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WELLBEING AND FAMILY EFFECT OF ROUX-EN-Y GASTRIC BYPASS SURGERY

Results from an observational study and RCT

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Wellbeing and family effect of Roux-en-Y Gastric Bypass surgery.
Results from an observational study and RCT.
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By

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To Albin and Roel ❤

Look deep into nature, and then you will understand everything better. */Albert Einstein*

ABSTRACT

Introduction: Obesity is a world-wide public health issue. Bariatric surgery has shown to be the only effective way to reduce and maintain weight loss over time, with Roux-en-Y Gastric Bypass (RYGB) as the most common method used in Sweden. Technical complications after surgery have decreased substantially, thus, our focus of research has turned towards the wellbeing of these patients. Physical part of quality of life increases substantially after surgery, with a peak after approximately one year, followed by a gradual decline. The mental part of quality of life has shown less clear results, as is also the case with objectively measured physical activity, eating behavior and other psychosocial aspects. Psychosocial interventions after bariatric surgery might help to improve these outcomes. Additionally, the major lifestyle changes that relate to bariatric surgery have made researchers ask questions how this might affect the patients' families, but little is known about this topic.

Aims: The general aims of this thesis were to see if there were any long-term effects from mothers' RYGB surgery on their children's weight status, eating attitudes, body-esteem, self-concept, physical activity and sedentary time. Additional aims include to investigate if a dissonance-based group intervention can improve wellbeing after RYGB surgery and if health related quality of life was associated with physical activity before and after RYGB.

Methods: This thesis consists of two data collections. The first one consists of a prospective cohort study of women undergoing RYGB surgery and their children, with a 4-year follow-up of psychosocial outcomes and physical activity. This data collection included home visits to the families, wearing accelerometers to objectively assess data on physical activity, and a number of psychosocial scales. The other data collection consists of a randomized controlled intervention study. Women waiting for RYGB surgery were recruited and then randomized to a dissonance-based group intervention (4 sessions) post-RYGB surgery or control group (standard care). These women also wore accelerometers and answered some psychosocial scales before, and one year after surgery.

Results: Sixty-nine women and 81 of their children were recruited and 35 women and 43 of their children participated in all 3 measurements (pre-surgery, 9 months and 4 years post-surgery). Out of these, 30 women and 40 children provided valid accelerometer data. Children's prevalence of overweight and obesity decreased 9 months post-surgery but increased again at 4 years follow-up. The same pattern was seen for children's eating attitudes and women's eating behavior, sleep quality and symptoms of depression and anxiety. Children's self-concept and body-esteem declined gradually. There were no differences in women's physical activity levels from pre- to post-surgery and children decreased their physical activity and increased their sedentary time over the same time period.

The intervention study recruited 259 women with 156 women randomized to the intervention group and 103 to the control group. Fifty-three women from the intervention group did not attend any group sessions and 203 women in total completed one-year follow up assessments. A great improvement in quality of life was seen one-year post RYGB, but there were no differences between the intervention and control group in any of the measured outcomes. Moreover, physical activity was associated with quality of life both pre- and post-RYGB surgery (the data set included over 60 women from the control group with complete data).

Conclusions: There might be an effect of mothers' RYGB surgery on their children, but more research, preferable studies including a control group, are needed to tease out if this effect is a natural pattern or not. Women and children did not increase their physical activity levels after the mothers' RYGB surgery and a decline in children's psychosocial variables were shown. Many of women's psychosocial variables showed a rebound effect 4 years after surgery, despite that weight remained stable from 9 months to 4 years post-surgery.
Physical activity is associated with health-related quality of life in women both before and after RYGB surgery. Meeting with physical activity recommendations showed overall stronger associations post- compared to pre-RYGB.
We found no early one-year effect on health-related quality of life, physical activity, social adjustment, body-esteem or eating behavior of a dissonance-based group intervention after RYGB surgery.

LIST OF SCIENTIFIC PAPERS

I. Fanny Sellberg, Ata Ghaderi, Mikaela Willmer, Per Tynelius, Daniel Berglind.
Change in Children's Self-Concept, Body-Esteem and Eating Attitudes Before and 4 Years After Maternal RYGB.
Obesity Surgery. 2018; 28:3276-3283. doi: 10.1007/s11695-018-3348-z.

II. Fanny Sellberg, Mikaela Willmer, Per Tynelius, Daniel Berglind.
Four years' follow-up changes of physical activity and sedentary time in women undergoing Roux-en-Y gastric bypass surgery and appurtenant children.
BMC Surgery. 2017; 17:133. doi: 10.1186/s12893-017-0318-7.

III. Fanny Sellberg, Sofie Possmark, Ata Ghaderi, Erik Näslund, Mikaela Willmer, Per Tynelius, Anders Thorell, Magnus Sundbom, Joanna Uddén, Eva Szabo, Daniel Berglind.
A dissonance-based intervention for women post roux-en-Y gastric bypass surgery aiming at improving quality of life and physical activity 24 months after surgery: study protocol for a randomized controlled trial.
BMC Surgery. 2018; 18:25. doi: 10.1186/s12893-018-0358-7.

IV. Fanny Sellberg, Sofie Possmark, Mikaela Willmer, Per Tynelius, Margareta Persson, Daniel Berglind.
Meeting physical activity recommendations is associated with health-related quality of life in women before and after Roux-en-Y gastric bypass surgery.
Quality of Life Research. 2019 Epub ahead of print. doi: 10.1007/s11136-019-02120-0.

V. Fanny Sellberg, Sofie Possmark, Mikaela Willmer, Per Tynelius, Daniel Berglind.
Quality of life and wellbeing after Roux-en-Y Gastric Bypass surgery: one-year follow-up of a randomized controlled trial.
Under revision (2nd draft) at **Surgery of Obesity and Related Diseases.**

CONTENTS

LIST OF ABBREVIATIONS

AGB	Adjustable Gastric Banding
BED	Binge Eating Disorder
BES	Body- Esteem Scale
BES-ATT	BES- Attribution
BES-APP	BES- Appearance
BES-W	BES- Weight
BMI	Body Mass Index
BPD/DS	Biliopancreatic Diversion with Duodenal Switch
BYI-S	Beck Youth Inventory- Self concept
ChEAT	Children's Eating Attitudes Test
cpm	Counts per minute
CRF	Cardiorespiratory Fitness
DEBS	Disordered Eating after Bariatric Surgery
DBI	Dissonance-Based Intervention
HADS	Hospital Anxiety and Depression Scale
HADS-A	HADS- Anxiety
HADS-D	HADS- Depression
HRQoL	Health-Related Quality of Life
KSQ	Karolinska Sleeping Questionnaire
ITT	Intention to Treat
LOC	Loss of Control eating
LPA	Light Physical Activity
MCS	Mental Component Summary score
MVPA	Moderate to Vigorous Physical Activity
NES	Night Eating Syndrome
PA	Physical Activity
PCS	Physical Component Summary score
% TWL	Percent Total body Weight Loss
RCT	Randomized Controlled Trial
RYGB	Roux-en-Y Gastric Bypass

SAS-SR	Social Adjustment Scale- Self Reported
SD	Standard Deviation
SF-36	36-item Short Form Health Survey
SG	Sleeve Gastrectomy
ST	Sedentary Time
TFEQ	Three-Factor Eating Questionnaire
TFEQ-CR	TFEQ- Cognitive Restraint
TFEQ-EE	TFEQ- Emotional Eating
TFEQ-UE	TFEQ- Uncontrolled Eating
VBG	Vertical Banded Gastroplasty
WELL-RYGB	Wellbeing after RYGB
WHO	World Health Organization

1 INTRODUCTION

Obesity has become one of the major health issues of modern societies, and much attention has been given to methods for weight loss and maintenance. This has not been only for medical purposes, but also as a result of the stigmatization of obesity and the thin ideals and norms that are prevalent in most societies. The issue of body weight has thus translated into both a physical and a psychological problem for individuals living with obesity.

Several weight loss interventions have been evaluated over the years. Some examples are conventional (food and exercise), medications, psychological interventions and bariatric surgery. Bariatric surgery has been shown to have a major effect and sustained results on weight loss, in many patients, compared with other treatment options. However, the surgery still requires a complete lifestyle change for the patient and many psychological difficulties to overcome. As many surgeons and other people working with bariatric surgery have told me over the years in this field: “cutting someone’s stomach does not magically solve all your problems”. I think that summarizes how bariatric surgery is treated in Sweden.

What fascinates me is that the preparation and the care after surgery do not include tools to help patients make these big lifestyle changes, or handle problems to come. Additionally, the few preparation routines that do exist before surgery differ between hospitals in Sweden, but also worldwide.

Another unexplored question is how a major lifestyle change like this might affect the family living with a person undergoing bariatric surgery.

This thesis includes a study of children of mothers who underwent bariatric surgery, as well as an intervention study trying to fill this gap of preparation and help, to make the necessary lifestyle changes and to handle problems that could arise after surgery.

2 BACKGROUND

2.1 OBESITY

The World Health Organization (WHO) defines obesity as an abnormal or excessive fat accumulation that may impair health, most often classified with body mass index (BMI, measured as kg/m^2) [1]. BMI ≥ 30 is usually used to classify obesity in general among adults, but it can also be divided into class I (BMI 30-34.9), class II (BMI 35-39.9) and class III (BMI ≥ 40) obesity, whereas overweight is defined as a BMI between 25-29.9. A BMI between 18.5-25 is considered normal weight.

Worldwide trends of overweight and obesity are still rising in most countries in adults [2] as well as in children and adolescents [3]. In 2016, obesity rates worldwide were as high as 13 %, in Europe approximately 23 % and in Sweden 21 %. Additionally, more men than women suffer from obesity (23 % vs. 18 %, respectively) in Sweden, but also worldwide [4].

2.2 HEALTH CONSEQUENCES

Physical consequences of obesity include an increased risk for several non-communicable diseases. Obesity is suggested to be a direct causal factor for coronary heart disease as well as most forms of cancer and type 2 diabetes [5]. Higher BMI has also been associated with mortality and is one of the leading causes of both death and disability-adjusted life-years [6].

Additionally, obesity also affects psychological aspects. For example, it has been suggested that 20-60 % of those with obesity also suffer from a psychiatric illness [7]. Depression has been found to have a bidirectional association with obesity [8] and stronger associations have been found for women compared to men [7, 9, 10]. However, this might indicate the gender differences in social norms and stigmatization, rather than that obesity itself is a cause of depression. Health-related quality of life (HRQoL) [11-13], possibly anxiety [7], body image and eating disorders (mostly binge eating disorder, but also night eating syndrome and, in some cases, bulimia) [7] have also been associated with obesity.

There are also several social consequences associated with obesity. Stigmatization of obesity and overweight is common and can by itself lead to several health consequences [14]. A recent systematic review found that weight stigma was associated with both physiological outcomes (obesity, diabetes risk, cortisol levels, oxidative stress levels and C-reactive protein levels) and psychological outcomes (eating disturbances, depression, anxiety, body image dissatisfaction and self-esteem) [14]. Weight gain at already very early ages, 3-5 years, is associated with negative attitudes [15], and this association increases with age. Moreover, obesity has been associated with impairments in sexual functioning [16]. Altogether, obesity can be associated with several mental and physical issues, although it is not always known what comes first. The causes of

obesity are numerous and may differ between individuals, making it a complex disease, requiring several different treatment approaches.

2.3 TREATMENT OPTIONS

As described above, there are many aspects to consider for a successful obesity treatment. In the best-case scenario, obesity would be prevented, but since this thesis does not include prevention of obesity, and since there are already many people suffering from this disease, prevention strategies will not be covered here. A common misperception is that people with obesity just have a bad “character” and that the solution is simple, eat less and move more. However, obesity is more complex than that, and just advising people to eat less and move more only contributes to further stigmatizing of this group and, in many cases, worsens the outcome. Hereafter follows a short overview of different approaches used to treat people suffering from obesity. I have divided them into traditional interventions, pharmacological interventions, and surgical approaches.

2.3.1 Traditional (lifestyle)

Lifestyle interventions usually include behavioral changes in dietary habits and/or physical activity, in an attempt to change energy intake and/or energy expenditure. Several approaches have been tried, including meeting in person with different health professionals, in groups, individual meetings, or over the internet/telephone. Some studies have evaluated just giving advice and other studies have used more extensive approaches with personal exercise, in groups or individually, and/or food supplements or meal replacements. In other words, there are several different methods to lose weight with traditional interventions. Additionally, the target population is not always individuals suffering from obesity, as many studies have also evaluated people with overweight or, in some cases, even individuals with normal weight. However, most lifestyle interventions do not result in sustained weight loss [17], even though quite a number of participants do manage to lose weight. Around 20% of those joining the “National Weight Control Registry” managed to achieve and maintain >10% weight loss for one year. However, this was self-reported data of a selective population [18]. A systematic review combining different lifestyle interventions showed that most interventions resulted in less than 5% weight loss, 2-4 years after the intervention [19]. A combination of diet and exercise seems to be a more efficient approach than only diet interventions alone for losing weight [20]. Franz et al. also conducted a systematic review and meta-analysis of different lifestyle interventions among people with obesity and found weight losses of around 5-9% at 6 months post-intervention. This study also found that diet and exercise interventions in combination showed greater weight loss compared to diet or exercise alone, and also that a few studies utilizing very low energy diets showed rapid and major weight loss during the first 6 months (around 16 %) [21]. The weight loss maintenance was not as promising, however. A few years after the diet and exercise interventions, weight loss maintenance was around 4 %, and only 5 %

weight loss remained a few years after the very low energy diet intervention [21]. Additionally, most studies of weight loss interventions have a substantial drop-out rate (in the review by Franz et al. around 30 %). This must to be regarded as a bias, since those failing to complete the intervention most likely had poorer weight loss results than those completing the intervention. Another possible bias in several studies is the use of self-reported weight data, which not reflects objectively measured weight very good, especially in people with higher BMI [22]. Altogether, this makes it hard to generalize the effects of lifestyle interventions to the general population.
In order to maintain the initial weight loss, it may be beneficial to use additional interventions, targeting lifestyle changes with both diet and exercise behavioral changes. However, there is limited evidence for such weight loss maintenance for more than 12 months [23].

Although most studies show only little weight loss from lifestyle interventions, these weight changes could lead to a decrease in cardiovascular risk factors [24]. Although, long-term weight maintenance remains poor and additional long-term studies with good follow-up are needed.

2.3.2 Pharmacotherapy

Pharmacotherapy may be a useful complement for people with obesity to lose and maintain weight. Most of the available weight loss drugs target biological mechanisms, such as reduced energy uptake or changes in appetite or insulin sensitivity.
There are a few options available, but they are not widely used by physicians, nor patients (at least in the US) and long-term use is required [25]. They should be used in combination with a robust lifestyle change and the effect may vary considerably between individuals, thus it is not a viable option for all patients [25]. In Sweden, there are currently four medications on the market, of which two can be partly paid for by the government. These two contain orlistat, which works by reducing fat absorption in the small intestine. A few more drugs are available in USA and Australia. However, weight loss is still limited, and weight regain is likely when the motivation to keep the new lifestyle declines. Hereafter follows a short overview of the four approved anti-obesity drugs in Sweden.

Orlistat has been seen to reduce weight by approximately two additional kilograms when compared to a control group receiving placebo [26]. Orlistat may further have a small effect on weight maintenance [27]. However, this was seen when including not only people with obesity but also people with overweight, who consequently have less weight to lose. In an overview of different pharmacotherapeutic options for obesity, orlistat is described as having a small effect on weight, but also as safe for long-term use, unless the patient is very troubled by the common gastrointestinal side effects [25].

The other two medications approved in Sweden are Saxenda (liraglutide) and Mysimba (naltrexone and bupropion), which both work on the path of satiety and hunger control. Liraglutide is a GLP-1 antagonist and has been shown to be able to reduce around 5-6 % of body weight but with individual variations and some side effects [28]. Liraglutide is a widely used medication for type 2 diabetes mellitus and has been associated with cardioprotective effects [25].
Naltrexone has been used for alcohol disorders, and bupropion is an antidepressant drug. Together they are used for achieving weight loss in people with obesity by reducing appetite and food cravings, and has been shown to reduce body weight by around 6 % [29]. In a one-year comparison with placebo or other drugs, Mysimba and Saxenda had a high percentage of people with a weight loss ≥ 5 % (over 55 %), but the odds for adverse events were high. Orlistat, on the other hand, had lower odds of adverse events, but less people with a weight loss ≥ 5 %. The mean BMI in this study was 36.1 at baseline [30]. Losing 5 % weight has been shown to have metabolic benefits. Therefore, it is often used as a marker for the success of anti-obesity drugs. However, 5 % weight loss is probably not seen as a success for many people with obesity, as that is often still far from crossing into the categories of normal weight or even overweight [25]. Common criteria for pharmacotherapy treatment of obesity is BMI > 30kg/m^2 or BMI > 27kg/m^2 with weight related comorbidities [29].

2.3.3 Surgery

When it comes to surgical treatment of obesity, previous research has comprehensively shown that bariatric surgery is far more effective for achieving weight loss and maintenance, reducing comorbidities and lowering all-cause mortality than traditional treatment options [31-35]. However, bariatric surgery is commonly offered for people with a BMI > 40kg/m^2 (or BMI > 35kg/m^2 with comorbidities), compared with pharmacotherapy, which is often indicated for those with lower BMI. In order to be eligible for bariatric surgery in Sweden, the candidate is usually required to be >18 years, have a BMI above 40 or 35 as detailed above. Additional eligibility criteria usually include to have made serious attempts to lose weight with other methods and to be free of any eating disorders (usually self-reported). However, there are regional differences and individual assessments are always made to determine the suitability of bariatric surgery.

Methods of bariatric surgery worldwide have changed over time, with decreasing use of adjustable gastric banding (AGB) and vertical banded gastroplasty (VBG), and increasing use of sleeve gastrectomy (SG). SG is currently the most commonly used method worldwide (54%), followed by Roux-en-Y Gastric Bypass (RYGB) (30%) [36], which was the most commonly used method a few years ago [37]. However, RYGB is still the most commonly used method in Sweden, accounting for 54 % of all primary bariatric procedures 2017 [38]. Approximately 1 % of primary bariatric surgeries in Sweden consists of biliopancreatic diversion with duodenal switch (BPD/DS). In Sweden and many other countries BPD/DS is

performed only in people suffering from extreme obesity, with BMI over 50-60kg/m^2 [38]. Additionally, only a few endoluminal procedures are currently performed in Sweden, and are often considered more of a temporary bariatric procedure. These procedures are still at an experimental stage, with no long-term evidence for its effectiveness and safety [38]. Worldwide, approximately 4 % of primary bariatric procedures were endoluminal and the remaining 96 % surgical in 2016 [36].

Since 2007, all clinics in Sweden that perform bariatric surgery are connected to a register, SOReg. They report details of all surgeries (type, time point, patient's weight etc.) together with various other variables from the patients (for example HRQoL and surgical complications). This makes it possible to obtain an overview of bariatric surgery in Sweden, and we can thus conclude that obesity surgery had its peak in 2011 with 8500 procedures. The rate is now slowly decreasing with 5 347 surgical procedures performed during 2017 [38, 39]. However, it is too early to say whether this decrease in performed procedures is due to reduced patient demand or to cutbacks in healthcare resources meaning that in some areas, elective procedures such as bariatric surgery have been temporarily cancelled or postponed in order to prioritize emergency surgeries. Of all bariatric surgical procedures in 2015, 77 % were performed in women [40].

2.4 DIFFERENT BARIATRIC SURGERY TECHNIQUES

Traditionally, bariatric surgery has been divided into restrictive and malabsorptive and restrictive procedures, but with the modern techniques used today, some might think of this as to simplistic. We are now aware of more working mechanisms of bariatric surgery, such as changes in gut peptides and gall absorption, thus the division maybe needs to be updated. However, I have chosen to use the simple division anyway, since I believe it is a good way of basic understanding of the procedures.

2.4.1 Restrictive procedures

With restrictive procedures, food intake is limited, but the intestinal anatomy remains intact. The previously popular VBG is a procedure where the upper part of the stomach is transected vertically and food intake is restricted by a band at the end of this created pouch [41]. The VBG procedure was overtaken by AGB, which was the first bariatric procedure to be performed laparoscopically. It is a simple procedure where nothing is altered in the stomach, but a band is placed around the upper part of the stomach to reduce food intake [36] (illustrated in figure 1, picture 1). The band is connected to a tube which leads to a port that is placed under the skin. The band can then be adjusted by the administration of saline solution through the port, so that it is tighter or looser and thus more or less food can pass.

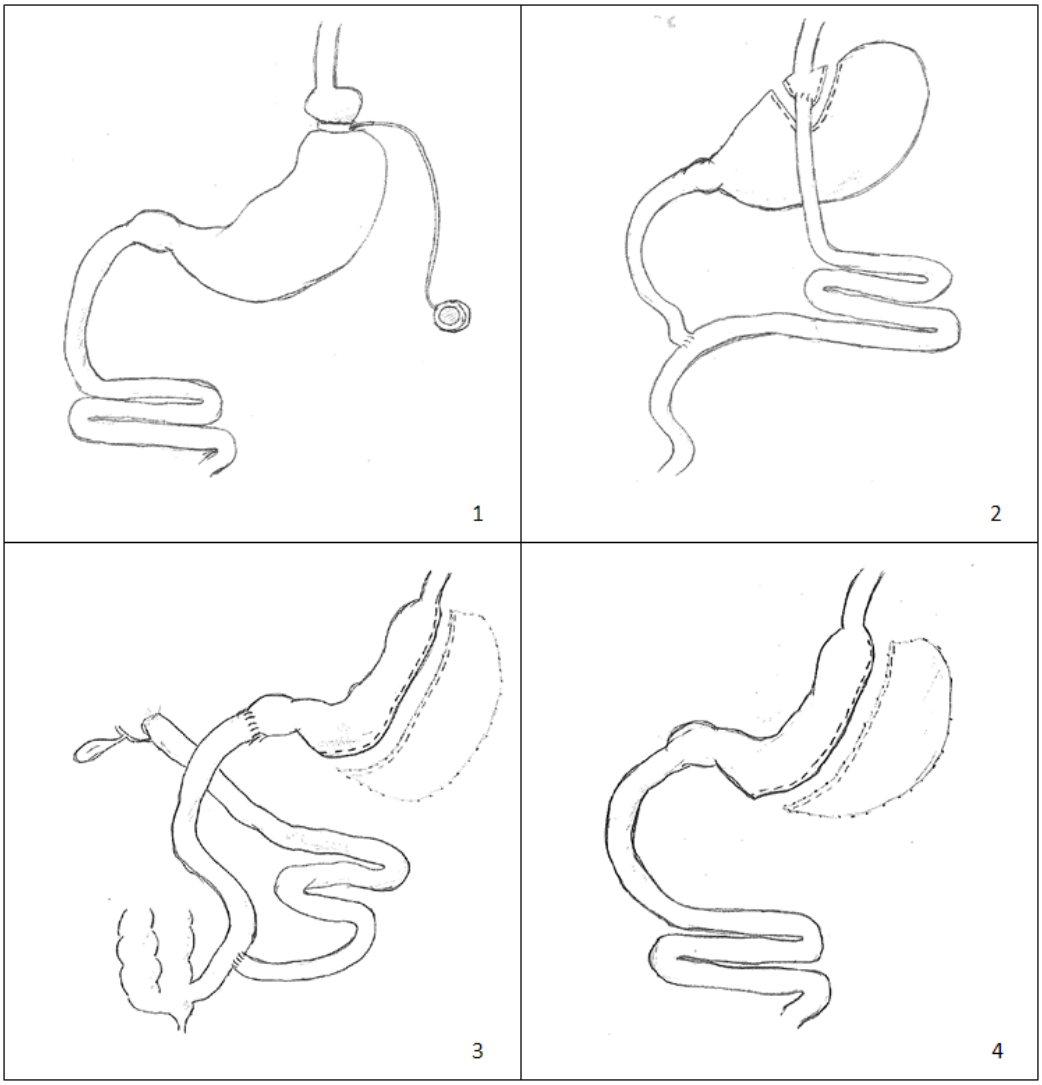

Figure 1. Different bariatric surgery techniques. 1: Adjustable Gastric Banding 2: Roux-en-Y Gastric Bypass 3: Biliopancreatic Diversion with Duodenal Switch 4: Sleeve Gastrectomy

Neither of these banding procedures are currently in common use due to the high rate of side effects, the need for reversions and, with VBG, the common occurrence of weight regain [41]. With AGB, side effects include band erosion or leak, port infection or port catheter leak. In some parts of the world, AGB is still used to some extent. In Australia, for example, AGB was more common than RYGB in 2015 [42]. Figure 1, picture 4 illustrates the SG procedure, which was originally created as a first part of the BPD/DS procedure for patients with extreme obesity. Patients would start losing weight before the second part of the surgery, the duodenal switch. The SG procedure removes a big part of the stomach and a sleeve-like stomach is left, reducing food intake and changing gut peptides etc. The SG was shown to reduce weight and to be safe as a stand-alone procedure and therefore SG started to increase in popularity, from accounting for around 5 % to becoming the world's most commonly-performed bariatric surgery in 2014 [36].

2.4.2 Restrictive and malabsorptive procedures

As mentioned above, RYGB surgery is still the most commonly performed bariatric procedure in Sweden. It is done by creating a small pouch of the stomach and then bypassing the first part of the intestine, leaving the stomach and the gallbladder to drain bile and gastric juices further down in the intestine where it is re-attached, illustrated in figure 1, picture 2. It is restrictive in the sense that the small pouch limits food intake, and malabsorptive in the sense that it bypasses the first part of the intestine where a large proportion of the absorption of nutrients normally occurs. As mentioned above, it also includes other working mechanisms, but I will not cover this area in this thesis. RYGB have previously been performed as open surgery, but as with all bariatric procedures, the laparoscopic techniques are associated with less complications and reduced morbidity. In 1994, RYGB was first performed laparoscopically [43]. The procedure has been used routinely for around 20 years and is still considered the golden standard by many surgeons, even though SG has recently overtaken RYGB in many parts of the world [36]. A newer, but less commonly used, procedure is the one-anastomosis gastric bypass (also called mini-gastric bypass). Here the stomach is shaped more like a tube, and the intestine is attached by one anastomosis (compared to the two attachments used in traditional RYGB). This procedure has also been shown to be safe and give good results, in some cases even better than RYGB, but it bypasses a longer part of the intestine, causing a higher risk of nutrient deficiency [44]. The one-anastomosis is more frequently used than RYGB in Asia, but is not even recognized as a bariatric surgery in the US [36]. The BPD/DS, mentioned above, is also both a restrictive (a tube of the stomach is produced, like SG) and a malabsorptive procedure. It divides the duodenum (first part of the small intestine) and connects it to the ileum, meaning that no nutrients will be absorbed in these sections of the small intestine (illustrated in figure 1, picture 3). This procedure is more malabsorptive than gastric bypass procedures, and thus results in the most weight loss. Hence, it is recommended for people with extreme obesity (BMI>50-60) mainly, as it is a more complex procedure with higher mortality and complication rates [36].

2.4.3 Endoluminal procedures

In addition to bariatric surgery, there a few bariatric procedures which have recently come on the market and which do not require surgery. They are known as endoluminal procedures, as mentioned above [45]. However, not all of them are in fact new, as gastric balloons have been in use for many years. Recently, a few types have been approved by the FDA (The U.S. Food and Drug Administration). Gastric balloons are usually placed endoscopically in patients, but tests have been performed on a new balloon which can instead be swallowed by the patient. Their effect is not fully understood, but the balloon supposedly takes up space in the stomach, slowing down gastric emptying and leading to a reduced food intake. This can lead to a subsequent weight loss of around 10 % [45]. Other endoluminal procedures include endoscopically placing a

percutaneous endoscopic gastrostomy tube in the patient's stomach wall. This allows them to remove some of the ingested calories through aspiration. Another method is gastric electrical stimulation systems to alter hunger/ satiety signals. Some adverse events have been documented, but because they are less invasive than surgery, the risks of endoluminal procedures are considered to be lower than those of bariatric surgery [36, 45]. The gastric emptying method has in Sweden been used in a clinical trial context, but no such procedures were reported in 2017. Two hospitals in Sweden started to use a balloon technique, also in 2017. Apart from these, there are no reported endoluminal procedures in Sweden [38]. However, there are private actors who do not report to the national register. Thus, there are probably more procedures done.

2.5 EFFECTS OF BARIATRIC SURGERY

As mentioned above, many obesity-related comorbidities are improved or resolved after bariatric surgery. Remission or improvements in type 2 diabetes mellitus is seen in over 85 % of patients [46-48], and especially so in the case of biliopancreatic diversion, closely followed by RYGB surgery [47, 49]. These effects do not seem to be dependent on patients' pre-surgical BMI [49], or to be mediated by weight loss alone [50], for RYGB patients. Cardiovascular disease and risk markers also improve after surgery [46, 48, 51], together with decreased cancer risk and cancer mortality [46, 52] and improved sleep apnea [48]. Additionally, a recent review and meta-analysis looking at biomarkers before and after bariatric surgery found an improvement in insulin resistance indicators, inflammation levels, adipokines and vascular function markers after surgery [53]. They also found a, non-statistically significant, but positive effect on metabolic hormones related to appetite control [53]. This is in contrast with weight loss achieved through lifestyle changes, where previous research has identified reciprocal response mechanisms to cause weight regain. For example by increasing appetite and cravings by hormonal changes [54].

Weight loss

To a certain extent, the amount of weight loss achieved through bariatric surgery depends on the type of bariatric surgery, but there are also large individual differences. Initial major weight loss is commonly followed by a minor weight regain (mean regain of around 4-15 % from the original weight loss), starting around 2 years post-surgery [55-58]. BPD/DS has been shown to be the most effective in terms of weight reduction with around 23-25 BMI units decrease over 1-2 years post-surgery [59]. Similar numbers have been seen in Sweden, and this correspond to around 40% total body weight loss (% TWL) after 1 year and 44 % TWL after 2 years [55].

Compared to RYGB surgery, BPD/DS results in an extra reduction of around 6.2 BMI units, thus RYGB has shown to result in a mean reduction of approximately 17 BMI units, 1-2 years post-surgery [59]. Swedish observational data shows a slightly lower rate of weight loss for RYGB patients, but this may be explained by

a different baseline BMI [55]. The percentage of TWL for RYGB in Sweden is around 32-34 %, 1-2 years post-surgery [55, 57]. Diabetes remission shows the same pattern, with better resolution with BPD/DS compared to RYGB (88% vs. 76% respectively), but the risks are higher with increased rates of complication and mortality with BPD/DS [59]. However, mortality is still very low (0.6 % vs. 0.2 % for BPD/DS vs. RYGB) [59]. The total 30-day mortality for all bariatric procedures in Sweden is only 0.03 %, and the 90-day mortality is 0.06 % [38].

In comparison to RYGB, SG surgery has shown to result in slightly less weight loss in randomized controlled trials (RCTs), but this difference has not always been significant [31, 60, 61]. Although there might be a difference favoring RYGB surgery, it has also been suggested that SG may have lower complication rates. In contrary, a large American database study has shown a lower rate of revision (conversion rate) for RYGB in comparison to SG (5 % vs. 10 %) [62]. However, that study only included 1781 SG procedures compared to 22,769 RYGB procedures, and it did not include BPD/DS. Thus, several factors should be taken into account when choosing the right type of surgery [63]. In general, operation times, complication rates and hospital stay have all been reduced [38, 55], with better techniques, more surgical experience and advances in health care. Complications include leaks, nutritional deficiencies (more common for malabsorptive procedures), vomiting, hernias, bowel obstructions and, specifically for SG and BPD/DS, increased reflux syndrome [31, 38]. However, with low rates of mortality and severe surgical complications, research attention is increasingly turning towards mental and psychosocial aspects of bariatric surgery. How does RYGB and the subsequent great weight loss affect the patients, and their families?

2.6 AFTER BARIATRIC SURGERY

It is believed by some that bariatric surgery is an easy way to lose weight without effort, and some even consider it “cheating”. From a clinical point of view, this is certainly not the case. Pre-surgery patients usually must go on a low-calorie diet (95% in Sweden go on this diet). This is in order to reduce complications and to show their motivation for weight loss. This results in reduced size and fat content of the liver, providing easier laparoscopic access and less complication rates. In Sweden, this diet usually consists of low-calorie meal replacements for at least two weeks pre-surgery. After the surgery, patients need to change their eating habits, often drastically, to several smaller, nutrient-dense meals per day in order to avoid nutrient deficiency and ensure weight loss. RYGB patients may experience what is known as “dumping syndrome”. A state caused by eating too much or choosing the wrong foods (commonly high-sugar or high-fat beverages) [64]. Symptoms include rapid heart rate, diarrhea, nausea, tremor and feelings of faintness. However, some patients perceive dumping as something positive, since it motivates them to avoid high-sugar beverages, for example. While some patients seem to experience dumping every day (some even from normal meals), some patients experience very little of these symptoms. Patients and clinicians

commonly view this phenomenon as a tool for enabling lifestyle changes, in conjunction with the purely physical effects of the surgery.

2.6.1 Quality of life after bariatric surgery

Short-term HRQoL (one-year post-surgery) typically improves greatly after bariatric surgery. This improvement mainly concerns the physical dimension, but also the mental dimension of HRQoL (often measured with the 36-item Short Form Health Survey, SF-36). However, there is major variability between studies [65]. A difference between the physical and mental aspects of quality of life has been seen in most studies. The physical part usually improves substantially, but the mental part shows less improvement [66, 67]. Long-term outcomes of HRQoL (≥ 5 years in a review by Andersen et al. 2015) showed peak improvements in HRQoL 1-2 years after surgery and then a gradual decline. However, there was still a net improvement at 5 years follow-up, compared to pre-surgery [68]. This is in line with a recently published 12-year follow-up study, showing initial improvements in the physical part of HRQoL and then a decline up until the end of the study. The surgery candidates did, however, still report better physical HRQoL than the non-surgery obesity comparison groups [67, 69]. No improvement from baseline to 12 years was seen for the mental part of HRQoL. Other recent studies with long-term follow-up mostly show the same patterns [70-72], with a few exceptions. Strain et al showed maintained improvements in all parts of SF-36 [73] and Aasprang showed improvements also in MCS (mental component summary score, part of SF-36) which then declined. The results still remained improved 10 years after surgery, compared to pre-surgery [74]. However, both of these studies had very few participants and both looked at HRQoL after BPD/DS. The follow-up rates are often low, between 55-92 % in the studies cited above. If there are differences between drop-outs and completers, this might bias the results, selection bias [68].

In a Swedish cross-sectional study, comparing people with obesity pre-surgery with people who underwent gastric bypass surgery 12 years ago, the surgery group showed better physical HRQoL (at least some of the sub scores). However, the surgery group still reported lower HRQoL than Swedish general population data [75]. A recent systematic review and meta-analysis of RCTs comparing surgery to other obesity treatments found that mental health-related quality of life (actual numbers nor improvement) did not differ between the surgery groups and the groups receiving conventional treatment. Although, they did not report weight loss and whether this was considered in the comparisons [76]. This is line with other research concluding that bariatric surgery and weight loss alone improve the physical part of HRQoL, but do not seem to have any lasting positive effect on the mental and psychosocial parts of HRQoL, compared to other treatments, or even no treatment [77]. The HRQoL after bariatric surgery has been widely studied. For example, a review of systematic reviews and meta-analysis has concluded that a higher BMI was associated with worse HRQoL and bariatric surgery improves HRQoL, while conventional treatments are inconsistent [11].

In short, bariatric surgery seems to improve physical HRQoL with a decline over the years, but still better than pre-surgery. No, or some improvement has been seen in mental HRQoL. However, there is not enough evidence for long-term follow-ups [78, 79]. Additionally, the type of surgery might be of importance [80], and there are major individual variations, thus some people might need more intensive follow-up care to improve and maintain good quality of life after surgery [81].

2.6.2 Other mental health aspects

A range of psychiatric disorders, psychiatric symptoms and behaviors after bariatric surgery have been studied in a variety of frequency, length and results. I will mainly focus on outcomes included in this thesis (social effect, depression, eating behavior, anxiety, body-esteem and sleep, some which could be included in HRQoL, but are presented separately here).

Depression

There is evidence for improvements in depression after bariatric surgery [70, 82-84] but, as with HRQoL, it seems like depression symptoms might increase again gradually after the first 1-2 years [70, 83, 85-88]. This is possibly associated with the rate and degree of weight loss [85]. Additionally, depression pre-surgery has been found to possibly predict post-surgery depression [89]. These studies have mainly included earlier methods of bariatric surgery, such as VBG, which are currently not widely used. Thus, the results should be interpreted with caution in relation to more modern methods such as SG or RYGB, where weight loss is usually larger and more sustainable. A small study, with a high drop-out rate, did not find a significant difference in depression improvement between surgery types, but there was a trend towards greater improvements with RYGB compared to SG, and with SG compared to AGB [90].

Some studies also shown contrary results to improvements in depression after bariatric surgery. Among those is a nationwide registry-based cohort study from Sweden. This study did not show any positive effect on depression, however, they looked at the incidence of hospital admissions for depression after RYGB [91]. This study also showed a slight increase in the use of antidepressant drugs in the years after surgery, which was in line with another 5 year follow up study [92]. Mitchell et al. found an increased prevalence of major depression 13-15 years post-gastric bypass surgery. However, only 78 participants were included in this study [93]. Another registry-based Swedish study also found increased risk of clinical depression after RYGB, but this was mainly attributable to pre-surgery depression [94]. In light of this, special care may be needed for those with pre-surgery depression, or anxiety disorders [87].

Anxiety disorders

With regards to improvement in anxiety after bariatric surgery, previous studies have shown mixed results [84, 93, 95, 96], and several have shown that initial

improvements are not sustained over time [87, 88]. Compared to depression, there is less previous research on anxiety and its association with obesity. A review by Sarwer et al. found that as high as 48% of bariatric candidates suffered from any anxiety disorder, however, this was the highest prevalence found in one of the included studies [97]. Another review and meta-analysis of mental health outcomes before and after bariatric surgery showed an increased rate of mood disorders (23%) and eating disorders (17%) pre-surgery, most commonly depression and binge-eating syndrome. No associations were found between mental health issues and worse weight outcomes (mixed results). Additionally, there was some evidence for bariatric surgery being associated with a reduction of depression frequency and depression severity [98]. In a clinical interview study to diagnose anxiety after bariatric surgery, no significant improvement was found. Additionally, there was a strong prediction of anxiety pre- to post-surgery [95], indicating that it was mostly the same patients who suffered from anxiety before and after surgery.

To summarize, it seems like depression might decrease after bariatric surgery, and possibly the same can be seen for anxiety, but for many patients, mental ill-health persists after surgery. For some, symptoms may even worsen after surgery, and any initial improvement might fade over time [99, 100]. There may be several reasons for these outcomes. Firstly, there is a great variation in the amount of weight lost and weight regain. Even a small weight regain could cause distress among those who fear they are “failing” with what is often perceived as the last available option for weight loss. Secondly, patients often perceive their weight to be the sole reason for their poor mental health, and when mental health problems remain despite weight loss, it might contribute to even poorer mental health [101]. Thirdly, patients may experience difficulties in adapting to their new situation; receiving more attention, noticing loose skin, adhering to new eating habits, coping with their own and others’ expectations, and so on [101].

Body-image

Loose or excessive skin and body dissatisfaction are also associated with depression and poorer quality of life, 4 to 5 years after RYGB surgery [102]. However, only approximately 11 % of the sample in the study above, underwent body contouring surgery. Most of them payed out of their own pocket, and the costs was the most common reason not to undergo body contouring surgery [102]. Body contouring surgery is believed to improve body image, but the topic is sparsely studied. In a review by Sarwer et al., the authors mentioned that some patients who seek body contouring surgery may also suffer from body dysmorphic disorder [103].

Body image after surgery is usually associated with loose or excessive skin [104]. And despite the above mentioned quite common loose skin, body-image seems to improve in general post-surgery and mixed results are found in comparison with population norms [105]. The same study also found that body-image is associated with eating behavior [105]. In a study with relatively long follow-up, body-image and depression, sexual functioning and sexual hormones improved 1-2 years after

surgery, but then declined 3-4 years post-surgery. However, body-image and depression were still improved at 4 years follow-up compared to pre-surgery [72]. An early study of body-image separated adult-onset obesity from child/adolescent-onset of obesity. They found that post-bariatric patients who had become obese in adulthood had a better body image than those who had lived with obesity from an early age [106]. This was not found in obese controls who did not undergo surgery. Thus, living with obesity from an early age could be predictive of less improvements in body-image after bariatric surgery. Additionally, all obese groups had worse body-image than normal weight controls [106].

In short, bariatric surgery might lead to better body-image, but body-image is associated with other mental-health outcomes and loose skin after surgery. Thus, there might be large variations and possibly a decline after some years, as in the other mental aspects.

Social effects

Bariatric surgery may also have many different social effects, but these are not well studied. A qualitative study found that family members experienced a decrease in interactions among the family directly post-surgery. However, after approximately 3 months post-surgery, family members experienced increased interactions and closeness within the family. They also experienced increased social interactions for the whole family with friends and relatives [107]. Another qualitative study, using semi-structured group interviews, found that some patients experienced improvements in family or friends' relationships, and some experienced the opposite [108]. They also highlighted the importance of guidance on these experiences and evaluations of adverse events post-surgery. They described many different phenomena, such as others not recognizing them after the massive weight loss, and changes in relationships and in how they were approached by others [108].

Many of the studied outcomes after bariatric surgery correlate with each other. In a study by Wrzosek et al. daily consumption of snacks and eating in response to emotions were associated with a higher odds of depression and insomnia. Reciprocally, insomnia and depression were associated with daily consumption of snacks in bariatric surgery candidates [109].

2.6.3 Eating behavior

The most evident psychosocial predictors of post-surgery weight loss is eating behavior and adherence to post-operative diet and physical activity recommendations [110]. Eating behavior is connected to BMI, with binge eating disorder (BED) showing an association with obesity [111]. BED is defined as eating a large amount of food within the span of 2 hours, accompanied by feelings of loss of control while eating. BED is common among bariatric surgery patients, along with loss of control eating (LOC) by itself and night eating syndrome (NES).

NES is commonly defined as consuming 25 % or more of daily energy intake after the evening meal and/ or waking up in the night to eat [103, 112].

Eating behavior after surgery

After surgery there are some evidence for improvements in BED and LOC, followed by a decline again after the first year [99, 113]. This pattern was, however, not found in a study measuring several parts of eating behavior [114]. A long-term study of RYGB and AGB patients found that a relatively high proportion of participants, not suffering from eating disorders pre-surgery, reported BED and LOC after surgery (5% and 25% respectively) [113]. Another study found similar results with newly developed problematic eating behaviors in as many as 39% [115]. Additionally, patients with NES pre-surgery, seem to have continuing issues after surgery [103]. This is in line with a Swedish study, including few participants, that showed worse eating behavior one- and two-years post-surgery in a group with pre-surgery poor eating control, compared to good eating control pre-surgery [116].

A review from 2011 showed improved eating behavior post-bariatric surgery [117], but a long-term study by Morseth et al. showed that 5 years after RYGB or BPD/DS, many patients still suffered from eating disorders. As many as 22 % of patients still reported objective bulimic episodes in the RYGB group and 7 % in the BPD/DS group, as compared with 29 % and 32 % pre-surgery, respectively [118]. The same study also found a difference in the Eating Disorder Examination-Questionnaire (EDE-Q) between the two surgery types. Thus, it seems reasonable to believe that eating behavior may differ depending on surgery type. A Swedish long-term study found that hunger and disinhibition decreased, along with an increase in cognitive restraint, post-surgery [119].

Grazing

Another common eating behavior after bariatric surgery is grazing, which has not been very well studied. A recent review found 5 studies on the topic [120]. The authors also found that there is no clear definition of grazing, one example was “the consumption of a small amounts of food continuously over an extended period of time, resulting in eating more than the subjects considers best for them”. Regardless of definition, the behavior was associated with weight regain. However, some eating behaviors, such as grazing, might be difficult to study after bariatric surgery, since the recommendations are to eat smaller meals more frequently [99].

Alcohol abuse

There have been frequent media reports on problematic alcohol consumption after bariatric surgery. Alcohol consumption seem to follow the same pattern as many other psychosocial aspects of bariatric surgery, with a decrease in alcohol consumption a year after surgery, followed by an increase. However, these issues are not thoroughly studied, and surgery type seems to be of great importance,

with RYGB surgery carrying a much higher risk of alcohol abuse than AGB for example [99, 103].

Additionally, men and women seem to differ in the context of wellbeing and bariatric surgery, with men suffering from more complications and poorer weight loss, but reporting higher wellbeing, compared to women [121].

Overall, it is of importance to further explore eating behavior after bariatric surgery and to find ways of improving eating behavior post-surgery. There are still uncertainties concerning why not all patients improve their eating behavior, and surgery type along with previous history might play a role.

2.6.4 Physical activity

Physical activity is of importance for health both before and after bariatric surgery [122, 123] in order to help maintain weight loss [124, 125] and to lower the short-term risk of complications [126]. As for the general population, exercise (i.e. higher intensity PA) comes with a whole host of physical and mental benefits [127]. However, for bariatric surgery patients, there may be both physical and mental barriers to engaging in exercise [128]. For example, a study by Shah et al. found that a high-volume exercise program was only feasible in 50 % of bariatric surgery patients [129]. Physical functioning, relative strength, walking time and pain is greatly reduced by bariatric surgery [130, 131] (with reductions at one-year post-surgery followed by slight increases from year 1-3) [130]. However, these improvements result in no, or very small, increases in objectively measured PA, with only clear increases regarding step counts [132]. Only one previous study has looked at objectively measured PA over a longer time than one year and found, compared to earlier studies, improvements of objectively measured PA. The authors found an increase in moderate to vigorous physical activity (MVPA) levels (approximately 20 min/week) and step counts, measured with a pedometer over 3 years follow-up [133]. In contrast to the small or no improvements of objectively measured PA, self-reported PA increases greatly post-bariatric surgery [132, 134], meaning that it is necessary to measure PA objectively. Berglind et al. even found a larger discrepancy between self-reported and objectively measured PA after surgery, compared to before, within the same individual [135]. Thus, especially after bariatric surgery it is of great importance to measure PA objectively.

There is a need for interventions to encourage and increase PA after bariatric surgery but, the type of activity might need to be individualized to increase compliance.
A review from 2013 by King and Bond shows that individualized PA counselling is a suitable approach to increase PA among bariatric surgery patients [122]. One study randomized 40 bariatric surgery patients to a PA intervention with 6 counseling sessions and compared them to 35 patients receiving usual care. They

found increased MVPA, measured in 10-minute bouts using accelerometers, in the intervention group, together with an increase in HRQoL [136]. This was by itself an interesting finding, since the relation between HRQoL and PA has not been studied in this population before. Another study used 3 groups, one receiving usual care, one receiving pedometers only, and one group receiving counselling as well as pedometers. Only the group receiving both counselling and pedometers showed an increase in PA, highlighting the need for multi-faceted and holistic approaches to improve PA in this patient group [137].

2.7 THE EFFECT OF BARIATRIC SURGERY ON THE PATIENT'S FAMILY

As bariatric surgery both requires and causes many lifestyle and psychosocial changes in the patients, there is also a need to consider how the surgery might affect the patient's family. In a qualitative study by Bylund et al., family dynamics were mostly affected by a family member's RYGB surgery [138], and many previous studies highlight the importance of family support for successful bariatric outcomes [139].

A few studies have investigated the effect of bariatric surgery on family members. Woodard et al. investigated family members' change in weight after parental RYGB surgery. They found that children had lower weight than expected one year after their parent's RYGB surgery [140]. They also found that children reported currently being on a diet more frequently after parental surgery, but found no change in quality of life [140]. Willmer et al. investigated children of RYGB mothers and found that they had a lower relative risk of overweight and obesity 9 months post-surgery [141]. They also found an improvement in body esteem and eating attitudes among boys, but not among girls, 9 months post maternal surgery [141, 142]. In contrast to these results, Aarts et al. found no change in children's BMI or eating behavior up to one year after parental RYGB surgery [143]. However, they did find weight loss among partners of RYGB patients, [143] which is consistent with another study by Willmer et al. [144]. Watowicz et al. compared 45 children with obesity, whose parents underwent bariatric surgery, with 90 control children, also with obesity but without parents who underwent bariatric surgery. They found that children of bariatric surgery patients ate more at unfavorable hours and reported eating more helpings of food, compared to control children [145]. Thus, it seems reasonable to assume that family members might be affected by a parent's bariatric surgery, but long-term studies are needed. Another study performed by Lent et al. found that over 90 % of partners and 50 % of children of a family member undergoing bariatric surgery also suffered from obesity [146]. However, many patients felt supported by family members in keeping a healthy diet and exercising more. The authors of this study concluded that engaging families in behavioral changes might be helpful to both the patient but also to their families in order to improve health [146].

2.7.1 Physical activity

PA behaviors in an individual can be affected by family PA behaviors [147]. For example, if parents are very active it seems likely that they would promote PA in their children. On the contrary, children's sport activities do not necessarily create motivation for their parents to be active. Very few studies with a family perspective on PA have been conducted on bariatric surgery patients. The study by Lent et al. mentioned above, found that sedentary time (ST) was high among the family members. On the other hand, the bariatric surgery patients also felt support from their family in increasing exercise after surgery [146]. This might be of importance for increasing PA both in patients and their family members. Woodard et el. found an increase in PA among partners and children after RYGB surgery, though this was measured subjectively [140]. Berglind et al. did not find any objectively measured increase in PA or decrease in ST among children or partners of women who underwent RYGB surgery. The authors rather found a significant decrease of MVPA and an increase of ST among children, comparing pre-surgery, to 9 months after maternal RYGB [148].

There are few studies done in the field of PA after bariatric surgery and even less in family members, and no study that we are aware of has had a follow-up period longer than one year [132].

2.8 INTERVENTIONS TO IMPROVE WELLBEING AFTER BARIATRIC SURGERY

Weight loss

Most previous psychosocial interventions with this patient group have focused on improving weight loss after bariatric surgery. For example, a review by Stewart and Avenell from 2016 showed that behavioral interventions might be of importance for both weight loss and quality of life [149]. The authors also found that the best timing for delivering interventions seems to be post-surgery, but before weight regain may occur [149], which was in line with another review on the topic [150]. Additionally, psychotherapeutic interventions and support groups seem to influence weight loss some years post-surgery [104]. However, the small number of studies and low methodological quality limit these findings. Another review from 2015, focusing on interventions for preventing weight regain, found that only a few RCTs have been performed, with the results showing at best only modest improvements. The authors also included observational studies and non-randomized trials, in comparisons with the other reviews [151]. In addition to weight loss interventions, a review by Livhits et al. concluded that support groups may be beneficial for weight loss, indicating that interventions might be beneficial just by providing support from the other group members [152].

Wellbeing

There have been only a few previous interventions aimed at improving wellbeing after bariatric surgery. A study by Bond et al. showed that a pre-surgical physical activity intervention improved HRQoL (together with increased levels of PA) [136]. A mindfulness intervention improved emotional eating post-surgery [153]. Another 10-week mindfulness intervention using cognitive behavioral therapy improved eating behavior and depressive symptoms [154]. A Swedish pilot study tried a 6-week acceptance and commitment therapy intervention, aiming at improving emotional eating behavior. The authors showed improved eating behavior, HRQoL, body dissatisfaction and weight-related thoughts and feelings after the intervention [155]. Another pilot study of 6 one-hour group sessions among bariatric patients who experienced weight regain, showed improvements in weight loss, grazing, binge eating episodes and depressive symptoms [156]. A videoconference psycho-educational group intervention one year after RYGB, showed no difference in HRQoL, eating behavior, depression, self-efficacy or weight loss [157]. However, the authors found a long-term effect, when the psychosocial effects of surgery started to deteriorate, in depression and self-efficacy, favoring the intervention group [158].

Intervention participation

Another common issue is participation in the interventions. Who chooses to participate, and who needs the intervention the most?

One RCT, delivering a pre-surgical intervention, found that the participants who were lost to follow-up were on average younger and lost less weight pre-surgery than those who remained in the study group [159]. Another study found that RYGB patients who attended support group meetings lost more weight than those not attending the meetings, although participants who chose not to attend group meetings felt that they did not need it, and that they could lose as much weight without the meetings [160]. Using remote delivery of intervention has been discussed, in order to increase availability and participation, but research on this is at a very primary stage with only a few studies published [161].

In conclusion, there seems to be good potential and an established need for psychosocial interventions after bariatric surgery, as mental health issues are relatively common post-surgery. It is likely that the timing and type of intervention, as well as the setting, are of importance. More randomized interventions, with good methodology and longer follow-up, are needed [149, 162].

2.8.1 Dissonance theory-based interventions

Dissonance-based interventions (DBIs) are based on the theory of cognitive dissonance, first developed by Festinger in 1957 [163]. The theory states that inconsistency arises when holding two different cognitions (knowledge, opinion or belief about the environment, oneself or behaviors) at the same time. This

inconsistency, called dissonance by Festinger, creates psychological discomfort, and individuals try their best to reduce this by changing one cognition. In interventions based on dissonance, cognitions are thus altered to create consistency, and therefore make the person more likely to change their behaviors or beliefs to fit with each other.

Stice et al. have developed a successful DBI program called the “Body Project” to prevent eating disorders among young women [164-166]. This program has showed good long-term results in preventing eating disorders and improving symptoms and risk factors for eating disorders [167]. The model has been implemented on a large scale in many different countries [164]. The same research team has also developed a program to prevent unhealthy weight gain, “Healthy Weight”, based on the same format [167]. When dissonance-inducing activities were added to this, resulting in “Project Health”, the effect on preventing weight gain was higher [168]. Other prevention programs targeting eating disorders have shown limited efficacy and DBIs have produced stronger effects for many eating disorder outcomes [169], with a higher amount of dissonance seeming to have greater effects [170]. Thus, DBIs seem like a promising method to try in the prevention of other food- and body-related problems.

A DBI program has never been tested with bariatric surgery patients in order to improve eating behavior, HRQoL and other outcomes as discussed above. Therefore, we developed such an intervention, explained in detail under the method section.

3 AIMS

The overall aim of this thesis was to investigate changes in wellbeing and PA from before to after RYGB surgery among women and their children, and if a group intervention could improve or prevent decline in wellbeing and PA in women after RYGB. Additional aim was to examine if PA was associated with HRQoL pre- and post-RYGB.

I. Aim study 1: To investigate changes in children's eating attitudes, self-concept, body-esteem and weight status before, to 9 months and 4 years after maternal RYGB surgery. Secondary aims were to investigate changes in mothers' eating behavior, relationship status, sleep quality and symptoms of anxiety and depression before RYGB, to 9 months and 4 years after RYGB. Additionally, to examine if there were any correlations between mothers' eating behavior or BMI, with children's eating attitudes.
II. Aim study 2: To investigate changes in objectively measured physical activity, sedentary time and prevalence of meeting with PA recommendations among children and their mothers, before-, 9 months and 4 years after mothers RYGB surgery.
III. Aim study 3: A study protocol to describe the study design and methods from a RCT looking at the effect of a dissonance-based group intervention aiming to improve or prevent decline in HRQoL and health related behaviors in women after RYGB surgery.
IV. Aim study 4: To examine the cross-sectional association between HRQoL and PA (meeting with recommendations, light physical activity, sedentary time and step counts) in women before, and one year after RYGB surgery.
V. Aim study 5: To investigate if there were any early effects from a dissonance-based intervention study on women's HRQoL compared to a control group, one-year post-RYGB surgery. Secondary aim included to investigate if there were any early effects from a dissonance-based intervention study on women's physical activity, sedentary time, social adjustment, eating behavior and body-esteem compared to a control group, one-year post-RYGB surgery.

4 MATERIALS AND METHODS

This thesis consists of two different data collections, one which will be referred to as the family study (a longitudinal cohort study), and one which is a randomized controlled intervention study called WELL-RYGB (Wellbeing after RYGB and in Swedish Välbefinnande efter gastric bypass, VÄLG). Study 1 and 2 used data from the family study, and study 3-5 used data from the WELL-RYGB trial.

4.1 THE FAMILY STUDY

This data collection started in 2011 with the recruitment of 69 women from waiting lists for RYGB surgery and 81 of their children. Women were recruited from 5 different hospitals in Sweden (St: Görans Hospital, Danderyd Hospital, Ersta Hospital, Uppsala University Hospital and Örebro University Hospital). All women had RYGB surgery between June 2012 and January 2013. Inclusion criteria were eligible for primary RYGB surgery, being able to speak Swedish, and having a child between 7-14 years old. In order to be eligible for RYGB surgery, it is required to have a BMI ≥ 40, or BMI ≥ 35 with obesity complications, to be over 18 years old, to have made earlier serious attempt to lose weight with conventional methods, and to be well informed about the surgery and willing to make lifestyle changes. In most cases, counter-indications include an ongoing eating disorder, recent cardiovascular disease or stroke, pregnancy or substance abuse, but each patient is evaluated individually by a surgeon for eligibility. The study was approved by the Stockholm Regional Ethical Review Board (no 2009/1472-31/3) and all participants gave written informed consent (parents gave informed consent for their children, along with the children themselves).

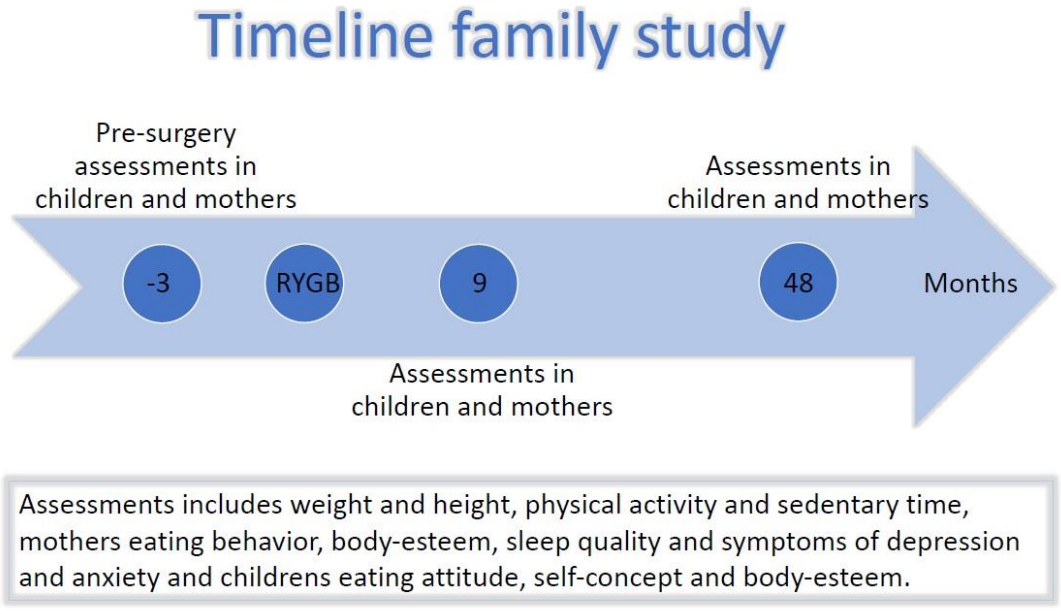

Figure 2. Timeline for the data collection of a 4-year cohort study, referred to as the family study in this thesis.

Figure 2 shows the times of assessment. For this thesis, data was collected at 4-years post-surgery, and the earlier assessments are included in two previous PhD theses with 6 published papers [135, 141, 142, 144, 148, 171]. PA data was collected via accelerometers worn on the right hip for one week. Weight, height and waist circumference were measured at participants' home at all time points. All other outcomes were measured through questionnaires. Women who underwent RYGB surgery, their children (aged 7-14 at baseline) and their partners (if they had one) were asked to join the study, and those willing to participate were measured as shown in figure 2. As not all women had partners, and there were several who dropped out or had ended their relationship at the 4-year follow-up, very few partners remained. Thus, partners were not included in this thesis.

Those who participated in the follow-up measurements each received a cinema ticket voucher as thanks, and at the fourth visit they also received a summary in Swedish of earlier results. Those who expressed interest also received the published articles from the previous data collections.

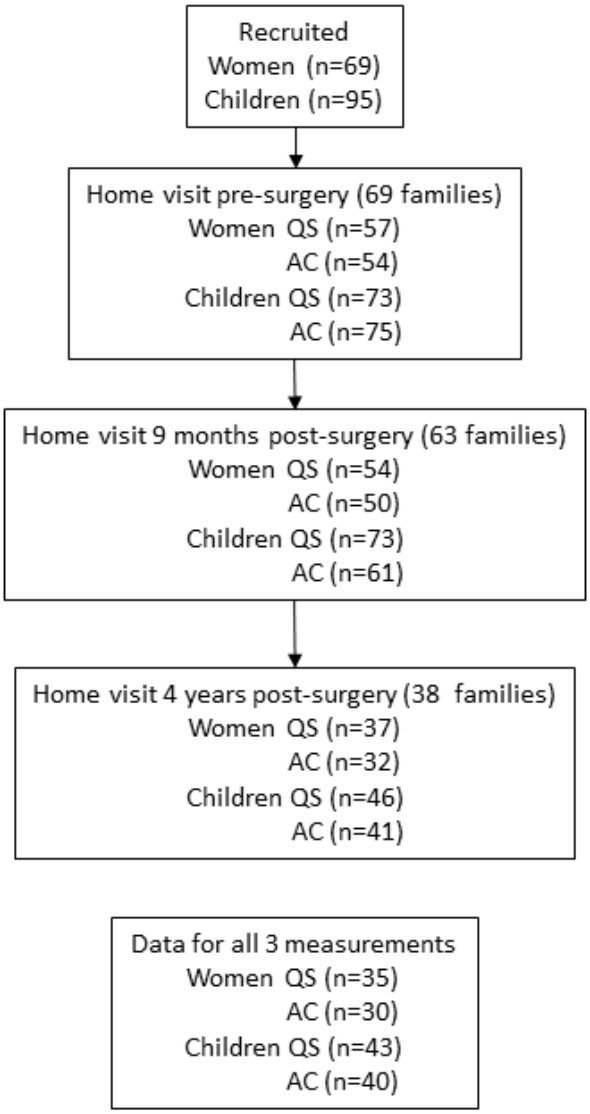

Figure 3. Participant flow of the family study. Number of families visited at each assessment and number of women and children with available data. QS: answered at least one questionnaire, AC: valid accelerometer data.

Figure 3 shows the available amount of data for each time point and those with all 3 assessments, in women and their children, separated into questionnaires and accelerometer data.

Anthropometric measurements
Weight was measured at the families' homes using a calibrated scale (VB2-200-EC, Vetek AB, Väddö, Sweden) at all assessment points. Height was measured with a portable stadiometer (Seca 213, Chino, CA, USA). Waist circumference was measured between the upper part of the hip bone and the belly button. If participants did not want to take part in specific measurements, this was respected. This was the case for some children/ adolescents who were not comfortable with having their weight measured.

4.2 WELL-GBP TRIAL

The WELL-GBP trial is a dissonance-based intervention study which started in January 2015. Participants eligible for RYGB surgery and able to speak Swedish were recruited from the same 5 hospitals as for the family study, (St: Görans Hospital, Danderyd Hospital, Ersta Hospital, Uppsala University Hospital and Örebro University Hospital). Participants were recruited at the hospitals by either the surgeons, or by a researcher from our team during the pre-surgery information meetings. A more detailed description of the study methods has been previously published and is included in this thesis, see study 3 "Protocol paper". However, I will briefly describe some of the methodology for the WELL-GBP trial. The study was approved by the Stockholm Regional Ethical Review Board with Dnr: 2013/1847-31/2 and registered in the ISRCTN registry with ISRCTN16417174. All participants provided written and oral informed consent to participate. An overview of the timeline is presented in figure 4.

All time-points included objective measures of PA and weight, and several questionnaires were completed. More details on the outcome measures can be found under section 4.3 measurements. Data collection up to 12-months follow-up is completed, and thus included in this thesis. Weight and height were collected through hospital records. Two researchers from our team validated the scales and found a maximum difference of 0.4 kg in one scale, but most scales had less than 0.1 kg difference.

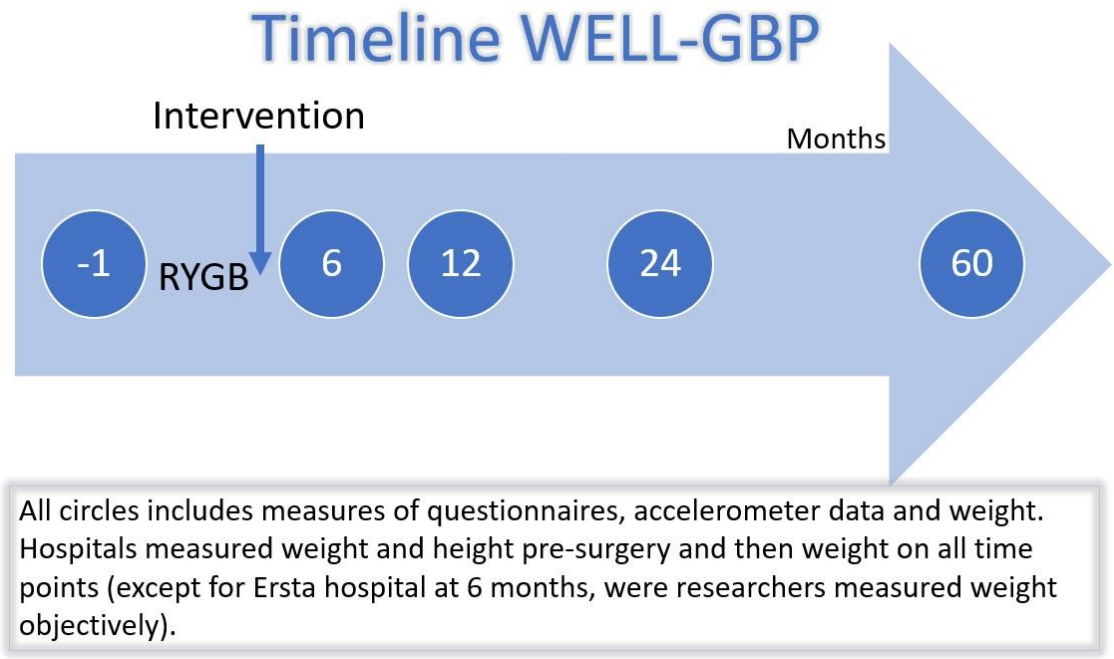

Figure 4. Timeline with 5 assessment points for the WELL-GBP trial. Intervention was done around 2-3 months post-RYGB surgery.

The intervention was delivered 2-3 months post-RYGB surgery and consisted of four group sessions of 1.5 hours each, once a week for four consecutive weeks. Each session focused on a different topic known to be potentially difficult after RYGB surgery ((1) PA, (2) eating behavior, (3) social relationships and (4) intimate relationships). The intervention format was built on Stice's dissonance-based intervention for preventing eating disorders "the Body Project" and also inspired by "Project Health" which focused on preventing unhealthy weight gain [168]. Like the Body Project [172], we developed a written manual to be used by a moderator during the group session. M.W., A.G. and myself developed this manual based on earlier experience and literature on common issues after bariatric surgery [173]. The intervention was created in order to induce dissonance to prevent worsening of HRQoL, increase PA and prevent or improve other psychosocial outcomes two years after RYGB surgery. The topics are discussed in detail in the protocol paper, study 3. The four sessions included mostly discussions on how to deal with possible problems which might arise in the future or which the participants were already experiencing. They also included a quiz, role play, homework and, in some sessions fictional letters for participants to take a stand on. After the start of the project, a booster session, around one-year after surgery, was added to summarize and follow-up participants. This session was not included in the analysis since it was not part of the dissonance-based intervention program, but more of a follow-up session.

Participants were randomized to intervention (n=153, 60%) or control (n=103, 40%) group after RYGB surgery. The control group received standard care after RYGB surgery, and the intervention group received the group sessions in addition to the standard care. Standard care differs somewhat between hospitals, but in general consists of weight measurements, diet consultations and a check for possible

surgical complications. Usually done around 6 weeks, 6 months and one- and two-years post-surgery.

Participants received a cinema ticket or voucher worth 100 Swedish kronor for each completed measurement as thanks for their participation, together with their accelerometer data, if provided.

Power calculations

New power calculations were conducted after those published in study 3 (the protocol paper), based on participants with complete one-year follow-up data. Initial power calculations estimated that a total of 240 subjects needed to be recruited. We recruited 259 participants and in study 5, our total number of participants with complete follow-up data was 203 (intervention group n=120 and control group n=83). With a significance level of 5%, the statistical power was still more than 90% to detect the pre-planned moderate effect sizes (Cohen's d=0.5).

An extended version of the published participant flow in the protocol paper is presented in figure 5. It shows overall participant flow and also the flow for participants attending different amount of group sessions.

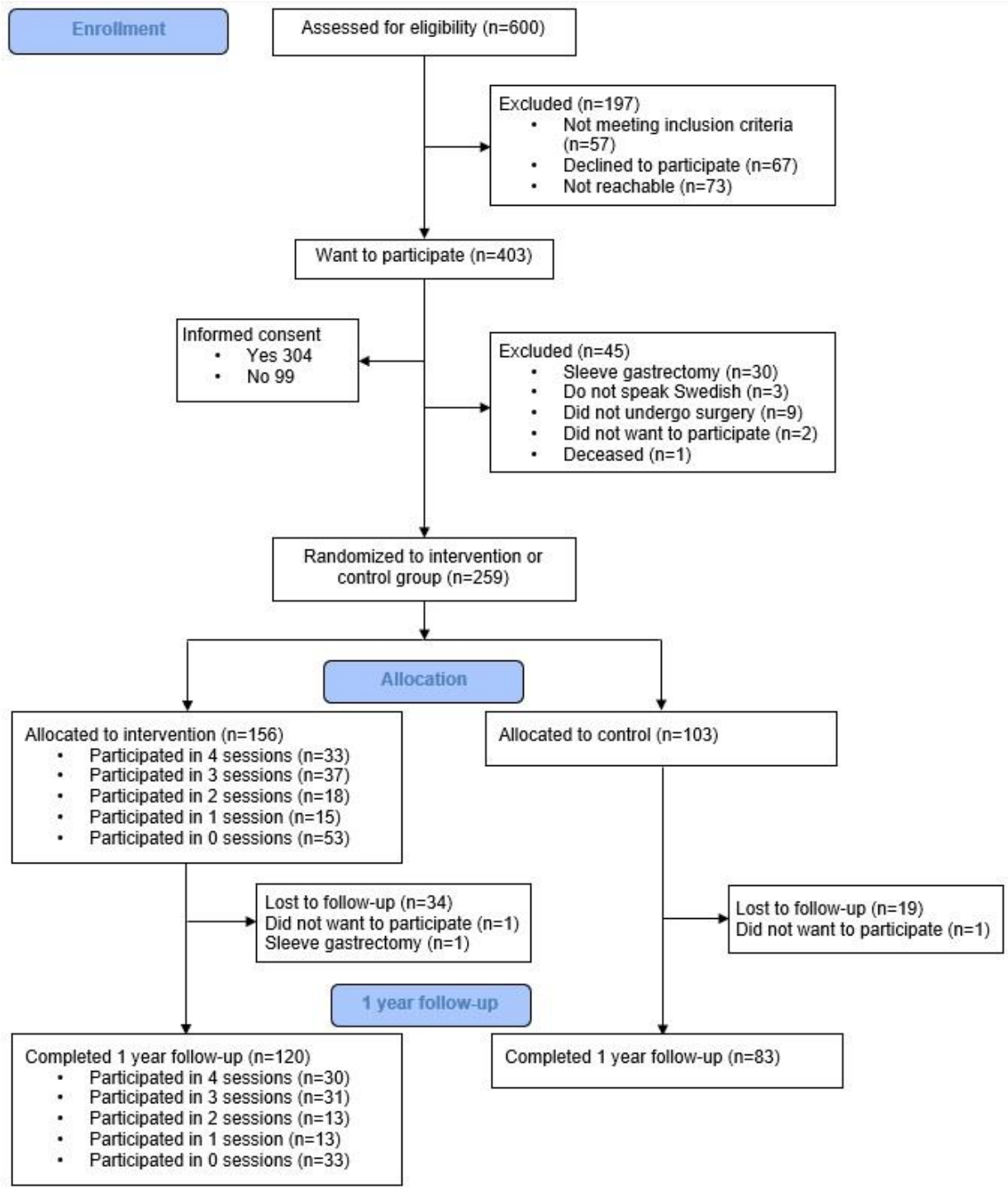

Figure 5. Participant flow chart from the WELL-GBP trial up until one-year follow-up.

4.3 MEASUREMENTS

Study 1	Study 2	Study 3	Study 4	Study 5
TFEQ (women)	PA (MVPA, LPA and ST) children and women	SF-36	PA (MVPA, MVPA in bouts, LPA, ST and step counts)	SF-36
HADS (women)	PA recommendations	TFEQ	PA recommendations	TFEQ
KSQ (women)		BES	SF-36	BES
BES (children)		SAS		SAS
BYI-S (children)		DEBS		DEBS
ChEAT (children)		PA (MVPA, LPA and ST)		PA (MVPA, LPA, ST and step counts)
				PA recommendations

Table 1. Overview of measurements used in the five studies.

4.3.1 Physical activity

Physical activity was measured with the same methods in both data collections, namely the GT3X+ accelerometer (ActiGraph, Pensacola, USA), measuring tri-axial movement with previously shown accuracy [174]. The tri-axial vector magnitude (V_m) activity counts were used in the analyses, calculated as the square root of the triaxal counts sum, recorded in 10-sec epochs and then tranformed into counts per mintues (cpm). Non-wear time was removed from the analysis, classified as 60 minutes of no counts with a maximum interruption of 2 minutes with non-zero counts, by Choi et al. [175]. Wear time was also derived from an algoritm by Choi et al. [175] and calculated together with bouts with the *ActiLife v.6.13.3* for study 3-5 and with the *PhysicalActivity* and *Accelerometry* R-packages (https: cran.r-project.org) for study 2.

Women and children in all studies were asked to wear the accelerometer for 7 consecutive days, all waking hours, on their right hip according to a visual picture included in the information. Cut points for ST were all counts below 100 per minute for adults and 180 for children. Light physical activity (LPA) was classified as between 100-3208 cpm for adults and 180-3360 for children and MVPA as more than 3208 cpm in adults and over 3360 cpm for children [176, 177]. In study 2, we included women and children with at least 10 hours wear time per day for at least 4 days, of which one had to be a weekend day. We only included particiapts with complete follow-up data on all three time points. In study 3, this wear time

minimum was used, but for study 4 and 5 a threshold of 3 days or more with at least 10 hours was used, in order to strike a balance between drop-out levels and quality of data [178, 179]. Table 1 shows the types of measures of PA that were included in the different studies. PA recommendations were taken from WHO recommendations on PA, which consist of 150 min of MVPA per week. Previous it was included that the activity needed to be in bouts of at least 10 min [180], but in WHOs latest factsheet on PA and in the second edition of the “Physical Activity Guidelines for Americans” this is not include anymore. Which is in line with a recent study showing that PA has positive health impacts however accumulated [181].

4.3.2 Questionnaires

Table 1 shows an overview of which questionnaires were used in each study. For both data collections there were also some additional background questions. The WELL-GBP trial included questions on long-term sickness, diabetes prevalence, tobacco and alcohol usage, education, working and living situation. For the family study there were questions on tobacco use, working situation, diabetes prevalence, education and whether the participants were currently living with the same partner as before surgery.

SF-36

The 36 item Short-Form Health Survey is a generic questionnaire designed to measure HRQoL in different populations. It is a stable instrument for repeated measures in healthy populations [182], has shown good construct validity and high internal consistency, both in its original version [183] and in the Swedish translated version [184, 185]. It has been tested in people suffering from severe obesity with acceptable validity [186] and it is widely used to measure HRQoL before and after bariatric surgery [65].

SF-36 is divided into eight domains: physical functioning, role limitations due to physical health problems (role physical), bodily pain, general health, vitality, social functioning, role limitations due to emotional problems (role emotional) and mental health. Scores are transformed into a 0-100 scale, where 100 represents perfect HRQoL. Two summary scores are created, physical component summary score (PCS) and mental component summary score (MCS).

Examples of questions are “How much bodily pain have you had during the past 4 weeks” with a scale from 1 (none) to 6 (very severe) or “My health is excellent” with a scale from 1 (definitely true) to 5 (definitely false).

TFEQ

The Three-Factor Eating Questionnaire is a 21-item scale measuring eating behavior in three domains: cognitive restraint (TFEQ-CR) (controlling food intake to influence weight and shape), emotional eating (TFEQ-EE) (overeating in relation to negative mood states) and uncontrolled eating (TFEQ-UE) (feelings of loss of control over eating) [187].

The questionnaire (21-item version) has shown acceptable validity in obese and normal weight Swedish samples [187] and has been tested in a mixed population with normal-, over- weight and obese individuals [188]. It has been used to measure eating behavior before and after RYGB surgery previously [116, 142, 189].
The items have a 4-point likert-type scale with higher scores indicating higher cognitive restraint, emotional and uncontrolled eating. Examples of questions is “I consciously hold back on how much I eat at meals to keep from gaining weight” (cognitive restraint), “ When I feel tense or “wound up”, I often feel I need to eat” (emotional eating) and “I’m always so hungry that it’s hard for me to stop eating before finishing all the food on my plate” (uncontrolled eating).

DEBS

In addition to TFEQ, the Disordered Eating after Bariatric Surgery (DEBS) questionnaire was used in all follow-up measures in the WELL-GBP trial. This scale was developed by Ghaderi et al. to specifically measure disordered eating after bariatric surgery for the previous month (28 days). It includes seven items, with a higher score indicating a higher rate of disordered eating. It has shown good reliability, validity, test-retest reliability and internal consistency [190].
Participants are asked to state the number of days out of the last 28 days that they have been eating although they were full, grazing throughout the day (more than what is recommended) and eating too much in a short time in relation to the new size of their stomach. The remaining questions are related to these first 3 questions and ask, for example, “how many of these days have you vomited?”.
Because of the open questionnaire format, some patients have replied with words instead of numbers, and in order to achieve consistency within the sample a manual was developed on how to score from text. Additionally, all questionnaires were double-checked for correctness and recoded if they differed.

ChEAT

The Children’s Eating Attitudes Test consists of 26 items in the form of statements originally adapted from the “Eating Attitudes Test” [191]. It is designed to measure children’s disordered eating attitudes and behaviors with good validity and reliability [192]. The instrument has been translated into Swedish and has been previously used in a Swedish sample of children in 5^{th} and 8^{th} grade [193].
Children answer the statements on a six-point likert-type scale from “never” to “always”. “Never”, “rarely” and “sometimes” result in a score of 0, “often” gives a score of 1, “very often” a score of 2 and “always” a score of 3, with higher scores thus indicating worse eating attitudes. The maximum score is 78. A score of 20 or more has been shown to be of clinical importance [191].
Examples of items from the questionnaire are “I stay away from eating when I am hungry”, “I think about food a lot of the time” and “I feel very guilt after eating”. Question 25 is reverse-scored; “I enjoy trying new rich foods”.

BES

The Body-Esteem Scale is a 23-item questionnaire measuring body-esteem (self-evaluations of one's body or appearance) in subscales: Attributions of positive evalutations about one´s body and appearance to others (BES-ATT), general feelings about appearance (BES-APP) and weight satisfaction (BES-W) [194]. It was originally designed for children with 24 items and a yes-no answer structure [195], but has been developed into a 5-point likert-type scale (rating amount of agreement) to fit adolescents and adults [194]. It has shown high test re-test reliability and good discriminant validity [194]. For the family study we used a Swedish translation of BES developed by Erling et al. more suitable for children [196] but with the new likert-type scale. With small adjustments in the language, the scale also fit adults and was used in the WELL-GBP trial.

An example of BES-ATT is "My friends like my appearance", BES-W "I'm satisfied with my weight" and BES-APP "I like what I see when I look in the mirror", and all questions are answered with "never" (0) to "always" (4). Higher score indicates better body-esteem.

BYI-S

The Beck Youth Inventory (self-concept subscale used in this thesis) measures children's own perceptions of their competency, self-worth and positive relations with others [197]. It is a 20-item questionnaire with a six-option likert-type scale ranging from "never" (0) to "always" (3). The answer "never" gives 0 points, "sometimes" and "seldom" gives 1 point, "often" gives 2 points and "very often" and "always" gives 3 points, which are then summarized into one total score. This score is then transformed into percentiles based on 2360 Swedish school children (normative data in this case). Scores that end up in the 26-89 percentile are considered average, over the 90th percentile is considered high self-concept and between 11-25th percentile is considered low, with 10th or lower considered very low self-concept.

The scale seems reliable and valid in children 7-14 years old [198].

The questions are in the form of statements, examples: "I have a good memory", "I'm just as good as other children" and "People want to be with me".

HADS

The Hospital Anxiety and Depression Scale is a widely used instrument with 14 questions measuring depression and anxiety. It performs well in assessing symptoms as well as cases in a variety of people (general population, primary care and psychiatric patients) [199], including in a Swedish sample [200]. It has been used in assessing depression and anxiety among bariatric surgery patients before [201-204].

The scale is divided into two subscales HADS-A (anxiety) and HADS-D (depression). It is scored from 0-3 with higher scores indicating higher levels of depression and anxiety, and 21 is the maximum score for each subscale. Additionally, different cut-offs have been discussed. In the current thesis, a score ≥ 8 was taken to be indicative of showing symptoms of depression or anxiety [199].

Examples of the depression part of the scale is “I feel cheerful” or “I still enjoy the things I used to enjoy” and is answered with four options for the last week. “I get sort of frightened feeling as if something awful is about to happen” and “I can sit at ease and feel relaxed” is examples of the anxiety part of the scale.

SAS-SR

The Social Adjustment Scale – self reported is a 42-item questionnaire developed as a self-report questionnaire from an interview tool [205] and has a wide applicability in a range of subjects [206]. In this thesis we used a modified version from an American to a British population [207], then translated into Swedish.

The questionnaire includes six role areas: work or housework, social and leisure activities, interpersonal relationships with partners, with children, the family unit and the extended family. It is answered from a perspective of the past 2 weeks and uses a 5-point likert-type scale ranging from “not at all” to “all the time”. Higher scores reflect greater impairment.

Examples are: Over the past two weeks have you: “Got angry with a or argued with people at work”, “Done the necessary housework each day” or “Been able to talk about your feelings and problems with your partner”.

KSQ

The Karolinska Sleeping Questionnaire measures disturbed sleeping, symptoms of insomnia, repeated and early awakenings, difficulties in waking up, nightmares, snoring, daytime sleepiness and insufficient rest, using 26 questions [208]. The questionnaire is then divided into four indexes: insomnia, snoring, awakening problems and sleepiness/fatigue. The first 18 questions are answered on a six-point likert-type scale ranging from “never” (0) to “always” (5) and are referred to as the index scores. “Difficulties to fall asleep” and “Nightmares” for the last three months are examples of questions. These are then followed by questions regarding participants’ usual wake-up times and bedtimes, which are mainly of importance for clinical use. In study 1, where this scale is included, only the first 18 questions were used. The index score was summarized in order to be able to compare overall sleep quality, and a higher score indicates better sleep quality.

KSQ has proven to be both a reliable and valid instrument [209] and has been mainly used in Scandinavian countries [210-212].

4.4 STATISTICAL ANALYSES

Studies 1-2 are longitudinal by design, with repeated measurements within the same individuals. This means that when analyzing changes in outcomes, fixed factors such as genetics, and to some extent, environmental factors, are controlled for by design. Since a number of participants dropped out at the 4-year follow-up, results from multiple regression analysis would have been unstable. Thus, a more descriptive approach was taken.

Study 3 includes baseline descriptive data characteristics and, as the main outcome, SF-36 and PA measurements, divided into control or intervention group.
Study 4 uses data from the WELL-GBP trial, but does not evaluate the intervention itself, but rather has another approach, investigating the association of HRQoL with PA. As the intervention aimed at improving HRQoL and PA, we only included the control group, where HRQoL and PA were not altered. Regression models were used to evaluate whether PA was associated with HRQoL in women with obesity before surgery and one year after RYGB surgery.
Study 5 aims at comparing control with intervention group one year after RYGB surgery. As a feature of the RCT design, the groups should not differ at baseline. Thus, comparing the outcomes at one year between the two groups is a good approach to examine possible effects of the intervention. Intention to treat (ITT) analysis was planned but because of drop out it was only conducted using participants with complete follow-up data [213]. Additional per protocol analyses were conducted using those receiving the intervention according to protocol (attending ≥ 3 group sessions).
BMI was calculated as the weight divided by the height squared (kg/m^2). Children's prevalence of overweight and obesity was calculated with age- and sex- specific cut-off points according to Cole et al. [214].
Missing data on a particular scale resulted in exclusion from that specific scale or subscale.
Analyses for study 1, 2 and 3 were made using STATA 14.1, and, for study 4 and 5, STATA 15.1 (StataCorp).

4.4.1 Statistical methods for study 1

Descriptive statistics of anthropometric variables and of mothers' and children's questionnaire data are presented for each assessment point with means and standard deviations (SDs) or frequencies and proportions, for continuous and categorical variables, respectively. Differences between the first and the second assessment, the second and the third assessment, and the first and the third assessment were calculated using paired t-tests or McNemar's test for continuous and categorical variables, respectively. Pearson correlations were calculated between mothers' BMI, children's BMI, mothers' TFEQ and children's ChEAT scores, in order to find possible associations between the mothers and their children.

4.4.2 Statistical methods for study 2

Similar as in study 1, descriptive statistics of anthropometric measures and PA variables were calculated as means and SDs or frequencies and proportions, and differences between the three measures were evaluated with paired t-tests or McNemar's test. The prevalence of meeting with PA recommendations (150min MVPA/week, with and without criteria of in 10 min bouts) for adults and children (60 min MVPA/day) was presented graphically. Additional sensitivity analysis

was performed, comparing the original study population with the study population presented in this study with valid PA at all three assessment points. Furthermore, all the analyses above were repeated with children and women who had at least 5 days of at least 12 hours data per day in order to find possible differences between those with lower-quality PA data, but no differences were found for any of the sensitivity analyses conducted.

4.4.3 Statistical methods for study 3

The statistical analyses described in the study protocol included analyses for the end of the study, which was planned to 2 years after surgery, but this has now been extended to 5 years post-surgery. For the present paper, chi^2 and t-test/Kruskal-Wallis test were used to compare independent means and proportions between baseline variables of the intervention compared to control group. Means and SDs or frequencies and proportions were used for presentation of baseline data, characteristics, SF-36 and PA.

4.4.4 Statistical methods for study 4

As previously described, data in this study is presented as means and SDs or frequencies and proportions and two-tailed t-tests used to compare differences between baseline and one-year data of BMI and PA. For the analysis of LPA, ST and step counts with SF-36 summary and sub-scores, multiple linear regressions were used, adjusting for confounders (occupation, long-term sickness and accelerometer wear time). Meeting with PA recommendations or not (> 150 min MVPA/week, with and without criteria of in 10 min bouts) was analyzed using multiple regression models, with SF-36 as an outcome. These regressions were adjusted for accelerometer wear time, occupation, long-term sickness and education. All analyses were conducted cross-sectionally at pre-surgery and one-year post-surgery. Sensitivity analyses were performed on participants with valid SF-36 and PA data at both measurements. Long-term sickness was defined as having a chronic disease, reduced physical function or long-term health condition, with reply alternatives “no”, “yes but it does not limit me”, “yes it limits me to some degree” or “yes, and it limits me to a high degree”.

4.4.5 Statistical methods for study 5

ITT analyses was done as described above with t-statistics, Wilcoxon signed rank test (non-normally distributed variables) or chi^2 (binary outcomes) to test for differences in outcomes between the intervention and control group. Effect sizes were calculated with Cohen’s *d* for all scales at one year. Per-protocol analyses were performed similarly but comparing those who received the intervention according to protocol with ≥ 3 group sessions, with the control group.

4.5 ETHICAL CONSIDERATIONS

All studies were approved by the regional ethical committee and all participants gave written and oral informed consent. However, there might still be some ethical aspects to consider.

For study 1-2, the main possible issue would be that weighing children might have a negative impact on their mental wellbeing. It is possible that children with overweight or obesity, especially, might feel uncomfortable being weighed because of shame or guilt related to the thin idealization. However, we did not attempt to persuade anyone to weigh themselves and were very careful with children who felt uncomfortable to not try to force or push them, resulting in some children not being weighed. Thus, we do not think it caused any harm and that long-term effects should be minimal. Additionally, women and children filled in questionnaires on topics that may be regarded as sensitive to some people, and that may have affected their wellbeing with triggering thoughts about eating behavior, self-esteem etc. We did not have any participants expressing such concerns, and if this should have occurred, A. Ghaderi, professor of clinical psychology, was in our team to catch these cases.

For study 3-5, there are similar concerns regarding the questionnaires, as discussed above. Additionally, the intervention itself might have had a negative effect on the participants' wellbeing. The intervention was designed to improve quality of life and other psychosocial factors, and thus we do not think it would have a negative impact. However, we cannot know how people are affected, and talking about sensitive topics in a group with other woman might cause distress. For example, if one participant did not agree with the rest of the group or experienced problems others were unable to relate to. The moderators of the groups tried to prevent this to the best of their ability by being open and adding comments that, for example, something might be a common issue, even though nobody else in this group have that experience. The group sessions were also evaluated by both Prof. Ghaderi, through video recordings of each session, and through evaluation questionnaires after the group sessions, and no problem of this kind were alluded to.

Altogether, it is the researchers' belief that the benefit from our studies by far outrange the possible harm that they may cause.

5 OVERVIEW OF THE FIVE STUDIES

	Study 1	**Study 2**	**Study 3**	**Study 4**	**Study 5**
Study material	Family study	Family study	WELL-RYGB	WELL-RYGB	WELL-RYGB
Outcome	Children´s body esteem, eating attitude, weight, self-concept and mothers' eating behavior, sleep quality depression and anxiety	Mothers' and children´s physical activity and sedentary time, objectively measured	Descriptive study design and method of the trial.	Health-related quality of life	Physical activity, sedentary time, health-related quality of life, eating behavior, social adjustment, body-esteem
Predictor variable	Mothers' RYGB surgery	Mothers' RYGB surgery	-	Physical activity and sedentary time	Intervention vs. control
Participants (N)	35 mothers and 43 children	30 mothers and 40 children	259 recruited women	66 pre- and 62 post-surgery	203 women
Follow up time	4 years	4 years	Planned for 5 years	1 year	1 year
Statistical analyses	Descriptive, differences in means between pre-surgery, 9 months and 4 years post-surgery	Descriptive, differences in means between pre-surgery, 9 months and 4 years post-surgery	Descriptive statistics and differences in means between the two groups at baseline	Regression models and graphically associations between PA and HRQoL	Effect sizes and differences in means between intervention and control group
Results	Several variables improved 9 months post-surgery but then rebound at 4 years.	Children decreased MVPA and increased ST and women's PA remained unchanged	There was no difference at baseline between the intervention and control group	Participants reaching PA guidelines had better HRQoL pre- and post-RYGB	There were no differences between the two groups
Conclusion	Mothers' RYGB could affect children´s wellbeing	There were no improvements in PA in children, nor their mothers pre- to post-RYGB	If the intervention is effective it can easily be implemented in Swedish post-surgical health care	PA is associated with HRQoL in obese individuals pre- and post- RYGB	There were no early effects of a dissonance-based intervention in any of the measured outcomes post-RYGB.

Table 2. Overview of the studies.

6 RESULTS

6.1 STUDY 1

Thirty-five women and 43 of their children participated in all three measurements. Women reduced their BMI from 39.2 to 27.0 from before to 9 months post-surgery and remained weight stable until 4 years. The prevalence of children with overweight were reduced by the 9 months follow-up after their mothers' RYGB surgery compared to baseline (from 20 to 16 children) and kept stable to 4 years, but the number of children with obesity increased from pre-surgery (n=5) and 9 months post-RYGB (n=5) to 4 years follow up (n=10).

Figure 6. Women's Karolinska sleep questionnaire (KSQ) and three-factor eating questionnaire (TFEQ) scores for all timepoints.

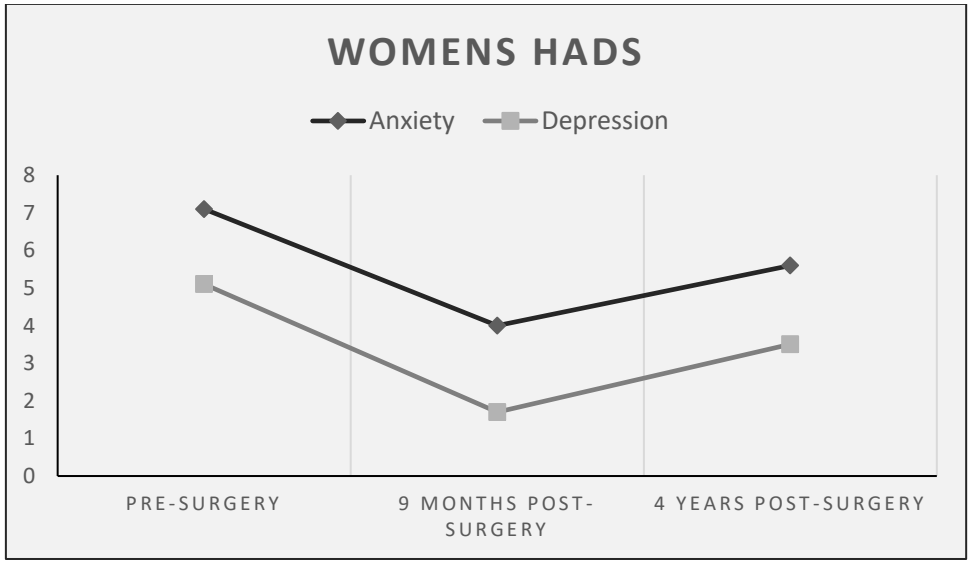

Figure 7. Women's hospital anxiety and depression scale (HADS) scores for all timepoints.

All women's scales and subscales improved 9 months post-surgery (except TFEQ-CR) and then declined 4 years post-surgery, however not all the declines

were statistically significant or clinically relevant, figure 6 and 7. At 9 months post-surgery had 77 % the same partner as before surgery, the same number for 4 years was 68 %.

Children's body esteem and self-concept subscales declined significantly by time, see article 1, table 3. Eating attitudes first improved, 9 months post-surgery, and then declined at 4 years to end up worse than pre-surgery, not significantly so, 0.7 increase from 9 months to 4 years ($p = 0.370$). Thus, children's eating attitudes followed the same pattern as mothers' eating behavior. However, children's individual changes showed a great variation.

Mothers' eating behavior was positively correlated with children's eating attitudes pre-surgery but not at follow-up. Mothers' and children's BMI did not correlate with each other.

6.2 STUDY 2

The study population included the 30 women and 40 of their children with valid accelerometer data on all three time points. They did not differ significantly from the 69 women and 95 children recruited from the start. Weight-related data was similar to study 1, since most participants were included in both studies. Women's wear-time was around 14.7 hours/day and children 14.0 hours/day.

Women's physical activity and sedentary time did not change after RYGB surgery. However, more women met the recommended 150 min of MVPA/ week in 10 min bouts, but less met the recommendations without 10 min bouts, figure 8.

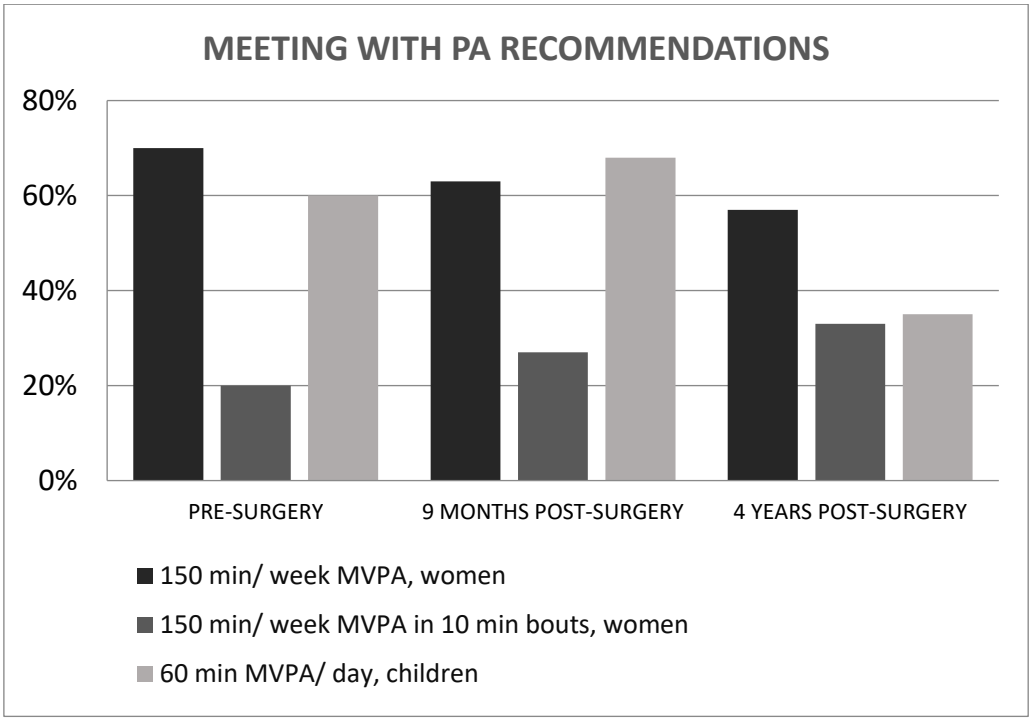

Figure 8. Percentage of women and children meeting with the PA recommendations, for women with or without in 10 minutes bouts. Moderate to vigorous physical activity (MVPA).

Children decreased their MVPA and LPA by time, from 72.6 (SD = 37.9) to 69.1 (SD = 33.4) to 59.4 (SD =35.7) for MVPA min/ day and from 446.2 (SD =90.3) to 417.9 (SD = 92.7) to 364.0 (SD =86.2) for LPA min/ day. Sedentary time increased by time, illustrated in figure 9. However, the number of children meeting with PA recommendations first increased slightly, from pre- to 9 months post-surgery, and then decreased, figure 8. However, the decreased PA among children can be an effect of increased aged.

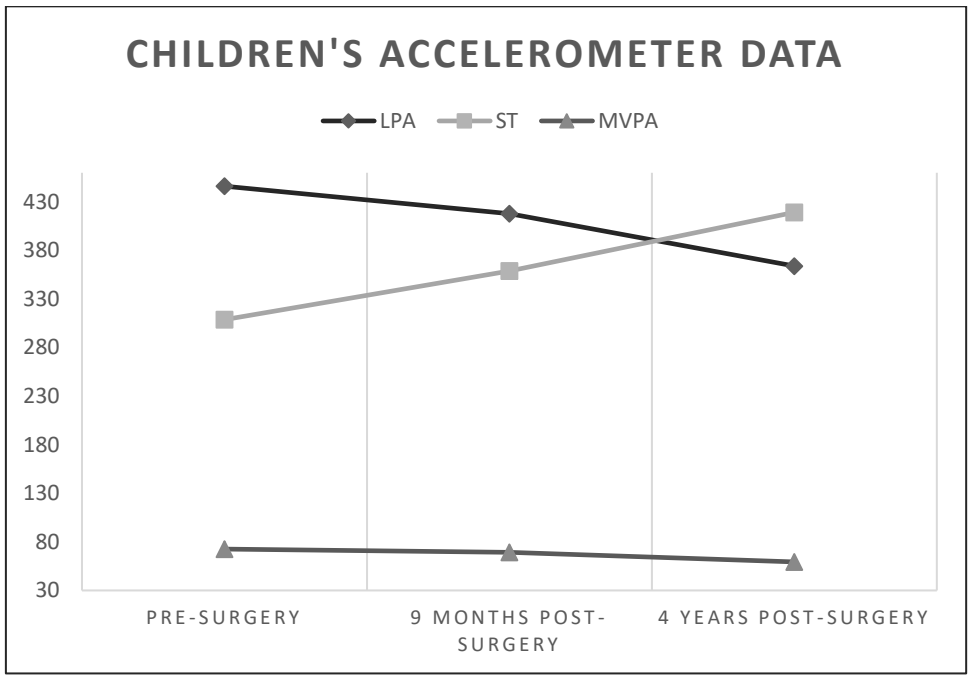

Figure 9. Children's moderate to vigorous physical activity (MVPA), light physical activity (LPA) and sedentary time (ST) in minutes/ day.

6.3 STUDY 3, STUDY PROTOCOL

The study protocol presents a detailed description of the WELL-GBP trial. It also includes some results from the baseline data. In the method section of this thesis, the flowchart diagram of the participants can be found. We expected a larger drop-out in the intervention group and therefore 60 % vs. 40 % were assigned to the intervention group.

As seen in the flowchart, figure 5, many participants did not attend the offered group sessions, even though all participants recruited to the study showed great enthusiasm for the group sessions. Around one third did not attend any session at all. Less than half of the intervention group received the intervention according to the protocol, with 44.8 % attending at least 3 sessions.

The randomization was considered "successful", since there were no differences between baseline data in the intervention vs. the control group. Some variables are presented in table 3. Additionally, participants wore the accelerometer for an average of 14.4 hours per day and had 6.7 valid days. From the intervention group, 155 participants had valid SF-36 data and 97 had valid accelerometer data at baseline. The corresponding numbers for the control group was 102 and 58 participants, respectively.

Variables	Intervention (n = 156) % (n)/mean (SD)	Control (n = 103) % (n)/mean (SD)	p-value
Age (years)	43.6 (10.7)	45.1 (10.1)	0.218
BMI (kg/m²)	40.7 (4.3)	41.2 (5.2)	0.712
Daily smokers	6.4 (10)	6.8 (7)	0.902
Education			0.535
Primary	12.3 (19)	8.7 (9)	
Secondary	56.1 (87)	54.4 (56)	
Post-secondary	31.6 (49)	36.9 (87)	
Born in Sweden	86.6 (97)	79.7 (59)	0.212
PCS	41.6 (9.5)	42.9 (9.6)	0.205
MCS	45.8 (11.0)	45.9 (11.3)	0.848
MVPA (min/day)	28.8 (17.4)	28.8 (22.4)	0.579
LPA (min/day)	369.4 (88.1)	380.2 (78.1)	0.518
ST (min/day)	465.1 (98.0)	447.0 (104.1)	0.399

Table 3. Characteristics and some primary outcome data at baseline, for the WELL-GBP trial, p-value for differences between the two groups. PCS = Physical Component Summary Score, SF-36, MCS = Mental Component Summary Score, SF-36, MVPA = Moderate to Vigorous Physical Activity, LPA = Light Physical Activity, ST = Sedentary Time.

6.4 STUDY 4

The study population consists of 90 women from the control group of the WELL-GBP trial, with at least one valid accelerometer measurement (pre- or 12 months post-surgery). Sixty-six participants had valid accelerometer and SF-36 data pre-surgery and 62 post-surgery, and of those, 39 had valid data on both measurements. Mean BMI pre-surgery was 40.9 (SD = 5.3) and 12 months post-surgery it was decreased to 28.1 (SD = 4.2). Mean age pre-surgery was 44.5 years, 32 % had education of at least university levels, 76 % were working and 59 % suffered from long-term sickness, which changed to only 27 % 12 months post-surgery. Participants increased their SF-36 scores from pre- to post-RYGB. The only significant improvement in PA was seen in step counts, 5971 steps pre-surgery to 7512 steps post-surgery, p = 0.014. Figure 10 shows the percentage of participants reaching the PA recommendations (150 min MVPA/day with and without the 10 min bout) pre- and post-surgery.

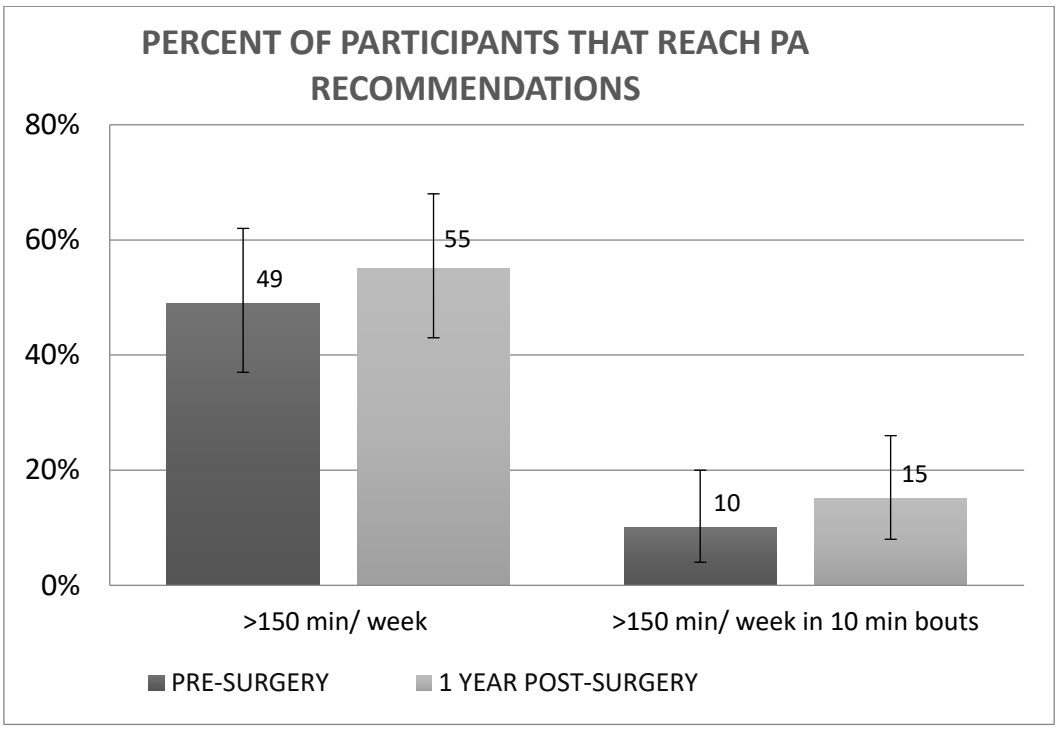

Figure 10. Percentage of participants reaching the PA recommendations pre- and one-year post-RYGB surgery.

Participants reaching the recommended level of PA had around 5 points higher MCS and PCS scores pre-surgery. These associations disappeared after adjusting for relevant confounders, except for some subscales. Vitality and mental health still had around 10 points higher scores in those reaching the recommended levels of PA compared to not reaching them, pre-surgery. Meeting with PA recommendations in 10 min bouts were not significantly associated with SF-36 scores pre-surgery.

Post-RYGB surgery, participants reaching the recommended PA levels had significantly higher PCS score, both unadjusted and adjusted, compared to those who didn't. Reaching the recommendations in 10 min bouts only showed significant results in unadjusted models. Bodily pain was a big contributing factor to the sum score association. Participants reaching PA recommendations had 19.7 higher score in bodily pain (higher scores mean less pain) and 23.6 when reaching PA recommendation in 10 min bouts, compared to not reaching the PA recommendations. MCS were not associated with reaching PA recommendations post-surgery.

Pre-surgery, each increase of 60 minutes LPA/day was associated with a 2.6 higher MCS score and a 1.7 higher PCS score. After adjustments, the associations were smaller, 1.7 and 0.3, respectively. The strongest association was found for social functioning, which increased with 9.2 scores per each hour of increased LPA/day. After adjustments, it increased with 7.2 scores per each increased hour of LPA/day. Post-surgery associations were weaker.

Increased ST (60 min/day), were associated with lower vitality and social functioning scores pre- and post-surgery. Number of steps walked per day was

associated with several SF-36 scores but almost all of them were insignificant in the adjusted models.
There were no meaningful differences in any sensitivity analysis, using only those with both measures, or including those with non-valid accelerometer data.

6.5 STUDY 5

Baseline characteristics and participant flow are explained above.
There were no early effects of the intervention, but an improvement in most measured variables were seen from pre- to post-RYGB surgery. Main results are presented in table 4. Higher values in MCS, PCS, BES, MVPA, LPA and steps are positive and TFEQ, DEBS, SAS-SR and ST improves with a lower value.

VARIABLES	BEFORE (INT) N=120	BEFORE (CON) N=83	AFTER (INT) N=120	AFTER (CON) N=83	P-VALUE	COHEN'S *D*
MCS	46.9 (10.8)	46.4 (10.6)	53.0 (9.8)	52.3 (9.8)	0.450	0.07
PCS	41.8 (9.5)	43.4 (9.5)	53.5 (8.7)	54.1 (7.3)	0.661	-0.09
TFEQ	48.7 (9.4)	49.4 (9.0)	38.5 (8.6)	40.5 (8.2)	0.092	-0.24
BES	25.3 (12.7)	26.3 (11.4)	55.2 (18.5)	57.5 (15.8)	0.370	-0.13
DEBS	-	-	10.9 (18.9)	16.5 (27.0)	0.255	-0.25
SAS-SR	1.6 (0.5)	1.6 (0.5)	1.3 (0.4)	1.3 (0.5)	0.897	-0.02
MVPA	26.4 (17.8)	27.4 (20.9)	27.4 (17.5)	29.7 (22.2)	0.830	-0.05
LPA	356.3 (92.2)	372.4 (71.4)	392.7 (86.8)	401.8 (77.9)	0.500	-0.16
ST	474.4 (102.5)	447.6 (90.8)	480.5 (113.0)	456.3 (100.0)	0.169	0.37
STEPS	6054.9 (2353.0)	6314.1 (2629.7)	7388.6 (2677.6)	7547.2 (2888.3)	0.723	-0.07

Table 4. Mean scores and SDs before and after surgery for intervention group (int) and control group (con), p-value for the difference between the two groups after surgery, and effect sizes measured with Cohen's d. Participants with valid accelerometer data pre-surgery were 89 (INT) and 53 (CON), and post-surgery were 98 (INT) and 63 (CON). MCS = Mental Summary Score, SF-36, PCS = Physical Summary Scores, SF-36, TFEQ = Three Factor Eating Questionnaire, BES = Body-Esteem Scale, DEBS = Disordered Eating after Bariatric Surgery, SAS-SR = Social Adjustment Scale- Self-Reported, MVPA = Moderate to Vigorous Physical Activity/ day, LPA = Light Physical Activity/ day, ST = Sedentary time/ day and steps/ day.

7 DISCUSSION

Overall, women's wellbeing after surgery improves, but then decline again over time, as does children's eating attitudes. Children do not seem to be greatly affected in terms of body-esteem, self-concept or PA by their mothers' RYGB surgery. Additionally, a dissonance-based group intervention did not have any early effects on women's wellbeing or PA one-year after RYGB surgery. PA was associated with HRQoL both pre- and post-RYGB.

Hereafter, the studies are discussed by data collection, the family study and the WELL-GBP study, respectively.

7.1 DISCUSSION STUDY 1 AND 2

Women undergoing RYGB surgery experience major weight loss, and in this study their weight remained unchanged from 9 months up to 4 years post-surgery, which is not consistent with earlier research which shows a weight regain after 1-2 years [215]. This could be explained by a selection of participants with the greatest weight loss attending the 4-year follow-up. It has been shown that patients not attending their follow-up visit experience a total weight loss that was significantly less than those who attended all follow-up visits [216]. Another explanation may be that weight was measured too early. If nadir weight loss is 2 years post-RYGB surgery [215], it is possible that participants in our study lost more weight after 9 months, and had in fact regained at 4 years.

Children's BMI did not correlate with mothers' BMI, indicating that children may not be greatly influenced by their mothers' BMI. On the other hand, the frequency of children with overweight was lower at 9 months post-surgery, but not statistically significant, however, we had few participants. When looking at all children, Willmer et al. found a significant lower relative risk 0.85 (0.73-1.00) for children to be overweight 9 months post-surgery, indicating a possible effect on children [141]. At 4 years post-surgery, children had a higher obesity frequency while overweight was still lower than pre-surgery. However, none of these results were significant. Thus, we cannot be sure whether this is a random, or a real effect, due to inadequate number of participants to reach significance. The prevalence of both overweight and obesity is higher than that of the general population, and the increase in obesity seen in our study cannot be explained by increased age or the passage of time [217, 218].

Even though women lost significant amount of weight and kept their weight on average stable, their mental wellbeing (eating behavior, anxiety, depression and sleep quality) had a rebound effect, with great improvements at 9 months followed by a decline up to 4 years after surgery. Children's eating attitudes showed similar patterns and were correlated to mothers' eating behavior pre-surgery, indicating that mothers' eating behavior might have an influence on their children. However, there were no correlations of mothers' and children's eating behavior after surgery. In the general population, children's (or at least girls') eating attitudes worsen with age (5^{th} to 8^{th} grade) ChEAT score from 2.03 to 5.82

among girls in a Swedish sample [193]. Which is an increase of 3.79 over 3 years, compared to our sample's 5.3 to 6.0 after 4 years. This was only seen in girls, however, and the sample in this data collection had around 50 % girls. There might be an effect of mothers' RYGB surgery on children's eating attitudes, which is somewhat in line with the few other studies made in this area [140, 145].
Children's self-concept and body-esteem decreased over time. This is in line with other Swedish children entering adolescence, which many of the children in the current data collection did [219, 220]. Thus, without a control group we cannot say if mothers' RYGB surgery affected children's body-esteem and self-concept. However, if there would have been any effects, they were not large enough to improve body-esteem or self-concept after surgery.
Over 30 % of the women in our study did not have the same partner at 4 years post-surgery compared to pre-surgery. This is in line with another study [221] and could have several explanations, possibly connected to the big lifestyle changes patients often make.

Physical activity
Even though the women lost a large amount of weight, they did not become substantially more physically active after surgery, which might be surprising. On the other hand, undergoing bariatric surgery and losing weight does not automatically mean that someone suddenly develops an enjoyment of physical activity, if they did not have it before surgery. However, the great benefits of PA makes it a very important lifestyle change, especially after bariatric surgery, since it is also important for maintaining weight loss and for body composition [122, 124, 222]. In our study sample there were no differences from pre- to post-RYGB PA levels, but 70 % of participants already reached the PA recommendations of 150 min MVPA/week pre-surgery. Thus, they were quite active, possibly leaving less room for improvement. However, the American Collage of Sport Medicine recommends a much higher weekly MVPA level to maintain weight loss, > 250 min/ week [222]. Only around 12 % of our sample reached these levels.
Women may have switched to longer time periods of PA, since the percentage reaching PA recommendations in at least 10 min bouts increased from 20 % to 33 %, 4 years after surgery. Even though the percentage reaching the recommendations without the 10 min bout criteria decreased.
Altogether, the mothers did not seem to increase their PA levels and the children did not either. In fact, the children decreased their MVPA and LPA and increased ST from pre- to 9 months- to 4 years post-surgery. It is impossible to say whether the mothers could have influenced their children's PA, because PA tends to decrease by age in all children. However, the decrease seems to be similar to other populations [223] and since mothers did not increase their PA, it is hard to find a theoretical reason why they would affect their children's PA levels in a positive direction.

Strengths and limitations
These studies have some strengths. The long-term follow-up of 4 years in children of bariatric surgery patients is very valuable, since we know that several

lifestyle related behaviors change after the first 1-2 years after surgery. No other studies we are aware of have had an equally long follow-up period. Other strengths include objective measures of weight, height and PA. It is also a strength to have several follow-up measurements within the same individuals in order to examine changes over time.

The main limitation is the high drop-out rate from an already relatively limited sample from the beginning. This makes the results unstable and selection bias is very likely. Although, those included in the study from the beginning did not differ substantially from those presented in this thesis. It could still be that they differed after surgery. There is no way to be sure of this, but when comparing with the larger data set in study 5, emotional and uncontrolled eating was higher pre-surgery but better post-surgery in study 1, indicating a "healthier" selection of people. Another limitation is the lack of a control group. A control group would have made it possible to find differences between children of mothers undergoing RYGB surgery compared to children of mothers not undergoing surgery. However, such a control group would be hard to recruit. Identifying people with obesity and approaching them to take part in research because of their weight might not be ethically or practically possible. Another issue is the generalizability, since we only recruited women (because we thought they may differ from men and we could not collect the double amount of data) we cannot generalize the findings to men. On the other hand, we recruited from different hospitals from different regions, and thus the results might be representative of other women in Sweden.

7.2 DISCUSSION STUDY 3-5

We have conducted a randomized controlled intervention study, which has many methodological benefits by design. The main findings were that the dissonance-based group intervention did not have any early effect on HRQoL or other parts of wellbeing at one-year after RYGB. We also found a cross-sectional association between PA and HRQoL in women with obesity and in women post-bariatric surgery.

PA associations with HRQoL

Engaging in the recommended level of PA, accumulated in any way, was associated with clinically meaningful higher SF-36 scores and especially the physical part of SF-36. However, these associations were mainly confounded by long-term sickness. This makes sense, since long-term sickness could easily affect both quality of life and the patient's willingness and ability to take part in PA. After adjustment, there was still some associations between PA and HRQoL. PCS were 4.0 scores higher in participants engaging in more than 150 min MVPA per week after surgery, compared to those engaging in less MVPA. Additionally, physical functioning and bodily pain was associated with more PA after surgery, and mental health and vitality was associated with more PA pre-surgery. It should be considered that the amount of people reaching 150 min of PA/week

accumulated in at least 10 min bouts, were very few. Thus, these results might not easily reach statistically significance, but most variables were still in the direction of a positive association.

LPA and number of steps were also associated with HRQoL. Many of these associations were stronger pre-surgery than post-surgery. Participants improved their HRQoL substantially after surgery, likely associated with the massive weight loss. Thus, PA might have a smaller impact on their HRQoL. A longer study, covering the time when HRQoL commonly starts to decline again, would be interesting in order to examine if these associations became stronger again with declining HRQoL. However, the associations of meeting PA recommendations were not stronger after surgery, but rather the opposite. Additionally, when we included only participants who completed both measurements (i.e. the same individuals pre- and post-surgery), the same trend was not seen. Thus, the stronger association pre-surgery might only reflect a difference in study population.

One can only speculate on why the associations are stronger or weaker at different time points, but it is not impossible that the relationship between PA and HRQoL differs when being obese compared to after massive weight loss. Another study, by Stolberg et al., found a correlation between bout-related PA and step counts with physical functioning, general health and PCS pre-RYGB surgery but not 6 months after [224]. In the same study, a PA intervention was tested which gave immediately increased PA, but this was not maintained over time. The intervention had a small impact on HRQoL after RYGB surgery. The Bari-Active trial also tried to improve HRQoL with increased PA pre-surgery. They increased PA in the intervention group with a 6-week training program, which resulted in increased HRQoL compared to a control group, pre-surgery [136]. Another study has also found that increased PA improved HRQoL in bariatric surgery patients, however subjectively measured PA was used, and this makes it difficult to compare with other studies using objective measures [225].

Intervention effects

As has already been mentioned, there were no early effects of the intervention in any of the outcomes. However, there was a great improvement on most measured outcomes, in line with previous research [65, 81, 226, 227]. Other studies, that mainly focused on improved weight loss, have shown positive results from post-operative psychosocial interventions and support groups [149]. Even though weight loss was not an outcome in our study, there was a small, non-significant difference favoring the intervention group in our study (0.6 further decrease in BMI from pre- to post-surgery in the intervention group compared to controls). Few other intervention studies have included psychosocial outcomes, but one other study, similar to ours but featuring a more extensive intervention, exists. They found a later effect, around 3 years post-surgery, in the form of less deterioration of self-efficacy and depression [158]. Even though no effect was found after one year [157] (only in people suffering from depression pre-surgery). This is in line with my own belief of our intervention, which is that it has a possibility to show preventive effects on the deterioration starting from 2 years.

That is why the follow-up has been extended from the original 2 years to 5 years follow-up. However, if such long-term effects would be found, we could not separate the effect of the intervention with the possible effect of only meeting other women in a group setting. Anyhow, testing for any early effects was still of interest, since earlier dissonance-based interventions have showed effects already at one year [228].

It usually takes a great deal of effort to increase one's PA levels, and it is often difficult to maintain the new higher levels. In our intervention, participants were encouraged to come up with their own strategies and methods to increase their physical activity. As mentioned in the introduction, physical and mental barriers to PA could differ greatly between individuals, and therefore this intervention differs from many earlier interventions on exercise programs. The earlier DBIs interventions trying to increase PA, measured PA subjectively, and it is thus hard to compare them to our results [228]. However, they found a post-test effect, not sustained one-year after surgery. We have data, not included in this thesis, on 6 months follow-up, but, as one-year post-surgery, they did not show any significant differences between the groups (data not shown). Thus, it seems unlikely that there were any even earlier effects of the intervention.
In our study, the levels of MVPA were quite high compared to other studies using objectively measured PA in bariatric surgery patients, although the number of steps was similar [132]. Many of these studies were, however, done in the US. Compared to a Swedish sample of approximately 1000 individuals from the general population, our study population had a higher LPA min/week than the general population. MVPA and the percentage reaching the PA recommendations were slightly lower, though [229].

Strengths and limitations
Strengths of this study include quite high generalizability, since the women in our study sample are representative of national Swedish data on bariatric surgery patients [38], a randomized design and a novel intervention not tested in this population before.
There are also some limitations. Firstly, many participants failed to attend the intervention, even though their wish to be randomized to the intervention group and joining the study was initially strong. The delivery of the intervention has been discussed, and an interview study has been conducted to try to identify the reasons for dropping out of the intervention (not published yet). This study shows that several women were unable to find the time to attend the sessions, even though they found the topics of interest. The use of smartphones or internet could be possible options [230]. However, another study found that adding contact through telephone as an alternative to face-to-face contact did not increase participation in a sample of bariatric surgery patients [231]. More research is needed to see if remote delivery of interventions could increase attendance in this study population [161].
Another limitation is that the sample size was too small to detect smaller effect sizes, for example some variables like the DEBS score showed differences, but

they were not statistically significant. However, most variables did not show any differences at all. Thus, we are probably not missing important results. Another concern could be that the outcomes might not match the intervention, in other words there could always be effects of the intervention that we did not detect with the chosen outcomes. Most participants expressed immediately improved wellbeing after the surgery to the moderator or other research staff. For example, as has been mentioned in the introduction, BED and NES are common eating disorders, both before and after bariatric surgery. Our questionnaires did not measure the prevalence of these disorders, and we might have missed important changes in these in the intervention group. On the other hand, our intervention was not designed specifically for BED or NES, and thus it should not be a big problem. Additionally, as in study 1 and 2, the study only included women, and women able to speak Swedish, which limits the results to men and women not being able to speak Swedish.

7.3 ADDITIONAL METHODOLOGICAL CONSIDERATIONS

The RCT study was not blinded. Thus, increasing the risk of bias. However, if it was the case the results would probably have been more in favor of the intervention group, since they knew they were receiving extra support to increase wellbeing. Additionally, it would have been beneficial to include another control group receiving group sessions without an intervention, just an opportunity to talk to each other. Then it would have been possible to blind the participants, though not the moderator, and possible later effects of the study could be separated from DBI and the group effect.

In most of the studies, we used self-reported questionnaires to assess wellbeing and psychosocial outcomes, this has its limitations since questions can be interpreted differently and can generate missing data. However, there are not many objective alternatives available. Additionally, we mainly compared outcomes within the same individuals, and we called participants with missing data for completion. Thus, trying to reduce possible bias, however, it cannot be excluded.

7.3.1 Accelerometers

Even though using objectively measured PA has many benefits compared to subjective measures (questionnaires), it also has some limitations.

First of all, it is difficult to compare the results to other studies, since accelerometers may differ between brands and settings, such as the way they measure and what filters they use. Not all accelerometers, especially those in previous use, do not measure tri-axial movement, but rather one axis. However, the G3TX+ is currently a well-used accelerometer in research contexts.

Sedentary behavior is difficult to measure using accelerometers, since they are unable to detect positions such as sitting or standing accurately. Other tools, such as the activPAL, might be used as an addition [232] in future research.

We reported PA recommendations in most studies. I believe that PA recommendations are an easy way to present data, and especially for people not involved with PA research this might be a good way to understand what the research results really means. However, PA recommendations are mainly built on subjectively measured PA, and thus comparing that with objectively measured PA will result in biased estimations. Our aim to compare PA measured with the same method before and after surgery and between intervention and control group, is still valid. But we need to be careful when comparing to other studies and population levels using different methods.
Additionally, using cut-offs for PA levels also has its limitations. It has been discussed that using absolute thresholds may not be optimal, especially not because they are derived from normal weight young people, and their cardiorespiratory fitness (CRF) is probably not the same as older people or people with overweight or obesity [233, 234]. A study by Raiber et al. compared the CRF between people with normal weight, overweight and obesity and in line with earlier studies, found that CRF was lower among people with obesity [233]. Additionally, Raiber et al. compared the amount of time spent in MVPA using different, both relative and absolute, cpm thresholds within different weight categories and gender. Even though people with a normal weight spent more time in MVPA than people with obesity, the difference was smaller when using relative thresholds compared to absolute. They also attempted to translate the commonly used 40% of VO2 max as moderate PA to cpm using 4 different equations for relative thresholds. The authors concluded that people with obesity and women had lower relative cpm thresholds than normal weight men (between 2035-3967 cpm as MVPA for obese women compared to between 3728-5576 cpm as MVPA for normal weight men) [233]. The threshold of 3208 cpm used in our studies comes from an equation from Santos-Lozano et al. and seems like a good proxy for estimating MVPA among the women with obesity included in our study [176]. However, the women with obesity in the study by Raiber et al. had a mean BMI of 35.4 and mean age of 34.6 which is lower than our study participants at baseline. In addition to this, CRF levels would increase with decreased BMI post-surgery. Thus, the actual MVPA levels might be overestimated post-surgery.

8 CONCLUSIONS

We cannot say whether a mother's RYGB surgery, the massive subsequent weight loss and the major lifestyle changes influence their children's prevalence of overweight and obesity, but if there is an effect it is probably short-term.

Women's eating behavior, sleep quality and symptoms of depression and anxiety improve shortly after RYGB surgery and then deteriorate again. However, several variables were still improved at 4 years, compared with pre-surgery. Children's eating attitudes followed the same rebound pattern as their mothers' and a correlation between mothers' eating behavior and children's eating attitudes were found pre-surgery. Children's self-concept and body-esteem, together with PA levels and ST only declined over time. This is, however, mostly in line with the general population, especially when entering puberty. Women's PA levels or ST did not significantly change over 4 years after RYGB. Additionally, many women did not live with the same partner 4 years after surgery, compared to pre-surgery.

PA is associated with HRQoL, both before and after RYGB surgery, and both meeting with PA recommendations, LPA, ST and steps seem important. Thus, some participants who might find it hard to exercise would still benefit from walking and engaging in light activity, and could therefore aim at increasing their overall PA. However, these were cross-sectional analyses and therefore we cannot tell if HRQoL affects PA or if PA affects HRQoL. Earlier studies that have accomplished increased PA in patients undergoing bariatric surgery saw increases in HRQoL as well. Additionally, promoting PA pre- and post-surgery has other beneficial health effects. Thus, should be recommended.

A dissonance-based intervention has a lot of potential, with low costs, easy implementation in health care, and no harmful effects for participants. However, we did not find any early effects of such an intervention on HRQoL, PA, ST, social adjustment, body-esteem or eating behavior at one-year after RYGB compared to a control group. A long-term follow-up could conclude whether there are possible preventive effects on deterioration of these outcomes over time.

In short, great improvement in women's HRQoL and wellbeing was seen after one year of the intervention study. Limited increases in PA were seen after one year. A rebound effect was seen in many wellbeing variables after 4 years, but some remained better than pre-surgery. Finally, there might be a short-term effect of a mothers' RYGB surgery on their children.

9 POPULÄRVETENSKAPLIG SAMMANFATTNING

Allteftersom vårt samhälle förändrats har även typen av sjukdomar som dominerar samhället förändrats. Övervikt och fetma räknas numera som en av vår tids svåraste utmaningar. Fetma definieras som ett BMI över 35 (normalviktig räknas som BMI 18–25), där BMI beräknas som kg/m^2. Orsaken till fetman kan ha många olika ursprung, men gemensamt är att fetma leder till ökad risk för många andra sjukdomar, som till exempel hjärt- och kärlsjukdomar, diabetes typ 2 och cancer. Det är även en riskfaktor för psykiska sjukdomar, stigmatisering och diskriminering. Därför är det viktigt att minska prevalensen av fetma, och tidigare forskning har visat att viktminskningsoperationer är den behandlingsmetod som har bäst effekt.

Det finns flera olika typer av viktminskningsoperationer, men den vanligaste i Sverige är den operation som kallas gastric bypass (GBP). Det är en operation där man förminskar magsäcken betydligt så att matintaget begränsas, samtidigt som man kopplar bort den första delen av tarmen så att näringsupptaget minskar. Det typiska förloppet efter en GBP-operation är en initial genomsnittlig viktminskning på ca 30 % av den totala kroppsvikten, följt av en liten viktuppgång efter 1 till 2 år, men det finns stora individuella skillnader. Följdsjukdomar minskar och välmående förbättras, men flera studier tyder på att många psykologiska variabler försämras igen 1 till 2 år efter operation. Dock är det oftast fortfarande bättre än ursprungsvärdet, men även detta varierar mellan individer, mellan olika variabler och över olika tidsperioder. Det finns få långtidsstudier med bra uppföljning som inkluderar flera psykologiska aspekter. Det finns även få studier som undersökt hur en förälders GBP-operation kan påverka deras barn. Eftersom operationen kräver stora och livslånga livsstilsförändringar är det tänkbart att den skulle ha en påverkan på resten av familjen.

Alltså var syftet med denna avhandling att undersöka om en mammas GBP-operation kunde ha en påverkan på hennes barns övervikt och fetma, ätbeteende, kroppsuppfattning, självuppfattning, fysiska aktivitet och stillasittande, 9 månader och 4 år efter mammans operation. Det andra syftet med avhandlingen var att undersöka om en gruppbaserad interventionsstudie efter GBP kunde ha en positiv effekt på livskvalitet, social anpassning, ätbeteende, kroppsuppfattning, fysisk aktivitet och stillasittande, ett år efter operationen. Slutligen var syftet med avhandlingen även att undersöka om fysisk aktivitet kunde vara kopplat till livskvalitet hos kvinnor som lider av fetma, innan GBP och sedan efter en GBP-operation, när de har förlorat mycket vikt.

Två projekt skapades för att undersöka dessa frågeställningar, en longitudinell kohortstudie med strax över 30 kvinnor och över 40 av deras barn, samt en randomiserad kontrollerad interventionsstudie med 290 kvinnor som genomgick GBP-operation. Båda projekten inkluderade kvinnor från olika sjukhus i och runt Stockholmsregionen, där kvinnorna och barnen har fått fylla i flera enkäter samt burit en rörelsemätare både före och efter operation. Sextio procent av kvinnorna i interventionsstudien var randomiserade till att delta i 4 gruppträffar som handlade om vanliga problem som kan uppstå efter viktminskningsoperation. Detta gjordes i förhoppning om att det skulle förbereda deltagarna inför dessa problem, och därmed

minska risken för den tidigare nämnda försämringen som sker hos vissa efter 1–2 år.

Resultaten av studierna presenteras i helhet i de 5 inkluderade artiklarna. I korthet så är det svårt att säga om mödrarnas GBP-operation har någon direkt effekt på hennes barn, det man kan se är möjligen en kortsiktig positiv effekt på barnens övervikt och ätbeteende. Däremot försämrades barnens kroppsuppfattning, självuppfattning, fysisk aktivitet och stillasittande över tid, vilket dock ofta följer med åldern. Fysisk aktivitet var kopplat till livskvalitet både före och efter GBP hos kvinnor, med högre fysisk aktivitet kopplat till bättre livskvalitet, men vi kan inte dra några slutsatser om orsakssamband. Gruppträffarna efter operation var uppskattade, men inte alla som var inbjudna kom på träffarna, trots visat intresse och frivilligt deltagande. Gruppträffarna hade inte heller någon tidig effekt på någon av de studerade variablerna, men en längre uppföljningstid kan behövas. Man bör även vidare diskutera hur man skulle kunna få fler att delta på träffarna, till exempel genom att erbjuda andra sätt att delta än bara fysiska träffar.

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