Notes on the Layout of this Thesis

This document is presented in two distinct parts, which are written such that they could be submitted as separate articles for publication. Therefore, the research is not referred to in the literature review, except obliquely. In addition, in order to stay true to the methodology of Classic Grounded Theory, where the researcher is encouraged to approach the data with as few preconceived ideas as possible, the literature review has a different focus to the research report. The literature review is an overview of the current literature surrounding bariatric surgery: why it is used, what it is, how it is thought to work and what the issues are. The research report, which starts on page 56 (after the literature review references) is a grounded theory study documenting the emergent theory of *Constructing Success for Bariatric Surgery.*

Bariatric Surgery:
A literature review and results from the BaSE study: a grounded theory of constructing success for bariatric patients

A thesis presented in partial fulfilment for the requirements of the degree of

Master of Science
in
Human Nutrition

at Massey University, Palmerston North
New Zealand

Sara Lake

2019

Summary

Background: In New Zealand, around one-third of adults are categorised as medically 'obese' and at risk of related comorbidities such as cardiovascular disease, diabetes, sleep apnoea and certain cancers. Obesity is complex, with an elaborate aetiology that encompasses physical, psychological and socio-economic domains. It has proved a tough challenge for health agencies to address, with lifestyle and pharmaceutical interventions consistently showing underwhelming to nil results, particularly for those classified as having class III obesity. Bariatric surgery is now widely accepted as the only effective treatment for severe obesity and related comorbidities with numbers of surgeries worldwide increasing exponentially each year.

Objective: The aim of this review was to document an overview of the current knowledge base around bariatric surgery including its effectiveness, the accepted or proposed mechanisms of action and known issues, while also identifying areas of special interest, findings that could be incorporated into best practice and deficits in the research.

Method: A focused non-systematic literature review was conducted through the Web of Science and PubMed databases using keywords relevant to each section of the review. Preference was given to papers that were recent, had large sample numbers, long follow-up times and that had been published in respected journals. Less prestigious papers were also included where they added to the depth and interest of the review.

Results: A number of topics were identified which may be of interest to clinicians and provide direction for future research. These included the emerging area of the influence of gut hormones and the microbiome on surgery outcomes, the ongoing problem of pre- and post-surgical nutrient deficiencies and the crucial impact of psychological states and conditions on bariatric outcomes. Recommendations include more intensive physical and psychological screening and preparation, longer and more thorough follow-up protocols, managing patient expectations and expanding the definition of bariatric 'success' so that, as well as weight loss and improvement of physical comorbidities, it includes measurable psychological and psychosocial variables as well as subjective eating behaviours.

Acknowledgements

Both parts of this project (the literature review and research report) would not have been possible without the assistance of many individuals.

Firstly to the 13 incredible women who generously shared their experiences for the research project which accompanies this review. I cannot thank you enough for your openness during what must have been an emotional time and I hope our efforts may eventually contribute toward improved outcomes for bariatric patients.

A huge thank you also to Jason Daniels for supporting me in every way and being the one that got me through those moments where it all seemed impossible. You really are the best.

To Saya Hashimoto and Bek Parry who were always there with encouraging words, and other types of words when I was looking for the right one, even late at night. I owe you both a drink.

Very special and warm thanks to Melissa Peaks for publicising the BaSE study on her bariatric blog (www.melissalosesit.co.nz), twice (!), and for answering my nosy questions. Without you, this study may have taken twice as long.

And lastly, to my supervisors Dr. Janet Weber and Dr. Jane Coad for showing the way and always being encouraging even when I was doubting myself. Thank you!

Table of Contents

Summary ..... **i**

Acknowledgements ..... **ii**

List of Tables ..... **iv**

List of Figures ..... **iv**

Abbreviations ..... **v**

1 Introduction and Background **1**

1.1 Obesity 1
1.2 The Surgery 1

2 Literature Review **4**

2.1 Method 5

2.2 Health and Risk Marker Changes 4
2.2.1 Weight Loss 5
2.2.2 Insulin Resistance and Type 2 Diabetes 5
2.2.3 Cardiovascular Risk 7
2.2.4 Dyslipidaemia 7
2.2.5 Sleep Apnoea 8
2.2.6 Other Improvements 9

2.3 Surgical Effects and Mechanisms of Action 9
2.3.1 Reduced Intake and Malabsorption 9
2.3.2 Appetite and Hedonics 10
2.3.3 Bile Acids and Gut Hormones 11
2.3.4 The Microbiome 14

2.4 Peri-Surgical Recommendations 16

3 Issues and Considerations **20**

3.1 Surgical Mortality and Complications 20
3.2 Nutrient Deficiencies 21
3.3 Weight Regain and Weight Loss Failure 23
3.4 Bowel Issues, Dumping and Hypoglycaemia 25

4 Psychological Aspects **27**

5 Summary Table of Outcome Predictors **38**

6 Conclusions and Recommendations **39**

References **42**

Research Report:
The BaSE Study: A Grounded Theory of Constructing Success for Bariatric Patients **56**

List of Tables

Table 1 Changes in bile acid, gut hormones and microbiota pre-surgery to post-surgery ………………………………………………………………………………………………… 16

Table 2 Peri-Surgical Nutritional Recommendations ……………………………………………… 17 - 19

Table 3 Summary Table of Outcome Predictors ………………………………………………………………. 38

List of Figures

Figure 1 Roux-en Y gastric bypass and sleeve gastrectomy anatomical diagrams …………. 2

Abbreviations

AHI	Apnoea-Hypopnoea Index
ASMBS	American Society of Metabolic and Bariatric Surgery
BDI	Beck Depression Inventory
BED	Binge Eating Disorder
BMI	Body Mass Index (weight in kg divided by height in m^2)
cAMP	Cyclic Adenosine Monophosphate
EWL	Excess Weight Lost
FGF19	Fibroblast Growth Factor 19
FXR	Farsenoid X Receptor
GB	Gastric Band
GERD	Gastroesophageal Reflux Disease
GLP-1	Glucagon-like Peptide 1
HOMA-IR	Homeostatic model assessment (Insulin Resistance)
HRQOL	Health Related Quality of Life
IFSO	International Federation for the Surgery of Obesity and Metabolic Disorders
LOC	Loss of Control (Eating)
MRI	Magnetic Resonance Imaging
NSAID	Non-Steroidal Anti-Inflammatory Drug
OSA	Obstructive Sleep Apnoea
PTSD	Post Traumatic Stress Disorder
RCT	Randomised Clinical Trial
RYGB	Roux-en Y Gastric Bypass
SF-36	36 Item Short Form Health Survey
SG	Sleeve Gastrectomy

SIBO	Small Intestine Bacterial Overgrowth
SES	Socio-Economic Status
SLEEVEPASS	Sleeve vs. Bypass Study
SM-BOSS	The Swiss Multicentre Bypass or Sleeve Study
SOS	Swedish Obese Subjects Study
WHO	World Health Organization

1. Introduction and Background

1.1 Obesity

Obesity, medically defined as having a Body Mass Index (BMI) of greater than 30 kg/m^2, is considered by national and global health agencies as an urgent issue. The 2016/2017 New Zealand Health survey reported that 32% of adults are classified as obese, a 5% increase from 2006/2007. Certain demographic populations are more vulnerable, with 50% of adult Maori and 69% of Pacific people falling into the obese category. The prevalence of obesity is also deprivation linked, with rates 1.5 times higher in most deprived compared to least deprived areas. The New Zealand Medical Journal reported in 2015 that NZ could become the most obese nation on earth by 2020 (Kelly & Flint, 2015). Severe obesity is a risk factor for physical comorbidities, including type 2 diabetes mellitus (T2DM), hypertension, obstructive sleep apnoea (OSA), cardiovascular disease, arthritis, gallbladder disease, fatty liver disease, metabolic syndrome and certain cancers. Living in a stigmatised body also affects psychosocial function.

Obesity is complex, involving interactions of biological, behavioural, psychosocial and economic factors. Despite public health efforts, lifestyle education, and pharmacotherapy, enduring weight loss remains elusive, particularly for those that are categorised as having class III obesity (BMI ≥40), want to lose more than 10% of their body weight or have psychological or physical comorbidities (Mechanick et al., 2013; Montesi et al., 2016).

1.2 The Surgery

Research consistently reports bariatric surgery as the only effective weight loss intervention for those classified as having class III obesity, with trials, meta-analyses and reviews reinforcing its effectiveness in resolving obesity and co-morbidities (Buchwald et al., 2004; Chang et al., 2014; Padwal et al., 2011). The most common bariatric surgeries worldwide are the Roux-en Y gastric bypass (RYGB) and the vertical sleeve gastrectomy (SG), with numbers increasing yearly. The International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO)'s 2014 global survey reported 579,517 bariatric surgeries performed worldwide in 2014, an increase from the 340,768 reported by their respondees in 2011. There has been a concomitant shift in preferred surgery type with SG becoming dominant in most regions then losing ground slightly with the introduction of the one anastomosis mini gastric bypass, which comprised about 5% of surgeries in 2018 reports (Himpens et al., 2018). Between 2011 and 2014 RYGB fell from 46.6% to 39.6% of all bariatric surgeries and SG increased from 27.8% to 45.9% (Angrisani et al., 2017; Buchwald & Oien, 2013). This trend is echoed by the American Society for Metabolic and Bariatric Surgery (ASMBS), whom reported 158,000 surgeries in 2011 (36.7% RYGB, 17.8% SG with 35.4% being the now unpopular gastric band) and 228,000 surgeries in 2017 (17.8% RYGB, 59.39% SG) (ASMBS, 2018). In New Zealand to the year ended February 2015, 889 bariatric surgeries were performed: 61% SG, 37% RYGB, and 1% each gastric band and duodenal switch (Kelly & Flint, 2015). The shift toward SG and mini gastric bypass is likely because the surgeries are simpler with fewer complications and is probably as efficacious as RYGB, although the last point is somewhat contentious for SG vs. RYGB (Arterburn, 2018; Vidal, Corcelles, Jimenez, Flores & Lacy., 2017).

After SG and RYGB, the remainder of bariatric surgeries are primarily biliopancreatic diversion (BPD) with or without duodenal switch (BPD-DS/DS), and gastric band (GB). These are restrictive and/or malabsorptive procedures. This literature review will focus on SG and RYGB, including other surgery types where relevant, for example, as a control or comparison. The SG is a restrictive procedure and RYGB is both restrictive and malabsorptive.

Figure 1 presents the pre-surgical gastrointestinal anatomy, vertical sleeve gastrectomy and Roux-en Y gastric bypass

Pre-Surgery	Sleeve Gastrectomy	Roux-en Y Gastric Bypass

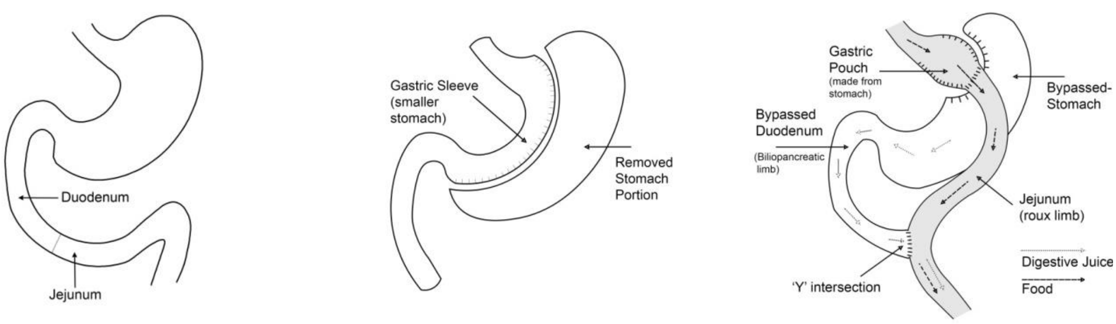

Figure 1. Roux-en Y gastric bypass and sleeve gastrectomy anatomical diagrams
(Source: Researcher's own design)

The SG involves resection and removal of ~70-80% of the stomach, creating a sleeve-shaped organ with residual gastric volume of about 125ml (Vidal et al., 2014). In RYGB the stomach is resectioned as shown with a 20-30ml gastric pouch operating as the new stomach. The duodenum, previously adjoining the jejunum, becomes the 50-100 cm biliopancreatic limb carrying digestive juices (but no food) and is re-connected further down the jejunum at the 'Y' intersection. The part of the jejunum which previously adjoined the duodenum becomes the 100-150 cm long 'Roux' or 'alimentary' limb, connecting directly to the pouch. This transports barely digested food to the 'Y' intersection where it encounters the gastric juices coming from the biliopancreatic limb. The impacts of these physiological changes are discussed in section 2.3.

2. Literature Review

2.1 Method

A search was conducted through the Web of Knowledge and PubMed databases using relevant keywords, for example: ‘bariatric surgery’ AND ‘psychopathologies’ AND ‘self-harm’ for the self-harm section. Reviews and meta-analyses were restricted to those published within 10 years. Where the search returned more than 100 studies, it was limited to studies that were recent (within 5 years), had large sample sizes, long follow-up periods and were published in high impact journals. All articles and their bibliographies were screened and included where relevant. Small studies were included where they added something novel or explanatory. The aim was to summarise the current knowledge base around the bariatric process while pinpointing deficits and areas of interest which may be directional for current best practice and future investigation.

2.2 Health and Risk Marker Changes

Bariatric surgery consistently establishes weight loss, resolves comorbidities and decreases all-cause mortality. As examples, at five years post-surgery, Sundbom et al. (2017) reported 27% reduction in body weight, and reduced prevalence of T2DM from 15.5% to 5.9%, hypertension from 29.7% to 19.5%, OSA from 9.6% to 2.6% and dyslipidaemia from 14% to 6.8% in RYGB patients. At 7 years, Adams et al. (2007) reported mortality decreases of 56% for coronary artery disease, 92% for diabetes and 60% for cancer between RYGB and a non-surgical ‘severely obese’ control group. At 4.3 years, Reges et al. (2018) reported overall mortality reduction of 2.51 fewer deaths per 1000 person years in their group of 8385 RYGB, SG and GB patients, compared to non-surgical controls. A 2014 review and meta-analysis reported a >50% reduction in mortality compared to non-surgical controls (Kwok et al., 2014), and finally Cardoso et al.’s 2017 review reported a 41% long-term reduction in all-cause mortality between bariatric patients and non-operated obese controls.

2.2.1 *Weight loss*

Needless to say, a primary effect, and measure of surgery success, is weight loss, usually referred to as 'excess weight lost' (EWL), but sometimes presented as percentage body weight lost or more rarely as excess BMI lost. The popular definition of 'success' is long-term maintenance of at least 50% EWL (Faria, de Oliveira Kelly & Lins et al., 2010). Maximum weight loss is experienced at 18-24 months post-surgery (Dalcanale et al., 2010; Parri et al., 2015) and varies with surgery type. Average weight loss is 70-85% EWL at the nadir, dropping to 55-66% EWL at 10-16 years for RYGB and 40-57% at five years for SG (Bastos, Barbosa, Soriano et al., 2013; Dalcanale et al., 2010; Felsenreich, Langer, & Prager, 2018). Although a recent small study suggested that RYGB weight loss is more durable than SG (Parri et al., 2015), other rigorous studies argue for comparable effects. The Swiss Multicentre Bypass or Sleeve (SM-BOSS) randomised clinical trial (RCT) and Finnish Sleeve vs. Bypass (SLEEVEPASS) randomised clinical equivalence trial found no significant difference in excess BMI and EWL at five years (Peterli et al., 2018; Salminen et al., 2018). In agreement, Dicker et al. (2016) reported similar reductions in BMI units of 8.8, 8.3 and 8.0 for RYGB, SG and GB respectively at five years and Kalinowski et al. (2017) reported comparable weight loss at 12 months post-surgery. The strongest predictor of long term EWL is compliance with lifestyle instructions. Other predictors, such as pre-surgical mental health, personality, ability to self-regulate, socio-economic status and improved post-surgical cognitive performance (particularly attention and executive memory function) have been noted, with their effect generally considered to be mediated by impact on behavioural compliance. (Carden, Blum, Arbaugh, Trickey, & Eisenberg, 2018; Generali & De Panfilis, 2018; Kinzl, Schrattenecker, Traweger, Mattesich, Fiala & Biebl, 2006; Pontiroli et al., 2008; Spitznagel et al., 2013).

2.2.2 *Insulin Resistance and Type 2 Diabetes*

The occurrence of obesity with insulin resistance is commonly known as 'diabesity' and bariatric patients are at risk of developing this condition. In their 2018 global registry report, IFSO recorded 19.8% of pre-surgical patients as taking T2DM medications, with considerable inter-country variation (4.5-97.7%) (Himpens et al., 2018). However, many trials show an impressively fast post-surgical resolution of diabetes. Post RYGB, improvements in insulin secretion, insulin resistance and glycaemic control occur within 2-7 days, an effect primarily due to acutely decreased energy intake. These improvements are weight loss independent but may be influenced by gut hormone alterations particularly for the incretins glucagon-like peptide 1 (GLP-1) and gastric inhibitory peptide (GIP) (Jackness et al., 2013; Laferrere et al., 2008).

Looking at longevity of results, the Swedish Obese Subjects (SOS) study showed durability of remission and/or moderation of diabetic vascular complications up to 17.6 years post-surgery (Dicker et al., 2016). Schauer et al. (2017) reported results from the 'Surgical Treatment and Medications Potentially Eradicate Diabetes Efficiently' (STAMPEDE) trial. In this study 150 individuals with diabetes were randomised to receive intensive medical therapy, with or without bariatric surgery. Although results were insignificant in the intention to treat (ITT) analysis, at five years the percentages of participants achieving a normal glycated haemoglobin (HbA1c) were 29% (RYGB), 23% (SG) and 5% (medical therapy alone). HbA1c measures average blood glucose over the previous 8-12 weeks. Surgery patients saw greater improvements in use of insulin, quality of life (QOL) and blood lipids. Earlier trial results from one and three years showed surgical patients had improved glycaemic control, quality of life (QOL), cardiovascular risk reduction and medication requirements compared to the medical therapy group. In a retrospective study, Dicker et al. (2016) reported remission rates of 53.2% at one year, and 54.4% at five years. In that study RYGB showed a faster diabetes resolution, however by 5 years, remission rates were similar between RYGB, SG and GB. Kalinowski et al. (2017)'s RCT found similarly, that by 12 months RYGB and SG patients showed similar improvements in glucose metabolism.

The potential of bariatric surgery as a 'metabolic surgery' for diabetes has lead the American Diabetes Association to suggest it as a treatment for those with hard-to-control diabetes and a BMI >35 kg/m^2 (ADA, 2015). Kaseem et al. (2017) stated in their mini-review that predictive factors for the impact of bariatric surgery on T2DM can be assessed using an ABCD score (**A**ge, **B**MI, **C**-peptide and **D**uration) along with HbA1c, fasting glucose and the incretins (GLP-1 and GIP). Duration of disease is a major predictor as long-term T2DM causes damage to the insulin-producing B-cells, reducing the chance of a remission (Chikunguwo et al., 2010).

2.2.3 *Cardiovascular Risk*

There is consistent evidence of enduring cardiovascular benefit after bariatric surgery. The SOS study reported 53% reduced risk of cardiovascular death and 33% reduced risk of a first time cardiovascular event in bariatric patients vs. obese controls after 14.7 years (Sjostrom et al., 2012). In a recent study of 60 SG patients, a significant decrease in carotid intima media thickness was observed at 6, 12 and 18 months post-surgery. This vascular morphology improvement correlated with a beneficial increase in the neutrophil to lymphocyte ratio, suggesting a strong decrease in cardiovascular risk (Baykara, Yazar, Cengiz, & Bulbuloglu, 2018). In their meta-analysis of four studies which evaluated hard clinical outcomes, Kwok et al. (2014) reported reduced risk of cardiovascular incidents (OR 0.54), myocardial infarction (OR 0.46) and stroke (OR 0.49) compared to non-surgical controls. They also noted that the research is inherently confounded as patients most at risk may be denied surgery.

Whether cardiovascular benefits are due to weight loss *per se* is uncertain, as some research suggests de-contexualised weight loss may instead be associated with increased cardiovascular and all-cause morbidity and mortality, particularly in diabetic individuals. This is known as 'the Obesity Paradox' (Chen et al., 2018). Conversely, some studies focusing on intentional weight loss note a protective effect (Chen et al., 2018; Kritchevsky et al., 2015; Sjostrom et al., 2012). In other words, perhaps cardiovascular risk is influenced by surgical factors beyond weight loss.

2.2.4 *Dyslipidaemia*

Bariatric surgeries have a positive effect on dyslipidaemia, a well acknowledged cardiovascular risk factor. In general, weight loss correlates with improvements in total cholesterol (TC), low-density lipoprotein cholesterol (LDLc), high-density lipoprotein cholesterol (HDLc) and triglycerides (TG), however post-bariatric lipid improvements may also be influenced by bile acid metabolism, gut hormones, the microbiome and altered cholesterol metabolism (Bays et al., 2016; Bays et al., 2016a). A recent retrospective analysis showed that at 5 years post-surgery 61.2% of RYGB vs. 26.1% of SG patients achieved normal LDLc levels. Improvements in TG and HDLc correlated with EWL, independent of surgery type (Climent et al., 2018). Other studies and analyses agree that RYGB has the strongest impact when compared to SG and GB (but not BPD), with up to 76% of RYGB and 43.5% of SG patients achieving normal TC (Spivak et al., 2017). There is, however, some disagreement. Spivak et al. (2017) found in their registry based analysis that HDLc became normal more often in SG patients (58.1% SG vs. 43.5% RYGB) while TG reduced by ~75% in both RYGB and SG, whereas Cunha et al. (2016) found in their age and sex-matched control study that RYGB, SG and GB improved TG and HDLc similarly, independent of weight loss, but that only RYGB reduced TC and LDLc when weight loss was controlled for. Heffrom et al.'s (2016) meta-analysis showed no difference between SG (LDLc), GB (LDLc and TC) and controls at one-year post-surgery. Another study showed decreased cholesterol synthesis in RYGB and GB patients in correlation with weight loss, with reduced cholesterol absorption in RYGB only (Pihlajamaki et al., 2010). Spivak et al. (2017) and Pihlajamaki et al. (2010) both reported a stronger lipid balancing effect in males.

2.2.5 Sleep Apnoea

Obstructive Sleep Apnoea (OSA) deserves special mention as the most common, often underdiagnosed comorbidity in pre-surgical bariatric patients (de Raaf et al., 2017). Some degree of OSA occurs in 60-70% of those with a BMI >35 kg/m^2, compared to general prevalence of 2-4%, and is associated with increased cardiovascular, pulmonary and neurovascular risk, and T2DM (de Raaff et al., 2017; Rasmussen, Fuller, & Ali, 2012). Moderate to severe OSA affects up to one third of patients, which is pertinent as OSA is associated with negative post-surgical outcomes such as post-operative respiratory failure, experiencing a cardiac even or requiring an unplanned transfer to the Intensive Care Unit (Hai et al., 2014). Some authors suggest routine polysomnography (P(S)G) pre-surgery, rather than the less-sensitive screening questionnaires commonly administered (de Raaff et al., 2017). In terms of improvements, post-surgical remission seems dependant on OSA severity, as measured by the Apnoea-Hypopnoea Index (AHI). Moderate to severe OSA (AHI >15) either resolves or becomes 'mild' in ~75% of cases, but remains unchanged in ~25%. Predictors of persistent moderate to severe disease are age ≥50, pre-operative AHI ≥30 and EWL of <60% (de Raaff et al., 2016; Sarkhosh et al., 2013). A small recent study suggested a lower rate of 'improvement or resolution' of 55.3%, however the study had high attrition and EWL was <60% (Sillo et al., 2018).

2.2.6 Other Improvements

Other risk markers and conditions improved by bariatric surgery are hypertension (Owen, Yazdi, & Reisin, 2017), inflammation (Khosravi-Largani et al., 2018), joint pain/dysfunction (King et al., 2016), cognition (Alosco et al., 2015), mental health (discussed in section 4) and Polycystic Ovarian Syndrome (PCOS). As regards PCOS, studies suggest a dramatic improvement in symptoms of PCOS, infertility and anovulation, effects that seem dependent on degree of EWL, independent of surgery type. Pregnancy outcomes are generally favourable, with reduced gestational diabetes, hypertension, pre-eclampsia and large-for-gestational-age babies, however premature labour, low birthweight and small-for-gestational-age incidences are increased after malabsorptive procedures and there appears an increased risk of still birth, especially in the first post-surgical year (Gonzalez et al., 2015; Jamal et al., 2012; Musella et al., 2012). Contradicting the frequent finding of increased fertility, one small survey-based study reported unchanged conception rates but lower live birth rates after RYGB (Goldman, Missmer, Farland, Robinson, & Ginsburg, 2015).

2.3 Surgical Effects and Mechanisms of Action

2.3.1 Reduced Intake and Malabsorption

The major physical effect of bariatric surgery is restriction of food intake with some reduction of nutrient absorption for malabsorptive procedures. Food intake after surgery decreases by up to 80% from pre-surgical levels in the early phase, sits around 30-60% reduced at 2-3 years and remains around 20% reduced at 10-years independent of surgery type (Munzberg, Laque, Yu, Rezai-Zadeh, & Berthoud, 2015; Sjöström, 2004; Svane et al., 2016). Surprisingly, studies and reviews consistently report a minor effect of energy malabsorption after RYGB with carbohydrate and protein absorption being relatively unaffected. Fat absorption is reduced from ~92% to 68% at 14 months post-surgery, accounting for ~170 kcal/d, whereas reduced food intake accounts for ~1420 kcal/day energy reduction at that time point (Mahawar & Sharples, 2017; Odstrcil et al., 2010). Studies enforcing a 'bariatric diet' on non-bariatric participants confirm that reduced food intake is the overarching driver of post-surgical weight loss and glycaemic control improvements (Jackness et al., 2013). As noted in Munzberg et al.'s (2015) review, separating deliberate behavioural adaptation from surgery-driven change in humans is difficult. However, in rodents subjected to bariatric procedures, suppressed food intake is less enduring, suggesting that behavioural adaptation and coaching may be powerful enforcers of long-term post-bariatric change in humans.

2.3.2 Appetite and Hedonics

It is of interest that food intake and choices change beyond what is explained by restriction alone. Bariatric patients report decreased preference for fatty and sweet foods acutely and longitudinally, a phenomenon explored in human and animal studies (Mathes & Spector, 2012; Shin & Berthoud, 2011; Shin, Zheng, Pistell, & Berthoud, 2011). A well-cited functional magnetic resonance imaging (MRI) study showed that when exposed to images of high-calorie foods, still-obese RYGB patients exhibited reduced neuronal hedonic activity as measured by the blood oxygen level-dependent (BOLD) response to food stimuli, which is a validated measure of neuronal activation. Participants rated those images as less appealing than did lean non-surgical controls or BMI-matched GB patients (Scholtz et al., 2014). They also reported reduced 'liking' of an ice-cream meal, recorded fewer fat calories in their diet diaries and scored lower on the psychological parameters of 'restraint' and 'external eating' compared to GB patients, suggesting that food was now experienced as less tempting. Another small study assessing the 'break point' of receiving a fatty/sweet reward for a progressive repetitive task showed that RYGB patients worked half as hard for the reward after surgery, and that shortening of the break point correlated with reduction in BMI (Miras et al., 2012). Further, in animals and humans the hyperphagia response which normally follows food restriction and weight loss is absent after SG and RYGB, leading some authors to speculate that the homeostatically defended 'set point' for body fat has lowered (Hao et al., 2016; Munzberg et al., 2015). Animal experiments show, for example, that an animal dieted to a weight lower than its post-surgical stabilisation weight will overeat only until it has regained that lower weight, rather than its pre-surgical weight. This also suggests that overeating is *possible* post-surgery, but for reasons not completely elucidated, is less likely (Zheng Hao, Zhao, Berthoud, & Ye, 2013; Stefater, Wilson-Perez, Chambers, Sandoval, & Seeley, 2012; Ye, 2014)

Animal studies also show that RYGB stimulates remodelling and activation of vagal nerve fibres in ways that impact food intake and satiety. There is vagal denervation and neurodegeneration in the stomach and surgical sites in the gastric tract. It is theorised that exaggerated signalling by vagal afferents in the small intestine may be stimulated by undigested nutrients, causing an elevated satiety response (Gautron, Zechner, & Aguirre, 2013; Hao et al., 2014). Lastly there is the less complicated theory that changed food desire after surgery is conditioned aversion. If a food makes you sick, you desire it less. (le Roux et al., 2011)

2.3.3 Bile Acids and Gut Hormones

Besides restriction and malabsorption, the revised bariatric physiology has effects which can be mechanistically linked to bile acids and/or the gut-brain axis; the latter referring to the signalling between central and enteric nervous systems. In RYGB, food bypasses the stomach and duodenum, entering the jejunum and then ileum directly after exiting the pouch and undiluted bile enters the duodenum from the biliopancreatic limb (Dixon, 2012; Rubino, Schauer, Kaplan, & Cummings, 2010; Scholtz et al., 2014). Bile acid levels increase after RYGB and, to a lesser degree, after SG (Nemati et al., 2018) and exert a variety of effects both through the usual farnesoid X receptor (FXR) pathway and independently. One of the effects of increased bile concentrations is production of fibroblast growth factor 19 (FGF19) in the ileum which animal studies show reduces food intake, regulates body weight, enhances mitochondrial activity and improves glucose tolerance (Pournaras et al., 2012; Ryan et al., 2013; Tomlinson, 2002). Levels of FGF19 are known to be higher in RYGB and SG patients (Haluzikova et al., 2013). Besides influencing FGF19 production, plasma bile acids cross the blood-brain barrier and interact with the TGR5 bile acid receptor which regulates metabolism, energy homeostasis and glycaemic control (Guo, Chen, & Wang, 2016; Pournaras et al., 2012). In-vitro studies suggest that bile-acid engagement with TGR5 is responsible for the elevations in glucagon-like peptide-1 (GLP-1) and Peptide YY (PYY) which are seen after surgery (Brighton et al., 2015; Kuhre et al., 2018). These affect glucose control and desire for food.

Bile Acids, GLP-1 and Diabetes. The combined role of bile acids and GLP-1 have been intensively explored as regards diabetes remission. In general bile acid concentrations correlate positively with GLP-1 and negatively with postprandial glucose. Increased fasting bile acid decreases insulin resistance by many pathways including inhibiting gluconeogenesis, increasing cyclic adenosine monophosphate (cAMP) and intracellular thyroid hormone levels (both secondary actions of binding to TGR5), promoting insulin signalling and activating glycogen synthase (Gonzalez-Regueiro, Moreno-Castaneda, Uribe, & Chavez-Tapia, 2017; Han et al., 2004; Watanabe et al., 2006), while GLP-1 stimulates insulin production in the pancreatic β-cells (Doyle & Egan, 2007). In terms of measurable outcomes of these effects, a 2018 study looked at correlation of bile acid levels and diabetes remission in RYGB and SG patients without reporting potential mediators, finding that fasting and prandial total, secondary and unconjugated bile acids were negatively correlated with HbA1c, independent of body weight (Nemati et al., 2018). Interestingly, they found no correlation between FGF19 and bile acid levels generally. However, in line with the potential mechanisms above, changes in postprandial FGF19 levels were negatively correlated with changes in HbA1c and visceral fat.

Appetite Hormones. Bariatric surgery also has an impact on the 'satiety hormone' leptin, the 'hunger hormone' ghrelin as well as GIP, glucagon and insulin. The pattern in severe obesity is hyperinsulinaemia with insulin resistance, elevated leptin with leptin resistance and elevated ghrelin which does not decrease post-prandially as much as in lean controls. Leptin and insulin decrease significantly and similarly in the first 12 months for both RYGB and SG (Kalinowski et al., 2017), stabilising at a level lower than pre-surgery but, for leptin, higher than in lean individuals (LeRoux et al., 2006). Ghrelin levels reduce acutely in SG with some recovery at 12 months, however ghrelin studies after RYGB are inconsistent showing increased (Kalinowski et al., 2017), unchanged (LeRoux et al., 2006) or decreased levels (Cummings, 2002). These contradictions may be due to energy balance-related flux (active weight loss vs. stable weight measurements), whether the pouch includes fundus cells and length of the Roux limb (Cummings, 2002; Faraj et al., 2003; E. Lin et al., 2004). As 70-80% of ghrelin is secreted from the gastric fundus mucosa, which is resected in SG, but remains in RYGB, it makes sense that SG ghrelin levels are lower, however, once weight stable, ghrelin remains lower across surgery types

(Cummings, 2002; Holdstock et al., 2003; Terra et al., 2013). As well as affecting appetite, improvements in ghrelin and leptin may be related to cognitive improvements, independent of weight loss (Alosco et al., 2015).

After surgery there is an 'early and exaggerated' insulin response to food (LeRoux et al., 2006). This may mediate the rapid post-surgical decrease in Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) value which is seen in SG and RYGB and suggests a return of cellular insulin sensitivity (Benaiges et al., 2013). Glucagon and GIP have received relatively less research than other hormones, with contradictory results and therefore will not be further discussed (Bradley, Magkos, & Klein, 2012; Kalinowski et al., 2017).

The aforementioned phenomenon of food becoming less pleasurable or 'hedonic' is modulated by gut hormone interaction with the cortico-limbic system and dopaminergic signalling in the brain (Mathes & Spector, 2012; Shin & Berthoud, 2011; Shin et al., 2011). Of particular interest are post-surgical increases in the anorexigenic hormones PYY and GLP-1 (Dimitriadis et al., 2013), plasma levels of which are linked with an acute decreased linking of fatty and sweet foods in mammals generally and correlate with less 'uncontrollable' eating after RYGB longitudinally (De Silva et al., 2011; Martin et al., 2009; Svane et al., 2016). The effect seems synergistic, with a 2016 study showing that pre-surgery, blocking GLP-1 increased food intake, whereas, post-surgery, antagonism of both hormones resulted in 20% increased food intake, but antagonising PPY or GLP-1 alone had no effect (Svane et al., 2016). A 2009 mouse study using GLP-1 knockout mice reported decreased sensitivity to sweet tastes and increased liking for umami flavours, probably due to alterations in GLP-1 and its receptor expression in the taste buds (Martin et al., 2009). It should be noted that the role of gut hormones in bariatric surgery is an emerging and sometimes confusing area. For example Scholtz et al.'s (2014) functional MRI study showed a strong change in food preference which did not actually correlate with any of the hormones measured. Therefore, while a promising area, the role of the gut-brain axis is still not fully understood. In addition, there are other hormones affected which have not been widely researched or discussed in this review, for example C-peptide (Lee et al., 2012), adiponectin (Holdstock et al., 2003) amylin (Dimitriadis et al., 2013), chemerin (Terra et al., 2013), cholecystokinin (Stefater et al., 2012), melanocortin (involved in set point theory) (Hao et al., 2016) and others.

2.3.4 The Microbiome

The microbiome is the commensal bacteria present in the gastrointestinal tract. In humans these bacteria comprise over 2000 species and contain 150-fold more genes than their host (Bell, 2015; Sender, Fuchs, & Milo, 2016). The microbiome's role is varied and incompletely understood but functions include metabolic regulation, immune system development, steroid hormone production and bile acid synthesis, metabolism and biotransformation (Lee & Mazmanian, 2010; Murphy et al., 2010). The microbiome differs in characteristic ways within the spectrum of obese, normal weight, previously obese (but now slim by dieting), post-surgery (still obese) and post-surgery (now normal weight). Human and animal studies suggest that dysbiosis features in obesity, and that there may exist an 'obese microbiome' which some, but not all, studies suggest is more efficient at harvesting energy from food (DiBaise et al., 2008; Murphy et al., 2010; Samuel & Gordon, 2006; Turnbaugh et al., 2006).

Changes in the Microbiome. The human microbiome is dominated by seven bacterial phyla: Bacteroidetes, Proteobacteria, Actinobacteria, Firmicutes, Fusobacteria, Verrucomicrobia and Cyanobacteria (Bell, 2015; Graessler et al., 2013). Although butyrate producing Firmicutes are dominant in both obese and lean people, in obese humans and animals the ratio of Firmicutes to Bacteroidetes is increased in what Bell (2015) calls 'the obesity pattern'. Obesity also correlates with increased H_2 producing *Prevotellaceae* and H_2 utilising, methanogenic types of archea (a non-bacterial microbial domain) (Zhang et al., 2009). During weight loss by any means, Bacteroidetes increase and Firmicutes decrease and there is a trend toward the microbiome of a lean person (Ley, Turnbaugh, Klein, & Gordon, 2006). Some studies suggest that restrictive diets have a negative effect on bacterial abundance, leading some researchers to theorise a negative impact on colon health which could be offset with prebiotics (Seganfredo et al., 2017).

After RYGB, there is increased richness and diversity of the microbiome. Kong et al. (2013) showed that phyla Proteobacteria, which are sensitive to changes in pH, absorptive surface area and digestion time (Seganfredo et al., 2017) account for 37% of the increase. Zhang et al. (2009) noted that this increase is mainly class Gammaproteobacteria, while Firmicutes are decreased. In their review, Seganfredo et al.

(2017) noted a decreased Firmicutes to Bacteroidetes ratio in the majority of SG and RYGB studies, although bacterial diversity is not greatly altered with SG. Although there are exceptions, human and animal studies generally show a more profound swing toward a lean Firmicutes to Bacteroidetes ratio after surgical weight loss, compared to non-surgical (Bell, 2015; Damms-Machado et al., 2015; Seganfredo et al., 2017). However, as Firmicutes and Bacteroidetes are highly diverse, the specific obesity-associated genera are not completely known. Clinical trials investigating species have showed increased *Escherichia-coli*, *Veillonella dispar*, *Veillonella parvula* and *Klebsiella pneumoniae* after RYGB and decreases in a number of species following SG (see Table 1).

Kong et al. (2013) examined the interaction of gut bacteria with White Adipose Tissue (*WAT*) gene expression, which modulates the adipose tissue secretions that are partly responsible for obesity being an inflammatory and metabolically altered state. They found 14 changed bacterial genera after RYGB, corresponding with changes in 202 WAT genes and in clinical phenotype. Importantly, half of their correlations were unrelated to caloric intake, which adds to the ongoing debate around direction of causality (Murphy et al., 2010; Palleja et al., 2016). Another potential mechanism of bariatric effects is what Liu et al. (2018) term the ‘crosstalk’ between microbiota and bile acids, wherein the microbiome differentially affects bile acid synthesis and conjugation while levels of bile acids correspondingly affect bacterial composition and diversity

The bile acid, gut hormone and microbiome changes discussed in this section are summarised in Table 1 (next page).

Table 1
Changes in bile acid, gut hormones and microbiota pre-surgery to post-surgery

	Effect before/after bariatric surgery
Bile Acid	Increased plasma levels
Anorexigenic Hormones	
Postprandial PYY[1]	Increased
Postprandial GLP-1[1]	Increased
Fasting Insulin[2]	Decreased
Postprandial Insulin[1]	Early and Exaggerated Response (RYGB)
Fasting Leptin[1, 2]	Decreased
Orexigenic Hormones	
Fasting and 24-hour Ghrelin[1,2,3]	Decreased (SG) Inconsistent (RYGB)
Microbiome	
Phyla	
Bacteriodetes[7]	Increased
Firmicutes[7]	Decreased (esp. *Lactobacillus sp*.)
Proteobacteria[6]	Increased (esp. Gammaproteobacteria)
Species	
Escherischia coli[4]	Increased (RYGB)
Veillonella dispar[4]	Increased (RYGB)
Klebsiella pseumoniae[4]	Increased (RYGB)
Veillonella parvula[4]	Increased (RYGB)
Eubacterium rectale[5]	Decreased (SG)
Bacteroides sp.3_1_40A[5]	Decreased (SG)
Coprococcus comes[5]	Decreased (SG)
Ruminococcus obeum[5]	Decreased (SG)
Dorea longicatena[5]	Decreased (SG)
Lachnospiraceae bact.5_1_63FAA[5]	Decreased (SG)
Clostridium sp. I.2_50[5]	Decreased (SG)
Bacteroides vulgatus[5]	Decreased (SG)

1. Roux et al. (2006) 2. Kalinowski et al. (2017) 3.Cummings et al. (2002) 4.Palleja et al. (2016) 5. Damms-Machado et al. (2015) 6. Kong et al. (2013) 7.Seganfredo et al. (2017)

2.4 Peri-Surgical Nutrition Recommendations

The peri-surgical period is the most prescriptive phase of bariatric nutrition. Pre-surgical dietary recommendations are characterised by a Very Low Calorie Diet (VLCD), for 2-4 weeks intended to reduce intra-hepatic fat deposits and induce weight-loss, while maintaining satiety and muscle mass through high protein content. This phase may be preceded by a more traditional weight loss diet. In New Zealand and Australia the VLCD utilises meal-replacement product Optifast, or nutritional equivalent. Pre-surgical weight loss and associated liver shrinkage increase surgical safety and reduce complications. In particular, a large liver increases technical difficulty, lengthens time under anaesthesia and may lead to conversion from laparoscopic to open surgery (Sivakumar, 2018). Although on occasion the VLCD may extend beyond 4 weeks, this is not recommended due to risk of complications like poor wound healing or impaired immunity. In addition, most liver shrinkage is achieved within two weeks of the VLCD (Alvarado, 2005; Colles, 2006; Sherf Dagan et al., 2017; Sivakumar, 2018).

As noted by Sivakumar (2018) the post-surgical regime may vary by clinic and surgeon, however it is crucial that patients are thoroughly screened pre-operatively and have a complete education in the requirements of the post-bariatric diet, including supplementation, and potential issues with non-compliance (Parrott et al., 2017a). Table 2 summarises the nutrition-related biochemical assessments and nutritional recommendations for RYGB and SG. It does not, however, represent a complete medical checklist for surgical readiness or recovery. Reference ranges mentioned have been converted to NZ values.

Table 2
Peri-Surgical Recommendations for Roux-en Y Gastric Bypass and Sleeve Gastrectomy

Pre-Operative Recommendations

Routine labs, including:
Fasting glucose
HbA1c (target 47.5-53 mmol/mol (6.5-7%), up to 64 mmol/mol (8%) for poorly managed)
Lipid panel
Kidney and liver function
Endocrine evaluation
INR
CBC
Iron studies
B12 (methylmalonic acid optional)
Folic acid (RBC folate optional)
25-hydroxyvitamin D

Advisable, based on physical signs and patient characteristics:
Thiamine
Vitamin A
Vitamin E
Vit D/Calcium (25(OH)D, serum alkaline phosphatase, PTH, 24-hr urinary calcium in relation to intake)
Zinc
Copper
Homocysteine

Other tests (e.g. Cushings syndrome and PCOS)

Discretionary:
DEXA scan for malabsorptive surgeries (may be inaccurate in very obese patients)

2-4 weeks very-low calorie diet (VLCD)
24 hour fast pre-surgery
Regular dietary counselling to ensure full awareness of the post-surgical dietary progression

Post-Operative Recommendations

Follow-up visits at 1,3,6 and 12 months and yearly thereafter

2x Daily Multivitamin/Mineral including
- Thiamine at least 15-50mg daily
- Folic Acid 400-800mcg daily, 800-1000mcg if of childbearing age
- Vitamin A 5000-10,000 IU/day
- Vitamin K 90-120mcg / day
- Vitamin E 15mg / day
- Zinc 8-22mg / day
- Copper 1mg / day, plus 1mg for every 8-22mg dose of zinc

Calcium 1200-1500mg / day in citrate form, not carbonate
Vitamin D ≥3000 IU / day to keep plasma levels >75nmol/L
B12 350-500 mcg/day, preferable by sublingual tablet or to maintain levels in range 250-650 pmol/L.
Thiamine supplementation (50-100mg) if persistent vomiting
Prophylactic iron supplementation 45-60mg elemental (may be part of the multi but separate from calcium, acid-reducing medications and dietary phytates)
Hydration >1.5L / day

At each visit:
CBC
Electrolytes
Iron
B12
Folate
Vitamin D
PTH
Bone formation / resorption markers
Metabolic panel

Advisable based on physical signs and patient characteristics
Thiamine (if vomiting, female or symptomatic)
Vitamin A (within first year for RYGB)
Vitamin K (if symptomatic)
Vitamin E (if symptomatic)
Zinc (annually for RYGB, if symptomatic for SG)
Copper (annually for RYGB, if symptomatic for SG)

Blood glucose monitoring if diabetic or showing hypoglycaemic symptoms.
Lipid panel every 6-12 months

DEXA scan bi-annually (RYGB)

Exercise: Minimum of 150 min/week and goal of 300 min/week, including strength training 2–3 times per week.

Graduated, supervised meal progression with the following stages:
- Low sugar clear liquid intake within 24 hours after surgery
- Gradual progression through soft / pureed food, then more solid foods over a period of 2-4 weeks
- Patients should be counselled to eat three small meals a day and to chew small bites of food thoroughly before swallowing

Allow at least 30 minutes between liquids and solids

Minimum protein intake of 60 g/day and up to 1.5 g/kg of target body weight per day. Protein supplements may comprise up to 30g/day

Consider sugar-free liquid version or crush tablets / open capsules into liquid if difficulty with hard capsules/tablet supplements

Mechanick et al. (2013), Busetto et al. (2017), Dagan et al. (2017), Parrott et al. (2017a)

Other non-nutrition recommendations are: avoiding non-steroidal anti-inflammatory drugs (NSAID's), smoking cessation, medication monitoring and adjustment, additional pre-surgery medical screening (e.g. for thyroid or cardiovascular disease), monitoring for complications and discussing body contouring surgery (Mechanick et al., 2013). Clinicians should be aware that there may be changes in other medical conditions: depression, hypertension and dyslipidaemia being a few. Surgery and rapid weight loss can impact on absorption of medication and on efficacy of medical devices. The Continuous Positive Airway Pressure (CPAP) device for OSA may require adjustment.

Due to the risks of nutritional and surgical complications, pregnancy is contraindicated for 12-18 months after surgery. Previously infertile or sub-fertile patients should be advised that fertility may increase. Pregnant bariatric patients require intensive nutrient status monitoring and physicians should be aware of the thiamine deficiency risk from vomiting and that glucose tolerance testing may cause dumping syndrome (as described in section 3.4) (Busetto et al., 2017; Goldman et al., 2015; Jamal et al., 2012; Musella et al., 2012).

3. Issues and Considerations

3.1 Surgical Mortality and Complications

Although beneficial, bariatric surgery is still surgery, with risks of complications and reoperations. Although it should be emphasised that the risk of post-surgical death is low, it represents a serious outcome of concern and interest to patients, professionals and the media and has attracted considerable research attention. A 2014 review put the ≤30 days and >30 days post-surgical mortality rates at 0.08% and 0.31% respectively for RCT's and 0.22% and 0.35% for observational studies noting that these numbers were lower than previously reported, perhaps showing improvements in bariatric management (Chang et al., 2014). A 2017 review endeavoured to avoid the deficiencies of previous reviews (reporting deaths at zero for missing data, use of frequentist statistical approaches to estimate effects and including secondary outcomes) and reported a short-term pooled all-cause mortality rate based on RCT's only of 0.18% at ≤30 days (Cardoso, Rodrigues, Gomes, & Carrilho, 2017).

Post-surgical complications include bleeding, stomal or sleeve stenosis, leaking, gastrogastric fistula, reflux, anastomotic ulcerations, intestinal obstructions, gastrointestinal symptoms, vomiting and nutritional and electrolyte imbalances (Chang et al., 2014; Schulman & Thompson, 2017). Due to fast weight loss and anatomical changes, the rate of cholecystectomy after RYGB is 3.5 times higher 6-12 months post-surgery than pre-surgery (Wanjura et al., 2017) and is also elevated after SG (Sioka et al., 2014). The Swiss Multicentre Bypass or Sleeve Study (SM-BOSS) RCT reported reoperation rates of 15.8% for SG and 22.1% for RYGB, most often for gastroesophageal reflux disease (GERD) for SG and internal hernia for RYGB (Peterli et al., 2018). Additionally, insufficient weight loss may lead to revisional surgery, usually from SG or GB to RYGB (Brethauer et al., 2014; Park, Song, & Kim, 2014). Surgical complications have been estimated at 10-20% incidence, with reoperation rates of 6-7% (Chang et al., 2014; Pech, 2012).

3.2 Nutrient Deficiencies

Vitamin and mineral deficiencies are one of the most common and serious complications of bariatric surgery, particularly after malabsorptive procedures. The most common micronutrient deficiencies following bariatric surgery are: iron and B12 for all surgeries, vitamin D and calcium for RYGB and vitamin A, vitamin E and vitamin K for BPD-DS (Busetto et al., 2017; Johnson et al., 2006). Nutrient deficiencies are primarily a factor of the changed physiology although they also relate strongly to compliance with diet, prophylactic supplementation (Parrott et al., 2017b) and pre-surgical nutritional status (Guan, Yang, Chen, Yang, & Wang, 2018). Requirements for rectifying deficiencies will be discussed only where they differ from standard non-bariatric practice.

Iron. Iron absorption is impaired in RYGB due to bypassing the sites of iron uptake: the duodenum and proximal jejunum, although deficiency also occurs with SG for less defined reasons. Iron deficiency is reported at 18-53% for RYGB and 1-54% for SG (Steenackers, Van der Schueren, et al., 2018). Conversion of the ferric form of iron ($Fe3+$) to the absorbable ferrous form ($Fe\ 2+$) is also hindered by decreased stomach acid production and increased rate of gastric emptying (Mechanick et al., 2013; Via & Mechanick, 2017). As well as these physiological issues, intake of iron-rich foods such as meat, fortified foods and vegetables may be low post-surgery (Schijns et al., 2018; Mechanick et al., 2009; Busetto et al., 2017).

B12. Vitamin B12 uptake is likewise affected by reduced stomach acid in both SG and RYGB and by reduced levels of intrinsic factor, which is required for B12 absorption (Damms-Machado et al., 2012). As B12 requirements are small and it bio-accumulates, B12 deficiency may arise years after surgery (Mechanick et al., 2013). In a recent review Via & Mechanick (2017) noted 20% deficiency after SG and 30-60% post RYGB. This agrees with an older study which reported deficiency in 33% RYGB patients at 2 years (Vargas-Ruiz, Hernandez-Rivera, & Herrera, 2008).

Calcium and vitamin D. These are often combined in the literature as deficiency of one *or* both can lead to the serious RYGB side effects of hyperparathyroidism and bone-demineralisation leading to osteopenia, osteoporosis and fractures. Calcium and vitamin D absorption not only happen primarily in the bypassed anatomy, but calcium uptake requires vitamin D and an acid environment. All of this is affected by RYGB, with deficiency incidence increasing per length of the Roux limb (Gasteyger, 2008). Any resulting deficiencies may persist despite supplementation, hence regular assessments are advisable (Johnson et al., 2006). The rate of vitamin D deficiency after RYGB is up to 50-60% (Johnson et al., 2006), however levels appear unaffected by SG (Damms-Machado et al., 2012). It is emphasised that it should not be assumed that calcium and vitamin D supplementation is adequate; sufficiency should be determined by testing for 25(OH)D and markers of bone mineral metabolism. It is suggested that serum calcium, bonespecific alkaline phosphatase or osteocalcin, vitamin D, parathyroid hormone (PTH) and 24-hour urinary calcium excretion rates should be confirmed as normal (Aills, Blankenship, Buffington, Furtado, & Parrott, 2008). To enhance absorption in a low acid environment, calcium should be supplemented in citrate form only, not as the more common carbonate (Aills et al., 2008).

Further nutrients of concern are the other fat-soluble vitamins (A, E and K) and thiamine. In the case of A, E and K, uptake is reduced, particularly with the BPD/DS, and prophylactic supplementation is advised (Busetto et al., 2017). The water soluble vitamin thiamine is rapidly depleted by persistent vomiting. Case reports show thiamine deficiency manifesting as peripheral neuropathy, the deficiency disease Wernicke's encephalopathy and its chronic sequelae Korsakoff's psychoses (Jeong, Park, Kim, Lee & Jang et al., 2011; Oudman, Wijnia, van Dam, Biter & Postma, 2018). These reports emphasise the need for clinical awareness of this complication, which may present as another neurological condition or stroke and can occur at any stage post-surgery. Complete recovery may be possible with parenteral thiamine. It is also recommended that oral or parenteral thiamine treatment be commenced in any patient that is vomiting or having trouble eating (Hamilton, Darby, Hamilton, Wilkerson, & Morgan, 2018; Loh et al., 2004; Zafar, 2015). Less often reported, but potentially serious deficiencies are zinc (up to 40% of RYGB patients, 19% SG), copper (10-20% RYGB patients), selenium, magnesium, potassium and B6 (Dalcanale et al., 2010; Parrott et al., 2017b). Supplementation with a high-dose multivitamin and mineral supplement ('multi') is often considered sufficient to avoid deficiencies of these nutrients (Schijns et al., 2018), however standardising the dose is difficult, and depending on the multi, and the patient, prescribed intake may need to be doubled or tripled which creates issues of compliance and cost (Gasteyger, 2008; Parrott et al., 2017a). An individualised approach based on clinical symptoms, laboratory tests and patient history is recommended.

In addition to micronutrient deficiencies, protein malnutrition can occur. Consuming >60g/day of protein is essential for maintaining muscle mass during rapid weight loss, however, this coincides with a time where patients may have difficulty eating protein rich foods due to gastric capacity and taste or smell alterations (Mechanick et al., 2013). In their small 2017 review, Steenackers et al., (2018) reported that 43-64% of RYGB and SG patients failed to consume 60g / day and that approximately one third of patients experienced mild protein depletion, with serum pre-albumin of <0.2g/L. Protein malnutrition rates up to 13% have been reported elsewhere for RYGB, with a potential relationship to length of the Roux limb (Busetto et al., 2017; Faintuch, 2004). In times of deficiency or increased need, for example pregnancy or illness, protein intake may be increased up to 2.1g /kg ideal body weight / day (Mechanick et al., 2013). Refractory protein malnutrition may require parenteral nutrition or surgical revision (Byrne, 2001).

A number of clinical studies have also reported pre-surgical nutrient deficiencies (Sanchez et al., 2016), some of which are not routinely screened for. Reported percentages of pre-surgical patients with deficiencies are: iron (8.4%-43.9%), thiamine (29%), 25(OH)D (~70%), magnesium (35.4%), phosphate (21.6%), vitamin A (16.9%), B12 (5.7%-10.6%) and zinc (2.9%-15.7% plasma vs. hair zinc) (Flancbaum, Belsley, Drake, Colarusso, & Tayler, 2006; Lefebvre et al., 2014; Sanchez et al., 2016). These findings reinforce the need for nutritional preparation and screening to avoid worsening during the pre-op diet and weight loss phase.

3.3 Weight Regain and Weight Loss Failure

It is acknowledged that up to 80% of patients will regain some weight from their lowest, which occurs around the 18 month mark (Odom et al., 2010). Numerous studies show that weight regain begins at approximately two years post-surgery and causes considerable psychological distress (Jirapinyo, Abu Dayyeh, & Thompson, 2017; Magro et al., 2008). Magro et al. (2008) reported in a five-year prospective study that weight regain occurred in 50% of their group of RYGB patients (n=782) at 24 months. At 5 years, among the regainers, average regain was 8% from the weight loss nadir. Those most prone to regain were the previously 'superobese' (BMI >50) with ~19% reaching the level of 'surgical failure' (loss of <50% excess weight) at 2 years. A 2017 meta-analysis of RCT's agreed, showing 8-10% regain of EWL for SG and RYGB at 5 years (Osland, Yunus, & Khan, 2017). Interestingly, regain does not necessarily correlate with a relapse in glycaemic control (Schauer et al., 2017). Significant weight regain, usually defined as an increase of at least 15% from lowest occurs in around 10-28% of cases (Bastos et al., 2013; Jirapinyo et al., 2017; Odom et al., 2010) with the SOS study showing that ~9% of patients across surgery types end up heavier than baseline at 10 years post-surgery (Karlsson, Taft, Ryden, Sjostrom, & Sullivan, 2007).

Of all negative bariatric outcomes, weight regain has received the most attention. Predictors identified include non-compliance with dietary recommendations leading to increased calorie intake (Magro et al., 2008; Sjöström, 2004), a 'grazing' eating pattern, increased food urges, decreased feelings of wellbeing, concerns over substance use, higher scores on the Beck Depression Inventory, (Odom et al., 2010), lack of nutritional follow-up (Freire, Borges, Alvarez-Leite, & Toulson Davisson Correia, 2012; Magro et al., 2008), binge and loss of control (LOC) eating (Kalarchian et al., 2002; Meany, Conceicao, & Mitchell, 2014), psychiatric comorbidities (Rutledge, Groesz, & Savu, 2011) and work activities related to food (Bastos et al., 2013). In SG patients, %EWL at 18 months is inversely correlated with increased residual gastric volume (sleeve stretching) at 12 months post-surgery (Vidal et al., 2014) and dilation of the stoma in RYGB patients (Yimcharoen et al., 2011). Self-monitoring seems protective (Odom et al., 2010) as does adherence to physical exercise (Freire et al., 2012).

A common factor in weight regain is non-compliance with pre- and post-surgical follow-up appointments, nutrition and exercise requirements. Non-compliance is more common post-surgery, perhaps as high as 72% for missed appointments and 57% for weight loss instructions (Toussi, Fujioka, & Coleman, 2009). There are many reasons why patients may have difficulties with clinic attendance and dietary, supplement or exercise compliance, including lack of engagement with the post-surgery process, mobility, employment issues and ongoing psychological, psychosocial and psychopathological factors (Goldenshluger et al., 2018; Poole et al., 2005; Reslan, Saules, Greenwald, &

Schuh, 2014; Toussi et al., 2009), however the 'why' of non-compliance has not been addressed within the body of research to the degree that could be expected, given its importance.

In terms of managing weight regain, Faria et al. (2010) noted that in a group of 30 regainers, with an average regain of 8 kg, nutritional counselling two years after RYGB reversed regain in 86% of their sample and enabled 'surgical success' (50% EWL) in half of the group that had not attained this post-surgery. The prescribed diet was low glycaemic index, 45% carbohydrates, 35% protein, and 20% fat with three servings of dairy and a 15 g fibre supplement daily. Another recent study showed reversal of weight regain with an intensive lifestyle intervention, the success of which was enhanced by addition of anorexigenic pharmaceuticals (Srivastava & Buffington, 2018).

3.4 Bowel Issues, Dumping and Hypoglycaemia

A certain amount of digestive difficulty is part of the post-surgical adjustment process and most patients will have a degree of gastric discomfort or unusual bowel habits. These should resolve within the first six months with reinforcement of post-surgical eating habits (Busetto et al., 2017). However, persistent diarrhoea, steatorrhea, faecal urgency, bloating, malodorous flatulence and constipation can impact on quality of life. Bloating, pain, gas and loose or fatty bowel movements may be caused by fat or carbohydrate malabsorption or small intestine bacterial overgrowth (SIBO) and are more common after malabsorptive surgery. A recent Swedish study reported more pain in RYGB patients and more flatus, urgency and requirement for dietary compliance in BPD/DS patients (Elias, Bekhali, Hedberg, Graf, & Sundbom, 2018). These symptoms can be treated by dietary adjustment and, if required, antibiotics (Afshar et al., 2016; Busetto et al., 2017). Constipation is also a common post-surgical complaint. One small study reported a significant 33% decrease in bowel movement frequency in a group of mixed SG and RYGB patients, 6 months after surgery (Afshar et al., 2016). In agreement, a 20% decrease in bowel movement frequency (from 10 to 8 per week) in RYGB patients was also reported by Elias et al. (2018). The incidence of constipation in Afshar et al's (2016) study was reported at 27%. Although this was not significantly different to pre-surgery it was considered to be a result of slower gut transit times and the observed 28% decrease in dietary fibre intake. Contradicting this, Potoczna et al. (2008) noted a decrease in constipation from 29.4% to 7.1% after RYGB, however patients in their study had an unusually long Roux limb of 250cm, compared to the common ~125cm.

Dumping. 'Dumping syndrome' occurs when concentrated nutrients and calories pass too quickly (dump) as chyme into the small intestine. Symptoms feel severe and may include pain, diarrhoea, borborygmus (noisy intestines), vomiting, nausea, sweating, racing heart, dizziness, fainting/syncope and shock (Busetto et al., 2017). Dumping is more likely with certain foods. For example, refined sugars and hydroscopic foods may absorb water and then 'dump'. The complete aetiology of dumping syndrome is unclear, but it is likely a combination of bowel distension, gastrointestinal hormone hypersecretion and sympathetic nervous system activation. Fluid influx into the lumen causes increased intestinal osmotic pressure with a corresponding decrease in intravascular volume and drop in blood pressure (Busetto et al., 2017).

Other contributors to dumping syndrome are the exaggerated release of gut hormones, for example GLP-1- which may contribute to nervous system dysregulation, vasoactive intestinal peptide, neurotensin, serotonin and bradykinin. There is also splanchnic vasodilation (Yamamoto et al., 2005). Dumping has been classified as 'early' (10 to 30 minutes after eating), and 'late' (1-3 hours after eating). Late dumping symptoms are due to reactive hypoglycaemia and may be closely linked to the exaggerated release of GLP-1 and insulin that occurs post-surgery (Nannipieri et al., 2016; Patti & Goldfine, 2014; Yamamoto et al., 2005).

Dumping has been reported variously as occurring in 42% (Banerjee, Ding, Mikami, & Needleman, 2013) and 70-76% of RYGB patients in the year following surgery (Mechanick et al., 2009), and by 40% and 33% of sleeve patients at 6 months and 12 months respectively (Papamargaritis et al., 2012), although much lower rates have also been reported (Ramadan et al., 2016). Given that the symptoms are not specific to dumping, the Sigstad's score diagnostic tool, which assigns a numerical weight to each potential symptom, may be utilised with a score of more than 7 indicating dumping syndrome. Dumping syndrome can usually be controlled by dietetic manipulation and recommendations include smaller frequent meals (~6 a day), studiously separating solid foods and liquids, increasing fibre, decreasing carbohydrate intake, choosing complex carbohydrates over simple, and lying down after meals (Berg & McCallum, 2016). Late dumping may be alleviated by taking juice or a small amount of sugar, one hour after eating (Busetto et al., 2017). Pharmaceuticals may be necessary if dumping is persistent (Busetto et al., 2017). Logically it would seem that dumping syndrome may facilitate weight loss and dietary compliance through conditioned aversion. Indeed, a recent qualitative study suggesting that patients see it as an aid to compliance that clinicians should present in a positive light (Laurenius & Engstrom, 2016). However, at least one study showed the reverse, with non-dumpers having a greater decrease in BMI at one and two years post-surgery (18.5 and 17.8 respectively) than dumpers (14.4 and 13.7) (Banerjee et al., 2013).

Hypoglycaemia. Hypoglycaemia post-surgery may be a transient or persistent and serious concern. In the case of diabetic patients, hypoglycaemia in the immediate post-surgical period should be avoided by twice daily testing of blood glucose and reduction or discontinuation of medication that increases insulin or its effectiveness (e.g. insulin, sulfonylureas and meglitinides) in the early post-surgical period. The drastic peri-surgical caloric reduction may mean that medication requirements are reduced, or eliminated completely. Furthermore, absorption of metformin is increased by approximately 50% after bariatric surgery, therefore careful monitoring is required until normalisation of glycaemic targets (Busetto et al., 2017; Mechanick et al., 2013). Persistent hypoglycaemia post-surgery is a serious side effect which can lead to life-threatening neuroglycopenia (Kassem et al., 2017). Treatment for persistent hypoglycaemia includes a low carbohydrate, low glycaemic diet, however failure to manage the condition may require surgery reversal.

4. Psychological Aspects

The relationship of bariatric surgery with psychological states and conditions is complicated as obesity commonly co-occurs with psychopathologies in the general population, meaning that bariatric patients are an already vulnerable group. A 2008 New Zealand study suggested that the relationship between BMI and psychopathologies is somewhat linear, except at the extremes of BMI (>50 kg/m^2 and <18.5 kg/m^2) (Scott, McGee, Wells, & Oakley Browne, 2008). That study also unexpectedly identified a relationship with Post Traumatic Stress Disorder (PTSD). The direction of causation is confounded. For example, obesity and mental health disorders like PTSD, depression and anxiety may follow trauma such as childhood abuse, but also, once obese, people in larger bodies are subjected to a life of stigmatising situations and may have physical comorbidities such as joint pain or sleep disorders which are themselves correlated with psychiatric disorders (Malik, Mitchell, Engel, Crosby, & Wonderlich, 2014).

Psychopathologies in Pre-Surgical Populations. Interestingly, those seeking surgery may be more prone to mental disorders than both general population and those with obesity that do not seek surgery. A 2014 review of studies that used the SCID (Structured Clinical Interview for DSM) (Malik et al., 2014) showed a clear increase in mental disorders in pre-surgical compared to non-surgical obese patients in all populations, however the non-surgical groups were not more disorder prone than general population in the US and Italy, but were in Germany. The most common disorders overall were the Axis I affective disorders, particularly anxiety. In a Chinese cohort of 841 pre-surgical and non-surgical obese individuals, Lin et al. (2013) reported a 42% prevalence of psychiatric disorders, primarily mood, anxiety and eating disorders with females showing more mood and eating disorders than men. There was a borderline significant difference between surgical (54.1%) and non-surgical (38.6%) groups.

Among pre-surgical patients, Binge Eating Disorder (BED), adjustment disorder and sleep disorders were more common than in the non-surgical group, however, the sleep disorder differential may be explained by the surgical group having a significantly higher baseline BMI (39.5 kg/m^2), as BMI correlated significantly with sleep disorder incidence. Interestingly, pre-surgical BMI was inversely associated with anxiety disorder, a trend also reported elsewhere with a non-surgical group (Haghighi et al., 2016). A 2012 evaluation of 547 pre-surgical patients reported more than half (64.5% of women and 44.9% of men) suffering psychological comorbidities, the most common being depression (17.2% of females, 10.8% males) and adjustment disorders, however this study also noted a prevalence of personality disorders (particularly cluster C) (Kinzl, Maier, & Bosch, 2012). Elsewhere, the prevalence of pre-surgical depression has likewise been estimated at 19% (Dawes et al., 2016), compared to ~4-7% in general population (NZGG, 2006;

WHO, 2017). In agreement with Lin et al. (2013), Kinzl et al. (2012) reported evidence of disordered eating in most of their pre-surgical cohort, with 20.3% females (those with the highest BMI's), and 13.9% of males demonstrating symptoms of BED. Similarly, a 2015 study reported BED in 15.7% of their sample (Mitchell et al., 2015) and a 2016 meta-analysis estimated it at 17% in pre-operative populations (Dawes et al., 2016). For reference, BED affects around 2.2% of general population (Qian et al., 2013). Mitchell et al. (2015) also reported LOC Eating in 43.4%, Night Eating Syndrome in 17.7% and Bulimia Nervosa in 2% of their pre-surgical participants. For clarity, other pre-surgical incidences are discussed in reference to post-surgical outcomes in the sections following.

Post-Surgical Psychological Aspects. In terms of post-surgical psychological outcomes, it is possible to identify general themes while acknowledging that there is a high degree of individual variation. The trend is improvements in affective/mood disorders, self-esteem and body image that peak at about 1-year post-surgery and are significantly correlated with degree of weight loss, with some, but not all, benefits declining over time and with weight regain. Where reported, rates of mental disorder, alcohol abuse, self-harm and suicide are usually lower than pre-surgical levels, but nearly always remain higher than general non-obese population (Morgan & Ho, 2017). Most studies report a strong relationship between pre-surgical and post-surgical mental health outcomes (Bhatti et al., 2016; Lagerros, Brandt, Hedberg, Sundbom, & Boden, 2017). The overall scenario is promising, with the rate of disorder remission being high (Kalarchian et al., 2016), and the incidence of disorders recurring or newly arising being much lower. However, it is in no way a 'case closed', particularly for suicide and alcohol use disorder.

Axis I Disorders. A 2016 multicentre, 3-year follow up study with RYGB and GB patients, which self-describes as 'the largest, carefully-assessed sample to date' (p. 6) reported the incidence of any Axis I (anxiety, mood and/or psychotic) disorder at baseline, two years and three years as 30.2%, 16.8% (p=0.003) and 18.4% (p=0.012) respectively. In this study, at three years post-surgery, the prevalence of anxiety disorders was significantly lower than pre-surgical baseline, but mood disorders were unchanged (Kalarchian et al., 2016). These results are vice-versa to those of an earlier study (de Zwaan et al., 2011) which found no change in anxiety, but a significant decrease in mood disorders at 24-36 months post-surgery. The SOS study found no significant differences for mood and anxiety at 10 years follow-up when compared to a non-surgical group, but there was decreased depression (Karlsson et al., 2007). Dawes et al. (2016)'s review put the prevalence of depression from pre- to post-surgery at an 8-74% decrease, with a 40-70% decrease in severity. Another large multi-centre study (Burgmer et al., 2014) showed improvement in depressive symptoms, with peak improvement at one year. Depression was significantly related to degree of weight loss, with 44.7% of those with >25% body weight loss recovering from pre-existing depression but 18.5% of those with <25% weight loss developing clinically significant depressive symptoms during the four years. In line with other studies (Karlsson et al., 2007; Lin et al., 2013) and in agreement with pre-surgical observations, anxiety was not positively correlated with weight. Although anxiety scores decreased in the first year, this never reached clinical significance, however 17% of those with previously normal scores developed severe anxiety over the four years. To recap: mood and anxiety disorders were either decreased or stable throughout the bariatric process in all but one of these studies, and depression generally improved. A recent large cohort study (n=22,539) reported having previous in-patient or out-patient care for depression, or having filled a prescription for anti-depressants (even in the absence of a specialist diagnosis) as being a risk factor for developing depression post surgically in RYGB patients (Lagerros et al., 2017).

Quality of Life and Self Esteem. As part of their study Burgmer et al. (2014) also assessed health related quality of life (HRQOL) using the internationally validated 36-Item Short Form Health Survey (SF-36) and self-esteem using the Rosenberg Self-Esteem Scale (RSE). In common with the findings of Lindekilde et al.'s (2015) 72-study meta-analysis, physical aspects of HRQOL improved throughout the study but mental HRQOL decreased between years 2-4. Self-esteem improved significantly for the first two years, then declined to a point not significantly different from baseline by year four. The SOS study also looked at HRQOL over 10 years, finding that there was a net gain in HRQOL, however it was tied to weight loss and gain over the years, peaking with maximum velocity of weight loss, declining with regain, and stabilising in years 6-10 when weight was also stable. At 10 years the surgical group had significantly higher scores in health perceptions, social interaction and psychosocial function than a 'conventional treatment' group (Karlsson et al., 2007). Studies looking at QOL are marked by heterogeneity, however the majority of studies conclude that bariatric surgery has a positive effect on overall QOL with a greater beneficial impact on physical, rather than other aspects of QOL and that physical QOL improves more in regards to effect of weight, than effect of other physical qualities such as gastrointestinal function (Lindekilde et al., 2015).

Self-Harm. Similar to their findings for depression, Lagerros et al. (2017) reported that although absolute incidence of post-surgical self-harm was low, there was a dramatically increased risk of self-harm (HR 36.6) in those that had a self-harm diagnosis within two years before surgery. Intriguingly, patients that had been hospitalised in a psychiatric facility for non-self-harm reasons were more likely to self-harm after surgery than those who had been hospitalised for self-harm before surgery. Among those that had not previously self-harmed, there was increased risk of post-surgical self-harming in those <25 years old. A different recent Canadian bariatric cohort (n=8815) analysis (98.5% RYGB) focusing on emergency admissions for self-harm noted a significantly increased risk of self-harm after surgery compared to before surgery (RR 1.54), reporting that 93% of those admitted had a pre-surgical mental disorder diagnosis, with 63.9% having a history of anxiety. Intentional overdose accounted for 72.8% of admissions (Bhatti et al., 2016). In partial contrast, an Australian study found increased risk of self-harm (IRR 1.47) an average of 2.4 years post-surgery when compared to general population, however this was not significantly different to pre-surgical levels. In agreement with Lagerros et al. (2017), and Bhatti et al (2016), this study found that pre-surgery hospitalisation for mental health issues (in this instance, depression) predicted self-harm after surgery (Morgan & Ho, 2017). Other predictors for self-harm have been reported as: low SES, living rurally (Bhatti et al., 2016), having no private health insurance, and having post-surgical gastrointestinal complications (Morgan & Ho, 2017)

Suicide. Studies typically report an increased risk of suicide among bariatric patients compared to general, pre-surgical obese and non-surgical obese populations. A well-cited ten year study reported a rate of 13.7/10,000 for men (compared to 2.4/10,000 local general population) and 6.6/10,000 for women (compared to 0.7/10,000). (Tindle et al., 2010), but a 2013 review which used those figures as the primary comparison for their own findings, suggested the rate is lower at 3.2-3.9/10,000 (Peterhansel, Petroff, Klinitzke, Kersting, & Wagner, 2013). Expanding on both those papers, a 2018, 32-study review reported a higher rate of 27/10,000 in post-bariatric populations with significant heterogeneity (Castaneda, Popov, Wander, & Thompson, 2018). Additionally, a large register-based 2016 study reported a nearly three-fold risk for suicide (HR 2.85) after RYGB compared to non-obese general population (Backman, Stockeld, Rasmussen, Naslund, & Marsk, 2016). In their meta-analysis, Castaneda et al. (2018) also reported increased risk pre- to post-surgery (OR 1.9, based on three studies) and when compared to age, gender and BMI-matched controls (OR 3.8, based on five studies). In contrast, Morgan et al. (2017) reported comparable rates of suicides between general population and their longitudinal cohort at 2.5 years and Marsk et al. (2010) described no significant difference in suicide between their surgical, non-surgical obese and general population cohorts at 7.5 years post-surgery.

Once again, there is a strong connection with pre-surgical issues. In Lagerros et al.'s. (2017) two-year follow-up, of those that suicided (0.08% of the cohort) 82.4% had fulfilled prescriptions for anti-depressants in the two years before surgery. A very recent, smaller study reporting deaths from self-harm (possible suicides) or accidental overdose in RYGB patients revealed that at surgery 50% had a depressive disorder, 9.1% had bipolar disorder, 63.6% were taking anti-depressants and 27.2% were on anti-anxiolytics. Of deceased patients, 72.7% had lifetime or current mental disorder diagnoses or treatment. In the death by self-harm group 83.3% had a history of depression and 50% had a history of suicidal ideation or behaviour (Lent et al., 2018). Revealingly, 40.9% of those that died had initially been denied surgery on the basis of 'dietary behaviours, lack of weight loss progress or understanding surgery, smoking, and mental health concerns', but later cleared. Studies addressing suicidal ideation, rather than completed suicide, find again that a psychiatric history and suicidal ideation pre-surgery (which may be correlated with weight stigma) were predictive of post-surgical suicidal ideation (Chen, Fettich, & McCloskey, 2012). Predictors of post-surgical suicide ideation were getting divorced, a decrease in perceived health and experiencing more depressive symptoms (Gordon et al., 2016).

The aetiology of suicide after bariatric surgery is presented as multi-factorial. Along with the existence of pre-surgical mental comorbidities, it is notable that approximately 30% of suicides happen in the first two years and 70% within three years after surgery (Tindle et al., 2010), that is, the point where weight regain is common and where mental health and body image improvements may have waned or returned to baseline. However, a 2005 study reporting the forensic and clinical aspects of three cases showed sustained weight loss (BMI's of 22.2, 25 and 29.4 kg/m^2 at death), but presence of major depressive disorder in all three individuals (Omalu et al., 2005). It has also been noted that rates may be underestimated as 'masked suicide' may be recorded, for example, as unintentional drug overdose (Castaneda et al., 2018; Tindle et al., 2010).

Binge Eating Disorder. Although there is an apparent post-surgical improvement in eating pathologies (Devlin et al., 2018), there is concern that the physiological restraints of surgically altered anatomy may mask objective symptoms, while the psychological sequelae of disordered or maladaptive eating remain. Of particular concern is BED, which Suzuki et al. (2012) found evidence of in 25.5% of patients three years post-surgery. Post-surgical BED is likely underdiagnosed due to not meeting the DSM criteria, one of which is eating an objectively large quantity of food, a behaviour that is physically impossible post-surgery. Some researchers suggest that assessment of LOC eating (feeling compulsion even when amounts eaten are small) is more appropriate as a 'binge eating' criteria for bariatric patients, and that problem behaviours such as grazing and picking may represent unresolved eating issues (Kalarchian et al., 2016; Kalarchian et al., 2002; Lindekilde et al., 2015; Niego, Kofman, Weiss, & Geliebter, 2007). Interestingly, BED appears to be the only eating disorder consistently observed post-surgery and is predictive of unsatisfactory weight loss (Kalarchian et al., 2016; Suzuki et al., 2012), whereas the evidence surrounding other psychopathologies and weight loss is inconsistent (Dawes et al., 2016; Kalarchian et al., 2016; Suzuki et al., 2012). Interestingly Kinzl et al. (2006) found that having a pre-operative eating disorder (BED, 'overeating' or 'atypical') predicted greater post-surgical weight loss at ~2.5 years post-surgery than having no pre-surgical eating disorder. Their proposed reasons include greater post-surgical behaviour change and stronger influence of genetics in the eating disordered patients.

Alcohol Use Disorder (AUD). Studies consistently show increased prevalence of post-surgical AUD over time. A prospective cohort study (n=1945) reported pre-surgical incidence of 7.6%. There was no significant change at one year post-surgery, but an increase to 9.6% at year two (p=0.01) (King et al., 2012). The SOS study (Svensson et al., 2013) reported that at 8-22 years after surgery, RYGB patients were much more likely to be diagnosed with AUD than matched non-surgical controls (adjHR 4.97), and were more likely to report 'alcohol problems' and drink above the World Health Organization (WHO) recommended limit. Another study looking at use of alcohol, drugs and cigarettes as a composite variable in RYGB and GB patients, found decreased use at one month only. By two years, use was increased relative to baseline, 1, 3, 6 and 12 months (Conason et al., 2013). A 2015 study using addiction treatment records from the Mayo clinic over an eight year period reported that RYGB patients were drinking at AUD levels earlier in life than non-surgical AUD patients (19.1 years ± 0.4 vs. 25.0 ± 1 p = 0.002) and that RYGB patients with AUD starting their post-op drinking at ~1.4 years, progressing to AUD at ~3.1 years before seeking treatment at 5.4 years. In the month before admission RYGB patients with AUD were drinking 8.1 ± 1.2 drinks/day compared to 2.5 ± 0.4 pre-surgery (p = 0.009). Importantly, that study excluded those that had been treated for AUD pre-operatively (Cuellar-Barboza et al., 2015). The situation seems similar for SG patients, with recent studies reporting decreased alcohol consumption and AUD at one year (Coluzzi, Iossa, Spinetti, & Silecchia, 2018; Ibrahim et al., 2018) with increases in the second year at rates comparable to RYGB (Ibrahim et al., 2018).

In a somewhat equivocal contradiction to the trend of the AUD research, Suzuki et al. (2012) reported in their survey-to-interview based study similar lifetime (35.3%) and current (11.8%) rates of AUD between bariatric patients and general population at ~43 months post-surgery and Wee et al. (2014) reported a non-significant decrease in high-risk drinking post-surgery. However, comparably to the Mayo clinic findings, none of Suzuki et al.'s (2012) sample reported AUD at surgery assessment, suggesting newly acquired AUD and need to evaluate for current *and* lifetime AUD at pre-surgical assessments. Suzuki et al. (2012) propose that, due to stimulating similar neural reward systems, pre-surgical AUD rates may drop as binge eating worsens. Lending credence to this idea, Cuellar-Barboza et al. (2015) reported fewer drinking days per week in pre-surgical patients than non-surgical controls. Theories as to why bariatric surgery increases the risk of AUD include 'addiction transfer', altered alcohol metabolism and failing to adjust alcohol consumption as weight loss occurs. Alcohol consumption causes a faster and two-fold higher peak blood alcohol content in both RYGB and SG patients compared to non-surgical controls (Acevedo et al., 2018). Mechanisms of action for RYGB include reduced gut transit time and altered first-pass alcohol metabolism due to reduced gastric alcohol dehydrogenase. Speed to peak blood alcohol content (BAC) is reduced from 30 minutes to ~10 minutes (Klockhoff, 2002). Time to regain sobriety is also increased post-surgery and the experience of being intoxicated may be more inebriating, with higher levels of dizziness, warmth and double vision (Acevedo et al., 2018; G. A. Woodard, Downey, Hernandez-Boussard, & Morton, 2011). Looking at SG, one study (Changchien, Woodard, Hernandez-Boussard, & Morton, 2012) reported no change in peak 'BAC' or time until sober compared to pre-surgery, however in that study 'BAC' was breath alcohol content, and as noted by Acevedo et al. (2018) breathaliser tests may underestimate peak BAC by ~27% post-surgery and miss the peak completely. Reported risk factors for AUD were a pre-surgical history of AUD (83% in Suzuki et al.'s (2012) study), being younger, smoking, regular drinking, recreational drug use, lower 'sense of belonging' and having RYGB surgery (King et al., 2012; Suzuki et al., 2012). Greater risk has been reported variously in males (King et al., 2012) or females (Cuellar-Barboza et al., 2015). Suzuki et al. (2012) found no association with weight loss.

Expectation vs. Reality. General satisfaction with surgery seems related to expectations, with qualitative studies showing that patients express unrealistically rosy expectations of how their bodies and lives will be after surgery. They may anticipate 'normality' and a release from experiences of stigma and shame (Homer, Tod, Thompson, Allmark, & Goyder, 2016). Excess skin can be an unexpectedly severe concern post-surgery, with a 2012 study reporting 75% of women and 68% of men desiring post-surgical body contouring surgery (Kitzinger et al., 2012). In addition patients may underestimate the impact on their personal and family relationships (Pories et al., 2016; Gavitt A. Woodard, Encarnacion, Peraza, Hernandez-Boussard, & Morton, 2011). Recommendations include a need to address the effects of past stigmatisation such as self-isolating and feelings of worthlessness (Homer et al., 2016), to ensure patients have realistic expectations for weight loss and psychosocial function, and to de-centralise weight loss as the primary desirable outcome, focusing instead on improvements in health and function. The issue of excess skin should be broached, along with the fact that body-contouring surgery may not be covered by public health or private insurance.

The implications of psychological aspects are vast. It may be that being seen as a 'surgical' procedure with a physical outcome, there is a tendency to under-emphasise the importance of psychological preparedness and outcomes. Some authors argue that along with weight loss and improvement of comorbidities, improvement in psychosocial function, quality of life and eating behaviours should be desired and measured outcomes of bariatric surgery and that psychological history should be thoroughly assessed and mental health continuously monitored even if there is the appearance of 'surgical success' (Busetto et al., 2017; Omalu et al., 2005; van Hout & Fortuin, 2006). Difficulties in maintaining weight loss should be addressed promptly, as this can impact on QOL over time (Karlsson et al., 2007).

There are also problems with the research in this area. As pointed out by Malik et al. (2014), the body of research on psychological aspects suffers from methodological inconsistency, for example administering the SCID face-to-face or by telephone, reporting incidences over differing timeframes, reporting on differing psychopathologies (anxiety vs. mood disorders vs. eating disorders for example) or administering the appraisal as part of the surgery approval process, which can lead to misleading answers. In their 2015 review of 72 studies, Lindekilde et al (2015) included studies with 22 different QOL scales. Not all studies separate statistics by type of surgery. In addition, as noted by Tindle et al. (2010), any randomised study of post-surgical mental health should use a specialised control group that has also been evaluated and approved for surgery in order to be accurate, as the appraisal process should, in theory, weed out those that are most at risk of negative outcomes. There is also a need for mechanistic studies that link psychological effects to physical changes, for example, investigating reduced post-surgical SSRI uptake (Hamad et al., 2012) and impact of ghrelin signalling on depressive symptoms (Lutter et al., 2008). In terms of supporting good psychological outcomes, at present, level of psychological support is at the discretion of individual clinics and there is limited research. Recent studies have suggested that attending psychological counselling sessions correlates with improved physical (≥6 sessions) and mental (1-4 sessions) wellbeing (Ristanto & Caltabiano, 2018) but that in general, patients feel a need for more psychological support, particularly at around 2 years post-surgery, which is where the ‘honeymoon’ phase is definitely over, but where any clinic led psychological support usually finishes (Parretti, Hughes, & Jones, 2019). Given the correlation of pre-surgical psychological issues with post-surgical mental disorders and the indications that surgery-seeking individuals may be more prone to psychopathologies than non-surgical populations, it seems prudent to suggest that every attempt is made to resolve existing psychological issues, disordered eating and effects of stigmatisation before approval for surgery. However, it seems reasonable to assume that this approach, which could require long-term pre-surgical treatment, might lead to delayed or cancelled surgeries and may not slot neatly into the bariatric process.

5. Summary Table of Outcome Predictors

Table 3 presents a summary of the main findings from this review that relate to predictors of long-term outcomes following bariatric surgery.

Table 3

Summary Table of Factors Correlated with Long-Term Bariatric Surgery Outcomes

Factor	Correlated with Desired Outcomes	Correlated with Undesirable Outcomes
Weight loss	Self Monitoring[3]	Working with Food[1]
	Physical Activity[4]	Binge and Loss of Control Eating[2]
	Higher dietary adherence[7]	A grazing eating pattern[3]
	Better post-operative cognitive function[18]	Decreased wellbeing[3]
	Compliance with clinic visits and post-surgical lifestyle instructions[18]	Substance use[3]
	Ability to self-regulate[22]	Higher BDI scores[3]
		Lack of Nutritional Follow-up[4]
		Binge Eating[5]
		Psychiatric Comorbidities (particularly ≥2)[6]
		BMI >50 pre-surgery[12]
		Lower SES[23]
Nutritional Status		Pre-surgical deficiencies[16]
		Dumping[24]
		Vomiting[24]
		Non-adherence with supplementation[25]
Diabetes Remission	Early disease stage at surgery[21]	Being older at time of surgery[16]
		Higher Hb1Ac at time of surgery[16]
		Pre-surgical use of insulin/diabetes medication[16]
		Longer duration of diabetes[17]
Metal Health Outcomes	Attending psychological counselling[26]	Fulfilling a prescription for anti-depressants pre-surgery[8]
		Historical diagnoses or hospitalisation for mental disorder[8,10]
		<25% Weight Loss[9]
		Being <25 years old (for self-harm)[8]
		Post-surgical complications[10]
		Decrease in perceived health[13]
		Low SES[11]
		Relationship breakdown[13]
		Smoking[14,15]
		Regular drinking of alcohol[14,15]
		Recreational drug use[14,15]
		Lower 'sense of belonging'[14,15]
Obstructive Sleep Apnoea		age ≥50[27]
		pre-operative AHI ≥30[27]
		EWL of <60%[27]

1. Bastos et al. (2013) 2. Meany et al. (2014) 3. Odom et al. (2010) 4. Freire et al. (2012) 5. Kalarchian et al. (2002)6. Rutledge et al. (2011)7. Sarwer et al. (2008) 8. Lagerros et al. (2017) 9. Burgmer et al. (2014) 10. Morgan & Ho (2017) 11. Bhatti et al. (2016) 12. Magro et al. (2008) 13. Gordon et al. (2016) 14. King et al. (2012) 15. Suzuki et al. (2012) 16. Guan et al. (2018) 16. Dicker et al. (2016) 17. Kassem et al. (2017) 18. Spitznagel at al. (2013) 19. Pontiroli et al. (2008) 20. Kinzl et al. (2006) 21. Chinkunguwo et al. (2010) 22. Generali & De Panfilis. (2018) 23. Carden et al. (2018) 24. Dalcanale et al. (2010) 25. Parrott et al. (2017a) 26. Ristanto & Caltabiano (2018) 27. Sarkhosh et al. (2013)

As can be seen in Table 3, investigating bariatric surgery outcomes requires addressing a range of interacting and diverse known predictors. The table is not exhaustive. There are a number of outcomes not represented, such as arthritis and cardiovascular disease, as the studies included in the review did not discuss predictors for these outcomes. In addition, there may be other predictors of the outcomes mentioned as the focus of the review was not predictors, and the search method was not designed to track down all such. However, the table does indicate that the profile of factors that influence bariatric outcomes is deep, wide and truly complex.

6. Conclusions and Recommendations

This review has presented a very broad overview of bariatric surgery, the benefits, potential mechanisms of action and issues that require consideration given that the trajectory of surgery numbers is unlikely to slow. Bariatric surgery is a procedure and experience that affects the whole person. There is a dramatic physical adjustment, with accompanying forced behaviour change and although the surgery facilitates undeniable health improvements, there are also risks of severe long-term physical and mental health issues. Roughly, the outcome of surgery seems dependent on an interplay of physical health, mental state, compliance and weight loss. An effective approach for managing the bariatric experience must be, for want of a better word, 'holistic', involving a team of professionals in what has recently been described as a 'shared care model' (O'Kane et al., 2016).

Several observations and practical recommendations can be gleaned from this review. Firstly, it reinforces the importance of intensive, personalised pre- and post-surgical nutritional and health screening. The literature highlights a need to resolve pre-surgical deficiencies and for awareness that standardised nutritional supplementation may not be adequate post-surgery, with deficiencies being common. It is noted that the practice of extending the pre-operative diet beyond two weeks is usually unnecessary and may be counterproductive. Secondly, a major finding of this review is that psychological aspects impact on the bariatric experience at least as much, and perhaps more than, the physical.

However, when measuring outcomes, there is often a too-narrow focus on weight loss as the primary measure of success.

Given the importance of pre-existing psychological conditions as risk factors for serious post-surgical mental disorders, particularly alcohol abuse, self-harm and suicide, there are indications that pre-surgical psychological assessment needs to be more thorough. It should investigate historical as well as current issues, with an understanding that a pre-existing condition may manifest post-surgery in a different way, for example, an individual hospitalised for non-self-harm reasons before surgery or with a history of anxiety could be at risk of self-harming after surgery. The assessment might ideally go beyond officially diagnosed disorders, considering related events, such as fulfilling a prescription for anti-depressants or being a heavy drinker earlier in life. Surgeons and primary care physicians must gain awareness that a patient seeking surgery may be already more vulnerable to mental disorders than an individual with obesity that does not desire surgery. It is suggested that, wherever possible, mental disorders, eating problems and effects of stigmatisation be resolved before surgery.

In addressing post-surgical outcomes, it is proposed that outcome indicators be expanded to include measures of quality of life, body image and psychosocial function, as well as physical markers. Eating behaviours should be assessed from both an objective and subjective point of view. What may be seen as a clinical success, may still represent a patient in distress. Even if apparently compliant, with adequate weight loss, a patient may be experiencing compulsion, 'loss-of-control' eating and behaviours such as picking and grazing which can indicate unresolved problem eating behaviours and indicate risk for psychological distress and weight regain.

To a large degree, patient expectations control post-surgical satisfaction, and it is recommended that a realistic picture of post-surgical life is conveyed, along with the facts around expected weight regain, possibility of loose skin and that the psychological ramifications of stigmatisation will not automatically resolve with weight loss. It may prove beneficial if patients are coached to appreciate the reliable improvements in comorbidities, rather than be fixated on becoming smaller. Lastly, it is evident that patients may benefit from an extended follow-up period as the most serious issues are observed at 1.5-3 years post-surgery, a point at which the psychological and weight loss benefits of the surgery may be waning, but clinic support has usually ended.

Areas of interest for further study include the role and direction of causality of bile acids, gut hormones, microbiota and adipose gene expression, particularly in relation to the unexplained reduction in desire for and liking of high calorie foods as well as resolution of diabetes and systemic inflammation. There is the question of why the usual hyperphagic response to food restriction and weight loss is absent after surgery, which also presents the possibility of enabling these changes by non-surgical means, an area which has not been widely studied. In the area of pre- and post-surgical psychological issues, there is a glaring need for methodologically consistent research with appropriate surgery-approved control groups. The realm of compliance with surgical instructions also lacks data, with many studies stating it is an issue, but few investigating the reasons for non-compliance in depth.

Finally, it requires clarification that this review has limitations, the main ones being the sheer volume and velocity of research in the field. There were nearly 3000 papers published with the keyword ‘bariatric surgery’ during the period of writing this review, which means there is a chance that new findings were excluded. In addition the scope was very broad, which disallowed an in-depth analysis of any one area. As such this paper presents an overview of bariatric topics, many of which require more attention from clinicians and researchers if we are to deliver the most promising long-term outcomes to individuals that seek bariatric surgery.

Note: the research report accompanying this literature review follows the references for the literature review. Please find *The BaSE Study: A Grounded Theory of Constructing Success for Bariatric Patients* on page 56

References

Acevedo, M. B., Eagon, J. C., Bartholow, B. D., Klein, S., Bucholz, K. K., & Pepino, M. Y. (2018). Sleeve gastrectomy surgery: when 2 alcoholic drinks are converted to 4. *Surgery for Obesity and related Diseases 14*(3), 277-283.

ADA, (2015). Standards of medical care in diabetes-2015 abridged for primary care providers. *Clinical Diabetes : a Publication of the American Diabetes Association, 33*(2), 97-111.

Adams, T. D., Gress, R. E., Smith, S. C., Halverson, R. C., Simper, S. C., Rosamond, W. D., . . . Hunt, S. C. (2007). Long-term mortality after gastric bypass surgery. *The New England Journal of Medicine, 357*(8), 753-761.

Afshar, S., Kelly, S. B., Seymour, K., Woodcock, S., Werner, A. D., & Mathers, J. C. (2016). The Effects of Bariatric Procedures on Bowel Habit. *Obesity Surgery, 26*(10), 2348-2354.

Aills, L., Blankenship, J., Buffington, C., Furtado, M., & Parrott, J. (2008). ASMBS Allied Health Nutritional Guidelines for the Surgical Weight Loss Patient. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 4*(5 Suppl), S73-108.

Alosco, M. L., Spitznagel, M. B., Strain, G., Devlin, M., Cohen, R., Crosby, R. D., . . . Gunstad, J. (2015). Improved serum leptin and ghrelin following bariatric surgery predict better postoperative cognitive function. *Journal of Clinical Neurology, 11*(1), 48-56.

Alvarado, R., Alami, R., Hsu, G., Safadi, B., Sanchez, B., Mortion, J., Curet, M. (2005). The impact of preoperative weight loss in patients undergoing laparoscopic reoux-en y gastric bypass. *Obesity Surgery, 15*, 1282-1286.

Angrisani, L., Santonicola, A., Iovino, P., Vitiello, A., Zundel, N., Buchwald, H., & Scopinaro, N. (2017). Bariatric Surgery and Endoluminal Procedures: IFSO Worldwide Survey 2014. *Obesity Surgery, 27*(9), 2279-2289.

Arterburn, D., Gupta,Anirban. (2018). Comparing the Outcomes of Sleeve Gastrectomy and Roux-en-Y Gastric Bypass for Severe Obesity. *Journal of the American Medical Association, 319*(3), 235-237.

ASMBS. (June 2018). Estimate of Bariatric Surgery Numbers, 2011-2017. Retrieved 11 November 2018, from https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers.

Backman, O., Stockeld, D., Rasmussen, F., Naslund, E., & Marsk, R. (2016). Alcohol and substance abuse, depression and suicide attempts after Roux-en-Y gastric bypass surgery. *The British Journal of Surgery, 103*(10), 1336-1342.

Banerjee, A., Ding, Y., Mikami, D. J., & Needleman, B. J. (2013). The role of dumping syndrome in weight loss after gastric bypass surgery. *Surgical Endoscopy, 27*(5), 1573-1578.

Bastos, E. C. L., Barbosa, E. M. W. G., Soriano, G. M. S., dos Santos, E. A., & Vasconcelos, S. M. L. (2013). Determinants of weight regain after bariatric surgery. *Arquivos brasileiros de cirurgia digestiva : ABCD = Brazilian Archives of Digestive Surgery, 26 Suppl 1*, 26-32.

Baykara, M., Yazar, F. M., Cengiz, E., & Bulbuloglu, E. (2018). Protective effects of laparoscopic sleeve gastrectomy on atherosclerotic and hemocytic parameters in obese patients. *Turkish Journal of Surgery, 34*(3), 169-177.

Bays, H., Kothari, S. N., Azagury, D. E., Morton, J. M., Nguyen, N. T., Jones, P. H., . . . Primack, C. (2016). Lipids and bariatric procedures Part 2 of 2: scientific statement from the American Society for Metabolic and Bariatric Surgery (ASMBS), the National Lipid Association (NLA), and Obesity Medicine Association (OMA). *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 12*(3), 468-495.

Bays, H. E., Jones, P. H., Jacobson, T. A., Cohen, D. E., Orringer, C. E., Kothari, S., . . . Primack, C. (2016). Lipids and bariatric procedures part 1 of 2: Scientific statement from the National Lipid Association, American Society for Metabolic and Bariatric Surgery, and Obesity Medicine Association: Executive Summary. *Journal of Clinical Lipidology, 10*(1), 15-32.

Bell, D. S. (2015). Changes seen in gut bacteria content and distribution with obesity: causation or association? *Postgraduate Medicine, 127*(8), 863-868.

Benaiges, D., Flores Le-Roux, J. A., Pedro-Botet, J., Chillaron, J. J., Renard, M., Parri, A., . . . Goday, A. (2013). Sleeve gastrectomy and Roux-en-Y gastric bypass are equally effective in correcting insulin resistance. *International Journal of Surgery, 11*(4), 309-313.

Berg, P., & McCallum, R. (2016). Dumping Syndrome: A Review of the Current Concepts of Pathophysiology, Diagnosis, and Treatment. *Digestive Diseases and Sciences, 61*(1), 11-18.

Bhatti, J. A., Nathens, A. B., Thiruchelvam, D., Grantcharov, T., Goldstein, B. I., & Redelmeier, D. A. (2016). Self-harm emergencies after bariatric surgery: A population-based cohort study. *JAMA Surgery, 151*(3), 226-232.

Bradley, D., Magkos, F., & Klein, S. (2012). Effects of bariatric surgery on glucose homeostasis and type 2 diabetes. *Gastroenterology, 143*(4), 897-912.

Brethauer, S. A., Kothari, S., Sudan, R., Williams, B., English, W. J., Brengman, M., . . . Morton, J. M. (2014). Systematic review on reoperative bariatric surgery: American Society for Metabolic and Bariatric Surgery Revision Task Force. *Surgery for Obesity and Related Diseases 10*(5), 952-972.

Brighton, C. A., Rievaj, J., Kuhre, R. E., Glass, L. L., Schoonjans, K., Holst, J. J., . . . Reimann, F. (2015). Bile Acids Trigger GLP-1 Release Predominantly by Accessing Basolaterally Located G Protein-Coupled Bile Acid Receptors. *Endocrinology, 156*(11), 3961-3970.

Buchwald, H., Avidor, Y., Braunwald, E., Jensen, M. D., Pories, W., Fahrbach, K., & Schoelles, K. (2004). Bariatric surgery: a systematic review and meta-analysis. *JAMA : The Journal of the American Medical Association, 292*(14), 1724-1737.

Buchwald, H., & Oien, D. M. (2013). Metabolic/bariatric surgery worldwide 2011. *Obesity Surgery, 23*(4), 427-436.

Burgmer, R., Legenbauer, T., Muller, A., de Zwaan, M., Fischer, C., & Herpertz, S. (2014). Psychological outcome 4 years after restrictive bariatric surgery. *Obesity Surgery, 24*(10), 1670-1678.

Busetto, L., Dicker, D., Azran, C., Batterham, R. L., Farpour-Lambert, N., Fried, M., . . . Yumuk, V. (2017). Practical Recommendations of the Obesity Management Task Force of the European Association for the Study of Obesity for the Post-Bariatric Surgery Medical Management. *Obesity Facts, 10*(6), 597-632.

Byrne, T. (2001). Complications of surgery for obesity. *Obesity Surgery, 81*, 1181–1193.

Carden, A., Blum, K., Arbaugh, C. J., Trickey, A., & Eisenberg, D. (2018). Low socioeconomic status is associated with lower weight-loss outcomes 10-years after Roux-en-Y gastric bypass. *Surgical Endoscopy*.

Cardoso, L., Rodrigues, D., Gomes, L., & Carrilho, F. (2017). Short- and long-term mortality after bariatric surgery: A systematic review and meta-analysis. *Diabetes, Obesity & Metabolism, 19*(9), 1223-1232.

Castaneda, D., Popov, V. B., Wander, P., & Thompson, C. C. (2018). Risk of Suicide and Self-harm Is Increased After Bariatric Surgery-a Systematic Review and Meta-analysis. *Obesity Surgery*. Electronic Supplement.

Chang, S. H., Stoll, C. R., Song, J., Varela, J. E., Eagon, C. J., & Colditz, G. A. (2014). The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012. *JAMA Surgery, 149*(3), 275-287.

Changchien, E. M., Woodard, G. A., Hernandez-Boussard, T., & Morton, J. M. (2012). Normal alcohol metabolism after gastric banding and sleeve gastrectomy: a case-cross-over trial. *Journal of the American College of Surgeons, 215*(4), 475-479.

Chen, E. Y., Fettich, K. C., & McCloskey, M. S. (2012). Correlates of suicidal ideation and/or behavior in bariatric-surgery-seeking individuals with severe obesity. *Crisis, 33*(3), 137-143.

Chen, Y., Yang, X., Wang, J., Li, Y., Ying, D., & Yuan, H. (2018). Weight loss increases all-cause mortality in overweight or obese patients with diabetes: A meta-analysis. *Medicine, 97*(35), e12075.

Chikunguwo, S. M., Wolfe, L. G., Dodson, P., Meador, J. G., Baugh, N., Clore, J. N., . . . Maher, J. W. (2010). Analysis of factors associated with durable remission of diabetes after Roux-en-Y gastric bypass. *Surgery for Obesity and Related Diseases 6*(3), 254-259.

Climent, E., Benaiges, D., Flores-Le Roux, J. A., Ramon, J. M., Pedro-Botet, J., & Goday, A. (2018). Changes in the lipid profile 5 years after bariatric surgery: laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy. *Surgery for Obesity and Related diseases : Official Journal of the American Society for Bariatric Surgery, 14*(8), 1099-1105.

Colles, S., Dixon, J., Marks, P., Strauss, B., O'Brien, P. (2006). Preoperative weight loss with a very-low-energy diet: quantitation of changes in liver and abdominal fat by serial imaging. *American Journal of Clinical Nutrition, 84*, 304-311.

Coluzzi, I., Iossa, A., Spinetti, E., & Silecchia, G. (2018). Alcohol consumption after laparoscopic sleeve gastrectomy: 1-year results. *Eating and Weight Disorders*.

Conason, A., Teixeira, J., Hsu, C. H., Puma, L., Knafo, D., & Geliebter, A. (2013). Substance use following bariatric weight loss surgery. *JAMA Surgery, 148*(2), 145-150.

Cuellar-Barboza, A. B., Frye, M. A., Grothe, K., Prieto, M. L., Schneekloth, T. D., Loukianova, L. L., . . . Abulseoud, O. A. (2015). Change in consumption patterns for treatment-seeking patients with alcohol use disorder post-bariatric surgery. *Journal of Psychosomatic Research, 78*(3), 199-204.

Cummings, D., Weigle, S., Scott Frayo, R., Breen, P., Ma, M., Dellenger, E., Purnell, J. (2002). Plasma ghrelin levels after diet-induced weight loss or gastric bypass surgery. *New England Journal of Medicine, 346*(21), 1623-1630.

Cunha, F. M., Oliveira, J., Preto, J., Saavedra, A., Costa, M. M., Magalhaes, D., . . . Carvalho, D. (2016). The Effect of Bariatric Surgery Type on Lipid Profile: An Age, Sex, Body Mass Index and Excess Weight Loss Matched Study. *Obesity Surgery, 26*(5), 1041-1047.

Dalcanale, L., Oliveira, C. P., Faintuch, J., Nogueira, M. A., Rondo, P., Lima, V. M., . . . Carrilho, F. J. (2010). Long-term nutritional outcome after gastric bypass. *Obesity Surgery, 20*(2), 181-187.

Damms-Machado, A., Friedrich, A., Kramer, K. M., Stingel, K., Meile, T., Kuper, M. A., . . . Bischoff, S. C. (2012). Pre- and postoperative nutritional deficiencies in obese patients undergoing laparoscopic sleeve gastrectomy. *Obesity Surgery, 22*(6), 881-889.

Damms-Machado, A., Mitra, S., Schollenberger, A. E., Kramer, K. M., Meile, T., Konigsrainer, A., . . . Bischoff, S. C. (2015). Effects of surgical and dietary weight loss therapy for obesity on gut microbiota composition and nutrient absorption. *BioMed Research International, 2015*, 806248.

Dawes, A. J., Maggard-Gibbons, M., Maher, A. R., Booth, M. J., Miake-Lye, I., Beroes, J. M., & Shekelle, P. G. (2016). Mental Health Conditions Among Patients Seeking and Undergoing Bariatric Surgery: A Meta-analysis. *JAMA : the Journal of the American Medical Association, 315*(2), 150-163.

de Raaff, C. A., Coblijn, U. K., Ravesloot, M. J., de Vries, N., de Lange-de Klerk, E. S., & van Wagensveld, B. A. (2016). Persistent moderate or severe obstructive sleep apnea after laparoscopic Roux-en-Y gastric bypass: which patients? *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 12*(10), 1866-1872.

de Raaff, C. A., Pierik, A. S., Coblijn, U. K., de Vries, N., Bonjer, H. J., & van Wagensveld, B. A. (2017). Value of routine polysomnography in bariatric surgery. *Surgical Endoscopy, 31*(1), 245-248.

De Silva, A., Salem, V., Long, C. J., Makwana, A., Newbould, R. D., Rabiner, E. A., . . . Dhillo, W. S. (2011). The gut hormones PYY 3-36 and GLP-1 7-36 amide reduce food intake and modulate brain activity in appetite centers in humans. *Cell Metabolism, 14*(5), 700-706.

de Zwaan, M., Enderle, J., Wagner, S., Muhlhans, B., Ditzen, B., Gefeller, O., . . . Muller, A. (2011). Anxiety and depression in bariatric surgery patients: a prospective, follow-up study using structured clinical interviews. *Journal of Affective Disorders, 133*(1-2), 61-68.

Devlin, M. J., King, W. C., Kalarchian, M. A., Hinerman, A., Marcus, M. D., Yanovski, S. Z., & Mitchell, J. E. (2018). Eating pathology and associations with long-term changes in weight and quality of life in the longitudinal assessment of bariatric surgery study. *The International Journal of Eating Disorders, 51*(12), 1322-1330.

DiBaise, J. K., Zhang, H., Crowell, M. D., Krajmalnik-Brown, R., Decker, G. A., & Rittmann, B. E. (2008). Gut microbiota and its possible relationship with obesity. *Mayo Clinic Proceedings, 83*(4), 460-469.

Dicker, D., Yahalom, R., Comaneshter, D. S., & Vinker, S. (2016). Long-Term Outcomes of Three Types of Bariatric Surgery on Obesity and Type 2 Diabetes Control and Remission. *Obesity Surgery, 26*(8), 1814-1820.

Dimitriadis, E., Daskalakis, M., Kampa, M., Peppe, A., Papadakis, J. A., & Melissas, J. (2013). Alterations in gut hormones after laparoscopic sleeve gastrectomy: a prospective clinical and laboratory investigational study. *Annals of Surgery, 257*(4), 647-654.

Dixon, J., le Roux, Carel W., Rubino, F., Zimmet, P. (2012). Bariatric surgery for type 2 diabetes. *The Lancet, 379*, 2300-2311. Retrieved from

Doyle, M. E., & Egan, J. M. (2007). Mechanisms of action of glucagon-like peptide 1 in the pancreas. *Pharmacology & Therapeutics, 113*(3), 546-593.

Elias, K., Bekhali, Z., Hedberg, J., Graf, W., & Sundbom, M. (2018). Changes in bowel habits and patient-scored symptoms after Roux-en-Y gastric bypass and biliopancreatic diversion with duodenal switch. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 14*(2), 144-149.

Faintuch, J., Matsuda, M,. Emilia, M., Cruz, L., Silva, M., Teivelis, M., Garrido Jr, A., Gama-Rodrigues, J. (2004). Severe protein-calorie malnutrition after bariatric procedures. *Obesity Surgery, 14*, 175-181.

Faraj, M., Havel, P. J., Phelis, S., Blank, D., Sniderman, A. D., & Cianflone, K. (2003). Plasma acylation-stimulating protein, adiponectin, leptin, and ghrelin before and after weight loss induced by gastric bypass surgery in morbidly obese subjects. *The Journal of Clinical Endocrinology and Metabolism, 88*(4), 1594-1602.

Faria, S. L., de Oliveira Kelly, E., Lins, R. D., & Faria, O. P. (2010). Nutritional management of weight regain after bariatric surgery. *Obesity Surgery, 20*(2), 135-139.

Felsenreich, D. M., Langer, F. B., & Prager, G. (2018). Weight Loss and Resolution of Comorbidities After Sleeve Gastrectomy: A Review of Long-Term Results. *Scandinavian Journal of Surgery : SJS*, 1457496918798192.

Flancbaum, L., Belsley, S., Drake, V., Colarusso, T., & Tayler, E. (2006). Preoperative nutritional status of patients undergoing Roux-en-Y gastric bypass for morbid obesity. *Journal of Gastrointestinal Surgery 10*(7), 1033-1037.

Freire, R. H., Borges, M. C., Alvarez-Leite, J. I., & Toulson Davisson Correia, M. I. (2012). Food quality, physical activity, and nutritional follow-up as determinant of weight regain after Roux-en-Y gastric bypass. *Nutrition, 28*(1), 53-58.

Gasteyger, C., Suter, M., Gaillard, R. C., & Giusti, V. . (2008). Nutritional deficiencies after Roux-en-Y gastric bypass for morbid obesity often cannot be prevented by standard multivitamin supplementation. *The American Journal of Clinical Nutrition, 87*(5), 1128–1133.

Gautron, L., Zechner, J. F., & Aguirre, V. (2013). Vagal innervation patterns following Roux-en-Y gastric bypass in the mouse. *International Journal of Obesity, 37*(12), 1603-1607.

Generali, I., & De Panfilis, C. (2018). Personality Traits and Weight Loss Surgery Outcome. *Current Obesity Reports, 7*(3), 227-234.

Goldenshluger, A., Elazary, R., Cohen, M. J., Goldenshluger, M., Ben-Porat, T., Nowotni, J., . . . Keinan-Boker, L. (2018). Predictors for Adherence to Multidisciplinary Follow-Up Care after Sleeve Gastrectomy. *Obesity Surgery, 28*(10), 3054-3061.

Goldman, R. H., Missmer, S. A., Farland, L. V., Robinson, M. K., & Ginsburg, E. (2015). Infertility and pregnancy after bariatric surgery. *Fertility and Sterility, 104*(3), e122.

Gonzalez-Regueiro, J. A., Moreno-Castaneda, L., Uribe, M., & Chavez-Tapia, N. C. (2017). The Role of Bile Acids in Glucose Metabolism and Their Relation with Diabetes. *Annals of Hepatology, 16*(Suppl. 1: s3-105.), 16-21.

Gonzalez, I., Rubio, M. A., Cordido, F., Breton, I., Morales, M. J., Vilarrasa, N., . . . Garcia-Luna, P. P. (2015). Maternal and perinatal outcomes after bariatric surgery: a Spanish multicenter study. *Obesity Surgery, 25*(3), 436-442.

Gordon, K., King, W., White, G., Belle, S., Courcoulas, A., Ebel, F., . . . Mitchell, J. (2016). A Prospective, Longitudinal Examination of Suicidal Ideation among Bariatric Surgery Patients. *Surgery for Obesity and Related Diseases, 12*(7), S44-S45.

Graessler, J., Qin, Y., Zhong, H., Zhang, J., Licinio, J., Wong, M. L., . . . Bornstein, S. R. (2013). Metagenomic sequencing of the human gut microbiome before and after bariatric surgery in obese patients with type 2 diabetes: correlation with inflammatory and metabolic parameters. *The Pharmacogenomics Journal, 13*(6), 514-522.

Guan, B., Yang, J., Chen, Y., Yang, W., & Wang, C. (2018). Nutritional Deficiencies in Chinese Patients Undergoing Gastric Bypass and Sleeve Gastrectomy: Prevalence and Predictors. *Obesity Surgery*.

Guo, C., Chen, W. D., & Wang, Y. D. (2016). TGR5, Not Only a Metabolic Regulator. *Frontiers in Physiology, 7*, 646.

Haghighi, M., Jahangard, L., Ahmadpanah, M., Bajoghli, H., Holsboer-Trachsler, E., & Brand, S. (2016). The relation between anxiety and BMI - is it all in our curves? *Psychiatry Research, 235*, 49-54.

Hai, F., Porhomayon, J., Vermont, L., Frydrych, L., Jaoude, P., & El-Solh, A. A. (2014). Postoperative complications in patients with obstructive sleep apnea: a meta-analysis. *Journal of Clinical Anesthesia, 26*(8), 591-600.

Haluzikova, D., Lacinova, Z., Kavalkova, P., Drapalova, J., Krizova, J., Bartlova, M., . . . Haluzik, M. (2013). Laparoscopic sleeve gastrectomy differentially affects serum concentrations of FGF-19 and FGF-21 in morbidly obese subjects. *Obesity, 21*(7), 1335-1342.

Hamad, G. G., Helsel, J. C., Perel, J. M., Kozak, G. M., McShea, M. C., Hughes, C., . . . Wisner, K. L. (2012). The Effect of Gastric Bypass on the Pharmacokinetics of Serotonin Reuptake Inhibitors. *American Journal of Psychiatry, 169*(3), 256-263.

Hamilton, L. A., Darby, S. H., Hamilton, A. J., Wilkerson, M. H., & Morgan, K. A. (2018). Case Report of Wernicke's Encephalopathy After Sleeve Gastrectomy. *Nutrition in Clinical Practice, 33*(4), 510-514.

Han, S. I., Studer, E., Gupta, S., Fang, Y., Qiao, L., Li, W., . . . Dent, P. (2004). Bile acids enhance the activity of the insulin receptor and glycogen synthase in primary rodent hepatocytes. *Hepatology, 39*(2), 456-463.

Hao, Z., Mumphrey, M. B., Morrison, C. D., Munzberg, H., Ye, J., & Berthoud, H. R. (2016). Does gastric bypass surgery change body weight set point? *International Journal of Obesity Supplements, 6*(Suppl 1), S37-S43.

Hao, Z., Townsend, R. L., Mumphrey, M. B., Patterson, L. M., Ye, J., & Berthoud, H. R. (2014). Vagal innervation of intestine contributes to weight loss After Roux-en-Y gastric bypass surgery in rats. *Obesity Surgery, 24*(12), 2145-2151.

Hao, Z., Zhao, Z., Berthoud, H.-R., & Ye, J. (2013). Development and Verification of a Mouse Model for Roux-en-Y Gastric Bypass Surgery with a Small Gastric Pouch. *PloS one, 8*(1).

Heffron, S. P., Parikh, A., Volodarskiy, A., Ren-Fielding, C., Schwartzbard, A., Nicholson, J., & Bangalore, S. (2016). Changes in Lipid Profile of Obese Patients Following Contemporary Bariatric Surgery: A Meta-Analysis. *The American Journal of Medicine, 129*(9), 952-959.

Himpens, J., Almino Ramos, Richard Welbourn, John Dixon, Robin Kinsman, & Walton, P. (2018). Fourth IFSO Global Registry Report. Retrieved from http://www.e-dendrite.com/4thIFSOGlobalRegistryReport.pdf

Holdstock, C., Engstrom, B. E., Ohrvall, M., Lind, L., Sundbom, M., & Karlsson, F. A. (2003). Ghrelin and adipose tissue regulatory peptides: effect of gastric bypass surgery in obese humans. *The Journal of Clinical Endocrinology and Metabolism, 88*(7), 3177-3183.

Homer, C. V., Tod, A. M., Thompson, A. R., Allmark, P., & Goyder, E. (2016). Expectations and patients' experiences of obesity prior to bariatric surgery: a qualitative study. *BMJ Open, 6*(2).

Ibrahim, N., Alameddine, M., Brennan, J., Sessine, M., Holliday, C., & Ghaferi, A. A. (2018). New onset alcohol use disorder following bariatric surgery. *Surgical Endoscopy*.

Jackness, C., Karmally, W., Febres, G., Conwell, I. M., Ahmed, L., Bessler, M., . . . Korner, J. (2013). Very low-calorie diet mimics the early beneficial effect of Roux-en-Y gastric bypass on insulin sensitivity and beta-cell Function in type 2 diabetic patients. *Diabetes, 62*(9), 3027-3032.

Jamal, M., Gunay, Y., Capper, A., Eid, A., Heitshusen, D., & Samuel, I. (2012). Roux-en-Y gastric bypass ameliorates polycystic ovary syndrome and dramatically improves conception rates: a 9-year analysis. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 8*(4), 440-444.

Jeong, H., Park, J., Kim, Y., Lee, Y., Jang, Y. & Seo, J. (2011) Wernicke's encephalopathy after sleeve gastrectomy for morbid obesity – a case report. *Annals of Rehabilitation Medicine, 35*(4), 583-586.

Jirapinyo, P., Abu Dayyeh, B. K., & Thompson, C. C. (2017). Weight regain after Roux-en-Y gastric bypass has a large negative impact on the Bariatric Quality of Life Index. *BMJ Open Gastroenterology, 4*(1), e000153.

Johnson, J. M., Maher, J. W., DeMaria, E. J., Downs, R. W., Wolfe, L. G., & Kellum, J. M. (2006). The long-term effects of gastric bypass on vitamin D metabolism. *Annals of Surgery, 243*(5), 701-704; discussion 704-705.

Kalarchian, M. A., King, W. C., Devlin, M. J., Marcus, M. D., Garcia, L., Chen, J. Y., . . . Mitchell, J. E. (2016). Psychiatric Disorders and Weight Change in a Prospective Study of Bariatric Surgery Patients: A 3-Year Follow-Up. *Psychosomatic Medicine, 78*(3), 373-381.

Kalarchian, M. A., Marcus, M. D., Wilson, G. T., Labouvie, E. W., Brolin, R. E., & LaMarca, L. B. (2002). Binge eating among gastric bypass patients at long-term follow-up. *Obesity Surgery, 12*(2), 270-275.

Kalinowski, P., Paluszkiewicz, R., Wroblewski, T., Remiszewski, P., Grodzicki, M., Bartoszewicz, Z., & Krawczyk, M. (2017). Ghrelin, leptin, and glycemic control after sleeve gastrectomy versus Roux-en-Y gastric bypass-results of a randomized clinical trial. *Surgery for Obesity and Related Diseases, 13*(2), 181-188.

Karlsson, J., Taft, C., Ryden, A., Sjostrom, L., & Sullivan, M. (2007). Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. *International Journal of Obesity, 31*(8), 1248-1261.

Kassem, M. A., Durda, M. A., Stoicea, N., Cavus, O., Sahin, L., & Rogers, B. (2017). The Impact of Bariatric Surgery on Type 2 Diabetes Mellitus and the Management of Hypoglycemic Events. *Frontiers in Endocrinology, 8*, 37.

Kelly, S., Flint, R. (2015). New Zealand is far behind Australia in offering weight-loss surgery. *New Zealand Medical Journal, 128*(1408), 10-11.

Khosravi-Largani, M., Nojomi, M., Aghili, R., Otaghvar, H. A., Tanha, K., Seyedi, S. H. S., & Mottaghi, A. (2018). Evaluation of all Types of Metabolic Bariatric Surgery and its Consequences: a Systematic Review and Meta-Analysis. *Obesity Surgery*.

King, W. C., Chen, J. Y., Belle, S. H., Courcoulas, A. P., Dakin, G. F., Elder, K. A., . . . Yanovski, S. Z. (2016). Change in Pain and Physical Function Following Bariatric Surgery for Severe Obesity. *JAMA : the Journal of the American Medical Association, 315*(13), 1362-1371.

King, W. C., Chen, J. Y., Mitchell, J. E., Kalarchian, M. A., Steffen, K. J., Engel, S. G., . . . Yanovski, S. Z. (2012). Prevalence of alcohol use disorders before and after bariatric surgery. *JAMA : the Journal of the American Medical Association, 307*(23), 2516-2525.

Kinzl, J., Schrattenecker, M., Traweger, C., Mattesich, M., Fiala, M., & Biebl, W. . (2006). Psychosocial Predictors of Weight Loss after Bariatric Surgery. *Obesity Surgery, 16*(12), 1609–1614.
Kinzl, J. F., Maier, C., & Bosch, A. (2012). Morbidly obese patients: psychopathology and eating disorders. Results of a preoperative evaluation. *Neuropsychiatrie : Klinik, Diagnostik, Therapie und Rehabilitation : Organ der Gesellschaft Osterreichischer Nervenarzte und Psychiater, 26*(4), 159-165.
Kitzinger, H. B., Abayev, S., Pittermann, A., Karle, B., Bohdjalian, A., Langer, F. B., . . . Frey, M. (2012). After massive weight loss: patients' expectations of body contouring surgery. *Obesity Surgery, 22*(4), 544-548.
Klockhoff, H., Näslund, I., Jones A.W. (2002). Faster absorption of ethanol and higher peak concentration in women after gastric bypass surgery. *British Journal of Clinical Pharmacology, 54*, 587-591.
Kong, L. C., Tap, J., Aron-Wisnewsky, J., Pelloux, V., Basdevant, A., Bouillot, J. L., . . . Clement, K. (2013). Gut microbiota after gastric bypass in human obesity: increased richness and associations of bacterial genera with adipose tissue genes. *The American Journal of Clinical Nutrition, 98*(1), 16-24.
Kritchevsky, S. B., Beavers, K. M., Miller, M. E., Shea, M. K., Houston, D. K., Kitzman, D. W., & Nicklas, B. J. (2015). Intentional weight loss and all-cause mortality: a meta-analysis of randomized clinical trials. *PloS one, 10*(3), e0121993.
Kuhre, R. E., Wewer Albrechtsen, N. J., Larsen, O., Jepsen, S. L., Balk-Moller, E., Andersen, D. B., . . . Holst, J. J. (2018). Bile acids are important direct and indirect regulators of the secretion of appetite- and metabolism-regulating hormones from the gut and pancreas. *Molecular Metabolism, 11*, 84-95.
Kwok, C. S., Pradhan, A., Khan, M. A., Anderson, S. G., Keavney, B. D., Myint, P. K., . . . Loke, Y. K. (2014). Bariatric surgery and its impact on cardiovascular disease and mortality: a systematic review and meta-analysis. *International Journal of Cardiology, 173*(1), 20-28.
Laferrere, B., Teixeira, J., McGinty, J., Tran, H., Egger, J. R., Colarusso, A., . . . Olivan, B. (2008). Effect of weight loss by gastric bypass surgery versus hypocaloric diet on glucose and incretin levels in patients with type 2 diabetes. *The Journal of Clinical Endocrinology and Metabolism, 93*(7), 2479-2485.
Lagerros, Y. T., Brandt, L., Hedberg, J., Sundbom, M., & Boden, R. (2017). Suicide, Self-harm, and Depression After Gastric Bypass Surgery: A Nationwide Cohort Study. *Annals of Surgery, 265*(2), 235-243.
Laurenius, A., & Engstrom, M. (2016). Early dumping syndrome is not a complication but a desirable feature of Roux-en-Y gastric bypass surgery. *Clinical Obesity, 6*(5), 332-340.
le Roux, C. W., Bueter, M., Theis, N., Werling, M., Ashrafian, H., Loewenstein, C., . . . Lutz, T. A. (2011). Gastric bypass reduces fat intake and preference. *American Journal of Physiology-Regulatory Integrative and Comparative Physiology, 301*(4), R1057-R1066.
Lee, W. J., Chong, K., Ser, K. H., Chen, J. C., Lee, Y. C., Chen, S. C., . . . Tsai, M. H. (2012). C-peptide predicts the remission of type 2 diabetes after bariatric surgery. *Obesity Surgery, 22*(2), 293-298.
Lee, Y. K., & Mazmanian, S. K. (2010). Has the microbiota played a critical role in the evolution of the adaptive immune system? *Science, 330*(6012), 1768-1773.
Lefebvre, P., Letois, F., Sultan, A., Nocca, D., Mura, T., & Galtier, F. (2014). Nutrient deficiencies in patients with obesity considering bariatric surgery: a cross-sectional study. *Surgery for Obesity and Related Diseases 10*(3), 540-546.
Lent, M. R., Avakoff, E., Hope, N., Festinger, D. S., Still, C. D., Cook, A. M., . . . Craig Wood, G. (2018). Clinical Characteristics of Roux-en-Y Gastric Bypass Patients with Death from Accidental Overdose or Intentional Self-Harm: a Descriptive Study. *Obesity Surgery, 28*(11), 3531-3537.

LeRoux, C. W., Aylwin, S. J. B., Batterham, R. L., Borg, C. M., Coyle, F., Prasad, V., . . . Bloom, S. R. (2006). Gut Hormone Profiles Following Bariatric Surgery Favor an Anorectic State, Facilitate Weight Loss, and Improve Metabolic Parameters. *Annals of Surgery, 243*(1), 108-114.

Ley, R. E., Turnbaugh, P. J., Klein, S., & Gordon, J. I. (2006). Microbial ecology - Human gut microbes associated with obesity. *Nature, 444*(7122), 1022-1023.

Lin, E., Gletsu, N., Fugate, K., McClusky, D., Gu, L. H., Zhu, J. L., . . . Smith, C. D. (2004). The effects of gastric surgery on systemic ghrelin levels in the morbidly obese. *Archives of Surgery, 139*(7), 780-784.

Lin, H.-Y., Chih-Kun, H., Chi-Ming, T., Hung-Yu, L., Yu-Hsi Kao., Ching-Chung, T., . . . Yung-Chieh, Y. (2013). Psychiatric disorders of patients seeking obesity treatment. *BMC Psychiatry, 13*(1).

Lindekilde, N., Gladstone, B. P., Lubeck, M., Nielsen, J., Clausen, L., Vach, W., & Jones, A. (2015). The impact of bariatric surgery on quality of life: a systematic review and meta-analysis. *Obesity Reviews, 16*(8), 639-651.

Liu, H., Hu, C., Zhang, X., & Jia, W. (2018). Role of gut microbiota, bile acids and their cross-talk in the effects of bariatric surgery on obesity and type 2 diabetes. *Journal of Diabetes Investigation, 9*(1), 13-20.

Loh, Y., Watson, W. D., Verma, A., Chang, S. T., Stocker, D. J., & Labutta, R. J. (2004). Acute Wernicke's encephalopathy following bariatric surgery: clinical course and MRI correlation. *Obesity Surgery, 14*(1), 129-132.

Lutter, M., Sakata, I., Osborne-Lawrence, S., Rovinsky, S. A., Anderson, J. G., Jung, S., . . . Zigman, J. M. (2008). The orexigenic hormone ghrelin defends against depressive symptoms of chronic stress. *Nature Neuroscience, 11*(7), 752-753.

Magro, D. O., Geloneze, B., Delfini, R., Pareja, B. C., Callejas, F., & Pareja, J. C. (2008). Long-term weight regain after gastric bypass: a 5-year prospective study. *Obesity Surgery, 18*(6), 648-651.

Mahawar, K. K., & Sharples, A. J. (2017). Contribution of Malabsorption to Weight Loss After Roux-en-Y Gastric Bypass: a Systematic Review. *Obesity Surgery, 27*(8), 2194-2206.

Malik, S., Mitchell, J. E., Engel, S., Crosby, R., & Wonderlich, S. (2014). Psychopathology in bariatric surgery candidates: a review of studies using structured diagnostic interviews. *Comprehensive Psychiatry, 55*(2), 248-259.

Marsk, R., Naslund, E., Freedman, J., Tynelius, P., & Rasmussen, F. (2010). Bariatric surgery reduces mortality in Swedish men. *The British Journal of Surgery, 97*(6), 877-883.

Martin, B., Dotson, C. D., Shin, Y. K., Ji, S., Drucker, D. J., Maudsley, S., & Munger, S. D. (2009). Modulation of taste sensitivity by GLP-1 signaling in taste buds. *Annals of the New York Academy of Sciences, 1170*, 98-101.

Mathes, C. M., & Spector, A. C. (2012). Food selection and taste changes in humans after Roux-en-Y gastric bypass surgery: a direct-measures approach. *Physiology & Behavior, 107*(4), 476-483.

Meany, G., Conceicao, E., & Mitchell, J. E. (2014). Binge eating, binge eating disorder and loss of control eating: effects on weight outcomes after bariatric surgery. *European Eating Disorders Review, 22*(2), 87-91.

Mechanick, J., Kushner, RF., Sugerman, HJ., Gonzalez-Campoy, JM., Collazo-Clavell, ML., Guven, S., Spitz, AF., Apovian, C., Brolin, R., Sarwer, DB., Anderson, WA., Dixon, J. (2009). American Association of Clinical Endocrinologists, The Obesity Society, American Society for Metabolic & Bariatric Surgery: Medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. *Obesity, 17*(Supplement 1), S1-S70.

Mechanick, J., Youdim, Garvey, T. Hurley, D., McMahon, M., Jones, D., . . . Brethauer, S. (2013). Clinical Practice Guidelines for the Perioperative Nutritional, Metabolic, and Nonsurgical Support of the Bariatric Surgery Patient—2013 Update. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 9*, 159-191.

Miras, A. D., Jackson, R. N., Jackson, S. N., Goldstone, A. P., Olbers, T., Hackenberg, T., . . . le Roux, C. W. (2012). Gastric bypass surgery for obesity decreases the reward value of a sweet-fat stimulus as assessed in a progressive ratio task. *The American Journal of Clinical Nutrition, 96*(3), 467-473.

Mitchell, J. E., King, W. C., Courcoulas, A., Dakin, G., Elder, K., Engel, S., . . . Wolfe, B. (2015). Eating behavior and eating disorders in adults before bariatric surgery. *The International Journal of Eating Disorders, 48*(2), 215-222.

Montesi, L., El Ghoch, M., Brodosi, L., Calugi, S., Marchesini, G., & Dalle Grave, R. (2016). Long-term weight loss maintenance for obesity: a multidisciplinary approach. *Diabetes, Metabolic Syndrome and Obesity : Targets and Therapy, 9*, 37-46.

Morgan, D. J., & Ho, K. M. (2017). Incidence and Risk Factors for Deliberate Self-harm, Mental Illness, and Suicide Following Bariatric Surgery: A State-wide Population-based Linked-data Cohort Study. *Annals of Surgery, 265*(2), 244-252.

Munzberg, H., Laque, A., Yu, S., Rezai-Zadeh, K., & Berthoud, H. R. (2015). Appetite and body weight regulation after bariatric surgery. *Obesity Reviews, 16 Suppl 1*, 77-90.

Murphy, E. F., Cotter, P. D., Healy, S., Marques, T. M., O'Sullivan, O., Fouhy, F., . . . Shanahan, F. (2010). Composition and energy harvesting capacity of the gut microbiota: relationship to diet, obesity and time in mouse models. *Gut, 59*(12), 1635-1642.

Musella, M., Milone, M., Bellini, M., Sosa Fernandez, L. M., Leongito, M., & Milone, F. (2012). Effect of bariatric surgery on obesity-related infertility. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 8*(4), 445-449.

Nannipieri, M., Belligoli, A., Guarino, D., Busetto, L., Moriconi, D., Fabris, R., . . . Ferrannini, E. (2016). Risk Factors for Spontaneously Self-Reported Postprandial Hypoglycemia After Bariatric Surgery. *The Journal of Clinical Endocrinology and Metabolism, 101*(10), 3600-3607.

Nemati, R., Lu, J., Dokpuang, D., Booth, M., Plank, L. D., & Murphy, R. (2018). Increased Bile Acids and FGF19 After Sleeve Gastrectomy and Roux-en-Y Gastric Bypass Correlate with Improvement in Type 2 Diabetes in a Randomized Trial. *Obesity Surgery*.

Niego, S. H., Kofman, M. D., Weiss, J. J., & Geliebter, A. (2007). Binge eating in the bariatric surgery population: a review of the literature. *The International Journal of Eating Disorders, 40*(4), 349-359.

NZGG, Ministry of Health (2006). Depression - Information for Primary Health Practitioners Retrieved from https://www.mentalhealth.org.nz/assets/ResourceFinder/depression-info-for-primary-health-practitioners.pdf

O'Kane, M., Parretti, H. M., Hughes, C. A., Sharma, M., Woodcock, S., Puplampu, T., . . . Barth, J. H. (2016). Guidelines for the follow-up of patients undergoing bariatric surgery. *Clinical Obesity, 6*(3), 210-224.

Odom, J., Zalesin, K. C., Washington, T. L., Miller, W. W., Hakmeh, B., Zaremba, D. L., . . . McCullough, P. A. (2010). Behavioral predictors of weight regain after bariatric surgery. *Obesity Surgery, 20*(3), 349-356.

Odstrcil, E. A., Martinez, J. G., Santa Ana, C. A., Xue, B., Schneider, R. E., Steffer, K. J., . . . Fordtran, J. S. (2010). The contribution of malabsorption to the reduction in net energy absorption after long-limb Roux-en-Y gastric bypass. *The American Journal of Clinical Nutrition, 92*(4), 704-713.

Omalu, B. I., Cho, P., Shakir, A. M., Agumadu, U. H., Rozin, L., Kuller, L. H., & Wecht, C. H. (2005). Suicides following bariatric surgery for the treatment of obesity. *Surgery for Obesity and Related Diseases, 1*(4), 447-449.

Osland, E., Yunus, R. M., & Khan, S. (2017). Weight Loss Outcomes in Laparoscopic Vertical Sleeve Gastrectomy (LVSG) Versus Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) Procedures: A Meta-Analysis and Systematic Review of Randomized Controlled Trials (vol 27, pg 8, 2017). *Surgical Laparoscopy Endoscopy & Percutaneous Techniques, 27*(5), E121-E121.

Oudman, E., Wijnia, J. W., van Dam, M., Biter, L. U., & Postma, A. (2018). Preventing Wernicke Encephalopathy after bariatric surgery. *Obesity surgery, 28*(7), 2060-2068.

Owen, J. G., Yazdi, F., & Reisin, E. (2017). Bariatric surgery and hypertension. *American Journal of Hypertension, 31*(1), 11-17.

Padwal, R., Klarenbach, S., Wiebe, N., Birch, D., Karmali, S., Manns, B., . . . Tonelli, M. (2011). Bariatric surgery: a systematic review and network meta-analysis of randomized trials. *Obesity Reviews, 12*(8), 602-621.

Palleja, A., Kashani, A., Allin, K. H., Nielsen, T., Zhang, C., Li, Y., . . . Arumugam, M. (2016). Roux-en-Y gastric bypass surgery of morbidly obese patients induces swift and persistent changes of the individual gut microbiota. *Genome Medicine, 8*(1), 67.

Papamargaritis, D., Koukoulis, G., Sioka, E., Zachari, E., Bargiota, A., Zacharoulis, D., & Tzovaras, G. (2012). Dumping symptoms and incidence of hypoglycaemia after provocation test at 6 and 12 months after laparoscopic sleeve gastrectomy. *Obesity Surgery, 22*(10), 1600-1606.

Park, J. Y., Song, D., & Kim, Y. J. (2014). Causes and outcomes of revisional bariatric surgery: initial experience at a single center. *Annals of Surgical Treatment and Research, 86*(6), 295-301.

Parretti, H. M., Hughes, C. A., & Jones, L. L. (2019). 'The rollercoaster of follow-up care' after bariatric surgery: a rapid review and qualitative synthesis. *Obesity reviews : an official journal of the International Association for the Study of Obesity, 20*(1), 88-107.

Parri, A., Benaiges, D., Schroder, H., Izquierdo-Pulido, M., Ramon, J., Villatoro, M., . . . Goday, A. (2015). Preoperative predictors of weight loss at 4 years following bariatric surgery. *Nutrition in Clinical Practice 30*(3), 420-424.

Parrott, J., Frank, L., Rabena, R., Craggs-Dino, L., Isom, K. A., & Greiman, L. (2017a). American Society for Metabolic and Bariatric Surgery Integrated Health Nutritional Guidelines for the Surgical Weight Loss Patient 2016 Update: Micronutrients. *Surgery for Obesity and Related Diseases 13*(5), 727-741.

Parrott, J., Frank, L., Rabena, R., Craggs-Dino, L., Isom, K. A., & Greiman, L. (2017b). American Society for Metabolic and Bariatric Surgery Integrated Health Nutritional Guidelines for the Surgical Weight Loss Patient 2016 Update: Micronutrients. Practice Guideline. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 13*(5), 727-741.

Patti, M. E., & Goldfine, A. B. (2014). Hypoglycemia after gastric bypass: the dark side of GLP-1. *Gastroenterology, 146*(3), 605-608.

Pech, N., Meyer, F., Lippert, H., Manger, T., Stroh, C. (2012). Complications and nutrient deficiencies two years after sleeve gastrectomy. *BMC Surgery, 12*(13), 1-7.

Peterhansel, C., Petroff, D., Klinitzke, G., Kersting, A., & Wagner, B. (2013). Risk of completed suicide after bariatric surgery: a systematic review. *Obesity Reviews, 14*(5), 369-382.

Peterli, R., Wolnerhanssen, B. K., Peters, T., Vetter, D., Kroll, D., Borbely, Y., . . . Bueter, M. (2018). Effect of Laparoscopic Sleeve Gastrectomy vs Laparoscopic Roux-en-Y Gastric Bypass on Weight Loss in Patients With Morbid Obesity: The SM-BOSS Randomized Clinical Trial. *JAMA : The Journal of the American Medical Association, 319*(3), 255-265.

Pihlajamaki, J., Gronlund, S., Simonen, M., Kakela, P., Moilanen, L., Paakkonen, M., . . . Gylling, H. (2010). Cholesterol absorption decreases after Roux-en-Y gastric bypass but not after gastric banding. *Metabolism: Clinical and Experimental, 59*(6), 866-872.

Pontiroli, A. E., Fossati, A., Vedani, P., Fiorilli, M., Folli, F., Paganelli, M., . . . Maffei, C. (2008). Post-surgery Adherence to Scheduled Visits and Compliance, More than Personality Disorders, Predict Outcome of Bariatric Restrictive Surgery in Morbidly Obese Patients. *Obesity Surgery, 17*(11), 1492-1497.

Poole, N. A., Al Atar, A., Kuhanendran, D., Bidlake, L., Fiennes, A., McCluskey, S., . . . Morgan, J. F. (2005). Compliance with surgical after-care following bariatric surgery for morbid obesity: a retrospective study. *Obesity Surgery, 15*(2), 261-265.

Pories, M. L., Hodgson, J., Rose, M. A., Pender, J., Sira, N., & Swanson, M. (2016). Following Bariatric Surgery: an Exploration of the Couples' Experience. *Obesity Surgery, 26*(1), 54-60.
Potoczna, N., Harfmann, S., Steffen, R., Briggs, R., Bieri, N., & Horber, F. F. (2008). Bowel habits after bariatric surgery. *Obesity Surgery, 18*(10), 1287-1296.
Pournaras, D. J., Glicksman, C., Vincent, R. P., Kuganolipava, S., Alaghband-Zadeh, J., Mahon, D., . . . le Roux, C. W. (2012). The role of bile after Roux-en-Y gastric bypass in promoting weight loss and improving glycaemic control. *Endocrinology, 153*(8), 3613-3619.
Qian, J., Hu, Q., Wan, Y., Li, T., Wu, M., Ren, Z., & Yu, D. (2013). Prevalence of eating disorders in the general population: a systematic review. *Shanghai Archives of Psychiatry, 25*(4), 212-223.
Ramadan, M., Loureiro, M., Laughlan, K., Caiazzo, R., Iannelli, A., Brunaud, L., . . . Nocca, D. (2016). Risk of Dumping Syndrome after Sleeve Gastrectomy and Roux-en-Y Gastric Bypass: Early Results of a Multicentre Prospective Study. *Gastroenterology Research and Practice, 2016*, 2570237.
Rasmussen, J. J., Fuller, W. D., & Ali, M. R. (2012). Sleep ap
nea syndrome is significantly underdiagnosed in bariatric surgical patients. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 8*(5), 569-573.
Reges, O., Greenland, P., Dicker, D., Leibowitz, M., Hoshen, M., Gofer, I., . . . Balicer, R. D. (2018). Association of Bariatric Surgery Using Laparoscopic Banding, Roux-en-Y Gastric Bypass, or Laparoscopic Sleeve Gastrectomy vs Usual Care Obesity Management With All-Cause Mortality. *JAMA : the Journal of the American Medical Association, 319*(3), 279-290.
Reslan, S., Saules, K. K., Greenwald, M. K., & Schuh, L. M. (2014). Substance Misuse Following Roux-en-Y Gastric Bypass Surgery. *Substance Use & Misuse, 49*(4), 405-417.
Ristanto, A., & Caltabiano, M. L. (2018). Psychological Support and Well-being in Post-Bariatric Surgery Patients. *Obesity Surgery*.
Rubino, F., Schauer, P. R., Kaplan, L. M., & Cummings, D. E. (2010). Metabolic surgery to treat type 2 diabetes: clinical outcomes and mechanisms of action. *Annual review of medicine, 61*, 393-411.
Rutledge, T., Groesz, L. M., & Savu, M. (2011). Psychiatric Factors and Weight Loss Patterns Following Gastric Bypass Surgery in a Veteran Population. *Obesity Surgery, 21*(1), 29-35.
Ryan, K. K., Kohli, R., Gutierrez-Aguilar, R., Gaitonde, S. G., Woods, S. C., & Seeley, R. J. (2013). Fibroblast growth factor-19 action in the brain reduces food intake and body weight and improves glucose tolerance in male rats. *Endocrinology, 154*(1), 9-15.
Salminen, P., Helmio, M., Ovaska, J., Juuti, A., Leivonen, M., Peromaa-Haavisto, P., . . . Victorzon, M. (2018). Effect of Laparoscopic Sleeve Gastrectomy vs Laparoscopic Roux-en-Y Gastric Bypass on Weight Loss at 5 Years Among Patients With Morbid Obesity: The SLEEVEPASS Randomized Clinical Trial. *JAMA : the Journal of the American Medical Association, 319*(3), 241-254.
Samuel, B. S., & Gordon, J. I. (2006). A humanized gnotobiotic mouse model of host-archaeal-bacterial mutualism. *Proceedings of the National Academy of Sciences of the United States of America, 103*(26), 10011-10016.
Sanchez, A., Rojas, P., Basfi-Fer, K., Carrasco, F., Inostroza, J., Codoceo, J., . . . Ruz, M. (2016). Micronutrient Deficiencies in Morbidly Obese Women Prior to Bariatric Surgery. *Obesity Surgery, 26*(2), 361-368.
Sarkhosh, K., Switzer, N. J., El-Hadi, M., Birch, D. W., Shi, X., & Karmali, S. (2013). The impact of bariatric surgery on obstructive sleep apnea: a systematic review. *Obesity Surgery, 23*(3), 414-423.
Sarwer, D. B., Wadden, T. A., Moore, R. H., Baker, A. W., Gibbons, L. M., Raper, S. E., & Williams, N. N. (2008). Preoperative eating behavior, postoperative dietary adherence, and weight loss after gastric bypass surgery. *Surgery for Obesity and Related Diseases, 4*(5), 640-646.

Schauer, P. R., Bhatt, D. L., Kirwan, J. P., Wolski, K., Aminian, A., Brethauer, S. A., . . . Kashyap, S. R. (2017). Bariatric Surgery versus Intensive Medical Therapy for Diabetes - 5-Year Outcomes. *The New England Journal of Medicine, 376*(7), 641-651.
Schijns, W., Schuurman, L. T., Melse-Boonstra, A., van Laarhoven, C., Berends, F. J., & Aarts, E. O. (2018). Do specialized bariatric multivitamins lower deficiencies after RYGB? *Surgery for Obesity and Related Diseases, 14*(7), 1005-1012.
Scholtz, S., Miras, A. D., Chhina, N., Prechtl, C. G., Sleeth, M. L., Daud, N. M., . . . Goldstone, A. P. (2014). Obese patients after gastric bypass surgery have lower brain-hedonic responses to food than after gastric banding. *Gut, 63*(6), 891-902.
Schulman, A. R., & Thompson, C. C. (2017). Complications of Bariatric Surgery: What You Can Expect to See in Your GI Practice. *The American journal of Gastroenterology, 112*(11), 1640-1655.
Scott, K. M., McGee, M. A., Wells, J. E., & Oakley Browne, M. A. (2008). Obesity and mental disorders in the adult general population. *Journal of Psychosomatic Research, 64*(1), 97-105.
Seganfredo, F. B., Blume, C. A., Moehlecke, M., Giongo, A., Casagrande, D. S., Spolidoro, J. V. N., . . . Mottin, C. C. (2017). Weight-loss interventions and gut microbiota changes in overweight and obese patients: a systematic review. *Obesity Reviews, 18*(8), 832-851.
Sender, R., Fuchs, S., & Milo, R. (2016). Are We Really Vastly Outnumbered? Revisiting the Ratio of Bacterial to Host Cells in Humans. *Cell, 164*(3), 337-340.
Sherf Dagan, S., Goldenshluger, A., Globus, I., Schweiger, C., Kessler, Y., Kowen Sandbank, G., . . . Sinai, T. (2017). Nutritional Recommendations for Adult Bariatric Surgery Patients: Clinical Practice. *Advances in Nutrition, 8*(2), 382-394.
Shin, A. C., & Berthoud, H. R. (2011). Food reward functions as affected by obesity and bariatric surgery. *International Journal of Obesity, 35 Suppl 3*, S40-44.
Shin, A. C., Zheng, H., Pistell, P. J., & Berthoud, H. R. (2011). Roux-en-Y gastric bypass surgery changes food reward in rats. *International Journal of Obesity, 35*(5), 642-651.
Sillo, T. O., Lloyd-Owen, S., White, E., Abolghasemi-Malekabadi, K., Lock-Pullan, P., Ali, M., . . . Wadley, M. S. (2018). The impact of bariatric surgery on the resolution of obstructive sleep apnoea. *BMC Research Notes, 11*(1), 385.
Sioka, E., Zacharoulis, D., Zachari, E., Papamargaritis, D., Pinaka, O., Katsogridaki, G., & Tzovaras, G. (2014). Complicated gallstones after laparoscopic sleeve gastrectomy. *Journal of Obesity, 2014*, 468203.
Sivakumar, J. (2018). Nutritional Management of Bariatric Surgical Patients in the Peri-operative Setting. *Journal of Obesity & Eating Disorders, 04*(01).
Sjöström, L., Lindroos, A., Peltonen, M., Torgerson, J., M.D., Bouchard, C.,Carlsson, B,.Dahlgren, S.,Larsson, B.,Narbro, K.,Sjöström, C., Sullivan, M.,Wedel, H. (2004). LIfestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. *The New England Jounal of Medicine, 351*(26), 11.
Sjostrom, L., Peltonen, M., Jacobson, P., Sjostrom, C. D., Karason, K., Wedel, H., . . . Carlsson, L. M. (2012). Bariatric surgery and long-term cardiovascular events. *JAMA, 307*(1), 56-65.
Spitznagel, M. B., Alosco, M., Strain, G., Devlin, M., Cohen, R., Paul, R., . . . Gunstad, J. (2013). Cognitive function predicts 24-month weight loss success after bariatric surgery. *Surgery for Obesity and Related Diseases, 9*(5), 765-770.
Spivak, H., Sakran, N., Dicker, D., Rubin, M., Raz, I., Shohat, T., & Blumenfeld, O. (2017). Different effects of bariatric surgical procedures on dyslipidemia: a registry-based analysis. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 13*(7), 1189-1194.
Srivastava, G., & Buffington, C. (2018). A Specialized Medical Management Program to Address Post-operative Weight Regain in Bariatric Patients. *Obesity Surgery, 28*(8), 2241-2246.
Steenackers, N., Gesquiere, I., & Matthys, C. (2018). The relevance of dietary protein after bariatric surgery: what do we know? *Current Opinion in Clinical Nutrition and Metabolic Care, 21*(1), 58-63.

Steenackers, N., Van der Schueren, B., Mertens, A., Lannoo, M., Grauwet, T., Augustijns, P., & Matthys, C. (2018). Iron deficiency after bariatric surgery: what is the real problem? *The Proceedings of the Nutrition Society, 77*(4), 445-455.

Stefater, M. A., Wilson-Perez, H. E., Chambers, A. P., Sandoval, D. A., & Seeley, R. J. (2012). All bariatric surgeries are not created equal: insights from mechanistic comparisons. *Endocrine Reviews, 33*(4), 595-622.

Sundbom, M., Hedberg, J., Marsk, R., Boman, L., Bylund, A., Hedenbro, J., . . . Naslund, E. (2017). Substantial Decrease in Comorbidity 5 Years After Gastric Bypass: A Population-based Study From the Scandinavian Obesity Surgery Registry. *Annals of Surgery, 265*(6), 1166-1171.

Suzuki, J., Haimovici, F., & Chang, G. (2012). Alcohol use disorders after bariatric surgery. *Obesity Surgery, 22*(2), 201-207.

Svane, M. S., Jorgensen, N. B., Bojsen-Moller, K. N., Dirksen, C., Nielsen, S., Kristiansen, V. B., . . . Holst, J. J. (2016). Peptide YY and glucagon-like peptide-1 contribute to decreased food intake after Roux-en-Y gastric bypass surgery. *International Journal of Obesity, 40*(11), 1699-1706.

Svensson, P. A., Anveden, A., Romeo, S., Peltonen, M., Ahlin, S., Burza, M. A., . . . Carlsson, L. M. (2013). Alcohol consumption and alcohol problems after bariatric surgery in the Swedish obese subjects study. *Obesity, 21*(12), 2444-2451.

Terra, X., Auguet, T., Guiu-Jurado, E., Berlanga, A., Orellana-Gavalda, J. M., Hernandez, M., . . . Richart, C. (2013). Long-term changes in leptin, chemerin and ghrelin levels following different bariatric surgery procedures: Roux-en-Y gastric bypass and sleeve gastrectomy. *Obesity Surgery, 23*(11), 1790-1798.

Tindle, H. A., Omalu, B., Courcoulas, A., Marcus, M., Hammers, J., & Kuller, L. H. (2010). Risk of suicide after long-term follow-up from bariatric surgery. *The American Journal of Medicine, 123*(11), 1036-1042.

Tomlinson, E., Fu, L., John, L., Hultgren, B., Huang, X., Renz, M., Stephan, J., Tsai, S., Powell-Braxton, L., French, D., Steward, T. (2002). Transgenic mice expressing human Fibroblast Growth Factor-19 display increased metabolic rate and decreased adiposity. *Endocrinology 143*(5), 1741-1747.

Toussi, R., Fujioka, K., & Coleman, K. J. (2009). Pre- and Postsurgery Behavioral Compliance, Patient Health, and Postbariatric Surgical Weight Loss. *Obesity, 17*(5), 996-1002.

Turnbaugh, P. J., Ley, R. E., Mahowald, M. A., Magrini, V., Mardis, E. R., & Gordon, J. I. (2006). An obesity-associated gut microbiome with increased capacity for energy harvest. *Nature, 444*(7122), 1027-1031.

van Hout, G. C. M., Boekestein, Petra., , & Fortuin, F. A. M., Pelle, Aline J.M., van Heck, Guus L. (2006). Psychosocial functioning following bariatric surgery. *Obesity Surgery, 16*, 787-794.

Vargas-Ruiz, A. G., Hernandez-Rivera, G., & Herrera, M. F. (2008). Prevalence of iron, folate, and vitamin B12 deficiency anemia after laparoscopic Roux-en-Y gastric bypass. *Obesity Surgery, 18*(3), 288-293.

Via, M. A., & Mechanick, J. I. (2017). Nutritional and Micronutrient Care of Bariatric Surgery Patients: Current Evidence Update. *Current Obesity Reports, 6*(3), 286-296.

Vidal, J., Corcelles, R., Jimenez, A., Flores, L., & Lacy, A. M. (2017). Metabolic and Bariatric Surgery for Obesity. *Gastroenterology, 152*(7), 1780-1790.

Vidal, P., Ramon, J. M., Busto, M., Dominguez-Vega, G., Goday, A., Pera, M., & Grande, L. (2014). Residual gastric volume estimated with a new radiological volumetric model: relationship with weight loss after laparoscopic sleeve gastrectomy. *Obesity Surgery, 24*(3), 359-363.

Wanjura, V., Sandblom, G., Osterberg, J., Enochsson, L., Ottosson, J., & Szabo, E. (2017). Cholecystectomy after gastric bypass-incidence and complications. *Surgery for Obesity and Related Diseases, 13*(6), 979-987.

Watanabe, M., Houten, S. M., Mataki, C., Christoffolete, M. A., Kim, B. W., Sato, H., . . . Auwerx, J. (2006). Bile acids induce energy expenditure by promoting intracellular thyroid hormone activation. *Nature, 439*(7075), 484-489.

Wee, C. C., Mukamal, K. J., Huskey, K. W., Davis, R. B., Colten, M. E., Bolcic-Jankovic, D., . . . Blackburn, G. L. (2014). High-risk alcohol use after weight loss surgery. *Surgery for Obesity and Related Diseases, 10*(3), 508-513.

WHO, W. H. O. (2017). Depression and Other Common Mental Disorders, Global Health Estimates *WHO Document Production Services* Retrieved from http://apps.who.int/iris/bitstream/handle/10665/254610/WHO-MSD-MER-2017.2-eng.pdf;jsessionid=31DD7A5F10A242E8EFFB130AB4B98262?sequence=1

Woodard, G. A., Downey, J., Hernandez-Boussard, T., & Morton, J. M. (2011). Impaired alcohol metabolism after gastric bypass surgery: a case-crossover trial. *Journal of the American College of Surgeons, 212*(2), 209-214.

Woodard, G. A., Encarnacion, B., Peraza, J., Hernandez-Boussard, T., & Morton, J. (2011). Halo Effect for Bariatric Surgery Collateral Weight Loss in Patients' Family Members. *Archives of Surgery, 146*(10), 1185-1190.

Yamamoto, H., Mori, T., Tsuchihashi, H., Akabori, H., Naito, H., & Tani, T. (2005). A possible role of GLP-1 in the pathophysiology of early dumping syndrome. *Digestive Diseases and Sciences, 50*(12), 2263-2267.

Ye, J., Hao, Z.,Mumphrey, M., Leigh Townsend, R.,Patterson, L.,Stylopoulos, N.,Münzberg, H.,Morrison, C., Drucker, D.,Berthoud, H. (2014). GLP-1 receptor signaling is not required for reduced body weight after RYGB in rodents. *American Journal of Physiology, 306*(5), R352–R362.

Yimcharoen, P., Heneghan, H. M., Singh, M., Brethauer, S., Schauer, P., Rogula, T., . . . Chand, B. (2011). Endoscopic findings and outcomes of revisional procedures for patients with weight recidivism after gastric bypass. *Surgical Endoscopy and Other Interventional Techniques, 25*(10), 3345-3352.

Zafar, A. (2015). Wernicke's encephalopathy following Roux en Y gastric bypass surgery. *Saudi Medical Journal, 36*(12), 1493-1495.

Zhang, H., DiBaise, J. K., Zuccolo, A., Kudrna, D., Braidotti, M., Yu, Y., . . . Krajmalnik-Brown, R. (2009). Human gut microbiota in obesity and after gastric bypass. *Proceedings of the National Academy of Sciences of the United States of America, 106*(7), 2365-2370.

The BaSE Study: A Grounded Theory of Constructing Success for Bariatric Patients

Abstract

Bariatric surgery is an increasingly utilised method of establishing weight loss and resolving obesity-related comorbidities. However, the surgery requires and enforces a dramatic behaviour change which impacts on many aspects of patients' lives and there is a need for studies which examine the embodied patient experience. The Bariatric Surgery Experienced (BaSE) study used the methodology of Classic Grounded Theory to explore the lived experiences of 13 female patients in the period immediately before and up to 15 months post-surgery. The result is a conceptually rich theory of *Constructing Success for Bariatric Patients.* The theory categorises and theoretically links key aspects of the peri-surgical period from the patients' perspective. Their main concerns, *Being Successful* and *Being Normal* were frequently challenged by the demands of post-surgical life, leading to help-seeking and strategizing actions which were categorised as *Seeking Help and Information from Professionals, Establishing Networks, Self-Education* and *Self-Devised Strategies*. The results of these actions were adaptions in behaviour and thought patterns, which ultimately impacted either positively or negatively on aspects of compliance with bariatric lifestyle instructions. There was also an aspect of *Resigning* or inaction which patients may slip into if they fail to resolve their issue, and a contextual category of *Personal Factors* which controlled the specifics of the process. Several areas pertinent to best practice were identified including medical professionals approach to bariatrics and larger bodies, level of psychological care provided to patients, the value of ancillary professionals and the importance of suitable peer support. The impact of individual personal factors was identified as an area which may benefit from more research.

Introduction

Undergoing bariatric surgery is an experience and a process that encompasses the whole person in a lived experience that enters them into a specialised group that must live the 'bariatric lifestyle' indefinitely. Bariatric surgery is widely reported as the only consistently effective treatment for lowering the Body Mass Index (BMI) once an individual has become classified as 'morbidly obese' or as having 'class III obesity' (BMI ≥40) (Buchwald et al., 2004; Chang et al., 2014). The procedure also has documented efficacy in resolving or improving comorbidities such as type II diabetes, joint pain, sleep apnoea, dyslipidaemia and certain mental health conditions. Given its apparent success, the number of bariatric surgeries performed worldwide has increased exponentially. Globally, there were ~341,000 surgeries performed in 2011 and this increased to

~645,000 in 2016 (Himpens, Ramos, et al., 2018). The two most popular surgeries are the vertical sleeve gastrectomy (SG) and the Roux-en Y gastric bypass (RYGB) which account for 85-98% of surgeries performed, depending on geographical area (Angrisani et al., 2017; Himpens, Almino Ramos, et al., 2018; Kelly & Flint, 2015). Less common surgery types are the gastric band, biliopancreatic diversion with or without duodenal switch (BPD/DS) and the one anastomosis 'mini' gastric bypass. These surgeries dramatically reduce the volume of food that is can be ingested and the RYGB, mini gastric bypass and BPD/DS also create a degree of nutrient malabsorption. Notwithstanding the success of bariatric surgery compared to the almost complete failure of 'diet and lifestyle' for severe obesity, there are concerns. Long-term follow up studies show that bariatric patients may suffer nutrient deficiencies that over time lead to serious health conditions such as neuropathies (Berger & Singhal, 2014) and decreased bone mineral density (Scibora, Ikramuddin, Buchwald, & Petit, 2012). Some studies show that bariatric patients are at increased risk of suicide , self-harm (Castaneda, Popov, Wander, & Thompson, 2018) and alcohol use disorder (Azam, Shahrestani, & Phan, 2018; Ibrahim et al., 2018) and that problem eating behaviours may recur post-surgery (Meany, Conceicao, & Mitchell, 2014). There is also the possibility of weight regain, which begins at around 18 months post-surgery and is significant (increase of 15% from lowest) in up to 28% of patients (Bastos, Barbosa, Soriano, dos Santos, & Vasconcelos, 2013; Jirapinyo, Abu Dayyeh, & Thompson, 2017; Odom et al., 2010) with a 10-year follow-up suggesting that ~9% of patients end up heavier than before surgery (Karlsson, Taft, Ryden, Sjostrom, & Sullivan, 2007).

Although there is some acknowledgement that inadequacy of the recommended post-surgical supplements may contribute to health issues (Gasteyger, 2008), the blame for negative outcomes is generally levelled at patients' lack of compliance with the strict post-surgical lifestyle requirements (Pontiroli et al., 2008; Toussi, Fujioka, & Coleman, 2009). For brevity, these requirements are not discussed in this paper but have been detailed elsewhere (Busetto et al., 2017). However, despite long-term health being linked to patient behaviour, there has been little research into how patients experience the process of bariatric surgery, what difficulties they may subjectively face, what matters most to them during the peri-surgical phase and how, where, when and why things may go awry for them in terms of physical and psychological adaptation and behavioural compliance. The Bariatric Surgery Experienced (BaSE) study set out to explore the patient experience of preparing for surgery, undergoing surgery and encountering post-surgical life, in the process generating a grounded theory which may enhance understanding of the lived bariatric experience and indicate areas for intervention in improving long-term outcomes for patients.

The Study

Aim

The aim of the BaSE study was to develop a grounded theory which described in conceptual depth what matters most to patients during the transformative time surrounding their surgery. The goal outcome was a data-grounded theory encapsulating the main concerns and the theoretical relationship between the actions which patients continuously use to resolve these concerns.

Design

The BaSE study design uses Classic Grounded Theory (CGT) methodology as described by Glaser and Strauss (1967) in the seminal work '*The Discovery of Grounded Theory: Strategies for Qualitative Research*' and later extensively refined through the 70's, 80's and 90's by Glaser. The techniques of theoretical sensitivity and constant comparative analysis allow emergence and inductive generation of a conceptually rich theory which encompasses most of the observations in the data without being influenced by any preconceived hypotheses about what might be found. 'All is data' and the aspects of it that end up in the theory have repeatedly earned their place there (Glaser, 1998). The strengths of CGT are that it fosters creativity in conceptualising an issue and provides a systematic framework for collection of a rich and deep body of data, and for construction of the theory which emerges from this data. The main weaknesses are that the immersive process is notably time-consuming and that key requirements of the approach, such as allowing emergence, theoretical sampling, use of memos and field notes, and limiting prior reading can present difficulties for novice researchers, particularly in a tertiary setting. As CGT is based purely on observations, the resulting theory may also lack generalisability (Hussain, Hirst, Salyers & Osuji, 2014).

Sample

Participants were recruited through flyers in surgeon's offices, university website advertising, media coverage and through the assistance of a bariatric blogger. Inclusion criteria were being female, older than 18 and that the surgery was not a revision.

Theoretical sampling was utilised in accordance with CGT, wherein the codes emerging from the data direct further sampling. Sampling of new participants, and additional interviews with existing ones were conducted with increasingly narrowed focus ('delimitation') as the research progressed, with the aim of attaining theoretical saturation of the core category, at which point sampling would be considered complete. Theoretical saturation is defined as the point at which categories and their properties are considered sufficiently dense and further data collection yields no new theoretical leads (Glaser & Strauss, 1967). At 'saturation', new data / participant actions appear interchangeable with those already in the category. Theoretical saturation became apparent with a final sample of 13 participants that had their surgeries with seven different surgeons across New Zealand and at one clinic in Tijuana, Mexico. There were six RYGB, six SG and one BPD/DS patient(s). Six surgeries were fully self-funded, four were partially covered by health insurance and three were funded through the New Zealand Ministry of Health.

Participant characteristics and number of interviews are detailed in Table 1.

Table 1

Participant Characteristics

ID	Age	Occupation	Surgery	First Interview	Second Interview	Third Interview
1.	45	Business Owner	RYGB Fully Private	5 days pre-surgery	7 months post-surgery	12 months post-surgery
2.	57	Te Reo Teacher	RYGB Fully Private	3 days pre-surgery	24 weeks post-surgery	
3.	50	Early Childhood Teacher	RYGB Fully Private	10 weeks post-surgery	24 weeks post-surgery	
4.	28	Bank Employee	Sleeve Health Insurance	5 months post-surgery	7 months post-surgery	15 months post-surgery
5.	55	Nurse	RYGB Public	2.5 months pre-surgery	4 months post-surgery	6 months post-surgery
6.	40	Teacher Aide	RYGB Health Insurance	3 weeks pre-surgery	12 weeks post-surgery	10 months post-surgery
7.	47	Community Advisor	Sleeve Health Insurance	4 weeks post-surgery	5 months post-surgery	
8.	42	Nurse	Sleeve Health Insurance	10 days post-surgery	5 months post-surgery	9 months post-surgery
9.	53	Account Manager	Duodenal Switch Public	6 Months pre-surgery	5 days pre-surgery	5.5 months post-surgery
10.	55	Adult Student / Massage Therapist	Sleeve Fully Private	Three days pre-surgery	7 months post-surgery	
11.	60	DHB Employee	Sleeve Public	8 weeks post-surgery	5 months post-surgery	
12.	47	Psychiatric Nurse	RYGB Fully Private	5 weeks post-surgery	5.5 months post-surgery	
13.	52	Office Relocations Worker	Sleeve Fully Private	1 week pre-surgery	12 weeks post-surgery	1 year post-surgery

Data Collection and Analysis

Data collection took the form of qualitative conversational interviews, one three-day food record, a 24-hour food recall and handwritten field notes. Interviews lasted from 30-90 minutes and were spread throughout the pre- and early post-surgical bariatric process, with the earliest being six months pre-surgery and the latest 15 months post-surgery. All participants gave two interviews, and seven kindly agreed to a third which was solely focused on 'fleshing out' the core concept. The interviews were conducted either in person or by Skype, and were audiorecorded using ifree Skype Recorder or Summer Mobile Apps Voice Recorder for Android. A total of 33 interviews were transcribed and uploaded to Dedoose Version 8.2.14, mixed-methods software, as media. The food record and recall were analysed using Xyris Foodworks 9 and key parameters, such as protein and fibre intake were entered into Dedoose as descriptors linked to the media.

In CGT the unit of analysis is the empirical 'incident' (participant action) derived from the data. Categories and their properties were generated through an iterative process of coding, constant comparison and theoretical sampling. Coding followed the process of 'open' line by line coding, 'selective' coding focused on the core category and theoretical coding. Theoretical codes integrate the theory and define relationships and 'fit' between substantive codes and categories. Throughout the process memos containing a free-flow of ideas about codes, categories and their relationships were written and later grouped. A theoretical outline was determined through theoretical sorting of memo groups both in Dedoose and in hard copy. Other data that emerged during emails or informal chats with participants were added to the memo bank as the study progressed, with participants' permission.

Ethics

The BaSE study was granted ethical approval by the Massey University Human Ethics Committee (Ref: 16/08) before recruitment began and all participants provided written informed consent. Participants were reminded during interviews that they were allowed to refuse to discuss topics that caused them discomfort and that participation was completely voluntary.

Findings

The Main Concern

From the point of deciding to have surgery, the participants' main concern was achieving lasting bariatric success: that is, achieving the surgery, losing the excess weight and keeping it off. After surgery *Being Successful* was still the primary concern although *Being Normal* began to emerge as part of that success. Having made considerable personal, and often financial, sacrifices to undergo surgery, participants wanted to put weight concerns behind them and live normally while maintaining bariatric success. All participants reported varying degrees of ‘successful’ weight loss cycles previous, but they had been unable to maintain their slimmer physiques and many had given up trying to lose weight. There was a sense of hope that surgery represents the end of a long, possibly lifelong, struggle to maintain a weight loss and all participants reported feeling positive about their decision and post-surgery were enjoying health and quality of life improvements, including the resolution of diabetes and hypertension, alleviation of joint pain, improvements in sleep apnoea, ease of movement, greater energy, greater self-esteem and the novelty of shopping in regular stores and fitting into an aeroplane seat easily. One participant was able to cease 11 different medications the day after surgery, and one had completed a triathlon at 12 months out. They also reported feeling less compulsion with food. However, having been educated throughout the process that weight regain is possible, there remained a spectre of failure that can never be put aside leading to a persistent concern with ensuring their actions would support success, whether these actions were technically compliant with bariatric instructions or not.

‘…it’s like, it’s my health! It’s like I’m at a stage where it’s like, I don’t want to be big anymore! I want to lose my weight, I want to keep it off because I’ve lost weight before but this one, this feels like it’s… I got the energy to do it again because this time I knew it’s a more permanent state’ – Participant 11

‘..the surgeon was really really blatant that, um, he said this surgery is like 30% effective, so you know, a lot more effective than diet, but still not… Still the odds aren’t that great and um and so he said, he said it’s up to you how effective this is.’ – Participant 8

Theoretical Overview

Figure 1 shows the model for theory of Constructing Success for Bariatric Patients

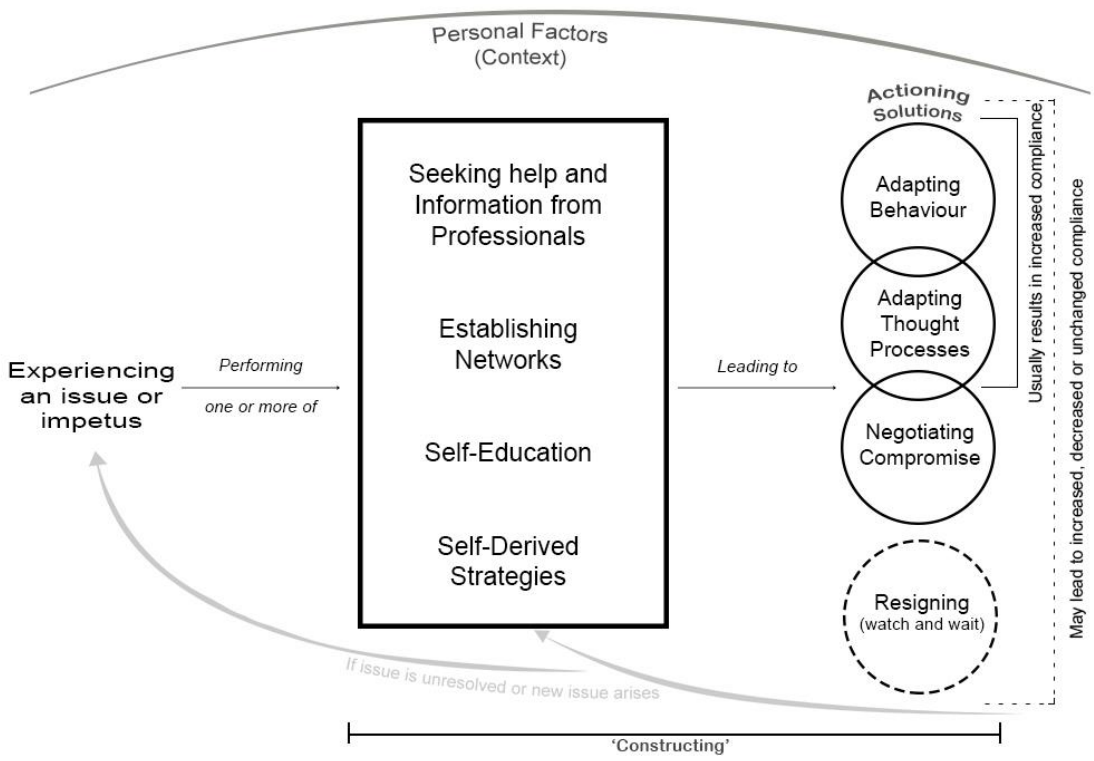

Figure 1. Theory model of *Constructing Success for Bariatric Patients*

The theory of *Constructing Success for Bariatric Patients* appears theoretically integrated as a basic social process, one of the more common theoretical codes in CGT, with aspects of context and consequence. The core category is *Constructing Success*, a concept which represents the engaged nature of the activities the participants were observed performing as they continuously resolved their main concern of achieving bariatric success and a normal life. There is a subcore contextual category of *Personal Factors* which accounted for much of the observed individual variation in *Constructing* activities and a related category of *Resigning (Watch and Wait)* which appeared at various points when patients could not immediately or completely resolve their issue or didn't know what to do. There were some differences between pre and post-surgical observed behaviours although they followed the same pattern of issue → help seeking / research → actioning solutions → consequence. Pre-surgery activities were directed by anticipating future problems and becoming prepared. This was a time of extreme motivation and the majority of participants reported feeling ready and undertaking preparation tasks, such as freezing meals and conducting personal research. Post-surgery was a time of responding to actual experiences.

What emerged was a complex theory with many possible areas where compliance is actively or passively ('accidentally') affected, either positively or negatively. The quotes used in the following sections are to be considered representative of a number of interchangeable incidences. Where there are unique incidents, these are mentioned within the paragraphs.

The *Constructing Success for Bariatric Patients* categories are presented in Table 1.

Table 1: Summary of Substantive codes in the theory of Constructing Success for Bariatric Patients.

Constructing Success ('Constructing') – Core Category which encapsulates the nature of the activities observed in the peri-surgical period and up to one-year post-surgery

Experiencing an Issue or Impetus ('Issues') – Sub Core Category which acts as a controller of Constructing Success, mediating the interaction of the process and the main concern

Properties: Logistics
Physical Issues
Psychological Issues

Seeking Help and Information from Professionals – Property of Constructing Success

Properties: Interacting with medical professionals
Interacting with ancillary professionals

Self-Education – Property of Constructing Success

Establishing Networks – Property of Constructing Success

Properties: Connecting with Empathetic Peers
Support Groups - face-to-face
Support Groups - online

Self-Derived Strategies – Property of Constructing Success

Property: Learning from Experience

Actioning Solutions – Property of Constructing Success

Properties: Adapting Behaviour
Adapting Thought Processes
Negotiating Compromise

Resigning (Watch and Wait) – Related Category

Personal Factors – Subcore Category operating as context

Compliance – Subcore Category operating as consequence

The Process

'Issues'

The Constructing process starts with experiencing an unsolved *Issue or Impetus (Issues)* that presents a current or potential barrier to bariatric success and that sometimes impacts directly or indirectly on compliance. Issues could be serious to mundane: a bowel obstruction, recurrence of sleep apnoea, a weight gain or stall, finding supplements too expensive, struggling with snacking or, in the pre-surgical stage, desiring more information about bariatric surgery. The properties of *Issues* are presented in Table 2.

Table 2: Properties of 'Issues'

Table 2
Properties of the 'Issues' Category

	Main Themes	Example Indicators
Logistics	Difficulties with quantity and timing of supplements Difficulties when travelling Finding food preparation difficult Communication difficulties with medical professionals / surgical delays	*Yeah, it's more a forgetting than a non-compliance thing, or, oh crap I haven't had my two doses today, now I can't fit my second one in, you know […] But, yeah, that's the only thing, even, it doesn't matter if I do reminders or something, when you are busy, it's just, you know I could be at a meeting, missed that hour and then I've got like [sigh] you know I have to toss up, do I take my iron, or do I take my…* - Participant 1 'what do you think are the things that prevent you getting to 100% [compliance]? *Um, that I'm lazy when it comes to cooking [laughing]'* – Participant 10
Physical Issues	Constipation Physical inability to eat vegetables while meeting protein requirements or drink enough water Food intolerances / reactions Unable to tolerate supplements	*'..when I started talking about it, I told him about it before I had my op and every single appointment, every single connection I've had with a, with either a reg. or a house surgeon or [surgeon] or [nurse specialist] or the dietitian I had mentioned it because it has been a problem. And it hasn't just been a 'oh, you know I feel a bit blocked up', problem, it's been an 'I can't go' problem.'* – Participant 5 *'but, even I, I haven't been taking extra iron because that blocked me up'* – Participant 6
Psychological Hurdles	Return of past habits, particularly afternoon or late night snacking Desire for previous pleasurable lifestyle experiences, for example wine drinking, eating mum's food Food fatigue / boredom	*'Little things are sneaking in.* What do you think is causing that? *Um, I'm… it will still be a head space, I think, I've tried to write myself a few notes too… It still is a huge head battle and the things that are going on.'* – Participant 6

The issue of constipation emerged as a major and emotive physical concern for all but one participant. Participants expressed that constipation was embarrassing to them, that they were unprepared for it, and that was not taken seriously by their medical team. As a matter of interest food records were examined for fibre intake, showing an average dietary fibre intake of 11g/day (SD 5.3) for the 3-day food record. One participant achieved ~24 g fibre intake/day and was also the only one without ongoing constipation issues. The other common issues were psychological, including food and sugar cravings, 'head hunger', habitual eating (particularly in the afternoon, late at night or when watching TV) and feelings of grief or distress at loss of foods or eating routines, such as joining the family at McDonalds. Participants reported a range of issues around supplements, many finding the recommended chewable or powdered supplements to cause vomiting and iron supplements to exacerbate constipation. In some cases this lead to accidental non-compliance, for example taking a tolerable low dose supermarket effervescent iron/B12 supplement instead of the prescribed one. The logistics of taking a large amount of supplements was an issue, particularly for RYGB patients. They reported desiring to reduce the number of required supplements or skipping iron or calcium which cannot be taken together. B12 as a separate supplement was most likely to be 'forgotten about', sometimes for months at a time. An infrequent, but important aspect of Issues was when potential patient-specific side effects of the surgery had not been communicated to patients or their GP's. The examples were a recurrence of sleep apnoea due to the CPAP machine becoming loose and blood lithium levels becoming too high in a patient with bipolar disorder.

Upon encountering or anticipating an issue, the bariatric patients sought to resolve their concern in four distinct and sometimes overlapping ways that were designated as properties of *Constructing Success*. These were: *Seeking Help and Information from Professionals, Establishing Networks, Self-Education* and *Self-Derived Strategies.* The results of these activities were adjustments: either *Adapting Behaviour, Adapting Thought Processes, Negotiating Compromise* or *Resigning.* The cycle may repeat. The direction and intensity of constructing was dependent on the subcore category of *Personal Factors.*

Seeking help and Information from Professionals

Interactions with medical professionals emerged as an emotion-charged property of *Constructing Success* and was the category with the most 'mentions' (reported incidences) in Dedoose. The medical professionals that participants had contact with were surgeons, general practitioners

(GP's), nurses, nutritionists, dietitians and psychologists, either one-to-one or in education classes and there was considerable heterogeneity in the level of contact and process between clinics, particularly in the area of psychological support. In every instance there were examples of positive and negative experiences which were often coloured by the contextual *Personal Factor* of past experiences, particularly with doctors and dietitians. In general participants spoke positively about pre-surgical education and felt prepared in the area of diet progression and were aware of potential problems such as addiction transfer, weight re-gain, dumping syndrome and nutrient deficiencies. Surgery-specific information was more appreciated than general nutrition with some feeling patronised by the basic nature of the group education.

'I didn't learn anything new, I didn't learn, you know and the people, the people in the class with me were all obese, they'd all managed, they'd had food issues all their lives they know more about food than anybody else on the planet, they know what they should be doing and I wasn't told about, about what I should be doing in the future.' - Participant 5

Interestingly, surgeons did not feature prominently, with interactions being experienced primarily as uncomplicated. There was a recurring element of frustration to the process of clinic communications with participants feeling uncared for or forgotten in the system.

'..and I was the one ringing them to organise stuff and they were like oh has no one done that yet? Oh has no one done that yet? Oh have you not got that yet? ... and I was like 'Ahhhhh!' – Participant 4

Interactions with General Practitioners (GP's)

GP interaction was a hot topic! Participants freely expressed a range of incidences both before and after surgery, relaying memorable experiences that either enhanced or negatively impacted on the bariatric experience. Before surgery the trend was for GP's to be discouraging and stigmatising when approached about weight or surgery and to continue to push 'diet and exercise' even after repeated failures. It was common for GP's to refuse to refer patients for surgery. There were some alarming individual accounts including patients being told to 'eat carrots, lettuce and celery', having physical complaints being attributed to weight, being advised to 'just go on Optifast' without supervision, being treated as unintelligent and even being subjected to bullying. There was agreement that GP's do not seem to know how to approach obesity. 'Negative GP Experiences Pre-Surgery' was the most consistently saturated Dedoose property of this study.

'..and because they are the gatekeepers because you need a referral from the, and I was actually scared to go and ask, um, because I knew the letter that I had, the referral letter that I had from the, the guy that I mentioned in 2011, I knew that would be old so I tried to use that and they said no, we need, you need to go, and I was scared to go and ask for a letter because I thought if I didn't have a GP that would listen to me and hear me, they could easily cut it off..' – Participant 2

'…at the GP level, absolutely beforehand […] I drove this, I made the decision, I went and saw about it, no GP ever said… Yes, they have told me to lose weight, yes they told me to diet, yes they've told me to exercise and they've been doing that for 30 years […]. But no one ever suggested this as an option. I think there's just an assumption that oh, it won't get funded, and you don't have the money' – Participant 7

After surgery patients reported some instances of GP's not understanding the bariatric body which put an extra burden on patients. In some cases this may lead to accidental non-compliance. Examples given were: prescription of NSAID's or effervescent potassium to RYGB patients and prescription of calcium carbonate instead of calcium citrate.

'.. I had to go to my GP but not for weight, or other than, um, issues with constipation, which has just been… I'm sort of managing now but, um, it always, um, they always question me and make me feel like I'm going to fail, um, when I go to the GP' – Participant 4

There were also positive and encouraging GP experiences and these were experienced as exceptional, welcome and as having an extremely positive impact on the bariatric experience. GP's operating from a position of being an ally were greatly appreciated.

'..but the doctor I have now is really good, she's a breath of fresh air, she's young, I said to her I need a new doctor, I need a referral because this is what I want to do, she said to me [friendly, enthusiastic tone] 'oh yes, I'll do that for you, she said are you paying for it your…?' So she was like asking me questions. She said to me oh sohrry I don't mean to be rude but I am asking you this because if I have other patients who might want to do it then I've got a bit of an idea' – Participant 2

Psychologist

There was a strong effect of *Personal Factors* on need for psychological support, with some patients having already had private counselling, and one choosing a clinic specifically because it did not require any 'psychological stuff'. There was also considerable variation in level of support offered. Four participants were not offered any psychological support. Incidents requiring psychological support happened in sometimes unpredictable ways and where personal circumstances prevented accessing a psychologist, and clinic support had ended, this could result in feeling alone, seeking help from laypeople or going into a *Resigning* phase of privately struggling with a difficulty, most usually non-compliant emotional or stress eating. The most frequently expressed view was a need for more psychological support.

'*I think there probably isn't enough, um, I think… because it's medical model… You are having surgery, they kind of focus on that side of things, where, and obviously for all of us that have ended up in this position there's got to be an emotional side to it as well*.' – Participant 8

Nutritionist / Dietitian and Ancillary Professionals

Appointments with nutritionists, dietitians and ancillary professionals (exercise physiologist, bariatric coach) were experienced positively, and interestingly, referred to as an additional, and sometimes indispensable, source of psychological support, often providing the impetus to take action after a period of *Resigning*. The popular bariatric retreat was also highly regarded as an ancillary support system. These ancillary professionals were experienced as less judgemental than doctors and nurses, although there were a few instances where dietetic support was considered insufficient or too rushed. One participant expressed distress at not having seen a nutritionist or dietitian from one week pre-surgery until her eight week appointment, post-surgery. When contact with ancillary professionals occurred outside of the provided clinic support, they were controlled by the *Personal Factors* of personal drive and personal finances.

'..the psychological side of it, like the dietitian appointments have probably been the most um… useful appointment for me but it's been more in ideas of things to eat and a few kind of and tricks and I reckon it really is that emotional side of eating that 'cause the surgery doesn't solve that' – Participant 8

'..she [exercise physiologist] is absolutely integral to, to some of the mind stuff that you've got to figure out, yeah, because, you know the, that's the big part of it

..what sort of things has she taught you that's useful? [sic]

Oh, just about me avoiding things and how I avoid, um, you know like I bury my head in the sand about stuff or, um, sabotage my own success' – Participant 7

Establishing Networks

Establishing peer networks took three main forms: online networking (Facebook), face-to-face support groups and direct contact with other bariatric patients. Lack of formalised, professionally overseen support networks emerged as a concern. Participants wanted to know what support groups were available, and once they knew, they wanted them to be credible sources of information and support. Facebook groups in particular were both incredibly helpful, and a source of conflicting or non-compliant information, such as how to cheat on the pre-op diet. It could trigger frustration seeing the struggles or non-compliances of others or noticing others lose weight more quickly. Face-to-face support groups appeared as hit-and-miss, sometimes a valuable source of support (when they could be located), but some proving unhelpful, for example by meeting in a bar, or showing a lack of confidentiality, in one case a member 'outed' a participant to someone she preferred not to know about her surgery. By far the most valued source of networking and information was other successful bariatric patients, there being a real desire to connect with empathetic others, especially those that were at a similar bariatric phase, or slightly ahead. The idea of being mentored, then mentoring others was appealing as a way of forming what one participant described as her 'tribe'.

'…it's good just to know that you can talk to somebody who knows what you are talking about you know and, or goes through the same struggles that you go through and you know, and, can encourage you! You know, she's like, I'm like, I'm not doing very well and she will say 'well come on we can do this, you know, lets, you can, you've got it' – Participant 2

Self Education and Self-Derived Strategies

Books, YouTube, Instagram, research articles, blogs and personal experience accounted for aspects of *Self Education* and *Self-Derived Strategies*. Self-devising emerged as an effective strategy for working through Issues in a personally relevant way, for example, taking up knitting, calling on techniques from previous alcoholism recovery, going to bed earlier, taking self-care days off work, timing exercise around 'craving time' or journaling, however there was potential for strategies to become problematic. There were instances of self-diagnosing low potassium or iron using 'Dr Google' then self-medicating using dietary supplements without clearing them with a medical professional. Nearly all participants took magnesium to help with constipation, cramps and sleep without knowing if uptake was impacted by their surgery. Other strategies were using protein powders with thermogenic 'fat loss' herbs added, use of 'liver detox' herbal programs, herbal sedatives, collagen, swapping intolerable supplements for lower dose ones, continued use of laxatives and potentially disordered behaviours such as chewing and spitting.

Learning from Experience emerged as a property of *Self-Derived Strategies* with the correcting strategy usually being obvious. Experiential learning had two directions. Firstly it was a method of resolving expectations, with participants expressing surprise that they experienced food differently, often developing a preference for strong umami flavours such as blue cheese, miso and olives. Food did not provide the 'hit' they were used to. For some this was a disappointment but most saw it as a means to enhance compliance and success.

' I sort of feel like I will still want the food that I used to eat and love, but.. But quite often I'm disappointed by it, you know? It's, it's not the same' – Participant 13

The other aspect of *Learning from Experience* was the trial and error approach to trying things. As the research period crossed the festive season, it was common for participants to test their limits. The result of this testing was often a negative event (dumping, illness or weight gain) which pushed them back toward compliance, although in some cases, they found unexpected tolerance to sweet or fatty foods which made future compliance more difficult.

'So, you started out highly compliant say 95%?

Yep, and then I reckon I got down to about 10%, well I was still eating the right amounts, but I just wasn't choosing the most nutritious food…

And then it didn't work for you… your weight loss stopped

Yes, exactly,

And so, where do you think you are now?

I think I am probably about 70%?' – Participant 8

Actioning Strategies

Adapting Behaviour and Thought Patterns

The results of the information and support seeking which follows identification of an issue are adaptation of thought patterns and behaviour and these things are not completely separate. For example revising a thought pattern often leads to a change of behaviour, and deliberately changing a behaviour may lead to a new outlook. Behavioural adaptions were diverse and usually enhanced compliance. They included learning new cooking techniques, developing strategies around portion control (e.g., making up single serve packets of crackers rather than eating from the packet), finding replacement foods, taking a 'protein first' approach when eating, developing routines and schedules, finding distractions, hobbies and 'replacement addictions' (e.g. coffee instead of cake when meeting friends), eating off a partners plate when socialising, self-care activities, exercise, cleaning, organising and shopping.

' ..aside from thinking about it constantly, I have read, like prepared my container with all my little bits and pieces to have like some, some good stuff, like maybe some nuts and I have, I know I can't take a container with two lots of nuts […] Like I go right that's enough for two snacks because I will eat the whole lot, so I have to have just enough for one' – Participant 2

Changing thought patterns often involved applying techniques learned during the bariatric process, from professionals and at the retreat, but also included personal revelations. Use of cognitive techniques such as reframing were applied too, for example, defusing a craving by reframing it as FOMO (fear of missing out). Mindful and slower eating was helpful, although sometimes difficult to do, and ditching the 'diet mindset' featured consistently as participants strove for normality. They reported giving their scales away, and feeling liberated from food tracking apps and the requirement to eat bland diet food. What was described was a process of discovery and personal evolution which let to revelations about the cause of their food issues.

'..I do a lot of secret eating in, in private, I've done all my life, binge eating, and so today I started to realise, you know I was always hiding, from my mum […] and I continued that right through adulthood, you know, because I was always hiding that stuff, and she was always commenting on it' – Participant 7

Negotiating compromise

Negotiating Compromise appeared as an attempt to use food as a coping mechanism, but without harming success, and usually represented a move away from compliance, but sometimes this was very slight, for example, a tsp of sugar in tea. It also showed as a reach for normality or to restore a previously enjoyable experience, such as drinking wine. One technique was designated as 'compliant cheating', snacking, sometimes compulsively but on 'less bad' foods than would previously have been eaten, for example protein balls, cheese and crackers, nuts and fruit.

'..um, I've adjusted the whole thing to suit my lifestyle and way I want it to be, and um, without regaining any […] I mean, um, yeah, I sort of keep an eye on overall what I'm eating and that, but, um, of course..

What kind of things have you adjusted? In what way?

Um, probably alcohol's a big thing […] I did drink a bit before the operation and now and then I went without for quite a long time and now I have sort of we.. reintroduced it, but on a much smaller scale.' – Participant 12

Resigning

Resigning was the least populated category in the theory, but holds importance as an area where a non-compliant behaviour or unhelpful mindset may take root. It also represents a possible result of insufficient care or clinic follow-up. A patient assumed to be doing well, may instead be in a 'watch and wait' period, not knowing how to resolve an issue.

'..have you been seeing a counsellor or a psychologist regularly for that?

Um, I did touch base with them a couple of weeks ago because I, that's when I really sort of realised what was going on and um, so I didn't actually hear back from them but I knew I had this retreat, and I think that they knew I had the retreat as well..' – Participant 4

Personal Factors

Personal Factors was identified as a subcore category that accounted for the observed variation in activities. The main factors that emerged were: personal drive, attitude toward compliance, past experiences and personal finances. Personal finances had a direct impact on ability to achieve the surgery if one did not meet the public criteria, ability to attend appointments, ability to afford the recommended bariatric supplements over the long term and ability to engage a medical or ancillary professional privately. Personal drive was an interesting and unexpected finding, with most participants identifying themselves as 'the sort of person' that is a determined 'go getter', reinforcing the point with physical indicators like smacking the desk with their hand or making a fist.

'I am, I am the sort of person that once they make up my mind to do something, I like it to… be done and get on with it and…' Participant 10

Past experiences showed mainly as reluctance to contact the clinic or see a GP even when suffering serious side effects, such as passing out. This reluctance was a result of previous stigmatising experiences in the healthcare system, but also, perhaps unique to the group, five participants worked within the healthcare system and had been exposed to the types of comments that were said about bariatric patients and severely obese people behind their backs. A participant reported a conversation with a colleague about a surgeon at her former workplace.

'ah, well [surgeon]' […] 'oh [surgeon] thinks weight loss surgery is a waste of time because it doesn't change behaviour', and I said, 'ahh', and I thought oh my God this is…' - Participant 8

Lastly, there was variation in attitude toward compliance, with differences in levels of willingness to comply. Some felt strongly that 'to the letter' was the only acceptable path, with others considering full compliance an unrealistic goal. Adding to the mix was the fact that advice from Nutritionists also varied on this topic, with some advising no deviation at all, and others encouraging participants to try off-plan things on a moderation basis.

'..there's two camps of thought, it's the 'well I still have to live my life so you know, I can have a little bit of this and a little bit… and it's okay' or complete abstinence. Now I believe in the complete abstinence thing' - Participant 1

'Well she said no snacks, absolutely no snacks, and I, and I heard her and I thought to myself 'stuff you!' […] It's almost like a little bit of a rebellion thing but, I, I think it's partly rebellion you know somebody tells you not to do something, and I'm thinking 'whatever' and partly the, the head thing' – Participant 2

Positioning the Theory in the Literature

The theory of *Constructing Success for Bariatric Patients* pulls together a range of aspects related to the embodied surgical experience which have not been presented in a theoretically linked way before. Qualitative studies examining the lived experience of bariatric surgery exist, but they are few. The BaSE study adds to the small but growing body of studies using grounded theory, a method well suited to a conceptually rich field such as the embodied experience of bariatric surgery. Engstrom et al.'s (2011) two year study followed a similar methodology to the BaSE study, using the newer approach of constructivist grounded theory, which, following constructivism, allows for construction of meaning through interpretation, rather than the discovery of latent meaning which is a feature of CGT (Charmaz, 2006). The core category (which was also designated as the main concern) was identified as "wishing for deburdening through a sustainable control over eating and weight", a category which could be comparable to the BaSE Study main concerns of *Being Successful* and *Being Normal* that drive the actions observed in the theory of *Constructing Success*. *Being Successful* may be comparable to 'sustainable control over eating and weight' and *Being Normal* may be similar to 'wishing for deburdening'. Although that study focused more on the evolution of patients' feelings rather than actions, there were comparable findings, the most pertinent being that health care practitioners were experienced as being uneducated about obesity and surgery. In common with the BaSE study, their participants reported being previously prescribed ineffective interventions, such as diet, exercise and pharmaceuticals and feeling dissatisfied with medical professionals. In another study, also using the constructivist grounded theory model (Graham, Hayes, Small, Mahawar, & Ling, 2017) patients were categorised according to risk tolerance (risk accepters, contenders and challengers) as a way of explaining differing approaches to social life after surgery. The risk construct is somewhat comparable to the *Personal Factor* of personal drive and the consequent impact on compliance, reinforcing that individual variation is important to patient behaviour. Another congruent finding was ongoing struggles with head hunger and examples of *Learning from Experience*. Interestingly, the risk profiles fit loosely with behaviours observed in the BaSE study group and may add additional context. For example the Risk Challenger type showed aspects of *Negotiating Compromise* by reducing compliance in order to be more normal. A 2018 study (Lin & Tsao, 2018) looked at aspects of living 'with my smaller stomach' in the year after surgery, finding again that patients struggle with the psychological aspects of post-surgical life. This study described a process which was in some ways similar to the *Constructing Success* theory, showing a reiterative process of struggles (issues) leading to change, and mentioned 'support from family' as a category, but did not mention the linking activity of seeking support and information that stood out in the BaSE study.

When taken out of the model, the individual aspects of *Constructing Success for Bariatric Patients* may seem unremarkable and predictable. It is already well acknowledged that people categorised as obese and bariatric patients face stigma from the medical profession (Megias et al., 2018), that patients report a need for more psychological follow-up care (Parretti, Hughes, & Jones, 2019), that financial status impacts on outcomes (Carden, Blum, Arbaugh, Trickey, & Eisenberg, 2018) and that certain personality traits such as self-directedness (Leombruni et al., 2007), ability to self-regulate (Generali & De Panfilis, 2018) and persistence (De Panfilis & Carlo Maggini, 2006) enhance bariatric success. The finding that participants were struggling with snacking behaviours is also a relatively common and important finding, as it may indicate eating patterns that represent disordered 'loss of control eating' which can lead to weight gain and emotional distress (Meany et al., 2014). Findings that have not been widely reported before are constipation as a major distressing issue, the role of other bariatric patients as a preferred support system and logistical problems with supplements. The contribution of the BaSE study is theoretically linking these and other aspects in a logical way that brings light to potential areas of weakness in the process where compliance may become impaired. For example, the issue of stress eating leading to weight regain is common. This issue may lead a patient with limited access to psychological help or reluctance to engage with professionals to self-devise a non-compliant strategy of negotiating compromise such as drinking alcohol or slipping into a psychologically comfortable grazing eating pattern. The areas of potential intervention in that scenario are improved access to psychological help, addressing the ramifications of past stigma and screening for potential problem eating or alcohol use behaviours early in follow-up.

Implications and Future Research

The BaSE Study grounded theory of *Constructing Success for Bariatric Patients* highlights several points of interest to long term bariatric success. Areas shown to be of concern to patients in their quest to become bariatric successes and achieve normality were: inconsistent knowledge and advice from doctors, issues with clinic communications, insufficiency of psychological care and lack of access to or awareness of credible support systems. The study also showed aspects which participants identified as supportive to their success. These were educated and sympathetic medical professionals, ancillary professionals (including the highly regarded bariatric retreat), accessible post-surgical psychological support and peer support or mentoring. In addition participants identified being a person with personal drive to be an asset.

The two areas that stood out in terms of impact were interactions with general practitioners and level of psychological support. There emerged a need for closer communication between clinic and GP, especially when patients have comorbid conditions, for example, are medicated for mental disorders or use a CPAP machine. Trust and communication should be encouraged between GP, patient and clinic, with an awareness that patients may be carrying the psychological effects of previous stigmatising interactions with medical professionals. It is worth reinforcing that interactions of this type and a sense (or not) of encountering an organised and knowledgeable ally can really 'make or break' the patient experience. The finding of dramatic inconsistencies in level of pre and post-surgical care represents an area of vulnerability for patients. Although there were minor concerns with level of dietetic support, it was psychological support that showed the most variation, with clinic-provided psychologist sessions numbering from zero to six. Of particular concern is a lack of pre-surgical psychological assessment, as failing to identify patients with current or lifetime mental disorders, eating disorders or problem drinking, can put them at risk of weight regain as well as serious post-surgical complications such as alcohol abuse, self-harm and suicide (Lagerros, Brandt, Hedberg, Sundbom, & Boden, 2017; Morgan & Ho, 2017). The emergence of snacking as a concern is emphasised as something medical professionals must pay attention to. As bariatric patients physically cannot binge eat, it has been proposed that the criteria for bingeing and Binge Eating Disorder post-surgery should be revised to include 'loss of control eating' (LOC) as a diagnostic feature (Kalarchian et al., 2002). LOC eating causes significant psychological distress and is a risk factor for weight regain, as is a 'grazing' eating pattern. Group and peer-to-peer support is a dimension of the study that presented interesting possibilities, and a few concerns. The identification of bariatric peers as a most appreciated support system, along a lack of awareness of support groups or wariness around the suitability of the ones that currently operate, leads to the idea of a voluntary peer-matching system or patient-led support groups that operate along clinic-approved guidelines.

In terms of future research, it was an intriguing finding of this study that personality factors had a strong influence on willingness to comply with lifestyle instructions, an area which has not received much research. This presents a thought-provoking direction for future research. Is there a 'bariatric personality' that more easily thrives after surgery? Do other personality types require more or different support? There is also the question of why this group of New Zealand patients suffered so severely from constipation, as this is not a consistent bariatric complication, usually only affecting about 30% of patients (Afshar et al., 2016; Potoczna et al., 2008). Although it appears fibre intake was low compared to national guidelines and to intakes observed in other bariatric studies (Afshar et al., 2016), the study was not designed to confirm causation.

Lastly, it needs to be stated that although the reported outcomes of this paper primarily highlight aspects of the bariatric process that may impact negatively on compliance and bariatric success, the amount of data collected was far more than could be presented in one article and much of it was positive. Some patients reported feeling completely looked after by their 'lovely' team, enjoying a wrap-around service with comprehensive two year follow-up and very few issues. It is hoped that elucidating the process of *Constructing Success for Bariatric Patients* may allow more bariatric patients to achieve a positive transition to the lifelong health improvements and normalcy they are seeking.

Limitations

Although it is hoped that the BaSE study enhances the body of bariatric research, the study does have limitations which must be acknowledged. The first is that the BaSE study represents the work of an inexperienced researcher using a complex qualitative methodology and may lack some theoretical sensitivity. The study is also subject to the issue of the researcher's presence potentially affecting the observations: as most participants were seen directly before and after their surgeries the interest of the researcher may have inadvertently been experienced as a source of support at a vulnerable time, thereby acting as an intervention. Although theoretical saturation was conclusive for some categories (particularly *Seeking Help and Information from Professionals* and *Establishing Networks*), it would have been desirable to gather more data to confirm saturation of categories with fewer incidences (e.g. *Resigning*) however, due to the time constraints of tertiary study, this was not possible. In addition three interviews were lost to file corruption, although the handwritten field notes were available for analysis. In terms of applicability it is clear that the relatively short follow-up mainly period captures the 'honeymoon' phase post-surgery where patients are on the high of finally losing weight and perhaps for the first time, experiencing life as a 'straight sized' person. For the few patients that gave interviews later in their process, some cracks were starting to show, particularly in terms of problem eating and weight stalls or regain, but due to time constraints, these could not be adequately explored. There is also a possibility that, given involvement was participant-directed, the BaSE study could represent a particularly motivated group, and as six participants either work, or had worked, in the healthcare sector, there may be an over-representation of those knew how to undertake personal research to solve their issues and that had insider knowledge of the weight bias that occurs within the medical system. In terms of generalisability, it is a limitation that the sample was women only, and limited to a relatively homogenous New Zealand sample. It may not be assumed that the theory could also be applied to men or other groups of women without modification.

References

Afshar, S., Kelly, S. B., Seymour, K., Woodcock, S., Werner, A. D., & Mathers, J. C. (2016). The Effects of Bariatric Procedures on Bowel Habit. *Obesity Surgery, 26*(10), 2348-2354.

Angrisani, L., Santonicola, A., Iovino, P., Vitiello, A., Zundel, N., Buchwald, H., & Scopinaro, N. (2017). Bariatric Surgery and Endoluminal Procedures: IFSO Worldwide Survey 2014. *Obesity Surgery, 27*(9), 2279-2289.

Azam, H., Shahrestani, S., & Phan, K. (2018). Alcohol use disorders before and after bariatric surgery: a systematic review and meta-analysis. *Annals of Translational Medicine, 6*(8), 148.

Bastos, E. C. L., Barbosa, E. M. W. G., Soriano, G. M. S., dos Santos, E. A., & Vasconcelos, S. M. L. (2013). Determinants of weight regain after bariatric surgery. *Arquivos brasileiros de cirurgia digestiva : ABCD = Brazilian Archives of Digestive Surgery, 26 Suppl 1*, 26-32.

Berger, J. R., & Singhal, D. (2014). The neurologic complications of bariatric surgery. *Handbook of Clinical Neurology, 120*, 587-594.

Buchwald, H., Avidor, Y., Braunwald, E., Jensen, M. D., Pories, W., Fahrbach, K., & Schoelles, K. (2004). Bariatric surgery: a systematic review and meta-analysis. *JAMA : the Journal of the American Medical Association, 292*(14), 1724-1737.

Busetto, L., Dicker, D., Azran, C., Batterham, R. L., Farpour-Lambert, N., Fried, M., . . . Yumuk, V. (2017). Practical Recommendations of the Obesity Management Task Force of the European Association for the Study of Obesity for the Post-Bariatric Surgery Medical Management. *Obesity Facts, 10*(6), 597-632.

Carden, A., Blum, K., Arbaugh, C. J., Trickey, A., & Eisenberg, D. (2018). Low socioeconomic status is associated with lower weight-loss outcomes 10-years after Roux-en-Y gastric bypass. *Surgical Endoscopy*. Online Supplement.

Castaneda, D., Popov, V. B., Wander, P., & Thompson, C. C. (2018). Risk of Suicide and Self-harm Is Increased After Bariatric Surgery-a Systematic Review and Meta-analysis. *Obesity Surgery*.

Chang, S. H., Stoll, C. R., Song, J., Varela, J. E., Eagon, C. J., & Colditz, G. A. (2014). The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012. *JAMA Surgery, 149*(3), 275-287.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. London: Sage.

De Panfilis, C., Cero, S.,Torre, M., Salvatore, P., Dall'Aglio, E., Adorni, A., & Carlo Maggini, M. (2006). Utility of the Temperament and Character Inventory (TCI) in Outcome Prediction of Laparoscopic Adjustable Gastric Banding: Preliminary Report. *Obesity Surgery 16*, 842-847.

Engstrom, M., & Forsberg, A. (2011). Wishing for deburdening through a sustainable control after bariatric surgery. *International Journal of Qualitative Studies on Health and Well-being, 6*(1).

Gasteyger, C., Suter, M., Gaillard, R. C., & Giusti, V. . (2008). Nutritional deficiencies after Roux-en-Y gastric bypass for morbid obesity often cannot be prevented by standard multivitamin supplementation. *The American Journal of Clinical Nutrition, 87*(5), 1128–1133.

Generali, I., & De Panfilis, C. (2018). Personality Traits and Weight Loss Surgery Outcome. *Current Obesity Reports, 7*(3), 227-234.

Glaser, B. G. (1998). *Doing Grounded Theory: Issues and Discussions*. Mill Valley: Sociology Press.

Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. New York: Aldine de Gruyter.

Graham, Y., Hayes, C., Small, P. K., Mahawar, K., & Ling, J. (2017). Patient experiences of adjusting to life in the first 2 years after bariatric surgery: a qualitative study. *Clinical Obesity, 7*(5), 323-335.

Himpens, J., Almino Ramos, Richard Welbourn, John Dixon, Robin Kinsman, & Walton, P. (2018). Fourth IFSO Global Registry Report. Retrieved from http://www.e-dendrite.com/4thIFSOGlobalRegistryReport.pdf

Himpens, J., Ramos, A., Welbourn, R., Dixon, J., Kinsman, R., & Walton, P. (2018). Fourth IFSO Global Registry Report 2018 Retrieved from https://www.ifso.com/pdf/4th-ifso-global-registry-report-last-2018.pdf

Hussein, M. E., Hirst, S., Salyers, V., & Osuji, J. (2014). Using Grounded Theory as a Method of Inquiry: Advantages and Disadvantages. *The Qualitative Report*, *19*(27), 1-15. Retrieved from https://nsuworks.nova.edu/tqr/vol19/iss27/3, 28 October 2019

Ibrahim, N., Alameddine, M., Brennan, J., Sessine, M., Holliday, C., & Ghaferi, A. A. (2018). New onset alcohol use disorder following bariatric surgery. *Surgical Endoscopy*.

Jirapinyo, P., Abu Dayyeh, B. K., & Thompson, C. C. (2017). Weight regain after Roux-en-Y gastric bypass has a large negative impact on the Bariatric Quality of Life Index. *BMJ Open Gastroenterology, 4*(1), e000153.

Kalarchian, M. A., Marcus, M. D., Wilson, G. T., Labouvie, E. W., Brolin, R. E., & LaMarca, L. B. (2002). Binge eating among gastric bypass patients at long-term follow-up. *Obesity Surgery, 12*(2), 270-275.

Karlsson, J., Taft, C., Ryden, A., Sjostrom, L., & Sullivan, M. (2007). Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. *International Journal of Obesity, 31*(8), 1248-1261.

Kelly, S., Flint, R. (2015). New Zealand is far behind Australia in offering weight-loss surgery. *New Zealand Medical Journal, 128*(1408), 10-11.

Lagerros, Y. T., Brandt, L., Hedberg, J., Sundbom, M., & Boden, R. (2017). Suicide, Self-harm, and Depression After Gastric Bypass Surgery: A Nationwide Cohort Study. *Annals of surgery, 265*(2), 235-243.

Leombruni, P., Pierò, A., Dosio, D., Novelli, A., Abbate-Daga, G., Morino, M., . . . Fassino, S. (2007). Psychological Predictors of Outcome in Vertical Banded Gastroplasty: a 6 Months Prospective Pilot Study. *Obesity Surgery, 17*(7), 941-948.

Lin, H.-C., & Tsao, L.-I. (2018). Living with my small stomach: The experiences of post-bariatric surgery patients within 1 year after discharge. *Journal of Clinical Nursing, 27*(23-24), 4279-4289.

Meany, G., Conceicao, E., & Mitchell, J. E. (2014). Binge eating, binge eating disorder and loss of control eating: effects on weight outcomes after bariatric surgery. *European Eating Disorders Review, 22*(2), 87-91.

Megias, A., Gonzalez-Cutre, D., Beltran-Carrillo, V. J., Gomis-Diaz, J. M., Cervello, E., & Bartholomew, K. J. (2018). The impact of living with morbid obesity on psychological need frustration: A study with bariatric patients. *Stress and health : journal of the International Society for the Investigation of Stress, 34*(4), 509-522.

Morgan, D. J., & Ho, K. M. (2017). Incidence and Risk Factors for Deliberate Self-harm, Mental Illness, and Suicide Following Bariatric Surgery: A State-wide Population-based Linked-data Cohort Study. *Annals of Surgery, 265*(2), 244-252.

Odom, J., Zalesin, K. C., Washington, T. L., Miller, W. W., Hakmeh, B., Zaremba, D. L., . . . McCullough, P. A. (2010). Behavioral predictors of weight regain after bariatric surgery. *Obesity Surgery, 20*(3), 349-356.

Parretti, H. M., Hughes, C. A., & Jones, L. L. (2019). 'The rollercoaster of follow-up care' after bariatric surgery: a rapid review and qualitative synthesis. *Obesity Reviews, 20*(1), 88-107.

Pontiroli, A. E., Fossati, A., Vedani, P., Fiorilli, M., Folli, F., Paganelli, M., . . . Maffei, C. (2008). Post-surgery Adherence to Scheduled Visits and Compliance, More than Personality Disorders, Predict Outcome of Bariatric Restrictive Surgery in Morbidly Obese Patients. *Obesity Surgery, 17*(11), 1492-1497.

Potoczna, N., Harfmann, S., Steffen, R., Briggs, R., Bieri, N., & Horber, F. F. (2008). Bowel habits after bariatric surgery. *Obesity Surgery, 18*(10), 1287-1296.

Scibora, L. M., Ikramuddin, S., Buchwald, H., & Petit, M. A. (2012). Examining the link between bariatric surgery, bone loss, and osteoporosis: a review of bone density studies. *Obesity Surgery, 22*(4), 654-667.

Toussi, R., Fujioka, K., & Coleman, K. J. (2009). Pre- and Postsurgery Behavioral Compliance, Patient Health, and Postbariatric Surgical Weight Loss. *Obesity, 17*(5), 996-1002.