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The prevention of weight regain in bariatric surgery patients at Counties Manukau Health

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Chapter 1. Introduction

1.1 Background

Obesity is defined by the World Health Organisation (WHO) as excess fat accumulation which may impair health, and in adults obesity is defined as a body mass index (BMI) greater than or equal to 30 kg/m² (World Health Organization, 2018). Obesity is a worldwide leading cause of preventable death (World Health Organization, 2018), resulting in many physical, societal, psychological and economic consequences (Sarwer et al., 2013). In today's society, obesity is significantly associated with morbidity and lower health-related quality of life than smoking, alcoholism and poverty (Sturm, 2002). Not only does obesity impact individuals themselves, it also has a negative impact on the wider society. Obesity causes complications such as hospitalization, premature deaths, higher mental health diagnoses and increased sick leave payments relating to decreased productivity (New Zealand Institute of Economic Research, 2015). These factors contribute to lower life earnings and therefore lower national economic benefit as well as an increased burden on society due to additional government taxes for obesity health related consequences (New Zealand Institute of Economic Research, 2015).

The first line treatment for those who are obese or overweight is health professional advice to reduce energy intake by restricting calories eaten and to increase energy output by increasing physical activity (National Institute for Health and Care Guidance, 2019). Weight loss medication therapy is sometimes offered as a second line treatment; however, morbid obesity is largely refractory to diet and weight loss medication therapy (Buchwald et al., 2004). Therefore, alongside the increasing prevalence of obesity, bariatric surgery is becoming the most commonly used worldwide strategy for weight loss treatment (Cummings, Overduin, & Foster-Schubert, 2004). Bariatric surgery is performed on the stomach and/or intestines to reduce extreme obesity via weight loss through malabsorption and/or restrictive physiological changes (Sabench Pereferrer et al., 2017) on patients with a median pre-surgery BMI of 41.7kg/m² (Welbourn et al., 2018). Bariatric surgery is considered to be the only safe and effective treatment for obesity where effective weight loss is achieved; as well as a significant

proportion of patients with diabetes, hyperlipidemia, hypertension, and obstructive sleep apnoea experience improvements and in some cases complete resolution (Buchwald et al., 2004; Welbourn et al., 2018). Bariatric surgery aims to provide the individual with positive outcomes such as weight loss, improved health risk factors, and reduced mortality (Sjöström, 2009).

However, not all patients consider the experience to be positive. Whilst the weight loss outcomes can be impressive, weight regain is commonly experienced by many patients post-surgery with some patients regaining up to 47% of their pre-surgery weight (Niego et al., 2007). Around 20 to 30% of bariatric surgery patients fail to reach targeted weight loss; and many patients find it difficult to maintain the lower body weight they achieved post-operation, especially at twenty four months post-surgery (Bradley et al., 2016; Vieira et al., 2019). Long term data also shows that 30 to 70% of patients will struggle to maintain a 20% weight loss ten years post-surgery (Niego, Kofman, Weiss, & Geliebter, 2007). Additionally, bariatric surgery poses a risk of nutritional deficiencies such as protein malnutrition, micronutrient deficiencies as well as dumping syndrome and eating behaviour problems (Lupoli et al., 2017).

The associated complications mean surgically induced weight loss has remained controversial as there is only a small amount of evidence reporting successful long-term outcomes (Baig, Priya, Mahawar, & Shah, 2019; Courcoulas et al., 2013b). Weight regain post-surgery has been observed in a high proportion of post-bariatric surgery patients, and is associated with significant medical, societal and economic implications (Karmali et al., 2013b). There are many factors thought to contribute to weight regain post-surgery. This can be narrowed down to: poor dietary quality, suboptimal eating behaviours, low commitment to clinical appointments, type of surgery, age, lower physical functioning, depressive symptoms, poor adherence and disclosure (Sjöström, 2013; Vieira et al., 2019; Wendy C et al., 2019). A reoccurring theme is the presence of weight regain which may be explained by maladaptive eating behaviours, increasing the risk of long term post-surgery weight gain (Pizato, Botelho, Gonçalves, Dutra, & de Carvalho, 2017a). Binge eating disorder, snack eating, grazing and eating with a sense of loss of control have been associated with increased energy intakes, and therefore poorer weight related outcomes post-surgery (Gavin, Eva, & James E, 2014).

Furthermore, the level of support patients receive has a significant impact on weight loss outcomes, in patients who attended all post-operative follow-up visits with the multi-disciplinary team (MDT), greater long term weight loss outcomes were found (Vidal et al., 2014). In a systematic review including 4,864 patients, support from the bariatric health care team was an important component in long-term success; of those with failed surgery, 60% had never seen a dietitian and 80% had never seen a psychologist (Karmali et al., 2013a). Patients who regularly attend follow up appointments with a dietitian are reported to more likely have successful weight loss outcomes (Masood et al., 2019). Poor support post operation, from family, friends or MDT support, has been associated with long term weight regain (Kaouk, Hsu, Tanuseputro, & Jessri, 2019). In a retrospective analysis including 130 participants, three to four years post bariatric surgery, those who maintained regular follow up three years post-surgery were shown to have better long-term weight loss outcomes than those without follow up after one year post-surgery (Gould, Beverstein et al., 2007). Despite the strong evidence for benefits of attending all follow up health care appointments, many bariatric patients do not attend their appointments mainly due to: location, time, work/family commitments, and financial concerns (Parretti, Hughes, & Jones, 2019).

In New Zealand the Ministry of Health (MOH) recommend that each District Health Board (DHB) aim for an intervention (bariatric surgery) of 0.5% of its morbidly obese population based on; the percentage of the population with a BMI >40kg/m² (the median pre-surgery BMI worldwide) as well as surgeon, volume and physical capacities of each District Health Board (Murphy et al., 2019). The NZ MOH target for public system bariatric surgeries was 261 in 2013 and increased to 387 in 2014/15 (Murphy et al., 2019). In 2018 Counties Manukau Health DHB (CM Health) completed 118 bariatric surgeries, this was a decrease from 165 in 2017 (Health, 2019). CM Health completed the majority of bariatric surgeries nation-wide in 2014/15 (n=151) (Murphy et al., 2019). Laparoscopic sleeve gastrectomy is the primary bariatric procedure conducted at CM Health, and among 400 bariatric procedures the median weight loss was 42kg, with a mean percentage excess weight loss (%EWL) of 51.5% (Lemanu et al., 2012).

Since bariatric surgery was established within CM Health in 2010 there has been over 1000 surgeries performed (Health, 2019). Of these patients, the weight loss nadir of 60% of excess weight was achieved between one and two years post-surgery, but decreased to 40% at five years' post-surgery (Lauti, Stevenson, Hill, & MacCormick, 2016a). These five year results from CM Health are similar to outcomes from other centres internationally, with patients experiencing weight gain from the time they are discharged from bariatric services (Lemanu et al., 2012).

Currently all patients who have a bariatric procedure at CM Health are offered a minimum of thirteen appointments, of which five will be with a dietitian. Appointments with the dietitian are diet and lifestyle focused, as bariatric patients need to adhere to strict dietary recommendations for life. The mean follow up period for bariatric patients at CM Health was 12 months post-surgery (Lemanu et al., 2012). In previous research conducted at CM Health, bariatric participants had expressed a desire for more support from the bariatric service 2016 (Lauti et al., 2016a). In response to this finding, an additional dietitian-led group education session (18-months post-operatively) was started in 2017 to support patients experiencing weight re-gain and/or to teach skills in managing eating behaviours. Additionally, a twelve-month post-operative group education session was commenced led by the surgeon, bariatric nurse and dietitian. This twelve-month session covered; potential complications, lifestyle maintenance, diet and exercise, lifelong multi-vitamin requirements, General Practitioner annual monitoring, and included shared learning's from patient experiences, addressing barriers to change and problem solving.

With the continuous rise in the incidence of obesity, and the corresponding rise in bariatric surgeries performed, it is essential to understand and provide the best quality of care to ensure optimal health outcomes for both individuals and society. High quality support available for bariatric patients throughout their journey, including group appointments, has been found to be beneficial for long term weight outcomes (E. M. Conceição, Utzinger, & Pisetsky, 2015).

1.2 Aims and Objectives

Aim:

The aim of this study was to assess the impact of a dietitian-led, group education programme, on food intake and eating behaviours that may contribute to weight regain in post bariatric surgery patients at CM Health.

Objectives:

1. To assess changes in weight and body composition between 12, 18 and 21-months post-surgery
2. To investigate changes in quality of life pre and post 18-month group education
3. To assess food intake changes pre and post 18-month group education
4. To investigate eating behaviour changes pre and post 18-month group education
5. To explore barriers and enablers related to weight management during the bariatric journey using a qualitative approach

Hypotheses:

We hypothesise that food intake and eating behaviours will improve and subsequently have a positive impact on weight status, in patients at CM Health after receiving eating behavioural support in a group education session.

1.3 Contributors to research

Contributor	Contribution to thesis
Gypsy Billing-Bullen	Primary researcher, study design and methodology, conductor of focus groups and education sessions, ethical application, data entry and analysis, statistical analysis, interpretation of results, author of the thesis

A/Prof Rozanne Kruger	Main thesis supervisor, study design and methodology, ethical application, data analysis and interpretation of results, revision and approval of thesis
A/Prof Carol Wham	Thesis co-supervisor, data analysis and interpretation of results, revision of thesis
Deirdre Nielsen	CM Health registered dietitian supervisor, planning and execution of methods, recruitment, leader of 18-month group session

1.4 Structure of thesis

This thesis has been structured into four chapters and five appendix sections. Chapter one includes an introduction, the justification for the research, aims, objectives and the contributions to the research. Chapter two includes a narrative literature review covering important topics including: weight related outcomes post bariatric surgery, contributing factors to weight regain post-surgery, dietary quality, energy metabolism, the experience of hunger post-surgery, problematic eating behaviours, mental illness pre-surgery, lack of support from medical professionals, the need for increased social support and physical activity. Chapter three presents the results as a research manuscript including an abstract, introduction, methods, results, and discussion. Chapter four presents the final overview of the research, as well as conclusions and future recommendations to improve the bariatric care program at CM Health. Appendices include: the nutritional barriers and enablers questionnaire, the focus group interview guide used by the primary researcher to conduct the focus groups and the mindful eating exercise used in the education session, Moore-Head Ardel quality of life questionnaire, TFEQ-18 questionnaire. All chapters have been formatted according to the Eating Behaviour's Journal and the reference style used was APA 6^t

Chapter 2. Literature Review

The literature search included years 2010 to 2019, older research was only presented if relevant. Databases utilised to conduct this literature search were Web of science, Discover, and Google Scholar. Searches were conducted using the key words: obesity, bariatric, bariatric surgery, weight regain, weight loss, weight maintenance, diet, social support, energy metabolism, resting energy expenditure, mental illness, eating behaviour, emotional eating, restrained eating, grazing, snacking, binge eating, physical activity, nutrient deficiencies, and support.

2.1 Background

Obesity is an excess accumulation of fat which may impair health (World Health Organization, 2018). The immediate cause of being overweight or obese is an energy imbalance between the calories consumed and the calories expended. However, many factors can contribute to the cause of obesity, including the environmental influence on the changes in dietary and physical activity patterns (Feng, Glass, Curriero, Stewart, & Schwartz, 2010). Internationally, obesity has nearly tripled since 1975, with 39% of adults aged over 18 years being overweight (Body mass index ≥ 25 kg/m²), and 13% being obese (Body mass index ≥ 30 kg/m²), in 2016 (World Health Organisation, 2018). The prevalence of obesity is also rising in New Zealand (NZ). Annual data from the 2017/18 New Zealand Health survey indicated a third (30.9%) of adults are obese; up from 28.6% in 2011/12 and rates of obesity are significantly higher among the Pacific (35%) and Māori (47%) population groups (Ministry of Health, 2017). These rates are projected to increase alongside an increasing obesogenic environment (Das et al., 2003). Severe obesity, defined as a body mass index ≥ 40 kg/m² or 35– 40 kg/m² with co-morbidities, such as cardiovascular disease, type two diabetes, musculoskeletal disorders like osteoarthritis; will eventually lead to premature death or disability (World Health Organization, 2013).

Bariatric surgery is defined as any surgery performed on the stomach or intestines of a person, as a means to induce weight loss (Willmer & Salzmann-Erikson, 2018). It is the

only treatment which is shown to have long term weight loss success, and is becoming the popular treatment for severe obesity (Willmer & Salzman-Erikson, 2018). There are three mechanisms which induce weight loss following bariatric surgery: firstly, restriction, secondly malabsorption or lastly, a combination of both. The procedures induce weight loss either by reducing stomach capacity and energy intake, or reducing the normal amount of nutrients absorbed via reduction of the duodenum (Billeter, Fischer, Wekerle, Senft, & Müller-Stich, 2014). The main types of restrictive bariatric surgery are sleeve gastrectomy (SG), and adjustable gastric banding (AGB). Whilst the other main bariatric procedures involve a combination of restrictive and malabsorptive mechanisms, including Roux-en-Y-gastric bypass (RYGB), One Anastomosis Gastric Bypass (OAGB) and biliopancreatic diversion with or without a duodenal switch (Anvari, Lemus, & Breau, 2018). Research evidence shows that RYGB and SG are the most common methods used worldwide, as well as the most common surgical procedures in New Zealand for weight loss (Ministry of Health Clinical Trials Research Unit, 2009; Willmer & Salzman-Erikson, 2018).

Bariatric surgery is funded in NZ for those who are severely obese and have obesity associated co-morbidities (Counties Manukau Health, 2019). The NZ Ministry of Health Weight Management Guidelines state that those who should be considered for publicly funded bariatric surgery, will have a weight of less than 160kg and a BMI of less than 55kg/m², or a BMI greater than 35kg/m² with medical comorbidities (Ministry of Health NZ, 2017). There is no upper limit eligibility criterion, but super obese (BMI > 50 kg/m²) patients may be declined for bariatric surgery if they are deemed as too high risk (Peterson, Anderson, Boundy, Ferguson, & Erickson, 2017). However, patients also need to have failed non-surgical attempts at weight loss for more than two years (Cecilia Westmacott, 2019). A 2019 nationwide survey of publicly funded bariatric surgeries in NZ, estimated that the majority of patients who had surgery, were NZ Europeans (percentage NZ Europeans not defined); 21% were Māori, and 9% were Pacifica (Tamasin Taylor, 2018). It was not clear whether the low rate of surgery in Pacific people was due to a low rate of referral and low rates of acceptance or because the attrition rate was high (Tamasin Taylor, 2018).

Benefits of bariatric surgery include possible remission of type two diabetes, improvements in sleep apnoea, hypertension and hyperlipidaemia, a reduction in cardiovascular disease risk, some cancers, and overall mortality, as well as improved functional ability (Scheen, De Flines, De Roover, & Paquot, 2009). However, in contrast, patients who have had bariatric surgery are at a nutritional deficiency risk for protein, vitamin B12, B1, C, calcium, folate, A, D, K as well as iron, zinc, selenium and copper (Kikkas et al., 2018; P. Shankar, M. Boylan, & K. Sriram, 2010). Food intolerances may also arise due to the altered anatomy of the gastrointestinal tract (Kikkas et al., 2018; P. Shankar et al., 2010). Protein malnutrition is one of the most commonly experienced nutrient deficiencies post bariatric surgery, mostly due to a common intolerance of protein rich foods experienced post-surgery (Martins et al., 2015; Steenackers, Gesquiere, & Matthys, 2018). Additional risks include dumping syndrome and problematic eating behaviours such as: binge eating disorder, grazing behaviours, picking and nibbling (Al-Najim, Docherty, & le Roux, 2018). These problematic eating behaviours are detrimental to weight loss outcomes due to excess consumption of calories (Al-Najim et al., 2018).

New Zealand bariatric dietetic care guidelines are adapted from the National Institute for Health and Care Guidance (National Institute for Health and Care Guidance, 2019). The National Institute for Health and Care (NICE) guidelines state patients who have had bariatric surgery should stay under medical care for two years post-surgery, and should then be discharged to primary care with annual reviews, to monitor the recommended criteria above (National Institute for Health and Care Guidance, 2019). Additionally, the guidelines from The American Association of Clinical Endocrinologists, The Obesity Society, and the American Association of Metabolic and Bariatric Surgery suggest patients should have routine metabolic and nutritional monitoring; including weight, eating behaviour and physical activity reviews (National Institute for Health and Care Guidance, 2019).

2.2 Weight related outcomes post bariatric surgery

Weight loss outcomes are highly variable; many participants initially have a good weight-loss response to surgery, but over time experience weight regain and the return

of obesity (Baig, Priya, Mahawar, Shah, & for the Indian Bariatric Surgery Outcome Reporting, 2019). Weight regain post bariatric surgery is a common problem, however, a definite cause remains unclear (Wharton, Kuk, Luszczynski, Kamran, & Christensen, 2019). Participants find it difficult to maintain the body weight they get down to post-surgery (Vieira et al., 2019). Around 20 to 30% of those who have bariatric surgery fail to reach targeted weight loss, or will begin to regain weight significantly within six to twenty-four months post-surgery (Bradley et al., 2016). The different terms/assessment criteria used to define weight loss and/or weight regain for bariatric patients are presented in table 2.1 below.

Table 2.1. Terms used to define weight loss (Sepúlveda et al., 2017).

Term	Definition	Calculation
Total weight loss (TWL)	The total reduction in body mass	Initial weight minus current weight
Percentage of total weight loss (%TWL)	Percentage of total body mass lost	Operative weight minus the follow-up weight, divided by the operative weight, and multiplied by 100
Percentage of excess weight loss (%EWL)	Amount of weight loss from excess weight (defined by ideal body weight)	Operative weight minus the follow-up weight, divided by the excess weight, and multiplied by 100.
Excess weight	Amount of excess weight the participant is carrying based on ideal/adjusted body weight	Operative weight minus ideal body weight based on a BMI of 25 kg/m ² and change in body mass index (BMI)

It is unclear which the best term is, but several authors suggest %TWL is the most accurate measure for weight loss assessment, as it is less affected by confounding anthropometric measures (confounding anthropometric measurements not defined by authors) (Grover et al., 2019). A favourable weight loss response is commonly defined as 50% %EWL and/or maintaining > 20% of %TWL (Grover et al., 2019). However,

there are other favourable ways to assess outcomes following bariatric surgery, including improvement of obesity-related comorbidities and quality of life.

Weight-related outcomes post bariatric surgery as well as other relevant outcomes (e.g. nutritional deficiencies, physiological issues, quality of life outcomes etc.) are presented in table 2.2. The studies selected to be presented in table 2.2 below were longitudinal studies, systematic reviews or intervention studies with higher participant numbers. Minimal studies have been conducted in New Zealand. Roux-en-Y-gastric bypass was the most effective with weight loss outcomes, having greater %TWL and %EWL, as well as greater improvements in BMI measurements (Chiappetta, Stier, Scheffel, Squillante, & Weiner, 2019; Chu, Steinberg, Mehta, O'Kane, et al., 2019; Courcoulas et al., 2013a; Sjostrom, 2013). However, RYGB was associated with greater surgery complication rates as well as higher perioperative and postoperative mortality rates, compared to GB and AGB. Roux-en-Y-gastric bypass was associated with higher rates of type two diabetes remission in participants as well as greater improvements in total cholesterol, high density lipoprotein-cholesterol, and insulin resistance compared to other bariatric surgery types. Weight regain was discussed in multiple studies with Baig et al., (2019) reporting a prevalence of weight regain being 35.1% after SG, 14.6% after RYGB, and 3% after OAGB. Interestingly one study reported that quality of life was higher in patients after SG compared to RYGB five years post-surgery (Salminen et al., 2018).

Table 2.2 Relevant outcomes of Bariatric Surgery

Authors, year and country.	Subjects and surgery type	Weight related outcomes	Additional nutritionally relevant outcomes of bariatric surgeries.
Chiappetta S, Stier C, Scheffel O, Squillante S, Weiner RA 2019 Europe and Middle East.	55 Participants RYGB n = 21 OAGB n = 34	Average % weight loss was $10.3 \pm 7.6\%$ (RYGB) and $15.8 \pm 7.8\%$ (OAGB) at 12-months	3 RYGB surgery patients had complications, whereas no patients in the OAGB group had surgery complications. At one-year post-surgery, no significant differences were seen between RYGB and OAGB regarding readmission and minor complications.
Baig, Priya, Mahawar and Shah 2019 India	9617 participants SG n=5458 RYGB n=2965 OAGB n=1194	The median weight regain at five years was 14.1% of lost weight, 1.92 kg/m ² , and 5 kg. Weight regain prevalence was 35.1% after SG, 14.6% after RYGB, and 3% after OAGB at five years Median total weight loss three years post-surgery, 28.7% SG, 29.9% RYGB, 33.3% OAGB at five years Median %EWL at three years post-surgery 68.8% SG, 67.5% RYGB, 79.0% OAGB	Severe albumin deficiency was highest in OAGB (5.9%) patients followed by SG (2.9%) and RYGB (2.2%) at 5 years. Haemoglobin levels < 10 g/dL were seen in 8.2%, 9.0%, and 13.9% of SG, RYGB, and OAGB patients respectively at five years.
Chu L, Steinberg A, Mehta M, O'Kane C, Toulany A, Langer JC, et al 2019 Canada	20 participants SG n=9 RYGB n=11	Mean %TWL was 28.5% at six months, 10.3% at 12 months. Mean %TWL for RYGB at six months 27.7%, SG 21.4%, 12 months RYGB 32.1%, SG 25.7%	In 13 patients, the REE decreased by 475.1 kcal/d (22%) at six months and 545.5 kcal/d (26%) at 12M compared with baseline.

Authors, year and country.	Subjects and surgery type	Weight related outcomes	Additional nutritionally relevant outcomes of bariatric surgeries.
Srivastava and Buffington 2018 Canada	48 participants SG n= 14 RYGB n= 25 AGB n= 9	Average weight regain 20% above nadir (defined as the lowest point) six years post-surgery (range = 1 to 20 years) Mean weight loss of -2.3 kg after 3 months and -4.4 kg at 6 months into the program	Participants most successful with weight loss were treated with anorexigenic pharmaceuticals.
Chang SH, Stoll CR, Song j, et al 2014 Systematic review. Literature searches included Medline, Embase, Scopus, Current Contents, Cochrane Library, and Clinicaltrials.gov	164 studies were included (37 randomized clinical trials and 127 observational studies).	Average BMI loss at 5 years post-surgery was 12 to 17 BMI points. Both vertical gastric banding and SG had significant effects on BMI loss	<p>Complication rate was 17% (95% CI, 11%-23%), and the re-surgery rate was 7% (95% CI, 3%-12%).</p> <p>AGB had the lowest perioperative and postoperative mortality rates (0.07% and 0.21%), followed by SG (0.29% and 0.34%) and then GB (0.38% and 0.72%).</p> <p>Complication rates were relatively low for SG (13%) and AGB (13%) compared with GB (21%).</p>

Authors, year and country.	Subjects and surgery type	Weight related outcomes	Additional nutritionally relevant outcomes of bariatric surgeries.
Sjostrom L. 2013 Sweden	The SOS intervention study includes a surgery group n= 2010 and a control group of non-surgically treated obese subjects n = 2037.	Mean weight loss 15 years post-surgery was 27% for RYGB, 18% for vertical banded gastroplasty, 13% for AGB	In the surgical group there was a 72% remission of type 2 diabetes after two years and 36% durable remission after 10 years. This study also found that bariatric surgery was associated with a reduced incidence of fatal or non-fatal cancer in women but not in men. At 16 years' follow-up, surgery was associated with a 29% lower risk of death from any cause compared with usual care.
Courcoulas AP, Christian NJ, Belle SH, Berk PD, Flum DR, Garcia L, et al 2013 United states of America	2458 participants RYGB n= 1738 AGB n= 610 Other n= 110	Median weight change was 31.5% for RYGB and 15.9% for AGB three years post-surgery	Remission of type 2 diabetes was noted in 67% and 28% of those who had RYGB and AGB respectively
Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, et al 2004 Medline, Embase, Scopus, Current Contents, Cochrane Library, and Clinicaltrials.gov		Weighted mean percentage of %EWL was 50% for AGB, 68% RYGB, 69% for vertical banded gastroplasty, and 72% for biliopancreatic diversion with duodenal switch	The rate of type 2 diabetes remission also varied greatly across procedures. The rate was 48% for AGB, 84% for RYGB, 72% for vertical banded gastroplasty, and 99% for biliopancreatic diversion with duodenal switch
O'Brien PE, MacDonald L, Anderson M, Brennan L, Brown WA. 2013 Australia	19 long term observational studies (≥10 years' duration; no RCTs)	Mean %EWL of 54.2% for AGB, 54.0% for RYGB Mean 47.1 %EWL at 15 years and 62 %EWL at 16 years	The revision group (Secondary bariatric surgery) showed a similar weight loss to the overall group at 10 years post-surgery.

Authors, year and country.	Subjects and surgery type	Weight related outcomes	Additional nutritionally relevant outcomes of bariatric surgeries.
Trastulli S, Desiderio J, Guarino S, Cirocchi R, Scalercio V, Noya G, et al 2013 PubMed, Embase, and Cochrane Central Register of Controlled Trial	1191 participants Includes 15 reviews	The %EWL ranged from 49% to 81% for vertical sleeve gastrectomy, 62% to 94% for RYGB, 29% to 48% AGB	The type 2 diabetes remission rate ranged from 27% to 75% for vertical SG versus 42% to 93% for RYGB.
Monpellier, V.M., Janssen, I.M., Antoniou, E.E., et al 2019 Netherlands	2562 participants RYGB n= 2562	Mean %TWL post-surgery was 30.8% at twelve months, 31.6% at fifteen months and 31.4% at twenty-four months The maximum overall mean %TWL was 32.7% and the mean baseline BMI pre-surgery was 44.4kg/m ²	Change in physical activity was positively associated with % TWL at 15, 36- and 48-months follow-up. More restrained eating at 36 months follow-up was related to higher weight regain, and more emotional eating at 36 months related to weight regain at 48 months.
Charalampos T, Maria N, Gavriella V, Triantafyllou Z, Dimitrios T, Raptis, Zografos, Leandros G, Emmanouil, Konstantinos 2019 Greece	94 participants OAGB n=94	Mean %EWL was 26.3% at 1 month, 66.1% at 6 months, 83.5% at 12 months, 91.8% at 24 months, and 92.5% at 36 months post-surgery The average BMI 36 months post-surgery was 27.5 kg/m ² which was a mean reduction of 21.7kg/m ² compared to baseline mean BMI and the ideal/target BMI was reached at thirty-six months post-surgery by 73.4% participants	All patients suffering from hypertension, diabetes, and dyslipidemia achieved full remission. 91.7% and 86.7% participants who experienced obstructive sleep apnoea and gastroesophageal reflux disease, achieved full remission respectively. Iron deficiency presented in 27.7% participants, vitamin B ₁₂ deficiency in 13.8% participants, folic acid deficiency in 19.1%, and mild hypoalbuminemia in 7.4% post-surgery.

Authors, year and country.	Subjects and surgery type	Weight related outcomes	Additional nutritionally relevant outcomes of bariatric surgeries.
DuPree CE, Blair K, Steele SR, Martin MJ. 2014 United States of America	38699 participants (all who had surgery from 2007-2010) SG n=4832 patients GB n=33 867	Weight loss failure (<50 %EWL and/or not maintaining > 20% of %TWL) was 28.0% among SG patients without preoperative GERD to 34.0% among those with preoperative severe GERD.	The presence of GERD had no effect on weight loss for the GB group but was associated with decreased weight loss in the SG group.
Salminen, P., Helmiö, M., Ovaska, J., Juuti, A., Leivonen, M., Peromaa-Haavisto, P., Victorzon, M. 2018 Finland	240 participants SG n=121 RYGB n=119	There was no significant difference in %EWL between SG and RYGB (49% vs 57% respectively) at five years	After 5 years there was no significant difference between the study groups in diabetes remission (P > .99). Complete remission was seen in 12% in the SG group and 25% in the RYGB group. At 5-years post-surgery, 47% of the SG group and 60% in the RYGB group had discontinued dyslipidemia medications Mean (Moorehead-Ardelt Quality of life) QOL total scores were 0.85 (SD, 1.08) in those who had had sleeve gastrectomy and 0.76 (SD, 1.01) in those who had had gastric bypass at five years.
Kowalewski, P. K., Olszewski, R., Walędziak, M. S., Janik, M. R., Kwiatkowski, A., Gałązka-Świderek, N., Paśnik, K. 2018 United states of America	100 participants SG n=84 Revisional surgery n=16	The mean %EWL was 51.1%, median %TWL was 23.5% for those who had SG. 50% of SG participants achieved the satisfactory %EWL of 50% after 8 years For those who had revisional surgery %EWL was 57.8% and median %TWL was 33% after 8 years	After SG 37% did not receive any medication for diabetes, 21% had their doses reduced after 8 years. 60% of SG patients reported recurring GERD symptoms after 8 years.

Abbreviations used: Sleeve Gastrectomy (SG), Roux-en-Y-gastric bypass (RYGB), Adjustable Gastric Band (AGB), One Anastomosis Gastric Bypass (OAGB), Gastric Bypass (GB), percentage total weight loss (%TWL), percentage excess weight loss (%EWL), Gastroesophageal reflux disease (GERD), Quality of Life (QOL), Resting Energy Expenditure (REE), Swedish Obese Subjects (SOS). Note: Moorehead-Ardelt Quality of life scores range from -0.5 (very poor) and 2.1 (very good).

2.3 Contributing factors to weight regain post bariatric surgery

The literature explores many factors contributing to weight regain in bariatric participants post-surgery. Firstly, physical state both pre- and post-surgery can impact weight outcomes. In the United States 1046 RYGB participants were evaluated to find characteristics associated with weight regain six years post-surgery. Younger age, high fasting triglycerides, venous oedema with ulcerations, worse physical functioning, poorer general health, and more depressive symptomatology were associated with higher prevalence of weight regain in these participants (Wendy C et al., 2019). Secondly, poor dietary quality post-surgery, usually defined by higher carbohydrate consumption and lower protein intake, was also associated with weight regain (Vieira et al., 2019). Thirdly, behaviours associated with weight regain were: eating when feeling full more than once a week, not weighing oneself at least weekly and regular use of meal replacements (Wendy C et al., 2019). Lastly, low commitment to clinical appointments was also identified as a contributing factor to weight regain in adult women in Brazil (Vieira et al., 2019).

Additionally, the type of surgery itself results in variable weight loss outcomes. However, a minimum 10% weight regain was found in all surgery type groups at three and five years post-surgery in The Swedish Obese Subjects trial (Sjöström, 2013). To get a different perspective, a qualitative approach was used to investigate suboptimal bariatric surgery outcomes from a surgeons perspective (Vieira et al., 2019; Ward & Ogden, 2019). Key themes which delayed weight related success in participants included: participant related factors such as underlying psychosocial issues; poor adherence to post-surgery behaviour change recommendations; and poor disclosure of behaviours and/or health related conditions to medical professionals. A key concern was that Multi-disciplinary teams (MDTs) did not work effectively, causing complications via lack of communication between primary and secondary carers (Ward and Ogden 2019).

2.4 Dietary quality and its relation to weight regain post-surgery

Poor dietary quality and adherence to guidelines has been associated with weight regain in multiple studies (36% of 22 studies) (Kaouk et al., 2019). Poor dietary quality was represented by: increased intake of carbohydrate, simple sugars, alcohol, as well as limited fibre, water intake and lower fruit and vegetable intake (Kaouk et al., 2019). Weight regain was observed in multiple studies where participant diets replicated the above poor dietary quality (Kaouk et al., 2019; Karmali et al., 2013a). In a study where participants stratified into weight regainers and weight maintainers (n=50), participants who followed the above poor diet had significantly more weight gain than those who followed healthy diets (62% vs. 14% respectively) (Masood et al., 2019).

Higher simple carbohydrate consumption appears to be the most evident dietary-related cause of weight regain. For example, an increased consumption of liquid calories and sugar from non-nutritive sources was the cause of weight regain in a systematic review which included sixteen studies (Karmali et al., 2013a). However, carbohydrate consumption, regardless of type, was also independently related to weight regain. In a systematic review including 32 studies, weight regainers had a higher carbohydrate intake (222 vs. 162 g/day, $p < 0.005$) than weight maintainers (Kaouk et al., 2019). Similarly, in another group of weight regainers (n=20), they did not consume a greater energy intake, but their carbohydrate intakes were higher and their protein intakes lower, compared with those of the stable weight groups (Vieira et al., 2019). It appears that poor dietary quality overall is associated with poor weight outcomes, in a prospective cohort study that examined 2458 participants pre and post-surgery within 10 different USA hospitals, more than half of the participants ate at least one fast food meal a week, with 50% of participants eating at least two to three take away meals a week. The increased consumption of take away meals was significantly associated with post-surgical weight gain (McGrice & Don Paul, 2015). It is likely that weight regain occurs due to lack of energy restriction and increased intake of “empty” calories from non-nutritious foods, whether this occurs due to overall poor dietary quality, increased simple and/or carbohydrate consumption, or increased consumption of take away foods.

Frequency of meals was also associated with weight regain. There is a tendency for participants to gradually increase their food intake post-surgery, leading to weight gain (Vieira et al., 2019). It has been found that eating seven or more times per day pre-surgery was independently associated with greater weight regain post-surgery (King, Hinerman, Belle, Wahed, & Courcoulas, 2018). This was similar to the findings in an 18-month follow-up intervention study conducted by the Obesity Research Centre in Saudi Arabia. In this study, weight regainers never ate more than five small frequent meals per day, including snacks, and usually did not eat breakfast (Masood et al., 2019).

2.5 Energy metabolism

It is questioned whether there are major physiological contributors to weight regain post-surgery. Weight regain after excess weight loss may be related to changes in resting energy expenditure and metabolic adaptation (Chu, Steinberg, Mehta, O'Kane, et al., 2019). Resting energy expenditure (REE) is defined as the minimum energy required to maintain every day bodily functions, and homeothermic temperature at rest, determined by the amount of fat free mass (Thivel et al., 2013). Resting energy expenditure was found to decrease in participants after bariatric surgery (Burguera et al., 2007; Thivel et al., 2013), as a result of changes to thyroid-stimulating hormones and fat-free mass (Mirahmadian, Hasani, Taheri, Qorbani, & Hosseini, 2018).

Resting energy expenditure was explored before and one year post-surgery in 233 participants with obesity after they had had RYGB, showing a reduction of 20.4% (Wilms et al., 2018). This is also supported by multiple prior studies which show a ~20% to 30% reduction in REE post-surgery (Carey, Pliego, & Raymond, 2006; Das et al., 2003; Moehlecke et al., 2017; Netto et al., 2015; Wilms et al., 2018).

The relationship between REE and weight loss outcomes were explored, finding a greater reduction in REE was associated with a smaller %TWL, as well as a decrease in FFM and FM at twelve months (Chu, Steinberg, Mehta, O'Kane, et al., 2019; Netto et al., 2015). Participants who had higher fat mass and lower REE after surgery were more likely to return to their pre-surgery weight (Leite Faria, de Oliveira Kelly, Pereira Faria, & Kiyomi Ito, 2009). Greater FM reductions may be linked to decreased leptin levels, due to leptin being secreted from both subcutaneous and visceral adipose tissue (Van

Harmelen et al., 1998). Thus, it is suspected that changes in REE and metabolic adaptation may cause weight regain post-surgery; investigating these changes further would be beneficial for optimal nutrition and lifestyle counselling for bariatric patients.

2.6 Experiencing hunger post-surgery

Many bariatric participants report an increase in appetite returning as length of post-surgery time increases, resulting in increased hunger, cravings, and problematic eating behaviours, which then results in excess calorie intake (Srivastava & Buffington, 2018). Changes in appetite may be related to the appetite-suppressing pro-opiomelanocortin (POMC) and the appetite-increasing neuropeptide Y (NPY)/agouti-related peptide (AgRP) neurons (Sohn, 2015). The hypothalamic peptides AGRP/NPY and POMC have strong anabolic and catabolic effects and are often discussed in terms of homeostatic regulation (Lanfray & Richard, 2017). An increase AGRP/NPY expression and/or decrease POMC expression can cause a “hungry” state, often seen after an energy depletion period. This state may be present after bariatric surgery, due to the period of extreme calorie restriction causing “metabolic hunger”, which may be related to an increased appetite (Dirksen, Jørgensen et al. 2013).

Another proposed mechanism for changes to appetite post-surgery is due to a change in gut-brain signalling hormones. The availability of energy is signalled from the gut by the gastrointestinal hormone ghrelin and bile acids (Münzberg, Laque, Yu, Rezai-Zadeh, & Berthoud, 2015). Pizato et al., (2017) explain that patients with post-surgery weight regain may experience an increase in ghrelin concentration and a decrease in NPY, which favours a high caloric intake (Pizato, Botelho, Gonçalves, Dutra, & de Carvalho, 2017b). The inability to suppress these ghrelin levels may also be an explanation for increased feelings of hunger and therefore, the development of grazing behaviour in obese individuals (Pizato et al., 2017b). First year post-RYGB, there seems to be a reduction in the level of appetite and cravings in the postprandial period compared with that in the preoperative period (Yeh et al., 2017). This improvement in appetite control may be in response to the increased production and secretion of intestinal hormones with anorectic effects, such as Glucagon-like peptide-1 (GLP-1) and NPY after RYGB (Dirksen et al., 2013). Weight regain may also be related to decreased leptin levels after fat loss, which drives energy intake (Wolfe et al., 2018).

The perception of increased hunger post-surgery was explored in a cross-sectional study. This study explored the outcomes of women who had RYGB surgery regainers (n=20), maintainers (n=20) were compared to a control group of obese participants (n=20) who had not been operated on. It was found that the perception of hunger/satiety response after a test meal was not significantly different between the groups (Vieira et al., 2019).

Physiological adjustments to gut-brain signalling hormones as well as catabolic/anabolic neuropeptides may be a cause of increased sensations of hunger post-surgery. However, it is not clear whether these changes occur as a direct bariatric surgery outcome, with the above study displaying no difference in hunger/satiety response between all groups. Therefore, these physiological responses are likely to have high variability between individuals.

2.7 Problematic eating behaviour

A variety of suboptimal eating behaviours have been found to be associated with weight regain, including, behavioural and emotional related contributing factors and/or disorders in bariatric participants. The most common relate to uncontrolled eating; overconsumption of foods whilst feeling unable to stop and binge-eating disorder; characterized by recurrent episodes of bingeing without compensatory behaviours, similar to behaviours seen in bulimia nervosa (Tanofsky-Kraff et al., 2013). As well as, grazing behaviour, or picking and nibbling at foods throughout the day (Pizato et al., 2017b).

Loss of control of eating, defined as a loss of control irrespective of the amount of food that is consumed; the feeling that one cannot stop eating or control how much they are eating (E. M. Conceição et al., 2015; Matherne et al., 2015) is also a common problematic eating behaviour, associated with weight regain observed in bariatric participants.

All the mentioned behaviours above lead to excess calorie intake, which can be detrimental to weight loss and/or maintenance post bariatric surgery. A significant association between weight regain post-surgery and disordered eating behaviour or

habits were found in 75% of studies, mostly as a result of disinhibited eating, tendency to overeat and unsuitable eating behaviour (Kaouk, Hsu et al. 2019). Additionally, 16% of variability in weight outcomes was caused by grazing and bingeing habits (Mitchell, King et al. 2015).

2.7.1 Binge Eating Disorder

A 2019 review has confirmed that the most commonly experienced eating disorder among bariatric patients is binge eating disorder (BED), experienced by 10% of bariatric participants (Brode & Mitchell, 2019). Additionally, those who suffered from BED prior to surgery were found to be more likely to suffer BED post-surgery (Pekkarinen et al., 2016). BED is also commonly associated with a feeling of a loss of control, it is estimated that 10% of those who have had bariatric surgery will develop a loss of control of eating around two years post-surgery, for some it emerged at six months post-surgery (E. Conceição et al., 2018). Furthermore, Night Eating Syndrome is another form of BED experienced by many bariatric participants (17%), where one will binge eat in the night, often subconsciously with no memories of the event (Brode & Mitchell, 2019; Kaouk et al., 2019).

It is clear that these behaviour's lead to weight regain post-surgery in the literature, with Masood, Alsheddi et al., (2019) confirming that late-night snacking, emotional binge eating and distracted eating behaviours were all significantly associated with weight regain (Masood et al., 2019). BED alone was found to be significantly associated with weight regain in a five-year follow-up of 257 participants. Those who binged gained significantly more weight than those who did not binge (24% vs. 50% respectively) two years post-surgery (Pekkarinen et al., 2016).

2.7.2 Emotional eating

Emotional eating, defined as the tendency to eat in response to emotional distress, usually in a mindless manner, is commonly experienced (38%) in participants post-surgery (E. M. Conceição et al., 2015; Nguyen-Rodriguez, Unger, & Spruijt-Metz, 2009). Emotional eating is found to be more common in women (Miller-Matero et al., 2018)

and participants often report that they are aware of their emotional eating behaviour (Jones, Cleator, & Yorke, 2016; Parretti et al., 2019).

A follow-up study including 4569 RYGB surgery participants at baseline, 15, 24, 36 and 48 months post-surgery, revealed that emotional eating was significantly related to weight regain (Monpellier, Antoniou, Aarts, Janssen, & Jansen, 2017). It was also found that participants who experienced more emotional eating post-surgery compared to pre-surgery, had less weight loss overall (Monpellier et al., 2017). Emotional eating was investigated in multiple studies of bariatric participants, with many reporting participants saying they needed help to change these behaviours (Groven & Glenn, 2016; Lauti, Stevenson, Hill, & MacCormick, 2016b; Parretti et al., 2019).

2.7.3 Picking, nibbling and grazing eating behaviours

Picking and nibbling/grazing disordered eating behaviours affect 30% of participants post-surgery (Brode & Mitchell, 2019). A recent systematic review analysed these behaviours and the impact on weight regain post-surgery. The findings concluded that even in participants who had adequate excess weight loss, weight regain was observed at 12 and 24-months post-surgery and mostly attributed to excess energy intake and episodes of 'eating modest amounts of food in an unplanned, repetitious way' (Pizato et al., 2017b). An additional cross-sectional study comparing a group of pre-surgery participants to a short-term (< two years post-surgery) and one a long term (>2 years post-surgery) group, also found a strong correlation between weight regain and grazing behaviour (E. Conceição et al., 2018). An increase in grazing behaviour may be as a result of reduced physical capacity to consume large amounts of food, therefore participants may replace BED with picking, nibbling and grazing eating behaviours post-surgery. Authors conclude that it is necessary to monitor disordered eating behaviours and intervene in early stages when patients are motivated to succeed (Brode & Mitchell, 2019).

2.7.4 Mood and eating behaviour

Participants with mood disorders such as bipolar disorder appear to have more problematic eating behaviours. Cognitive behavioural therapy as an intervention,

resulted in a 1.6 kg weight loss in six weeks, for participants who had weight regain post bariatric surgery (Grothe et al., 2014). Behavioural and psychological factors may lead to unsuccessful weight loss outcomes, as the surgery limits the food consumed in one sitting but does not necessarily limit the ability to overeat throughout the day.

It is well known that those who have had bariatric surgery are likely to experience problematic eating behaviours, and therefore weight regain. As a result, assessing the prevalence of these behaviours has become common in bariatric research. The Three-factor eating questionnaire (TFEQ) is a widely used tool which determines the presence of cognitive restraint, uncontrolled eating and emotional eating, behaviours in obese populations (Mostafavi et al., 2017; Saade et al., 2019).

2.8 Mental illness pre-surgery

Participants who have pre-surgery mental illness, such as anxiety or depression for example, may be more likely to have less successful weight related outcomes post-surgery (Müller et al., 2019). The impact of pre-surgery mental illness on post-surgery outcomes was investigated in 386 participants, with and without mental illness over four years post RYGB or SG surgery (Müller et al., 2019). Depressive disorders were experienced by 63.9% of participants (Müller et al., 2019). Those with mental illness, had a smaller %TWL over the study period, compared to those without (25.1% vs. 28.8% respectively) (Müller et al., 2019). Similarly, additional research found pre-operative mental illness lead to lower long term weight loss, and increased risk of weight regain after surgery (Gorin & Raftopoulos, 2009; Karlsson, Taft, Rydén, Sjöström, & Sullivan, 2007).

The need for psychological help is recognised by bariatric participants (Parretti et al., 2019), who reported, valuing psychological input (Ogle, Park, Damhorst, & Bradley, 2015), and desire of greater access to psychological support throughout their journey (Lauti et al., 2016b; Liebl, Barnason, & Brage Hudson, 2016; Moroshko, Brennan, Warren, Brown, & O'Brien, 2014; Ogden, Avenell, & Ellis, 2011; Sharman et al., 2017).

2.9 Lack of support from medical professionals

A common theme reported in the literature is the desire for additional support from healthcare professionals. Eighteen to twenty-four months is the usual time for final discharge from care. Multiple studies report that participants found it difficult having regular care stopping at this time (Engström & Forsberg, 2011; Groven & Glenn, 2016; Jones et al., 2016; Lauti et al., 2016b), as they felt they needed more support due to a plateau in weight loss and troubles adhering to dietary and lifestyle advice (Jones et al., 2016; Lauti et al., 2016b). Participants also reported that compared to pre-surgery, minimal support seemed to be offered post-surgery (Groven & Glenn, 2016). Overall, there are reoccurring themes of need for more follow-up support, adequate dietetic care and especially psychological care post-surgery (Luca et al., 2002).

However, the above findings may be confused with the strong evidence of poor compliance to follow-up appointments, reported in the bariatric literature. Attendance to follow-up appointments varies between 3-63%, depending on the procedure and follow-up programme (Vidal et al., 2014). It is well known that failure to attend follow-ups, has been associated with poor outcomes, and is therefore a concerning factor in weight loss success (Vidal et al., 2014). For example, in a recent systematic review including 276 studies, 23% showed that poor support post-surgery was associated with long term weight regain (Kaouk et al., 2019). Participants who attended regular follow-up three years post-surgery, had better long term weight outcomes than those who did not attend (74% EWL, 56% EWL respectively) (Kaouk et al., 2019). Weight regain of up to 14% was observed in 75% of participants who no longer received follow-up after three years post-surgery. In comparison, of those who received ongoing follow-up five to six years post- surgery, only 25% experienced weight regain (Kaouk et al., 2019). Similarly, another study found an 18% difference in %EWL in participants who received regular follow-ups, compared to those who were lost to follow-up within the first year (Kaouk et al., 2019). Additionally, greater long term outcomes were observed in participants who attended all post-operative follow-up visits with a MDT (Gould, Beverstein, Reinhardt, & Garren, 2007), and specifically attendance to dietitian appointments, was associated with successful weight maintenance outcomes (Masood et al., 2019).

The reasons for not attending appointments were investigated in a qualitative review, including 33 studies. The key reasons for not attending appointments were: difficulty attending due to location, time of appointments, work/family commitments, and expense, with participants suggesting health care professionals need to make more effort to initiate contact (Parretti et al., 2019). Participant reported enablers for attending follow-up sessions were: self-efficacy as well as non-judgemental attitudes, knowledge and continuity of care from health professionals (Parretti et al., 2019).

Support from the bariatric health care team is an important component in long-term success; of those who failed to maintain weight loss, 60% had never seen a dietitian and 80% had never seen a psychologist (Karmali et al., 2013a). It is important for health care professionals to understand patient needs and experiences, to deliver effective care throughout the bariatric program (Parretti et al., 2019).

2.10 Increased need for social Support post-surgery

Satisfaction of social support is a predictor of physical and mental related quality of life outcomes for bariatric participants post-surgery (E. M. Conceição et al., 2015). Lower quality of life, and lower satisfaction with treatment, was associated with a lack of support in multiple studies (Chesler, 2012; de Zwaan, Marschollek, & Allison, 2015; Luca et al., 2002). In a cross sectional study (n=139), the perception of greater social support was the only associated factor with a higher %TWL, when compared with other psychological determinants (E. M. Conceição et al., 2019).

Increased social support may be related to improved weight loss outcomes for various reasons. Firstly, perceived social support from significant others to adhere to diet and exercise recommendations provided a good indicator of successful weight loss (ter Braak, Hinnen, de Jong, & van de laar, 2018). In comparison, medium to low levels of family support resulted in increased grazing behaviour and therefore more weight regain (E. Conceição, Mitchell, et al., 2014). Secondly, a recent New Zealand qualitative analysis involving 29 Māori women showed that whanau was one of the biggest motivators for women to have bariatric surgery, with whanau continuing to be the main

motivator throughout the bariatric journey (Rahiri, Tuhoe, MacCormick, Hill, & Harwood, 2019).

In participants who had minimal social support, support was often searched for in the form of online platforms (used by 84% of participants) including Facebook (E. M. Conceição et al., 2019). Online platforms were viewed as a way to receive support, and share one's own accomplishments and challenges (Colles, Dixon, & O'Brien, 2008)

In contrast, there is evidence which shows that non-married participants were more likely to stick to their dietary and physical activity recommendations and achieve their weight loss targets (Silvia, Emily, Orlando, & Marina, 2009). The significant changes and new lifestyle that participants are encouraged to adopt may collide with their spouse's and/or family habits, such as regular mealtimes, and adjusted nutrient components of a meal. Relationship quality tended to decline after surgery for couples who did not adjust to the lifestyle and behavioural modifications this surgery requires (de Zwaan et al., 2010; Mervyn, 2008).

2.11 Physical activity

Physical activity was found to have an impact on weight regain post-surgery in four systematic reviews, which confirmed that weight regain was associated with lower physical activity levels (Kaouk et al., 2019). Participants who engaged in more than 150 minutes of moderate-vigorous activity per week had greater %EBWL than those who were less physically active 2-5 years post-surgery. Those who did regain a significant amount of weight post-surgery did less physical activity than patients who maintained their weight (Amundsen, Strømme, & Martins, 2017; Montpellier et al., 2017). The American College of Sports Medicine guidelines recommend more than 250 minutes of moderate physical activity per week to prevent weight regain. Regular exercise can prevent a decrease in energy expenditure, and increase REE due to increased lean body mass which may also contribute to prevention of weight regain (Hunter, Fisher, Neumeier, Carter, & Plaisance, 2015). Physical activity and dietary intake are the best strategies to prevent the decline in lean body mass and REE post bariatric surgery (Thivel et al., 2013).

2.12 Summary

In summary, weight regain is experienced by up to 31.5% participants post bariatric surgery with many participants finding weight maintenance an ongoing battle (Baig, Priya, Mahawar, & Shah, 2019). It appears there are many causes which can be attributed to the cause of weight regain in bariatric patients including: dietary quality, suboptimal dietary choices, physiological hunger mechanisms, problematic eating behaviours, a lack of support from either a health professional or a social aspect, mental illness, energy metabolism and physical activity.

Chapter 3. Research Manuscript

3.1 Abstract

Background: Weight-regain is commonly experienced post-bariatric surgery. This study aimed to assess the impact of a structured eating behaviour group education programme on food intake and eating behaviours which contribute to weight regain.

Methods: Participants (n=41) were adults at least 12-months post-bariatric-surgery, recruited through CM Health over six months, representing gender and ethnic diversity. This study evaluated whether the current dietitian-led group education session at 18-months resulted in changes to weight, body composition, quality of life, food intakes and/or eating behaviours. There was also an additional 21-month group session added, which involved a focus group to explore barriers and enablers related to weight management during the bariatric journey. Quantitative measures included body composition analysis using bioelectrical impedance, dietary and eating behaviour measures were conducted utilising validated questionnaires, and data was analysed with Wilcoxin, and Paired T-tests. Thematic analysis was used to evaluate the focus group investigations of participant (n=28) experiences.

Results: There were no significant changes in body composition, eating behaviours, and energy or nutrient intakes in the three-day WFRs between 18 and 21-months post-surgery, but food variety scores significantly increased from 51.0 to 59.29 (p= 0.032). Flesh food intakes significantly increased from 2.50 to 7.50 per week between 18 and 21-months, as did savoury snack foods (1.50 to 2.0 per week, p <0.001). Quality of life significantly decreased at 18 and 21-months, compared to 12-months post-surgery (1.91, 0.95, 0.99, respectively, p= 0.002). Thematic analysis revealed five key themes: a life changing health journey, barriers to following a healthy lifestyle, challenges to changing eating behaviour, mindset changes and requiring ongoing support. The focus groups also identified that the participants desired more support throughout the bariatric program.

Conclusion: Thematic analysis identified the group education programme was found valuable, providing patients with increased support post-surgery from dietitians and peers. These findings provide important insights into the challenges bariatric patients face and key learnings to develop specific supports in the future. Although quantitative

improvements to eating behaviours were not found, some areas of dietary quality improved.

3.2 Introduction

New Zealand has the third highest rate of obesity within the Organisation for Economic Co-operation and Development, currently, a third (30.9%) of NZ adults are classified as obese (Body mass index ≥ 30 kg/m²) (Ministry of Health, 2017), and the rates are continuously on the rise (Ministry of Health, 2019). Obesity, particularly excess body fat, is associated with several adverse health outcomes, including type two diabetes mellitus, cardiovascular disease, stroke, sleep apnoea, reproductive abnormalities, osteoarthritis and several common cancers, impacting not only the individual themselves, but society as a whole (Ministry of Health, 2019).

With the increasing rise in obesity, bariatric surgery is becoming one of the most used treatments for severe obesity (Cummings et al., 2004). Counties Manukau Health (CM Health), is the leading district health board in offering bariatric surgical procedures in New Zealand, conducting 1359 bariatric surgical procedures between 2010 to 2018 (Counties Manukau Health, 2019). This surgical procedure poses many benefits to health, with extreme weight loss often resulting in reduction of obesity associated comorbidities, as well as improved functional ability, and therefore improved health related quality of life (Buchwald et al., 2004; Welbourn et al., 2018). A systematic review concluded that the average weight loss post-surgery is around 60-75% of excess body weight, with the maximum weight loss period being between 18 and 24-months post-surgery (Bastos, Barbosa, Soriano, Santos, & Vasconcelos, 2013). However, several studies show that weight regain begins to occur from two years post-surgery, with up to 35% of those who have had surgery experiencing weight regain (Baig, Priya, Mahawar, Shah, et al., 2019). Therefore, the long-term success of bariatric surgery remains controversial. The contributing factor to weight regain varies between individuals. The likelihood of patients regaining weight increases with problematic eating behaviours, poor dietary quality, low physical activity, and lack of medical and social support (Sjöström, 2013; Vieira et al., 2019; Wendy C et al., 2019). Experiencing weight regain post bariatric surgery is detrimental to patient outcomes, and results in both physiological and psychological implications (Karmali et al., 2013b).

There is substantial evidence which concludes that long-term weight loss success in bariatric patients is associated with attendance at clinical appointments, particularly dietitian appointments (Karmali et al., 2013a; Masood et al., 2019), however, poor attendance remains an issue in this patient group (Vidal et al., 2014). Furthermore, attendance to group based appointments has been shown to be an effective strategy for preventing weight regain in bariatric patients, with those who attended support groups experiencing an additional 8.4% excess weight loss (%EWL) compared to those who did not attend (Orth, Madan, Taddeucci, Anderson, & Tichansky, 2008). In response to the evidence and previous research conducted at CM Health, which concluded that bariatric patients expressed a desire for more support from the bariatric service (Lauti et al., 2016a), the bariatric care team questioned whether the addition of a dietitian-led eating behaviour group education programme may aid in long-term successful weight loss outcomes.

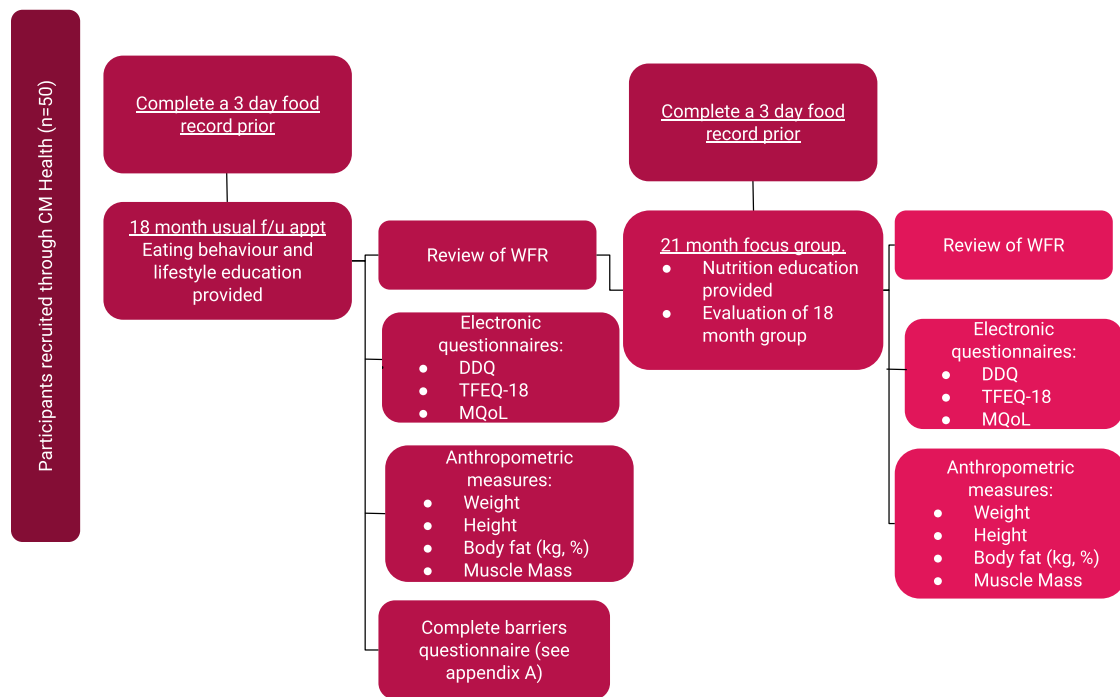
The aim of this study was to assess the impact of a structured eating behaviour group education programme at 18-months post-surgery, on food intake and eating behaviours, that may contribute to weight regain in post bariatric surgery patients at CM Health. The analysis assessed changes to weight outcomes, dietary intakes, and eating behaviours using both quantitative and qualitative methodology.

3.3 Materials and methods

3.3.1 Participants and procedures

The bariatric weight management study is an evaluation study of a dietary intervention programme among men and women who have had bariatric surgery at CM Health. The sample size (n=50) was calculated based on the current surgery rate (approximately 10 per month) within the recruitment time frame of the study (December 2018 to May 2019). Inclusion criteria were CM Health bariatric patients aged 18 years and over who had undergone bariatric surgery 12-months prior and were booked for follow-up appointments during the nine-month study time frame. Participants were invited to participate in the study at their usual dietitian 12-month follow up appointment and written consent was gained before any data collection began. The study procedure involved the evaluation of the current dietitian-led 18-month group session as well

providing an additional education session and conducting a focus group at 21-months post-surgery (Figure 1).



Abbreviations used: Weighed Food Record (WFR), Dietary Diversity questionnaire (DDQ), Three-factor Eating Questionnaire (TFEQ-18), Moorehead-ardelt Quality of Life questionnaire (MQoL).

Figure 3.1 Flow diagram for patient data collection points

Post-surgery, and prior to data collection, participants should have attended three individual follow-up appointments with the dietitian, as well one group session. The 18-month education group was led by the CM Health Bariatric Dietitian as part of standard practice, with eating behaviour advice being the main topic, including content on determining the difference between physical and emotional hunger, ways to overcome non-hungry eating, mindful eating, and developing healthy long term habits.

Participants completed a three-day weighed food record (WFR) at home prior to attending both the 18-month and 21-month group sessions, which was reviewed for accuracy by the primary researcher at the group session. Socioeconomic, anthropometric, Quality of Life questionnaire (MQoL), Dietary Diversity questionnaire (DDQ) and Three Factor Eating questionnaire (TFEQ-18) data were collected at both 18

and 21-month sessions. Participants also completed a questionnaire which addressed nutrition and lifestyle related barriers and enablers to weight maintenance post bariatric surgery at the 18-month groups session. The answers to this questionnaire were used to inform the content of the 21-month group education session, which was based on identified nutrition and lifestyle related barriers. In addition, the 21-month group sessions involved a focus group (six focus groups conducted in total) which addressed barriers and enablers to achieving weight loss maintenance.

Ethical Statement

This project was approved by the Massey University Human Ethics Committee (MUHEC) as a Low-Risk Research Project on the 1st of October 2018 (HEC: Southern A Application SOA 18/54). It was also approved by the CM Health research office (Research Registration Number: 821) Ethics Reference Number: SOA 18/54 from the 18th of November 2018 to the 1st of October 2021.

3.3.2. Study measures and variables

3.3.2.1 Participant characteristics

Age and gender were self-reported, and ethnicity, pre-surgery weight, weight at one-year post surgery, and any medical complications experienced by the participant were obtained from the CM Health patient database.

3.3.2.2 Anthropometric and body composition measurements

Standing height was measured using a stadiometer to the nearest 0.5cm. Participants were instructed to remove their footwear before height was measured at both appointments and measurements were entered into an Excel spread sheet.

Weight, body fat percentage, muscle mass, and basal metabolic rate were electronically captured and measured by a Tanita SC-331S Total Body Composition Analyzer; Bioelectrical Impedance Analysis (BIA) at both the 18 and 21-month group sessions. Height and weight were then used to calculate BMI (Weight (kg)/ height (m²)). Participants were instructed to remove shoes, and 1kg was subtracted from total weight

(kg) to account for any clothing. Weight and height outcomes were recorded on the same equipment and by the same trained researcher to improve reliability.

3.3.2.3 Dietary measures

Participants were given written instructions on how to record all the food and beverages they consumed, a diary to record their food intake, and were invited to watch an online video on how to complete a food record (FR) (developed by Dietitians and Nutritionists in the School of Sport, Exercise and Nutrition, Massey University). They were also given a photographic portion atlas with eight photographed portion sizes per food item to assist estimation of food types and portion sizes. The photographic atlas was focused on foods which are advised for bariatric patients to consume, including protein foods (e.g. chicken, lamb) and non-starchy vegetables (e.g. chicken, lamb, spinach). It further included a variety of foods not recommended for consumption, such as breads, cereals, and starches (e.g. white bread slice, cornflakes, potatoes). Nutrient composition of the weighed food records (WFR) was analysed using Food Works Professional Edition version 10 (Xyris Software, 2013).

Dietary diversity was assessed using the 220- item food frequency questionnaire adapted from the Adult National Nutrition survey in NZ (Ministry of Health NZ, 1997). The variety of food consumed was representative of the nutrient adequacy diets over a seven-day time frame. The DDQ consists of eight nutritious food groups: flesh foods (animal meats), eggs, dairy products, breads/cereals/starchy vegetables, legumes and nuts, fruits and juices, vegetables, oils and fats, and six discretionary food groups including: drinks, alcohol, sauces/spreads/flavourings, sweet snacks, savoury snacks, take away and fast foods. The questionnaire was scored firstly by the number of food groups consumed (Dietary diversity score (DDS; from 1-14 groups), as well as a nutritious DDS (1-8) and discretionary DDS (1-6), where one point is given for one food item consumed from each food group; a food is only scored once. Secondly, it was scored for the number of foods consumed overall, namely a food variety score (FVS) or the exact number of foods eaten overall (1-220) which was then further scored into a nutritious FVS, and a discretionary FVS.

3.3.2.4 Nutrition and lifestyle related barriers and enablers questionnaire

An open-ended questionnaire was designed to include five prompting questions addressing both barriers and enablers in relation to preventing future weight regain (Appendix A.). The responses to these prompts were used as a guide to form the education session conducted at the 21-month group sessions. All the education sessions at the 21-month time point were the same and involved tips on how to include mindful eating in daily life as well as a mindful eating exercise (Appendix B.).

3.3.2.5 Eating behaviour measures

Eating behaviour was assessed using the three-factor-eating questionnaire shortened version (TFEQ-R18) - a widely used tool to study eating behaviour in overweight and obese individuals (Engstrom et al., 2015). The TFEQ-R18 consists of 18 questions to measure obesity-related cognitive restraint, uncontrolled eating and emotional eating (Beechy, Galpern, Petrone, & Krupa Das, 2012). Each response to the questions were graded on a four point scale (1-4), with the higher value representing more of the behaviour; measuring either how frequent the behaviour was, or how true a statement was for the participant (Anglé et al., 2009; Fleurbaix Laventie Ville Sante Study Group, 2004). The questionnaire was then scored in three sections: cognitive restraint scored from 1-8 being low , 8-16 being medium and 16-24 being high; uncontrolled eating scored from 1-12 being low, 12-24 being medium, and 24-36 being high; emotional eating scored from 1-4 being low, 4-8 as medium and 8-12 as high (Fleurbaix Laventie Ville Sante Study Group, 2004).

3.3.2.6. Quality of Life questionnaire

Quality of life was assessed using the Moorehead–Ardelt Quality of Life Questionnaire (MQoL) which measures post-operative self-perceived quality of life. The MQoL assesses six areas; self-esteem, physical well-being, social relationships, work, sexual activity and eating behaviour, and has been validated in morbidly obese gastric bypass patients (Beechy et al., 2012). The MQoL is scored on a scale of -0.5 to +0.5. All participants are given an overall score ranging from -0.5 (very poor) and 2.1 (very good).

3.3.3 Focus groups addressing barriers and enablers to preventing future weight gain

Focus groups were conducted at all 21-month group sessions (six focus groups in total) and, included two to ten participants per group, each lasted 45-60 minutes. The aim of the focus groups was to explore participant self-reported enablers and barriers to preventing future weight regain, using an interview guide to capture the main topics (see appendix 3.). Only the researchers, research assistants and participants were present during the discussions. Data was captured by a digital recorder, professionally transcribed and uploaded to NVivo 12 qualitative data analysis software QSR (International Pty Ltd, 2018) for thematic analysis. NVivo was used to determine codes and frequently used words in the thematic analysis to derive and explore the common themes. The themes were then translated into recommendations for future CM Health bariatric care programmes.

3.3.4 Statistical analysis

Statistical analysis was conducted using IBM SPSS Statistics version 22.0 (IBM Corp, 2013). First, data was tested for normality using the Kolmogorov Smirnov normality test. Parametric data were then summarised by mean \pm standard deviation, non-parametric data were log transformed and reported as geometric mean (95% confidence interval), or as untransformed median (25- 75th percentile). Differences in anthropometric and questionnaire-based data between 18 and 21-months post-surgery were analysed by dependent T-test for parametric data or Wilcoxin test for non-parametric data. The differences between baseline, 18 and 21-month data were analysed using the Friedmans test for non-parametric data and repeated measures ANOVA for parametic data. Significance was represented by a p value <0.05.

3.3 Results

3.3.1 Participant characteristics

The final study sample were 41 participants, with 28 participants attending both the 18 and 21-months sessions. (Figure 2).

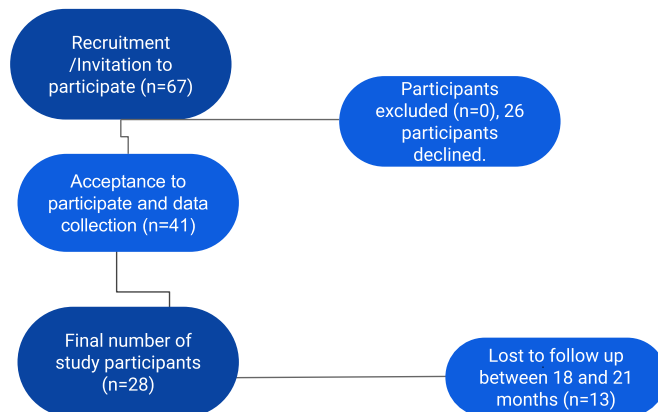


Figure 3.2 Flow diagram of recruitment and final number of participants for data analysis

The number of participants in data outputs change due to some participants wishing to be excluded from certain measures or not having baseline (12 month) data on file. The mean pre-surgery weight was 126.74kg. Of the participants 41.5% were of NZ European ethnicity, with most being female (73.2%) (Table 1). The majority of the participants had Gastric Sleeve (GS) surgery (92.31%), and 20% of these participants experienced some form of post-surgical complication.

Table 3.1 Participant Characteristics

Variable	Descriptive statistics	
	N (%)	Mean ± STD
Age (Years)	41	49.2 ± 8.543
Gender		
Female	30 (73.2)	
Male	9 (22)	
Not specified	2 (4.9)	
Ethnicity		
European	17(41.5)	
NZ Maori	6 (14.6)	
Pacific	9 (22)	
Other	9 (22)	
Pre-surgery weight (kg)		126.7 ± 26.5
Type of surgery		
Gastric Sleeve	36 (87.8)	
Previously had gastric band	3 (7.3)	
Missing data	2 (4.8)	
Surgical Complications		
Experienced post-surgical complications	8 (19.5)	

Values are Mean± SD

3.3.2 Anthropometric, body composition and quality of life outcomes

Weight changes are presented in table 3.2. The mean weight increased at 21-months compared to 12 and 18- months post-surgery (86.3 (74.0,97.9), 87.2kg (74.5, 98.5), to 90.7kg (76.0,105.3)) but no significant differences were shown ($p > 0.05$). Between 18 and 21 months 19 (67%) participants gained weight, with three (10.7%) participants gaining ≥ 5 kg. Whilst 8 (28.57%) participants lost weight, only one (3.57%) of the participants lost ≥ 5 kg, however, none of these changes were significant. The mean MQoL scores (table 3) showed a significant decrease in QoL at 18 and 21-months compared to 12 months ($p = 0.002$). There was no significant change in QoL between 18- and 21-months post-surgery ($p = 0.740$).

Table 3.2 Body composition and quality of life at 12, 18- and 21-months post-surgery.

	12 months	18 months	21 months	P Value
Weight(kg) (n=27)	86.3 (74.0, 97.9)	87.2 (74.5, 98.5)	90.7 (76.0,105.3)	0.881 ^b
BMI (n=27)	31.4 (27.2, 35.5)	29.6 (27.0, 35.6)	33.4 (27.2, 35.5)	0.878 ^b
MQoL (n=16)	1.91 ± 0.65	0.95 ± 0.87	0.99 ± 1.07	0.002*

Values are Mean ± SD and ^b Median (25, 75th percentiles). Significance tested using repeated measures parametric ANOVA and Friedman's non-parametric test. *Significant findings p <0.05. Note: Moorehead-Ardelt QOL(MQoL) is scored on a scale of -0.5 to +0.5. All participants are then given an overall score ranging from -0.5 (very poor) and 2.1 (very good).

Table 3.3 shows the anthropometric measurements and body composition data of all participants at 18 and 21-months post-surgery, one participant was unable to be measured by the BIA scales. Non-significant (p > 0.05) changes were observed for weight, body fat percentage (BF%), fat mass (kg), BMI, and basal metabolic rating between 18-months compared to 21-months post-surgery.

Table 3.3 Changes to body composition measures at 18-months and 21-months post-surgery (n=27).

Anthropometry data	18 months	21 months	P value
Body Fat (%)	35.5 ± 9.44	36.9 ± 7.58	0.546 ^b
Fat Mass (kg)	27.0 (24.2, 38.8)	30.6 (25.5, 42.9)	0.799
Fat Free Mass (kg)	54.1(49.9, 64.0)	54.3 (48.6, 69.3)	0.949
Muscle Mass (kg)	51.4(47.4, 60.8)	51.6 (46.1, 65.9)	0.949
Total Body Water (kg)	38.4(35.3, 46.8)	38.8 (34.4, 48.3)	0.722
Basal Metabolic Rate (kJ)	6837 (6251, 8230)	6707 (6042, 8234)	0.689

Values are median (25th, 75th percentiles) and ^b Mean ± SD. Significance compared using dependent t tests for parametric data and Wilcoxin test for non-parametric data. *Significant findings p <0.05. Note: Tanita SC-331S Total Body Composition Analyzer; Bioelectrical Impedance Analysis (BIA). Basal Metabolic rate was calculated using the Harris-Benedict equation.

3.3.3 Dietary intake

Table 3.4 shows the energy and nutrient intakes at both 18 and 21-months post-surgery, nine participants did not complete food dairies. No significant changes between macronutrient or micronutrient intakes were found between the two time points. Percentage carbohydrate intakes were below the acceptable macronutrient distribution ranges (AMDR), and protein intakes were within the AMDR at both 18 and 21-months post-surgery. Percentage energy intakes from fat and saturated fat were higher than the AMDR recommendations at both time points. Calcium and vitamin D intakes were inadequate, iron intakes were adequate for men but not for women, and vitamin B12 intakes were adequate at both 18- and 21-months post-surgery.

Table 3.4 Energy and nutrient intake at 18- and 21-months post-surgery (N=19).

	Nutrient Reference Values	18 months	21 months	P value
Total energy intake (kJ) ^e	11000-16000kj	5283 (4077, 6717)	5054 (3572, 7418)	0.372
% KJ from fat ^d	20-35%	36.4 ± 7.7	36.9 ± 6.71	0.815
% KJ Saturated fat ^d	<10%	15.2 ± 4.5	13.1 ± 3.0	0.135
% KJ from protein ^d	15-25%	22.1± 6.67	21.5 ± 7.3	0.642
%KJ Carbohydrate ^d	45-65%	36.4 ± 8.7	40.4 ±8.2	0.122
Protein (g) ^e	37g/day (F) 52g/day (M)	71.0 (56.3, 90.2)	69.7 (46.2, 94.6)	0.927
Total fat (g)		50.2(38.1, 75.6)	46.0(36.5, 70.7)	0.390 ^b
Saturated fat (g)			16.1 (12.7, 29.9)	0.131 ^b
Polyunsaturated (g)		20.5(14.3, 35.1)	7.67 (4.75, 11.1)	0.179 ^b
Monounsaturated (g)		5.98 (4.54, 8.54) 18.5(13.8, 24.0)	17.3(12.8, 27.2)	0.758 ^b
Carbohydrate (g)		123.7(78.8, 149.3)	107.6 (81.4, 165.5)	0.372 ^b
Sugars (g) ^d	<10% total energy	68.3 (39.6, 76.8)	56.9 (41.7, 32.3)	0.312 ^b
Calcium (mg) ^e	840mg/day (F) 840mg/day (M)	672.3 (434.9, 987.0)	608.2 (430.2, 836.4)	0.058 ^b
Iron (mg) ^e	8mg/day (F) 6mg/day (M)	6.09 (4.95, 8.79)	6.52 (4.267, 11.1)	0.884 ^b
Vitamin B12 (ug) ^e	2.0ug/day (M/F)	3.66(2.73, 5.812)	2.80 (1.74, 3.10)	0.249 ^b

Vitamin D (ug) ^f	5.0ug/day (F/M)	2.60(1.33, 2.84)	1.73 (1.00, 2.97)	0.220 ^a
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Values are Mean \pm SD, ^ggeometric mean (95% confidence intervals), ^b Median (25, 75th percentiles). Significance compared using dependent t tests for parametric data and Wilcoxin test for non-parametric data. *Significant findings p <0.05.

Note: Reference values used ^dAcceptable Macronutrient Distribution Range, ^eEstimated Average Requirement, ^fAdequate Intake, based on the Nutrient Reference Values for Australia and New Zealand (National Health and Medical Research Council & of Health and Ageing, 2017). Total energy intake reference values are based on a 76kg male, sedentary to moderate physical activity levels.

The overall dietary diversity, nutritious food group and discretionary food group DDS reported in table 3.5 showed no significant change between 18 and 21-months. The overall mean FVS significantly increased between the groups (p=0.032). Food variety scores were also recorded within the nutritious and discretionary food groups, there was a significant increase in the food eaten from the discretionary food group at 21-months compared to 18-months post-surgery (p=0.017). Participants had high diversity in their diets at both 18 and 21-months post-surgery (12.5, 13.0 respectively, out of a total of 14). The intake of food items from the nutritious and discretionary food groups were high both at 18- and 21-months post-surgery.

Participant's diversity of food intake is reported in Tables 3.5 and 3.6. The average number of foods consumed from the flesh foods group, sauces, spreads, and flavourings group, and the savoury snacks group significantly increased at 21 months compared to 18 months (p = <0.001, p = 0.026 and p = 0.026 respectively). There were no significant changes for the remaining categories.

Table 3. 5 Food variety and dietary diversity in bariatric diets 18 and 21-months post-surgery (n=28).

	Score range	18 months	21 months	P value
Dietary Diversity score	1-14	12.5 (11, 13)	13.0 (12.0 13.8)	0.093 ^a
Nutritious food groups	1-8	8.00 (7.00, 8.00)	8.00 (7.00, 8.00)	0.163 ^a
Discretionary foods group	1-5	4.00 (3.00, 4.00)	4.00 (4.00, 5.00)	0.093 ^a
Food Variety score	1-220	51.0 \pm 23.5	59.3 \pm 17.3	0.032*
Nutritious food variety score	1-164	34.8 \pm 15.3	39.1 \pm 11.8	0.057
Discretionary food variety score	1-71	15.10 \pm 8.5	18.7 \pm 7.8	0.017*

Note: values are mean \pm SD, ^amedian (25th, 75th percentiles). Significance compared using dependent t tests for parametric data and Wilcoxin test for non-parametric data. *Significant findings p <0.05.

Table 3.6 Food groups consumed 18- and 21-months post-surgery (n=28).

Food group	# food items Consumed per week	Participants choosing food group n (%)	# food items Consumed per week	Participants choosing food group n (%)	P value
	18month		21month		
Nutritious food groups					
Flesh Foods	2.50 (1.25, 4.00)	90	7.50 (4.25, 9.00)	100	<0.001* b
Eggs	1.00 (1.00, 1.00)	83.3	1.00 (1.00, 1.00)	83.3	0.655 ^b
Dairy Products	3.00 (3.00, 4.75)	86.7	4.00 (3.00, 5.00)	100	0.093 ^b
Breads, Cereals & Starchy Vegetables	8.00 (5.25, 10.00)	86.7	7.00 (5.00, 8.75)	96.7	0.074 ^b
Legumes & Nuts	1.50 (1.00, 3.75)	83.3	1.50 (1.00, 2.75)	83.3	0.547 ^b
Fruits & Juices	5.39 ± 3.07	90	4.64 ± 2.248	96.7	0.118
Vegetables	11.50 (8.00, 13.75)	73.3	12.00 (8.50, 14.75)	100	0.295
Oils and Fats	2.00 (2.00, 3.00)	90	2.00 (2.00, 3.00)	96.7	0.710
Discretionary food group					
Drinks	4.00 (3.00, 5.75)	93.3	4.50 (3.25, 6.00)	100	0.348 ^b
Alcohol	0.00 (0.00, 1.00)	13.3	0.00 (0.00, 1.00)	30	0.429 ^b
Sauces, spreads and flavourings	4.00 (2.00, 5.00)	90	7.00 (4.00, 8.00)	96.7	<0.001 ^b
Sweet snacks	3.00 (2.00, 4.00)	86.7	3.00 (2.00, 4.75)	86.7	0.581 ^b
Savoury snacks	1.50 (1.00, 2.00)	80	2.00 (1.00, 3.00)	83.3	0.015 ^b
Take a ways and fast foods	2.00 (0.25, 4.00)	73.3	3.00 (1.00, 3.75)	76.7	0.726 ^b

Values are Mean ± STD, ^b Median (25, 75th percentiles), categorical data as n%. Significance compared using dependent t tests for parametric data and Wilcoxin test for non-parametric data. *Significant findings p <0.05.

Eating behaviour scores are presented in table 3.7, showing no significant changes between 18 and 21-months. Low cognitive restraint was experienced by 17 (60%) participants, 22 (78%) participants were uncontrolled eaters and 9 (32%) participants were emotional eaters. Of participants who had low/medium levels of cognitive restraint (n=17), six (21.4%) also had a high prevalence of uncontrolled eating, with an additional five (17.9%) participants having low/medium levels of cognitive restraint as well as high uncontrolled eating and emotional eating scores. Twenty-two participants had high uncontrolled eating, of these participants nine (32%) also had high emotional eating scores.

Table 3.7 Eating behaviours at 18- and 21-months post-surgery (n=28).

	Score range	18 Months	21 Months	P value
Cognitive Restraint	1-24; >16 high	15.3 ± 1.82	15.4 ± 1.77	0.769
Uncontrolled Eating	1-36; >24 high	23.3 ± 5.74	25.4 ± 4.23	0.088
Emotional Eating	1-12; >8 high	7.54 ± 2.03	7.89 ± 2.28	0.386

Values are mean ± SD. Significance compared using dependent t tests for parametric data. *Significant findings p <0.05. Note: Cognitive restraint low 1-8, medium 8-16, high 16-24; uncontrolled eating 1-12 low, 12-24 medium, 24-36 high, emotional eating 1-4 low, 4-8 medium, 8-12 high.

The mean differences between those who had low cognitive restraint, uncontrolled eating and emotional eating are compared with high prevalence of the behaviours for weight, energy and macronutrient intakes in table 3.8. Weight was significantly higher in participants with a higher prevalence of cognitive restraint than those with low cognitive restraint (p=0.0138). No significant changes were found for energy, fat, carbohydrate or protein intakes between 18 and 21-months post-surgery.

Table 3.8 Weight, energy and macronutrient outcomes by presence of eating behaviour (n=28).

	Low/medium cognitive restraint (n=17)	High cognitive restraint (n=11)	P value	Low/medium uncontrolled eating (n=6)	High uncontrolled eating (n=22)	P value	Low/medium emotional eating (n=19)	High emotional eating (n=9)	P value
Weight (kg)	86.1 ± 16.1	109.7 ± 11.7	0.0138*	93.5 ± 31.2	94.7 ± 16.2	0.431	100.2 ± 25.3	87.2 ± 11.7	0.075
Energy intake (KJ)	6180 ± 3842	7597.4 ± 5200.5	0.270	8834 ± 6350	5752.1 ± 2869.4	0.149	7777.2 ± 5006.6	5331.5 ± 2921.3	0.096
Fat intake (g)	65.8 ± 42.8	73.3 ± 47.8	0.368	87.7 ± 58.5	60.2 ± 34.7	0.159	82.3 ± 49.3	51.6 ± 29.4	0.0513
Carbohydrate intake (g)	135.2 ± 104.0	183.2 ± 131.9	0.212	220.5 ± 165.6	122.6 ± 71.9	0.106	173.7 ± 129.8	125.5 ± 89.8	0.170
Protein intake (g)	73.1 ± 37.2	92.9 ± 75.8	0.267	99.7 ± 84.0	69.3 ± 34.5	0.214	91.0 ± 65.2	66.7 ± 30.6	0.144

Note: Values are Mean ± SD, significance compared using independent paired t tests. *Significant findings p <0.05

3.4 Qualitative investigation of patient experiences through the bariatric programme.

Five themes were identified in the thematic analysis from the six participant focus groups. The focus groups included a total of 28 participants.

Theme one. Life changing health-related quality of life: *“For me it has definitely been life changing in a positive way. My health has improved drastically.....it has been a really amazing life changing opportunity”*

Theme one reflected the journey of the participants throughout the bariatric surgery programme, including health improvements, weight outcomes and overall health related quality of life. Improved health outcomes post-surgery was reported by most participants (n=26), particularly in terms of a reduced obesity related co-morbidities, such as type two Diabetes Mellitus (T2DM), sleep apnoea, high blood pressure and high cholesterol. Subsequently, many participants were able to reduce the number of medications they used for managing their associated illnesses. One participant developed a new case of T2DM post-surgery, however, despite this, the participant mentioned the health improvements had been worth it.

“I haven’t got diabetes anymore; I am not taking diabetic medication. I’m on a wee bit of blood pressure medication but minimal compared to what I use to be”;

“Health wise to get a report back from the doctor I don’t know how many times for years and years and years I was, you know I hadn’t managed my health and to get those reports and think now? And now to have all green, all normal it’s just so cool”;

“My journey has been nothing short of amazing. I think my highs is that I am able to touch my toes, but I have actually got a daughter out of this and that is such a blessing”.

Furthermore, all participants (n=28) reported an overall improved health-related quality of life post-surgery compared to pre-surgery. Participants felt they had an improved quality of life mostly due to increased energy levels, “The energy levels have gone right up”; which meant they were able to spend more time with their children and/or grandchildren, return to work, and do laborious tasks around the house such as gardening.

"I work at a primary school, so I am doing lots of physical work with kids..... Now it's easy, where before, it was an effort and I'd get home from work and I couldn't stand up. I couldn't do anything. I couldn't walk. I was in so much pain in my knees and just swollen legs and everything";

"Instead of driving everywhere I can walk where I need to go and I spend time with the grandkids so it's a much better lifestyle".

All participants expressed a significant change in their functional abilities, with some reporting they were now able to do regular physical activity such as running, cycling, gym classes, or even just being able to walk to the mailbox without experiencing pain.

"I enjoy it as well and I can walk so much further than I used to be able to. I walk up a hill and I get up halfway and I would be huffing and puffing like a train."

Whilst many participants reported the bariatric journey was not easy, saying they faced multiple challenges, all participants said they had no regrets and would go through it all again.

"I definitely would recommend this to anybody that can do this. I definitely don't want to ever look back to wherever I was, that was real ugh".

Subtheme 1. Food and quality of life: *"I have discovered some foods that upset me, like I can't eat coriander anymore which breaks my heart because I loved it, but it gives me really, really bad reflux and heartburn".*

Participants in all six focus groups reported having new food intolerances, developing post-surgery. Twelve participants reported specific intolerances of eggs, water, and meat. Nausea, vomiting, and reflux were the common symptoms experienced in response to food intolerances.

"I am still struggling with certain foods that I just can't eat.....did spaghetti the other night and I just find the mince side of it, I just can't eat it with the tomato puree and that in it. If it was plain mince maybe, but even then, I went out for dinner with the boss the other night in Tauranga and yeah, a bit of eye fillet and it came with two little pieces.....and I only managed to eat one and maybe a teaspoon of mash";

"One thing I struggled with was eggs and it was like- why can't I eat eggs anymore?".

The majority of participants (n=26) reported following a strict diet in fear of experiencing nausea and vomiting in response to trying a new food.

“I can’t eat some things; I get nauseous and I end up on the floor. I literally end up on the floor as soon as I have something other than ... like, I try different foods. Since my surgery I haven’t eaten anything that has come in a plastic packet.....I am fixated... it’s almost like OCD. It’s just the same food every single day”;
“I would like to have something different. Even our daughter the other night said can we have something different? Because we tend to stick to what we know we can eat”.

Many participants also experienced vomiting after eating a meal too quickly, however, all participants discussed that this quickly taught them they needed to eat meals slowly.

“You eat too fast because you have only got half an hour and then it comes back up”.

In contrast, they reported that foods with higher sugar and fat content were ‘easier to go down’, which increased the temptation to eat energy-dense foods.

“The unfortunate thing is the easy to eat foods are the ones that are bad for you like chocolate ice cream, because they dissolve in your mouth”.

The feeling of hunger was controversial with some participants stating they did not feel hunger, and needed to remind themselves to eat, whilst others felt hunger, which was often associated with feelings of guilt.

“I got my head around the eating and I don’t really feel hungry and the food, I don’t really care what we have for dinner; food is not the big part of my life like it used to be”;

“The only thing I have struggled with is that I feel hungry. I can eat and I fill up very quickly but then an hour later I can be hungry. And I shouldn’t be hungry, so I am just battling with that....they sort of said that you won’t feel hungry but that hasn’t been the case unfortunately, so just that battle going on constantly with knowing physically I shouldn’t be hungry but mentally I am feeling like I am hungry”.

Dehydration was commonly experienced post-surgery as reduced gastric capacity results in decreased fluid intake. Although it is recommended that patients sip frequently throughout the day as they are no longer able to consume large amounts in one sitting, participants reported this was often a struggle.

“Water. I just sit there and burp the whole time and experience pain.”

Participants reported they could no longer tolerate water as it caused nausea and felt as though it “*just sits there*”, this results in dehydration and dizziness as well as constipation.

“With the dehydration, you don’t want to eat....because it sucks to eat when you are dehydrated..... it just hurts and thenyou don’t have bowel movements and all that”.

A few participants (n=3) reported desiring hydration via intravenous therapy.

“I get dehydrated..... I have lived overseas a lot and we can just go to the hospital and get a drip put in and hello... I find that I am always dizzy, always. And I try my best to drink. Even walking here, I was like –damn, I forgot my water bottle. But I always have it with me, and I am always drinking but because it comes up a lot, I am always dizzy and always dehydrated. So, I don’t know if that’s part of this that could somehow be helped. To just maybe once a month to be hydrated and get that feeling”.

Subtheme 2. Weight and quality of life: *“I lost over half my body weight”; “For me I knew I was big, but I didn’t realise how big I was until now”.*

Weight outcomes were discussed in all focus groups with all participants stating they had lost large amounts of weight in the first year after surgery, thereby contributing to their quality of life.

“By the time I had surgery, I was 102. Two years on I now sit around between 79 and 81. I thought maybe I’ll get down to 75, but I’m 52 and I’m not 21 anymore, so I’m happy to get to 80 or even 85, although I’m thinking that might be a bit too much. I’m letting myself go if I go to 85”.

However, many (n=11) reported weight regain starting to occur at the 21-month group, which was unexpected, and they felt as though it was challenging to maintain their weight. The two key reasons for weight gain reported were eating calorie dense foods and not exercising enough.

“I have put on a couple of kg which I am not happy about, but I will get back on the Optifast”;

“I’m getting to that two-year stage and I had been gradually losing weight really and now it’s starting to come back up, I’m kind of like, oh, what’s happening here. Am I starting to let myself go?”;

“It’s hard to actually keep the weight off. I find it a bit difficult. I think it’s some food choices as well. I know you maybe think it’s good food, but sometimes it may be not the best”.

All participants reported a fear of weight regain or “returning to their old self”. A few participants mentioned they did not realise how big they were previously until post-surgery. “I think I’m a little bit scared, I don’t want to go back to how I was”.

Furthermore, a significant challenge reported by all participants was dealing with excess skin as a consequence of weight loss surgery, which decreased feelings of confidence.

“Once I lost the weight, the excess skin did my head in”;

“I’m carrying five kilograms of loose skin. If we cut it all off, I’d be a healthy BMI. I stand in front of the mirror.....my boobs hang down to my belly button.....that does get me down. Some days, I look in the mirror and I feel fatter now than I ever was when I was 140 kilograms”.

Participants also discussed the challenges of finding clothes to hide the loose skin, with some saying the loose skin makes them feel bigger post-surgery than they felt pre-surgery.

“You can’t hide all the loose skin. I’ve really battled to find clothes. I actually find it more difficult buying clothes now than when I was fat, especially just to try and hide all the loose skin, especially in my arms, because all the shirts are these little cut off tiny things”.

Theme two. Barriers to following a healthy life style: *“having the time and managing timetrying to adjust all the time.....the thing that’s not healthy at the moment is trying to get the meals right and not snacking in between”.*

All focus groups (n=6) involved a discussion around the challenges to following a healthy lifestyle. Financial stress was mentioned as a barrier to health in all focus groups, mainly in terms of purchasing nutritious foods with participants explaining that it is cheaper to feed their families with take away foods.

“I’m under huge financial stress at the moment”;

“The prices of vegetables, everyone is telling you to eat healthy, but it is cheaper for us all to go and get a Macca’s or a Burger King or something”.

Time limitations were viewed as a barrier, particularly for doing exercise. A few participants (n=4) mentioned that they did not feel like exercising once they got home from work.

“Having the time and managing time cause I work shift work so it’s trying to adjust all the time cause I do two earlies, two lates and two nights so it’s always moving the time. The thing that’s not healthy at the moment is trying to get the meals right and not snacking in between”.

Socializing was mentioned in all focus groups as challenges / barriers to following a healthy lifestyle, especially in family-related gatherings. “Culturally we celebrate and socialize. At family gatherings, it is all around the food”.

The majority of participants noted an increased awareness of food being the center of many social activities, work meetings, and cultural celebrations.

“I think it’s just society in general. Even in work meetings and things, it is almost rude not to eat something, even if you are not hungry or you don’t feel like it. It is odd to have food in front of you and sit there and not have anything”.

One participant stated she became depressed post-surgery, as she did not realize how many social events she was going to miss out on, due to the required changes of eating habits.

“I did struggle with that quite a bit at the beginning, the socialising. Everything we seemed to do was always around food or a meal or drinks”.

A few participants (n=5) reported a lack of knowledge regarding what foods to eat, and what to cook. One participant mentioned being strongly influenced by marketing and advertisements of foods. For example, finding it a challenge to avoid chocolate over Easter time, due to increased marketing and displays throughout supermarkets.

“Advertising influences me, as much as you say it doesn’t, it always does”.

All participants said that they believed the enablers to preventing future weight were sticking to dietary and exercise recommendations.

“You’ve got to find a really good balance between exercise and diet”;

“Just being conscious of what you put in your mouth, that’s the main thing”.

Theme three. Challenges to changing eating behaviour: “you can no longer suppress with the food anymore” “The mind games don’t go away”.

Almost all participants reported struggling with problematic eating behaviours at some point post-surgery. Problematic eating behaviours mentioned included: emotional eating, binge eating, increased snacking behaviours, overeating or unconscious night snacking, often with feelings of no self-control.

“It was just that there was no self-control for me. I would just go to the nearest take a ways and go through the drive-thru and I would eat that before I got home and then I would still eat when I got home”

Participants identified emotional eating especially when feeling stressed, anxious, or depressed as a key reason for weight regain. Participants also reported no longer being able to eat / binge on large volumes of food post-surgery, however, the binge eating mindset was still there, which resulted in overeating.

“Binge now is like a little bag of chips and a biscuit because you can’t get anything down. But, I mean, that mindset is still there”;

“I start feeling sick because I overeat”.

Additionally, overeating almost always involved consumption of the ‘wrong foods’.

“I am back to the old me; chips, biscuits, lollies... that type of food, easier to put down”.

Two out of six focus groups discussed a common theme of caution and responsible eating in front of others, followed by binge eating when alone; to avoid feelings of shame and judgment from others.

“The kids are at school, I would sneak out and eat, get rid of the rubbish”;

“When I have a meal.....I noticed one of the questions in there was do you consciously behave yourself in front of people- and I do”;

“When I’m around people, I behave myself but as soon as that door shuts or I am on my own, it’s like let me loose”.

One participant mentioned the use of mindful eating skills learnt from the 18-month group being an extremely helpful tool to control emotional eating and avoiding feelings of guilt after eating sweet treats.

“The mindful eating thing that Deirdre talked about, which I found really useful is that you’re going to do it, get rid of the guilt, get rid of all that, make it a conscious

decision, I'm going to sit down and have some of my son's birthday cake, and I'm going to savour it".

Theme four. Changes in mindset: *"The mental game has been the biggest for me".*

Changes to mindset post-surgery were discussed in all six focus groups. The majority of participants noted an increased positive outlook on life and increased feelings of happiness post-surgery.

"I am much more positive now and I always think that if I go down this track, do I still want to be this person at 109kg who has lost 30kg? would I want to go back to that? The easy answer is no";

"Everything's just looking up and it's the best thing I ever did. I am a better mother and a better employer, everything. I'm really happy".

Increased feelings of confidence were also expressed in all focus groups, particularly in terms of body image. Four out of six focus groups involved a strong theme of increased enjoyment related to clothes shopping, due to being able to fit "normal clothes".

"I'm 100% more confident";

"It really boosts you to be able to go into a normal clothes shop and buy clothes, that is just amazing"; "it feels really good and it makes you feel so much better about yourself. Because you can go out and you can find clothes.....it's good being able to go into a shop and actually fit something rather than going in there and going, I don't know if it is going to fit me, I had better put it back".

However, some participants (n=6) had a negatively focused mindset post-surgery. In three out of six focus groups there was a strong theme of participants still viewing themselves as being fat. Almost all participants reported still struggling with some form of mental challenge, with some participants stating that they were really struggling emotionally.

"I am struggling mentally because I still see a fat blob. I still go and pick up size 14 and 16 and my daughter still says no you are a 10 or a 12. I am struggling big time with that";

"It's been very hard for me emotionally";

"There was nothing mentioned about struggling mentally. There's nothing. And as I say, I don't know if it would have changed my mind to be fair, but if they had acknowledged then that mental issues come up then maybe there is a protocol put

in place throughout the journey to be able to see someone and talk to someone rather than end up where I am today”.

A newly found obsession with food and weight was discussed in all focus groups, with participants stating they feel as though their life now revolves around food, including obsessing around mealtimes, and finding acceptable foods to eat.

“I found that I obsess about food and I obsess about my weight”.

Participants also expressed new feelings of negative judgment towards what others eat, particularly in terms of food quantities.

“I have got very negative towards other people and what they eat”;

“I’ll watch them pile up their plates and think, you shouldn’t be eating all that”.

Theme five. Requiring ongoing support: *“When people regain they don’t ask for help when they need it, and when they have asked for help it is there momentarily and then it’s gone but I need it continually”.*

The benefit of supportive family and friend environments, as well as support from the bariatric health care professionals was discussed in all focus groups.

Many participants agreed that they felt like they did not get enough support from the bariatric team at CM Health and they felt the need for longer follow up care appointments; this was a main theme in all focus groups. Participants found that the majority of appointments were within the first year when weight loss was at its peak, but that they were discharged when the weight regain started to occur and when they needed the most help.

“I do still struggle with the lack of support because basically I have found that once you have had the surgery and you have gone through the three stages that were in the booklet it was like there you go- you are on your own”.

Participants also felt as though they were not educated enough pre-surgery about how hard the journey was going to be, and then felt as though once they had the surgery they were ‘dropped’. Participants would have liked more help in terms of diet, psychological/mental support, and “just having regular check ins”.

“I would like you guys to give us a bit of a warning. Well, not a warning but maybe teach us before maybe and maybe a little bit of advice of what we do and don’t need to do before we go for the operation. Because I actually thought I was going to come out and look like Barbie.”

In terms of family/friend-based support it was important for participants to have someone who believed in them. This improved their feelings of perceiving themselves to be able to maintain weight outcomes. Many participants felt as though they lost friends throughout their journeys due to their changed lifestyle and due to judgement from others.

"I don't believe in me at the moment and I have got nobody else that does. So I just do nothing";

"I lost heaps of friends".

Three out of six focus groups had participants who avoided telling people they had had bariatric surgery out of fear of judgement and criticism.

"I don't like telling people because the minute you say to them that I have had weight loss surgery, they go-oh. Couldn't stick to a thing and then you have gone to a surgeon. But they don't know the aftermath of that, of what you have to go through".

A number of participants mentioned their small food intakes being a subject of discussion at family gatherings, as well as feeling judged when eating out.

"Going out for dinner and people would say what's wrong with it? And I was like, there's nothing wrong. I just can't eat it all, sorry. And because I am still big they look at me like- yeah right!".

It was also mentioned that partners end up increasing their food intakes at family gatherings to eat the leftovers to avoid comments from others.

"My hubby's put on like 5 kilos, the doctor goes stop eating your wife's food".

It was commonly mentioned that participants felt judged by their friends and families for having the surgery. It was also mentioned family/friends who did not know of the surgery had thought they had become sick with cancer or were on drugs.

"The only one that has been negative to be honest would be my father. He's like you can do better, you can do better. And I'm like – dude. I have lost 90kg and you are telling me I can do better? And he's like – yeah, go down to what you were when you were 18. I am 55 now".

The majority of the participants (n=24) were a part of the bariatric Facebook support groups, however, within the focus groups there were mixed reviews on whether they found this helpful. Some participants stated that the Facebook pages provided false medical information from others who have had the surgery, with a lack of a health

professional monitoring the group or the accuracy of the information shared. A few participants also mentioned that it was hard to view the success of others on this page whilst they felt like they were struggling. In contrast, others found the page helpful as a motivator to maintain weight.

"I follow bariatric groups, but sometimes I got a bit frustrated and I had to back away because when you are struggling and everyone's like, "La la la lah" it's a bit difficult at times";

"I found the Bariatric Facebook pages quite good to see, especially at the very beginning with peoples progress and stuff. That really gave me something to aim for".

The 18-month group session was discussed in all six focus groups, with every participant stating they found the group setting extremely helpful. The main reasons participants found the group session helpful were due to a sense of not being alone and gaining a sense of understanding through other's journeys. Participants also mentioned gaining valuable ideas off others, whether this was diet, mindset, or exercise related.

"it was nice to know that someone else was going through the same kind of thing and to get ideas off other people you know that's really valuable";

"I just think the group thing reinforces everything and sort of tops you up again cause when you're on your own It's very easy to fall off the wagon";

"I'm gaining and losing, gaining and losing and I don't know what it is I might be just because I'm always at the gym, always, but I'm not, I don't have any reward at the end of it. So, I'm sort of..... you know sort of giving up I thought it was really good that you heard that people were struggling the same as you. That made you feel normal because you think it's only you that's scared of putting on the weight again or feels guilty and stuff like that. But to hear that everybody else did, it was just great".

3.4 Discussion

The purpose of the bariatric weight management project was to evaluate the value of the addition of a nutrition group education session at 18-months post-surgery. We investigated the participant's change in quality of life, eating behaviours, dietary intake, weight and body composition measures as well as qualitatively investigating the patient's perspectives on barriers and enablers to maintaining weight post-surgery.

No change in weight or body composition measures

In this study the mean weight (kg), BMI (kg/m²), fat mass (kg), and percentage body fat increased at 21-months compared to 18-months post-surgery, however these changes were not significant. Furthermore, in the qualitative analysis, participants (n=11) reported weight regain beginning to occur at 21-months post-surgery with all participants saying they feared weight regain. It is well known that weight increases alongside increased time post-surgery for many bariatric patients, once major physiological and metabolic adaptations have occurred, and extreme weight loss begins to plateau around 12-months post-surgery (Odom et al., 2010). A study including 782 bariatric-surgery participants concluded that weight regain begins to occur two to five years post-surgery, with 50% of participants experiencing a mean 8% weight increase (from the lowest point at 18-months post-surgery) 24-months post-surgery (Magro et al., 2008). Similarly, in this study, between 18 and 21-months, 19 (67%) of the participants gained weight, with three (10.7%) participants gaining ≥ 5 kg, a 5.5% mean increase from 18-months post-surgery.

The increasing trends in body composition measures, specifically weight, over this three-month time period do show concern for future weight regain in this participant group. Similar to our study participants, previous findings conclude discharge from care usually occurs between 12 to 18-months post-surgery (Engström & Forsberg, 2011; Groven & Glenn, 2016; Jones et al., 2016; Lauti et al., 2016b). However, a common theme in this study was the need for longer follow-up, with participants stating that the time they were discharged was the time they felt they needed the most support. This is

supported by previous studies, which found participants desired more care at this time as they were struggling to maintain weight and adhere to dietary advice (Jones et al., 2016; Lauti et al., 2016b).

Increased Quality of life at 12 vs 18 and 21-months

In this study, all participants had a 'good' MQoL score post-surgery (0.95 and 0.99 at 18 and 21-months post-surgery, respectively). Morbid obesity and associated co-morbidities are found to have a negative impact on quality of life, therefore improved quality of life has become one of the main aims of bariatric surgery (Le Foll, Lechaux, Rascle, & Cabagno, 2019; Major et al., 2015). Quality of life has also been shown to significantly improve post-surgery in previous research, with participants reporting 'good' and 'very good' qualities of life when assessed with MQoL, compared to the highest proportion of participants reporting 'medium' qualities of life pre-surgery (Major et al., 2015). It is well evidenced that bariatric surgery results in reduction of obesity associated co-morbidities, particularly Type 2 Diabetes Mellitus (27% to 75% for SG) (Wolfe, Kvach, & Eckel, 2016). In the focus group discussions participants reported reversal of type two diabetes, sleep apnoea, as well as improved blood pressure and blood lipid profiles. The majority of participants also mentioned a subsequent decrease in medication use, thereby improving their overall health-related quality of life. Additionally, all participants in this study reported improved functional ability, for example, now being able to walk to the letter box which they could not previously achieve. This resulted in increased participation in intentional daily physical activities such as going to the gym, running and walking, for many participants which further improved their quality of life. This finding is supported by Ryder and co-workers who found that participant's post-bariatric surgery experience significantly improve functional abilities which then resulted in a trend toward increased physical activity levels (Ryder et al., 2016). Decreased functional ability is a severe consequence of morbid obesity, experienced in the forms of severe knee and back pain, with increased severity individuals may become walker dependent, wheel chair bound or become bed ridden (Ryder et al., 2016). Hence, resolution of these symptoms significantly enhancing qualities of life.

However, quality of life was significantly higher at 12 months compared to 18- and 21-months post-surgery in this study (1.91, 0.95, 0.99, respectively, $p= 0.002$). These findings were similar to findings by Le Foll et al., (2019) in a two-year longitudinal study which found that average quality of life increased between three- and fifteen-months post-surgery but then decreased between 15 and 24-months post-surgery. Often, participants reported a plateau in weight loss and/or weight regain during this time period, which was often the reason for decreased quality of life (Le Foll et al., 2019).

The thematic analysis of the focus groups conducted during this research showed that improved quality of life in the first-year post-surgery was related to increased energy levels, improved and/or resolved obesity-related comorbidities, reduction in medications, improved functional ability and overall increased levels of confidence. Participants identified the first-year post-surgery being the honeymoon period where weight loss was easy, but as time increased post-surgery, it was harder to maintain the weight loss. At 18 and 21-months post-surgery participants reported finding old habits sneaking in and an emerging fear of weight regain. Participants also reported being able to eat more foods as time progressed, particularly the less nutrient-dense, discretionary foods. They all felt they were still struggling with problematic eating behaviours which impacted on feelings of decreased quality of life. These findings further highlight the importance of continued care at this time, due to it being the first critical period of weight regain occurrence and potential for a decrease in self-perceived quality of life.

Dietary intakes

We observed no changes in energy, macro or micronutrient intakes between 18 and 21-months post-surgery. Participants were meeting the mid-range AMDR for protein requirements, however, carbohydrate intakes were about 10% below the AMDR, and fat intakes slightly exceeded the AMDR recommendations. Bariatric patients are advised that protein should form the main component of the meal, due to the high risk of protein energy malnutrition; intakes should be 60-80g/day and protein and leucine rich foods should be consumed over high fat/carbohydrate foods to preserve muscle mass (Elliot, 2003; Sherf Dagan et al., 2017b). The results from this study were in favour of the

recommendations, as protein intakes exceeded 60g at both timeframes, with a mean of 71g and 69.7g consumed at 18 and 21-months post-surgery, respectively. These findings imply this participant group should not experience protein malnutrition or associated muscle loss.

Percentage mean fat intakes among the participants were 36.4 and 36.9 of total energy intake at 18 and 21-months post-surgery, respectively. Similarly, the long-term Swedish Obese Subjects trial (n=2010) demonstrated an increase in percentage fat intake (36.6% of total energy intakes) in bariatric participants, compared with control groups (34.2% total energy intakes), which increased with longer post-surgical periods (Lissner, Lindroos, & Sjöström, 1998; Sjöstrom, 2013). Thus, increased risk of weight regain is a concern within this participant group, with previous evidence suggesting a relationship between weight regain and fat intakes contributing to 37% of total energy intakes. Those who favoured protein intakes (20-30% of total energy) over carbohydrate and fat had higher weight loss outcomes (17.7% total weight loss, compared to 14.7% in those who favoured other macronutrients over protein)(Kanerva, Larsson, Peltonen, Lindroos, & Carlsson, 2017). Therefore, lower fat intakes (<35% total energy intakes) are generally recommended post-surgery for bariatric patients, due to greater weight loss outcomes (Sjöstrom, 2013).

Participant's vitamin B₁₂ intakes met the estimated average requirement and/or adequate intake recommendations, however, calcium and vitamin D intakes were inadequate for all, and iron intakes were adequate for men but inadequate for women. Iron and B₁₂ are reported to be the most common nutrient deficiencies post-surgery in previous studies (experienced by 44% and 25% of participants respectively) (Harbottle, 2011). Vitamin D is also a common micronutrient deficiency experienced by 10.2% of participants post-surgery (Harbottle, 2011). Within the CM Health bariatric program, all participants are recommended to take the a multivitamin supplement daily, which provides 18mg of iron, 200mg of calcium, and 25mcg of vitamin D₃ (Centrum, 2020). It is therefore likely that participants would be meeting their micronutrient requirements if they are compliant with taking the supplements. However, the dietary results highlight the importance of micronutrient supplementation in order to prevent key nutritional deficiencies, particularly with decreased opportunity to consume nutrients from food due to reduced gastric capacity in bariatric patients, as well as increased

malabsorption in those who underwent the gastric bypass procedure. Although this study did not address supplement compliance, previous research found that 42% of post-surgery bariatric participants struggled to take their multivitamin supplements with forgetting, side effects, unpleasant taste and flavour being the main barriers identified to taking supplements (Zheng, 2014). Thus, these findings highlight the importance of nutrition guidance to achieve micronutrient intakes post-surgery. We further explored dietary diversity and observed a significant increase in foods consumed from the flesh foods groups at 21 months compared to 18 months post-surgery (2.50 items, 7.00 items, respectively, $p = 0.000$). This increase in flesh foods is also beneficial in prevention of protein malnutrition and muscle preservation for this participant group. One key discussion point in the focus groups was the importance of protein intake for prevention of muscle wasting and hair loss as well as increased satiety benefits. Therefore, these changes may or may not be as a result of the additional dietitian-led nutrition education provided at the 18-month group session. Similarly, previous research evaluated a group of participants who had two or more nutrition counselling sessions with a registered dietitian, compared to those who didn't. The participants who had more education provided by a dietitian had improved dietary quality, and significantly more weight loss than the group who did not (Rachal, Pope, Kim, & Erickson, 2015).

Problematic eating behaviours

In this study, cognitive restraint, uncontrolled eating and emotional eating scores did not change between 18 and 21 months post-surgery. However, 17 (60%) participants were classified as having low cognitive restraint, 22 (78%) of participants were uncontrolled eaters and 9 (32%) participants were emotional eaters, all of which are problematic eating behaviours favouring weight gain. Furthermore, participants with problematic eating behaviours were likely to have more than one of the behaviours present, increasing the risk of weight regain. The thematic analysis displayed participants in this study struggling with problematic eating behaviours, specifically binge eating, emotional eating and increased snacking behaviours. It is well known that problematic eating behaviours are commonly experienced by bariatric patients across the literature, and are a contributing factor to long term weight regain post-surgery (E.

Conceição, Bastos, et al., 2014; Matherne et al., 2015; Mitchell et al., 2015; Tanofsky-Kraff et al., 2013).

Furthermore, when exploring the dietary diversity and food variety of participants, we observed an increase in the savoury snack items consumed at 21 months compared to 18 months post-surgery (1.50 items, 2.00 items, respectively, $p=0.026$). There is sufficient evidence in the literature, finding snacking behaviour is commonly seen post-surgery, with 60% of participants becoming 'grazers' one year post-surgery, and 94% of pre-operative grazers continuing this behaviour post-surgery (Colles et al., 2008).

Evidence across the literature shows bariatric patients often shift their eating behaviours from bingeing to grazing due to reduced stomach capacity (Blacke, 2019; E. Conceição, Bastos, et al., 2014). Consequently, these behaviours post-surgery are associated with weight regain (Colles et al., 2008). Similarly to previous findings, in the qualitative analysis of this study, participants also reported that they are no longer physiologically able to binge on large amounts of food, and therefore admit to increasingly snacking on smaller amounts of foods throughout the day. Furthermore, participants in this study report struggling with "mind games" in regards to their eating behaviour and that problematic eating behaviours were still prevalent for most of them post-surgery. Interestingly, a theme reported by participants was increased awareness of responsible eating in front of others, with a new fear of judgement around food intake and others thinking they 'had failed surgery'. This resulted in participants eating less nutritious foods when no one else was around, and then hiding the 'evidence'.

Another key finding in this study was a significant increase in the discretionary FVS at 21-months compared to 18-months post-surgery, therefore indicating that participants tended to eat increased amounts of non-nutritious foods with increased time post-surgery. A reduction in food intolerances, problematic eating behaviours, dehydration and preference for non-nutritious foods may all be reasons for this increase in discretionary FVS. Food related phobias develop in many patients post bariatric surgery, especially in response to experiencing Dumping Syndrome, which often decreases food variety (Sherf Dagan et al., 2017a). Increases in food variety are shown to increase with increased time post-surgery in previous research, commonly related to reductions in food intolerances (Boerlage, van de Laar, Westerlaken, Gerdes, & Brandjes, 2017). In this study post-surgical food intolerances were experienced by a few participants ($n=12$), resulting in nausea and/or vomiting episodes. Food intolerance

symptoms created fear of trying new foods and resulted in participants limiting their dietary intakes to foods they knew would not cause symptoms. However, participants often expressed feelings of boredom with their diet as a result. They reported finding it easier to eat non-nutritious foods (discretionary), for example ice cream and chocolate, as they just 'slide down' in comparison to nutritious foods. Furthermore, dehydration was a frequent symptom experienced by participants which often resulted in constipation, therefore participants often found discretionary foods easier to eat due to many having increased moisture contents.

Barriers and enablers to preventing future weight regain

Barriers and enablers to preventing future weight regain were investigated in the participant focus group discussions. The two key factors reported by participants as enablers for preventing future weight regain were participation in regular physical activity and following a healthy diet. This is in alignment with previous research reporting that adhering to daily physical activity, self-monitoring weight and following required dietary modifications (for example eating smaller regular meals, avoiding fast foods, and limiting intake of non-nutritious foods and reducing fat intakes) were adequate strategies in preventing weight regain (Westerveld & Yang, 2016).

In contrast, the major barriers to following a healthy lifestyle reported by participants were: financial stress particularly in relation to the cost of nutritious foods, time limitations; mostly due to full time working hours, and the influence of society, culture and social gatherings often being centred around food and expectations regarding participation. Results from this study were similar to previous research which identified financial factors as a major barrier to preventing weight regain (Westerveld & Yang, 2016). Increased support from both health professionals, friends and family were strong enablers discussed among participants in this study. Participants expressed the need for positive support around them, saying they needed others to believe in them, for them to be able to believe in themselves. Previous research supports these findings, where increased social support has been associated with greater weight loss outcomes and/or maintenance post-surgery (E. M. Conceição et al., 2019).

Evidence suggests bariatric participants are often reluctant to disclose their weight loss method with others in social situations, sometimes even with close relatives and/or

friends due to fear of criticism and judgment (Graham, Hayes, Small, Mahawar, & Ling, 2017). In this study, a strong theme was non-disclosure of bariatric surgery due to the fear of judgement or public comments. Some participants discussed loss of friendships throughout their bariatric journey due to judgement and criticism related to their new dietary behaviours, for example, newly developed food intolerances to high fat meals eaten at cultural celebrations.

Additionally, increased access to health care professionals and a longer follow-up period was desired by all participants in this group. All participants found the 18 month group education session to be extremely helpful; saying it decreased feelings of loneliness, and was an extremely valuable way to gain ideas and a sense of support from others who were on the same journey. Participants also mentioned other helpful components of the 18-month group session which included: an opportunity to ask diet-related questions, gathering new meal ideas off others, as well as the dietitian-provided mindful eating advice. Support group meetings appear to be integral to weight loss success following bariatric surgery and in participants who attend support groups compared to those who did not attend improved weight loss outcomes are achieved (55.5 %EWL, 47.1 %EWL respectively) (Orth et al., 2008). It is suggested that support groups should be run by either the surgeon, nurse practitioner or dietitian as an opportunity to continue patient education (Orth et al., 2008). Previous research concludes that poor attendance to clinical appointments is an issue in bariatric patients (Vidal et al., 2014), therefore, designing appointments around patient centred feedback, is likely to result in increased attendance.

To conclude, it is clear that weight regain is a post-surgical problem in bariatric participants, which has severe physiological and psychological implications for the individual. Bariatric surgery results in increased quality of life, however as post-surgical time increases, old behaviours can tend to reappear, and the risk of weight regain increases which may adversely impact quality of life. This study highlights factors which may contribute to weight regain post-surgery including; poor dietary quality, problematic eating behaviours, lack of support from health professionals and/or family and friends, financial stress, time limitations, the influence of a social/cultural food environment and time restrictions. All participants were aware that adhering to dietary

and physical activity guidelines were enablers to prevent weight regain post-surgery, however, they expressed a need for increased support to achieve this. The addition of the group education session was perceived as an extremely valuable way of increasing support for these participants throughout their journey. Providing education around diet, nutrition and eating behaviours can improve dietary and eating behaviours and help patients meet improved and sustainable weight related outcomes.

Chapter 4. Discussion and conclusions

4.1 Overview and conclusions

The aim of this study was to assess the impact of a structured eating behaviour group education programme on food intake and eating behaviours that may contribute to weight regain in post bariatric surgery patients at CM Health.

The first objective was to assess changes in weight and body composition pre and post group education. To do this, a bioelectrical impedance machine was used to measure participants weight, fat mass, fat free mass, muscle mass and basal metabolic rate at both 18 and 21-months post-surgery. Height was also measured, which meant body mass index could be calculated. We observed no significant changes in weight or body composition measures between 18- and 21-months post-surgery. However, between 18 and 21-months 19 (67%) of the participants gained weight, with three (10.7%) participants gaining ≥ 5 kg, a 5.5% mean increase from 18-months post-surgery. Additionally, there were increasing trends in all body composition measures between the two time points. Furthermore, the thematic analysis revealed 11 participants beginning to regain weight at 21-months post-surgery in the focus groups, with all participants saying they feared weight regain. These findings are consistent with previous literature which suggests weight regain is commonly experienced in bariatric patients (50%), with weight regain beginning after the first-year post-surgery (Magro et al., 2008).

The second objective was to investigate changes in quality of life pre and post group education, using the Moorehead-Quality of life questionnaire, which has been validated for use within obese bariatric surgery patients (Beechy et al., 2012). Quality of life data was electronically captured at 12, 18 and 21-months post-surgery. This data was investigated to determine whether the eating behaviour group education programme resulted in increased quality of life. We observed no significant changes in quality of life outcomes between 18- and 21-months post-surgery, however, compared to 12-months post-surgery, quality of life was significantly lower at 18 and 21-months post-surgery.

This finding was similar to findings previously described in literature, where qualities of life are commonly shown to increase in the first year post surgery (Le Foll et al., 2019; Major et al., 2015). Qualitative investigation, in this study, showed that extreme weight loss resulted in reduction of obesity associated comorbidities and a subsequent decrease in medications, as well as improved functional abilities. These improvements to health were likely the reasons for increased quality of life. Improved health outcomes allowed participants to return to work, run around with children and/or grandchildren, as well as having overall increased energy levels, hence, resulting in improved quality of life outcomes. Similarly to other research, the results from this study also showed a decline in quality of life at 18-months post-surgery (Le Foll et al., 2019), where participants started to notice that they were regaining weight, and/or fears of weight regain which was a reason for lower qualities of life.

The third objective was to assess food intake changes pre and post group education. Changes in food intake were investigated firstly with a three-day weighed food record (WFR), and secondly, with the use of the dietary diversity questionnaire (DDQ). The WFR was used to assess energy and nutrient intakes, specifically, total energy, protein, carbohydrate, and fat, as well as calcium, iron, vitamin B12, and vitamin D, which are identified as the most at-risk nutrients in bariatric patients (Padmini Shankar, Mallory Boylan, & Krishnan Sriram, 2010). We observed no significant changes in macronutrient or micronutrient intakes between 18 and 21-months post-surgery based on the WFR. However, the WFR analysis identified that participants were achieving the Recommended Daily Intakes (based on the Acceptable Macronutrient Distribution Ranges) for protein intake, but not for carbohydrate, and that fat intakes exceeded the AMDR at both time points. In terms of micronutrient intakes, participants were meeting the EAR's for vitamin B12, and iron intakes were adequate for men but not for women. Vitamin D and calcium intakes were inadequate for both men and women at 18 and 21-months post-surgery. However, micronutrient intakes did not include the contribution of the prescribed daily multivitamin supplement. The DDQ provided insight into the dietary diversity and food variety of the participant's diet over a seven day time period which were inclusive of the WFR. We observed no changes in overall dietary diversity, or by disaggregation to nutritious and discretionary food group scores between 18 and 21- months post-surgery. In previous research, participants commonly experienced

new food intolerances post-surgery, however, evidence shows that food intolerances tend to reduce with increased time post-surgery as physiological adaptations resolve (Boerlage et al., 2017). In this study, we observed a significant increase in both the overall food variety score (FVS) and the discretionary FVS at 21-months compared to 18 months post-surgery, perhaps due to participants finding it easier to eat non-nutritious foods as it did not have so many side-effects. Furthermore, participants increased their food variety in the flesh food, sauces, spreads and flavourings, and savoury snack groups at 21-months post-surgery. This may also be due to a reduction in food intolerances with increased time post-surgery.

The fourth objective was to investigate eating behaviour changes pre and post group education using the TFEQ-18. We did not observe any changes in cognitive restraint, uncontrolled eating or emotional eating between 18 and 21-months post-surgery. However, low cognitive restraint was experienced by 17 (60%) participants, 22 (78%) of participants were uncontrolled eaters and 9 (32%) participants were emotional eaters. Of these participants, most experienced more than one of the problematic eating behaviour's listed above. These findings are consistent with previous research showing problematic eating behaviours affect 30% of bariatric patients post-surgery (Brode & Mitchell, 2019). These results are concerning as they are likely to result in excess calorie consumption and therefore weight regain. Previously, weight regain post-surgery was associated with disordered eating behaviour or habits (disinhibited eating, tendency to overeat, and other unsuitable eating behaviours) in 75% of studies investigated in a systematic review (Kaouk et al., 2019). These findings were also further supported by qualitative analysis in this study, all participants struggled with their own versions of problematic eating behaviour, such as emotional eating and snacking behaviours, especially since 12-months post-surgery. A key change in this study was an increase in savoury snacks consumed at the 21-months stage, mostly due to their new physiological restrictions for eating large amounts of foods. However, many participants compensated by switching from binge eating disorder to regular snacking behaviour (Blacke, 2019). All participants expressed the desire for psychological support in terms of dealing with the mind games around these eating behaviours. (Luca et al., 2002).

The fifth objective was to explore barriers and enablers related to weight management, this was captured with using qualitative methodology, conducting a focus group at 21-months post-surgery. All participants expressed the desire for psychological support in terms of dealing with the mind games around these eating behaviours. (Luca et al., 2002). Financial stress, increased cost of healthy foods, lack of time, lack of support whether from medical professionals, friends or family, and socialising in general were key barriers to preventing future weight regain. These barriers are commonly reported in other literature, particularly support, where lower quality of life and weight outcomes were associated with lower levels of patient support (Chesler, 2012; de Zwaan et al., 2015; Luca et al., 2002).

In conclusion, although we did not observe any significant changes to weight or other body composition measures between 18 and 21-months post-surgery, a trend of some weight gain for some participants was evident from 12 to 21-months. Significant changes were however demonstrated for reduced quality of life, increased snacking and discretionary FVS, between 18 and 21-months, emphasising the importance and need for support, especially after the extreme weight loss in the first year post-surgery. Lack of support from the medical team was expressed by participants throughout this study, specifically in terms of requiring more support when weight regain began to occur, and stating that the time of discharge was when they felt as though they needed the most support. All participants expressed high levels of gratification for the 18-month group session, due to both increased education from the dietitian in regards to dealing with problematic eating behaviours, but more so, being able to connect with others on the same journey. The group session provided a sense of “not being alone” for the participants, as well as a valuable way to gain ideas and inspiration from others who knew what they were going through. The participants clarified ways in which more support could be provided by the bariatric team throughout their journeys, and these recommendations are summarised in table 4.1 below. Overall, these results demonstrate the need for increased support for patients post-surgery and a need for increased follow-up time. The additional education session that CM Health has added 18-months post-surgery was incredibly valuable for the participants in this study and should be continued.

4.2 Strengths of this research

Strengths of this research include having a mixed-methods approach, using both a quantitative and qualitative methodologies; the qualitative enquiry provided rich data to supplement the quantitative results, where minimal change was evident due to a small sample size. Additionally, the qualitative analyses was a strength of the research as it produced a set of viable patient centred suggested recommendations to improve the bariatric programme, which will be presented to CM Health. Having continuity of care was an additional strength, as it strengthened relationships with participants, therefore allowing an environment where participants felt they could openly share their opinions and journeys through the bariatric program.

4.3 Limitations of this research

A limitation of this research was the smaller sample number (overall n=41, participants lost to follow up at 21-months post-surgery n=13) firstly due to the number of participants lost to follow up at the 21-month group, and secondly, due to the inability to recruit the desired number of participants throughout the study timeframe. Additionally, introducing the follow-up session at 21-months post-surgery, just three months after the first group was a limitation. As the literature suggests weight regain mainly begins to occur from 24-months post-surgery, having a longer time period in between may have produced more significant changes. Finally, not having a control group was a limitation of this research as it would have been beneficial to compare outcomes from those who participated in the nutrition education group, to those who didn't.

4.4 Recommendations for future research

Although there were no significant changes in weight and other body composition measures in this study, there was an increasing trend in weight and body composition measures between the two time periods. A future study with an increased participant numbers over a longer timeframe would be extremely valuable. Additionally, having an increased length of time between the two time periods being assessed, would be beneficial. To really understand if the group education session improves weight outcomes in those post-surgery, it would be beneficial to have a control group, thereby

even if participants do regain weight which is commonplace post-surgery in bariatric patients, it would be useful to investigate weight differences between the two groups. Finally, including micronutrient supplementation compliance would further determine the likelihood of nutrient deficiencies in this population group, which should be supported by biochemical testing (collecting blood samples).

Table 4.1 Recommendations for CM Health to improve the bariatric program based on the focus group discussions.

Recommendation	Proposed 'how to' ideas	Reasons and rationale
Provide a meal plan post-surgery.	<ul style="list-style-type: none"> - Bariatric related meal plan after surgery - Cook book with suggested recipes for bariatric patients 	<p><i>"Diet was on what you eat and how you did it, but it's not anything that was given to us to actually follow a proper diet plan"</i></p> <p><i>"It would have been nice to have a bit more. Like, I would email Sarah, the other dietician that was here, and she would always message me back which was good if I was struggling.</i></p> <p><i>But I think for me, I wanted ... I am better if someone tells me you should do it like this, rather than me focusing on trying to think what should I do."</i></p> <p><i>"I think maybe that would have been helpful before surgery as well. I know we did talk about it a couple of times about what are you eating and suggestions and things like that, but I think sometimes it is much better to have a proper meal plan to follow"</i></p> <p><i>"Sometimes I get home and just think what on earth can I cook or eat"</i></p> <p><i>"I have been googling heaps about bariatric meals thinking that they would be really good to follow. But one thing I am finding is that a lot of them are still so high in carbs"</i></p>
Addition of a psychologist to the team for support post-surgery.	<ul style="list-style-type: none"> - Pre and post-surgery but especially one year post surgery when the weight regain begins to happen again 	<p><i>"There is no counselling, I paid for my own."</i></p> <p><i>"when people regain they don't ask for help when they need it, and when they have asked for help it is there momentarily and then it's gone but I need it continually"</i></p> <p><i>"Definitely in my opinion there is not enough mental support, I am really struggling"</i></p> <p><i>"Just the mental help. There's none. There's none unless you go private and I can't afford that.</i></p> <p><i>But there ... I can appreciate that the surgery is expensive and I get all of</i></p>

		<p><i>that and I am blessed and grateful, but you really ... sorry, I won't speak for everyone, but for me I really was just... I felt like I was just dropped"</i></p> <p><i>"I am most grateful and have no regrets or anything like that, but losing the weight is for me only a very small part of it and now I have flipped the page and now I have got other secondary problems that have come along with it and they are not the best."</i></p>
<p>More group appointments.</p>	<ul style="list-style-type: none"> - Similar to cardiac rehab group; once per month. Half the session being a patient expert, half being a health care professional e.g. dietitian, surgeon, nurse. - Having allocated time for patients to be able to ask their own questions, which all others in the room will be able to learn from - Pre and post-surgery groups with around 10 participants - Put emails out to patients prior to the group session asking what they are struggling with and then the health professional centres their part of the talk around this issue e.g. snacking 	<p><i>"It was nice to know that someone else was going through the same kind of thing and to get ideas off other people you know that's really valuable"</i></p> <p><i>"I actually enjoyed the group session and hearing what other people were eating and they were struggling with maybe steaks and other people could eat bread and other people couldn't. It was quite interesting to realise that everybody was on a very different journey personally, but in some way it all kind of made sense as a group, what we were going through"</i></p> <p><i>"I prefer groups so that everyone can see what is happening with everyone else in the same boat."</i></p> <p><i>"No, for example going back to that, we do a combination. The first half of – we call them a meeting – is where we have either a heart surgeon or a dietician or someone to do with the monitors and they come and talk for 20 minutes, half an hour. And then it is open question time and we can ask them something. And then it is open forum and we can all ask each other questions."</i></p> <p><i>"Half the time – people don't want to go to places because someone is just sitting there talking"</i></p>
<p>Mentoring from previous bariatric surgery</p>	<ul style="list-style-type: none"> - Having someone to present to patients before surgery who 	<p><i>"Someone to really tell you what you're in for"</i></p>

<p>patient pre and post-surgery.</p>	<p>has been through the journey and can really say what it's like.</p> <ul style="list-style-type: none"> - Two people to be able to talk to post bariatric surgery; one who had a great experience and one who had a negative experience. 	<p><i>"I think it would be really good to have a couple of people that have been through the surgery to speak to you at the beginning"</i></p> <p><i>"I think it would be really good to have a couple of people that have been through the surgery to speak to you at the beginning. I think that would be great if you had someone that had a really good time of it, like I have no problems or anything. I can't eat some stuff, but big deal. And then someone that's had a really crap time just so people know. Everybody's different and what you can expect, because some people think they're going to look like a supermodel and they're not going to have any excess skin or that and they're really disappointed, but they've got to be realistic"</i></p>
<p>Increased number of appointments with the dieitian.</p>	<ul style="list-style-type: none"> - Patient centred approach - Six monthly follow ups for five years - Increased appointments / help in diet progression stages 	<p><i>"You go to the dietitian and things like that but I found the dietitians weren't really hearing what I was saying. It was very broad information"</i></p> <p><i>"I would have liked really more help when I went in to go and see the dietitians as I progressed and was eating normally again... and it's quite difficult because when you're looking and speaking to a whole lot of other bariatric patients, every surgeon and doctors and things are different. Some insist you should be eating five meals a day. Some insist you should be eating three meals a day"</i></p>
<p>Education about benefits, and side effects of medications and nutritional supplements.</p>	<ul style="list-style-type: none"> - A detailed list of common medications which cause weight gain and increased appetite. 	<p><i>"when I was on Zopiclone, I was unconsciously snacking"</i></p> <p><i>"That exact medication is the one that I found myself waking up and there were banana skins by my bed. I am single and I am by myself in my house, so there is nobody else. And I was like – okay. And then I went to the doctor and they said this is an effect of what your pills do"</i></p>

<p>Health professional monitored Bariatric Facebook group for patients.</p>	<ul style="list-style-type: none"> - A group Facebook page for Bariatric patients to support each other but that is monitored by health professionals who can provide and monitor input to medical questions 	<p><i>"People are saying you can't do this and you can't do that; well, everybody is different and what you can tolerate and what you can't tolerate. Like, one girl has hurt herself and everyone says you need to take Brufen ... oh no, you are not allowed to take it."</i></p> <p><i>"I found the Bariatric Facebook pages quite good to see, especially at the very beginning with peoples progress and stuff. That really gave me something to aim for"</i></p>
<p>Emphasis on weight changes rather than BMI.</p>	<ul style="list-style-type: none"> - Refraining from telling patients what BMI category they are in. 	<p><i>"Where you go and weigh yourself and there is a chart on the wall. I try not to weigh myself because it becomes an obsession; it was becoming an obsession. I can put on 5kg in a week, easy and lose it the next. I don't understand it and I don't try to. But I am still obese. And either that chart needs to come down or there needs to be more information around that chart because that's nasty. That's really nasty because I can't do any more than what I am doing. And whether it needs to be a BMI thing, I don't know. But yeah, I am still obese"</i></p>
<p>Guidelines and tips on how to deal with social situations.</p>	<ul style="list-style-type: none"> - A work book on how to deal with eating in social occasions - What to order when out at restaurants - 'safe foods' to order if travelling overseas. 	<p><i>"Lots of my life revolved around consuming food and sharing food and family gatherings and all of that. And all of a sudden, I felt isolated and so at the start I didn't expect that I didn't know that that was even going to be a thing."</i></p> <p><i>"A workbook, regardless of whether it's a cultural thing or whether it's just socialising. Just getting on with life afterwards in the social arena. How are you going to deal with that?"</i></p>
<p>Developing an inpatient meal code for bariatric patients post-surgery.</p>	<ul style="list-style-type: none"> - Ensure only food suitable for post bariatric surgery is delivered 	<p><i>"The meals straight after surgery. They brought out a huge meal and nobody told us that you were supposed to eat it all or what are we supposed to</i></p>

	- Increased education about what to do instantly after surgery	<i>have straight after. It was quite a large tray of food"</i>
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4.5 Conflicts of interest

None.

4.6 References

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Appendix A: Nutritional barriers and enablers questionnaire

Bariatric Weight Management Project

1. What factors do you believe are important to achieve long term weight maintenance?
2. In your opinion what causes weight re-gain after bariatric surgery?
3. On a scale of 1-10 how confident do you feel in keeping the weight off in the long term? With 10 feeling very confident and 0 not confident.
4. On a scale of 1-10 how important is it to you to keep your weight maintained?

Appendix B: Focus group questions

Focus group questions:

1. How do you feel about your journey through the bariatric programme?
 - Ask everyone
 - Probes – weight, social, life, eating
2. Do you think you are following a healthy lifestyle at the moment?
 - Why / please explain what you are doing
 - What helps you to do that (make healthy lifestyle choices (in relation to food and exercise)?
2. What are your barriers to making healthy lifestyle choices?
Why?
3. Do you currently think there is any dietary/lifestyle advice missing from the bariatric program? (clarify what you mean)
 - a. And what is this?
4. Did you find the additional 18 month session to be beneficial / valuable?
 - What information/tips have you been able to use from the 18 month group session?
 - why?
 - Has anything stopped you from using the information/tips?
 - why?
4. Are there any other discussion points/topics that you would like to be added to the 18 month group session?
 - why would you like to know about that?
 - emotional eating, nutrition/dietary help, symptom management
6. What do you think would help you to keep the weight off in the long term?
 - explain
 - is there anything else we can do to further support you (to keep the weight off in the long term?
7. Have you had a change in your mind-set about your weight from pre to post surgery (for keeping your weight stable)? Mind-set- your thought process, thoughts that go through your mind e.g. negative/positive thoughts.

-Why and what had made the change happen for you.

Is there anything the bariatric team (nurse, Dietitian, surgeon) could do to help you with this (offer to help prepare your mind-set for surgery?)

9. Did you use anything other than what was provided by the bariatric team to support you through the process?

Types

What

Did they help or not?

Were there anything that you think you would have liked, resources that self-help resources e.g support groups, websites, recipe ideas etc have you used to help support you through bariatric surgery (pre and post-op

Appendix C: Mindful eating script for education session

Mindful eating exercise script:

We would ask you to approach the exercise with an open mind. There are no rights or wrongs, just your individual experience.

1. Please place the chocolate into the palm of your hand. Now look at the chocolate, consider its texture, colour, and weight in your hand
2. Could you please now lift the chocolate to your nose and take note of the smell - does the smell trigger any other senses? Can you feel your mouth water with anticipation?
3. Now please take a bite of the chocolate but do not eat it. Simply hold it in your mouth. Could you please now close your eyes.
4. Notice how the chocolate feels as it begins to melt away in your mouth?
5. Where in your mouth can you taste it?
6. What is the consistency of the chocolate now?
7. What is happening with your mouth, teeth, tongue, lips as it melts?
8. Move the chocolate around your mouth
9. Does the area of taste change?
10. Does the taste itself change?
11. How do you feel?
12. Now could you please swallow the chocolate, and focus on the sensation it creates.
13. Is there any lingering taste?

Take another bite. Repeat those thoughts and notice the feelings you experience as you finish your piece of chocolate.

How to apply mindful eating daily:

Eating is a really big part of our daily lives. Often, we eat when we are distracted or in a rush. One moment, our plates are full, and in the next, completely empty. We can find ourselves hardly even tasting our food or consciously enjoying it. Mindful eating focuses on how to eat rather than what to eat.

By using some mindful eating throughout the day we can become more aware of what we eat, enjoy and improve our relationship with food.

Including mindful eating into our daily lives can seem challenging but here are a few simple tips to help you get started.

First off, make the commitment to yourself. Set aside only a few minutes each day to practice mindful eating. Start with committing to eating one meal or snack mindfully each day and then increase the amount of meals or snacks every week or two until you find yourself practicing mindful eating for every meal and snack.

Make a simple food choice: when first choosing a meal or snack to eat mindfully, begin with a small amount of one type of food. Choose a food that is not a trigger for you to over eat, for example a few grapes or some pieces of banana. As you practice mindful eating, you can progress to some more foods you may find more challenging such as biscuits or sweets.

Give your full attention to eating. Allow all your senses to become aware when you are eating. Include sight, smell, touch, and feeling into your eating experience, as we just did in our exercise previously.

Be mindful of your thoughts and feelings during your eating experience. If your mind begins to wonder, that is fine, acknowledge those thoughts and then bring your attention back to eating. By bringing our body and mind together, we are empowering ourselves. It helps us to see that we have a choice in our eating. We can actually taste and experience what we're eating, or we can eat unskillfully and miss the whole experience entirely.

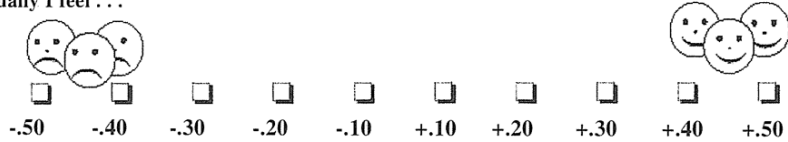
Appendix D: Moore-Head Ardel quality of life questionnaire

Moorehead et al

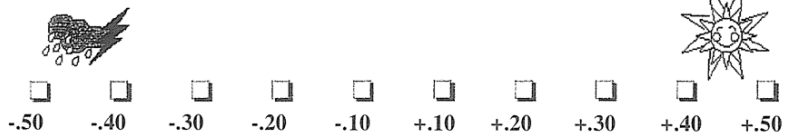
Appendix 2. The M-A QoLQII scoring key.

Self Esteem and Activity Levels SCORING KEY

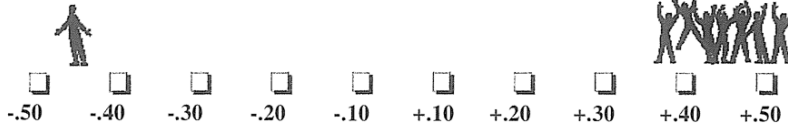
1. Usually I feel . . .



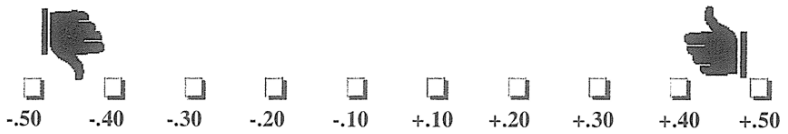
2. I Enjoy Physical Activities . . .



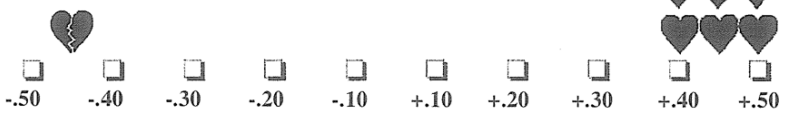
3. I Have Satisfactory Social Contacts . . .



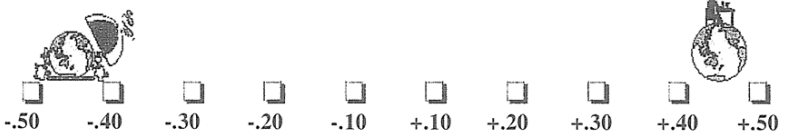
4. I Am Able to Work . . .



5. The Pleasure I get Out of Sex Is . . .



6. The Way I Approach Food Is . . .



-3 to -2.1	-2 to -1.1	-1	0	1	1.1 to 2	2.1 to 3
Very Poor	Poor	Fair		Good	Very Good	

Quality of Life

Appendix E: TFEQ-18

The Three-Factor Eating Questionnaire

Please read each statement and select from the multiple choice options the answer that indicates the frequency with which you find yourself feeling or experiencing what is being described in the statements below.

1. When I smell a delicious food, I find it very difficult to keep from eating, even if I have just finished a meal.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
2. I deliberately take small helpings as a means of controlling my weight.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
3. When I feel anxious, I find myself eating.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
4. Sometimes when I start eating, I just can't seem to stop.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
5. Being with someone who is eating often makes me hungry enough to eat also.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
6. When I feel blue, I often overeat.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
7. When I see a real delicacy, I often get so hungry that I have to eat right away.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
8. I get so hungry that my stomach often seems like a bottomless pit.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
9. I am always hungry so it is hard for me to stop eating before I finish the food on my plate.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
10. When I feel lonely, I console myself by eating.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
11. I consciously hold back at meals in order not to weight gain.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
12. I do not eat some foods because they make me fat.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
13. I am always hungry enough to eat at any time.
Definitely true (4)/ mostly true (3)/ mostly false (2)/ definitely false (1)
14. How often do you feel hungry?
Only at meal times (1)/ sometimes between meals (2)/ often between meals (3)/almost always (4)
15. How frequently do you avoid "stocking up" on tempting foods?
Almost never (1)/ seldom (2)/ moderately likely (3)/ almost always (4)
16. How likely are you to consciously eat less than you want?
Unlikely (1)/ slightly likely (2)/ moderately likely (3)/ very likely (4)
17. Do you go on eating binges though you are not hungry?
Never (1)/ rarely (2)/ sometimes (3)/ at least once a week (4)
18. On a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

Revised 18-Item (Karlsson et. Al. 2000)

