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Mental health in adolescents undergoing bariatric surgery

Psychological outcomes four months and
two years after gastric bypass

KAJSA JÄRVHOLM

FACULTY OF SOCIAL SCIENCES | DEPARTMENT OF PSYCHOLOGY | LUND UNIVERSITY



Mental health in adolescents undergoing bariatric surgery

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two years after gastric bypass

Kajsa Järholm



LUND
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DOCTORAL DISSERTATION

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<p>Abstract</p> <p>Bariatric surgery is tried out as a new treatment option for adolescents with severe obesity. Little is known about outcomes in mental health in adolescents who undergo weight loss surgery.</p> <p>The 3 studies in this thesis assess mental health in adolescents before, and after 4 months, 1 year and 2 years after undergoing gastric bypass. The studies are part of the Swedish national AMOS study and all adolescents in the studies are from the AMOS cohort. AMOS included adolescents 13–18 years with a BMI ≥ 40 or ≥ 35 with comorbidity who had been under regular childhood obesity treatment for at least one year before undergoing surgery. Exclusion criteria were few but included psychotic disease and alcohol/drug dependence. Two out of 3 adolescents in AMOS are girls; mean age at surgery was 16.8 years and mean BMI 45.6.</p> <p>In study I, mental health was evaluated in 37 adolescents from baseline to 4 months after surgery. Compared to age and gender-matched population norms, the adolescents presenting for bariatric surgery reported impaired mental health. Four months after surgery significant improvements were seen for anxiety, depressive symptoms and self-concept. No significant change was seen for anger or disruptive behavior. The adolescents reported on average a mental health comparable to norms 4 months after surgery. However, not all adolescents had a positive mental health outcome and 16 % reported clinically significant impaired mental health on two or more variables. No baseline differences could be seen between the impaired adolescents and the improved or unchanged adolescents.</p> <p>In study II mental health was assessed in 88 adolescents at baseline and 1 and 2 years after surgery. Two years after surgery significant reduction was seen in symptoms of anxiety, depression, anger, and disruptive behavior. Also obesity-related problems were reduced. Improvements were seen for self-concept, self-esteem and mood. Improvements took place mainly during the first year after surgery and the second year was characterized by stabilization. Two years after surgery, the adolescents reported on average symptoms of anxiety, depression, anger, and disruptive behavior comparable to norms. Also self-concept was at a normative level. However, the adolescents reported mood lower than age-matched peers and mood was also low when it was compared to middle-aged adults undergoing surgery. A marked group, 19 %, reported depressive symptoms in the clinical range and 13 % reported severe depressive symptoms.</p> <p>In study III adolescents (20 %) who reported poor mental health (PMH) 2 years after surgery were compared to adolescents who reported average/good mental health 2 years after surgery. Anxiety, depression and mental health at baseline could significantly predict PMH 2 years after surgery. However, several aspects of mental health were assessed at baseline and no other variable could predict mental health after surgery. Significant differences were seen between the groups at the follow-up 1 year after surgery; however few mental health variables had a significantly different trend between the groups over the first year. Suicidal ideation was reported by 14 % of the adolescents 2 years after surgery. Weight outcome was comparable between the two groups at all assessment points and physical health was equally improved in both groups 2 year after surgery.</p> <p>The studies in the present thesis show a general improvement in several aspects of mental health in adolescents, such as reduced symptoms of anxiety and depression, reduced externalizing symptoms, improved self-concept and reduced problems related to weight and body shape over 2 years after gastric bypass. However, not all adolescents have a positive psychosocial outcome and 4 months after surgery 16 % report impaired mental health. Depressive symptoms in the clinical range are reported by 1 out of 5, 2 years after surgery and 14 % report suicidal ideation. These figures are much higher than expected from the adult surgery literature. The studies in the present thesis indicate that adolescent bariatric surgery candidates are a vulnerable group and that repeated monitoring and psychological interventions are important before and after bariatric surgery.</p>			
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Till Eskil, Elsa och Svea

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List of papers

This thesis is based on the following three papers. In the text, they are referred to by their Roman numerals.

- I. Järholm, K., Olbers, T., Marcus, C., Mårild, S., Gronowitz, E., Friberg, P., Johnsson, P., & Flodmark, C.-E. (2012). Short-term psychological outcomes in severely obese adolescents after bariatric surgery. *Obesity*, *20*(2), 318-323. doi: 10.1038/oby.2011.310
- II. Järholm, K., Karlsson, J., Olbers, T., Peltonen, M., Marcus, C., Dahlgren, J., Gronowitz, E., Johnsson, P., & Flodmark, C.-E. (2015). Two-year trends in psychological outcomes after gastric bypass in adolescents with severe obesity. *Obesity*, *23*(10), 1966-1972. doi: 10.1002/oby.21188
- III. Järholm, K., Karlsson, J., Olbers, T., Peltonen, M., Marcus, C., Dahlgren, J., Gronowitz, E., Johnsson, P., & Flodmark, C.-E. (2016). Characteristics of adolescents with poor mental health after bariatric surgery. *Surgery for Obesity and Related Diseases*, *12*(4), 882-890. doi: 10.1016/j.soard.2016.02.001

Abstract

Bariatric surgery is tried out as a new treatment option for adolescents with severe obesity. Little is known about outcomes in mental health in adolescents who undergo weight loss surgery.

The 3 studies in this thesis assess mental health in adolescents before, and after 4 months, 1 year and 2 years after undergoing gastric bypass. The studies are part of the Swedish national AMOS study and all adolescents in the studies are from the AMOS cohort. AMOS included adolescents 13–18 years with a BMI ≥ 40 or ≥ 35 with comorbidity who had been under regular childhood obesity treatment for at least one year before undergoing surgery. Exclusion criteria were few but included psychotic disease and alcohol/drug dependence. Two out of 3 adolescents in AMOS are girls; mean age at surgery was 16.8 years and mean BMI 45.6.

In study I, mental health was evaluated in 37 adolescents from baseline to 4 months after surgery. Compared to age and gender-matched population norms, the adolescents presenting for bariatric surgery reported impaired mental health. Four months after surgery significant improvements were seen for anxiety, depressive symptoms and self-concept. No significant change was seen for anger or disruptive behavior. The adolescents reported on average a mental health comparable to norms 4 months after surgery. However, not all adolescents had a positive mental health outcome and 16 % reported clinically significant impaired mental health on two or more variables. No baseline differences could be seen between the impaired adolescents and the improved or unchanged adolescents.

In study II mental health was assessed in 88 adolescents at baseline and 1 and 2 years after surgery. Two years after surgery significant reduction was seen in symptoms of anxiety, depression, anger, and disruptive behavior. Also obesity-related problems were reduced. Improvements were seen for self-concept, self-esteem and mood. Improvements took place mainly during the first year after surgery and the second year was characterized by stabilization. Two years after surgery, the adolescents reported on average symptoms of anxiety, depression, anger, and disruptive behavior comparable to norms. Also self-concept was at a normative level. However, the adolescents reported mood lower than age-matched peers and mood was also low when it was compared to middle-aged adults undergoing surgery. A marked group, 19 %, reported depressive symptoms in the clinical range and 13 % reported severe depressive symptoms.

In study III adolescents (20 %) who reported poor mental health (PMH) 2 years after surgery were compared to adolescents who reported average/good mental health 2 years after surgery. Anxiety, depression and mental health at baseline could significantly predict PMH 2 years after surgery. However, several aspects of

mental health were assessed at baseline and no other variable could predict mental health after surgery. Significant differences were seen between the groups at the follow-up 1 year after surgery; however few mental health variables had a significantly different trend between the groups over the first year. Suicidal ideation was reported by 14 % of the adolescents 2 years after surgery. Weight outcome was comparable between the two groups at all assessment points and physical health was equally improved in both groups 2 year after surgery.

The studies in the present thesis show a general improvement in several aspects of mental health in adolescents, such as reduced symptoms of anxiety and depression, reduced externalizing symptoms, improved self-concept and reduced problems related to weight and body shape over 2 years after gastric bypass. However, not all adolescents have a positive psychosocial outcome and 4 months after surgery 16 % report impaired mental health. Depressive symptoms in the clinical range are reported by 1 out of 5, 2 years after surgery and 14 % report suicidal ideation. These figures are much higher than expected from the adult surgery literature. The studies in the present thesis indicate that adolescent bariatric surgery candidates are a vulnerable group and that repeated monitoring and psychological interventions are important before and after bariatric surgery.

Svensk sammanfattning

Psykisk hälsa hos ungdomar som genomgår fetmakirurgi – psykologiskt utfall fyra månader och två år efter fetmakirurgi

Svår fetma är ett svårbehandlat tillstånd och hittills har fetmakirurgi visat sig vara den metod som ger den största och mest beständiga viktminskningen över längre tid. Fetmakirurgi har tidigare endast erbjudits vuxna både i Sverige och i andra länder. Under senare år har fetmakirurgi börjat prövas som ett behandlingsalternativ till ungdomar med svår fetma där annan behandling inte har gett tillräckliga resultat. Tonårstiden är en tid som är starkt präglad av intensiv psykologisk och social utveckling. Om och innan fetmakirurgi börjar övervägas som ordinarie behandling vid svår fetma hos tonåringar är det extra angeläget att studera hur den psykiska hälsan påverkas av att genomgå fetmakirurgi under tonåren.

I denna avhandling ingår tre studier. Data till samtliga studier är hämtade från Adolescent Morbid Obesity Surgery (AMOS)-studien, som är en svensk nationell studie med syfte att undersöka om gastric bypass är en effektiv och säker behandlingsmetod för ungdomar med svår fetma. I AMOS inkluderades ungdomar som gått i ordinarie viktbehandling minst ett år och hade ett Body Mass Index (BMI) över 40 eller över 35 med fetmarelaterad samsjuklighet. Totalt opererades 88 ungdomar inom ramen för AMOS-studien. Ungdomarna var mellan 13 och 18 år då de genomgick sin operation. Snittåldern var 16,8 år. Fler flickor, 67 %, än pojkar genomgick operation och snitt-BMI inför operationen var 45,6 kg/m².

I den första studien beskrivs den psykiska hälsan hos ungdomarna innan operationen och vid uppföljningen i genomsnitt fyra månader efter operationen. Studien visar att ungdomar med svår fetma och som vill genomgå fetmakirurgi, har en försämrad psykisk hälsa innan operationen. Ungdomarna uppger att de har fler symptom på ångest, depression, ilska och normbrytande beteende i jämförelse med andra ungdomar i samma ålder och av samma kön. Ungdomarna skattar också att de har en lägre självbild än andra ungdomar. Fyra månader efter operationen så uppger ungdomarna att de har signifikant färre ångest- och depressionsymptom och en förbättrad självbild i jämförelse med före operationen. De opererade ungdomarna skattar bekymmer kring ångest och depression samt sin självbild på en genomsnittlig nivå utifrån ålder och kön fyra månader efter gastric bypass. För de mer utåtagerande problemen, ilska och normbrytande beteende, fanns ingen signifikant förändring på gruppnivå. Den förbättring av den psykiska hälsan som framkom var dock inte jämnt fördelad mellan alla ungdomar utan några ungdomar förbättrades mycket, några hade en oförändrad psykisk hälsa och några försämrades. Ytterligare en analys gjordes för att undersöka om det fanns en undergrupp av ungdomar som hade en påtagligt försämrad psykisk hälsa på kort

sikt efter operationen. Totalt sett bedömdes 16 % av ungdomarna ha en påtagligt försämrad psykisk hälsa fyra månader efter kirurgin. Dessa ungdomar skilde sig inte från övriga opererade ungdomar innan kirurgin.

I den andra studien följs den psykiska hälsan hos de opererade ungdomarna under två år efter fetmakirurgin. Uppgifter om den psykiska hälsan är insamlade innan operationen, ett år efter operationen och två år efter operationen. I studien studeras en rad olika områden av psykisk hälsa, bl.a. ångest, depression, stämningsläge och självbild, men också viktrelaterat psykosocialt fungerande. Två år efter operationen är ungdomarna signifikant förbättrade på alla undersökta områden förutom grad av aktivitet/passivitet. Förbättringarna äger rum under det första året efter operationen och det andra året präglas av stabilisering. Inget av måtten på psykisk hälsa samvarierar signifikant med viktnedgången, d.v.s. bland ungdomarna i studien finns det inget samband mellan att de som går ner mest i vikt också får den största förbättringen av sin psykiska hälsa. Trots stora förbättringar av den psykiska hälsan hos ungdomarna efter operationen, finns det fortfarande en relativt stor grupp som rapporterar psykisk ohälsa. Två år efter operationen skattar 19 % av ungdomarna att de har depressionssymptom på en nivå som indikerar att de har en faktisk depression och 13 % rapporterar depressionssymptom som motsvarar en svår depression. Studien indikerar också att ungdomar som genomgår fetmakirurgi har en sämre psykisk hälsa än medelålders vuxna som blir opererade, då de opererade ungdomarna skattar samma stämningsläge ett år efter operationen som vuxna som genomgår fetmakirurgi gör innan de opereras.

I den tredje studien jämförs de ungdomar (20 %) som rapporterar dålig psykisk hälsa två år efter operationen med de ungdomar som rapporterar en genomsnittlig eller god psykisk hälsa. Tre mått på psykisk hälsa, ångest, depression och mental hälsa, kan redan innan operationen predicera vilka ungdomar som har större risk att rapportera en dålig psykisk hälsa två år efter operationen. De flesta mått på psykisk hälsa, som samlades in innan operationen, kunde inte predicera vilka ungdomar som hade ökad risk för psykisk ohälsa efter operationen. Redan ett år efter operationen sågs påtagliga skillnader mellan dem som rapporterade dålig psykisk hälsa två år efter operationen och övriga opererade ungdomar, samtidigt hade de flesta mått på psykisk hälsa en likartad utvecklingstrend i de båda grupperna under det första året efter operationen. Två år efter operationen rapporterade 14 % av ungdomarna att de hade självmordstankar. Trots att det fanns stora skillnader i den psykiska hälsan mellan grupperna så sågs ingen skillnad i viktutvecklingen mellan grupperna under de två första åren efter operationen och båda grupperna hade en likartad förbättring av den fysiska hälsan efter operationen.

Sammantaget visar studierna i avhandlingen att den psykiska hälsan förbättras hos ungdomar på kort och medellång sikt efter fetmakirurgi. Ungdomarna skattar att de har färre symptom på ångest, depression, ilska och normbrytande beteende efter operationen än vad de hade innan. De skattar också att de har en bättre självbild och att de är mindre begränsade av sin vikt i sociala sammanhang. Dock har inte alla ungdomar en god psykisk hälsa efter fetmakirurgi. Direkt efter operationen är det en grupp (16 %) som rapporterar att deras psykiska hälsa är påtagligt sämre än innan operationen och två år efter operationen så uppger 1 av 5 ungdomar att de har symptom som vid en klinisk depression. Det är fler ungdomar som rapporterar psykisk ohälsa än förväntat utifrån hur det ser ut hos ungdomar generellt och också fler ungdomar som uppger att de mår psykiskt dåligt i jämförelse med hur medelålders vuxna uppger att de mår efter fetmakirurgi. Ungdomar som skattar att de har mer ångest och mer depressiva symptom innan operationen har större risk för en psykisk ohälsa efter operationen än andra ungdomar. Två år efter fetmaoperationen uppger 14 % av ungdomarna att de har suicidtankar. Studierna saknar kontrollgrupp och därför går det inte att uttala sig om gruppen som uppger psykisk ohälsa är större eller mindre än vad den skulle ha varit om ungdomarna inte hade blivit opererade. Studierna visar på att ungdomar som genomgår fetmakirurgi utifrån ett psykologiskt perspektiv är en sårbar grupp och att det är viktigt att erbjuda ett psykosocialt stöd både före och efter operationen och att stödet sträcker sig längre än första året efter operationen.

Abbreviations

%WL = Percent Weight Loss

ADHD= Attention Deficit Hyperactivity Disorder

A/GMH= Average/Good Mental Health

AMOS= Adolescent Morbid Obesity Surgery

AN= Anorexia Nervosa

BDI= Beck Depression Inventory

BDI-II= Beck Depression Inventory II

BED= Binge Eating Disorder

BMI= Body Mass Index

BN= Bulimia Nervosa

BYI= Beck Youth Inventories

ES= Effect Size

HRQoL = Health Related Quality of Life

MACL=Mood Adjective Check List

OP= Obesity-related Problems scale

PMH= Poor Mental Health

QoL= Quality of Life

RCT= Randomized Controlled Trial

SD= Standard Deviation

SF-36= Short Form-36 v2

SG= Sleeve Gastrectomy

SOS= Swedish Obese Subjects

SRM= Standardized Response Mean

WLS=Weight Loss Surgery

Introduction

Obesity prevalence has increased over the last decades and this is also true for more severe forms of obesity. Bariatric surgery has been a treatment option for adults with severe obesity for many years and leads to substantial and sustained weight loss and reduced morbidity and mortality. A spontaneous reaction for most people is that bariatric surgery should not be performed in adolescents and that obesity in teenagers should be treated in a less invasive way. However, outcomes after lifestyle interventions to adolescents with severe obesity are discouraging. Clinicians, adolescents and their families have started to consider whether bariatric surgery also could be a safe and effective treatment option for adolescents with severe obesity and if there are special benefits or risks with undergoing weight loss surgery (WLS) while a teenager. When introducing a treatment to a new group, however, many ethical and practical concerns are always raised. One specific and important question is how bariatric surgery affects the adolescents' mental health. The adolescent and young adulthood years are characterized by intense psychosocial development and it is also a vulnerable period in life when mental health problems may emerge. The studies in the present thesis evaluate mental health status in adolescents undergoing bariatric surgery from baseline to two years after surgery. The studies are part of the Swedish national Adolescents Morbid Obesity Surgery (AMOS) study.

Obesity

Defining obesity

The most common way to classify weight and to define overweight and obesity is using Body Mass Index (BMI). BMI is calculated as kg/m^2 . For adults there are fixed cut-offs for defining underweight, normal weight, overweight, and grades of obesity (Table 1). The higher obesity categories are often referred to as severe obesity, morbid obesity, or extreme obesity. BMI is used to define overweight and obesity as it is an easy and inexpensive way to estimate the amount of excess body fat and there is a high correlation between BMI and body fat (Pi-Sunyer, 2000).

However, BMI is not a perfect measure of excess body fat and BMI does not distinguish between lean mass and fat mass (Sweeting, 2007). Amount of body fat at the same BMI varies between gender and different ethnic groups, and BMI may misclassify some individuals with high muscularity or in extreme height ranges (Deurenberg, Yap, & van Staveren, 1998; Sweeting, 2007).

Table 1
Classification of BMI

BMI	Classification
<18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Overweight
30.0–34.9	Obesity class I
35.0–39.9	Obesity class II
≥40	Obesity class III

In children and adolescents weight related to height and body composition varies with age and gender, but relative to adults, BMI is always supposed to be lower in children and adolescents under 18. There are different ways to define overweight and obesity in children and adolescents and methods vary between countries (Guillaume, 1999). The International Obesity Task Force has recommended that overweight and obesity in children and adolescents should be classified according to sex- and age-specific cut-offs that correspond to a BMI ≥ 25 and BMI ≥ 30 in adults (Cole, Bellizzi, Flegal, & Dietz, 2000) and this is the classification normally used in Sweden. In many studies, overweight in children and adolescents is defined as a BMI $\geq 85^{\text{th}}$ percentile but below the 95^{th} percentile for youth of the same age and gender. A BMI $\geq 95^{\text{th}}$ percentile for age and gender is classified as obesity (Barlow & Dietz, 1998). Severe obesity is sometimes defined as a BMI $\geq 99^{\text{th}}$ percentile but in new recommendations it is suggested that severe obesity in youth should be defined as either a BMI $\geq 120\%$ of the 95^{th} percentile or a BMI ≥ 35 , whichever is the lowest (Kelly et al., 2013). Even small differences in classifying obesity or differences in the reference populations used in different countries can make comparisons between studies complicated (Guillaume, 1999). However, this problem is often not present in studies of adolescents undergoing obesity surgery as their actual unadjusted BMI is used to report weight status and weight outcome. At the same time, this means that if the same BMI eligibility criteria are used for adolescents as used in adults, adolescents need to be relatively more obese than adults to be candidates for bariatric surgery and their obesity could be regarded as even more severe.

Obesity prevalence

The prevalence in overweight and obesity has increased steeply from the 1960s in Western Europe and USA but also in other parts of the world including developing countries (Sørensen, 1988; WHO, 2015). Obesity is considered a global epidemic and today excess weight lead to more mortality than underweight and starvation (WHO, 2015). The major explanations for this increase are mainly a general higher intake of calorie dense food and a more sedentary and less physically active life style (WHO, 2015). However, not everyone seems to be equally susceptible to these environmental changes and also genetic factors have an impact on obesity (Sorensen & Echwald, 2001; Vogler, Sorensen, Stunkard, Srinivasan, & Rao, 1995). According to recent data there might be a levelling off in the prevalence of overweight and obesity (Chung et al., 2016; Han, Lawlor, & Kimm, 2010). A Swedish study reported a stabilization in overweight and obesity in Swedish children from 2003 to 2011, and in 2011 16.0% of 12-year-old boys and 12.8% of 12-year-old girls were either overweight or obese (de Munter et al., 2016). Except the gender difference, overweight and obesity is more common in rural areas and less common in children with mothers with a high education (de Munter et al., 2016). These findings are in accordance with other studies in Swedish children suggesting a higher prevalence of overweight and obesity in children outside the larger cities (Moraeus et al., 2012; Sjöberg et al., 2011) and in lower socioeconomic groups (Moraeus, Lissner, & Sjöberg, 2014; Moraeus et al., 2012; Sjöberg et al., 2011). Obesity prevalence in youth in USA has also plateaued as no significant change in obesity prevalence has been found from 2003–2004 to 2011–2012 (Ogden, Carroll, Kit, & Flegal, 2014). Prevalence figures from USA from 2011–2012 show that 31.8% of youths (2–19 years) have either overweight or obesity and 16.9% have obesity (Ogden et al., 2014). In USA there is no significant difference between genders but obesity prevalence varies significantly between ethnic groups as obesity is more common in Black and Hispanic youths compared to white youths (Ogden et al., 2014). From 1969–1974 to 2000–2005 there was a 10-fold increase from 0.1% to 1.3% in morbid obesity (BMI \geq 35) in Swedish young men aged 18 years (Neovius, Teixeira-Pinto, & Rasmussen, 2007). In USA, 13.9% of adolescents aged 12–19 years have a BMI \geq 30 (Ogden et al., 2014) and even if a general levelling off is seen in the prevalence of overweight and obesity, more severe forms of obesity are still increasing in adolescents in USA (Skinner & Skelton, 2014).

Findings are mixed whether there is a plateau in prevalence of overweight and obesity in Swedish adults. Some studies support there being a levelling off but others still report an increase in prevalence (Johansson, 2010; Neovius, Johansson, Kark, Tynelius, & Rasmussen, 2013; Sundquist, Qvist, Johansson, & Sundquist, 2004). In Sweden, approximately 50% of adult men and 35% of adult women are

classified as either overweight or obese and 11% in both sexes as obese (Johansson, 2010). In 2011–2012 over two-thirds of the adult population in USA was classified as either overweight or obese, and 34.9% as obese. This means that in USA, it is more common to have overweight or obesity than to be normal weight. Of the adult population 6.4% have extreme obesity (BMI \geq 40) and extreme obesity is more common in adult women (8.3%) than in adult men (4.4%; Ogden et al., 2014).

Consequences of obesity

The rationale for a society and/or a health care system to prevent and treat obesity is that obesity is significantly related to morbidity and mortality (Mossberg, 1989; Must, Jacques, Dallal, Bajema, & Dietz, 1992). Obesity is related to increased risk of heart disease, stroke, hypertension, type II diabetes, and cancer (Must et al., 1999). Obesity leads to a reduced life expectancy. Health consequences are more severe in higher obesity grades (Must et al., 1992; Must et al., 1999). There is a specific incitement to treat overweight and obesity in children as 80% of those with overweight during adolescence will have obesity as adults (Dietz & Robinson, 2005). Obesity with onset in childhood and adolescence leads to more severe forms of obesity in adulthood, and children and adolescents with obesity are five times more likely to have obesity as adults compared to those who are normal weight during childhood (Dietz & Robinson, 2005; Simmonds, Llewellyn, Owen, & Woolacott, 2016). Severe obesity at younger age leads to a significantly decreased life expectancy as White men and women with BMI $>$ 45 at 20 years of age approximately have 13 respectively 8 years of lost lifetime compared to those with a BMI of 24 (Fontaine, Redden, Wang, Westfall, & Allison, 2003). Obesity is also related to an increase in mental health problems and studies have reported an association between obesity and impaired cognitive functioning in both children and adults (Smith, Hay, Campbell, & Trollor, 2011). Besides negative physical and psychological outcomes, having overweight or obesity as a teenager is also related to lower income in adulthood and a Swedish boy with obesity at age 18 is expected to earn 18% less than normal weight peers (Lundborg, Nystedt, & Rooth, 2014). Also, from a societal perspective obesity is associated with an increased risk of future disability pension (Robroek et al., 2013).

Mental health in adolescence

Psychiatric disorders during childhood and adolescence are not uncommon even if point prevalence for each disorder is low (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003), and about 22% of adolescents aged 13–18 years report mental health problems with severe impairment or distress at some point (Merikangas et al., 2010). In Sweden it is debated whether mental health problems increase in adolescents or not, but there seems to be an increase in problems related to depression and anxiety especially in girls (Kungl. Vetenskapsakademien, 2010). It is known that there is an increase in outpatient treatment for anxiety and depression in both girls and boys in Sweden. Swedish girls report a higher degree of mental health problems than boys, and older adolescents report more mental health problems than younger adolescents (Kungl. Vetenskapsakademien, 2010). In a longitudinal population study from USA of 1420 children between 9 and 13 years, 36.7% met a psychiatric diagnose at any point in time, and children with a history of a psychiatric disorder were three times more likely to have any psychiatric disorder at a later assessment than children with no previous disorder (Costello et al., 2003). During adolescence, anxiety disorders are the most common (31.9%), followed by behavior disorders (19.1%) and mood disorders (14.3%; Merikangas et al., 2010). Age of onset varies between disorders where anxiety disorders have a median age of onset at 11 and mood disorders have a median onset at 30 (Kessler et al., 2005). Approximately 50% will at some time in their life meet the criteria for any psychiatric disorder, half of these cases will have their onset by age 14 and 75% by the age of 24, indicating that mental health problems start early in life (Kessler et al., 2005). The most common mental disorders, depression and anxiety, have a sharp increase after childhood and peak in adolescence and early and middle adulthood (Whiteford et al., 2013).

Depression

Depression is rare in children before puberty, and before puberty depression rates are equal in boys and girls (Costello et al., 2002; Nolen-Hoeksema & Girgus, 1994). The depression prevalence increases after puberty onset and 12-month prevalence of major depressive disorder has been reported to be 7.5% in adolescents aged 13–18 years (Avenevoli, Swendsen, He, Burstein, & Merikangas, 2015). Severe depressive disorder was reported by 2.3% and this group reported significantly more suicidal thoughts and behaviors than those with less severe forms of depression (Avenevoli et al., 2015). Depression is more common in adolescent girls and adult women compared to adolescent boys and adult men (Avenevoli et al., 2015; Nolen-Hoeksema & Girgus, 1994). Most adolescents with a depressive disorder do not seek or receive any disorder-specific treatment (Avenevoli et al., 2015). However, in recent years more Swedish adolescents

receive inpatient treatment for depression (SOU, 2006:77). It is not known if this represents an actual increase in depression in Swedish adolescents or if today's youths are more willing to seek and receive treatment. Depression is significantly related to body image, especially in girls (Stice & Bearman, 2001).

Suicide in adolescents

No increase in completed suicide has been reported for Swedish adolescents during the last years. However, for all other age-groups there has been a marked decline in completed suicides during the same period (Kungl. Vetenskapsakademien, 2010). Suicide ideation is quite frequent during adolescence, and girls report more suicide ideation than boys. Any suicide attempt was reported by 9.7% of adolescents and 29.9% reported suicide ideation at some point (Evans, Hawton, Rodham, Psychol, & Deeks, 2005). However, completed suicide is more common in boys than in girls. Most adolescents with suicidal ideation or behavior are not receiving any mental health treatment (Husky et al., 2012). Suicide attempts peak in adolescents aged 16 to 18 years and thereafter decline (Kessler, Borges, & Walters, 1999). Low parental monitoring is a risk factor related to increase in suicide ideation and attempts (King et al., 2001). Suicide in adolescents is highly related to mood disorders, sometimes in combination with conduct disorder or substance abuse (Shaffer, Gould, Fisher, & et al., 1996). Risk factors, besides a psychiatric disorder, are a family history of suicide and psychopathology, and stressful life events (Gould, Greenberg, Velting, & Shaffer, 2003).

Self-esteem

Different terms are used to define a person's evaluation of her- or himself and in research: two terms frequently used are self-esteem and self-concept. There is not always a clear distinction between these two concepts, but self-esteem usually refers to the global value of the self as a whole, whereas self-concept rather refers to a descriptive evaluation of the self and could also be related to specific domains such as athletic competence, academic competence, etc. A negative evaluation of the self is associated with psychopathology and impaired psychosocial functioning (Zeigler-Hill, 2011). Self-esteem is generally higher during childhood, begins to decline during adolescence but rises again gradually during adulthood (Robins & Trzesniewski, 2005). Adolescent girls generally report lower self-esteem than adolescent boys and over the life span the largest difference between genders is seen during late adolescence (Kling, Hyde, Showers, & Buswell, 1999; Råty, Larsson, Söderfeldt, & Wilde Larsson, 2005). Even if self-esteem varies in different phases, it is rather consistent within an individual; high self-esteem at one point is predictive of high self-esteem at another point (Robins & Trzesniewski, 2005).

Body image

As children reach adolescence societal body ideals have become internalized and they become more critical of their own bodies (Frisén, Lunde, & Berg, 2015). Body image concerns increase during puberty and it has been suggested that this increase is linked to the weight gain associated with puberty (Striegel-Moore & Franko, 2002). Body image dissatisfaction is so prevalent among adolescent girls that it is sometimes referred to as a normative discontent (Rodin, Silberstein, & Striegel-Moore, 1984). Between 50% and 80% of adolescent girls report that they want to be thinner (Levine & Smolak, 2002). Most girls that report a wish to lose weight already have a weight in the normal range (Striegel-Moore & Franko, 2002). Body image concerns in boys mostly relate to either dissatisfaction with excess weight or with too little muscularity (Smolak, 2004). Body image dissatisfaction is quite stable during adolescence, i.e. someone who is dissatisfied at one point in time is also likely to be dissatisfied at another point in time (Frisén, Holmqvist Gattario, & Lunde, 2014). Body image dissatisfaction is related to depression in both girls and boys (Paxton, Neumark-Sztainer, Hannan, & Eisenberg, 2006; Stice & Bearman, 2001).

Health-related quality of life

Health-related quality of life (HRQoL) is a multidimensional construct that assesses an individual's perception of his or her overall physical and mental health and related functioning in everyday life. HRQoL is higher in adolescent boys than adolescent girls and better in younger adolescents, 13–15 years, compared to older adolescents (Jörngården, Wettergen, & von Essen, 2006). Differences between girls and boys are particularly seen in domains assessing mental health but not in domains assessing physical health (Jörngården et al., 2006). Adolescents reporting poor physical health on a HRQoL measure also report less general satisfaction with life (Zullig, Valois, Huebner, & Drane, 2005).

Assessment of mental health in adolescents

The gold standard for assessing mental health and particularly for assessing whether a person meets the criteria for a mental health disorder is a clinical interview. The clinical interview is thought to generate more valid and reliable data than other methods of assessment and the clinical interview is necessary for diagnosing psychiatric disorders. However, the clinical interview has some drawbacks as it is time consuming and requires special training. A common way to assess mental health in both clinical settings and in research is to use questionnaires. Questionnaires are most often validated in both population samples and clinical groups. Advantages with questionnaires are that they are easy and quick to administer and they ensure to some extent that data is collected in the

same way in various settings. When questionnaires are applied to assess mental health in adolescents, either age-specific or general instruments, validated for both teenagers and other groups, can be used. The major advantage of using age-specific questionnaires is that the items can focus on topics that are specifically important for teenagers such as school-functioning, peer relationship, and physical maturation (Frisén, 2007). Other advantages are that the items can be formulated for optimal comprehension in adolescents, and that norms are age-specific. Shortcomings of age-specific questionnaires are that they constrain longitudinal follow-up with the same questionnaire into adulthood and they prevent comparison with other age-groups. When mental health and psychosocial functioning is assessed in adolescents, the adolescent him- or herself is not the only possible informant. Often parents, and sometimes teachers, are used as informants. There is not always a high agreement in assessment made by adolescents and parents (Achenbach, McConaughy, & Howell, 1987; Frisén, 2007).

Defining clinically meaningful change in mental health and quality of life

Symptoms of mental health problems fluctuate in all individuals over time and can also be more or less present even during the same day. However, most of these changes are not large enough for the individual to experience that his or her inner state is qualitatively different. Also, in intervention studies mental health and quality of life (QoL) can be affected in the sample in one direction or the other and this change can be large enough to be statistically significant, but might still be so small that it is not relevant in the daily life for the participants. Different ways to define a clinically meaningful change, i.e. a change that is large enough to be noticeable and relevant for the individual, have been suggested (Crosby, Kolotkin, & Williams, 2003). Some methods are reliable change index (RCI, there is a meaningful change when $RCI > 1.96$), effect size (ES, there is a meaningful change when $ES > 0.5$), and standard error of measurement (SEM, there is a meaningful change when a score is changed with at least one SEM; Eisen, Ranganathan, Seal, & Spiro Iii, 2007).

Weight and mental health

Mental health in adults with obesity

It is not clear how weight status is related to mental health. It has been suggested that the increase in obesity and mental health problems over the last decades are related, either because obesity and mental health problems have increased due to a common underlying factor, or that the increase in obesity have resulted in more people getting mental health problems, or that more mental health problems have made people gain weight (Kalarchian & Marcus, 2012). Whatever is the case, mental health in the population with obesity is not homogeneous. Worth noticing is that not all that are classified as overweight or obese according to BMI perceive themselves as overweight and it has been suggested that seeing oneself as overweight (whether overweight or not) is more negative for the mental health than being overweight without recognizing it (Jansen, van de Looij-Jansen, de Wilde, & Brug, 2008).

Results from cross-sectional population studies are mixed regarding the association between overweight and obesity and mental health in adults. There are several studies of the association between depression and obesity. In a large population study, obesity, but not overweight, was significantly associated with past-month depression in women but not in men (Onyike, Crum, Lee, Lyketsos, & Eaton, 2003). Another large population study also found an increased risk of major depression in women with obesity compared to average weight women (odds ratio = 1.37), but no increased risk for overweight women (Carpenter, Hasin, Allison, & Faith, 2000). However, the same study found a decreased risk of depression and suicide attempts in men with obesity compared to average weight men, whereas underweight men had an increased risk of suicidal behavior (Carpenter et al., 2000). Most studies find that mental health is more negatively affected in women with obesity than in men with obesity (Onyike et al., 2003; Zabelina, Erickson, Kolotkin, & Crosby, 2009). There are several hypotheses why mental health is differently affected by weight in men and women. One hypothesis is related to body ideals, where women with obesity and men who are underweight are furthest from the societal ideal body which dictates slimness in women and muscularity in men. Also, one study found that higher BMI in women, but not in men, was associated with finding rewarding behavior less enjoyable than those with lower BMI (Pagoto, Spring, Cook, McChargue, & Schneider, 2006). However, not only gender affects the association between obesity and mental health, but degree of obesity is also an important factor and the strongest association between obesity and depression is found in the group with severe obesity (BMI \geq 40; Onyike et al., 2003; Wadden et al., 2006).

Mental health is more affected in those who seek obesity treatment (Fabricatore & Wadden, 2004). In a study of 165 treatment seeking Swedish young adults (16–25 years) with severe obesity, it was reported that 29% had at least one psychiatric diagnose. Depression and attention deficit hyperactivity disorder (ADHD) were the most common diagnoses, and 26% reported anxiety symptoms in the clinical range. When HRQoL was assessed with Short Form-36 (SF-36), this group reported significantly lower mental health than physical health. Any previous suicide attempt was reported by 12% of the sample (Dreber, Reynisdottir, Angelin, & Hemmingsson, 2015).

Mental health in children and adolescents with obesity

Despite expressing more dissatisfaction with their own bodies, children and adolescents with overweight and obesity in community samples do not seem to be more depressed or have lower self-esteem than others (Latzer & Stein, 2013; Wardle & Cooke, 2005). In a population study of adolescents in USA no significant association between depression and obesity was found for the overall sample (Merikangas, Mendola, Pastor, Reuben, & Cleary, 2011). Results from several studies indicate that mental health is more affected in children and adolescents seeking obesity treatment than in those with the same BMI not seeking treatment, and it has been hypothesized that mental health problems are an important factor for seeking obesity treatment (Braet, Mervielde, & Vandereycken, 1997; Eremis et al., 2004; Latzer & Stein, 2013; Wardle & Cooke, 2005). However, one study found that when controlling for other factors, such as higher BMI in the treatment seeking group, there were not many differences between treatment-seekers and non-treatment-seekers (Vlierberghe, Braet, Goossens, & Mels, 2009). In a study of treatment seeking adolescents with obesity it was found that adolescents with depression or anxiety more often had severe obesity than adolescents without mental health problems (Fox, Gross, Rudser, Foy, & Kelly, 2015). Adolescents with severe obesity seeking inpatient treatment report a high burden of psychiatric disorders. Of 47 patients only 30% reported no psychiatric disorder, 36% received one or two diagnoses, and 34% received three diagnoses or more. Common disorders were mood, anxiety, and eating disorders (Britz et al., 2000). Parental psychopathology and parental style affect mental health, but not degree of obesity, in children and adolescents with obesity (Decaluwe, Braet, Moens, & Van Vlierberghe, 2006). One specific factor that could affect mental health in children and adolescents with obesity is peer victimization. Youth with overweight and obesity are more likely to be victims or perpetrators of bullying compared to non-overweight peers (Janssen, Craig, Boyce, & Pickett, 2004; Puhl, Luedicke, & Heuer, 2011) and adolescents with overweight who lose weight report decreased weight-related teasing (Rancourt et al., 2014). There is a strong association between peer victimization and depression (Hawker & Boulton, 2000).

Obesity and self-esteem

BMI is significantly associated with self-esteem in adolescent girls and young adult women as a higher BMI is related to lower self-esteem. In USA, this is more pronounced in White than Black girls (Biro, Striegel-Moore, Franko, Padgett, & Bean, 2006). Before puberty there is little difference in self-esteem between children with obesity and children with normal weight but self-esteem decreases with increasing age (Strauss, 2000). Areas that are particularly affected in children with obesity are perceived competence in sports, physical appearance, and peer engagement (Franklin, Denyer, Steinbeck, Catterson, & Hill, 2006). Self-esteem decreases with higher age in treatment seeking children and adolescents with obesity (Nowicka et al., 2009). Self-esteem was found to be below the normative level in older treatment seeking adolescents and girls reported lower self-esteem than boys (Nowicka et al., 2009).

Obesity and health-related quality of life

Overweight and obesity might affect HRQoL and mental health differently in different age-groups. As expected, higher age is related to more problems in the physical domains, but younger subjects with obesity report lower self-esteem and more public distress than older age-groups (Zabelina et al., 2009). However, in a study of an adolescent population sample, obesity was associated with poor physical QoL, but excess weight was not associated with reduced social, school- or emotional functioning (Swallen, Reither, Haas, & Meier, 2005). In a study comparing HRQoL in adolescents and adults in their late 20s and late 30s all with severe obesity, it was found that the mental health aspects were the most affected in those in their 20s (mean age =27 years), whereas the adolescents reported mental health HRQoL scores comparable to norms (Dixon, Rice, Lambert, & Lambert, 2015).

Weight and suicidal behaviors

There is a strong association between depression and suicide, and suicidal thoughts are a core feature of depression (American Psychiatric Association, 2013). Although obesity is related to an increase in depression, increased BMI does not lead to an increased risk of completed suicide (Klinitzke, Steinig, Blüher, Kersting, & Wagner, 2013). Instead, there is an inverse relationship between BMI and risk of completed suicide for both men and women (Klinitzke et al., 2013). For women, the association between suicidal behavior and BMI is complex as women with higher BMI have an increased risk of suicide attempts but still a low risk of completed suicide (Zhang, Yan, Li, & McKeown, 2013). In a study of adolescents, it was found that adolescents with obesity and extreme obesity engaged more in suicidal ideation than other adolescents, yet they did not report

more suicide attempts than normal weight adolescents (Zeller, Reiter-Purtill, Jenkins, & Ratcliff, 2013).

Obesity and eating disorders

A general belief is that obesity in most cases is caused by an eating disorder. However, there is little evidence to support that conclusion. The eating disorders with the highest prevalence are Anorexia Nervosa (AN; 0.9% in women, 0.3% in men), Bulimia Nervosa (BN; 1.5% women, 0.5% men), and Binge Eating Disorder (BED; 3.5% women, 2.0% men; Hudson, Hiripi, Pope Jr, & Kessler, 2007). As underweight is a mandatory criteria for AN, it is not possible for a person with obesity to meet the criteria for an AN diagnose (American Psychiatric Association, 2013). BN consists of regular episodes of binge eating followed by some sort of compensatory behavior such as self-induced vomiting, the use of laxatives, or compulsive exercise (American Psychiatric Association, 2013). Most people with BN do not become obese (Fairburn, Cooper, Doll, Norman, & O'Connor, 2000).

Binge eating means eating an unusual large amount of food given the circumstances during a limited period of time. To be diagnosed with BED the overeating must be accompanied with a feeling of loss of control (American Psychiatric Association, 2013). Overeating without the feeling of loss of control and distress is not considered a psychiatric disorder. BED is diagnosed if a person binge eats at least once a week for three months (American Psychiatric Association, 2013). These diagnostic criteria are new. Most published studies on BED in populations with obesity, including all studies referred in the present thesis, have used the former criteria (i.e. binge eating episodes twice a week for at least six months). In a study comparing the prevalence of BED using new or old criteria in adults seeking obesity surgery, the prevalence more than doubled when the new criteria were used (Vinai et al., 2015). BED is highly related to excess weight and a BMI ≥ 40 is significantly more common in people with BED than in people without any eating disorder (Hudson et al., 2007). This does not mean that a majority of people with a BMI ≥ 40 have BED. In bariatric surgery samples, where the overwhelming majority have a BMI ≥ 40 , 15.7% meet the BED criteria at evaluation before surgery (Mitchell et al., 2015). Eating disorders are highly associated with other forms of psychopathology (Hudson et al., 2007), and individuals with obesity and concurrent BED consistently report more mental health problems than those with obesity without BED (Fabricatore & Wadden, 2004; Mitchell et al., 2015).

The average age of onset for BED is 25.4 years (Hudson et al., 2007), making it less frequent during childhood and adolescence, and lifetime prevalence is reported to be 1.6% in adolescents (Swanson, Crow, Le Grange, Swendsen, &

Merikangas, 2011). In a study of children and adolescents, 10–16 years, seeking obesity treatment, only 1% met the criteria for BED and 9% reported episodes of binge eating with loss of control (Decaluwé & Braet, 2003). For those with binge eating episodes, these started after obesity onset so in most cases obesity preceded binge eating (Decaluwé & Braet, 2003). Rather than eating disorders causing obesity, obesity during childhood is a risk factor for later development of BED and BN (Hilbert et al., 2014). Children and adolescents with obesity often recognize the societal pressure to become thinner, a drive for thinness can lead to efforts to restrain eating, and an effort to restrain eating can lead to overeating (Decaluwé & Braet, 2005).

Even if very few children and adolescents with overweight and obesity meet the criteria for any eating disorder, this does not mean that they are not bothered by their eating and eating behaviors or that they do not have eating-related problems. In a study of 126 children and adolescents seeking obesity treatment, 36.5% reported any binge eating episode during the last month (Decaluwé, Braet, & Fairburn, 2003). Those reporting binge eating also reported lower self-esteem and other forms of eating-related problems, but were not more depressed or overweight than the others (Decaluwé et al., 2003). However, binge eating prevalence can be affected by the assessment method used. Children and adolescents with obesity report more eating pathology when assessed with questionnaires compared to interviews, and it seems especially difficult for youths to value whether they engage in binge eating or not (Decaluwé & Braet, 2004).

It has been suggested that it is more relevant to assess loss of control over eating (LOC) in children and adolescents rather than to search for a full-blown BED, as youth reporting LOC, report distress and mental health problems to the same extent as those meeting full BED criteria (Kalarchian & Marcus, 2012). In community samples LOC is reported by 2–10% (Wolkoff et al., 2011) and LOC is related to elevated BMI (Schlüter, Schmidt, Kittel, Tetzlaff, & Hilbert, 2015). In recent years, a decrease in disordered eating behavior is seen in non-overweight youths, but no decrease is seen in overweight girls and a less decrease in overweight boys (Loth, Wall, Larson, & Neumark-Sztainer, 2015).

Obesity as a cause or consequence of mental health problems

Numerous studies have aimed to explore the casual links between mental health problems and obesity. Results from longitudinal studies show that obesity is prospectively related to depression and that depression is prospectively related to obesity, but the associations vary between different groups (Mühlig, Antel, Föcker, & Hebebrand, 2016).

In a longitudinal study, obesity was found to be predictive of major depressive disorder in girls but not in boys. However, obesity with an early onset (before age 14) was not predictive of later depression, but obesity developing during late adolescence (14–20 years) was particularly predictive of later depression. The authors hypothesize that it is especially difficult for girls who develop obesity during a phase in life where so much emphasis is put on conforming to ideals (Marmorstein, Iacono, & Legrand, 2014). Another study found that obesity is related to future increase in depressive symptoms in adolescent girls but not to an increased risk for a major depressive disorder (Boutelle, Hannan, Fulkerson, Crow, & Stice, 2010). Especially in adolescent girls with obesity, such a robust association has been found between obesity and subsequent depression that it has been recommended that mood should be monitored in this group (Korcak, Lipman, Morrison, & Szatmari, 2013). In a recent study in adolescents, neither overweight nor obesity was found to increase the risk of a future anxiety disorder (Roberts & Duong, 2016).

Obesity is highly stigmatized in both children and adults. Studies looking at the association between stigma, obesity, and depression have consistently found evidence for this connection, i.e. those who have experienced stigma have a higher incidence of depression (Preiss, Brennan, & Clarke, 2013). Also, individuals with obesity that report more weight and shape concern and body dissatisfaction have a higher incidence of depression (Preiss et al., 2013). Some studies show that obesity with childhood onset is related to greater body dissatisfaction (Schwartz & Brownell, 2004).

Depressed mood in adolescents has been found to be related to onset or persistence of obesity later in adolescence (Franko, Striegel-Moore, Thompson, Schreiber, & Daniels, 2005; Goodman & Whitaker, 2002; Stice, Presnell, Shaw, & Rohde, 2005). In a longitudinal study the earliest cases of major depressive disorder (before age 14) were the most predictive of later obesity in girls, but depression that developed in late adolescence did not predict obesity in young adulthood (Marmorstein et al., 2014). Both obesity and depression are associated with elevated inflammation. In a recent review article a model was proposed where both obesity and increased inflammation in adolescent girls are seen as outcomes of depression (Byrne, O'Brien-Simpson, Mitchell, & Allen, 2015). In both girls and boys, anxiety has been associated with increased BMI (Rofey et al., 2009).

One core feature of ADHD is an impaired ability to inhibit impulses. If this impulsivity is also directed towards food, that might make those with ADHD more prone to develop overweight and obesity over time. However, a recent meta-analysis including data from 43 studies and more than 700 000 subjects found no such association in children, a weak association between ADHD and excess weight in adolescent girls with other psychiatric comorbidities but no association

in adolescent boys, and a moderate association between ADHD and obesity in adults (Nigg et al., 2016). BED might mediate the association between ADHD and overweight and obesity in adult populations (Pagoto et al., 2009).

Other factors related to mental health, such as abuse and neglect, have also been found to be related to onset of obesity later in life (Hemmingsson, Johansson, & Reynisdottir, 2014). However, in a study of adolescents with severe obesity, no more child maltreatment was reported than expected from the general population. However, girls in the sample with a history of child maltreatment reported more mental health problems than the other adolescents (Zeller et al., 2015).

Mental health consequences of weight loss

Early in the dieting era, weight loss and dieting were thought to be related to negative affective outcomes (Smoller, Wadden, & Stunkard, 1987), but in recent years intentional weight loss through weight loss programs has consistently been reported to improve aspects of mental health both in children and adults (Butryn & Wadden, 2005; Epstein, Paluch, Saelens, Ernst, & Wilfley, 2001; Faulconbridge et al., 2009; Lloyd-Richardson et al., 2012). Even participating in weight loss treatment has been reported to improve mental health regardless of weight loss (French, Story, & Perry, 1995). However, not all subjects report improved mental health after participating in weight loss treatment and in a study of adults undergoing obesity treatment (medical, lifestyle, or both), 13.9% reported discernible increase in symptoms of depression one year after starting treatment and some cases of new onset of suicidal ideation were reported (Faulconbridge et al., 2009). Patients who reported more depression after treatment had to a higher extent a previous history of psychiatric problems compared to the rest of the sample and they lost less weight (Faulconbridge et al., 2009). Losing weight regardless of intention seems to have less favorable impact on mental health. In a study of a population sample no improvement and even impairment in mental health was found in those who lost weight even when controlling for illness and life-stressors (Jackson, Steptoe, Beeken, Kivimaki, & Wardle, 2014).

Assessment of mental health and quality of life in individuals with obesity

When assessing mental health in an individual with obesity it is necessary to consider whether questionnaires or other forms of assessment correctly reflect mental health status or if the result is inflated by factors predominantly related to obesity. Loss of energy is an often assessed symptom of depression, but lack of energy in a person with severe obesity can be related to physical consequences of

obesity such as poor sleeping quality. Also, generic instruments do not capture mental health issues specifically related to obesity such as stigmatization and body image concerns. There are some obesity-specific questionnaires especially developed to assess the impact of weight on QoL. They focus on factors that are specifically related to obesity and are sensitive to capture changes in mental health or QoL related to change in weight (Karlsson, Taft, Sjostrom, Torgerson, & Sullivan, 2003). However, the downside of using disease-specific questionnaires is that it limits the possibilities to compare with other groups and the general population. For a conclusive assessment of mental health in an individual with obesity it is recommended to use both generic and obesity-specific assessment (Wadden & Phelan, 2002).

Obesity treatment

There are different forms of obesity treatment and they vary in delivery method, intensity, and invasiveness. Obesity can be tackled at a societal level but these interventions are mostly aimed at prevention and not treatment, e.g. school-based programs can be effective for preventing childhood obesity (Wang et al., 2015).

Behavioral treatment

Lifestyle interventions and behavioral treatment are always the first hand choices in obesity treatment. Most behavioral programs contain interventions to reduce calorie intake, increase activity level, and behavioral modification beneficial for weight loss or weight maintenance. Components for behavioral change are mostly based on psychological models and many programs are based on behavioral therapy, cognitive behavioral therapy, and, in treatment of children and adolescents, also family therapy (Fabricatore, 2007; Flodmark, 2005; Nowicka & Flodmark, 2011). In treatment of obesity in children, active parental involvement is superior to treatment directed to the child alone (Epstein, Paluch, Roemmich, & Beecher, 2007; Epstein, Valoski, Wing, & McCurley, 1994; Kitzmann et al., 2010; Young, Northern, Lister, Drummond, & O'Brien, 2007). However, a recent study in adolescents found that increasing parental involvement in treatment did not lead to greater weight loss, rather there was a trend towards less weight loss in the group with more parental involvement (Jelalian et al., 2015).

Lifestyle interventions for treating overweight and obesity in children produce significant and clinically meaningful changes in weight, but children who are not offered treatment continue to gain weight (Epstein et al., 1994; Moens, Braet, & Van Winckel, 2010; Wilfley et al., 2007). However, many intervention studies are

criticized for addressing highly selective samples and excluding children and adolescents with mental health problems (Jelalian, Wember, Bungeoth, & Birmaher, 2007). Also, age seems to be an important factor for success in pediatric obesity treatment. A greater BMI reduction was seen after behavioral treatment in children compared to adolescents (Epstein et al., 2007). In a study comparing treatment effects in different age-groups, 80% of children aged 6–9 had a clinically significant BMI reduction compared to only 28% of adolescents aged 14–16 years (Danielsson et al., 2012). This is also true for children and adolescents with extreme obesity, where lifestyle interventions are more effective in children under 10 years (Knop et al., 2015) but have almost no effect in adolescents with severe obesity (Danielsson, Kowalski, Ekblom, & Marcus, 2012). Also, adolescents have a higher drop-out rate from treatment compared to children (Danielsson et al., 2012). Professionally administered weight loss interventions for children and adolescents do not lead to an increased risk for developing an eating disorder (Butryn & Wadden, 2005; Epstein et al., 2001).

Children's global self-worth is a positive predictor of outcome, whereas maternal psychopathology is a negative predictor (Moens et al., 2010). Barriers to weight loss described by youngsters are the extended time period before starting to lose weight, delayed recognition of parents, and previous negative experience with weight loss (Murtagh, Dixey, & Rudolf, 2006). In adults, initial weight change in weight loss treatment is related to long-term outcome. Individuals who lose more weight during the first months of the treatment have a greater weight loss eight years after inclusion (Unick et al., 2015).

Even if many programs are successful for weight loss, a considerable number of patients regain weight again after ending the program (Brownell, 2010), and one year after finishing obesity treatment adult patients have on average regained one third of their lost weight (Butryn, Webb, & Wadden, 2011). Even in programs especially designed to prevent weight regain a majority regain weight (Cooper et al., 2010). Five years after starting treatment about 50% return to their baseline weight (Butryn et al., 2011). Furthermore, lifestyle interventions do not lead to sufficient weight loss for all and more intense or invasive treatment models have been developed. Inpatient treatment has been tried out with large weight reduction in children and adolescents and with sustained weight loss at follow-up (Braet, Tanghe, Decaluwé, Moens, & Rosseel, 2004). However, inpatient treatments are expensive and separate the child or adolescent from its primary caregivers for a lengthy period.

Pharmacologic treatment

There are few drugs available for obesity treatment; however, two new pharmaceutical drugs have recently been released in Europe. They are approved for obesity treatment in adults but not in children and adolescents (European Medicines Agency, 2015). Drugs should be used in combination with lifestyle treatment and a weight loss > 5% of total body weight is considered clinically meaningful. Obesity drugs can work through different mechanisms such as reducing appetite or reducing fat uptake from the food eaten (Bray, Frühbeck, Ryan, & Wilding, 2016; Patel, 2015). Some previous drugs have been retracted from the market due to unacceptable side effects (Patel, 2015). Some of the negative side effects have been reduced mental health (Christensen, Kristensen, Bartels, Bliddal, & Astrup, 2007).

Bariatric surgery in adults

Surgery as a treatment option for severe obesity was first tried in the 1950s (Akkary, 2012). In 2013, about 468 000 bariatric procedures were performed in the world and about 7500 of these bariatric surgery procedures were performed in Sweden (Angrisani et al., 2015). Bariatric surgery is today the most effective treatment for substantial and long lasting weight reduction in adults with severe obesity (Buchwald, Avidor, Braunwald, & et al., 2004). Besides weight loss, bariatric surgery leads to substantial reduction or resolution of obesity-related comorbidity (Buchwald et al., 2004; Sjöström et al., 2004) and to decreased mortality (Adams, Gress, & Smith, 2007; Sjöström et al., 2007).

Eligibility criteria for bariatric surgery are generally a BMI ≥ 35 with an obesity-related comorbidity, or a BMI ≥ 40 (Mechanick et al., 2013). A higher proportion of women than men with severe obesity undergo bariatric surgery. In USA, more than 80% of patients that undergo WLS are women, even though women only constitute 63% of the population with severe obesity (Pickett-Blakely, Huizinga, & Clark, 2012; Santry, Gillen, & Lauderdale, 2005). In Sweden, women are more likely to undergo bariatric surgery at a younger age than men, and even if bariatric surgery is subsidized by the health care system for those meeting the eligibility criteria those in the lowest socioeconomic group are less likely to undergo surgery (Memarian, Calling, Sundquist, Sundquist, & Li, 2014).

There are different bariatric procedures. The most common are gastric banding, gastric bypass, and sleeve gastrectomy (SG). Bariatric surgery is normally performed laparoscopically. Gastric bypass is the most performed procedure in Sweden and Europe (Angrisani et al., 2015). Worldwide, the numbers of gastric bandings are steeply decreasing whereas SG procedures are increasing, and SG is

today the most performed procedure in USA and Canada (Angrisani et al., 2015). In a gastric bypass the stomach is divided and a small pouch (in the size of a thumb) is created. This small pouch is connected to the intestine, see Figure 1. A gastric bypass reduces the amount of food that can be eaten, and it also leads to changes in appetite signaling (Miras & le Roux, 2013).



Figure 1
Gastric bypass (Olbers, Lönroth, Fagevik-Olsén, & Lundell, 2003, reproduced with permission from the author)

It has been suggested that mental health could be an important factor for which treatment a patient applies for and that those seeking WLS should have an impaired health compared to patients seeking behavioral treatment. However, findings are mixed and studies show relatively similar degree of mental health problems in patients seeking WLS or residential treatment (Gradaschi et al., 2013; Stout, Applegate, Friedman, Grant, & Musante, 2007), but those who seek WLS perceive that their weight has a more negative impact on their lives (Stout et al., 2007).

Bariatric surgery in adolescents

Until quite recently bariatric surgery has not been considered a treatment option for adolescents with severe obesity. However, there are reports about a few cases in the 1980s and the 1990s (Black, White, Viner, & Simmons, 2013; Paulus et al., 2015; Sugerman et al., 2002). Today, the number of bariatric operations in adolescents is increasing. In USA the number of adolescents (< 20 years) undergoing bariatric surgery more than doubled from 2003 to 2009, and in 2009 1615 were operated (Zwintscher, Azarow, Horton, Newton, & Martin, 2013). Many adolescents that undergo bariatric surgery do this as a part of clinical trials which is also true for most Swedish adolescents who have undergone surgery. Some studies also include young adults (≤ 21 years) in their analysis (Lennerz et al., 2014). So far, studies have shown that adolescents have a weight loss similar to operated adults and low short-term complication rates have been reported (Göthberg et al., 2014; Inge et al., 2015; Lawson et al., 2006; Lennerz et al., 2014; O'Brien et al., 2010; Olbers et al., 2012). Bariatric surgery seems to lead to the resolution of obesity-related comorbidities to the same extent in adolescents as in adults (Inge et al., 2015; O'Brien et al., 2010; Olbers et al., 2012). As in adults, greater weight loss is seen after gastric bypass or gastric sleeve compared to gastric banding (Black et al., 2013; Lennerz et al., 2014; Paulus et al., 2015), and the greatest weight loss is seen after gastric bypass (Paulus et al., 2015).

After bariatric surgery, patients are required to take vitamin and mineral supplementation every day as uptake of vitamins and minerals is altered after surgery. Neglect of supplementation can lead to deficit with adverse long-term consequences. Poor adherence to vitamin and mineral supplementation has been reported in adolescents six months (Modi, Zeller, Xanthakos, Jenkins, & Inge, 2013) and two years after surgery (Olbers et al., 2012) with only one out of three adolescents being adherent. Low ferritin levels were found in 57% of operated adolescents three years after bariatric surgery (Inge et al., 2015). Besides reports for single patients (Sugerman et al., 2002), long-term outcome data for adolescents beyond three years are lacking. It is not known whether there is a continuation of this non-adherence to supplementation after the first years after surgery and what the consequences are of possible long-term deficiency of vitamins and minerals in those who undergo bariatric surgery as adolescents.

Bariatric surgery in adolescents is a controversial issue and it is debated whether it is ethical to offer a sometimes irreversible procedure to someone younger than 18 years (Caniano, 2009; Hofmann, 2013). The conceptualization of severe obesity in adolescents influences obesity specialists' acceptance of bariatric surgery as a treatment option for adolescents as those who view obesity as predominantly a medical condition are more positive to surgery whereas those who perceive it as a

psychosocial condition are more negative (van Geelen, Bolt, van der Baan-Slootweg, & van Summeren, 2013).

Mental health in adults and adolescents undergoing bariatric surgery

Mental health assessment in adults undergoing weight loss surgery

Different practices are used in different countries regarding whether and how mental health should be assessed in adults seeking obesity surgery. In Sweden it is not mandatory for those ≥ 18 years to undergo a mental health evaluation before bariatric surgery and most patients are cleared for surgery without meeting a mental health care professional. In other countries, e.g. USA, nearly all bariatric surgery candidates meet a psychologist (or other mental health care professional) as this is required by their bariatric surgical team and/or by their insurance company (Bauchowitz et al., 2005; Marcus, Kalarchian, & Courcoulas, 2009; Mechanick et al., 2013). In the best practice guidelines from the American Society for Metabolic and Bariatric Surgery an extensive assessment of bariatric surgery candidates is suggested including previous weight loss attempts, eating behavior, physical activity, substance use, risk-taking behavior, compliance, legal history, cognitive functioning, coping skills, psychopathology, developmental history, current life situation, and motivation (LeMont, 2004). These guidelines were written in 2004 and are currently being updated. Most adults who undergo mental health evaluation before surgery are unconditionally recommended for surgery, but between 3–20% of adults are excluded from bariatric surgery due to psychosocial reasons (Sarwer, Wadden, & Fabricatore, 2005; Walfish, Vance, & Fabricatore, 2007).

Most psychologists use either clinical interviews or questionnaires, or both, to assess mental health in bariatric surgery candidates. However, there is variability in what psychologists assess and in what they consider reasons for delaying or denying surgery (Bauchowitz et al., 2005; Fabricatore, Crerand, Wadden, Sarwer, & Krasucki, 2006; Pull, 2010; Walfish et al., 2007). Most psychologists report that they assess presence of psychiatric symptoms such as depression, anxiety, and behaviors and cognitions related to eating disorders (Fabricatore et al., 2006; Wadden & Sarwer, 2006; Walfish et al., 2007). Some also assess cognitive functioning and personality traits (Fabricatore et al., 2006). The variability in clinical practice is often explained by the fact that there are few psychological factors that can robustly predict outcome after surgery (Fabricatore et al., 2006;

Wadden & Sarwer, 2006). However, there is consensus that current alcohol or substance abuse, active psychosis, and dementia are contraindications to undergo bariatric surgery (Bauchowitz et al., 2005; Fabricatore et al., 2006; Marcus et al., 2009; Muller, Mitchell, Sondag, & de Zwaan, 2013; Walfish et al., 2007). Doubt about a patient's ability to informed consent and ability to follow the requirements after bariatric surgery are also common reasons for delay or denial of bariatric surgery (Fabricatore et al., 2006; Marcus et al., 2009; Walfish et al., 2007). Factors unrelated to the patient can affect clearance for surgery as a study found that mental health care professionals that were younger and/or seeing fewer WLS patients recommended postponed surgery more often (Fabricatore et al., 2006).

Some specific factors must be considered when mental health is assessed in patients undergoing WLS. As the mental health evaluation before surgery, in many cases, is a part of a decision process whether a candidate should be accepted for surgery or not, there is a risk of patients withholding information about mental health problems, so called impression management (Fabricatore, Sarwer, Wadden, Combs, & Krasucki, 2007). Studies that use an assessment procedure independent of the clearance process report a higher prevalence of psychiatric disorders than studies where data are collected as a part of the preoperative inclusion evaluation (Malik, Mitchell, Engel, Crosby, & Wonderlich, 2014).

As mentioned above, factors related to obesity can affect mental health assessment, and this could be especially salient in bariatric surgery populations where subjects have severe obesity. Some studies have explored whether Beck Depression Inventory (BDI) and Beck Depression Inventory II (BDI-II) correctly assess depression in subjects undergoing WLS or if depression scores are inflated due to obesity-related problems (Hayden, Brown, Brennan, & O'Brien, 2012; Krukowski, Friedman, & Applegate, 2008; Munoz et al., 2007). BDI-II performs better than BDI as a screening of depressive symptom in bariatric samples (Hayden et al., 2012). BDI-II has been found to be a reliable and valid indicator of depressive symptoms in adults seeking WLS (Hall et al., 2013).

Mental health status in adults seeking bariatric surgery

There are consistent reports that mental health is impaired in adults seeking WLS compared to normal weight population samples (Dawes, Maggard-Gibbons, Maher, & et al., 2016; Malik et al., 2014) and non-treatment seeking samples with obesity (Malik et al., 2014). In a recent meta-analysis including data from more than 65 000 patients, it was concluded that the most common mental health conditions in patients seeking WLS were depression (19%), BED (17%), and anxiety (12%; Dawes et al., 2016). In some studies, over 40% of patients seeking WLS report depressive symptoms of clinical relevance (Burgmer et al., 2007;

White et al., 2015), but even if bariatric surgery candidates are more burdened with depression than the general population, few patients (approximately 5%) report moderate to severe depressive symptoms before surgery (Mitchell et al., 2014).

Considering the risk for impression management the most reliable data are thought to be generated by studies with assessment independent from the formal evaluation process of acceptance for surgery. When assessing mental health with clinical interviews separately from the preoperative mental health evaluation, Mitchell et al. (2012) found that 33.7% of the patients reported symptoms meeting a current psychiatric disorder and the most common current disorder being any anxiety disorder. Findings were similar in a study by Kalarchian et al. (2007), also using clinical interviews with assessment independent of the approval process. They reported a current psychiatric disorder in 37.8% of the sample also with anxiety disorders being the most common. In Mitchell et al.'s (2012) sample 68.8% met the criteria for any lifetime psychiatric disorder, with any affective disorder as the most common lifetime disorder. Similarly, 66.3% in Kalarchian et al.'s (2007) sample met the criteria for any lifetime psychiatric disorder, with any mood disorder being the most common. In Mitchell et al.'s (2012) sample, current BED was reported by 10.1% and lifetime BED by 13.1%. Also, 33.2% reported a history of alcohol abuse or dependence which is higher than in population samples. However, only 0.5% reported current problems with alcohol, which is lower than in population samples (Mitchell et al., 2012).

Most studies, however not all, analyzing gender separately, find that mental health is more severely affected in women seeking WLS compared to men (Kalarchian et al., 2007; Mazzeo, Saunders, & Mitchell, 2006; Mitchell et al., 2012). When comparing rates of psychopathology over different studies, Malik et al. (2014) found that most psychopathology was reported in the sample with the lowest mean age. The authors suggested that there might be an association between lower age and more psychopathology in adults seeking bariatric surgery as this association also has been found in other populations with obesity. Data from the Scandinavian Obesity Surgery Registry show that mental health (as measured by the SF-36) is more deteriorated in the youngest adults (< 25 years) compared to older adults both before and after surgery even if the youngest are the least physically impaired (Scandinavian Obesity Surgery Registry, 2015). Furthermore, patients reporting childhood verbal abuse were found to be more likely to report depressive symptoms prior to surgery (Salwen, Hymowitz, O'Leary, Pryor, & Vivian, 2014). Patients reporting disordered eating before surgery are also known to report other mental health problems to a higher extent than patients with no eating pathology (Mitchell et al., 2015). No strong association has been found between mental health problems and degree of obesity in bariatric samples (Abilés et al., 2010; Fabricatore, Wadden, Sarwer, & Faith, 2005).

Outcomes in mental health and quality of life in adults after bariatric surgery

Bariatric surgery has consistently been found to be associated with improvements in mental health and HRQoL in adults (Bocchieri, Meana, & Fisher, 2002; Dawes et al., 2016; Herpertz et al., 2003). Improvements in mental health and HRQoL tend to occur relatively soon after surgery as studies find improvements already during the first six months after surgery (Sarwer et al., 2010). Most studies find a peak improvement in mental health one year after bariatric surgery with a subsequent levelling off or decline in the years after (Booth et al., 2015; Burgmer et al., 2014; Herpertz et al., 2015; Karlsson, Taft, Rydén, Sjöström, & Sullivan, 2007; Mitchell et al., 2014). Improvements are relatively stable from the second year after surgery until six years after surgery (Kolotkin, Davidson, Crosby, Hunt, & Adams, 2012) and partially sustained until ten years after surgery (Karlsson et al., 2007). However, a recent study found that mental health was deteriorated in a surgical group from four to nine years after surgery and mental health was equivalent or worse compared to baseline nine years after surgery (Herpertz et al., 2015).

Many studies assessing mental health in bariatric populations focus on depression. In a majority of studies, it is found that depression is significantly and substantially improved after bariatric surgery (Dawes et al., 2016; White et al., 2015), which has led to the conclusion that depression is a comorbidity of severe obesity (Dixon, Dixon, & O'Brien, 2003). Largest improvements are seen in patients with more depressive symptoms at baseline (Mitchell et al., 2014), but baseline depressive disorders are predictive of depressive disorders after surgery (de Zwaan et al., 2011). Improvements in depressive symptoms were reported to be sustained four years after surgery (Burgmer et al., 2014). However, in one study following patients up to seven years after surgery it was found that the initial improvements in depression were not maintained (Booth et al., 2015). In several studies, symptoms of depression and weight outcome have been found to be associated as those who lose more weight also have the largest improvements in depressive symptoms (Burgmer et al., 2014; Karlsson et al., 2007; Mitchell et al., 2014). However, the casual direction of this relationship is not known, and not all studies find an association between weight loss and improvement of depressive symptoms (Ayloo, Thompson, Choudhury, & Sherifdeen, 2015).

Anxiety symptoms are less studied in patients undergoing bariatric surgery and findings are mixed. Some studies find no change in anxiety symptoms after surgery (Burgmer et al., 2007; de Zwaan et al., 2011) whereas other studies find improvements during the first year after surgery (Burgmer et al., 2014; Karlsson et al., 2007), and three years after surgery (Kalarchian et al., 2015). Baseline anxiety is predictive of anxiety post-surgery (de Zwaan et al., 2011). It has been suggested

that anxiety is less weight dependent than depression as there was no significant association between change in anxiety and weight loss after surgery (Karlsson et al., 2007).

Most aspects of body image are improved after bariatric surgery (Adami, Meneghelli, Bressani, & Scopinaro, 1999; Sarwer & Steffen, 2015) and body image improves early after surgery (Sarwer et al., 2010). However, while self-esteem was improved the first year after surgery, four years after surgery there was no significant difference in self-esteem compared to baseline (Burgmer et al., 2014).

Significant HRQoL improvements are reported after bariatric surgery (Karlsson, Sjostrom, & Sullivan, 1998; Kolotkin et al., 2012; Lindekilde et al., 2015; Sarwer et al., 2010), and especially when weight-related QoL is assessed substantial improvements are seen (Karlsson et al., 2007; Lindekilde et al., 2015; Sarwer & Steffen, 2015). Peak improvement is seen during the first year after surgery (Andersen et al., 2015; Karlsson et al., 1998). Despite improvement, generic HRQoL scores are still on average below population norms after surgery (Andersen et al., 2015). Improvements are larger in the physical HRQoL domains and these improvements are also sustained over time (Burgmer et al., 2007; Herpertz et al., 2015; Lindekilde et al., 2015). Lesser or no improvements are seen in the mental health domains of HRQoL and these improvements often erode in the years following surgery (Burgmer et al., 2007; Herpertz et al., 2015). Improvements in HRQoL are related to weight loss (Karlsson et al., 1998). However, improvement in depressive symptoms was found to be the best predictor of HRQoL one year after surgery and was a better predictor than weight outcome (Masheb et al., 2007).

The reasons for the general improvements in mental health and HRQoL after bariatric surgery are not fully understood. Different explanations have been put forward such as reduced stigmatization, improved body image, improved self-esteem, and a renewed sense of control after surgery (Ogden, Clementi, & Aylwin, 2006). Substantial weight loss can also enhance engagement in behaviors that promote mental well-being. Also, changes in physical health might explain the improvement such as resolution of comorbidities and reduced inflammation (Capuron et al., 2011; Emery et al., 2007).

Adverse mental health outcomes after bariatric surgery

As most studies show improvements in mental health in adults after surgery, cases with adverse mental health outcomes are not often reported. Patients with new onset of depression are rare, and de Zwaan et al. (2011) reported that 3.6% of WLS patients with no previous history of depression developed a depressive

disorder after surgery. In another study, a clinically significant increase in depressive symptoms from six to twelve months after WLS was reported by 13.1% and no baseline differences were seen between the group with worsened mood post-surgery and others (Ivezaj & Grilo, 2015). Patients with sub-optimal weight loss seem to be at higher risk for postoperative depression and in patients that lost less than 25% of their initial weight, 18.5% reported clinically relevant onset of depressive symptoms after surgery (Burgmer et al., 2014). Single cases of eating disorders after WLS have also been reported (Segal, Kinoshita Kusunoki, & Aparecida Larino, 2004). As negative outcomes after bariatric surgery are not often discussed, patients with problems related to WLS may experience that they suffer in silence (Groven, Raheim, & Engelsrud, 2010).

Suicide

There are reports about an increased risk of completed suicide in adults after bariatric surgery (Adams et al., 2007; Peterhänsel, Petroff, Klinitzke, Kersting, & Wagner, 2013) and a review study with data from various countries estimated the risk of completed suicide to be four times higher in operated adults than in the general population (Peterhänsel et al., 2013). Some studies have reported the prevalence of suicidal ideation and behavior before surgery. Prevalence figures and assessment methods vary, but in one sample, 6.29% reported suicide ideation in the previous two weeks (Chen et al., 2012) and in another study 15.8% reported any past or current suicidal ideation or behavior (Adamowicz, Salwen, Hymowitz, & Vivian, 2015). Few studies have reported suicidal behavior post-surgery, but a study reported that 2.8% reported more suicidal ideation after surgery than before and all of them reported passive suicidal ideation as in “I have thoughts of killing myself, but I would not carry them out” (Ivezaj & Grilo, 2015). There is no clear evidence for the cause of the increased risk for suicide after WLS but several possible risk factors have been suggested including reemergence of mood disorders, continued impairment in QoL, and low self-esteem (Mitchell et al., 2013). A recent study has also reported an increased risk in deliberate self-harm after WLS with an intentional overdose as the most common self-harm behavior, and 93% of the self-harm events occurred in patients with a preoperative mental health disorder (Bhatti et al., 2015).

Alcohol problems

There is growing evidence for an increased risk of developing alcohol dependence after undergoing bariatric surgery (Spadola et al., 2015; Svensson et al., 2013). One often suggested explanation for this by people in general is addiction transfer as in when you cannot turn to food for emotional relief you turn to alcohol instead (Steffen, Engel, Wonderlich, Pollert, & Sondag, 2015). However, this increased risk is not seen after all bariatric procedures and studies indicate that there is an increased risk for alcohol use disorder especially after gastric bypass but no or less

increased risk after other procedures (Conason et al., 2013; Dawes et al., 2016; Spadola et al., 2015; Steffen et al., 2015; Svensson et al., 2013). After a gastric bypass, alcohol absorption is more rapid and alcohol concentration in the blood is increased and these differences could explain a greater sensibility for developing an alcohol abuse disorder (Steffen et al., 2015). Other suggested risk factors are younger age, preoperative alcohol use, and symptoms of ADHD (Spadola et al., 2015).

Is there an association between mental health and weight outcome after surgery?

Several studies have explored whether mental health status affects other outcomes after WLS, predominantly weight loss. It can be presupposed that an impaired mental health would decrease patients' ability to comply with the recommendations post-surgery and thereby lose less weight. However, findings are inconsistent whether preoperative mental health problems affect weight loss after surgery (Dawes et al., 2016; Herpertz, Kielmann, Wolf, Hebebrand, & Senf, 2004; Marek, Ben-Porath, & Heinberg, 2016; Pull, 2010). Some studies find that patients with mental health problems at baseline lose less weight than others (de Zwaan et al., 2011; Kalarchian et al., 2008; Kinzl et al., 2006; Legenbauer et al., 2009), other studies find no such association (Kalarchian et al., 2015; White et al., 2015), and some studies find that those reporting more distress at baseline lose more weight than others (Averbukh et al., 2003; Dubovsky, Haddenhorst, Murphy, Liechty, & Coyle, 1985). One review concluded that females, younger patients, and those with obesity onset before the age of 18 lose more weight after surgery than others (van Hout, Verschure, & Van Heck, 2005). Considering the variations in findings over studies, baseline psychopathology does not seem to be a robust predictor of weight outcome after surgery (Herpertz et al., 2004).

However, as mentioned above, greater improvements in mental health are generally seen in those who lose more weight after surgery, and mental health problems after surgery seem to be more related to weight outcome. Patients with remaining or new onset of eating-related pathology (Kalarchian et al., 2015; Sheets et al., 2015; White, Kalarchian, Masheb, Marcus, & Grilo, 2010; Wimmelman, Dela, & Mortensen, 2014b) or depressive disorder have lesser weight loss after WLS (de Zwaan et al., 2011; Sheets et al., 2015; White et al., 2015). One study found more weight regain after gastric bypass in patients with lower self-esteem after surgery (Livhits et al., 2011).

Greenberg and colleagues have suggested that one of the reasons for finding no or weak associations between preoperative mental health and outcome after surgery is that the population undergoing surgery is not representative of all seeking

bariatric surgery, i.e. patients with the most severe mental health problems are not cleared for surgery (Greenberg, Sogg, & Perna, 2009). Another suggested reason for the mixed findings is the variability in how mental health is assessed, and which aspects of mental health that are being assessed. Today, the common practice is to assess symptoms and not underlying psychological constructs (Marek et al., 2016).

Mental health assessment in adolescents undergoing weight loss surgery

Most guidelines emphasize that psychological or psychiatric evaluation of adolescents seeking bariatric surgery is vital (Apovian et al., 2005; Brei & Mudd, 2014; Inge & Lawson, 2005). The guidelines often suggest extensive components of such an evaluation. Areas that should be assessed are the adolescent's ability to consent, ability to compliance, motivation, knowledge of bariatric surgery, family functioning and access to support, drug abuse, and mental health including mood and eating disorder (Apovian et al., 2005; Inge et al., 2004; Inge & Lawson, 2005; Michalsky et al., 2012; Pratt et al., 2009). However, there is not much guidance for clinicians in which adolescents to approve, which to postpone, and which to deny surgery (Sysko et al., 2013). Most adolescent guidelines state that well controlled psychopathology, including eating disorders, is not an exclusion criteria from bariatric surgery (Brei & Mudd, 2014).

In a review of existing practices of psychosocial assessment of adolescents before bariatric surgery, it was reported that what has been assessed so far in adolescents is depression, anxiety, eating pathology, QoL, stigmatization, and social isolation (Sysko et al., 2013). Sysko and colleagues (2013) suggest that a preoperative evaluation of adolescents consists of three parts: a clinical interview with both the adolescent and parents, assessment with self-report questionnaires, and cognitive assessment. Few studies have reported the proportion of adolescents being denied surgery based on the psychosocial evaluation, but Sysko et al.(2013) reported that only 1.5% of the assessed adolescents at their clinic were denied surgery. In a study of 25 adolescents, Kim et al. (2008) reported that nine (36%) were not unconditionally recommended for surgery. The most common reason for delay of surgery was feared non-adherence to diet. Impression management at preoperative evaluation does not seem to be as pronounced in adolescents as in adults (Ratcliff, Reiter-Purtill, Inge, & Zeller, 2011).

Mental health status in adolescents seeking bariatric surgery

Most studies that have assessed mental health in adolescents seeking WLS have found that they have a substantially impaired mental health compared to norms and that adolescents seeking WLS seem to have an affected mental health in a similar manner as adults. In a study of 25 adolescents, a lifetime psychiatric diagnose was made in 22. Depression was the most common diagnose (68%; Kim et al., 2008). In a review of 200 evaluated adolescents at a single site, 20% had a history of any psychiatric disorder and 31.5% had a current psychiatric disorder (Sysko et al., 2013). ADHD (6%) and major depressive disorder (6%) were most commonly reported. Few adolescents met the formal criteria for any eating disorder, but problems related to binge eating or night eating were quite commonly reported (16% and 9.5%). A history of or current psychiatric (34%) or psychological treatment (29.5%) was common and 15% reported ongoing psychiatric medication. Also, 5.5% reported a previous suicide attempt and 15.5% past significant suicidal ideation. Deliberate self-harm was reported in 10.5% (Sysko et al., 2013). In another study, past suicide ideation was reported by 40% of adolescents seeking WLS, suicide attempt by 15%, and past self-harm by 25% (Duffecy, Bleil, Labott, Browne, & Galvani, 2008). Regular alcohol use (0.5%) and illicit drug use (1.5%) were uncommon (Sysko et al., 2013). However, a recent multi-center study from USA, comparing adolescents seeking WLS to adolescents in lifestyle interventions found more psychopathology in the group undergoing behavioral treatment compared to the surgical group (Rofey et al., 2015). When both groups were analyzed together, no more psychopathology was found in this group of adolescents with severe obesity than in the general adolescent population. The authors concluded that the adolescents accepted for bariatric surgery was a highly selective group and that the complex process of being approved for surgery might skew the surgery group to include adolescents with a better mental health (Rofey et al., 2015).

In a latent class analysis of 125 evaluated adolescents, three subgroups of adolescents seeking WLS with different levels of psychopathology were found. The largest group, consisting of 50% of the adolescents, was classified as “low psychopathology”. The adolescents in this group reported lower levels of depressive symptoms, less anxiety, higher QoL, and better family function than the other groups. One group of adolescents, 14%, was classified as “eating pathology” and this group reported high levels of both general psychopathology and eating disorder related behaviors. The adolescents in this group were older, more lived in underprivileged areas, and there were more Caucasians in this group. A third group, 36%, was defined as “non-specific psychopathology” and was characterized by intermediate levels of psychopathology and family functioning (Sysko, Zakarin, Devlin, Bush, & Walsh, 2011). The authors concluded that

specific attention should be directed to adolescents who report eating-related problems as this is associated with other mental health problems.

Some studies reporting mental health in adolescents seeking bariatric surgery have used BDI or BDI-II to assess depressive symptoms. A BDI score ≥ 17 can be used as a conservative marker of depressive symptoms in the clinical range (Beck, Steer, Brown, & Lindfors, 2006). The proportion of adolescents with clinical depressive symptoms varies between studies. The lowest prevalence, 16%, was reported by Kim et al. (2008) and the highest, 62.5%, by Zeller et al. (2011). Other studies have reported 25% (Sysko et al., 2011), 30% (Zeller, Roehrig, Modi, Daniels, & Inge, 2006), 32% (Duffecy et al., 2008; BDI score ≥ 16 was used as cut-off in this study), and 38.7% (Zeller, Modi, Noll, Long, & Inge, 2009) with depressive symptoms in the clinical range. The studies with the lowest and highest prevalence figures had quite small samples ($n=25$ and $n=16$). Regardless of variations over studies, the prevalence figures are higher than what is normally reported in adolescent samples (Avenevoli et al., 2015). Moderate to severe depressive symptoms were reported by 27% of adolescents before surgery in one study (Zeller et al., 2006) and by 13% in another study (Kim et al., 2008). Few studies have reported anxiety data, but in one study 25% reported anxiety-related problems (Duffecy et al., 2008).

Other affected aspects are self-esteem, body image, and QoL. Both self-assessed and parent reported QoL is lower in adolescents seeking WLS compared to norms and/or normal weight controls (Aldaqaal & Sehlo, 2013; Olbers et al., 2012; Sysko et al., 2011; Zeller et al., 2006). In a study from Saudi Arabia it was found that adolescents seeking surgery had significantly lower self-esteem and lower own and parent-reported QoL compared to normal weight controls (Aldaqaal & Sehlo, 2013).

Outcomes in mental health and quality of life in adolescents after bariatric surgery

There are few studies today that have assessed mental health outcomes in adolescents after bariatric surgery. Some of these studies have quite small samples. Most studies find the same outcome in adolescents as in adults, i.e. large improvements during the first year after surgery and then levelling off or decline (Herget, Rudolph, Hilbert, & Blüher, 2014; Hillstrom & Graves, 2015).

Improvements seem to take place already early after surgery as Zeller et al. (2009) reported that the major and clinically significant improvements for depressive symptoms and most domains of HRQoL took place during the first six months after surgery and then decelerated. Both depression and HRQoL were significantly improved one year after gastric bypass and HRQoL was within one standard

deviation (SD) of healthy adolescent comparison (Zeller et al., 2009). In a follow-up over the first 15 months after gastric banding, Sysko et al. (2012) found significant improvements in depression and QoL. Improvement in depressive symptoms was correlated to change in BMI and the major improvements for depression were seen in the first months after surgery. Loss of control over eating and family conflict were significant negative predictors of weight loss over the first year after gastric banding (Sysko et al., 2012). Loux et al. (2008) reported substantial improvements in QoL in adolescents even in the first month after surgery indicating that improvements in fact take place early after surgery. In another study of adolescents undergoing gastric banding significant improvements were seen in self-esteem and HRQoL one year after surgery. Also in this study they found that weight loss was a significant predictor of improvement in self-esteem and HRQoL (Aldaqa & Sehlo, 2013). A meta-analysis of outcome studies in adolescents was conducted and overall QoL improved with 2.8 SDs and depression with 0.52 SD. Larger QoL improvements were seen in physical domains compared to mental health domains (White et al., 2015).

Little is known about what happens with mental health in adolescents after the first postoperative years. In a two-year follow-up of 16 adolescents, Zeller et al. (2011) found significant improvements in depressive symptoms and HRQoL during the first year after surgery with a deceleration during year two. During the second year after surgery a significant increase in depressive symptoms was seen and there was also a significant reduction of various aspects of HRQoL. However, depressive symptoms were still lower than at baseline and HRQoL was improved. Most aspects of mental health were on average in the normative range two years after surgery suggesting not only improvement but also normalization of mental health. Two years after surgery all aspects of self-concept, except athletic competence, were in the normative range. A significant weight gain was seen during the second year (Zeller et al., 2011).

In a core publication from AMOS reporting outcomes over the first two years after surgery, HRQoL data based on SF-36 were reported. At the two-year follow-up all physical domains were significantly improved as well as the physical component summary score. In the mental health domain only two variables were significantly improved, vitality and social functioning, whereas role-emotional, mental health, and the mental health component summary score were not significantly improved compared to baseline (Olbers et al., 2012). In a study of 242 operated American adolescents it was reported that weight-related QoL was significantly improved three years after bariatric surgery (Inge et al., 2015).

Specific relevant aspects of mental health after bariatric surgery are body image and psychosocial problems with excess skin. Body image dissatisfaction was significantly reduced during the first year after surgery and the most substantial

improvements took place during the first six months after surgery (Ratcliff, Eshleman, Reiter-Purtill, & Zeller, 2012). There was no significant correlation between estimated body size and attitudinal body image or weight-related QoL in this group of 16 adolescents. However, adolescents with lesser discrepancy between their estimated body size and their ideal body size had a better body image. That is, being closer to one's ideal is more important than actual body size for body image (Ratcliff et al., 2012). In a study of 47 of the adolescents in the AMOS cohort, a majority reported significant problems in their daily life due to excess skin after gastric bypass. Problems the adolescents associated to the excess skin was the feeling of having an unattractive body, problems finding clothes that fitted, and not being comfortable in intimate situations. The authors concluded that, despite a previous assumption that young bariatric surgery candidates would experience fewer problems with excess skin, they actually reported more problems than in previous studies of adults (Staalesen et al., 2014).

Psychosocial adverse events are also seen in adolescents after bariatric surgery. In a study of suicidal ideation and behavior in adolescents undergoing WLS, five adolescents were hospitalized for a suicide attempt after WLS and two adolescents committed suicide (McPhee et al., 2015). From AMOS, two cases of suicide attempt during the first two years after surgery have been reported (both with medication overdose) and five cases of addictive use of alcohol or drugs (Olbers et al., 2012).

Adolescents that report more depressive symptoms and loss of control over eating before surgery have poorer attendance to follow-up visits. Lower attendance to visits after surgery is related to less weight loss two years after surgery, at least for adolescents that have undergone gastric banding (Sysko et al., 2014).

Summary of the empirical studies

The AMOS study

The studies in this thesis were conducted as a part of the Swedish nationwide AMOS study. AMOS is a ten-year controlled prospective study of gastric bypass in adolescents with severe obesity. AMOS is a co-joint study from the three largest childhood obesity units in Sweden: Stockholm, Gothenburg and Malmö, and the adolescents were recruited via these centers. The AMOS study was approved by the regional ethical committee in Gothenburg. All adolescents underwent laparoscopic gastric bypass and all were operated at Sahlgrenska University Hospital in Gothenburg. The adolescents underwent surgery between May 2006 and January 2010 and in total 88 adolescents were operated. When AMOS was planned and set up outcome data for bariatric surgery in adolescents were very scarce. The scientific board decided that a broad study of the feasibility and effectiveness of gastric bypass to adolescents was necessary before a randomized controlled trial (RCT) could be set up.

In the published (Olbers et al., 2012) and planned core papers from the AMOS study, data from the first operated 81 adolescents (May 2006 to May 2009) were evaluated. For this core group of 81 adolescents, there are two control groups available. One control group consists of 81 conventionally treated adolescents from the Swedish Childhood Obesity Treatment Register, BORIS, approximately matched for BMI, age, and gender to the adolescents in AMOS. The other control group consists of 81 gender- and BMI-matched adults aged 35–45 years who underwent gastric bypass at the same institution and at the same time as the operated adolescents. The available comparison data from both control groups have so far mainly been anthropometrics and there is no mental health or HRQoL data available from baseline for any of the control groups. For the five-year follow-up the conventionally treated group from BORIS has been invited to assessment at the clinics, so for the five-year evaluation there is also comparison data for QoL, mental health, and biochemical markers. In other studies from the AMOS group, including the studies in the present thesis, data from all the available adolescents in the AMOS cohort ($n = 88$) were used.

Inclusion criteria in AMOS were age 13–18 years and a BMI ≥ 40 or ≥ 35 with obesity-related comorbidity. Most adolescents in AMOS were ≥ 16 years when undergoing surgery, 26% of the sample were under 16 when operated and only one adolescent was younger than 14 years. For BMI, most adolescents, 63%, had a BMI between 40 and 49, 14% had a BMI 35–40, and only one adolescent had a BMI > 60 . Before inclusion the adolescent should have been in conventional childhood obesity treatment at a pediatric clinic for at least one year.

Exclusion criteria were few but included mental retardation, psychotic disease, and ongoing drug abuse. The exclusion criteria related to mental health and psychological functioning, such as psychosis and substance abuse, are rather infrequent in adolescents. This resulted in that almost all adolescents who were opting in for AMOS were accepted for surgery. The adolescents in the studies were hence not a highly selected group, and a previous study from AMOS has reported that 31% had any neuropsychiatric disorder, 16% reported deliberate self-harm, and 41% had ever received mental health service from a pediatric psychiatric unit. Only 32% reported no history of mental health problems (Olbers et al., 2012).

Assessment at inclusion and follow-ups took place at the units in Stockholm, Gothenburg and Malmö. In a few cases assessments were made outside the clinic due to the convenience of the adolescents. Most questionnaires were collected by the study coordinators at each site, but two forms, Beck Youth Inventories (BYI) and BDI-II, were administered by clinical psychologists, and these questionnaires were also a part of the clinical evaluation before and after surgery.

General aims and methods in study I–III

The general aims of the papers in the present thesis have been to evaluate mental health in adolescents with severe obesity seeking bariatric surgery, and to study how their mental health is affected by undergoing surgery in a short term and a two year perspective. Another aim has been to explore whether there are subgroups of adolescents who have a less positive or negative psychological outcome after gastric bypass and to describe what defines these groups. In the studies, we have hypothesized that we would see the same outcome in mental health in adolescents as has previously been described in adults with large improvements during the first year after surgery followed by levelling off or even decline.

Subjects in the papers are adolescents from the AMOS cohort. In all studies, self-report questionnaires are used to assess mental health and HRQoL. BYI has been

used in all three studies. Most data presented in study I-III have not been presented elsewhere, but outcomes regarding weight, biochemical markers, and SF-36 are also presented in a previous paper from AMOS (Olbers et al., 2012). In study II and III mostly the same data are used, but in study II outcomes for the whole operated group are presented and in study III the sample is divided into two groups and compared to each other.

Study I – Short-term psychological outcomes in severely obese adolescents after bariatric surgery

Specific aims

The aim of study I was to describe mental health in adolescents before and shortly after gastric bypass. A secondary aim was to evaluate clinically meaningful change in mental health in all adolescents and to explore if there was any subgroup of adolescents that needed extra support soon after surgery.

Subjects and methods

Subjects were 37 of 39 adolescents from the AMOS cohort who underwent surgery between September 2007 and November 2009. Mean age for this group was 16.6 (\pm 1.3), mean BMI 46.5 kg/m², and 68% were girls. Follow-up was planned to three months post-surgery, but the actual mean time for follow-up was 4.2 (SD \pm 1.4) months after surgery. Mental health was assessed with the five scales in BYI: anxiety, depression, anger, disruptive behavior, and self-concept. Depressive symptoms were also assessed with BDI-II at follow-up.

Change from baseline to follow-up was analyzed using paired *t*-test. Analyses of clinically meaningful change were conducted for all adolescents for all variables on the BYI. A 95% confidence interval (CI) was set around the baseline score and a follow-up score outside this interval was considered either a clinical improvement or impairment. Baseline scores and BMI for adolescents clinically significantly impaired on two scales or more after surgery were compared with baseline values for the other adolescents using the Mann-Whitney U test.

Results

Before gastric bypass surgery, mental health was impaired in the adolescents compared to population norms. For baseline mean percentile and percent of adolescents in respective category, see Table 2 for anxiety, depression, anger, and disruptive behavior. The mean percentile for self-concept was 38.2 prior to surgery and 19% of the adolescents were categorized as having a very low self-concept, 24% as having a somewhat low self-concept, 54% as having an average self-concept and 3% as having a high self-concept.

Table 2

Descriptive percentile values for BYI symptoms scales at baseline and 4 months. Four months values only presented for significantly changed variables

	Mean percentile	Average symptoms	Slightly elevated symptoms	Highly elevated symptoms
Anxiety baseline	70.6	43%	35%	22%
Anxiety 4m	55.2	65%	24%	11%
Depression baseline	65.9	49%	24%	27%
Depression 4m	54.6	68%	21%	11%
Anger baseline	68.3	43%	35%	22%
Disruptive behavior baseline	64.5	57%	29%	14%

Anxiety, depressive symptoms, and self-concept were significantly improved four months after surgery. Mean percentiles and categories for anxiety and depression are presented in Table 2. Self-assessed symptoms of anxiety and depression were closer to population norms four months after surgery and the mean percentile for self-concept was 51.1 after surgery. Group mean score for BDI-II (mean 9.7, SD \pm 10.2) indicated depressive symptoms in the minimal range. No significant change was seen for anger and disruptive behavior.

A majority of adolescents reported either improvements or unchanged levels of symptoms four months after surgery, but 38% (n = 14) were impaired at one variable or more, see Figure 2. Impairment on two variables or more was seen in 16% (n = 6) of the adolescents. All adolescents who reported impairment for either anxiety or depression were also impaired on at least one other scale. No significant baseline differences were found between impaired adolescents and adolescents with an unchanged or improved mental health. In addition to the group impaired

on two variables or more, 8% (n = 3) remained with highly elevated symptoms for either anxiety or depression or both. In this study, we found no significant association between mental health and BMI or amount of weight loss.

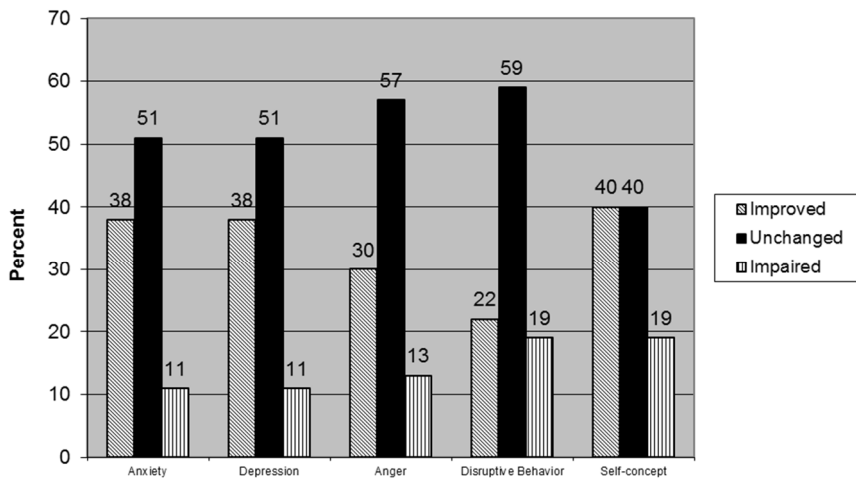


Figure 2
Percent of adolescents improved, unchanged or impaired post-surgery (n = 37)

Conclusions

- Swedish adolescents presenting for WLS report an impaired mental health compared to an age- and gender-matched norm population. Both internalizing and externalizing symptoms were on average elevated and self-concept was on average lower than in adolescents from the general population. However, not all adolescents seeking WLS are affected and for each assessed variable between 43% and 57% reported average symptoms.
- Four months after surgery, symptoms of anxiety and depression were significantly reduced and self-concept was significantly improved. No significant changes were seen for anger and disruptive behavior. Adolescents reported anxiety, depressive symptoms, and self-concept comparable to norms four months after undergoing gastric bypass.
- A subgroup, 16% (n = 6), reported a clinically significant deterioration of mental health in at least two aspects four months after surgery.

- No significant baseline differences could be detected between impaired adolescents and improved or unchanged adolescents.
- Another small separate subgroup, 8% (n = 3), reported substantial mental health problems before surgery, and showed no or very little improvement after surgery. This group was still highly burdened with mental health problems after surgery.
- No significant association between BMI and mental health was found.

Study II—Two-year trends in psychological outcomes after gastric bypass in adolescents with severe obesity

Specific aims

The specific aim of study II was to explore the changes in mental health in adolescents over the first two years after gastric bypass.

Subjects and methods

Subjects were all 88 adolescents from the AMOS cohort. Mean age at surgery was 16.8 years, mean BMI 45.6 kg/m², and 65% were girls. Mental health was assessed at baseline and at one year and two years after surgery with both generic and obesity-specific questionnaires.

Change over time was analyzed using multilevel mixed-effect regression models. Variables not normally distributed were transformed with zero-skewness log-transformation. Standardized response mean (SRM) was used to assess the magnitude of change in significantly changed variables. SRM was evaluated using criteria proposed by Cohen, where < 0.2 is trivial, 0.2 to < 0.5 is small, 0.5 to < 0.8 is moderate, and ≥ 0.8 is large ES (1988). Associations between different aspects of mental health and weight outcome were tested with Pearson's r.

Results

All measured aspects of mental health were significantly improved two years after surgery except activation which is one aspect of mood, see Table 3 and Figure 3 a-f. For most variables the improvement took place during the first year after surgery and during the second year mental health stabilized. Improvement in symptoms of anxiety, self-concept, and obesity-related problems from baseline to two years after surgery corresponded to a moderate ES. For depressive symptoms, anger, disruptive behavior, overall mood, and self-esteem the ES was considered small. At follow-ups, depressive symptoms were also assessed with BDI-II. Two years after surgery the mean score for the whole group indicated depressive symptoms in the minimal range. In total, 19% scored over the cut-off for depressive symptoms in the clinical range, and 13% reported severe depressive symptoms two years after surgery.

Table 3

Anthropometrics and psychological health in adolescents with severe obesity at baseline and at 1 year and 2 years after gastric bypass

Abbreviations: BMI Body Mass Index, BY1 Beck Youth Inventories, MACL Mood Adjective Check List, OP Obesity-related Problems scale. Data are shown as mixed-models mean (95% CI). Significant *P*-values in bold.

¹Due to non-normal distribution, these variables were transformed with zero-skewness log-transformation before analyses. Means and confidence intervals are expressed on the original scale.

	Baseline	n	1 year post-surgery	n	P-value 1 year vs. baseline	2 years post-surgery	n	P-value 2 years vs. baseline	P-value 2 years vs. 1 year
BMI	45.6 (44.4–46.8)	86	30.9 (29.9–31.9)	85	<0.001	30.1 (29.0–31.2)	85	<0.001	0.065
Anxiety BY1¹	14.2 (12.1–16.4)	63	10.2 (8.2–12.3)	52	<0.001	10.5 (8.5–12.7)	63	0.001	0.763
Depression BY1¹	14.1 (12.0–16.6)	63	9.5 (7.5–11.8)	52	<0.001	9.9 (7.8–12.4)	63	0.001	0.694
Anger BY1¹	11.3 (9.4–13.5)	63	9.3 (7.3–11.6)	52	0.056	7.8 (5.8–10.1)	62	0.001	0.125
Disruptive behavior BY1¹	4.8 (3.7–6.0)	63	3.7 (2.8–4.8)	52	0.048	3.4 (2.5–4.5)	63	0.022	0.585
Self-concept BY1	34.6 (32.2–37.1)	63	41.3 (38.6–44.1)	52	<0.001	40.5 (37.8–43.3)	63	<0.001	0.587
Rosenberg Self-esteem¹	20.6 (19.0–22.0)	82	24.2 (23.0–25.2)	84	<0.001	23.9 (22.5–25.2)	75	<0.001	0.648
Pleasantness MACL	2.88 (2.76–2.99)	82	3.08 (2.97–3.20)	83	<0.001	3.04 (2.92–3.17)	74	0.015	0.509
Activation MACL	2.61 (2.50–2.72)	81	2.83 (2.71–2.95)	83	<0.001	2.71 (2.58–2.84)	75	0.124	0.058
Calmness MACL	2.61 (2.49–2.72)	82	2.85 (2.74–2.97)	83	<0.001	2.76 (2.63–2.89)	75	0.027	0.129
Overall Mood MACL	2.70 (2.60–2.79)	82	2.92 (2.82–3.03)	83	<0.001	2.83 (2.71–2.95)	75	0.025	0.084
OP-14	51.5 (45.99–57.04)	82	29.4 (24.4–34.4)	81	<0.001	32.9 (27.2–38.5)	75	<0.001	0.187

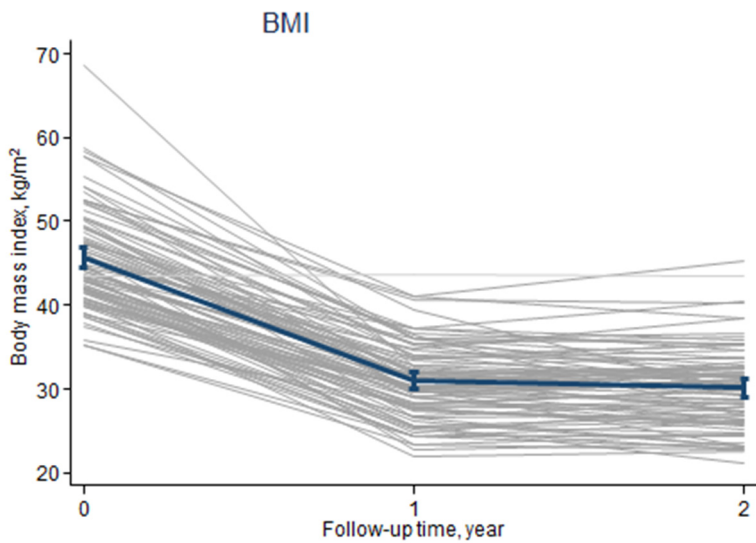


Figure 3a
BMI

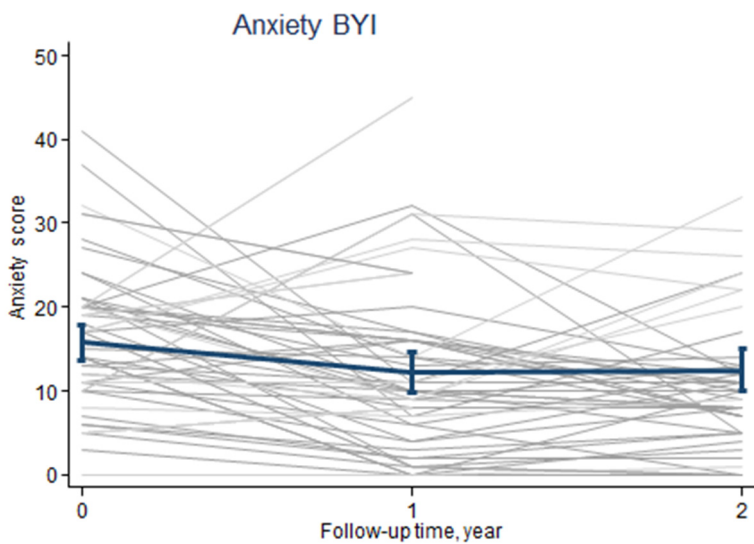


Figure 3b
BYI Anxiety

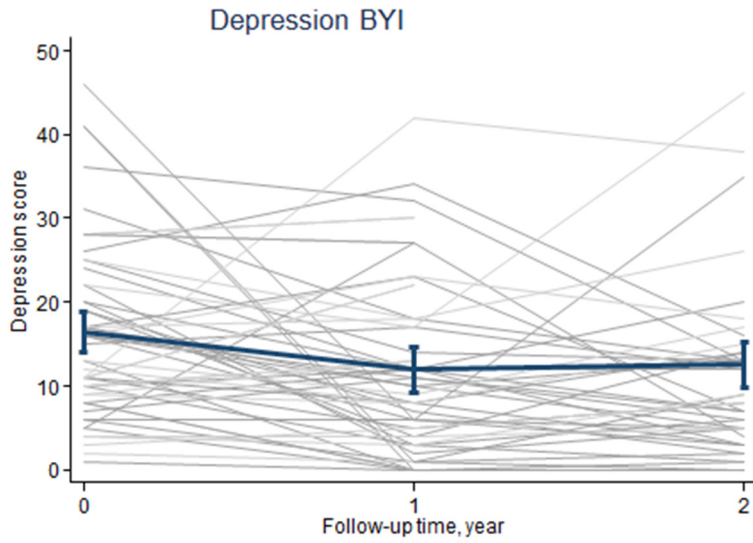


Figure 3c
BYI Depression

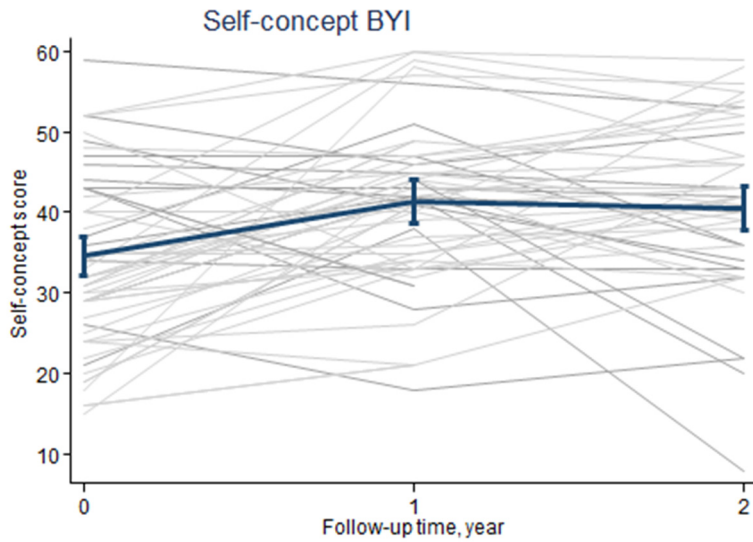


Figure 3d
BYI Self-concept

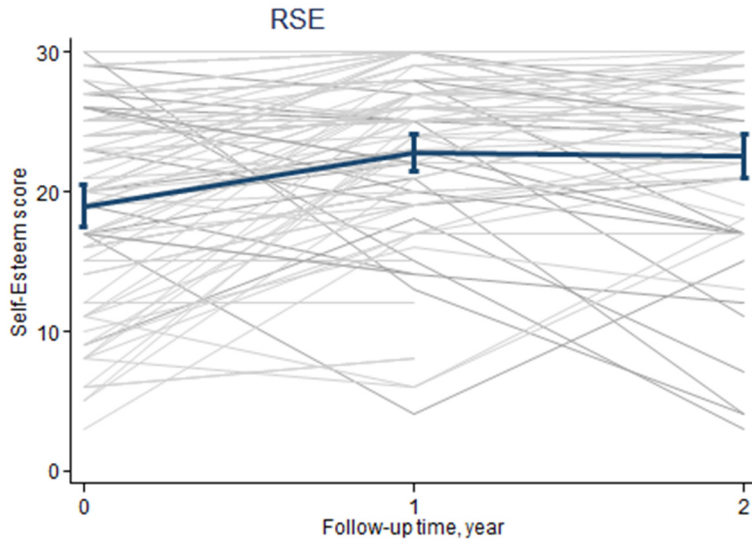


Figure 3e
Rosenberg Self-esteem

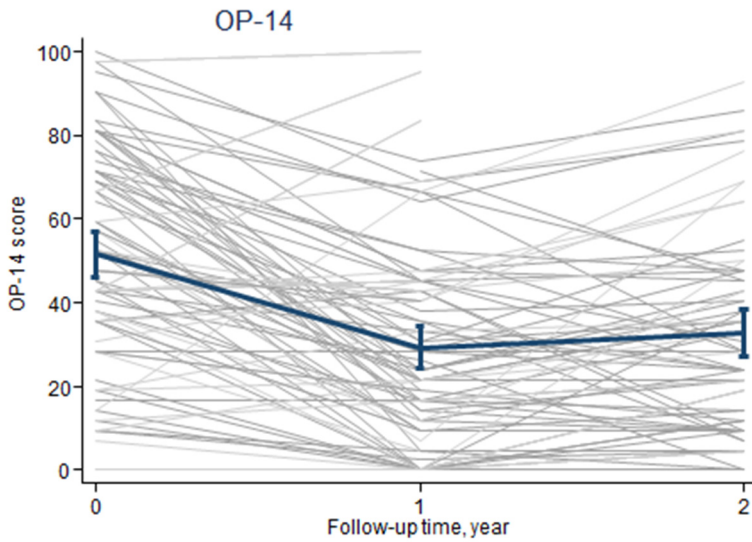


Figure 3f
Obesity-related problems scale

For most variables with population norms, the adolescents in the present study scored close to the mean value for age- and gender-matched population norms two years after surgery. This indicates that most adolescents have a mental health in the normative range two years after undergoing bariatric surgery; see Table 4 for mean and median percentile and percent of adolescents in respective symptom severity category at baseline and two years after surgery. However, for overall mood, assessed with Mood Adjective Check List (MACL), the adolescents scored 0.8 SD below age-matched norms two years after surgery, and, compared to middle-aged adults undergoing bariatric surgery the adolescents also reported lower overall mood.

Table 4

Descriptive percentile values at baseline and two years after surgery for significantly changed BYI variables. Abbreviations: BYI Beck Youth Inventories, yr years

¹Swedish gender-specific norms for adolescents aged 9-18 are available and BYI scores are transformed to percentiles, indicating whether a respondent have more or equal symptoms compared to sex and age-matched peers. ² Percent of adolescents in each symptom severity category.

	mean percentile ¹ (±SD)	median percentile ¹ (IQR)	percentile range ¹ (min-max)	average symptoms ²	slightly elevated symptoms ²	highly elevated symptoms ²	n
BYI anxiety baseline	67.0 (±28.3)	79.4 (41.5)	3.8–99.9	44%	37%	19%	63
BYI anxiety 2 yr follow-up	50.9 (±30.6)	45.3 (46.4)	1.6–99.9	76%	8%	16%	63
BYI depression baseline	66.0 (±26.9)	71.5 (36.6)	9.1–99.9	56%	21%	24%	63
BYI depression 2 yr follow-up	50.9 (±31.3)	52.0 (53.3)	1.9–99.7	71%	13%	16%	63
BYI anger baseline	61.7 (±27.0)	65.8 (46.4)	7.9–99.7	59%	22%	19%	63
BYI anger 2 yr follow-up	46.9 (±33.9)	40.8 (64.1)	4.2–99.0	69%	13%	18%	62
BYI disruptive behavior baseline	62.0 (±23.3)	60.4 (41.4)	13.1–98.7	62%	29%	9%	63
BYI disruptive behavior 2 yr follow-up	53.3 (±25.9)	52.8 (40.2)	13.1–99.6	78%	6%	16%	63

There was no significant correlation between percent weight loss (%WL) and any aspect of mental health including obesity-related problems. Instead improvement in obesity-related problems was significantly correlated to improvements in depressive symptoms, overall mood, and self-esteem.

Conclusions

- Mental health is improved in adolescents two years after undergoing WLS, and adolescents report an average mental health compared to population norms for most variables.
- The improvements in mental health took place during the first year after surgery. Mental health was stable during the second year after surgery.
- Almost one in five reported depressive symptoms in the clinical range and 13% reported severe depressive symptoms two years after gastric bypass.
- More severe mental health problems were reported by adolescents after surgery compared to adults.
- Change in weight and mental health was not associated.

Study III– Characteristics of adolescents with poor mental health after bariatric surgery

Specific aim

The aim of study III was to explore differences between adolescents with a poor mental health (PMH) two years after surgery to adolescents with an average or good mental health (A/GMH) two years post-surgery.

Materials and methods

Subjects were all 82 adolescents from the AMOS cohort who had completed any mental health questionnaire at the two-year follow-up after gastric bypass. Mean age at surgery was 16.8 years, mean BMI was 45.4 kg/m² and 67% were girls. Adolescents were classified as having a PMH if they had a BDI-II score ≥ 17 and/or a scale score ≥ 60 at the Obesity-related Problems scale (OP) at the two-year follow-up. Two different measures had to be used as not all adolescents completed all questionnaires. Adolescents with PMH two years after gastric

bypass were compared with adolescents with A/GMH for anxiety, depression, anger, disruptive behavior, self-concept, self-esteem, mood, obesity-related problems, and HRQoL at baseline and at one year and two years after surgery. Weight outcome and bio-chemical markers were also compared between the groups.

Differences between the groups for each variable at each assessment point were analyzed using mixed models and non-normal distributed variables were transformed with zero-skewness log-transformation before significance testing. Differences in developmental trends from baseline to the one-year follow-up were also tested with mixed models. Univariate logistic regression models were used to analyze which mental health variables at baseline were associated with PMH at the two-year follow-up.

Results

Sixteen adolescents (20%) were classified as having PMH two years after gastric bypass. No significant age or gender differences were seen between the groups. Neither was there any difference in receiving mental health service before surgery between the groups.

Anxiety, depression, and mental health at baseline could significantly predict PMH two years after surgery and ES indicated a large difference between the groups for anxiety at baseline and a moderate difference for depression and mental health, as can be seen in Table 5 and 6. However, several other mental health and HRQoL variables were assessed at baseline, and none of these could significantly predict PMH two years after surgery. This was also true for the OP-scale, even if this measure was used to differentiate between the groups two years after surgery, see Figure 4. Mental health variables presented separately for each group at all assessment points are presented in Table 5 and for HRQoL in Table 6.

Table 5

Mental health variables at baseline, 1- and 2-year follow-up stratified by average/good mental health or poor mental health at year 2. Abbreviations: BYI Beck Youth Inventories, yr year/years BDI-II Beck Depression Inventory-II, MACL Mood Adjective Check List, OP Obesity-related Problems scale. Data are shown as mixed-models mean (95%CI). Significant *P*-values in bold. Effect size criteria: < 0.2 is trivial; 0.2 to < 0.5 small; 0.5 to < 0.8 moderate; and ≥ 0.8 large.

¹Due to non-normal distribution transformed variables were used for significance testing. Variables were transformed with zero-skewness log-transformation.

	Average/good mental health year 2	n= 66	Poor mental health year 2	n= 16	<i>P</i> -value	Effect size
Anxiety BYI						
<i>baseline</i>	13.9 (11.6–16.1)	47	21.6 (16.8–26.4)	10	0.008¹	0.84
<i>1 yr</i>	9.9 (7.5–12.2)	40	19.8 (15.1–24.5)	10	<0.001¹	1.00
<i>2 yr</i>	8.4 (6.3–10.5)	50	26.6 (22.6–30.7)	13	<0.001¹	2.82
Depression BYI						
<i>baseline</i>	14.6 (11.9–17.2)	47	21.6 (15.9–27.4)	10	0.030¹	0.62
<i>1 yr</i>	9.5 (6.8–12.1)	40	18.6 (13.3–23.9)	10	0.001¹	0.88
<i>2 yr</i>	8.2 (5.9–10.4)	50	28.1 (23.7–32.5)	13	<0.001¹	2.83
Anger BYI						
<i>baseline</i>	11.8 (9.4–14.2)	47	15.5 (10.4–20.6)	10	0.138 ¹	
<i>1 yr</i>	10.0 (7.5–12.5)	40	17.9 (12.9–22.8)	10	0.006¹	0.68
<i>2 yr</i>	6.3 (4.1–8.6)	49	24.8 (20.5–29.1)	13	<0.001¹	2.78
Disruptive Behaviour BYI						
<i>baseline</i>	5.9 (4.4–7.4)	47	6.0 (2.9–9.1)	10	0.926 ¹	
<i>1 yr</i>	5.2 (3.7–6.7)	40	7.1 (4.1–10.2)	10	0.277 ¹	
<i>2 yr</i>	3.7 (2.3–5.1)	50	10.6 (7.9–13.3)	13	<0.001¹	1.47
Self-concept BYI						
<i>baseline</i>	35.8 (33.1–38.6)	47	33.7 (27.9–39.5)	10	0.522	
<i>1 yr</i>	42.4 (39.5–45.4)	40	39.3 (33.4–45.1)	10	0.345	
<i>2 yr</i>	43.9 (41.2–46.6)	50	29.4 (24.1–34.7)	13	<0.001	1.47
Pleasantness MACL						
<i>baseline</i>	2.92 (2.79–3.05)	63	2.73 (2.47–2.99)	16	0.193	
<i>1 yr</i>	3.18 (3.07–3.30)	64	2.85 (2.62–3.09)	16	0.014	0.70
<i>2 yr</i>	3.21 (3.09–3.33)	60	2.43 (2.18–2.68)	14	<0.001	1.53
Activation MACL						
<i>baseline</i>	2.64 (2.51–2.76)	62	2.48 (2.24–2.73)	16	0.282	
<i>1 yr</i>	2.88 (2.76–3.01)	64	2.76 (2.51–3.02)	16	0.404	
<i>2 yr</i>	2.85 (2.72–2.99)	60	2.20 (1.93–2.47)	15	<0.001	1.21
Calmness MACL						
<i>baseline</i>	2.68 (2.55–2.80)	63	2.38 (2.12–2.63)	16	0.041	0.56
<i>1 yr</i>	2.97 (2.85–3.08)	64	2.58 (2.34–2.82)	16	0.004	0.84
<i>2 yr</i>	2.95 (2.83–3.07)	60	2.11 (1.87–2.35)	15	<0.001	1.65
Overall Mood MACL						

<i>baseline</i>	2.74 (2.63–2.85)	63	2.53 (2.31–2.75)	16	0.089	
<i>1 yr</i>	3.01 (2.91–3.12)	64	2.73 (2.52–2.94)	16	0.021	0.66
<i>2 yr</i>	3.01 (2.90–3.12)	60	2.23 (2.01–2.45)	15	<0.001	1.68
Rosenberg Self-esteem						
<i>baseline</i>	18.7 (17.0–20.4)	63	20.8 (17.4–24.2)	16	0.213 ¹	
<i>1 yr</i>	23.8 (22.4–25.2)	65	20.7 (17.8–23.6)	16	0.019¹	0.54
<i>2 yr</i>	24.8 (23.4–26.2)	60	14.5 (11.8–17.3)	15	<0.001¹	2.01

Table 6

Health-Related Quality of Life (SF-36) variables at baseline, 1- and 2-year follow-up stratified by average/good mental health or poor mental health at year 2. Abbreviations: SF-36 Short Form-36. Data are shown as mixed-models mean (95% CI). Significant *P*-values in bold. ¹Due to non-normal distribution transformed variables were used for significance testing. Variables were transformed with zero-skewness log-transformation.

SF-36	Average/good mental health year 2	n=66	Poor mental health year 2	n=16	<i>P</i> -value
Physical Functioning					
<i>baseline</i>	72.4 (67.5–77.4)	63	64.4 (54.5–74.2)	16	0.622 ¹
<i>1 yr</i>	90.6 (86.7–94.5)	65	84.7 (76.8–92.6)	16	0.252 ¹
<i>2 yr</i>	87.7 (70.4–89.7)	63	80.0 (70.4–89.7)	15	0.178 ¹
Role-Physical					
<i>baseline</i>	74.6 (68.6–80.6)	62	70.3 (58.5–82.1)	16	0.550 ¹
<i>1 yr</i>	90.1 (85.0–95.2)	65	81.6 (71.3–92.0)	16	0.109 ¹
<i>2 yr</i>	88.3 (83.4–93.3)	62	66.7 (56.6–76.7)	15	0.010 ¹
Bodily Pain					
<i>baseline</i>	68.3 (62.0–74.6)	63	62.8 (50.2–75.3)	16	0.495 ¹
<i>1 yr</i>	81.2 (75.8–86.7)	65	68.4 (57.4–79.4)	16	0.028 ¹
<i>2 yr</i>	83.7 (78.3–89.0)	63	61.6 (50.7–72.6)	15	0.001 ¹
General Health					
<i>baseline</i>	54.0 (48.8–59.2)	63	48.2 (37.9–58.5)	16	0.497 ¹
<i>1 yr</i>	77.4 (72.7–82.0)	65	61.0 (51.6–70.4)	16	0.002 ¹
<i>2 yr</i>	74.0 (69.4–78.6)	63	51.5 (42.0–60.9)	15	<0.001 ¹
Vitality					
<i>baseline</i>	49.2 (44.6–53.9)	63	44.9 (35.6–54.2)	16	0.416
<i>1 yr</i>	61.4 (57.0–65.9)	65	54.7 (45.7–63.7)	16	0.189
<i>2 yr</i>	60.6 (55.6–65.7)	63	42.2 (31.9–52.6)	15	0.002
Social Functioning					
<i>baseline</i>	81.3 (75.8–86.7)	63	60.9 (50.1–71.8)	16	0.058 ¹
<i>1 yr</i>	92.1 (87.8–96.4)	65	71.1 (62.5–79.7)	16	0.115 ¹
<i>2 yr</i>	90.5 (85.6–95.3)	63	56.4 (46.4–66.3)	15	0.030 ¹
Role-Emotional					
<i>baseline</i>	78.5 (71.6–85.4)	61	62.5 (49.0–76.0)	16	0.270 ¹
<i>1 yr</i>	87.2 (81.6–92.8)	65	69.3 (58.0–80.5)	16	0.003 ¹
<i>2 yr</i>	86.4 (80.7–92.1)	62	41.9 (30.2–53.5)	15	<0.001 ¹
Mental Health					
<i>baseline</i>	67.9 (62.9–72.9)	63	55.3 (45.3–65.3)	16	0.027
<i>1 yr</i>	77.2 (73.2–81.2)	65	60.3 (52.2–68.4)	16	<0.001
<i>2 yr</i>	76.2 (71.7–80.7)	63	45.2 (36.0–54.4)	15	<0.001
Physical Component					
<i>baseline</i>	43.7 (41.5–45.9)	61	42.4 (38.1–46.6)	16	0.583
<i>1 yr</i>	52.4 (50.6–54.2)	65	49.9 (46.3–53.5)	16	0.225
<i>2 yr</i>	51.8 (49.8–53.9)	61	48.7 (44.7–52.8)	15	0.183
Mental Component					
<i>baseline</i>	46.1 (43.2–49.0)	61	38.1 (32.4–43.8)	16	0.085 ¹
<i>1 yr</i>	49.3 (46.9–51.6)	65	39.6 (34.9–44.3)	16	0.001 ¹
<i>2 yr</i>	48.9 (46.3–51.6)	61	28.6 (23.3–33.9)	15	<0.001 ¹

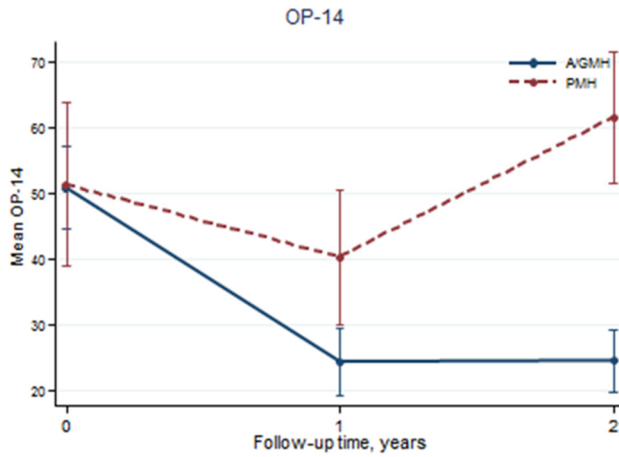


Figure 4
Obesity-related problems scale separate for adolescents reporting PMH or A/GMH two years after gastric bypass

One year after surgery, the PMH group reported lower mental health in eight out of eleven variables (Table5). In the mental health domain of SF-36, two out of four variables were worse in the PMH group one year after surgery as well as the mental health summary score compared to adolescents with A/GMH. Differences in the physical domain of QoL had also started to emerge as the PMH adolescents reported more pain and worse general health. However, only two of the mental health and HRQoL variables, RSE (Figure 5) and general health, had significantly different trends over the first year after surgery.

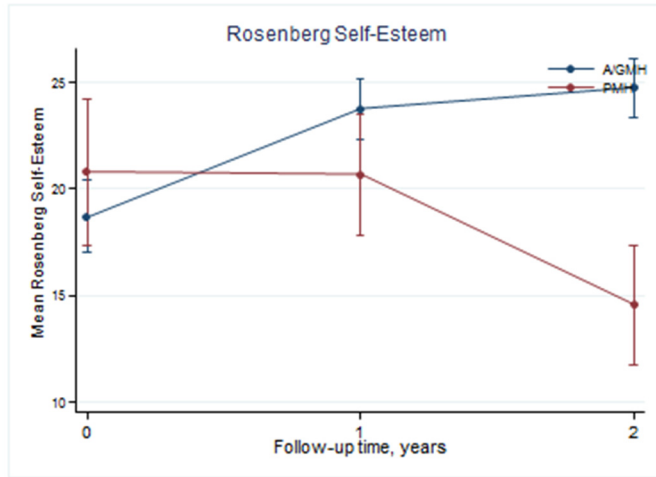


Figure 5
Rosenberg Self-esteem separate for adolescents reporting PMH or A/GMH two years after gastric bypass

At the two-year follow-up adolescents with PMH reported lower mental health on all mental health variables compared to the A/GMH group. ES indicated large differences for all variables (Table 5). Also all mental health variables in SF-36 were lower including the mental health summary score. In the physical domain, adolescents with PMH reported lower values for three out of four variables but still there was no difference for physical functioning or the physical component summary score, see Figure 6.

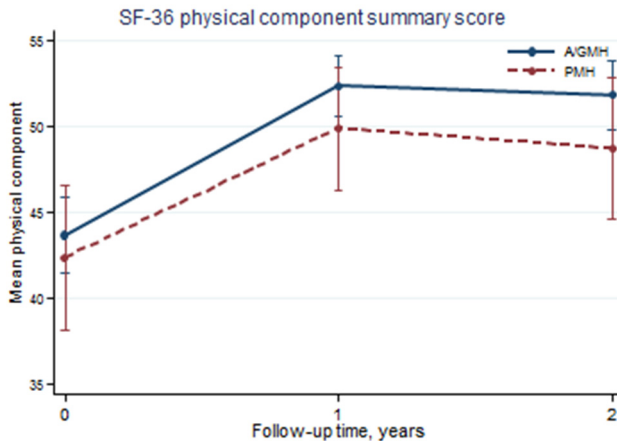


Figure 6
SF-36 Physical Component Summary Score separate for adolescents reporting PMH or A/GMH two years after gastric bypass

Two years after surgery, 14% of the 63 adolescents assessed with BDI-II reported any suicidal ideation. Six adolescents, three from the PMH group and three from the A/GMH group disclosed passive suicidal ideation reporting: “I have thoughts of killing myself, but I would not carry them out.” Three adolescents reported: “I would kill myself if I had a chance”, and all these three adolescents belonged to the PMH group.

Weight and weight outcome were assessed as BMI, %WL and excess BMI loss. There were no significant differences between the PMH and A/GMH groups for weight or weight outcome at any assessment point (Table 7 and Figure 7). Biochemical markers were used as indicators of physical health and mineral supplementation and there was no baseline difference between the groups. At the one-year follow-up adolescents with PMH had significantly higher ferritin and C - reactive protein, and lower hemoglobin. At the two-year follow-up, ferritin remained significantly higher in the PMH group, but the other differences had disappeared, see Table 7.

Table 7

Weight and biochemical markers at baseline, 1- and 2-year follow-up stratified by average/good mental health or poor mental health at year 2. Abbreviations: BMI Body Mass Index, yr year/years %WL percent weight loss, ALT alanine transferases, TG triglyceride, HDL high-density lipoprotein, CRP C-reactive protein, FE iron, HB hemoglobin. Data are shown as mixed-models mean (95%CI). Significant *P*-values in bold.

¹Due to non-normal distribution transformed variables were used for significance testing. Variables were transformed with zero-skewness log-transformation.

	Average/good mental health year 2	n=66	Poor mental health year 2	n=16	<i>P</i> -value
BMI (kg/m²)					
<i>baseline</i>	45.3 (44.0–46.7)	66	46.0 (43.2–48.8)	16	0.662
<i>1 yr</i>	30.4 (29.3–31.5)	66	31.4 (29.1–33.6)	16	0.463
<i>2 yr</i>	29.6 (28.4–30.7)	66	31.1 (28.8–33.5)	16	0.228
%WL					
<i>1 yr</i>	31.4 (30.0–32.7)	66	31.7 (28.9–34.4)	16	0.835
<i>2 yr</i>	33.3 (30.9–35.7)	66	31.8 (27.0–36.7)	16	0.593
Excess BMI loss					
<i>1 yr</i>	75.2 (71.9–78.6)	66	73.1 (66.3–80.0)	16	0.588
<i>2 yr</i>	78.8 (73.2–84.4)	66	72.3 (60.9–83.7)	16	0.313
ALT (ukat/L)					
<i>baseline</i>	0.66 (0.58–0.75)	61	0.52 (0.34–0.69)	16	0.144
<i>1 yr</i>	0.36 (0.30–0.41)	62	0.35 (0.24–0.46)	16	0.937
<i>2 yr</i>	0.34 (0.30–0.38)	62	0.36 (0.28–0.45)	15	0.593
P-insulin (mU/L)					
<i>baseline</i>	32.6 (28.9–36.4)	62	25.3 (17.6–33.0)	14	0.095
<i>1 yr</i>	7.5 (5.4–9.6)	62	5.9 (1.6–10.2)	15	0.520
<i>2 yr</i>	7.7 (6.2–9.3)	62	7.0 (3.8–10.2)	15	0.691
TG (mmol/L)					
<i>baseline</i>	1.3 (1.2–1.4)	61	1.3 (1.0–1.5)	16	0.926
<i>1 yr</i>	0.9 (0.8–1.0)	62	0.9 (0.7–1.1)	15	0.559
<i>2 yr</i>	0.8 (0.7–0.9)	62	0.9 (0.7–1.0)	15	0.300
HDL (mmol/L)					
<i>baseline</i>	1.09 (1.03–1.16)	62	1.10 (0.97–1.23)	16	0.931
<i>1 yr</i>	1.37 (1.29–1.45)	62	1.42 (1.26–1.57)	15	0.624

2 yr	1.48 (1.39–1.57)	62	1.52 (1.33–1.70)	15	0.725
CRP (mg/L)					
<i>baseline</i>	6.9 (5.4–8.4)	58	9.5 (6.5–12.5)	14	0.428 ¹
1 yr	2.3 (0.6–3.9)	54	3.2 (0.1–6.4)	15	0.033¹
2 yr	2.9 (0.5–5.3)	57	2.7 (0–7.6)	14	0.316 ¹
FE (umol/L)					
<i>baseline</i>	13.1 (11.6–14.6)	58	13.1 (10.3–16.0)	16	0.996
1 yr	16.2 (14.5–18.0)	55	15.5 (12.1–18.9)	15	0.705
2 yr	17.4 (15.3–19.6)	52	18.8 (14.6–23.0)	13	0.584
Ferritin (ug/L)					
<i>baseline</i>	59.3 (48.6–69.9)	51	55.6 (34.0–77.2)	12	0.383 ¹
1 yr	45.5 (34.4–56.5)	61	90.5 (68.4–112.7)	15	0.006¹
2 yr	39.5 (25.7–53.2)	61	68.9 (41.2–96.6)	15	0.023¹
HB (g/L)					
<i>baseline</i>	140 (136–143)	59	136 (130–142)	16	0.301
1 yr	137 (133–140)	62	129 (122–135)	16	0.032
2 yr	134 (130–137)	62	129 (122–136)	15	0.277

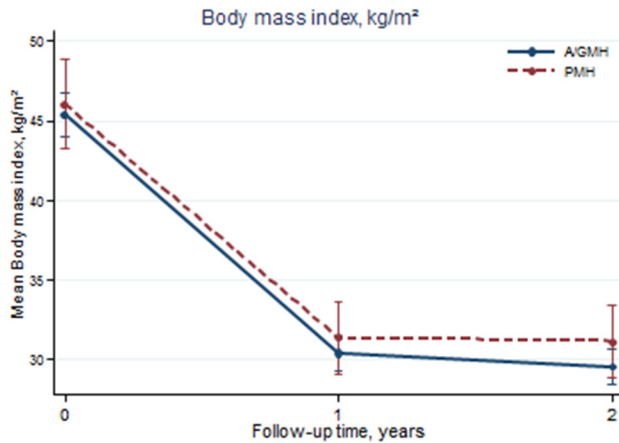


Figure 7
BMI separate for adolescents reporting PMH or A/GMH two years after gastric bypass

Conclusions

- PMH was reported by 20% of the adolescents two years after WLS.
- Most variables did not differ between the groups at baseline, but symptoms of anxiety and depression and mental health as assessed by a generic HRQoL measure at baseline could significantly predict PMH two years after surgery.
- Significant differences were seen between the groups for most variables already one year after surgery.
- Only two of the assessed mental health and HRQoL variables showed significantly different trends during the first year after surgery.
- A subgroup, 14%, reported suicidal ideation two years after WLS and some adolescents reported active suicidal ideation.
- The average weight loss in the PMH group did not differ significantly from the average weight loss in the A/GMH group indicating that adolescents with PMH after WLS lose as much weight as other adolescents. Their physical health also seems equally improved.

General discussion

Adolescents with severe obesity are a relatively new population in the bariatric surgery clinics. Mental health has been quite thoroughly studied in adults undergoing bariatric surgery, but the mean age in most studies reporting mental health aspects is 40 to 50 years (Dawes et al., 2016). The papers in this thesis add on to the so far scarce knowledge about mental health in adolescents undergoing bariatric surgery. Some findings in the studies confirm findings from previous studies, some findings contradict previous findings, and some findings bring new knowledge to the field.

Analytic approach in the studies

The research questions in this thesis are mainly driven from clinical needs, observations, and experiences. When the studies in this thesis were set up, there were very few published papers reporting mental health outcome data after bariatric surgery in adolescents. It was considered of high clinical relevance to explore how mental health is affected by undergoing bariatric surgery during adolescence, and primarily analyze whether it is harmful or not. Accordingly, the general aim in study I and II has been a rather simple pre- and posttest, to explore how mental health is affected in adolescents after gastric bypass. In study I, differences between baseline and four months post-surgery were analyzed with *t*-test. In study II, differences between baseline and follow-ups one year and two years after surgery were analyzed using mixed models, so that adolescents with missing data could be included as well.

In clinical settings most care and attention is directed to patients that are considered to have the greatest needs. In study I and III, we pre-defined which groups we wanted to analyze based on clinical experience of which adolescents that needed most support. When doing follow-ups of adolescents returning to the clinics three to four months after surgery, most adolescents reported improved mental health and expressed that they were very pleased to have had surgery which corresponded to the often described post-bariatric honeymoon. However, a subgroup of adolescents returned to the first follow-up and reported that their

mental health was worse and some needed referral to psychiatric treatment. At this first follow-up after surgery, it seemed most relevant to look at those who were impaired as this is in such great contrast to what adolescents expect and what has been previously described by research in both adolescents and adults.

Limits for clinically meaningful change were set up in study I. Rather conservative limits were used, not to overestimate impairment or improvement. Adolescents who were clinically impaired on two or more of the five scales on BYI were considered a specific group. Some adolescents, 22%, reported impairment on only one variable but improved or unchanged symptoms at the other variables. Several adolescents in this group reported improvement for many aspects of mental health but also substantially more disruptive behavior. This was understood as when adolescents become more outgoing and social they also have more opportunities for disruptive behavior. This group was considered of less clinical interest compared to those who reported deteriorated mental health on several aspects. All adolescents that reported more anxiety and/or depressive symptoms also reported impairment in at least one other variable too.

After the two-year follow-up it seemed more clinically relevant to focus on those who reported the greatest mental health problems regardless of them being impaired compared to baseline or not. Therefore, in study III pre-established cut-offs from two different questionnaires were used to define the PMH-group. Cut-offs from two questionnaires were used as not all questionnaires were collected for all adolescents at year two. BDI-II and OP were selected as they have validated cut-offs for clinical impairment and both instruments are indicators in a clinical setting that there is a need for interventions. As growing evidence of increased risk of suicide after bariatric surgery has been presented in recent years, it also seemed important to describe suicidal ideation in adolescents after gastric bypass.

Choosing one analytic approach mostly means excluding another. The analysis of outcome for the whole group is quite simple and straightforward and more advanced analytical approaches could have been made, bringing more information out from the data. A common approach in psychological research is to seek for specific subgroups in the data using factor analysis. This approach would also have resulted in important and clinically relevant results and could be a possible approach in upcoming studies.

Mental health in adolescents before bariatric surgery

The findings in study I and II add on to the knowledge that adolescents seeking bariatric surgery are a vulnerable group. In line with previous studies of adolescents more symptoms of depression and an impaired self-concept were reported before surgery compared to population norms for teenagers (Aldaqa & Sehlo, 2013; Herget et al., 2014). Novel findings in the studies were that adolescents had elevated symptoms of anxiety prior to surgery and that they also reported elevated levels of externalizing behavior (i.e. anger and disruptive behavior). It seems especially important to assess anxiety and conduct disorders when assessing mental health in adolescents as both these disorders have an earlier onset than mood disorders and have a higher prevalence during adolescence (Merikangas et al., 2010; Whiteford et al., 2013). Also, studies of mental health in adults seeking WLS have found that any anxiety disorder is the most commonly reported current psychiatric disorder even if mood disorders are more common in a lifetime perspective (Kalarchian et al., 2007; Mitchell et al., 2012).

However, a substantial group of adolescents that seek WLS report no more mental health problems than the average teenager and our findings are in accordance with previous studies. Sysko et al. (2011) reported that 50% of adolescents seeking WLS reported low psychopathology and in study I and II between 43% and 62% reported average symptoms of anxiety, depression, anger, and disruptive behavior.

It is important to put findings about mental health in adolescents seeking WLS in perspective. Adolescence is a period in life where many mental health disorders have their onset and even if reported incidence is higher in adolescents seeking WLS compared to the general population, it is not uncommon to experience mental health problems while a teenager (Costello et al., 2003; Merikangas et al., 2010). For many teenagers in the general population, no attention is brought to their mental health problems and it goes untreated (Avenevoli et al., 2015; Husky et al., 2012).

Mental health problems are not exclusive to adolescents with severe obesity seeking WLS, and many studies, however not all, find increased prevalence of mental health problems in children and adolescents with obesity regardless of treatment seeking status (Kalarchian & Marcus, 2012). The AMOS study does not have any baseline mental health or HRQoL data from a control group. Consequently, we do not know whether adolescents that seek WLS have a worse mental health than adolescents with severe obesity who do not seek treatment or seek other forms of treatment. In a study assessing mental health in adolescents with severe obesity seeking long-term inpatient treatment it was also reported a high incidence of mental health problems and only 30% did not report any psychiatric disorder (Britz et al., 2000). A recent paper from a multi-center study

in USA compared adolescents with severe obesity seeking behavioral treatment to adolescents seeking surgical treatment and reported more mental health problems in the behavioral treatment group. However, the group accepted for WLS was reported to be highly selected (Rofey et al., 2015), which is not true for the AMOS cohort.

Mental health in adolescents after bariatric surgery

The main findings from study I and II are that mental health is improved in adolescents four months and two years after WLS. This improvement is seen even if the expected trend in the general population is an increase in mental health problems from adolescents into young adulthood (Whiteford et al., 2013). Previous studies of adolescents have reported that depressive symptoms and HRQoL are improved during the first months after bariatric surgery (Loux et al., 2008; Zeller et al., 2009) and in study I we showed that an improvement could be seen for internalizing symptoms (anxiety and depression) and self-concept four months post-surgery. The findings are also in line with studies of operated adults showing that symptoms of anxiety and depression as well as self-concept are improved after surgery (Bocchieri et al., 2002).

Study II showed that all assessed aspects of mental health, but one (activation), were improved in adolescents two years after gastric bypass, and that most improvements took place during the first year after surgery. The findings in study II are in line with previous studies in adolescents and adults showing a substantial improvement in mental health during the first postoperative year (Burgmer et al., 2014; Mitchell et al., 2014; Sysko et al., 2012; Zeller et al., 2009). Some studies in adolescents and adults report a decline in mental health already during the second year after surgery (Mitchell et al., 2014; Zeller et al., 2011), but in study II the second year was characterized by stabilization. Depression and HRQoL are often studied outcome variables, but in study II we also showed improvements in a wide range of mental health variables. As population norms were available for some of the variables, we could show that adolescents on average have a mental health equal to population norms two years after gastric bypass for several variables. However, overall mood was still below age-matched norms.

All three studies resulted in interesting findings regarding anxiety outcome. Anxiety seems to be less weight dependent than depression in the general population as obesity does not increase the risk of a subsequent anxiety disorder (Roberts & Duong, 2016) and anxiety has not been related to weight outcome after WLS as is the case for depression (de Zwaan et al., 2011; Karlsson et al., 2007). Findings in studies of adults are also mixed as to whether anxiety is reduced after

WLS or not (Burgmer et al., 2014; Burgmer et al., 2007; de Zwaan et al., 2011; Kalarchian et al., 2015; Karlsson et al., 2007). Study I and II showed that anxiety symptoms were significantly reduced four months and two years after gastric bypass. The change in anxiety two years after surgery was one of the few changes that corresponded to a moderate ES, which in clinical research is necessary to be considered clinically meaningful. Also anxiety was one of few variables from baseline that could predict PMH two years later and ESs indicated that there was a large difference between the groups already at baseline. More research is necessary to understand the association between anxiety and obesity in adolescents and the implications for outcome after WLS.

Our and other studies indicate that improvements in mental health take place very early after surgery. Most substantial improvements seem to take place during the first six months after surgery (Sarwer et al., 2010; Zeller et al., 2009). This means that the improvements in mental health take place long before the patient has reached their final weight loss after surgery. Most studies, including the ones in the present thesis, can only describe how, but not explain why, mental health is improved after WLS. It has been hypothesized that it is the experience of losing weight that improves mental health rather than the actual weight loss (Zeller et al., 2009). Depression is sometimes understood as a reaction to a repeated experience of an inability to solve problems that are considered important to the individual. Most adolescents and adults have struggled with their weight for several years before undergoing WLS. Some adolescents seeking WLS say that they have tried to lose weight for as long as they can remember. Living in a society with a general belief that everyone can control their own weight if only they make an effort, can inflict on some people with severe obesity a feeling of incompetence and inferiority (Crandall et al., 2001). When finally losing weight, patients can regain a feeling of competence and control (Ogden et al., 2006), which could improve their mental health.

Even if the trend in study I and II indicated a general improvement, mirroring the improvements reported in previous studies of adolescents and adults, there were also findings in study II indicating that adolescents are more vulnerable than adults undergoing bariatric surgery. First, when overall mood was at its highest in the adolescents in AMOS (which was at the one-year follow-up after surgery), they still scored at the baseline value of adults seeking obesity surgery in the Swedish obese subjects (SOS) study (Karlsson et al., 2007). Second, a substantial subgroup reported depressive symptoms in the clinical range two years after surgery and 13% reported severe depressive symptoms. In a recent study of depressive symptoms in adults, only 0.2% reported severe depressive symptoms two years post-surgery (Mitchell et al., 2014). These findings can have several possible explanations. One explanation is selection phenomenon. Maybe more adolescents with mental health problems were included in AMOS than is done in studies of

adults. However, no more mental health problems were found at baseline in AMOS than is reported in studies of adults. It is possible that there are different pathways between mental health problems and obesity in adolescents compared to adults. Early cases of depression in girls are predictive of subsequent obesity (Marmorstein et al., 2014), and it is not obvious that a reduction of obesity that is developed after the onset of mental health problems will improve mental health status. Another possible explanation is that adolescents undergoing WLS are offered less treatment, and Mitchell et al. (2012) have reported a rather high rate of psychiatric medication in their adult sample. Yet another explanation is that adolescents in general are more heavily burdened by mental health problems than middle-aged adults as suggested by research in population samples (Whiteford et al., 2013). However, norms for MACL used to assess mood in study II and III and in the SOS study do not suggest that mood should be substantially lower in the younger age-groups.

In study I we found a group of adolescents (16%) who experienced impairment on two aspects or more of mental health four months after surgery. No baseline differences between impaired adolescents and other adolescents could be detected. The same pattern was seen in a study of adults where no baseline differences could be seen between patients that were impaired after surgery and others (Ivezaj & Grilo, 2015). However, study I had a rather small sample and confirmatory studies are necessary. It could also be argued that if mental health is followed prospectively in any group, some subjects in that group will report impaired mental health at a later point in time as mental health is not perfectly stable over time. Without a control group it is not possible to evaluate if 16% are more, fewer than, or equal to what would be reported by other adolescents with severe obesity followed over a few months. Nevertheless, if someone has a worsened mood after WLS interventions should be offered. Even if a previous study has reported less impression management in adolescents than in adults before surgery (Ratcliff et al., 2011), it cannot be completely ruled out that what looks like an impairment is instead an effect of increased honesty about mental health problems early after surgery. When negative outcomes after surgery are evaluated, it must be kept in mind that adverse mental health outcomes also can be seen after other forms of obesity treatment (Faulconbridge et al., 2009).

In study III, a further analysis of adolescents with PMH two years after surgery was made. About 20% of the adolescents belonged to this group. Symptoms of anxiety and depression and impaired mental health already at baseline were predictive of PMH two years after surgery. This coincides with findings in the general population that suggest that those with a previous history of mental health problems have an increased risk of mental health problems in the future compared to those with no history of mental health problems (Costello et al., 2003). Also in adults undergoing WLS an association is seen between baseline psychiatric

symptoms and mental health outcome after surgery (Herpertz et al., 2004; Wimmelmann, Dela, & Mortensen, 2014a). However, for most aspects of mental health there were no baseline differences between the groups. Our findings indicate that further studies are necessary to better understand why some adolescents have such substantial mental health problems after gastric bypass and if the same outcome is seen in samples where a more restrictive selection process has been applied. However, there are indications that those who are younger when undergoing WLS have a worse mental health than older subjects (Malik et al., 2014; Scandinavian Obesity Surgery Registry, 2015). It is also important to study what kind of psychological or psychiatric treatment that would be the most beneficial for this group and when is the best time for treatment delivery.

In study III we could also report a rather high incidence of suicidal ideation in adolescents two year after WLS. There seems to be a complex association between weight and suicidal behavior (Klinitzke et al., 2013; Zhang et al., 2013). This is also true for those undergoing WLS. For the vast majority, WLS leads to an improvement in mental health (Dawes et al., 2016) and suicidal behavior is highly related to mental health problems (Harris & Barraclough, 1997). Therefore it could be expected that the number of suicides would fall in those undergoing WLS, but instead there is an increased risk of suicide after gastric bypass (Adams et al., 2007; Peterhänsel et al., 2013). The cause of this somewhat counterintuitive increase in suicide is not known and there are several possible explanations. One possible explanation is that some patients experience feelings of extreme failure and disappointment after surgery if their expectations are not met and that suicide is an escape from such feelings. A related explanation is that some patients experience an extreme feeling of hopelessness when they still struggle with weight-related problems after WLS and hopelessness is a factor that has specifically been found to be related to suicidal behavior (Mitchell et al., 2013).

In many studies of adults an association between amount of weight loss and improvement in mental health is found, i.e. the subjects with the greatest weight loss also show the greatest improvements in mental health (Burgmer et al., 2014; Karlsson et al., 2007; Mitchell et al., 2014). Also, in a study of adolescents undergoing gastric banding a significant association was found between improvement in depressive symptoms and change in BMI (Sysko et al., 2012). In the studies in the present thesis, no association between weight outcome and mental health was found. Not even the reduction of obesity-related problems was significantly associated with amount of weight loss. The results also indicate that adolescents with less positive mental health outcome lose as much weight after surgery and gain improvements in physical health to the same degree as other adolescents. The reason for this result is not known and these findings must be confirmed in future studies before further conclusions can be drawn. Instead, we saw that different aspects of mental health were highly interrelated. One possible

explanation is that there was not much variation in the amount of weight loss, leaving little variance to be explained. Another possible explanation is that mental health in adolescents after gastric bypass is less weight dependent than in adults and that other factors may better explain more or less improvement in mental health than amount of weight lost.

Clinical implications of the findings

The clinical implications of the studies in the present thesis are several. First of all, adolescents seeking bariatric surgery come across as a psychologically vulnerable group both before and after WLS. If bariatric surgery is accepted as a regular treatment of severe obesity in adolescents in Sweden, adolescents should only be referred to such bariatric surgical teams that can also meet their psychosocial needs.

However, the studies in the present thesis cannot provide an answer to whether some of the adolescents should have benefited from postponed surgery until adulthood or from having surgery after more mental health interventions. Only RCTs can guide clinicians in this dilemma. Possibly, the number of adolescents with severe depressive symptoms would have been fewer two years after surgery if stricter inclusion and exclusion criteria had been used. It is important that the preoperative mental health evaluation of adolescents in a clinical setting is not reduced merely to a selection process as it also gives an opportunity to intervene and address psychological and social factors that could improve the patient's readiness for surgery (Greenberg et al., 2009). It seems especially important to assess symptoms of anxiety in adolescents seeking WLS.

Clinical research and practice has been predominantly occupied with giving input on which mental health factors that should be assessed prior to surgery and there is little consensus on which aspects of mental health that are the most important to assess after surgery and when mental health follow-up is the most relevant and beneficial (Muller et al., 2013). Study I indicates that screening of mental health is important during the first months after WLS as one out of four adolescents belonged to either the impaired group or the group with sustained substantial mental health problems. Since such a substantial number of studies show that the greatest improvement in mental health is seen in the first months after surgery, it should also be considered whether this is a specifically important period to deliver interventions to those who do not improve or are impaired.

Special attention in clinical settings should be given to adolescents who report more symptoms of anxiety and depression and poor mental health on SF-36 before

surgery as this is predictive of poor mental health after surgery. However, not all adolescents who reported PMH two years after surgery reported mental health problems at baseline and this indicates that at least some sort of mental health screening is necessary in all adolescents. Suicidal ideation seems especially important to assess after WLS as it can be present also in adolescents who do not report many other mental health problems.

Our findings indicate that prolonged follow-up is necessary. Most attention is normally given to bariatric surgery subjects during the first year after surgery. Study III showed that follow-up of mental health seems to be especially important during the second year after surgery. In the second year the weight loss phase transcends to weight stabilization, and in some subjects weight regain, and adolescents with a PMH might be more susceptible to interventions when they no longer can expect that they will lose more weight. If mental health is less weight dependent in adolescents after gastric bypass than in adults, interventions to improve mental health and reduce social impairment due to weight and body shape should focus on psychosocial factors and not put emphasis on extra weight loss.

Study II showed the importance of using age- and domain-specific questionnaires for clinicians when assessing mental health in adolescents undergoing WLS. A previous paper from AMOS found little improvement in mental health two years after surgery when mental health was assessed with SF-36 (Olbers et al., 2012). Rather, the findings in study II indicate both normative levels of most mental health problems two years after gastric bypass when age-specific questionnaires were used and that improvements were not trivial, but either small or moderate.

Ethical considerations

Introducing bariatric surgery to adolescents raises ethical concerns (Caniano, 2009; Hofmann, 2013). Beauchamp and Childress have set up four principles for biomedical ethics that can be used to evaluate the ethical aspects of different treatments: respect for autonomy, non-maleficence, beneficence, and justice (Beauchamp & Childress, 2001), and the findings will be analyzed according to the first three principles.

Beneficence and non-maleficence

The overall aim of the studies in the present thesis was to look at bariatric surgery as a treatment for adolescents with severe obesity in a beneficence and non-maleficence perspective. Beneficence and non-maleficence refer to that a treatment should do more good than harm and not cause unnecessary harm or burden. The major finding, that mental health is improved both four months and

two years after gastric bypass in adolescents, indicates that undergoing bariatric surgery while a teenager is not harmful for mental health for most adolescents, but rather beneficial. Many studies of mental health after bariatric surgery settle with the conclusion that bariatric surgery seems to be beneficial for the great majority, but in all three studies we specifically searched for adolescents with a negative or less positive mental health outcome. In all studies, groups were found that were considered to have a less profitable outcome for mental health. However, as there was no control group it is not known whether groups with mental health problems are smaller, greater or equal to what would have been seen in adolescents with severe obesity not undergoing WLS. Study III indicated that substantial mental health problems two years after surgery do not affect weight loss or physical benefits after gastric bypass, at least in a two-year perspective. Therefore, from a strict medical perspective, they gained as much from the surgery as the others even if their mental health was much worse. One important question regarding WLS to adolescents refers to timing as in when bariatric surgery is the most beneficial and the least harmful (Hofmann, 2013). That is also a question that only could be addressed in a RCT study.

Autonomy

The autonomy principle refers to the respect of the individual's right to self-decision and the capacity to informed consent. Psychologists play an important role when it comes to evaluating adolescents' competence to make informed consent. The studies in the present thesis raise questions about whether mental health problems prior to WLS affect the adolescents' ability to decide whether they should undergo surgery and how much mental health problems affect the willingness to be operated. Several studies of children and adolescents with obesity have found higher prevalence of mental ill-health in those who seek obesity treatment compared to non-treatment seekers (Braet et al., 1997; Eremis et al., 2004). It has been suggested that the mental health problems are an important motivator to seek treatment. In behavioral treatment this does not constitute a great ethical dilemma as there is little risk that the treatment causes harm and the treatment can be interrupted at any time and has then not created any permanent changes in the body. A gastric bypass is considered a permanent operation and once an adolescent is operated, he or she will stay operated. Technically a gastric bypass is reversible, but is normally only reversed when severe medical problems exist and such a procedure is associated with much higher medical risks than undergoing the primary bariatric surgery. Also, a restored anatomy does not guarantee a restored functioning. A SG is not reversible. If adolescents are driven to undergo WLS by their mental health problems and would have chosen not to if their mental health problems were treated elsewhere, this constitutes an urgent ethical dilemma.

Methodological considerations, limitations and strengths

The studies in the present thesis have several limitations. The most important limitation is the lack of a control group. Study I and II describe how mental health is affected in adolescents with severe obesity when undergoing gastric bypass but we do not know how their mental health would have developed over four months and two years if not undergoing WLS. The possibility that we would have found the same outcomes without surgery could not be rejected. Threats to internal validity are the most acute when they are supposed to act in the same direction as the effect of the treatment. If a natural improvement in mental health was expected in adolescents when followed over time, this would have led to greater doubt about whether the improvements seen in mental health in adolescents after WLS surgery were an effect of WLS or just by time. However, both in the general population and in adolescents and young adults with extreme obesity, the natural development rather seems to be impairment than improvement. This knowledge makes it more probable that the seen general improvement in mental health is related to undergoing WLS. It is more difficult to interpret the findings about those who are impaired and those who report substantial mental health problems two years after surgery. We do not know whether they are more than, fewer than or as many as expected without undergoing WLS.

In study I and II comparisons with age- and/or gender-matched control groups were made. This procedure cannot compensate for the lack of a control group, and several factors must be considered when population norms are used. The resemblance between adolescents undergoing bariatric surgery and the norm population is not known, with the risk of making the comparison invalid. Also, a comparison with norms for age 13–18 was made in study II even though the mean age was > 18 years at the two-year follow-up. Since time trends in the manual suggest an increase in symptoms as adolescents become older (Beck, Beck, Jolly, Tideman, & Näswall, 2007), this rather constitutes a risk of underestimating and not exaggerating improvement. The adolescents in the study group were assessed repeatedly which is not true for the norm group. The adolescents undergoing surgery presented with rather impaired mental health before surgery and extreme values are expected to be less extreme at another assessment point. Therefore, it cannot be ruled out that some of the improvements in adolescents undergoing WLS in comparison to the norm group are an effect of a regression to the mean. However, internal consistency for all used mental health measures was either good or excellent. Reliability of measures is also especially important in repeated measurement in longitudinal studies.

In all studies mental health has been assessed with self-report questionnaires. The most valid assessment of mental health is considered to be generated by clinical

interviews. One variable, depression, was assessed with two different questionnaires at follow-ups; all other variables were only assessed with one scale. Above this, we only collected data from one possible informant, the adolescent him- or herself. A shortcoming of this single method approach is that we cannot control for systematic variance that is unrelated to the outcome such as response style or not taking assessment seriously. Also, using only symptom questionnaires merely informs us that adolescents report significantly less symptoms after surgery and we cannot be completely sure that this corresponds to an actual improvement. External measures, such as school attendance or participation in social activities, would have added valuable information about psychosocial functioning.

Some further steps could have been taken to improve the validity and reliability in the findings. Repeated pretests could have been used. A repeated pretest would have given information concerning the natural development of mental health over time in adolescents who want to undergo WLS. It could also have controlled for how much impact regression to the mean has over results. Repeated pretesting is also a method to control for impression management, even if the probable effect of impression management would be that improvements after surgery seem to be smaller than they actually are.

A weakness is that we have no information about external factors that could have affected the mental health in the adolescents during the first two years after surgery such as stressful or traumatic life events. Especially in study III this would have been valuable information.

The approaches in the studies have been explorative. According to this approach, multiple comparisons have been made without any correction procedure controlling for the risk of mass significance. However, findings have been consistent over different measures and all outcome measures have been reported, not only the significant ones. Also, ESs have been reported in study II and III for all variables with significant differences and effects have not been trivial, which makes it less possible that the significant differences were just caused by chance. In study III the PMH group was small, which resulted in low power and that there might be differences of clinical significance between the groups, especially at baseline, that we could not detect.

A major strength in the studies is the low attrition. Many clinical studies have substantial problems with attrition and in many cases it is not known whether the attrition has affected the outcomes. In study II data from all adolescents in the AMOS cohort could be used.

One important question to consider is external validity and whether the results regarding mental health in the AMOS study are valid for other adolescents undergoing WLS. Many studies of mental health in bariatric samples are

conducted at a single site and mostly in a single country. In a case-control study comparing Spanish and North American subjects suitable for bariatric surgery, it was found that weight-related QoL was lower in the Spanish group (Caixàs et al., 2013). The authors suggest that people in Europe are less used to handle severe obesity compared to people living in USA and therefore experience more reduced QoL (Caixàs et al., 2013). Also, different rules for reimbursement for surgery may give different groups access to medical care. As mentioned above, the adolescents in the AMOS study are not a highly selected group as exclusion criteria were few. If a more strict selection had been made it would have been more difficult to generalize our results as they could be thought to be only valid for a specific subgroup of adolescents seeking WLS. On the other hand, if adolescents with more psychosocial problems are included in a study, maybe more improvement can be seen than would be expected in a healthier group as there is more room for improvement.

In AMOS adolescents aged 13–18 years could be included, however the mean age in AMOS was 16.8 years and about three out of four adolescents in AMOS were 16 or older when undergoing surgery. Most adolescents that request bariatric surgery are > 15 years. In study III, we found no significant age difference between adolescents with PMH and other adolescents. However, the results in the studies must be interpreted as being representative mostly for the assessed age-group and we cannot be sure that we would have seen the same outcomes for a substantially younger group of adolescents. We also do not know whether our results are valid for WLS to adolescents in general or only valid for adolescents undergoing gastric bypass. However, most results in the studies in the present thesis mirror what have been found in other studies even though they were conducted in other settings and countries, with different procedures, in other age-groups, with different possible selection processes, and different practices for reimbursement for surgery.

Future considerations

Long-term follow-ups of adolescents who have undergone WLS are necessary to study how mental health is affected beyond two years. Long-term follow-ups in adults have yielded conflicting results in which some find partially sustained improvement in mental health and others find that the improvements are deteriorated several years after WLS. Follow-up of adolescents who report PMH and/or suicidal ideation seems especially important. More complex analyses could be used looking at mediating factors that impact outcome in mental health. Even if WLS has proven to be safe and effective in adolescents only randomized

controlled trials could resolve whether it is better to offer surgery during adolescence or wait with surgery until adulthood.

Bariatric surgery is a new treatment option for adolescents. A psychologist that is about to assess the suitability and readiness for an adolescent to undergo bariatric surgery and to follow adolescents after WLS has had to rely on studies of adults. Doing that might lead to focusing on areas that are not age relevant. As more adolescents will be offered bariatric surgery it is important to develop an age appropriate assessment that will give valid and relevant information. Qualitative methods could be used in future studies to generate new hypothesis and gain insight to areas that are considered important to affect outcome by the adolescents themselves. One important area to study is the adolescents' expectations about undergoing WLS. Future studies of adolescents undergoing WLS could also focus on more age-relevant topics such as family functioning, school functioning, peer and romantic relationships, risk-taking behavior and adherence, and peer victimization. In childhood obesity treatment in general, involvement of parents is an important factor that impacts outcome. Future studies of WLS in adolescents should study whether more and what kind of parental involvement that could improve outcome further.

Eating-related behavior was not addressed in the studies in the present thesis. However, it is consistently reported that patients with obesity and eating-related problems also report worse mental health in other areas (Fabricatore & Wadden, 2004; Mitchell et al., 2015). This seems to be true also for adolescents seeking WLS (Sysko et al., 2011). Future studies could explore this association further and adolescents reporting disordered eating before and/or after surgery might be in the need of more psychosocial interventions.

Considering the several studies that have found an increased risk of alcohol dependence after bariatric surgery and especially after gastric bypass (Spadola et al., 2015; Svensson et al., 2013), and that young people have a higher risk of developing alcohol dependence than older, it is important to address alcohol-related problems in long-term follow-up of adolescents. Also, almost one out of three adolescents in AMOS had any neuropsychiatric diagnose at baseline and ADHD has been found to be a risk factor for alcohol abuse after WLS (Spadola et al., 2015).

One side effect of bariatric surgery is excess skin and adolescents report as much or more problems with excess skin than middle aged adults after WLS. Future studies should analyze if there is any association between excess skin and mental health in adolescents after WLS either as in more excess skin leading to more mental health problems or in that adolescents with impaired mental health experience more discomfort with excess skin.

Many studies of WLS surgery patients, including those in the present thesis, focus on symptom reporting but do not assess more general underlying psychological factors such as emotion regulation or positive and negative emotionality. Such factors might be more reliable for predicting outcome compared to symptoms.

If WLS is introduced as a regular treatment for adolescents with severe obesity, the total number of adolescents that will undergo bariatric surgery in Sweden each year will still be low and there is only need for a few centers in Sweden with expertise in WLS to adolescents. However, some adolescents who will undergo bariatric surgery will not live in the proximity of any of these centers. Future studies should explore whether some mental health screening could be done over the internet. Future studies should also focus on interventions that can improve mental health in adolescents who have a negative mental health outcome after surgery, and when the best time is to deliver these interventions.

Approximately 50% of the adolescents who seek WLS report no impaired mental health. Future studies should focus on this group to analyze protective factors both in the individual and the environment. Contrasting adolescents with the most improved mental health to those with deteriorated mental health could also generate valuable knowledge.

Several of the aspects of mental health studied in the present thesis, such as anxiety, depression, self-esteem, and disruptive behavior, have expected gender differences both in the general population and in WLS samples. Most outcomes have not been analyzed separately by gender, mostly due to the small sample size and the few boys in the AMOS study. Future studies with larger samples should analyze whether outcomes differ by gender.

Conclusions

For most adolescents, mental health is improved four months and two years after undergoing gastric bypass even though the surgery is performed during a sensitive period in life when mental health problems are expected to increase rather than decrease. However, there are subgroups of adolescents who have a less positive outcome and it seems to be even more important to offer psychological screening and interventions to adolescents undergoing bariatric surgery compared to adults.

Today there are few other effective treatment options to offer patients with severe obesity. Many adolescents with severe obesity will eventually undergo bariatric surgery. Only long-term follow-ups and RCTs can better guide clinicians, adolescents and their families whether it is more beneficial to undergo WLS as a teenager or to wait until adulthood, and in a better way make specific recommendations to different groups of adolescents.

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Paper I

Short-Term Psychological Outcomes in Severely Obese Adolescents After Bariatric Surgery

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Bariatric surgery is suggested as a treatment option for severely obese adolescents. Because adolescence is characterized by intense psychosocial adjustment and development, it is important to study the effect of this procedure on adolescents' psychological health. This study examined baseline status and short-term changes in anxiety, depression, anger, disruptive behavior, and self-concept in 37 adolescents (mean age 16.6 ± 1.3). Participants completed the Beck Youth Inventories (BYI) at inclusion and (on average) 4 months after undergoing Roux-en-Y gastric bypass (RYGB). Internalizing (anxiety and depression) and externalizing (anger and disruptive behavior) symptoms were higher at baseline than gender-specific norms. One fifth had a very low self-concept. Four months after surgery, the adolescents showed significantly fewer symptoms of anxiety and depression and significantly improved self-concept from baseline. Anger and disruptive behavior showed no significant changes. An analysis of clinically meaningful changes was conducted, and besides the overall positive outcome, 16% ($n = 6$) of the adolescents had deteriorated on two or more inventories in BYI shortly after surgery. This impaired group did not show any specific features at inclusion. The results indicate the importance of psychological monitoring immediately after bariatric surgery and the need for additional psychosocial support to be available for vulnerable sub-groups of adolescents. Further studies with larger samples are necessary to identify characteristics predictive of short-term adverse psychological outcomes in adolescents after bariatric surgery.

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INTRODUCTION

Pediatric obesity is an important health problem that requires urgent action (1). Long-term health complications in overweight children after 40-year follow-up include significantly increased rates of cardiovascular and digestive diseases and also increased mortality (2). Another follow-up study of overweight adolescents after 55 years found increased mortality of all causes and increased coronary heart disease in men (3). The few published studies assessing bariatric surgery for severely obese adolescents where other forms of treatment have failed, show promising results for the surgery's safety and efficacy (4,5). Psychosocial effects of bariatric surgery are important outcome measures, especially in adolescents, whose lives are characterized by intense psychological and social development.

Based on previous findings about the relationship between obesity and psychological well-being, we expected adolescents

presenting for obesity surgery to have an elevated risk of poor mental health. Adolescents with obesity are known to be more psychologically affected than younger children with obesity (6), and treatment-seeking obese adolescents tend to have especially impaired psychological health (6,7). A BMI >40 is a known risk factor for poor psychological health (8), and obesity surgery in adults and adolescents usually requires a BMI ≥ 40 or a BMI ≥ 35 with additional obesity-related comorbidity (9).

Studies in adults seeking bariatric surgery reveal a high incidence of psychiatric comorbidity and the reported point prevalence of a clinical mental disorder before surgery ranges from 20 to 60% in different studies (10). The few published studies on the adolescent bariatric surgery population indicate that severely obese adolescents are a vulnerable group regarding psychosocial health. Adolescents seeking weight-loss surgery

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have higher levels of depressive symptoms (11–15) and a more impaired health-related quality of life (11,14,15) than other teenagers. Less is known about other aspects of mental health in this group of adolescents, such as anxiety, externalizing symptoms, and self-concept.

In the adult bariatric surgery literature, a majority of studies report decreases in anxiety and depression and improvements in self-concept postoperatively (16,17). In one of the few longitudinal studies of psychosocial outcomes in teenagers, Zeller *et al.* found improvements in depressive symptoms and health-related quality of life 6 months and 1 year after gastric bypass (14). However, it is not obvious that the psychological outcomes will be the same in adolescents as in adults, since the pathways between obesity and depression in adolescents are not the same as in adults (18,19). In adolescents, depression is a risk factor for obesity onset, but this association is not seen in depressed adults. Consequently weight-loss surgery might not be as efficient for improving mental health in adolescents as it is for adults. A majority of outcome studies describe changes in mean values and few studies report if any individual cases with adverse psychosocial outcomes were found.

The aim of this study was to evaluate the mental health of obese Swedish teenagers before and shortly after Roux-en-Y gastric bypass (RYGB). Both internalizing (i.e., depression and anxiety) and externalizing (i.e., anger and disruptive behavior) symptoms as well as self-concept were assessed to get an extended knowledge of the psychological health in this group of adolescents. Based on previous findings in adults and adolescents, our main hypothesis was that we would find improvements in mood and self-concept at the first clinical follow-up a few months after surgery when patients have reached stability after operation and already lost some weight. A secondary aim was to explore individual trajectories and tolerance of obesity surgery by analyzing clinically meaningful change soon after surgery to assess whether any definable sub-group of adolescents needed more psychosocial support.

METHODS AND PROCEDURES

Participants

The participants were recruited from the Adolescent Morbid Obesity Surgery (AMOS) study. The AMOS study is a nationwide 10-year prospective feasibility and safety study of RYGB in adolescents 13–18 years old and all adolescents were included from the three largest childhood obesity centers in Sweden (Stockholm, Gothenburg, and Malmö) between 2006 and 2009. The inclusion criteria in the AMOS study required participants to have a BMI ≥ 40 or BMI ≥ 35 with an obesity-related comorbidity. Before inclusion, the adolescents should have attended a comprehensive conservative weight-loss treatment at a pediatric clinic for at least 1 year. Exclusion criteria were few but included mental retardation, drug abuse, a history of psychotic disease, or an inability to comply with the requirements of the procedure. The retention of participants in the study was supported by traceable addresses from the national population register, and contacts in person and by telephone and mail. All adolescents had their laparoscopic RYGB at Sahlgrenska University Hospital (Gothenburg, Sweden). The surgery was subsidized by the Swedish health care system.

Three months after surgery the adolescents were invited to a clinical follow-up at their local study site according to the protocol. All adolescents undergoing surgery from September 2007 to November 2009 were

invited to take part in this sub-study evaluating short-term psychological effects of surgery. Thirty-nine (of 81 participants included in AMOS) underwent surgery during the selected period and 37 adolescents (95%) agreed to participate, 25 girls (67.6%) and 12 boys (32.4%). The mean age was 16.6 years (s.d. 1.3, range 14.5–18.6).

Procedure

All adolescents were assessed at their local study site upon inclusion. A majority of the adolescents returned to their local study center for follow-up ($n = 35$); two adolescents preferred to have their follow-up outside the study center. At baseline and at follow-up, all adolescents met a clinical psychologist for an interview and assessment with self-rating questionnaires. The adolescents were invited to follow-up ~3 months after surgery. However, the actual mean follow-up time (\pm s.d.) was 4.2 ± 1.4 months postoperatively. Informed written consent was obtained from both the adolescents and from their primary caregivers. All the procedures were approved by the regional ethical review board in Gothenburg.

Measures

Anthropometrics. The examination early in the morning after an overnight fast included anthropometric measurements of weight and height, which were taken according to standard procedures (20). Body weight was measured using an electronic scale to the nearest 0.1 kg with the subject wearing light clothing without shoes. Height was measured using a standardized stadiometer to the nearest 0.1 cm without shoes. BMI was calculated as weight (kg) divided by the square of height (m). For three adolescents the anthropometrics were missing at the follow-up.

Beck Youth Inventories. The Swedish version of Beck Youth Inventories (BYI) consists of five self-report inventories for children and adolescents aged 7–18 years (21). The inventories assess symptoms of anxiety, depression, anger, disruptive behavior, and self-concept. Each inventory consists of 20 questions about feelings, thoughts, and behaviors associated with the aspect measured. BYI has good psychometric properties and is a valid and reliable screening tool for social and emotional impairment in children and adolescents (21). The total raw score on each inventory ranges from 0 to 60. Higher total raw scores correspond to more symptoms on the anxiety, depression, anger, and disruptive behavior scales. For the self-concept inventory a higher total score reflects a more positive self-concept. BYI has Swedish gender-specific norms for boys and girls aged 9–18 and raw scores can be translated to percentiles. Scores ≥ 90 th percentile according to gender-specific norms in the inventories for anxiety, depression, anger, and disruptive behavior are interpreted as highly elevated and can be regarded as in the clinical range, i.e., where everyday life is substantially affected; scores from the 76th to the 89th percentile are interpreted as slightly elevated, and scores ≤ 75 th percentile are considered to reflect average levels of symptoms. In the self-concept scale a raw score ≤ 10 th percentile is considered to represent very low self-concept, a score from the 11th to the 25th percentile is regarded as reflecting a somewhat low self-concept, a score from 26th to the 89th percentile is considered average, and a raw-score ≥ 90 th percentile is interpreted as reflecting a high self-concept (21).

Beck Depression Inventory II. The AMOS study is a long-term follow-up study. BYI was chosen because it measures several different aspects of psychological health in adolescents, and Beck Depression Inventory II (BDI-II) was chosen because it is a valid measure of depressive symptoms in both adolescents and adults and can be used as a long-term follow-up measure into adulthood. BDI-II is also one of the most widely used instruments to assess depressive symptoms in adults (22,23) and adolescents (11–15) undergoing bariatric surgery. A high agreement between depression measured by the depression scale in BYI and measured by BDI-II may be expected because both instruments were developed around the same construct by the Beck Institute. However, the resemblance between the two instruments in the adolescent bariatric surgery population is not known, and therefore BDI-II was

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administered as an additional measure of depressive symptoms. The Swedish version of BDI-II (24) is used for assessing depressive symptoms in adolescents ≥ 13 years and adults. BDI-II consists of 21 items and is a valid and reliable questionnaire for screening for depression (24). BDI-II was completed at follow-up and raw scores were used in this study. Higher raw scores indicate more symptoms of depression. In a clinical setting raw scores between 0 and 13 are considered to reflect minimal symptoms; 14–19, mild symptoms; 20–28, moderate symptoms; and 29–63, severe symptoms (24).

Statistical analysis. All statistical analyses were performed using SPSS 17.0. Means, standard deviations and ranges were calculated for age, BMI, BYI, and BDI-II. Paired *t* test was used to analyze the BMI outcome and changes in depressive symptoms, anxiety, anger, disruptive behavior, and self-concept between baseline and follow-up. An analysis of clinically meaningful change was conducted. Clinically meaningful change, i.e., noticeable and meaningful for the individual in everyday life, can be estimated in different ways. The standard error of measurement is a valid and usual method to find clinically meaningful change and already a change outside one standard error of measurement can be regarded as clinically meaningful (25). However, in this study we wanted to use a more conservative limit so as not to over-estimate changes at this early state after surgery and a 95% confidence interval (CI) was set up around the baseline raw score (95% CI calculated as standard error of measurement \times 1.96). This 95% CI was used as the limit to evaluate whether a change from baseline to follow-up in BYI could be regarded as clinically significant. A change was regarded as a clinical improvement or impairment if the follow-up raw score fell outside the 95% CI of the baseline score. In this study the standard error of measurement derived from norm data was used. In practice, this means that a change $> \pm 4$ in raw score for the anxiety, depression, anger, and disruptive behavior inventories and a change $> \pm 5$ in raw score for the self-concept inventory were regarded as clinically meaningful (21). For all scales in BYI, the limits based on 95% CI also correspond to a change equal to or greater than half a standard deviation. Half a standard deviation has previously been used to evaluate meaningful changes in symptoms of depression after obesity treatment (26). A nonparametric test, the Mann–Whitney U test, was used to analyze baseline differences between impaired adolescents and unchanged or improved adolescents. Pearson's *r*, was used to test for correlations. All *P* values are two-tailed; *P* < 0.05 regarded as significant.

RESULTS

BMI

The mean weight loss at the first follow-up expressed in BMI was 9.9 kg/m² (s.d. 4.7, *n* = 34) (Table 1), meaning that the adolescents had lost an average of 21% (range –2–44%) of their inclusion BMI before the first visit at the regional study center after RYGB. A significant correlation was found between follow-up time (months passed since RYGB) and BMI reduction ($r_s = 0.341$, *P* = 0.048), but at this first follow-up visit changes in BMI had no significant relationship with any of the psychological parameters.

Anxiety

At the time of inclusion 22% (*n* = 8) of the adolescents had a BYI anxiety score ≥ 90 th percentile according to gender specific norms and 43% (*n* = 16) had anxiety symptoms in the average range (≤ 75 th percentile). The mean percentile for anxiety for the entire group was 70.6 (range 16.1–99.9). There was a significant decrease (*P* = 0.004) in the total raw scores for anxiety between inclusion and follow-up (Table 1). After surgery, 11% (*n* = 4) had an anxiety score ≥ 90 th percentile and 65% (*n* = 24)

were now in the average range. The mean percentile was 55.2 (range 3.0–99.9). On an individual level a majority of adolescents had a lowered or unchanged level of anxiety symptoms at this early follow-up, but 11% (*n* = 4) reported markedly more symptoms of anxiety 4 months after surgery (Figure 1).

Depressive symptoms

At baseline 27% (*n* = 10) had a raw score ≥ 90 th percentile on the depression inventory in BYI and 49% (*n* = 18) had depressive symptoms in the average range (≤ 75 th percentile). The mean percentile for the whole group was 65.9 (range 9.1–99.9). Raw scores for depressive symptoms were significantly decreased (*P* = 0.020) between baseline and follow-up (Table 1). Early after surgery 11% (*n* = 4) had a depression score ≥ 90 th percentile and 68% (*n* = 25) were now in the average range. The mean percentile was 54.6 (range 1.9–99.9). Four adolescents (11%) reported substantially more depressive symptoms on BYI and were regarded as impaired compared to baseline, whereas the

Table 1 Observed means and standard deviations of BMI and self-reported means and standard deviations for psychological well-being before and after RYGB

	Baseline mean (s.d.)	Follow-up mean (s.d.) <i>n</i> = 34	<i>P</i>
BMI	46.5 (5.9)	37.2 (4.7)	<0.0005
BYI anxiety	16.0 (8.2)	12.2 (8.9)	0.004
BYI depression	15.8 (10.3)	12.3 (9.5)	0.020
BYI anger	14.7 (8.7)	12.0 (8.6)	NS (0.054)
BYI disruptive behavior	6.9 (5.7)	6.5 (5.2)	NS (0.742)
BYI self-concept	35.3 (11.0)	40.2 (11.1)	0.004

BYI, Beck Youth Inventories. (*N* = 37, except where noted.)

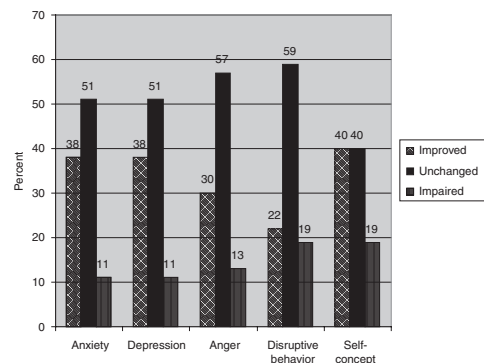


Figure 1 Percent of adolescents improved, unchanged, or impaired post surgery (*N* = 37). A follow-up raw score outside 95% confidence interval of the baseline raw score is considered a clinically meaningful change.

Table 2 Median and range baseline values presented separately for improved/unchanged adolescents and impaired (impaired on ≥ 2 BYI-scales postRYGB) adolescents

	Improved/unchanged group <i>n</i> = 31	Impaired group <i>n</i> = 6	<i>P</i>
BMI	45.5 (38.5–68.5)	46.9 (39.8–50.2)	NS (0.967)
BYI anxiety	14.0 (5–41)	15.0 (10–32)	NS (0.606)
BYI depression	15.0 (2–46)	13.5 (4–31)	NS (0.934)
BYI anger	13.0 (1–41)	15.0 (8–23)	NS (0.650)
BYI disruptive behavior	6.0 (0–26)	3.5 (0–10)	NS (0.494)
BYI self-concept	33.0 (15–59)	44.5 (29–49)	NS (0.122)

A second analysis with independent sample *t* test did not reveal any significant difference either. BYI, Beck Youth Inventories; NS, non significant.

rest ($n = 33$) were unchanged or improved (Figure 1). The mean total raw score on BDI-II at follow-up was 9.7 ± 10.2 (mean \pm s.d.), which is in the minimal range according to the normative guidelines. There was a high and significant correlation between BYI depression total score postoperatively and BDI-II, $r = 0.804$ ($P < 0.0005$).

Anger

At baseline 22% ($n = 8$) of the adolescents had a raw score ≥ 90 th percentile for anger and 43% ($n = 16$) had anger symptoms in the average range (≤ 75 th percentile). The mean percentile for anger was 68.3 (range 7.9–99.7). No significant difference for raw scores in anger (Table 1) was found between baseline and follow-up. Five (13%) of the adolescents reported markedly more symptoms of anger on the BYI 4 months after the surgery, whereas the rest (87%) reported unchanged or decreased levels of anger (Figure 1). There was a high and significant correlation between depressive symptoms (measured with BYI) and anger both at baseline ($r = 0.730$ $P < 0.0005$) and follow-up ($r = 0.792$ $P < 0.0005$).

Disruptive behavior

For disruptive behavior, 14% ($n = 5$) had a score ≥ 90 th percentile prior to surgery and 57% ($n = 21$) had disruptive behavior symptoms in the average range (≤ 75 th percentile). The group mean was at the 64.5th percentile (range 13.1–98.7) compared to norms. No significant difference for disruptive behavior raw scores was found between baseline and follow-up (Table 1). Seven adolescents (19%) reported markedly more disruptive behavior 4 months after the surgery, while the majority (81%) declared unchanged or lesser levels of disruptive behavior (Figure 1).

Self-concept

Before surgery 19% ($n = 7$) had a very low self-concept (< 10 th percentile), 24% ($n = 9$) had a somewhat low self-concept, 54% ($n = 20$) had an average self-concept and 3% ($n = 1$) had a high self-concept. According to gender-specific norms the mean percentile for self-concept was 38.2 (range 1.8–97.3) prior to surgery. There was a significant improvement ($P = 0.004$) in self-concept raw scores between baseline and follow-up (Table 1). Four months after surgery 8% ($n = 3$) had a very low

self-concept, 22% ($n = 8$) had a somewhat low self-concept, 57% ($n = 21$) had an average self-concept and 13% ($n = 5$) had a high self-concept. The mean percentile for self-concept was 51.1 (range 2.0–96.0). Six adolescents (16%) reported a noticeably lower self-concept shortly after surgery, but 31 out of 37 (84%) reported an improved or unchanged self-concept (Figure 1).

Impaired adolescents

In total, 14 adolescents (38%) were impaired on at least one of the scales on the BYI 4 months after surgery. Of these 14 adolescents, 6 (16% of total sample) were impaired on two or more scales. Those who were impaired on the anxiety or depression scale after surgery ($n = 5$) were also impaired on one or more other scales of psychosocial function on BYI. In Table 2 the baseline median and range levels for all variables on BYI and BMI are presented separately for the group of six adolescents who were impaired on two or more inventories in BYI after surgery. No significant baseline differences were found between this group and those who were not negatively affected after surgery (Table 2). Besides this impaired group there were three adolescents (8%) who remained in the clinical range (raw score ≥ 90 th percentile) for symptoms of anxiety or depression, or both, i.e., they had high levels of symptoms both before and after surgery but were not considered impaired.

DISCUSSION

Before obesity surgery the adolescents in the present study scored, at a group level, higher for anxiety, depression, anger, and disruptive behavior than gender-specific norms, i.e., they were elevated in both internalizing (anxiety and depression) and externalizing symptoms (anger and disruptive behavior). Relative to norms, more individuals were in the clinical range, where the level of symptoms is assumed substantially to affect everyday life. Self-concept was severely affected in almost one-fifth of the adolescents before surgery. On the other hand, about 40–60% of the adolescents displayed average levels of symptoms according to age and gender on each aspect measured, which is similar to the $\sim 50\%$ of adolescents who were classified as having low psychopathology in a study of 125 adolescents presenting for obesity surgery (15).

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This study is one of the first to show that symptoms of anxiety are as elevated as symptoms of depression in adolescents presenting for weight-loss surgery. Anxiety disorders are more common than mood disorders such as depression in both referred (to conservative treatment) and nonreferred obese children and adolescents (27), therefore it is valuable to include measures of anxiety when assessing adolescents seeking bariatric surgery. Adolescents who were grouped to an eating pathology class before surgery were found to have more severe symptoms of anxiety than other adolescents presenting for obesity surgery (15). Another novel finding is that adolescents presenting for bariatric surgery display almost as many symptoms of externalizing problems (anger and disruptive behavior) as internalizing problems. Externalizing and internalizing problems overlap (28) and in this study a strong association between depressive symptoms and anger were found both before and after surgery. For adolescents, depression can show more as an irritable mood (29) than a traditionally depressed mood, which could be one explanation for this association.

In this study, 27% of the adolescents reported depressive symptoms in the clinical range at baseline. This is much higher than the 1-year depression prevalence in adolescent population samples (4–7% (30)), but in the same range (16–38.7%) found in previous American studies of depressive symptoms assessed with BDI-II in adolescents before bariatric surgery (11–15). The high and significant correlation found between the BYI depression scale and the BDI-II in the present study indicates that the measurement of depressive symptoms in adolescents seeking weight-loss surgery might be comparable using either scale.

Four months after gastric bypass we found an overall significant improvement in self-rated anxiety, depression, and self-concept. This indicates that, at a group level, there was a short-term improvement in internalizing symptoms as well as in self-concept. The findings are consistent with the findings of Zeller *et al.* in a study of 31 obese adolescents undergoing RYGB (14). They concluded that depressive symptoms and health-related quality of life are significantly improved both at 6 months and at 1 year compared to baseline, and our results suggest that an improvement is present as early as 4 months after the procedure. Our results are also consistent with what is seen in adults undergoing weight-loss surgery. The vast majority of studies in the adult bariatric surgery population find that anxiety, depression, and self-concept are improved after surgery (16,17). The most substantial psychosocial improvements are seen in the first years after surgery, but these improvements tend to level off after the first year (31). The improvements in symptoms of anxiety and depression and the improved self-concept seen in the first months postoperatively might be related to a growing feeling of competence and control that follows the experience of the long-anticipated rapid weight loss (32).

Both anger and disruptive behavior are important aspects of the day-to-day functioning for adolescents, but it is unclear if surgery-induced weight loss affects externalizing symptoms and behaviors. In this study, no significant improvement was found in either anger or disruptive behavior 4 months after surgery. However, longer follow-up times are required before it

can be established if anger and disruptive behavior are affected by bariatric surgery.

In this study, we were not able to find any significant association between psychological status and initial changes in BMI after surgery. The present sample might be too small to enable differences to emerge, however the results indicate that short-term weight loss after RYGB in adolescents is not affected by psychological status. Most adult studies do not find a robust association between psychological status and weight outcome after surgery (33). However, two recent studies have shown that more psychopathology prior to surgery might lead to lesser weight loss in both 6 months (34) and 4 years (35) after surgery.

While the overall picture suggests improvement in mood and self-concept in adolescents following bariatric surgery, these data also suggest that there may be sub-groups of adolescents who need additional psychosocial support and care in the initial postoperative period: of the 37 adolescents in this study, 4 (11%) were referred to a psychiatric unit after their first follow-up visit after the surgery. Our exploratory analyses indicate one group of 3 adolescents (8%) who reported poor psychological adjustment before surgery and showed no improvement at 4 months postsurgery. This group is characterized by poor mental health before and shortly after surgery, but they show no decline after surgery. A second unique subgroup was the 16% ($n = 6$) who showed a decline in functioning on two or more of the five scales in BYI 4 months after RYGB. Adolescents who experienced markedly more symptoms of anxiety or depression after surgery than before were also affected in at least one other area of psychosocial functioning. Few studies report adverse cases, but Larsen (36) reported that 9% of adult subjects had clinically “worse” or “much worse” psychosocial function 1 year after horizontal gastric banding. In this small sample, we were not able to detect any significant baseline differences between the adolescents impaired on two scales or more and the other adolescents (Table 2). Only longer-term outcome studies with larger samples will provide a clearer understanding of whether early improvements or impairments are sustained or if they wane over time. Planned follow-up of the adolescents in the AMOS study is ongoing at 1, 2, and 5 years after operation. However, the clinical implications of our initial outcome data suggest psychological monitoring is critical, as not all adolescents show psychological change in a positive direction.

This study has several limitations that must be considered when the results are interpreted. Even though it is comparable to other studies examining psychosocial health in adolescents undergoing obesity surgery, 37 remains a small sample size. A major shortcoming is the lack of a control group. In this study, all the psychological data were collected through self-report questionnaires, and especially at inclusion there might be a risk of over- or under-reporting psychological distress, because the adolescents might perceive that more or fewer symptoms may enhance their eligibility for surgery. However, a recent study has shown that adolescents seeking weight-loss surgery are less prone to impression management than adults (37). Future studies could benefit from collecting data from

different sources. The follow-up time in this study is short and longer follow-up times are needed.

In conclusion, meeting the adolescent bariatric surgery population means meeting a group of adolescents who are at great risk of having more impaired psychological well-being than other teenagers. Even so, our findings also suggest that a large proportion of adolescents seeking weight-loss surgery have average psychological health compared for their age and gender. On the group level we found a decrease in symptoms of anxiety and depression and improved self-concept during the first months after surgery. However, there was a small group, which could not be identified at baseline, who experienced impaired mental health after surgery. Therefore we strongly advocate for a "safety net" within the team after the surgical intervention to catch these adolescents and offer support. The social and psychological outcomes must not be overlooked when evaluating the safety of this procedure.

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DISCLOSURE

T.O. has received consulting fees from Covidien PLC and J&J. The other authors declared no conflict of interest.

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Paper II

Two-Year Trends in Psychological Outcomes After Gastric Bypass in Adolescents with Severe Obesity

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Objective: This study aimed to evaluate changes in mental health over 2 years in adolescents undergoing gastric bypass.

Methods: Eighty-eight adolescents (65% girls) aged 13 to 18 years were assessed at baseline and 1 and 2 years after surgery. Generic and obesity-specific questionnaires were used to evaluate outcomes in mental health, also in relation to age- and gender-specific norms.

Results: Symptoms of anxiety ($P = 0.001$), depression ($P = 0.001$), anger ($P = 0.001$), and disruptive behavior ($P = 0.022$) were significantly reduced at 2 years after surgery, as were obesity-related problems ($P < 0.001$). Self-esteem ($P < 0.001$), self-concept ($P < 0.001$), and overall mood ($P = 0.025$) improved significantly. Improvements were mainly observed during the first year after surgery. The second year was characterized by stabilization. Symptoms of anxiety, depression, anger, disruptive behavior, and self-concept were at normative levels after surgery. However, 19% of the adolescents had depressive symptoms in the clinical range.

Conclusions: A substantial improvement in mental health in adolescents over the first 2 years after gastric bypass was found. Most adolescents had a level of mental health and self-concept similar to norms, but a marked subgroup showed substantial depressive symptoms 2 years after surgery.

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Introduction

Treatment options for adolescents with severe obesity are urgently needed. While lifestyle interventions initiated in younger ages seem effective, in adolescents they are less successful (1-3). Studies of bariatric surgery for adolescents with severe obesity have shown results in both weight loss and resolution of comorbidities in line with those of adults (4-6). Because it is conducted during a time characterized by intense psychosocial development, the effects of surgery on adolescents' quality of life (QoL) and mental health are of particular interest.

Adolescents with severe obesity are a vulnerable group living with a highly stigmatized disease (7,8), and those presenting for obesity surgery are more heavily burdened with mental health problems than other teenagers (9-11). Symptoms of ongoing depression have been reported in 16% to 39% of adolescents seeking weight loss surgery (9-12). In one study, 68% of adolescents reported a history of depression (11). High levels of anxiety and low self-esteem have

been reported (9) as has poor QoL (10,12). Previously reported baseline data from the Adolescent Morbid Obesity Surgery (AMOS) study showed that 41% of patients had been under treatment in a pediatric psychiatric unit [versus a prevalence of 15% in a general Swedish sample of children and adolescents under the age of 18 years (13)], and 31% had a neuropsychiatric diagnosis (4).

Large-scale, long-term follow-ups of adults after bariatric surgery show that QoL and different aspects of mental health improve significantly post-surgery (14-17) and that these improvements are sustained up to 6 years after surgery (18). However, most prospective studies have included patients with a mean age >40 years, and there is a lack of studies investigating mental health outcomes among adolescents who have undergone surgery.

Short-term outcome studies in adolescents have shown substantial improvements in psychological well-being during the first year after

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TABLE 1 Anthropometrics and psychological health in adolescents with severe obesity at baseline and 1 and 2 years after gastric bypass

	Baseline	n	1 year post-surgery	n	P value, 1 year vs. baseline	2 years post-surgery	n	P value, 2 years vs. baseline	P value, 2 years vs. 1 year
BMI	45.6 (44.4-46.8)	86	30.9 (29.9-31.9)	85	<0.001	30.1 (29.0-31.2)	85	<0.001	0.065
Anxiety BYI ^a	14.2 (12.1-16.4)	63	10.2 (8.2-12.3)	52	<0.001	10.5 (8.5-12.7)	63	<0.001	0.763
Depression BYI ^a	14.1 (12.0-16.6)	63	9.5 (7.5-11.8)	52	<0.001	9.9 (7.8-12.4)	63	0.001	0.694
Anger BYI ^a	11.3 (9.4-13.5)	63	9.3 (7.3-11.6)	52	0.056	7.8 (5.8-10.1)	62	0.001	0.125
Disruptive behavior BYI ^a	4.8 (3.7-6.0)	63	3.7 (2.8-4.8)	52	0.048	3.4 (2.5-4.5)	63	0.022	0.585
Self-concept BYI	34.6 (32.2-37.1)	63	41.3 (38.6-44.1)	52	<0.001	40.5 (37.8-43.3)	63	<0.001	0.587
Rosenberg Self-Esteem ^a	20.6 (19.0-22.0)	82	24.2 (23.0-25.2)	84	<0.001	23.9 (22.5-25.2)	75	<0.001	0.648
Pleasantness MACL	2.88 (2.76-2.99)	82	3.08 (2.97-3.20)	83	<0.001	3.04 (2.92-3.17)	74	0.015	0.509
Activation MACL	2.61 (2.50-2.72)	81	2.83 (2.71-2.95)	83	<0.001	2.71 (2.58-2.84)	75	0.124	0.058
Calmness MACL	2.61 (2.49-2.72)	82	2.85 (2.74-2.97)	83	<0.001	2.76 (2.63-2.89)	75	0.027	0.129
Overall mood MACL	2.70 (2.60-2.79)	82	2.92 (2.82-3.03)	83	<0.001	2.83 (2.71-2.95)	75	0.025	0.084
OP	51.5 (46.0-57.0)	82	29.4 (24.4-34.4)	81	<0.001	32.9 (27.2-38.5)	75	<0.001	0.187

Abbreviations: BMI, body mass index; BYI, Beck Youth Inventories; MACL, Mood Adjective Check List; OP, Obesity-related Problems scale. Data are shown as mixed-models mean (95% CI). Significant P values in bold.

^aBecause of non-normal distribution, variables were transformed with zero-skewness log-transformation before analyses. Means and confidence intervals (CI) are expressed on the original scale.

surgery (9,19,20). One study found a tendency to improvement in mental health already when adolescents were waiting for surgery (21). Outcome studies suggest not only psychological improvement but also normalization of psychological health after surgery (9,20). A small study of 16 adolescents demonstrated that improvements in psychosocial well-being are sustained up to 2 years (22). Improvements in adolescents appear to mimic changes in adults undergoing surgery, with major improvements occurring during the first year of rapid weight loss. However, not all adolescents have a positive outcome. In AMOS we previously reported two cases of attempted suicide and five cases of drug abuse during the first two postoperative years (4), as well as impaired psychological health in 16% of patients 4 months after surgery (9).

The aim of the present study was to explore 2-year outcomes in generic and obesity-specific psychological health in Swedish adolescents (13-18 years) undergoing laparoscopic gastric bypass. We hypothesized that trends in psychological well-being observed among adults should also be found in adolescents, i.e. major improvements during the first postoperative year and a deceleration of improvement or minor decline during the second year.

Methods

AMOS is an ongoing Swedish 10-year prospective study examining the safety and efficacy of gastric bypass in adolescents with severe obesity. Inclusion and exclusion criteria are presented in detail elsewhere (4). Eligibility criteria were age 13-18 years and body mass index (BMI) ≥ 40 or ≥ 35 with comorbidity. The adolescent should have attended an obesity treatment program at a pediatric clinic for at least 1 year before entering the study. Exclusion criteria included psychotic disease and ongoing drug abuse.

This study sample from the AMOS cohort consists of 88 consecutively enrolled adolescents (65% girls and 35% boys) undergoing laparoscopic gastric bypass between May 2006 and January 2010. Mean age at surgery was 16.8 years (SD ± 1.2 ; range 13-18). Participants were enrolled and followed-up at the three largest childhood obesity units in Sweden: Stockholm, Gothenburg, and Malmö. All surgeries were performed at Sahlgrenska University Hospital, Gothenburg. The study was approved by the regional ethics committee.

Procedure

Data were collected at inclusion and at the 1- and 2-year post-surgery follow-ups. All adolescents visited the nearest study centre for assessment. A battery of generic and obesity-specific self-assessment questionnaires was used to measure psychological health. Questionnaires were collected by study coordinators; however, two questionnaires, the Beck Youth Inventories (BYI) and Beck Depression Inventory II (BDI-II), were administered by a clinical psychologist and were only collected when a psychologist was available at the clinic. Therefore, the BYI and BDI-II (BDI-II only administered at follow-ups) were collected from 72% at baseline, in 59% at the 1-year follow-up, and in 72% at the 2-year follow-up. For other questionnaires the collection rates varied between 85 and 95%. Available data is shown in Table 1.

Measures

Anthropometrics. Weight was measured on an electronic scale to the nearest 0.1 kg with the subject wearing light clothing. Height was measured without shoes to the nearest 0.1 cm using a wall-mounted standardized stadiometer. BMI was calculated as kg/m^2 .

Beck Youth Inventories. BYI consists of five self-report inventories for children and adolescents aged 7 to 18 years and assess symptoms of anxiety, depression, anger, disruptive behavior, and

self-concept (23). Scale scores range from 0 to 60, and higher scores on the anxiety, depression, anger, and disruptive behavior inventories indicate more symptoms, while a higher score on the self-concept inventory reflects a more positive self-concept. Swedish gender-specific norms are available for children aged 9 to 18 and scores are transformed to percentiles. Percentiles indicate whether a respondent's symptoms are greater or equal to those of sex- and age-matched peers. Symptom severity is classified according to standardized cut-offs. On four of the scales (anxiety, depression, anger, and disruptive behavior) the following cut-offs are used for categorization: ≥ 90 th percentile highly elevated, 89th-76th percentiles slightly elevated, ≤ 75 th percentile in the average range. In the self-concept inventory the following cut-offs are used for categorization: ≤ 10 th percentile very low self-concept, 11th-25th percentiles somewhat low self-concept, 26th-89th percentiles average, and ≥ 90 th percentile high self-concept (23).

Beck Depression Inventory II. The BDI-II assesses depressive symptoms in adolescents (≥ 13 years) and adults (24), and is a valid tool for screening for clinical mood disorders in bariatric samples (25). BDI-II is widely used to assess depressive symptoms in adolescents (10,12,19,20,22) and adults (26,27) undergoing obesity surgery. In a clinical setting, scores ≤ 13 are categorized as minimal symptoms, 14-19 mild symptoms, 20-28 moderate symptoms, and 29-63 severe symptoms. A score ≥ 17 is used as a conservative cut-off for depressive symptoms at the clinical level (24).

Rosenberg Self-Esteem. The Rosenberg Self-Esteem (RSE) questionnaire is widely used to assess global self-worth in adolescents and adults (28). The RSE consists of 10 items and total score range between 0 and 30. Higher scores reflect higher self-esteem.

Mood Adjective Check List. The Mood Adjective Check List (MACL) assesses both positive and negative moods and contains 38 adjectives. The MACL covers three major dimensions of mood: pleasantness/unpleasantness (e.g., optimistic/resigned), activation/deactivation (e.g., active/passive, apathetic), and calmness/tension (e.g., relaxed/tensed). An overall mood score is also calculated. Scale scores range from 1 to 4, with higher scores indicating a more positive mood. The MACL is a valid instrument for detecting changes in mood in populations with obesity during weight loss and relapse (14,29,30). Age- and gender-specific norms are available.

Obesity-related Problems scale. The Obesity-related Problems scale (OP) is a condition-specific questionnaire assessing the impact of obesity on psychosocial functioning in everyday life. Subjects estimate how disturbed they are because of their weight or body shape in social situations such as attending parties, bathing in public places, and intimate situations. The OP consists of 14 items measured on a four-point scale. It is a reliable and valid questionnaire for assessing weight-related psychosocial impairment in populations with obesity and is responsive to change in weight status (31). Responses are aggregated on a scale of 0-100. A score < 40 is categorized as mild impairment, 40-59 as moderate impairment, and ≥ 60 as severe impairment.

Internal consistency of mental health variables. Internal consistency was calculated for all administered mental health variables at all assessment points. Cronbach's alpha varied between 0.86 and 0.96, indicating good to excellent internal consistency.

Statistical analysis

Descriptive statistics are given as mean, confidence interval (CI), standard deviation (SD), and range where appropriate. A sensitivity analysis comparing persons with complete and missing data was conducted with *t* tests for continuous and chi-square tests for dichotomous variables. Multilevel mixed-effect regression models were used to analyze the data to assess changes over the study period. Because observations were considered nested within persons, standard errors (SE) were calculated by taking into account the repeated measurements. Mean changes over time are expressed with 95% CI. Variables which were not normally distributed (BYI anxiety, depression, anger, and disruptive behavior, BDI-II, and RSE) were transformed with zero-skewness log-transformation. Change over time and correlations were analyzed with the transformed variables. Before reporting the means and CI, the results were retransformed back to the original scale. Observed values were used to calculate the standardized response mean (SRM). The SRM estimates the magnitude of change within a group between two assessment points and is calculated as mean change divided by the SD of change. SRM is evaluated according to standard criteria for effect sizes (ES) in which $ES < 0.2$ is considered trivial, 0.2 to < 0.5 is small, 0.5 to < 0.8 is moderate, and ≥ 0.8 is large (32). Pearson's *r* was used to test for correlations. All *P* values are two-tailed and $P < 0.05$ was considered statistically significant. Statistical analyses were carried out using the Stata statistical package 12.1 (Stata-Corp, 2011, Stata Statistical Software: Release 12.1, College Station, TX; StataCorp LP) and SPSS 20.0 (IBM, Released 2011, IBM SPSS Statistics for Windows, Version 20.0, Armonk, NY: IBM).

Results

Missing data

An analysis was conducted for all variables at baseline comparing adolescents with complete data in relation to those having missing data. There were no statistically significant differences on any variable (all $P > 0.05$). Furthermore, there were no significant differences for age ($P = 0.705$) or gender ($P = 0.203$).

BMI

Mean BMI decreased significantly from baseline until 2 years after surgery (Table 1 and Figure 1a). At the 2-year follow-up, 50% of the adolescents were no longer in the obese range (BMI < 30). The other 50% were still classified as obese, and 4 of these (5%) remained class III obese (BMI ≥ 40). None had a BMI < 20 .

Anxiety, depression, anger, and disruptive behavior

Symptoms of anxiety, depression, anger and disruptive behavior measured on the BYI were significantly decreased 2 years after surgery compared to baseline (Table 1). The effect size of the 2-year change was moderate for anxiety ($ES = 0.53$) and small for depression ($ES = 0.47$), anger ($ES = 0.41$), and disruptive behavior, ($ES = 0.25$). Reductions in anxiety, depressive symptoms and disruptive behavior were observed during the first year after surgery while the second year was characterized by stabilization (Table 1 and Figure 1b-c). Anger symptoms gradually decreased as no change reached significance between consecutive assessments, but there was

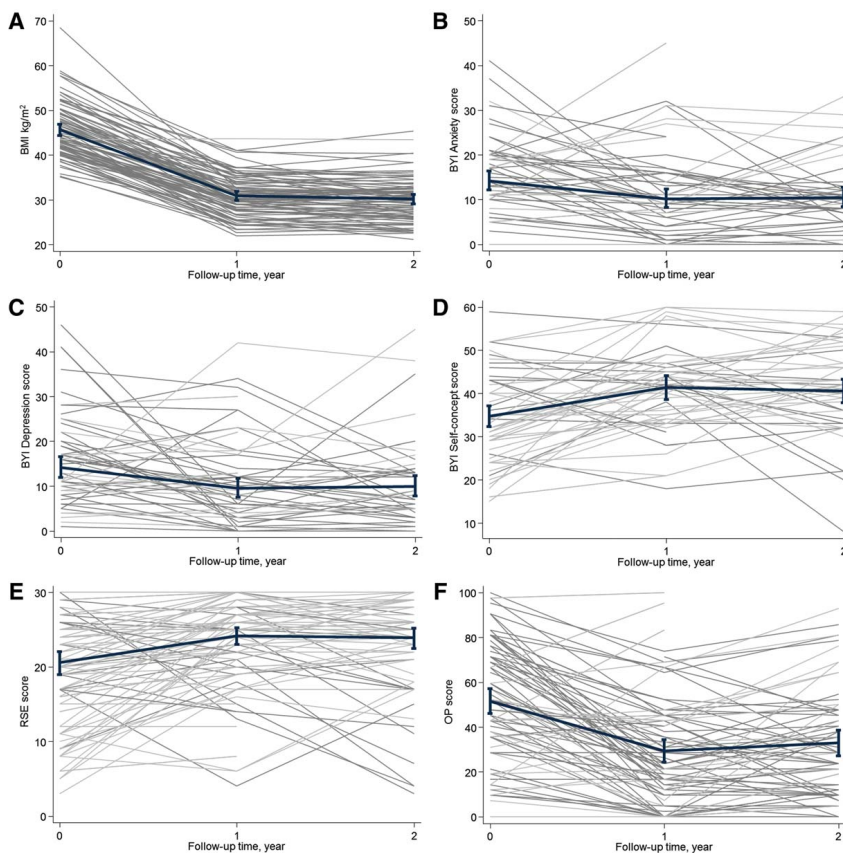


Figure 1 BMI and mental health data in adolescents before and after gastric bypass. Black line = mean (95% CI). Grey lines = individual development for adolescents with more than one assessment. Abbreviations: BMI = body mass index, BYI = Beck Youth Inventories, RSE = Rosenberg Self-Esteem, OP = Obesity-related Problems scale. Because of non-normal distribution, BYI variables and RSE were transformed with zero-skewness log-transformation before analyses. In reporting the means and confidence intervals (CI), these are retransformed back to the original scale. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

a significant change from baseline to 2 years (Table 1). Descriptive values for percentiles for baseline and 2-year follow-up are presented in Table 2. The mean BYI percentiles at baseline indicate that adolescents with severe obesity have more symptoms of anxiety, depression, anger, and disruptive behavior before bariatric surgery than other adolescents. The mean percentiles 2 years after surgery indicate a general alleviation of symptoms, but some continued to have highly elevated symptoms at the 2-year post-surgery follow-up.

Two years after surgery the mean BDI-II depression score was in the minimal range ($m = 10.4$, $SD \pm 13.6$, range 0-52, $n = 63$). According

to cut-offs, 76% had depressive symptoms in the minimal range, 5% in the mild range, 6% in the moderate range, and 13% in the severe range. A score ≥ 17 indicates clinical depression, and 19% scored above this cut-off 2 years after surgery.

Self-concept and self-esteem

Self-concept (BYI) and self-esteem (RSE) were significantly improved 2 years after gastric bypass (Table 1), with a moderate ES (0.65) for self-concept and small (0.40) for self-esteem. The improvement occurred during the first year, and changes between 1

TABLE 2 Descriptive percentile values at baseline and 2 years after surgery for BYI variables

	Mean percentile ^a (±SD)	Median percentile ^a (IQR)	Percentile range ^a (min-max)	Average symptoms ^b	Slightly elevated symptoms ^b	Highly elevated symptoms ^b	<i>n</i>
BYI anxiety, baseline	67.0 (±28.3)	79.4 (41.5)	3.8-99.9	44%	37%	19%	63
BYI anxiety, 2-year follow-up	50.9 (±30.6)	45.3 (46.4)	1.6-99.9	76%	8%	16%	63
BYI depression, baseline	66.0 (±26.9)	71.5 (36.6)	9.1-99.9	56%	21%	24%	63
BYI depression, 2-year follow-up	50.9 (±31.3)	52.0 (53.3)	1.9-99.7	71%	13%	16%	63
BYI anger, baseline	61.7 (±27.0)	65.8 (46.4)	7.9-99.7	59%	22%	19%	63
BYI anger, 2-year follow-up	46.9 (±33.9)	40.8 (64.1)	4.2-99.0	69%	13%	18%	62
BYI disruptive behavior, baseline	62.0 (±23.3)	60.4 (41.4)	13.1-98.7	62%	29%	9%	63
BYI disruptive behavior, 2-year follow-up	53.3 (±25.9)	52.8 (40.2)	13.1-99.6	78%	6%	16%	63

BYI = Beck Youth Inventories.

^aSwedish gender-specific norms for adolescents aged 9-18 are available, and BYI scores are transformed to percentiles, indicating whether a respondent has more or equal symptoms compared to sex- and age-matched peers.

^bPercent of adolescents in each symptom severity category.

and 2 years after surgery were not significant (Table 1 and Figure 1d-e). At baseline the mean percentile for self-concept was 36.8 (SD ± 26.3, range 1.8-97.3) and 17% were categorized as having a very low self-concept, 25% a somewhat low self-concept, 56% an average self-concept, and 2% a high self-concept. Two years after surgery the mean percentile was 54.4 (SD ± 28.7, range 0.4-97.3); 10% reported a very low self-concept, 8% a somewhat low self-concept, 68% an average self-concept, and 14% a high self-concept.

Mood

Overall mood and two specific aspects of mood, pleasantness and calmness, were significantly improved 2 years after surgery (Table 1). The effect size of change for overall mood was small (ES = 0.28). The improvement took place during the first year, while a non-significant decline was observed during the second year (Table 1). Activation was significantly improved during the first year after surgery, but at the 2-year follow-up the improvement no longer reached significance (Table 1). At follow-up 2 years after surgery lower mean scores were observed for all aspects of mood compared to age-matched norms. For overall mood the mean score 2 years after surgery was 0.8 SD below norms.

Obesity-related problems

Obesity-related problems were significantly reduced at year 2 after surgery (Table 1) and the change corresponded to a moderate ES (0.65). The improvements were noted during the first year, with a non-significant decline during the second year (Table 1 and Figure 1f). Before surgery, the adolescents mean score indicated moderate impairment and at year 2 the mean score indicated mild impairment. There was no significant correlation between the OP score and BMI at any time point nor was there any significant correlation between percent weight loss (%WL) from baseline to 2-year follow-up and improvement in OP during the same period ($r = 0.10$, $N = 73$, $P = 0.40$), still OP showed excellent internal consistency at each time point. However, improvement in OP correlated negatively and

significantly to BYI depression ($r = -0.28$, $n = 54$, $P = 0.043$), and BDI-II ($r = -0.28$, $n = 54$, $P = 0.038$) and correlated positively to MACL overall mood ($r = 0.32$, $n = 72$, $P = 0.006$) and RSE ($r = 0.28$, $n = 72$, $P = 0.016$) at year 2.

Correlation between weight loss and improvement in mental health

There was no significant correlation between %WL and change in any mental health variable ($r = -0.19$ to 0.037 , $n = 53-73$, $P = 0.178-0.794$) 2 years after surgery.

Discussion

This is the first study with a larger sample showing that different aspects of mental health, mood, self-esteem and obesity-related problems are significantly improved in adolescents 2 years after undergoing bariatric surgery. As shown in other studies of adolescents (19,20) and adults (14,15), major improvements take place during the first year after surgery when weight loss is rapid. In this study, the second year was characterized by stabilization. No changes between the first and second years' follow-up were significant, although results from other studies have suggested a relative decline in mental well-being during the second postoperative year in both adolescents and adults (15,22).

Reduction in depressive symptoms is generally seen after bariatric surgery in both adults (17) and adolescents (33), but results for changes in anxiety in adults are inconsistent (34,35). It has been suggested that anxiety is less weight dependent than depression in populations with obesity (14). In this study, we found that anxiety symptoms were significantly reduced in adolescents after 2 years, which to our knowledge has not been previously reported. While fewer than half of the patients had average anxiety symptoms at

baseline, 2 years after gastric bypass three out of four had average anxiety symptoms.

Overall, our data show that adolescents undergoing gastric bypass achieve a level of mental health and self-concept comparable to norms at 2 years after surgery. These findings emphasize the importance of using domain- and age-specific instruments to capture clinically meaningful changes in mental health in adolescents. Previously reported 2-year QoL results from AMOS suggested no significant improvements in role-emotional, mental health, or the mental health summary component as measured by the generic Short Form-36 Health Survey (4). In the present study, only one mental health variable (activation) did not improve from baseline to the 2-year follow-up.

As assessed on the OP, adolescents are significantly less disturbed by their weight and body shape in social situations at 2 years after gastric bypass, despite many adolescents expressing severe self-consciousness arising from excess skin (36). The OP is designed to measure the impact of overweight and body shape on psychosocial health and is highly sensitive to change in weight (31), i.e. the greater the weight loss, the greater the improvement in weight-related psychosocial functioning. In the present study, we found no significant correlation between %WL or BMI and improvements in OP, maybe explained by a substantial weight loss in most adolescents. Instead there were significant correlations between depressive symptoms, mood, and self-esteem at year 2 and improvements on the OP. Increasing mental well-being and global self-worth may be crucial for reducing social impairment due to concerns about weight and body shape in adolescents.

Several findings in the present study add evidence that adolescents seeking bariatric surgery are a vulnerable group. They appear as psychosocially even more burdened than adults undergoing obesity surgery. In this study, the highest mean value for overall mood (2.92) was reported at 1-year follow-up, which is similar to the baseline value (2.93) of 665 adult surgical cases (mean: 47.0 years) in the SOS-study (14). Thus, mood at its highest point after surgery in adolescents is similar to the average level in adults presenting for weight loss surgery. Norm data from general population do not suggest that this difference could be expected just based on age.

Similarly, in a substantial number of cases (13%), we found severe depressive symptoms at 2 years after surgery as assessed with BDI-II. In a recent study by Mitchell et al. only 0.2% of adults had BDI scores in the severe range 2 years after surgery (mean age at baseline: 46) (15). Our results are in line with a 2-year follow-up of 16 adolescents in which 14.3% had a BDI-II score ≥ 17 (22) compared to 19% in the present study. The high prevalence of severe depressive symptoms in this cohort must not be overlooked given the link between depressive disorders and suicide (37), the increased risk of suicide after bariatric surgery (38) and the two cases of attempted suicide in AMOS (4). The findings suggest that the needs for psychological and psychiatric treatment for depression are going unmet in adolescents undergoing bariatric surgery. Studies of adolescents demonstrating severe depressive symptoms after bariatric surgery are needed to detect this high-risk group even before surgery and to develop targeted interventions.

The main limitation of this study is the lack of a control group. Little is known about the natural development of mental health in adolescents

with severe obesity over time independent of weight loss. However, several of the instruments used allowed comparisons to age-matched population norms. The study relies on self-report questionnaires. More informants or diverse methods (e.g., clinical interview) would have yielded a more comprehensive picture of the psychosocial status of the adolescents. Also, BYI norms for the age span 9-18 were used to evaluate mental health, even though most subjects were over 18 years at the 2-year follow-up. Time trends according to the BYI-manual show an increase in symptoms and a reduced self-concept in the higher age range (23). Using aggregated norms for 9- to 18-year-olds may lead to under-estimation of mental health in those over 18. Strengths of the present study are the prospective longitudinal design, a high retention of participants in the study, and the use of both generic and obesity-specific questionnaires.

Conclusion

In summary, we found broad improvements in mental health, self-esteem, mood, and obesity-related problems in adolescents 2 years after treatment for severe obesity by gastric bypass. Symptoms of depression, anxiety, anger, disruptive behavior, and self-concept were at the same level as norms for adolescents, indicating a mental health in the normative range, 2 years after surgery. The improvements took place mainly during the first year after surgery, and the second year was characterized by stabilization. However, mood was still remarkably lower than that of age-matched norms, and 19% showed depressive symptoms at a clinical level 2 years after surgery. We strongly advocate repeated monitoring of adolescents after bariatric surgery to ensure that adolescents with mental health problems have access to the supports they need. **O**

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Paper III



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SURGERY FOR OBESITY
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Integrated health original article

Characteristics of adolescents with poor mental health after bariatric surgery

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Abstract

Background: About 20% of adolescents experience substantial mental health problems after bariatric surgery.

Objectives: The aim of this study was to explore differences between adolescents with poor mental health (PMH) 2 years after surgery and those with average/good mental health.

Setting: Three university hospitals in Sweden.

Methods: Mental health and health-related quality of life were assessed in 82 of 88 adolescents (mean age: 16.8 yr, 67% female) at baseline and 1 and 2 years after laparoscopic gastric bypass. Possible associations among mental health, weight, and biochemical outcomes were explored.

Results: Two years after surgery 16 (20%) adolescents were identified as having PMH. More symptoms of anxiety and depression and worse mental health at baseline significantly predicted PMH 2 years later. The decline in mental health for the PMH group happened mainly during the second year after surgery. Suicidal ideation was reported in 14% of the total sample 2 years postsurgery and was more frequent in the PMH group. Weight outcomes between groups were comparable at all time points, and physical health was equally improved 2 years after surgery.

Conclusions: Although adolescents with PMH after surgery lose as much weight and have similar improvements in physical health compared with other adolescents, special attention should be given to adolescents who report mental health problems at baseline and follow-up, especially during the second year after gastric bypass. The high prevalence of suicidal ideation in adolescents 2 years after bariatric surgery is another indication that longer follow-up is necessary. (Surg Obes Relat Dis 2016;12:882–892.)
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Keywords:

Bariatric surgery; Adolescents; Mental health; Depression; Anxiety; Health-related quality of life

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Bariatric surgery is to date the most effective method for obtaining substantial and long-lasting weight reduction in adult patients with morbid obesity [1,2]. Along with weight loss, most patients experience significant and lasting improvements in mental health and health-related quality of life (HRQoL) after surgery [3–5]. Recently, bariatric surgery procedures have been introduced as a treatment option for adolescents with morbid obesity [6,7].

It is well established that mental health is impaired in adults seeking bariatric surgery. Compared with the general population, these patients have a higher prevalence of past or present mood disorders, anxiety disorders, and eating disorders [8,9]. Adolescents presenting for bariatric surgery seem to experience similarly impaired mental health. The few studies published to date point to elevated levels of depression [10–13] and anxiety [13] and impaired HRQoL [10,12]. However, a recent study found that adolescents accepted for bariatric surgery reported less psychopathology than adolescents with severe obesity in lifestyle modification programs [14]. Being severely obese might, from a psychosocial perspective, be even more burdensome in adolescence and early adulthood than it is in later life [15,16].

Most patients undergoing bariatric surgery show large improvements in mental health. However, these broad improvements may mask the number of patients who are further impaired or not sufficiently improved. In a recent report from the Adolescent Morbid Obesity Surgery (AMOS) study, we found a substantial general improvement in mental health in adolescents 2 years after gastric bypass; however, we also found that a significant number, 19%, had depressive symptoms in the clinical range, and 13% reported severe depressive symptoms [17]. From a clinical perspective, deeper knowledge of the characteristics of patients with mental health problems postsurgery is needed to define possible targets for extra intervention. This seems especially important in light of the increased risk for suicide after bariatric surgery [18,19].

The aim of the present study was to compare adolescents who reported poor mental health (PMH) at 2-year follow-up to adolescents who reported average/good mental health (A/GMH) 2 years after surgery. We also sought to use explorative analyses to determine if differences were present between these groups at an earlier time point (baseline or at 1-year follow-up) and whether any differences at baseline were predictive of reported PMH 2 years after bariatric surgery. In addition, we assessed the prevalence of suicidal ideation in adolescents 2 years after surgery. Our final aim was to explore whether other important factors, such as weight loss, physical health, and mineral supplementation, as indicated by biochemical markers, differed between the groups at any time point.

Methods

Patients were 82 adolescents (67% female) from the AMOS study cohort who underwent laparoscopic Roux-en-

Y gastric bypass (LRYGB) between May 2006 and January 2010. During the selected period, 88 adolescents underwent surgery. All adolescents who had completed questionnaires measuring psychological variables at 2-year follow-up were included in the present study.

AMOS is a 10-year Swedish national study investigating the efficacy and safety of LRYGB in adolescents (aged 13–18 yr). Weight eligibility criteria were body mass index (BMI) ≥ 40 kg/m² or BMI ≥ 35 kg/m² plus an obesity-related co-morbidity. At least 1 year of obesity treatment at a pediatric clinic was mandatory. Inclusion and exclusion criteria are presented in detail elsewhere [20]. Exclusion criteria were few, but included ongoing drug abuse or a psychotic disease.

Mean age at surgery was 16.8 years (± 1.19) and mean BMI was 45.4 kg/m² (± 6.05 ; range 35.1–68.5). Participants were recruited from the 3 largest childhood obesity units in Sweden: Stockholm, Gothenburg, and Malmö. Baseline and follow-up assessments took place at the respective units. All questionnaires, anthropometrics, and blood samples were collected at baseline and 1 and 2 years after surgery, except the Beck Depression Inventory (BDI-II), which was administered at follow-up only. Study coordinators administered most questionnaires, but Beck Youth Inventories (BYI) and BDI-II were administered by clinical psychologists, and were only collected when a psychologist was available. All adolescents underwent surgery at Sahlgrenska University Hospital, Gothenburg. The study was approved by the regional ethical committee in Gothenburg. Informed consent was collected from adolescents and parents. AMOS is registered at ClinicalTrials.gov (NCT00289705).

BYI

The BYI consist of 5 inventories assessing anxiety, depression, anger, disruptive behavior, and self-concept in children and adolescents aged 7 to 18 years [21]. Each inventory consists of 20 questions, with scores ranging from 0 to 60. Higher scores indicate more impairment in the anxiety, depression, anger, and disruptive behavior inventories, and a higher self-concept in the self-concept inventory.

BDI-II

The BDI-II assesses depressive symptoms in adolescents ≥ 13 years old and adults [22]. Scores range from 0 to 63, with higher scores indicating more depressive symptoms. In a clinical setting, scores are categorized as indicating minimal (≥ 13), mild (14–19), moderate (20–28), and severe (29–63) depression. In research, a BDI-II score ≥ 17 is suggested as a conservative cut-off for depressive symptoms in the clinical range, as 93% of those who score above this cut-off are found to have true clinical depression [22]. Several studies of adolescents undergoing bariatric surgery have also used a cut-off of ≥ 17 to report

the number of cases with depressive symptoms in the clinical range [10–12,23,24]. BDI-II has one item that explicitly asks about suicidal ideation.

Rosenberg Self-esteem (RSE)

The RSE is one of the most widely used questionnaires to assess self-esteem. It consists of 10 items and measures global self-worth [25]. Total scores range from 0 to 30, and a higher score indicates better self-esteem.

Mood Adjective Check List (MACL)

The MACL is a 38-item questionnaire that assesses 3 basic dimensions of mood: pleasantness/unpleasantness (e.g., satisfaction/resignation), activation/deactivation (e.g., activity/passivity), and calmness/tension (e.g., relaxation/tension) [3]. Scores range from 1 to 4, and a higher score reflects a better mood. The 3 dimensions can be collapsed to an overall mood score, which is a good indicator of general well-being.

Obesity-related Problems Scale (OP)

The OP is an obesity-specific questionnaire that assesses the impact of obesity and body shape on everyday life. The OP consists of 14 items, and respondents are asked to rate how disturbed they are by their weight or body shape in social situations, such as eating out, shopping for clothes, and being intimate. Scores range from 0 to 100, and higher scores reflect more impairment. The OP has cut-offs for categorizing impairment: <40 indicates mild impairment, 40 to 59 moderate impairment, and ≥ 60 severe impairment. In the validation of OP, it was found that an OP score of ≥ 60 was highly related to symptoms of depression and anxiety and poor overall mood [26]. OP is a valid questionnaire for assessing the impact of obesity and is responsive to changes in weight status [26].

Internal consistency reliability estimates were calculated for the total sample for all mental health variables at all assessment points. The reliability was either good or excellent (Cronbach $\alpha = .83$ – 0.96).

Short Form-36 version 2 (SF-36)

The SF-36 is a generic HRQoL questionnaire that is widely used in different medical settings and often used to evaluate treatment outcomes [27]. The SF-36 consists of 8 scales. Four scales are predominantly in the physical domain (physical functioning, role physical, bodily pain, and general health) and 4 are in the mental domain (vitality, social functioning, role emotional, and mental health). Scale scores range from 0 to 100, and higher scores indicate better health. Two summary measures, the physical and mental component summary scores, are calculated using norm-based scoring, with a mean of 50. Higher values represent better health.

Anthropometrics and blood samples

Weight was measured to the nearest .1 kg on an electronic scale with patients wearing light clothing. Height was measured without shoes to the nearest .1 cm with a stadiometer. BMI was calculated as kg/m^2 , percent excess BMI loss as $(\text{preoperative BMI} - \text{postoperative BMI} / \text{preoperative BMI} - 25) \times 100$ and percent total weight loss as $(\text{preoperative weight} - \text{postoperative weight} / \text{preoperative weight}) \times 100$. Blood samples were taken after overnight fasting.

Classification of adolescents with PMH 2 years after surgery

PMH was defined as a BDI-II score ≥ 17 and/or an OP score ≥ 60 at 2-year follow-up. Two different instruments were used, since not all questionnaires were collected for all adolescents. BDI-II and OP were chosen because they have validated cut-offs for clinical impairment [22,26] and a score above the cut-off on either or both instruments indicates a possible need for intervention.

Statistical analysis

Descriptive values are presented as mean with 95% CI or SD. Association between age and PMH was evaluated with t-test. Associations between dichotomous variables (sex, suicidal ideation, utilization of mental health service) and PMH were evaluated with Fisher's exact test. Univariate logistic regression models were used to evaluate associations between PMH at year 2 and baseline values of all mental health and HRQoL variables. The results are presented as standardized odds-ratios (SOR) with 95% CI, expressed per 1 SD unit of respective predictor variable. Multilevel mixed-effect regression models were used to analyze differences in means between groups at each assessment point. The models take into account the repeated measurements nested within individuals. Furthermore, interactions between changes from baseline to 1-year follow-up and mental health status at year 2 were analyzed using mixed-effect regression. Variables with nonnormal distribution (see Tables 1–3 and BDI-II) were transformed with zero-skewness log-transformation before testing for significance. Observed values were used to calculate effect sizes (ES). ES were evaluated according to standard criteria: ES < .2 is considered trivial, .2 to < .5 small, .5 to < .8 moderate, and $\geq .8$ large. Statistical analyses were carried out with Stata statistical package version 12.1 (StataCorp LP, College Station, TX) and SPSS version 22.0 (IBM, Armonk, NY).

Results

At 2-year follow-up, 16 adolescents (20%) had a score above the cut-off on BDI-II, OP, or both and were classified as having PMH. Six adolescents had both a BDI-II score ≥ 17 and OP ≥ 60 , 2 had BDI-II ≥ 17 with OP data

Table 1
Mental health variables at baseline, 1 year, and 2 year follow-up stratified by average/good mental health and poor mental health at year 2

Mental Health Variable	Average/good mental health at year 2	(N = 66)	Poor mental health at year 2	(N = 16)	<i>P</i>	Effect size
Anxiety (BYI)						
Baseline	13.9 (11.6–16.1)	47	21.6 (16.8–26.4)	10	0.008*	0.84
1 yr	9.9 (7.5–12.2)	40	19.8 (15.1–24.5)	10	< 0.001*	1.00
2 yr	8.4 (6.3–10.5)	50	26.6 (22.6–30.7)	13	< 0.001*	2.82
Depression (BYI)						
Baseline	14.6 (11.9–17.2)	47	21.6 (15.9–27.4)	10	0.030*	0.62
1 yr	9.5 (6.8–12.1)	40	18.6 (13.3–23.9)	10	0.001*	0.88
2 yr	8.2 (5.9–10.4)	50	28.1 (23.7–32.5)	13	< 0.001*	2.83
Anger (BYI)						
Baseline	11.8 (9.4–14.2)	47	15.5 (10.4–20.6)	10	0.138*	
1 yr	10.0 (7.5–12.5)	40	17.9 (12.9–22.8)	10	0.006*	0.68
2 yr	6.3 (4.1–8.6)	49	24.8 (20.5–29.1)	13	< 0.001*	2.78
Disruptive Behaviour (BYI)						
Baseline	5.9 (4.4–7.4)	47	6.0 (2.9–9.1)	10	0.926*	
1 yr	5.2 (3.7–6.7)	40	7.1 (4.1–10.2)	10	0.277*	
2 yr	3.7 (2.3–5.1)	50	10.6 (7.9–13.3)	13	< 0.001*	1.47
Self-Concept (BYI)						
Baseline	35.8 (33.1–38.6)	47	33.7 (27.9–39.5)	10	0.522	
1 yr	42.4 (39.5–45.4)	40	39.3 (33.4–45.1)	10	0.345	
2 yr	43.9 (41.2–46.6)	50	29.4 (24.1–34.7)	13	< 0.001	1.47
Pleasantness (MACL)						
Baseline	2.92 (2.79–3.05)	63	2.73 (2.47–2.99)	16	0.193	
1 yr	3.18 (3.07–3.30)	64	2.85 (2.62–3.09)	16	0.014	0.70
2 yr	3.21 (3.09–3.33)	60	2.43 (2.18–2.68)	14	< 0.001	1.53
Activation (MACL)						
Baseline	2.64 (2.51–2.76)	62	2.48 (2.24–2.73)	16	0.282	
1 yr	2.88 (2.76–3.01)	64	2.76 (2.51–3.02)	16	0.404	
2 yr	2.85 (2.72–2.99)	60	2.20 (1.93–2.47)	15	< 0.001	1.21
Calmness (MACL)						
Baseline	2.68 (2.55–2.80)	63	2.38 (2.12–2.63)	16	0.041	0.56
1 yr	2.97 (2.85–3.08)	64	2.58 (2.34–2.82)	16	0.004	0.84
2 yr	2.95 (2.83–3.07)	60	2.11 (1.87–2.35)	15	< 0.001	1.65
Overall Mood (MACL)						
Baseline	2.74 (2.63–2.85)	63	2.53 (2.31–2.75)	16	0.089	
1 yr	3.01 (2.91–3.12)	64	2.73 (2.52–2.94)	16	0.021	0.66
2 yr	3.01 (2.90–3.12)	60	2.23 (2.01–2.45)	15	< 0.001	1.68
Rosenberg Self-Esteem						
Baseline	18.7 (17.0–20.4)	63	20.8 (17.4–24.2)	16	0.213*	
1 yr	23.8 (22.4–25.2)	65	20.7 (17.8–23.6)	16	0.019*	0.54
2 yr	24.8 (23.4–26.2)	60	14.5 (11.8–17.3)	15	< 0.001*	2.01

BYI = Beck Youth Inventories; MACL = Mood Adjective Check List;

Data are shown as mixed-models mean (95% CI). Significant *P* values in bold. Effect size criteria: $< .2$ = trivial; $.2$ to $< .5$ = small; $.5$ to $< .8$ = moderate; and $\geq .8$ = large.

*Due to nonnormal distribution transformed variables were used for significance testing. Variables were transformed with zero-skewness log-transformation.

missing, 3 had OP ≥ 60 with BDI-II data missing, 4 met the BDI-II criteria but had an OP < 60 , and 1 adolescent had an OP-score ≥ 60 but a BDI-II score < 17 .

The PMH group consisted of 14 girls (25% of the girls in the total sample) and 2 boys (7% of the boys). Inequality in gender distribution between groups did not reach significance ($P = .075$). No significant age difference was found ($t = 1.043$, $df = 80$, $p = .30$). Information on whether patients received mental health services before surgery was available for a subsample of 39 adolescents (8 with PMH and 31 with

A/GMH). There was no difference in preoperative mental health treatment between the groups ($P = 0.451$).

The mean BDI-II score at year 2 for the PMH-group was 32.7 (95% CI, 28.7–36.7) and 4.7 (95% CI, 2.6–6.8) for the A/GMH group. The mean OP score at year 2 was 61.5 (95% CI, 51.5–71.5) for the PMH group and 24.5 (95% CI, 19.7–29.3) for the A/GMH group. Both BDI-II and OP differed significantly between the groups at year 2 ($P < 0.001$). OP was also assessed at baseline, and there was no significant difference between groups at baseline ($P = 0.951$, see also Fig. S1).

Table 2

Health-related quality of life (SF-36) variables at baseline, 1 year, and 2 year follow-up stratified by average/good mental health and poor mental health at year 2

SF-36 Variables	Average/good mental health at year 2 (N = 66)	Poor mental health at year 2 (N = 16)	P	Effect size
Physical Functioning				
Baseline	72.4 (67.5–77.4)	64.4 (54.5–74.2)	0.622*	
1 yr	90.6 (86.7–94.5)	84.7 (76.8–92.6)	0.252*	
2 yr	87.7 (70.4–89.7)	80.0 (70.4–89.7)	0.178*	
Role Physical				
Baseline	74.6 (68.6–80.6)	70.3 (58.5–82.1)	0.550*	
1 yr	90.1 (85.0–95.2)	81.6 (71.3–92.0)	0.109*	
2 yr	88.3 (83.4–93.3)	66.7 (56.6–76.7)	0.010*	1.07
Bodily Pain				
Baseline	68.3 (62.0–74.6)	62.8 (50.2–75.3)	0.495*	
1 yr	81.2 (75.8–86.7)	68.4 (57.4–79.4)	0.028*	0.60
2 yr	83.7 (78.3–89.0)	61.6 (50.7–72.6)	0.001*	1.01
General Health				
Baseline	54.0 (48.8–59.2)	48.2 (37.9–58.5)	0.497*	
1 yr	77.4 (72.7–82.0)	61.0 (51.6–70.4)	0.002*	0.98
2 yr	74.0 (69.4–78.6)	51.5 (42.0–60.9)	<0.001*	1.15
Vitality				
Baseline	49.2 (44.6–53.9)	44.9 (35.6–54.2)	0.416	
1 yr	61.4 (57.0–65.9)	54.7 (45.7–63.7)	0.189	
2 yr	60.6 (55.6–65.7)	42.2 (31.9–52.6)	0.002	0.91
Social Functioning				
Baseline	81.3 (75.8–86.7)	60.9 (50.1–71.8)	0.058*	
1 yr	92.1 (87.8–96.4)	71.1 (62.5–79.7)	0.115*	
2 yr	90.5 (85.6–95.3)	56.4 (46.4–66.3)	0.030*	1.63
Role Emotional				
Baseline	78.5 (71.6–85.4)	62.5 (49.0–76.0)	0.270*	
1 yr	87.2 (81.6–92.8)	69.3 (58.0–80.5)	0.003*	0.91
2 yr	86.4 (80.7–92.1)	41.9 (30.2–53.5)	<0.001*	1.83
Mental Health				
Baseline	67.9 (62.9–72.9)	55.3 (45.3–65.3)	0.027	0.63
1 yr	77.2 (73.2–81.2)	60.3 (52.2–68.4)	<0.001	1.04
2 yr	76.2 (71.7–80.7)	45.2 (36.0–54.4)	<0.001	1.62
Physical Component				
Baseline	43.7 (41.5–45.9)	42.4 (38.1–46.6)	0.583	
1 yr	52.4 (50.6–54.2)	49.9 (46.3–53.5)	0.225	
2 yr	51.8 (49.8–53.9)	48.7 (44.7–52.8)	0.183	
Mental Component				
Baseline	46.1 (43.2–49.0)	38.1 (32.4–43.8)	0.085*	
1 yr	49.3 (46.9–51.6)	39.6 (34.9–44.3)	0.001*	1.04
2 yr	48.9 (46.3–51.6)	28.6 (23.3–33.9)	<0.001*	1.88

SF-36 = Short Form-36.

Data are shown as mixed-models mean (95% CI). Significant *P* values in bold. Effect size criteria: $<.2$ = trivial; $.2$ to $<.5$ = small; $.5$ to $<.8$ = moderate; $\geq .8$ = large.

*Due to nonnormal distribution, transformed variables were used for significance testing. Variables were transformed with zero-skewness log-transformation.

Mental health and HRQoL

In logistic regression analyses, BYI anxiety (SOR = 2.56; 95% CI, 1.20–5.49; $P = .015$; Fig. S2), BYI depression (SOR = 2.03; 95% CI, 1.04–3.94; $P = .037$; Fig. S3), and SF-36 mental health (SOR = .55; 95% CI, .32–0.95; $P = .032$) at baseline significantly predicted PMH at 2-year follow-up. No other variable at baseline predicted PMH at 2-year follow-up with significance. ES indicated a large difference in anxiety between the groups at baseline

and a moderate difference for depression and mental health (Tables 1 and 2).

Comparisons between adolescents with PMH and A/GMH are presented in Table 1 for mental health variables and in Table 2 for HRQoL variables for all assessment points. At 1-year follow-up, significant differences between groups were seen on 8 of 11 mental health variables, but self-concept, disruptive behavior, and activation did not differ significantly. At 2-year follow-up, the group with PMH scored significantly worse on all mental health

Table 3
Weight and biochemical markers at baseline, 1-year, and 2-year follow-up stratified by average/good mental health and poor mental health at year 2

Variables	Average/good mental health at year 2	(N = 66)	Poor mental health at year 2	(N = 16)	P
BMI (kg/m²)					
Baseline	45.3 (44.0–46.7)	66	46.0 (43.2–48.8)	16	0.662
1 yr	30.4 (29.3–31.5)	66	31.4 (29.1–33.6)	16	0.463
2 yr	29.6 (28.4–30.7)	66	31.1 (28.8–33.5)	16	0.228
%WL					
1 yr	31.4 (30.0–32.7)	66	31.7 (28.9–34.4)	16	0.835
2 yr	33.3 (30.9–35.7)	66	31.8 (27.0–36.7)	16	0.593
Excess BMI loss					
1 yr	75.2 (71.9–78.6)	66	73.1 (66.3–80.0)	16	0.588
2 yr	78.8 (73.2–84.4)	66	72.3 (60.9–83.7)	16	0.313
ALT (μkat/L)					
Baseline	0.66 (0.58–0.75)	61	0.52 (0.34–0.69)	16	0.144
1 yr	0.36 (0.30–0.41)	62	0.35 (0.24–0.46)	16	0.937
2 yr	0.34 (0.30–0.38)	62	0.36 (0.28–0.45)	15	0.593
p-insulin (μU/L)					
Baseline	32.6 (28.9–36.4)	62	25.3 (17.6–33.0)	14	0.095
1 yr	7.5 (5.4–9.6)	62	5.9 (1.6–10.2)	15	0.520
2 yr	7.7 (6.2–9.3)	62	7.0 (3.8–10.2)	15	0.691
TG (mmol/L)					
Baseline	1.3 (1.2–1.4)	61	1.3 (1.0–1.5)	16	0.926
1 yr	0.9 (0.8–1.0)	62	0.9 (0.7–1.1)	15	0.559
2 yr	0.8 (0.7–0.9)	62	0.9 (0.7–1.0)	15	0.300
HDL (mmol/L)					
Baseline	1.09 (1.03–1.16)	62	1.10 (0.97–1.23)	16	0.931
1 yr	1.37 (1.29–1.45)	62	1.42 (1.26–1.57)	15	0.624
2 yr	1.48 (1.39–1.57)	62	1.52 (1.33–1.70)	15	0.725
CRP (mg/L)					
Baseline	6.9 (5.4–8.4)	58	9.5 (6.5–12.5)	14	0.428*
1 yr	2.3 (0.6–3.9)	54	3.2 (0.1–6.4)	15	0.033 *
2 yr	2.9 (0.5–5.3)	57	2.7 (0–7.6)	14	0.316*
FE (μmol/L)					
Baseline	13.1 (11.6–14.6)	58	13.1 (10.3–16.0)	16	0.996
1 yr	16.2 (14.5–18.0)	55	15.5 (12.1–18.9)	15	0.705
2 yr	17.4 (15.3–19.6)	52	18.8 (14.6–23.0)	13	0.584
Ferritin (μg/L)					
Baseline	59.3 (48.6–69.9)	51	55.6 (34.0–77.2)	12	0.383*
1 yr	45.5 (34.4–56.5)	61	90.5 (68.4–112.7)	15	0.006 *
2 yr	39.5 (25.7–53.2)	61	68.9 (41.2–96.6)	15	0.023 *
HB (g/L)					
Baseline	140 (136–143)	59	136 (130–142)	16	0.301
1 yr	137 (133–140)	62	129 (122–135)	16	0.032
2 yr	134 (130–137)	62	129 (122–136)	15	0.277

BMI = body mass index; %WL = percent weight loss; ALT = alanine transferase; TG = triglycerides; HDL = high-density lipoprotein; CRP = C-reactive protein; FE = iron; HB = hemoglobin.

Data are shown as mixed-models mean (95% CI). Significant *P* values in bold.

*Due to nonnormal distribution, transformed variables were used for significance testing. Variables were transformed with zero-skewness log-transformation.

measures, and ES indicated large differences between groups.

One year after surgery, adolescents classified as having PMH at year 2 reported significantly lower scores on the SF-36 mental health scale, the role emotional scale, and the mental component summary score (Table 2). At 2-year follow-up, all SF-36 mental health scale scores were significantly lower in the PMH group, and differences were large according to ES.

No baseline differences were seen in the SF-36 physical health domains, but at 1-year follow-up, adolescents with PMH reported more pain and worse general health (Table 2). These differences were still present at year 2, and then the PMH group also reported significantly lower scores on role physical. Physical functioning and the physical component summary score (Fig. S4) did not differ between groups at any assessment point.

Between-group differences in developmental trends were tested from baseline to 1-year follow-up to explore whether the groups already had significantly different developmental paths during the first year after surgery. Only 2 of the mental health and HRQoL variables, RSE ($P < .001$) and general health ($P = .041$), had significantly different trends over the first year after surgery.

Suicidal ideation

Two years after surgery, 9 (14%) of the 63 adolescents who completed the BDI-II reported suicidal ideation. Six (3 from the PMH group and 3 from the A/GMH group) expressed passive suicidal thoughts, admitting, "I have thoughts of killing myself, but I would not carry them out." Two of the 3 adolescents in the A/GMH group who reported passive suicidal ideation were borderline cases, according to the BDI-II cut-off (BDI-II scores: 16 and 14). The third adolescent had a BDI-II score of 10. Three adolescents, all from the PMH group, admitted, "I would kill myself if I had a chance," indicating active suicidal ideation. Suicidal ideation was significantly more common among adolescents with PMH ($P = .001$).

Outcomes in weight and biochemical markers

There were no significant differences in weight outcomes (BMI, percent total weight loss, and percent excess BMI loss) between adolescents with PMH and A/GMH at baseline or at either follow-up (Table 3; see also Fig. S5).

No significant between-group differences were found in biochemical markers at baseline (Table 3). At the 1-year follow-up, the PMH group had significantly higher C-reactive protein (CRP) and ferritin levels and significantly lower hemoglobin. Two years after surgery the PMH group still had higher ferritin, but no other significant differences in biochemical markers were found.

Discussion

A subgroup of 16 adolescents (20%) was identified as having PMH (depression and/or severe obesity-related impairment) 2 years after undergoing LRYGB. Increased anxiety and depression at baseline as well as lower values on the SF-36 mental health scale significantly predicted PMH 2 years after surgery. Previous studies in adults have reported an association between baseline psychiatric symptoms and mental health outcomes after bariatric surgery [28,29]. Our findings indicate that extra attention after surgery should be offered to adolescents with mental health problems at baseline. The largest baseline difference between groups was seen in anxiety. Previous studies in adult bariatric samples suggest that anxiety is not as weight-dependent as depression [3,30]. However, it is notable that most mental health variables at baseline could not predict PMH after surgery, and there was no difference in

utilization of mental health services before surgery between groups. Postsurgery mental health problems also occurred in individuals without apparent major mental health problems before surgery, so psychological monitoring is important in all adolescents after bariatric surgery.

Substantial and significant differences were already present between the groups at 1-year follow-up. However, for most mental and physical health variables, both groups experienced improvements during the first year, which may make it difficult to motivate adolescents to accept mental health interventions at this point. The decline in mental health in the PMH group occurred mainly during the second year. Studies in adults and adolescents report improvements in mental health and HRQoL during the first year after surgery, with subsequent leveling off or even decline [3,5,23,24,31–34]. Therefore, psychological follow-up seems equally or more important during the second year, when the intense weight-loss phase is over and mental ill-health may re-emerge.

Two years after surgery, 14% of patients reported passive or active suicidal ideation. Few studies have reported the frequency of suicidal ideation postsurgery, but in a study of 107 adults assessed with BDI, 2.8% reported passive suicidal ideation and none reported active suicidal ideation 1 year after surgery [35]. Suicidal ideation is quite common among adolescents in general [36], and obese adolescents are at even greater risk [37]. Suicidal ideation is a core symptom of depression [38], so as expected, suicidal ideation was significantly more frequent among adolescents with PMH. However, passive suicidal ideation also was reported by 3 adolescents classified as having A/GMH with BDI-II scores below, but in 2 cases close to, the cut-off for depression in the clinical range. This indicates the importance of assessing suicidal ideation in all adolescents, not only those who report clinical depressive symptoms. A general screening for suicidal ideation postsurgery was suggested by McPhee et al. [39]. They compared adolescents with suicidal ideation or behavior to adolescents reporting no suicidal ideation and found that a significant proportion with suicidal ideation or behavior postsurgery had no indication presurgery and showed no proximal risk factors.

Substantial mental health problems after surgery were not associated with less successful weight reduction over the first 2 postsurgical years in our study. These findings contradict previous results in adults that suggest an association between postsurgery depressive symptoms and poorer weight outcomes [40]. There were some significant differences in biochemical markers between the groups after surgery, and studies have suggested a link between inflammatory markers such as CRP and depression [41]. In the present study, the PMH group had significantly higher CRP and ferritin, both possible markers of inflammation, and lower hemoglobin at 1-year follow-up, but only ferritin remained higher at 2

years. Other studies have also found an association between CRP and depression and anxiety in bariatric samples [42,43]. The role inflammation plays in mental health problems post-bariatric surgery is not clear, and future studies with larger samples are necessary. In terms of biochemical markers for cardiovascular risks, adolescents reporting PMH seem to experience improvements similar to the A/GMH group. As indicated by blood levels, adolescents with PMH also appear to be as adherent to mineral supplementation after surgery as adolescents with A/GMH. However, long-term follow-up is needed to assess whether differences in mental health generate poorer outcomes in weight and physical health over time.

This study has several limitations. Self-report questionnaires were used to assess mental health; using clinical interviews may have provided more reliable data. Two different variables were used to define PMH, with a possible risk of making this group less homogenous. The sample was divided in two groups around cut-offs and cases close to a cut-off might be regarded as ambiguous. However, the PMH group had substantially worse scores on all mental health measures 2 years after surgery, suggesting that the groupings were reliable. BDI-II was not collected at baseline, which is another limitation. The explorative analyses used to study differences between groups have an inherent risk of mass significance due to multiple comparisons. However, there was consistency in the results in that similar variables showed a similar pattern over time, making it less plausible that significant differences occurred by chance. Nevertheless, the limited total sample size, and thus small PMH group, may have prevented the detection of existing differences between the groups. The small sample size also ruled out more complex prediction models that could take into account more than one variable at a time. Therefore, our results must be regarded as tentative until studies with larger sample sizes can be conducted. Strengths of the present study are its relatively good retention rate (only 7% totally lost to follow-up) and the use of a variety of both generic and obesity-specific questionnaires to capture various aspects of mental health.

Conclusions

More symptoms of anxiety and depression and reduced mental health before surgery were predictive of PMH in adolescents 2 years after undergoing LRYGB. Our findings indicate that extra attention should be offered to adolescents with existing mental health problems at baseline; however, all adolescents need psychological follow-up after LRYGB. The decline in mental health for adolescents with PMH mainly occurred during the second year after surgery; therefore, psychological monitoring and interventions seem especially important after the first postsurgical year.

The frequency of suicidal ideation at year 2 is another indication that prolonged follow-up is necessary. However, adolescents with more mental health problems 2 years after surgery lose as much weight as other adolescents, and their physical health is equally improved. This suggests that adolescents at risk for PMH after surgery should probably not be denied surgery, but rather offered bariatric surgery in combination with extended psychological care before and after surgery.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.soard.2016.02.001>.

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Mental health in adolescents undergoing bariatric surgery

Bariatric surgery is now tried out as a treatment option for adolescents with severe obesity where other treatment options have not been successful enough. The teenage years are characterized by intense psychosocial development and it is important to know how mental health is affected by undergoing weight loss surgery while an adolescent. In this thesis, mental health is studied in 88 adolescents aged 13–18, before and four months, one year, and two years after undergoing gastric bypass.

For a majority of adolescents, mental health is improved both four months and two years after undergoing gastric bypass. Improvements in mental health take place during the first year after surgery, and the second year is characterized by stabilization. However, not all adolescents have a positive mental health outcome. Four months after surgery, 16% of the adolescents report impaired mental health compared to baseline, and two years after surgery one out of five adolescents reports depressive symptoms in the clinical range. The studies indicate that, from a psychological perspective, adolescents with severe obesity undergoing bariatric surgery are a vulnerable group, also in comparison to adults undergoing bariatric surgery. This thesis shows that it is necessary to offer psychological monitoring and interventions to adolescents undergoing bariatric surgery, and that follow-up after the first postoperative year is important.

The studies are part of the Swedish national Adolescents Morbid Obesity Surgery (AMOS) study.

