activity, diet and behaviour modification in the treatment of overweight and obese adults: A systematic review. *Perspectives in Public Health* 2009; 129: 132–44.
34. Yoong SL, Carey M, Sanson-Fisher R, Grady A. A systematic review of behavioural weight-loss interventions involving primary-care physicians in overweight and obese primary-care patients (1999-2011). *Public Health Nutrition* 2012; 16: 2083–99.
35. Moldovan AR, David D. Effect of obesity treatments on eating behavior: Psychosocial interventions versus surgical interventions. A systematic review. *Eating Behaviors* 2011; 12: 161–7.
36. Berkel LA, Poston WSC, Reeves RS, Foreyt JP. Behavioral interventions for obesity. *Journal of the American Dietetic Association* 2005; 105: s35–43.
37. Miller C, Fraser SF, Levinger I, Straznicky NE, Dixon JB, Reynolds J *et al*. The effects of exercise training in addition to energy restriction on functional capacities and body composition in obese adults during weight loss: A systematic review. *PLoS ONE* 2013; 8: e81692.
38. Armstrong MJ, Mottershead TA, Ronksley PE, Sigal RJ, Campbell TS, Hemmelgarn BR. Motivational interviewing to improve weight loss in overweight and/or obese patients: A systematic review and meta-analysis of randomized controlled trials. *Obesity Reviews* 2011; 12: 709–23.
39. Elwyn G, O'Connor A, Stacey D, Volk R, Edwards A, Coulter A *et al*. Developing a quality criteria framework for patient decision aids: Online international Delphi consensus process. *BMJ* 2006; 333: 417.
40. Tsai AG, Wadden TA. Systematic review: An evaluation of major commercial weight loss programs in the United States. *Annals of Internal Medicine* 2005; 142(1): 56–66.
41. Trastulli S, Desiderio J, Guarino S, Cirocchi R, Scalercio V *et al*. Laparoscopic sleeve gastrectomy compared with other bariatric surgical procedures: A systematic review of randomized trials. *Surgery for Obesity and Related Diseases* 2013; 9: 816–30.
42. Lynch J, Belgaumkar A. Bariatric surgery is effective and safe in patients over 55: A systematic review and meta-analysis. *Obesity Surgery* 2012; 22: 1507–16.
43. Brethauer SA, Hammel JP, Schauer PR. Systematic review of sleeve gastrectomy as staging and primary bariatric procedure. *Surgery for Obesity and Related Diseases* 2009; 5: 469–75.
44. Khalifa KA, Ansari AA, Alsayed AR, Violato C. The impact of sleeve gastrectomy on hyperlipidemia: A systematic review. *Journal of Obesity* 2013; 2013: 643530.
45. O'Brien P, McPhail T, Chaston TB, Dixon JB. Systematic review of medium-term weight loss after bariatric operations. *Obesity Surgery* 2006; 16: 1032–40.
46. Franz MJ, VanWormer JJ, Crain AL, Boucher JL, Histon T, Caplan W. Weight-loss outcomes: A systematic review and meta-analysis of weight-loss clinical trials with a minimum 1-year follow-up. *Journal of the American Dietetics Association* 2007; 107: 1755–67.
47. Sumithran P, Prioetto J. Ketogenic diets for weight loss: A review of their principles, safety and efficacy. *Obesity Research and Clinical Practice* 2008; 2: 1–13.
48. Avenell A, Broom J, Brown TJ, Poobalan A, Aucott L, Stearns SC *et al*. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement. *Health Technology Assessment* 2004; 8: 1–4.
49. Furlow EA, Anderson JW. A systematic review of targeted outcomes associated with a medically supervised commercial weight-loss program. *Journal of American Dietetic Association* 2009; 109: 1417–21.
50. Heymsfield SB, van Mierlo CAJ, van der Knaap HCM, Heo M, Frier HI. Weight management using a meal replacement strategy: Meta and pooling analysis from six studies. *International Journal of Obesity* 2003; 27: 537–49.
51. Anderson JW, Konz EC, Frederich RC, Wood CL. Long-term weight-loss maintenance: A meta-analysis of US studies. *American Journal of Clinical Nutrition* 2001; 74: 579–84.
52. Barte JCM, ter Bogt NCW, Bogers RP, Teixeira PJ, Blissmer B, Mori TA *et al*. Maintenance of weight loss after lifestyle interventions for overweight and obesity, a systematic review. *Obesity Review* 2010; 11: 899–906.
53. Seo DC, Sa J. A meta-analysis of psycho-behavioral obesity interventions among US multiethnic and minority adults. *Preventive Medicine* 2008; 47: 573–82.
54. Orzano AJ, Scott JG. Diagnosis and treatment of obesity in adults: An applied evidence-based review. *Journal of the American Board of Family Practice* 2004; 17: 359–69.
55. Ayyad C, Anderson T. Long-term efficacy of dietary treatment of obesity: A systematic review of studies published between 1931 and 1999. *Obesity Reviews* 2000; 1: 113–9.
56. Beck NN, Johannsen M, Stoving RK, Mehlsen M, Zachariae R. Do postoperative psychotherapeutic interventions and support groups influence weight loss following bariatric surgery? A systematic review and meta-analysis of randomized and nonrandomized trials. *Obesity Surgery* 2012; 22(11): 1790–7.
57. Pataky Z, Carrard I, Golay A. Psychological factors and weight loss in bariatric surgery. *Current Opinion in Gastroenterology* 2011; 27: 167–73.
58. Rudolph A, Hilbert A. Post-operative behavioural management in bariatric surgery: A systematic review and meta-analysis of randomized controlled trials. *Obesity Reviews* 2013; 14: 292–302.
59. Tsai AG, Wadden TA. The evolution of very-low-calorie diets: An update and meta-analysis. *Obesity* 2006; 14: 1283–93.
60. Livhits M, Mercado C, Yermilov I, Parikh JA, Dutson E, Mehran A *et al*. Is social support associated with greater weight loss after bariatric surgery?: A systematic review. *Obesity Reviews* 2011; 12: 142–8.
61. Adams ST, Salhab M, Hussain ZI, Miller GV, Leveson SH. Preoperatively determinable factors predictive of diabetes mellitus remission following roux-en-y gastric bypass: A review of the literature. *Acta Diabetologica* 2013; 50: 475–8.
62. Parikh M, Issa R, Vieira D, McMacken M, Saunders JK *et al*. Role of bariatric surgery as treatment for type 2 diabetes in patients who do not meet current NIH criteria: A systematic review and meta-analysis. *Journal of American College of Surgeons* 2013; 217: 527–32.
63. Meijer RI, van Wagensveld BA, Siegert CE, Eringa EC, Serne EH *et al*. Bariatric surgery as a novel treatment for type 2 diabetes mellitus: A systematic review. *Archives of Surgery* 2011; 146: 744–9.
64. Van de Laar A, de Caluwe L, Dilleman B. Relative outcome measures for bariatric surgery. Evidence against excess weight loss and excess body mass index loss from a series of laparoscopic roux-en-y gastric bypass patients. *Obesity Surgery* 2011; 21: 763–7.
65. Galani C, Schneider H. Prevention and treatment of obesity with lifestyle interventions: Review and meta-analysis. *International Journal of Public Health* 2007; 52: 348–59.
66. Cuspidi C, Rescaldani M, Tadic M, Sala C, Grassi G. Effects of bariatric surgery on cardiac structure and function: A systematic review and meta-analysis. *American Journal of Hypertension* 2014; 27: 146–56.
67. Aucott L, Gray D, Rothnie H, Thapa M, Waweru C. Effects of lifestyle interventions and long-term weight loss on lipid outcomes – A systematic review. *Obesity Reviews* 2011; 12: e412–25.
68. Aucott L, Rothnie H, McIntyre L, Thapa M, Waweru C, Gray D. Long-term weight loss from lifestyle intervention benefits blood pressure?: A systematic review. *Hypertension* 2009; 54(4): 756–62.
69. Aucott L, Poobalan A, Cairns S, Smith S, Avenell A, Jung R *et al*. Effects of weight loss in overweight/obese individuals and long-term hypertension outcomes: A systematic review. *Hypertension* 2005; 45: 1035–41.
70. Sarkhosh K, Switzer NJ, El-Hadl M, Birch DW, Shi X, Karmali S. The impact of bariatric surgery on obstructive sleep apnea: A systematic review. *Obesity Surgery* 2013; 23: 414–23.
71. Herpertz S, Kielmann R, Wolf AM, Langkafel M, Senf W, Hebebrand J. Does obesity surgery improve psychosocial functioning? A systematic review. *International Journal of Obesity* 2003; 27: 1300–14.
72. Lasikiewicz N, Myrissa K, Hoyland A, Lawton CL. Psychological benefits of weight loss following behavioural and/or dietary weight loss interventions. A systematic research review. *Appetite* 2014; 72: 123–37.

73. Poobalan AS, Aucott LS, Precious E, Crombie IK *et al*. Weight loss interventions in young people (18 to 25 year olds): A systematic review. *Obesity Reviews* 2010; 11(8): 580–92.
74. Baillot A, Romain AJ, Boisvert-Vigneault K, Audet M, Baillargeon JP, Dionne IJ *et al*. Effects of lifestyle interventions that include a physical activity component in class II and III obese individuals: A systematic review and meta-analysis. *PLoS ONE* 2015; 10(4): e0119017.
75. Bliddal H, Leeds AR, Christensen R. Osteoarthritis, obesity and weight loss: Evidence, hypotheses and horizons – A scoping review. *Obesity Reviews* 2014; 15(7): 578–86.
76. Buchwald H, Estok R, Fahrbach K, Banel D, Sledge I. Trends in mortality in bariatric surgery: A systematic review and meta-analysis. *Surgery* 2007; 142(4): 621–32.
77. Maggard-Gibbons M, Maglione M, Livhits M, Ewing B, Maher AR, Hu J *et al*. Bariatric surgery for weight loss and glycemic control in nonmorbidly obese adults with diabetes: A systematic review. *Journal of the American Medical Association* 2013; 309(21): 2250–61.
78. Thomas H, Agrawal S. Systematic review of 23-hour (outpatient) stay laparoscopic gastric bypass surgery. *Journal of Laparoendoscopic & Advanced Surgical Techniques* 2011; 21: 677–81.
79. Matrana MR, Davis WE. Vitamin deficiency after gastric bypass surgery: A review. *Southern Medical Journal* 2009; 102: 1025–31.
80. Aurora AR, Khaitan L, Saber AA. Sleeve gastrectomy and the risk of leak: A systematic analysis of 4888 patients. *Surgery Endoscopy* 2012; 26: 1509–15.
81. Kubik JF, Gill RS, Laffin M, Karmali S. The impact of bariatric surgery on psychological health. *Journal of Obesity* 2013; 2013: 837989, http://dx.doi.org/10.1155/2013/837989
82. Toussi R, Fujioka K, Coleman KJ. Pre- and postsurgery behavioral compliance, patient health, and postbariatric surgical weight loss. *Obesity* 2009; 17(5): 996–1002.
83. Poylin V, Serrot FJ, Madoff RD, Ikrumuddin S, Mellgren A, Lowry AC *et al*. Obesity and bariatric surgery: A systematic review of associations with defecatory dysfunction. *Colorectal Disease* 2011; 13(6): e92–103.
84. Karmali S, Brar B, Shi X, Sharma AM, de Gara C, Birch DW. Weight recidivism post-bariatric surgery: A systematic review. *Obesity Surgery* 2013; 23: 1922–33.
85. Wykowski K, Krouse HJ. Self-care predictors for success post-bariatric surgery. *Gastroenterology Nursing* 2013; 36: 129–35.
86. Mustajoki P, Pekkarinen T. Very low energy diets in the treatment of obesity. *Obesity Reviews* 2001; 2(1): 61–72.
87. O'Neil PM, Jarrell MP. Psychological aspects of obesity and very-low-calorie diets. *American Journal of Clinical Nutrition* 1992; 56: 185S–9S.
88. Dombrowski SU, Snichotta FF, Avenell A, Johnston M, MacLennan G, Araujo-Soares V. Identifying active ingredients in complex behavioural interventions for obese adults with obesity-related co-morbidities or additional risk factors for co-morbidities: A systematic review. *Health Psychology Review* 2012; 6: 7–32.
89. Speck RM, Bond DS, Sarwer DB, Farrar JT. A systematic review of musculoskeletal pain among bariatric surgery patients: Implications for physical activity and exercise. *Surgery for Obesity and Related Diseases* 2014; 10(1): 161–70.
90. Da Silva SSP, Da Costa Maia A. Obesity and treatment meanings in bariatric surgery candidates: A qualitative study. *Obesity Surgery* 2012; 22(11): 1714–22.
91. Burke LE, Steenkiste A, Music E, Styn MA. A descriptive study of past experiences with weight-loss treatment. *Journal of American Dietetic Association* 2008; 108: 640–7.
92. Deitel M, Gawdat K, Melissas J. Editorial: Reporting weight loss 2007. *Obesity Surgery* 2007; 17: 565–8.
93. Gloy VL, Briel M, Bhatt DL, Kashyap SR, Schauer PR. Bariatric surgery versus non-surgical treatment for obesity: A systematic review and meta-analysis of randomised controlled trials. *BMJ* 2013; 347: 1–16.
94. Aucott L, Poobalan A, Smith WCS, Avenell A, Jung R, Broom J *et al*. Weight loss in obese diabetic and non-diabetic individuals and long-term diabetes outcomes – A systematic review. *Diabetes, Obesity & Metabolism* 2004; 6: 85–94.
95. Ditschuneit HH. Do meal replacement drinks have a role in diabetes management? *Nestle Nutrition Workshop Series: Clinical and Performance Program* 2006; 11: 171–9.
96. Hamdy O, Zwiefelhofer D. Weight management using a meal replacement strategy in type 2 diabetes. *Current Diabetes Reports* 2010; 10: 159–64.
97. Douketis JD, Macie C, Thabane L, Williamson DF. Systematic review of long-term weight loss studies in obese adults: Clinical significance and applicability to clinical practice. *International Journal of Obesity* 2005; 29: 1153–67.
98. Espeland M. Reduction in weight and cardiovascular disease risk factors in individuals with type 2 diabetes: One-year results of the look AHEAD trial. *Diabetes Care* 2007; 30: 1374–83.
99. Wing RR, Lang W, Wadden TA, Safford M, Knowler WC, Bertoni AG *et al*. Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. *Diabetes Care* 2011; 34: 1481–6.
100. Wimmelmann CL, Dela F, Mortensen EL. Psychological predictors of weight loss after bariatric surgery: A review of the recent research. *Obesity Research & Clinical Practice* 2014; 8(4): e299–313.
101. Reoch J, Mottillo S, Shimony A, Filion KB, Christou NV, Joseph L *et al*. Safety of laparoscopic vs open bariatric surgery: A systematic review and meta-analysis. *Archives of Surgery* 2011; 146: 1314–22.
102. Lopes EC, Heineck I, Athaydes G, Meinhardt NG, Souto KEP, Stein AT. Is bariatric surgery effective in reducing comorbidities and drug costs? A systematic review and meta-analysis. *Obesity Surgery* 2015; 23: 1994–2003.
103. Zevin B, Agarwal R, Grantcharo TP. Volume-outcome association in bariatric surgery: A systematic review. *Annals of Surgery* 2012; 256: 60–71.
104. Kruseman M, Leimgruber A, Zumbach F, Golay A. Dietary, weight, and psychological changes among patients with obesity, 8 years after gastric bypass. *Journal of the American Dietetic Association* 2010; 110: 527–34.
105. Heneghan HM, Heinberg L, Windover A, Rogula T, Schauer PR. Weighing the evidence for an association between obesity and suicide risk. *Surgery for Obesity and Related Diseases* 2012; 8: 97–107.
106. Adams TD, Gress RE, Smith SC, Halverson RC, Simper SC, Rosamond WD *et al*. Long-term mortality after gastric bypass surgery. *New England Journal of Medicine* 2007; 357: 753–61.
107. Tindle HA, Omalu B, Courcoulas A, Marcus M, Hammers J, Kuller LH. Risk of suicide after long-term follow-up from bariatric surgery. *American Journal of Medicine* 2010; 123: 1036–42.
108. Mitchell JE, Crosby R, de Zwaan M, Engel S, Roerig J, Steffen K *et al*. Possible risk factors for increased suicide following bariatric surgery. *Obesity* 2013; 21(4): 665–72.
109. Thabane L, Chu R, Cuddy K, Douketis J. What is the quality of reporting in weight loss intervention studies? A systematic review of randomized controlled trials. *International Journal of Obesity* 2007; 31: 1554–9.
110. Moroshko I, Brennan L, O'Brien P. Predictors of dropout in weight loss interventions: A systematic review of the literature. *Obesity Reviews* 2011; 12(11): 912–34.
111. Mold F, Forbes A. Patients' and professionals' experiences and perspectives of obesity in health-care settings: A synthesis of current research. *Health Expectations* 2013; 16(2): 119–42.
112. Borradaile KE, Halpern SD, Wyatt HR, Klein S, Hill JO, Bailer B *et al*. Relationship between treatment preference and weight loss in the context of a randomized controlled trial. *Obesity* 2012; 20: 1218–22.
113. Linde JA, Jeffery RW, Finch EA, Ng DM, Rothman AJ. Are unrealistic weight loss goals associated with outcomes for overweight women? *Obesity Research* 2004; 12: 569–76.
114. Crawford R, Glover L. The impact of pre-treatment weight-loss expectations on weight loss, weight regain, and attrition in people who are overweight and obese: A systematic review of the literature. *British Journal of Health Psychology* 2012; 17: 609–30.
115. VanWormer JJ, Martinez AM, Cosentino D, Pronk NP. Satisfaction with a weight loss program: What matters? *American Journal of Health Promotion* 2010; 24: 238–45.
116. Coulman KD, Abdeirahman T, Owen-Smith A, Andrews RC, Welbourn R, Blazeby JM. Patient-reported outcomes in bariatric surgery: A systematic review of standards of reporting. *Obesity Reviews* 2013; 14: 707–20.
117. Ferchak CV, Meneghini LF. Obesity, bariatric surgery and type 2 diabetes: A systematic review. *Diabetes/Metabolism Research and Reviews* 2004; 20: 438–45.
118. Chang S, Stoll CR, Song J, Varela E, Eagon CJ, Colditz GA. The effectiveness and risks of bariatric surgery: An updated systematic review and meta-analysis, 2003-2012. *Journal of the American Medical Association Surgery* 2014; 149: 275–87.