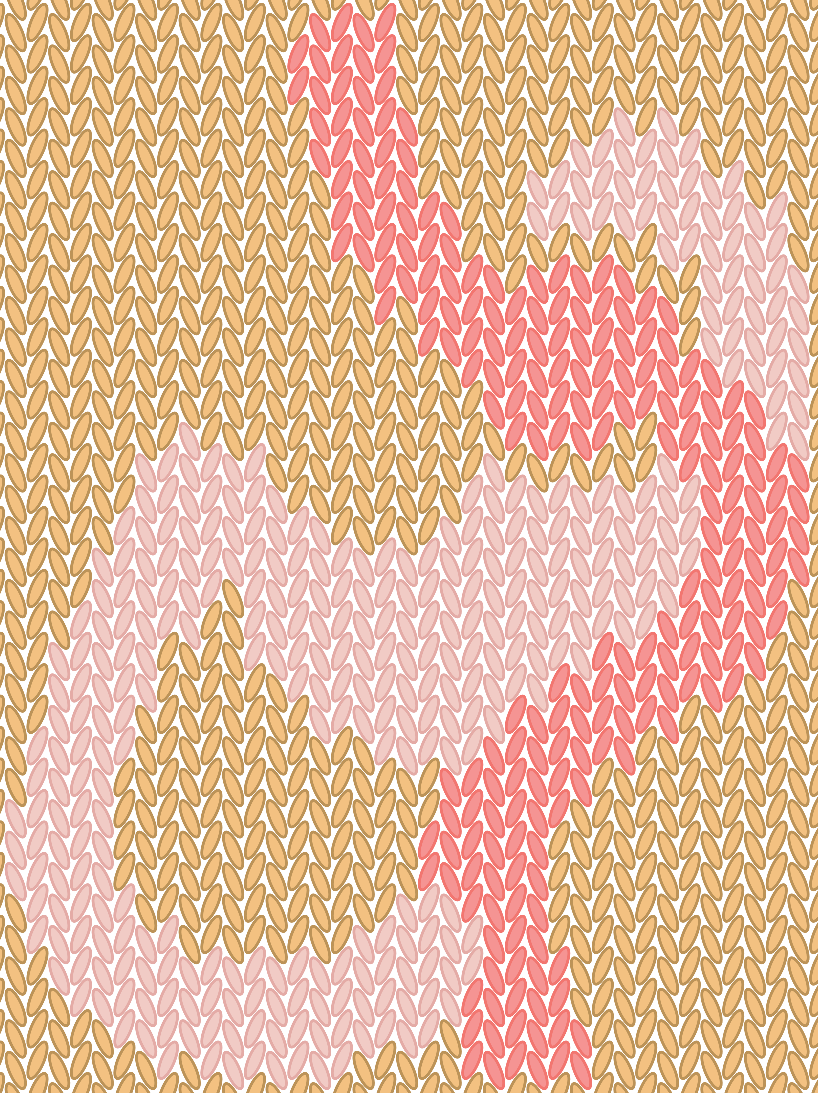

PERSON FACTORS IN BARIATRIC SURGERY

Moving beyond weight loss

Dennis J. S. Makarawung

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Dennis Jeroen Sebastiaan Makarawung

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Moving beyond weight loss

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PROMOTOREN

Prof. dr. A.B. Mink van der Molen
Prof. dr. R. Geenen

COPROMOTOR

Dr. V.M. Monpellier

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CHAPTER 1

GENERAL INTRODUCTION

THE GLOBAL CHALLENGE OF OBESITY

Today, one of the greatest global challenges in public health is obesity. Obesity is a chronic disease described by the World Health Organization (WHO) as an accumulation of excessive fat which may impair health due to systemic inflammation. Individuals with obesity have a body-mass index (BMI) of 30 kilograms (kg) / height in meters squared (m^2) or greater [1]. Globally, more people are obese than underweight; this is true for every region except parts of sub-Saharan Africa and Asia [1].

Obesity reached pandemic proportions and results in the estimated annual death of 2.8 million people, making it the 5th leading risk factor for global deaths [1,2]. In perspective, obesity and overweight accounted roughly for 5% of the 55.4 million deaths worldwide in 2019. Since 1975, prevalence is increasing in all age groups with a dramatic tenfold increase in both childhood and adolescent obesity [3]. Currently, there are more than 1 billion people in the world with obesity and their numbers are still rising; 650 million adults, 340 million adolescents and 39 million children are living with obesity [1]. It is estimated that by 2025, approximately 167 million people, including children, will experience a decrease in health status due to overweight or obesity [4]. In 2016 global estimates revealed 39% of adults were overweight and 13% were obese [1].

Obesity poses a major risk factor for several conditions such as hypertension, type 2 diabetes, cardiovascular disease, osteoarthritis, obstructive sleep apnea and several types of cancer [5,6]. Depending on the severity of these obesity associated medical problems, obesity is associated with a decline in life expectancy between 5 and 20 years [7–9]. The etiology of obesity is multifactorial; it is based on genetic, biological, behavioral, environmental, socioeconomic, and cultural factors that result in an imbalance between energy intake and expenditure which promotes excessive fat deposition [10,11].

In addition to medical complications, obesity is related to psychopathology, can impair health-related quality of life (HRQL), and have socioeconomic disadvantages [12–14]. Furthermore, individuals who have obesity may experience issues with their mood, self-esteem and body image [15]. Emotional distress and negative body image are some of the reasons individuals with obesity seek weight reducing treatment [16–18].

BARIATRIC SURGERY AS A TREATMENT FOR OBESITY

Various treatments for obesity are available including lifestyle modifications, pharmacotherapy and surgery [19]. The basis of obesity treatment consists of lifestyle modifications, such as a healthy diet, physical activity and psychological management. Pharmacotherapy can be applied as an adjunct to lifestyle modifications in individuals with a BMI ≥ 30 kg/m^2 or BMI ≥ 27 kg/m^2 and the presence of an adiposity related medical problem [20].

Bariatric metabolic surgery (BS) refers to a category of procedures intended to help people with obesity and assist in achieving long-term weight loss. BS should be considered in patients over 18 years of age with a BMI ≥ 40 kg/m2 or ≥ 35 kg/m^2 and the presence of an obesity associated medical problem, as well as a history of identifiable weight interventions [21,22].

The benefits patients experience do not only result directly from weight loss itself, but also from improvements in glycemic control, hypertension, lipid metabolism, sleep apnea, osteoarthritis, gastro-esophageal reflux disease and cardiovascular morbidity [23–27]. BS significantly reduces overall mortality and seems to reduce the incidence of some forms of cancer and cancer-related mortality [28–31]. In comparison to non-surgical weight loss interventions, BS is the most effective treatment regarding long-term weight loss, improvements in obesity associated medical problems, and increased HRQL [12,23,32–34].

Over the last 10 years, an increasing prevalence is reported in bariatric procedures [35,36]. According to the 6th IFSO Global Registry Report in 2021, generated with data from 50 contributing countries that performed 507,298 procedures, the most frequently performed procedures worldwide between 2016 and 2019 were the sleeve gastrectomy (SG) (50.2%) and the Roux-en-Y gastric bypass (RYGB) (36.9%) [37].

Although the exact mechanisms are not fully understood, the anatomical modifications made during BS procedures induce weight loss through changes in the biology of the gut [38,39]. These changes include alterations in gastrointestinal hormones and peptides, bile acid levels and microbiota. Altered signaling in pathways from the gut to the brain is considered a key mediator and facilitates reduced energy intake. Also, the increase in gut microbiota is thought to affect adiposity by regulating lipid metabolism and reducing energy intake through gut peptides [38,39].

Both RYGB and SG promote massive weight loss with a reduction of 31.9% and 29.5% of baseline body weight after one year, respectively [40]. Five years after surgery, mean percentage total weight loss (%TWL) for RYGB was 28.1% and for SG 27.0%.

HEALTH-RELATED QUALITY OF LIFE IN BARIATRIC SURGERY

The World Health Organization defines quality of life (QOL) as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns". The term HRQL is a multidimensional construct that encompasses aspects affected by health, which includes physical and mental health perceptions and their correlates (health risks and conditions, functional status, socioeconomic status and social support) [41,42].

People living with obesity experience on average lower HRQL in comparison to people without obesity and consequently, HRQL is considered a key outcome of BS [12,43]. After BS, most studies reported general improvements in HRQL [12,44–47]. Effect sizes associated with these improvements are significantly greater for physical than for mental HRQL [48–50]. While a peak improvement in physical HRQL is demonstrated one to two years after surgery, followed by a gradual decline, mental HRQL has shown a less consistent pattern [46,47,51,52].

Studies report significant variability in HRQL and some even low HRQL scores after BS [12,53,54].

PATIENT-REPORTED OUTCOME MEASURES

HRQL is assessed via patient-report outcomes (PROs). A PRO is an outcome reported by the patient and enables an interpretation unbiased by a clinician or anyone else. These outcomes are measured by patient-reported outcome measures (PROMs): standardized, validated instruments (most often questionnaires) that assess the patients' perception of their own health [55,56].

PROMs can be grouped into two categories: generic measures to assess broad aspects of HRQL and disease-specific measures to assess HRQL specific to a medical condition [57,58].

In the assessment of HRQL, different purposes may warrant different PROMs [59,60]. For example, generic HRQL measures such as the RAND-36 (also known as SF-36) are useful in assessing individuals both with and without a health condition [61]. These data allow researchers and clinicians to compare different groups, for instance, with population norms. Disease-specific measures of HRQL are developed to evaluate the effect of a condition or treatment and often provide additional, complementary information about a patient's HRQL. [61].

If health measurement instruments are not reliable and valid enough, they could result in imprecise and biased outcomes, which in turn, may lead to inaccurate conclusions [62]. The same applies to PROMs. The COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) is a guideline developed to assess the measurement properties of PROMs [62]. Measurement properties are defined as "a feature of a measurement instrument that reflects the quality of the measurement instrument'' [63]. The COSMIN guideline advices to evaluate measurement properties in three domains: validity, reliability and responsiveness. These properties are defined as follows in, for example, a PROM that assesses HRQL:

1. Validity: refers to "the degree to which a PROM measures the construct(s) it purports to measure" (HRQL) [63]. This domain includes the measurement properties content validity, construct validity and criterion validity. Content validity assesses whether the items included in the PROM are relevant, comprehensive, and comprehensible to measure the construct (HRQL) [63]. Construct validity assesses whether the PROM actually measures the construct (HRQL) based on correlations with similar PROMs and the ability to differentiate between relevant groups of patients [63]. Criterion validity assesses the extent to which the PROM agrees with a standard or benchmark.
2. Reliability: refers to "the extent to which scores for patients who have not changed are the same for repeated measurement under several conditions" [63]. In this domain, internal consistency, reliability and measurement error are evaluated. Internal consistency describes whether different items of the PROM that measure the same aspect of HRQL (e.g., physical functioning), actually do this [63]. The measurement

property reliability is evaluated by test–retest reliability, which measures the degree to which the scores of the PROM are similar over time, in a patient whose HRQL has not changed [63]. Measurement error evaluates the variability of the measured value in comparison to the true value.

3. Responsiveness: refers to "the ability of a PROM to detect change over time in the construct to be measured (HRQL)" [63].

PATIENT-REPORTED OUTCOME MEASURES IN BARIATRIC SURGERY

A systematic review identifying studies on measurement properties of PROMs that were used to measure HRQL in BS found 26 articles describing 24 instruments [64]. The quality of the studies on measurement properties of these 24 instruments were evaluated using the COSMIN checklist and Terwee criteria. Based on these findings, a recommendation on the most suitable HRQL instrument was given. The authors concluded that no instruments met all the required criteria to be recommended for the measurement of HRQL in people undergoing BS. These findings are supported by the first global multidisciplinary consensus meeting including persons living with obesity and healthcare professionals [65]. The American Society for Metabolic and Bariatric Surgery (ASMBS) states that for evaluation of BS either a generic instrument, an obesity-specific instrument, or a combination, should be used based on the research aims [66]. Above all, it is recommended to utilize a validated instrument for all published reports. A previous systematic review identified 68 different PROMs that were used in BS studies; the SF-36 or RAND-36 being one of the most frequently applied measures [44,64].

The RAND-36 is a PROM that evaluates generic HRQL and includes important health domains such as physical and mental health; domains affected by both weight and other factors. The RAND-36 has demonstrated good quality of measurement properties to evaluate generic HRQL in many populations, including good construct validity and high internal consistency [67,68]. Furthermore, the RAND-36 allows for comparison of HRQL scores between patients undergoing BS and population norms and other conditions. However, one cannot assume that the quality of measurement properties is equal in different populations, nor with different measurement purposes [63]. The measurement properties of the RAND-36 to measure HRQL in patients undergoing BS were evaluated in a single study of preoperative patients [69]. This study found sufficient construct validity and internal consistency, but did not assess content validity, test re-test reliability, nor responsiveness. These measurement properties need to be assessed to determine the quality of the RAND-36 in measuring HRQL in patients undergoing BS.

A PROMs that has the potential, pending further validation, to be recommended in future studies was the BODY-Q [64]. The BODY-Q is a PROM that was developed following international standards and provides scales that measure concepts important to people living with obesity, people who underwent surgical or non-surgical weight loss or patients who received body contouring surgery (BCS) [70–72]. The BODY-Q consists of scales that measure HRQL, appearance, eating-related concerns and experience of care, and are developed with input of patients and experts in the field of obesity. The BODY-Q is psychometrically validated in an international (Canada, USA, and UK) field-test study that involved 734 patients: 403 patients who received BS and 331 patients BCS [73–75].

BODY IMAGE IN PEOPLE LIVING WITH OBESITY

Body image is defined as the subjective view of one's body, irrespective of their physical traits. It is a multidimensional construct that comprises self-perceptions and self-attitudes regarding our own physical appearance, and includes a cognitive, affective, perceptual and behavioral component: 1) cognitive refers to thoughts and beliefs regarding the body, 2) affective includes feelings about the body, 3) perceptual describes how people self-observe the shape and size of their body (parts) and 4) behavioral describes the actions people take to check on, tend to, conceal or alter their body [76–78].

Related but different terms are used in the literature to describe a disturbance in body image, such as body image distortion, body dissatisfaction, negative body image and body image misperception [78]. The complexity of this variety in terms is increased because terms refer to one or more domains of body image, or are used to describe a general disturbance in body image. This thesis will refer to a disturbance in body image as concerns with body image, irrespective of the component(s) affected.

Previous research has suggested that individual and cultural factors including gender, ethnicity and sexual orientation are related to body image [79–81]. In addition, body image can be negatively affected by obesity, however, this relationship is complex. Not all individuals with obesity demonstrate body image concerns or are equally vulnerable [77,82,83]. Women often report greater body image concerns than men, and are, in general, more concerned with their appearance. Also, women report greater negative affective consequences of concerns with their body image [81,82,84,85].

BODY IMAGE AND BARIATRIC SURGERY

Body image concerns may play a role in the decision to choose BS. Body image is believed to be one of the motivational catalysts for appearance enhancing behavior, such as weight loss and in turn, is considered a motivator to undergo BS [16,17,86]. However, no case-control studies have been conducted to evaluate body image disparities between patients who undergo BS and a matched control group. Knowledge about motivations to undergo BS will enable healthcare professionals to adequately inform patients regarding outcomes, both positive and negative, optimize patient selection and identify patients who may benefit from additional counseling or interventions.

Following BS, improvements in body image are commonly reported [87–90]. Most studies demonstrate significantly better body image scores in comparison to baseline scores, albeit, not every individual attains population norms [88,90,91]. The best body image scores are reported between one and three years after surgery, generally followed by a stabilization [89,91,92]. There is a paucity of studies that assess long-term body image results, however, it appears that body image improvements are sustained [93,94].

Although weight loss and body image scores develop in a similar slope and direction after BS, no consensus exists whether weight loss and body image are associated [74,75,87,88,90,95,96]. Some studies suggest a more negative body image results in increased motivation to change appearance and hence, is related to higher weight loss [95,97]. On the contrary, a more positive body image could be associated with more weight loss; higher appreciation and satisfaction towards appearance may motivate people in attaining healthy behaviors. In non-surgical weight loss populations, a positive body image was correlated with better long-term weight loss [98,99]. Similarly, there may be an association between body image and long-term weight loss in patients undergoing BS, although, this has not been investigated.

POST-BARIATRIC BODY CONTOURING SURGERY AND ASSOCIATED RISKS

Although the positive effects of BS are evident, there are negative consequences to be considered. Up to 96% of patients undergoing BS develop redundant skin, which may negatively impact their body image, mental well-being, physical functioning, and eventually could lead to weight regain [100–103]. The only effective treatment for this redundant skin is post-bariatric BCS. Body contouring surgery has proven to promote positive effects on both body image and weight loss maintenance [104–108].

However, body contouring procedures are generally extensive, involve undermining of large soft tissue and have high complication rates ranging from 27-70%, with most being wound-related [109–113]. Several factors are linked to these high occurrences of complications, and it is suggested that especially patients who had BS have increased risks. This may be due to the higher prevalence of nutritional deficiencies after BS: nutrients play a role in wound healing with effects on wound tensile strength, collagen syntheses and immune function, all of which are potentially diminished in patients who had BS [114].

THESIS OUTLINE

In summary, BS is the most effective treatment for obesity and its related complications. Nevertheless, there appear to be heterogeneous outcomes in HRQL, body image, weight loss and post-bariatric BCS. To improve the outcome for patients, more insight into factors that influence health, well-being, functioning, and weight loss after BS, together with complications after post-bariatric BCS, are needed. This thesis aims to contribute to the optimization of outcome after BS by investigating the relationship between body image and weight as well as identifying factors associated with patient reported and clinical outcomes. This information can then be used to improve psychoeducation, optimize patient selection, develop patient-tailored clinical practice guidelines and mediate long-lasting success after BS.

The first part of this thesis focuses on the relationship between body image and weight. As previously discussed, the relationship between weight status and body image is complex. More knowledge regarding the complex relationship between body image and weight may be used to optimize treatments for enhancing body image or provide tools for helping people with underweight, overweight or obesity. Therefore, **chapter 2** aims to provide insight into body image for the whole spectrum of body weight. Several components of body image will be assessed and compared within all weight categories (underweight, normal weight, overweight, obesity). It will be examined whether specific body image profiles exist, and if these profiles are more common within a certain weight category in comparison to other weight categories.

Body image is considered a motivator to pursue weight loss interventions. Identifying motivators for weight loss treatment will enable healthcare providers to adequately inform patients regarding treatment outcomes. However, no case-control studies exist that examined whether body image concerns are more prevalent in a sample of patients undergoing BS. In **chapter 3**, the concept of body image as a motivator for bariatric surgery is evaluated in a sample consisting of patients on a waiting list for BS and a matched control group from the general population. Multiple dimensions of body image are assessed to examine differences between the two groups. Additionally, the magnitude of body image scores of both groups are compared to scores from a large sample of the general population.

In the final chapter of this part, **chapter 4**, the association of body image with weight loss is evaluated in a prospective cohort of patients who underwent BS. This knowledge is needed to optimize weight outcomes and promote long-term success after BS.

The second part of this thesis centers on HRQL and identifies relevant factors that can be used to optimize patient related and clinical outcomes after BS. Attending to patient factors reflects patient-centered care, which has the potential to improve HRQL outcomes by tailoring healthcare to the needs of the individual patient. **Chapter 5** assesses a large sample of patients who previously underwent BS to identify patient factors that affect, among others, variability in HRQL outcomes.

A fair number of individuals who are obese need to cope with psychopathology, low self-esteem and body image concerns. These problems may be a reason to seek weight-reduction treatment. However, following BS, it seems that physical functioning is improved more than mental functioning. To enhance understanding of the effects of BS on mental functioning, **chapter 6** focusses specifically on psychological well-being in a large cohort of patients who underwent BS and identifies factors which are predictive of improved scores postoperatively.

Most studies that examined and demonstrated improvements in HRQL after BS applied the RAND-36, a PROM developed to evaluate generic HRQL. The ASMBS recommends the use of a validated instrument for all published reports regarding BS, although, no consensus exists which PROM should be the standard. To evaluate the applicability of the RAND-36 to measure HRQL in a pre- and postoperative BS population, **chapter 7** assesses the measurement properties of the RAND-36. This chapter includes the results of an online survey sent to patients and healthcare providers to provide feedback, the internal consistency analysis, the test-retest reliability and hypothesis testing.

Many patients develop redundant skin after BS and some patients experience negative consequences of this redundant skin. The only treatment, BCS, has a high prevalence of wound-related complications, which may be due to nutritional deficiencies, a frequent complication of BS. **Chapter 8** evaluates the clinical practice guideline of the federation of Dutch Plastic Surgeons (NVPC). This includes a preoperative assessment of protein intake by a dietician and evaluation of nutritional deficiencies via blood sampling. The occurrence of wound-related complications is assessed, and factors associated with these complications are identified after BCS.

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PART I

BODY IMAGE AND WEIGHT

CHAPTER 2

THE RELATIONSHIP OF BODY IMAGE AND WEIGHT: A CROSS-SECTIONAL OBSERVATIONAL STUDY OF A DUTCH FEMALE SAMPLE

D.J.S. Makarawung
M.J. Boers
F. van den Brink
V.M. Monpellier
L. Woertman
A.B. Mink van der Molen
R. Geenen

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ABSTRACT

Background

Body image concerns may play a role in weight changing behavior. The objective of this study was to assess body image in different weight groups.

Methods

Participants reported satisfaction with (AE) and investment in (AO) appearance, and the discrepancy between current and ideal body size (BS). These scores were compared between weight groups based on body-mass index (BMI) using analysis of variance. One-sample *t*-tests and Cohen's *d* effect sizes examined the magnitude of differences within each weight group relative to neutral midpoints of the scales; cluster analysis identified body image profiles.

Results

A total of 27,896 women were included in this study. AE scores were highest for people with underweight and normal weight, AO scores were highest for the underweight group and lowest in class III obesity, and BS scores were largest in the obese groups (all $p<.001$). Cluster analysis identified eight body image profiles. In people with obesity, the most prevalent profiles included a preference for a smaller body and low satisfaction with appearance, but differed in investment in appearance (low vs. high). Most people with underweight were allocated to profiles showing high investment in their appearance, preference of a larger body, but differences in satisfaction with appearance (neutral vs. high).

Conclusion

While people with a higher BMI have on average more body image concerns, different body image profiles exist in all weight groups. Future research should examine whether and which individuals in terms of body image profile may benefit more from weight interventions.

INTRODUCTION

Body image is a multidimensional construct referring to a person's body-related self-perceptions and self-attitudes [1]. It includes a cognitive component covering beliefs and thoughts about appearance and body shape, a perceptive component comprising identification and estimation of body size, shape and weight, an affective component including feelings regarding one's body and body (dis)satisfaction and a behavioral component involving actions taken to change, hide, alter or tend to the body [1,2]. Body image may also refer to other aspects of the body experience (e.g., body functionality), however, this study specifically focused on appearance [3]. Several questionnaires have been developed to measure single or multiple dimensions of body image. These include, among others, appearance evaluation (i.e., feelings of physical attractiveness), appearance orientation (i.e., investment in one's appearance) and body size perception discrepancy (i.e., difference between one's ideal and current body size) [4,5]. A negative body image has been related to poor physical and mental health. [2,6–9].

Research has suggested that body image concerns are associated with a higher body-mass index (BMI) [10–14]. In people with obesity, the degree of obesity may influence the severity of body image concerns [15]. Also, body image concerns have been described as a motivational catalyst to weight changing behavior [16]. Indeed, individuals with obesity participating in weight loss programs have demonstrated more body image concerns in comparison with those who were not seeking treatment [15,17,18]. In line with these findings, improving concerns with body image has been reported a motivator to pursue weight reduction treatment [19–23]. Individuals with underweight, normal weight or overweight (but not obesity) may also have body image concerns. However, correlations between body image concerns and body weight in these groups are inconsistent [17,24–28]. This suggests that within body weight groups, there may be subgroups of people in terms of characterization by body image concerns. Moreover, conclusions from previous studies are frequently hampered by small sample sizes, homogeneous weight populations or by evaluating only single dimensions of body image.

In addition to physical correlates such as BMI, previous research has suggested individual and cultural factors including gender, ethnicity and sexual orientation to be related to body image [29–36]. In general, men have a more positive body image than women [14,32,33]. Body image concerns among women are so common that it has been labeled as a 'normative discontent' [27]. With regard to body image questionnaires, there is growing emphasis on gender-specific measures due to limited evidence of validity and reliability of existing measures for use in male and female populations [37]. For this reason, we chose to focus our study on women. To get a more encompassing overview of the relationship between body weight and body image, multiple dimensions of body image should be investigated in a large sample representing all weight groups, preferably taking account of other factors that could influence body image, such as age, education level and sexual orientation.

Understanding the association of BMI and body image may help to improve care and psychoeducation of individuals in all weight groups. More specifically, the identification of body image profiles may provide a basis to assess which people with underweight, overweight and obesity may benefit more from weight counseling and weight interventions. Also, insight into body image profiles may inform clinical practice by identifying individuals who might benefit from additional body image management before or next to weight interventions. Previous research showed that people who are invested in appearance and at the same time consider themselves unattractive are more likely to pursue weight changing or cosmetic surgery [22,38]. Thus, more knowledge on body image (profiles) may elucidate when body image acts as a barrier or may be a cue to action for weight changing behavior [39].

Therefore, this observational cross-sectional study assessed body image, measured by appearance evaluation, appearance orientation and body size perception discrepancy, in a large sample of the Dutch population including all weight groups (i.e., underweight, normal weight, and class I, II and III obesity). This study focused specifically on women due to the body image differences compared with men. First, the relationships between the body image dimensions and weight groups were evaluated. Second, profiles of body image, comprising appearance evaluation, appearance orientation and body size perception discrepancy, were identified and assessed per weight group.

METHODS

Participants

This cross-sectional, observational study used data collected between March 2007 and June 2008 in the Netherlands. A documentary addressing the unrealistic beauty ideals of women and esthetic surgery was broadcasted on television twice. Afterwards, interested viewers could visit a referred website for participation in a psychological self-image test that took about 15 minutes to complete and involved multiple validated questionnaires [40]. Before participation, all individuals were mandated to read the instructions and view a video message from the principal investigator regarding the test. Then, participants could start the test via a link 'self-test'. Participants that completed the test received their own results. There were no exclusion criteria for participation in this study.

The database consisted of 41,119 people from the Dutch population aged from 9 to 89 years old. Men and participants under the age of 18 or with missing values on the body image questionnaires were removed. To investigate multivariate outliers Mahalanobis distance was adopted: another 235 (0.57%) respondents with a Mahalanobis distance > 16.27 (the critical value with three dependent variables) were excluded [41]. The final sample for analysis included 27,896 women. It was divided into six weight groups based on BMI (kg/m^2): underweight (BMI < 18.5), normal weight (BMI 18.5 – 25), overweight (BMI 25 – 30), class I obesity (BMI 30 – 35), class II obesity (BMI 35 –40) and class III obesity (BMI > 40).

Instruments

Height and weight measurements, demographics and level of education were collected in the questionnaire by self-report. For this study, level of education was dichotomized: Primary education, lower vocational education, and secondary vocational education were combined, as well as higher general and pre-university education, higher professional education, and academic education. Our study included two questionnaires in analyses, the Multidimensional Body-Self Relations Questionnaire – Appearance Scales (MBSRQ-AS) and Stunkard's Figure Rating Scale (SFRS) [4,5].

The Multidimensional Body-Self Relations Questionnaire

The Dutch version of the MBSRQ-AS was used to measure body image. This instrument was created to assess cognitive, affective and behavioral dispositions to one's body and has been validated extensively [4,42]. Answers are rated on a five-point Likert scale ranging from "definitely disagree" to "definitely agree". The following subscales were used:

- "Appearance evaluation": a 7-item scale that measures positive or negative feelings towards one's physical attractiveness (a higher score suggests a more positive appraisal about appearance). It includes statements like "My body is sexually appealing" or "I like the way my clothes fit me".
- "Appearance orientation": a 12-item scale that measures the extend of cognitive and behavioral investment in one's physical appearance (a higher score suggests the person places more importance on appearance, pays more attention to appearance and engages more in efforts to manage or enhance appearance) [4]. This subscale comprises items like "I check my appearance in a mirror whenever I can" or "I am always trying to improve my physical appearance".

Lower scores were defined as a composite mean score below the neutral midpoint of 3.0 on the scale [43]. The internal consistencies for both subscales were good. Cronbach's alpha for appearance evaluation was .88 and for appearance orientation .83.

Stunkard's Figure Rating Scale

To measure body size perception, SFRS was used [5]. Subjects had to choose one drawing from nine drawings of silhouettes, which ranged from very thin (1) to very obese (9). To measure body size perception, participants were asked to select the silhouette that most accurately depicted their current body size [44]. Additionally, subjects chose a silhouette that represented their ideal body size for themselves. Subsequently, a score for body size perception discrepancy was calculated by subtracting the ideal body size from the current body size (scores ranged from -8 to +8) [45,46]. A positive or negative score indicated a smaller or larger preferred body size, respectively. Greater scores represented greater discrepancies. The neutral midpoint for this scale, a score of 0, was considered a congruent body size perception.

2

Statistical analysis

Analyses were performed with SPSS (version 26). A two-tailed *p*-value < .05 was considered statistically significant. The sample was tested for univariate normality, linearity, multicollinearity and homogeneity. To optimize normal distribution, extreme scores (SD < -4 or SD > 4) for body size perception discrepancy were standardized to either -4 or 4 (this included 1 participant with SD < -4 and 74 participants with SD > 4). One-way analysis of variance (ANOVA) and chi-squared test were used to compare continuous and categorical variables, respectively. For continuous variables, Tukey's test for post hoc comparisons was used. In case the assumption of homogeneity of variances was violated, a Welch test and Games-Howell for post hoc comparisons test were performed. Omega squared effect sizes (ω^2) were calculated to estimate which proportion of variance in the dependent variable was accounted for by an effect in the independent variable [47]. The magnitude of effect was interpreted as follows: .01 (small), .06 (medium), .14 (large) [48]. For categorical variables, Cramer's V ($V\varepsilon$) was reported to express effect size and post hoc comparisons were performed by calculating adjusted residuals. An absolute value that exceeded +/- 2 indicated a significant association between the categories [49]. Bonferroni correction was applied to account for the large number of analyses.

Demographic characteristics and body image scales were described for and compared between weight groups. For age, BMI and the body image scales, $p < .003$ was considered significant after Bonferroni correction (15 comparisons for all 6 weight groups). The Bonferroni correction for educational level yielded $p < .004$ (12 comparisons) and for sexual orientation $p < .003$ (18 comparisons). Per weight group, scores on appearance evaluation, appearance orientation and body size perception discrepancy were compared with the neutral midpoint of the scale. To express the magnitude of differences for each scale, one-sample *t*-tests were used, and Cohen's *d* effect sizes were calculated, using the standard deviation of the whole sample as reference values. Cohen's *d* effect sizes were interpreted as follows: |0.0| – |0.2| (trivial), |0.2| – |0.5| (small), |0.5| – |0.8| (medium), |0.8| – |1.2| (large), |1.2| – |2.0| (very large) and > |2.0| (huge) [50,51].

A cluster analysis was performed to identify profiles comprising the three body image scales. Scores were standardized by dividing the deviation from the neutral midpoint of the scale by the standard deviation of the whole sample, which yields an effect size similar to Cohen's *d*. An optimization clustering (i.e., k-means cluster analysis in SPSS) was performed to allocate participants to clusters. The number of clusters was decided by the research team based on interpretability and clinical relevance of mean scores within clusters. From here on the clusters are referred to as profiles.

The distribution of body image profiles was examined per weight group for significant differences. Prevalence of educational level and sexual orientation were described by numbers and percentages within the individual profiles. The body image profiles were evaluated for significant age differences.

RESULTS

Participant characteristics

The sample consisted of 27,896 women. Participants had a mean age of 34.2 ± 12.0 years (range 18 – 89) and a mean BMI of 23.2 ± 4.1 kg/m^2 (range 13.0 – 69.6). Most respondents had higher general, pre-university education, higher professional or academic education (78.5%), and were heterosexually oriented (86.5%).

Patient characteristics per weight group are presented in Table 1. There were significant differences between weight groups for age [Welch $F(5, 1124) = 315$, $p < .001$], which held a medium effect ($\omega^2 = .06$). On average, the overweight and obese groups were 5 to 6 years older than the normal weight group ($p < .001$), while the underweight group was about 6 years younger ($p < .001$, 95%CI [-6.6, -4.9]). The prevalence of participants with lower education was significantly higher in the overweight and obese groups [$X^2(10) = 79$, $p < .001$], which held a weak association [$V\varepsilon = .1$] Especially the group with class III obesity included a high percentage of people with a homosexual or bisexual orientation [$X^2(5) = 302$, $p < .001$], this association was moderate [$V\varepsilon = .04$].

Table 1. Demographic characteristics of the female sample presented per weight group (n = 27,896).

	Underweight n = 361	Normal weight n = 19,980	Overweight n = 4783	Class I obesity n = 1255	Class II obesity n = 354	Class III obesity n = 163
Age, years [a]	27.5 (10.0)	33.2 (11.6)	38.3 (12.3)	39.2 (12.0)	39.2 (11.2)	38.8 (11.7)
BMI, kg/m^2 [b]	17.7 (0.8)	21.7 (1.7)	26.9 (1.3)	31.9 (1.4)	37.0 (1.4)	45.8 (6.8)
Educational level, *n* (%)						
Primary-, lower-, or secondary vocational education	285 (20.9)	3861 (19.3) [c]	1236 (25.8) [c]	437 (34.8) [c]	117 (33.1) [c]	65 (39.9) [c]
Higher general and pre-university education, higher professional or academic education	1076 (79.1)	16,119 (80.7) [c]	3547 (74.2) [c]	818 (65.2) [c]	237 (66.9) [c]	98 (60.1) [c]
Sexual orientation, *n* (%)						
Men	1172 (86.1)	17,412 (87.1) [d]	4038 (84.4) [d]	1071 (85.3)	300 (84.7)	131 (80.4)
Men and women	110 (8.1) [d]	1002 (5.0) [d]	260 (5.4)	85 (6.8)	27 (7.6)	17 (10.4)
Women	79 (5.8) [d]	1566 (7.8)	485 (10.1) [d]	99 (7.9)	27 (7.6)	15 (9.2)
MBSRQ-AS [e]						
Appearance evaluation [f]	3.86 (1.03)	3.86 (0.91)	3.20 (1.00)	2.74 (1.02)	2.50 (0.93)	2.38 (1.03)
Appearance orientation [g]	3.71 (0.78)	3.60 (0.77)	3.47 (0.77)	3.41 (0.82)	3.36 (0.80)	3.28 (0.83)
Body size perception discrepancy [h]	-0.16 (1.03)	0.76 (0.80)	1.48 (0.73)	2.01 (0.81)	2.43 (0.90)	2.60 (1.16)

Note: data are presented as mean (SD) unless stated otherwise. Significant differences were calculated for continuous variables by analysis of variance (Welch test) and Games Howell post hoc comparisons, and for categorical variables adjusted residuals were calculated by Chi square post hoc tests (an absolute value > 2 was interpreted as a difference). Bonferonni correction was applied for al analyses.

[a] Underweight and normal weight groups differed significantly from each other and differed both from all other weight groups ($p < .003$).

[b] All weight groups differed significantly from each other ($p < .003$).

[c] Significant deviation from other weight groups ($p < .004$).

[d] Significant deviation from other weight groups ($p < .003$).

[e] MBSRQ-AS = Multidimensional Body-Self Relations Questionnaire-Appearance Scales.

[f] Only the underweight and normal weight groups ($p = 1.0$), as well as the class II and class III obesity groups ($p = .80$) were not significantly different.

[g] Only the underweight and normal weight groups differed significantly from each other and all other weight groups ($p < .003$).

[h] As measured by Stunkard's Figure Rating scale. A negative score indicates a larger preferred body size, a positive score a smaller preferred body size. All weight groups except class II and class III ($p = .57$) differed from each other ($p < .001$)

Body image

Mean scores on each body image scale were compared between weight groups using ANOVA (Table 1). For every scale, the assumption of equality of variances was violated. There were significant differences for appearance evaluation [Welch $F(5, 1117) = 774$, $p < .001$], this effect was medium ($\omega^2 = .13$). Appearance orientation differed significantly between weight groups and this effect was small [Welch $F(5, 1119) = 50$, $p < .001$, $\omega^2 = .009$]. Body size perception discrepancy scores differed significantly per weight group [Welch $F(5, 1114) = 1722$, $p < .001$], which was a large effect ($\omega^2 = .26$). All post hoc comparisons are presented in Supplementary Table S1. The highest scores on appearance evaluation were found in the underweight and normal weight group (3.86 ± 1.03 and 3.86 ± 0.91, respectively, $p < 1.00$). All other weight groups, except class II and III obesity ($p = .80$), had significant discrepancies ($p < .001$; class I and class III obesity, $p = .001$). For appearance orientation, the highest scores were found in the underweight and normal weight groups (3.71±0.78 and 3.60±0.77, respectively, $p < .001$) and differed significantly from each other and all other weight groups ($p < .001$). Body size perception discrepancy scores were highest in class I obesity (2.01±0.81), class II obesity (2.43±0.90) and class III obesity (2.60±1.16). The differences between all weight groups were significant ($p < .001$), except between class II and class III obesity ($p = .57$).

Cohen's *d* effect sizes were calculated to quantify deviations from the neutral midpoint of the body image scales for each weight group (Figure 1) (Supplementary Table S2). All deviations were significant ($p < .001$). With regard to appearance evaluation, the results demonstrated large positive deviations for the underweight ($d = 0.86$) and normal weight ($d = 0.86$) groups and a small positive deviation for the overweight group ($d = 0.19$), indicating higher levels of satisfaction with appearance. All three groups with obesity showed negative deviations ranging from small ($d = -0.26$, class I obesity) to medium ($d = -0.50$ and $d = -0.62$ for class II and III obesity, respectively), representing unhappiness with appearance. For appearance orientation, deviations for all weight groups were positive, ranging from large ($d = 0.91$, underweight) to small ($d = 0.36$, class III obesity). These results implied that, on average, participants of all weight groups generally invested in their appearance. For body size perception discrepancy, only participants with underweight had a trivial ($d = -0.17$) negative deviation, indicating a larger preferred body size. All other weight groups had positive deviations with huge effect sizes for the groups with obesity ($d > 2.14$), reflecting a smaller preferred body size.

Body image profiles

To allocate participants to body image profiles, a k-means cluster analysis was conducted that yielded seven options containing three to nine clusters. All seven possibilities were examined by the research team to determine the final number of clusters. The possibilities were examined for interpretability, potential clinical relevance, diversity between clusters and homogeneity within clusters. At the extreme, the option containing three clusters

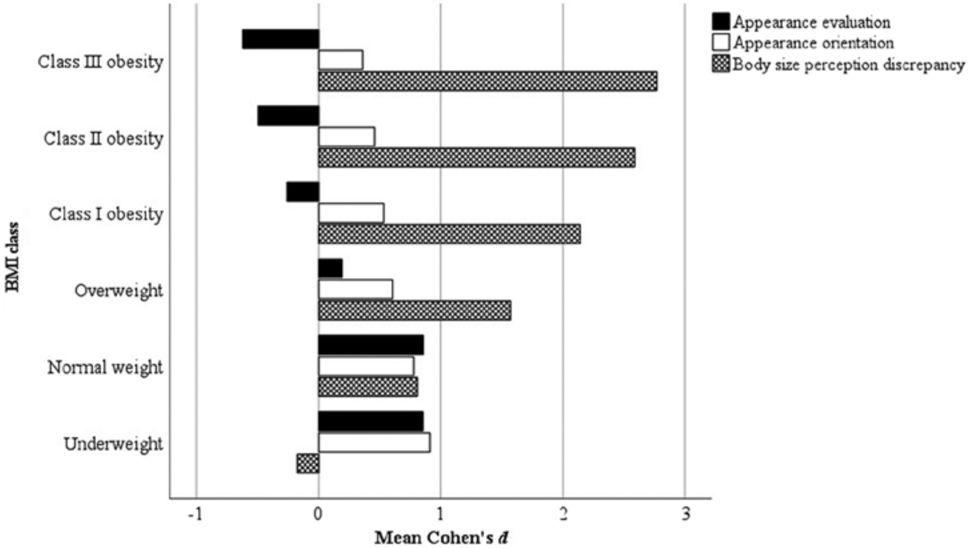

Figure 1. Cohen's d effect sizes of deviations from the neutral midpoint of body image scales per weight group.

was rejected because it included one cluster with a low appearance evaluation, one with low appearance orientation and large heterogeneity within the clusters. Eventually, in consensus meetings by the research team, the final number of body image profiles was set at eight.

Arguments to choose this option were that it included: 1) two profiles with both low appearance evaluation and considering oneself too large combined with either a high or low appearance orientation and 2) two profiles with both high appearance orientation and considering oneself too small combined with high or low appearance evaluation. The combination of these profiles that was not found in solutions with less or more profiles was considered clinically relevant.

Figure 2 shows for each profile the deviations from the neutral midpoint on the body image scale (Cohen's *d* effect sizes). Profile 1 has both high appearance evaluation (very large effect size, d = 1.56) and appearance orientation (very large effect size, d = 1.28), combined with a positive body size perception discrepancy (small effect size, d = 0.49). Profile 2 includes a high appearance evaluation (small effect size, d = 0.46), a high appearance orientation (very large effect size, d = 1.31) and positive body size perception discrepancy (huge effect size, d = 2.18). Profile 3 represents both a low appearance evaluation (small effect size, d = -0.26) and appearance orientation (small effect size, d = -0.30) combined with a positive body size perception discrepancy (very large effect size, d = 1.57). Profile 4 has a high appearance evaluation (small effect size, d = 0.28), high appearance orientation (very large effect size, d = 1.41) and a positive body size perception discrepancy (large effect size, d = 1.03). Profile 5 includes a high appearance evaluation (very large effect size, *d* = 1.37), low appearance orientation (small effect size, *d* = -0.37) and a positive body size perception discrepancy (medium effect size, *d* = 0.59). Profile 6 represents a high appearance evaluation (very large effect size, *d* = 1.30) and high appearance orientation (large effect size, *d* = 0.81) combined with a negative body size perception discrepancy (large effect size, *d* = -1.19). Profile 7 has a low appearance evaluation (large effect size, *d* = -1.12), high appearance orientation (very large effect size, *d* = 1.39) and a positive body size perception discrepancy (huge effect size, *d* = 2.50). Profile 8 includes a low appearance evaluation (trivial effect size, *d* = -0.07), high appearance orientation (large effect size, *d* = 0.82) and a negative body size perception discrepancy (small effect size, *d* = -0.46).

An overview of the eight profiles and participant characteristics per weight group including age, level of education and sexual orientation, is given in Table 2. On average, every profile mostly consists of participants who are heterosexually orientated with a higher level of education. For age, the assumption of equality of variances was violated. There were significant differences for age between profiles [$F(7, 6440) = 70$, $p < .001$], which held a small effect ($\omega^2 = .02$). Participants with the highest mean age were significantly allocated to profile 3 and differed from all other profiles ($p < .001$). Profile 6 included the highest prevalence of participants with the lowest mean age, this was significantly different from profiles 1, 2, 3, 4 and 5 ($p < .001$).

Table 3 presents the distribution of body image profiles per weight group as calculated by Chi-square tests. Figure 3 illustrates an overview of this distribution. Respondents who were underweight were mostly allocated to body image profiles 1, 6 and 8. This high occurrence of profile was only significant for profiles 6 and 8 ($p < .001$), both representing

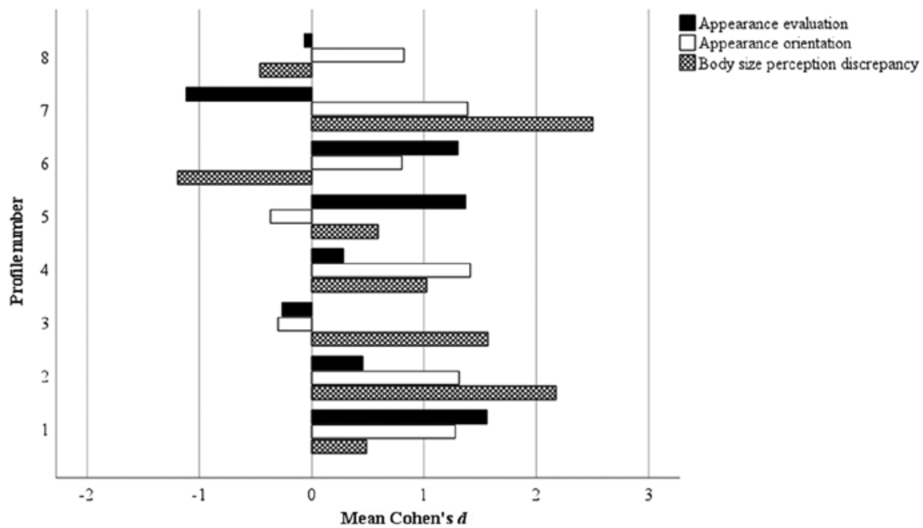

Figure 2. Cohen's *d* effect sizes of deviations from the neutral midpoint of body images scale per profile.

participants who consider themselves too small. Profile 8 has a low (trivial effect size, *d* = -0.07) and profile 6 a high appearance evaluation (very large effect size, *d* = 1.30), while being similarly invested in appearance (large effect size *d* = 0.82 and *d* = 0.81, respectively). The occurrence of profile 1 is significantly higher in participants with normal weight ($p < .001$), representing people who prefer a smaller body (small effect size, *d* = 0.49), are satisfied with (very large effect size, *d* = 1.56) and invested in (very large effect size, *d* = 1.28) their appearance. Also, for the normal weight group, many respondents were significantly allocated to profiles 4 and 5 ($p < .001$).

Participants with profile 4 have a high appearance evaluation (small effect size, *d* = 0.28), high appearance orientation (very large effect size, *d* = 1.41) and prefer a smaller body (large effect size, *d* = 1.03). Profile 5 has a low appearance orientation (small effect size, *d* = -0.37), high appearance evaluation (very large effect size, *d* = 1.37) and desires a smaller body (medium effect size, *d* = 0.59). In the overweight group, most respondents were allocated to four profiles (3, 4, 5 and 7) , however, this distribution was only significant for profiles 3, 5 and 7 ($p < .001$). On average, all participants in these profiles prefer a smaller body, but the effect sizes differ from medium (*d* = 0.59) to huge (*d* = 2.50). In the groups with obesity, the most dominant significantly prevalent profiles were 3 and 7 ($p < .001$). These respondents prefer a smaller body (very large effect size, *d* = 1.57 and huge effect size, *d* = 2.50, respectively), have a low appearance evaluation (small effect size, *d* = -0.26 and large effect size, *d* = -1.12, respectively) and either a low

Table 2. Participant characteristics per body image profile presented as mean (standard deviation) for age and numbers (percentages) for level of education and sexual orientation.

Profile	Age	Higher education	Heterosexual
Profile 1	33.6 (11.8)	5535 (81.3)	5990 (88.0)
Profile 2	34.1 (12.5)	1584 (73.5)	1900 (88.1)
Profile 3	37.1 (12.1)	2554 (78.0)	2754 (84.1)
Profile 4	33.0 (12.0)	3823 (76.2)	4425 (88.2)
Profile 5	35.7 (11.7)	5149 (84.1)	5165 (84.4)
Profile 6	31.2 (11.2)	643 (78.1)	719 (87.4)
Profile 7	32.5 (11.6)	1791 (68.7)	2219 (85.1)
Profile 8	32.6 (12.5)	816 (74.8)	952 (87.3)

Profile 1: high appearance evaluation (*d* = 1.56), high appearance orientation (*d* = 1.28) and positive body size perception discrepancy (*d* = 0.49). Profile 2: high appearance evaluation (*d* = 0.46), high appearance orientation (*d* = 1.31) and positive body size perception discrepancy (*d* = 2.18). Profile 3: low appearance evaluation (*d* = -0.26), low appearance orientation (*d* = -0.30) and positive body size perception discrepancy (*d* = 1.57). Profile 4: high appearance evaluation (*d* = 0.28), high appearance orientation (*d* = 1.41) and positive body size perception discrepancy (*d* = 1.03). Profile 5: high appearance evaluation (*d* = 1.37), low appearance orientation (*d* = -0.37) and positive body size perception discrepancy (*d* = 0.59). Profile 6: high appearance evaluation (*d* = 1.30), high appearance orientation (*d* = 0.81) and negative body size perception discrepancy (*d* = -1.19). Profile 7: low appearance evaluation (*d* = -1.12), high appearance orientation (*d* = 1.39) and positive body size perception discrepancy (*d* = 2.50). Profile 8: low appearance evaluation (*d* = -0.07), high appearance orientation (*d* = 0.82) and negative body size perception discrepancy (*d* = -0.46).

(small effect size, *d* = -0.30, profile 3) or high (very large effect size, *d* = 1.39, profile 7) appearance orientation.

DISCUSSION

The present study assessed body image, measured by appearance evaluation (i.e., feelings of physical attractiveness), appearance orientation (i.e., investment in one's appearance)

Table 3. Body image profiles per weight group.

		Underweight	Normal weight	Overweight	Class I obesity	Class II obesity	Class III obesity	Total
Profile 1	Count (%)	**374 (27.5)**	**5905 (29.6)**	476 (10.0)	43 (3.4)	3 (0.9)	4 (2.5)	6805
	Adj. Res.	**2.7**	**31.9** [a]	-25.6 [a]	-17.7 [a]	-10.4 [a]	-6.5 [a]	
Profile 2	Count (%)	32 (2.4)	1200 (6.0)	642 (13.4)	214 (17.1)	49 (13.8)	19 (11.7)	2156
	Adj. Res.	-7.6 [a]	-17.1 [a]	16.2 [a]	12.7 [a]	4.3 [a]	1.9	
Profile 3	Count (%)	32 (2.4)	1607 (8.0)	**1096 (22.9)**	*378 (30.1)*	*111 (31.4)*	*52 (31.9)*	3276
	Adj. Res.	-11.0 [a]	-30.5 [a]	**26.4** [a]	*20.7* [a]	*11.5* [a]	*8.0* [a]	
Profile 4	Count (%)	95 (7.0)	3925 (19.6)	*885 (18.5)*	90 (7.2)	13 (3.7)	8 (4.9)	5016
	Adj. Res.	-10.8 [a]	11.5 [a]	*1.0*	-10.2 [a]	-7.0 [a]	-4.4 [a]	
Profile 5	Count (%)	203 (14.9)	*4944 (24.7)*	843 (17.6)	104 (8.3)	21 (5.9)	6 (3.7)	6121
	Adj. Res.	-6.4 [a]	*18.0* [a]	-7.9 [a]	-12.0 [a]	-7.3 [a]	-5.7 [a]	
Profile 6	Count (%)	*321 (23.6)*	501 (2.5)	1 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	823
	Adj. Res.	*46.1* [a]	-6.9 [a]	-13.2 [a]	-6.3 [a]	-3.3 [a]	-2.2	
Profile 7	Count (%)	52 (3.8)	1 081 (5.4)	822 (17.2)	**423 (33.7)**	**157 (44.4)**	**73 (44.8)**	2608
	Adj. Res.	-7.2 [a]	-35.9 [a]	20.5 [a]	**30.3** [a]	**22.8** [a]	**15.6** [a]	
Profile 8	Count (%)	252 (18.5)	817 (4.1)	18 (0.4)	3 (0.2)	0 (0.0)	1 (0.6)	1091
	Adj. Res.	28.5 [a]	2.4	-13.9 [a]	-6.9 [a]	-3.8 [a]	-2.2	

Note: cells in **bold** depict the most prevalent profile within the respective weight group. Cells in *italics* depict the second most prevalent profile within the respective weight group. Differences in prevalence between body image profiles per weight group are assessed by Chi square post hoc tests (adjusted standardized residuals). An absolute value > 2 was interpreted as a difference. Adj. Res. = adjusted residual.

[a] Indicates a significant association after Bonferroni correction ($p < .001$) of body image profile within weight group.

Profile 1: high appearance evaluation (*d* = 1.56), high appearance orientation (*d* = 1.28) and positive body size perception discrepancy (*d* = 0.49).

Profile 2: high appearance evaluation (*d* = 0.46), high appearance orientation (*d* = 1.31) and positive body size perception discrepancy (*d* = 2.18).

Profile 3: low appearance evaluation (*d* = -0.26), low appearance orientation (*d* = -0.30) and positive body size perception discrepancy (*d* = 1.57).

Profile 4: high appearance evaluation (*d* = 0.28), high appearance orientation (*d* = 1.41) and positive body size perception discrepancy (*d* = 1.03).

Profile 5: high appearance evaluation (*d* = 1.37), low appearance orientation (*d* = -0.37) and positive body size perception discrepancy (*d* = 0.59).

Profile 6: high appearance evaluation (*d* = 1.30), high appearance orientation (*d* = 0.81) and negative body size perception discrepancy (*d* = -1.19).

Profile 7: low appearance evaluation (*d* = -1.12), high appearance orientation (*d* = 1.39) and positive body size perception discrepancy (*d* = 2.50).

Profile 8: low appearance evaluation (*d* = -0.07), high appearance orientation (*d* = 0.82) and negative body size perception discrepancy (*d* = -0.46).

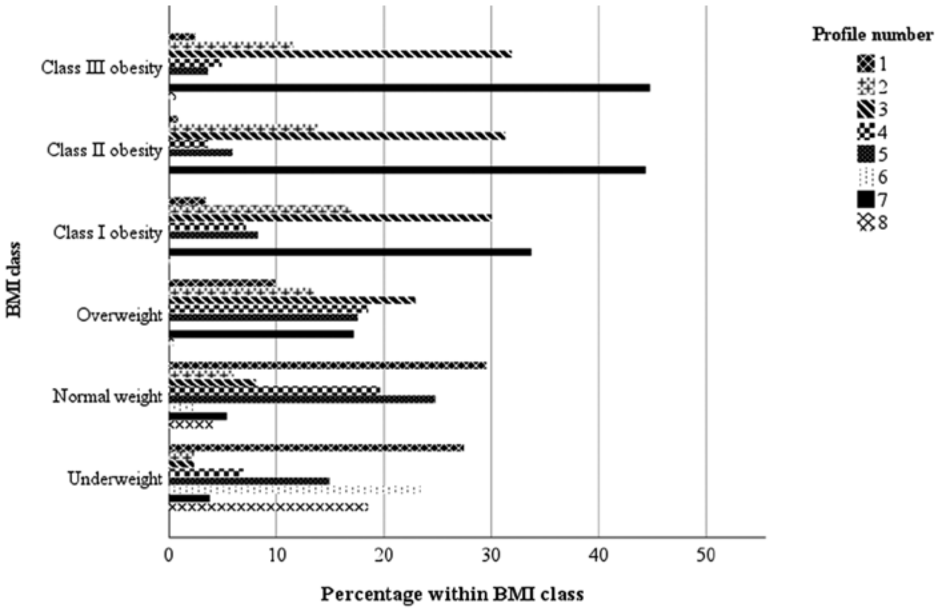

Figure 3. Distribution of profiles in percentages per weight group.

and body size perception discrepancy (i.e., difference between one's ideal and current body size), in a large sample of Dutch women. Our results demonstrated significant differences for each body image scale between weight groups. In general, participants in the higher weight groups appraised their physical attractiveness lower, invested less in their appearance and desired a smaller body. On average, all weight groups invested in their appearance as reflected in self-reports of importance placed on appearance, attention to appearance and engagement in efforts to manage or enhance appearance. In contrast to all other groups, only the participants with underweight generally preferred a larger body. Analysis of body image profiles indicated subgroups of participants with underweight that were and were not satisfied with their appearance, and that did and did not prefer a larger body. Participants with obesity, on average, desired smaller bodies, evaluated their physical appearance negatively, but varied in terms of investment in their appearance (high vs. low investment).

Participants in the underweight and normal weight groups were equally and mostly satisfied with their physical appearance, in contrast to participants in the higher weight groups, who generally were less positive about their appearance. These results are supported by previous studies observing a negative correlation between higher BMI and less positive feelings of physical attractiveness, and other work that found similar results in people with obesity [11,12,22]. The negative appreciation for one's appearance may reflect a state of lower self-efficacy maintaining poor weight management, but, it could also be a motivator to weight changing behavior, especially when someone is inclined to invest in their physical appearance [22,38]. Healthcare providers should be aware that concerns with body image could be a barrier or facilitator of weight management behavior [52].

Regarding appearance orientation, scores were gradually lower comparing groups with more severe obesity to the underweight group. This indicates that people with higher BMI tend to invest less in and are less concerned with appearance, grooming and presentation. Previous work that evaluated appearance orientation yielded inconsistent results, demonstrating either no differences between weight categories or supporting our results wherein people with obesity invested less in their appearance [22,53,54]. Investing less in appearance may potentially clear the way for negligent health behavior, more weight gain and eventually obesity. On the contrary, our findings may also reflect an indifference to appearance as a consequence of feeling impotent towards achieving weight loss. Future studies should evaluate whether people with low scores on appearance orientation may benefit from therapy addressing appearance investment to motivate weight changing behavior and enhance health.

Our results of body size perception discrepancy are in accordance with previous work which demonstrated that the majority of women in their sample, regardless of weight, preferred a smaller body [24,55]. However, interpretation of our body size perception discrepancy results is severely hampered by floor and ceiling effects. Only the underweight group preferred a larger body size, but the scale did not give respondents the opportunity to choose an even smaller preferred body size because they were already in the lowest category. For all other groups, the increasing positive discrepancy reflecting the ideal of a smaller body was parallel to the ceiling effects of the scale. Nevertheless, the results might give a realistic reflection that people with a higher weight are further off their ideal body size. Also, our results imply that, on average, people with normal weight prefer smaller bodies. It should be considered that selection of a smaller ideal than current body size does not necessarily imply a desire for a smaller body. People may be satisfied with their current body even if their concept of ideal is different.

The assessment of body image profiles showed that the majority of people with normal weight (73.9%) is distributed over three profiles that all have, on average, a positive appraisal towards their physical appearance combined with an ideal of a smaller body size, which may reflect current Western society's positive view on slenderness [55,56]. Regarding respondents with underweight, the most common profiles (69.6%) can be divided into people who are on average satisfied with their appearance and wish to become smaller, and people who prefer a larger body size but differ in feelings of attractiveness (neutral vs. high). This variety in current-ideal body size has already been demonstrated for individuals with underweight [57]. However, for people who desire a larger body, the subgroup that has a larger discrepancy between low satisfaction with appearance and a high investment in appearance may be more susceptible to help with weight changing behavior (profile 8) [22]. Overall, our work demonstrates the diversity of body image profiles in people with underweight that need more research employing longitudinal or clinical experimental designs.

People with overweight are equally distributed over four profiles (76.2%). These profiles have in common that the ideal body size is smaller than the current body size. These findings are in accordance with a previous review [55]. The subgroup with low satisfaction with appearance combined with high investment in appearance may be inclined to receive help in managing their weight. On the contrary, the people with overweight who consider themselves attractive may need other motives to prevent further weight gain. For healthcare providers, knowledge about the diverse body image profiles in people with overweight may help in developing strategies to address health concerns and prevent further weight gain as well as obesity related comorbidities.

For people with class I, class II and class III obesity, two profiles are mostly present. Both profiles are characterized by a smaller ideal body size, but for one profile satisfaction with and investment in appearance are both low, while the other profile is characterized by low satisfaction with appearance and high investment in appearance. In a previous study, we found that patients on a waiting list for bariatric surgery showed a large discrepancy between low satisfaction with appearance and high investment in appearance, which we interpreted as reflecting high dissatisfaction with appearance [22]. Unfortunately, the intention to choose a weight reducing procedure was not assessed in this study. The results of this previous study may suggest that individuals with a negative evaluation of their physical appearance who are inclined to invest in appearance are more motivated to seek help with weight management. However, greater investment in appearance may have different meaning for different individuals. For some it may be caused by body image dissatisfaction, poorer global self-esteem and more disturbed eating attitudes [58]. In addition, attending to, valuing and managing one's physical appearance may not necessarily imply a pathognomonic orientation to one's body [59]. Therefore, the clinical implications of the profile characterized by low satisfaction with and high investment in appearance need further in-depth investigation.

Prior work has documented the relationship between BMI and body image [12,55]. However, the results lacked consistency and most studies only reported single dimensions of body image. Findings of this observational cross-sectional study add to these results and provide additional information regarding the complex link of BMI and body image. Insight into this relationship may be used to optimize treatments for enhancing body image or provide tools for helping people with underweight, overweight or obesity. For example, identifying body image profiles may provide healthcare physicians with the opportunity to start a dialogue about treatment of body image, personal motivation, goal setting and weight changing behavior [23,60]. Therefore, our findings regarding body image profiles should be replicated in future research while assessing their links with behavior and other constructs like motivation and self-efficacy cognitions. This may elucidate whether and which body image profiles are susceptible to weight interventions in which weight groups, and also which profiles may benefit from additional interventions to enhance body image before focusing on weight.

Strengths of this study include the large sample size and the use of different questionnaires to assess body image, making it a valuable descriptive study in which it was possible to identify body image profiles as related to body weight groups. Several limitations should be considered too. This large sample of Dutch women was a convenience sample that may not have been representative of the general population as exemplified by the high rate of higher schooled participants, which seems a biased reflection of the Dutch population [61]. Our data did not include assessments of the measures people take to change their body weight. Moreover, psychiatric conditions such as eating, mood and anxiety disorders were not assessed, but these conditions could be possible confounders affecting body image. The SFRS may not be sensitive enough to pick up subtle but meaningful differences in body size perception, although the scale is previously validated for this use, the figures of the scale do not appear obese enough to represent the more extreme cases of obesity, and interpretation of the discrepancy scores are hampered by serious floor and ceiling effects [60]. The cross-sectional nature of our study prevents a causal interpretation of the links. Data in this study were collected in 2007 and 2008 and therefore may be outdated, since beauty ideals can change over time.

CONCLUSION

The current study evaluated multiple dimensions of body image in relationship to weight in a female Dutch population. Significant differences in body image were demonstrated between weight groups for each scale. In general, there were lower feelings of attractiveness, less investment in appearance and a larger discrepancy for ideal-current body size in the highest weight groups. Eight body image profiles were identified that can be used in future studies to characterize participants and to examine whether their profile is associated with commitment to change their body weight. In the longer-term, this knowledge may help healthcare providers with a way of engaging people with underweight, overweight or obesity and to encourage and guide them in weight changing behavior.

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SUPPLEMENTARY FILES

Table S1.1. Post hoc comparisons of appearance evaluation and weight groups using a Games Howell test.

				95% CI	
Weight group (I)	Weight group (J)	Mean difference (I-J)	SE	Lower	Upper
Underweight	Normal weight	0.00	0.03	-0.08	0.08
	Overweight	0.67 [a]	0.03	0.58	0.75
	Class I obesity	1.12 [a]	0.04	1.01	1.24
	Class II obesity	1.36 [a]	0.06	1.20	1.52
	Class III obesity	1.48 [a]	0.09	1.24	1.73
Normal weight	Underweight	0.00	0.03	-0.08	0.08
	Overweight	0.67 [a]	0.02	0.62	0.71
	Class I obesity	1.13 [a]	0.03	1.04	1.21
	Class II obesity	1.37 [a]	0.05	1.22	1.51
	Class III obesity	1.49 [a]	0.08	1.25	1.72
Overweight	Underweight	-0.67 [a]	0.03	-0.75	-0.58
	Normal weight	-0.67 [a]	0.02	-0.71	-0.62
	Class I obesity	0.46 [a]	0.03	0.36	0.55
	Class II obesity	0.70 [a]	0.05	0.55	0.84
	Class III obesity	0.82 [a]	0.08	0.58	1.05
Class I obesity	Underweight	-1.12 [a]	0.04	-1.24	-1.01
	Normal weight	-1.13 [a]	0.03	-1.21	-1.04
	Overweight	-0.46 [a]	0.03	-0.55	-0.36
	Class II obesity	0.24 [a]	0.06	0.08	0.40
	Class III obesity	0.36 [a]	0.09	0.11	0.61
Class II obesity	Underweight	-1.36 [a]	0.06	-1.52	-1.20
	Normal weight	-1.37 [a]	0.05	-1.51	-1.22
	Overweight	-0.70 [a]	0.05	-0.84	-0.55
	Class I obesity	-0.24 [a]	0.06	-0.40	-0.08
	Class III obesity	0.12	0.09	-0.15	0.39
Class III obesity	Underweight	-1.48 [a]	0.09	-1.73	-1.24
	Normal weight	-1.49 [a]	0.08	-1.72	-1.25
	Overweight	-0.82 [a]	0.08	-1.05	-0.58
	Class I obesity	-0.36 [a]	0.09	-0.61	-0.11
	Class II obesity	-0.12	0.09	-0.39	0.15

[a] Significant mean difference after Bonferroni correction (15 comparisons) (p < .003).

Table S1.2. Post hoc comparisons of appearance orientation and weight groups using a Games Howell test.

Weight group (I)	Weight group (J)	Mean difference (I-J)	SE	95% CI	
				Lower	Upper
Underweight	Normal weight	0.10 [a]	0.02	0.04	0.17
	Overweight	0.24 [a]	0.02	0.17	0.30
	Class I obesity	0.29 [a]	0.03	0.21	0.38
	Class II obesity	0.35 [a]	0.05	0.22	0.49
	Class III obesity	0.43 [a]	0.07	0.23	0.62
Normal weight	Underweight	-0.10 [a]	0.02	-0.17	-0.04
	Overweight	0.13 [a]	0.01	0.10	0.17
	Class I obesity	0.19 [a]	0.02	0.12	0.26
	Class II obesity	0.25 [a]	0.04	0.13	0.37
	Class III obesity	0.32 [a]	0.07	0.14	0.51
Overweight	Underweight	-0.24 [a]	0.02	-0.30	-0.17
	Normal weight	-0.13 [a]	0.01	-0.17	-0.10
	Class I obesity	0.06	0.03	-0.02	0.13
	Class II obesity	0.11	0.04	-0.01	0.24
	Class III obesity	0.19	0.07	0.00	0.38
Class I obesity	Underweight	-0.29 [a]	0.03	-0.38	-0.21
	Normal weight	-0.19 [a]	0.02	-0.26	-0.12
	Overweight	-0.06	0.03	-0.13	0.02
	Class II obesity	0.06	0.05	-0.08	0.19
	Class III obesity	0.13	0.07	-0.07	0.33
Class II obesity	Underweight	-0.35 [a]	0.05	-0.49	-0.22
	Normal weight	-0.25 [a]	0.04	-0.37	-0.13
	Overweight	-0.11	0.04	-0.24	0.01
	Class I obesity	-0.06	0.05	-0.19	0.08
	Class III obesity	0.08	0.08	-0.15	0.30
Class III obesity	Underweight	-0.43 [a]	0.07	-0.62	-0.23
	Normal weight	-0.32 [a]	0.07	-0.51	-0.14
	Overweight	-0.19	0.07	-0.38	0.00
	Class I obesity	-0.13	0.07	-0.33	0.07
	Class II obesity	-0.08	0.08	-0.30	0.15

[a] Significant mean difference after Bonferroni correction (15 comparisons) ($p < .003$).

Table S1.3. Post hoc comparisons of body size perception discrepancy and weight groups using a Games Howell test.

				95% CI	
Weight group (I)	Weight group (J)	Mean difference (I-J)	SE	Lower	Upper
Underweight	Normal weight	-0.92 [a]	0.03	-1.01	-0.84
	Overweight	-1.64 [a]	0.03	-1.73	-1.56
	Class I obesity	-2.18 [a]	0.04	-2.28	-2.08
	Class II obesity	-2.60 [a]	0.06	-2.76	-2.44
	Class III obesity	-2.77 [a]	0.09	-3.04	-2.49
Normal weight	Underweight	0.92 [a]	0.03	0.84	1.01
	Overweight	-0.72 [a]	0.01	-0.75	-0.68
	Class I obesity	-1.26 [a]	0.02	-1.32	-1.19
	Class II obesity	-1.67 [a]	0.05	-1.81	-1.54
	Class III obesity	-1.84 [a]	0.09	-2.11	-1.58
Overweight	Underweight	1.64 [a]	0.03	1.56	1.73
	Normal weight	0.72 [a]	0.01	0.68	0.75
	Class I obesity	-0.54 [a]	0.03	-0.61	-0.46
	Class II obesity	-0.96 [a]	0.05	-1.10	-0.81
	Class III obesity	-1.12 [a]	0.09	-1.39	-0.86
Class I obesity	Underweight	2.18 [a]	0.04	2.08	2.28
	Normal weight	1.26 [a]	0.02	1.19	1.32
	Overweight	0.54 [a]	0.03	0.46	0.61
	Class II obesity	-0.42 [a]	0.05	-0.57	-0.27
	Class III obesity	-0.59 [a]	0.09	-0.86	-0.32
Class II obesity	Underweight	2.60 [a]	0.06	2.44	2.76
	Normal weight	1.67 [a]	0.05	1.54	1.81
	Overweight	0.96 [a]	0.05	0.81	1.10
	Class I obesity	0.42 [a]	0.05	0.27	0.57
	Class III obesity	-0.17	0.10	-0.46	0.13
Class III obesity	Underweight	2.77 [a]	0.09	2.49	3.04
	Normal weight	1.84 [a]	0.09	1.58	2.11
	Overweight	1.12 [a]	0.09	0.86	1.39
	Class I obesity	0.59 [a]	0.09	0.32	0.86
	Class II obesity	0.17	0.10	-0.13	0.46

[a] Significant mean difference after Bonferroni correction (15 comparisons) ($p < .003$).

Table S2. Cohen's *d* effect sizes of deviations from the neutral midpoint of body image scales per weight group.

Body image scale	Weight group	Mean (SD)	*d* (SD)	Effect size interpretation
Appearance evaluation	Underweight	3.86 (1.03)	0.86 (1.02)	Large
	Normal weight	3.86 (0.91)	0.86 (0.90)	Large
	Overweight	3.20 (1.00)	0.19 (0.99)	Trivial
	Class I obesity	2.74 (1.02)	-0.26 (1.01)	Small
	Class II obesity	2.50 (0.93)	-0.50 (0.93)	Medium
	Class III obesity	2.38 (1.03)	-0.62 (1.02)	Medium
Appearance orientation	Underweight	3.71 (0.78)	0.91 (1.00)	Large
	Normal weight	3.60 (0.77)	0.78 (0.99)	Medium
	Overweight	3.47 (0.77)	0.61 (1.00)	Medium
	Class I obesity	3.41 (0.82)	0.53 (1.05)	Medium
	Class II obesity	3.36 (0.80)	0.46 (1.02)	Small
	Class III obesity	3.28 (0.83)	0.36 (1.07)	Small
Body size perception discrepancy	Underweight	-0.16 (1.03)	-0.17 (1.09)	Trivial
	Normal weight	0.76 (0.80)	0.80 (0.86)	Large
	Overweight	1.48 (0.73)	1.57 (0.78)	Very large
	Class I obesity	2.01 (0.81)	2.14 (0.86)	Huge
	Class II obesity	2.43 (0.90)	2.59 (0.96)	Huge
	Class III obesity	2.60 (1.16)	2.77 (1.23)	Huge

All scores had significant *p*-values < .001.

CHAPTER 3

BODY IMAGE AS A POTENTIAL MOTIVATOR FOR BARIATRIC SURGERY: A CASE-CONTROL STUDY

D.J.S. Makarawung
V.M. Monpellier
F. van den Brink
L. Woertman
H. Zijlstra
A.B. Mink van der Molen
B. van Ramshorst
R. Geenen

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ABSTRACT

Background

Not every eligible person opts for bariatric surgery. Body image concerns might be a reason to choose surgery. This case control study evaluated differences in body image between a pre-bariatric surgery population and a weight-matched control group from the general population. We hypothesized that the pre-bariatric group would show less satisfaction with appearance, defined as a discrepancy between evaluating one's global appearance as less attractive while attaching more importance to appearance.

Methods

Data from 125 pre-bariatric patients were compared with 125 body-weight matched controls from the general population. The Multidimensional Body-Self Relations Questionnaire-Appearance Scales was used to assess appearance evaluation (AE), appearance orientation (AO) and their discrepancy score. Both groups were compared with norms from the non-body-weight matched general population.

Results

The pre-bariatric group had lower AE scores (mean 2.23±0.65 vs. mean 2.54±1.06) and higher AO scores (mean 3.33±0.69 vs. mean 3.04±0.90) than the control group. The discrepancy between AE and AO was larger in the pre-bariatric group ($p < .001$). Compared with the general population, both groups showed lower AE scores ($d = -1.43$ and $d = -1.12$, $p < .001$) and lower AO scores ($d = -0.23$ and $d = -0.58$, $p < .001$).

Conclusions

People with morbid obesity have on average less body image satisfaction. The results indicate that part of the motivation of people that choose bariatric surgery may be due to relatively low global appearance evaluation combined with considering appearance more important. Knowledge about motivations can be used to communicate realistic expectations regarding treatment outcome.

INTRODUCTION

Although the health benefits of bariatric surgery are evident [1,2], only a small part of the people with extreme obesity choose surgery to reduce their weight [3]. Men are underrepresented in the bariatric population; reasons for this include the idea there is still time to pursue other weight loss options, less impact of obesity on health-related quality of life (HRQL), less health awareness – men tend to wait until they are older and have comorbidities – and less eligibility (according to the IFSO-criteria) of men [4-7]. Another factor that could influence men from not applying for bariatric surgery is difference in body image between men and women. Women commonly report greater body image concerns than men, are more concerned with their appearance, and report greater negative affective consequences of body image dissatisfaction [8–11]. Body image dissatisfaction may influence whether people with extreme obesity choose surgery or not.

Body image is a multidimensional construct that is defined as one's body-related self-perceptions and self-attitudes, including feelings, beliefs, thoughts and behaviors [12]. Specifically, the discrepancy between considering appearance important (higher appearance orientation) and evaluating one's appearance as less attractive (lower appearance evaluation) is suggested to reflect dissatisfaction with appearance [13]. Body image concerns are believed to be one of the motivational catalysts for appearance enhancing behavior such as weight loss and are reported as a motivator to undergo bariatric surgery [14–20]. This suggests that obese people with body image dissatisfaction would opt for surgical treatment.

Understanding the role of body image dissatisfaction in extreme obesity and more specifically in bariatric surgery patients may help to improve care and outcome for these patients. To our knowledge, no case-control studies have been conducted to evaluate body image disparities in pre-bariatric surgery patients and people with (extreme) obesity from the general population. In order to gain insight into body image as a potential motivator to seek bariatric surgery, this study evaluated differences in body image between patients who chose to undergo bariatric surgery versus a body weight-matched control group from the general population, and to quantify the extent of body image problems for both extremely obese groups in comparison to the general (non-weight-matched) Dutch population. We hypothesized that the *pre-bariatric group* would show more dissatisfaction with their appearance (defined as a discrepancy between higher appearance orientation and lower appearance evaluation scores) than a matched obese sample from the general population and that appearance evaluation would be less in both obese groups compared with the general population.

METHODS

Patient selection

Pre-bariatric group

3

This case-control study uses data sets collected in two cohorts as follows: pre-bariatric surgery patients and the general population. Data of the *pre-bariatric group* were collected between January 2008 and November 2010. Patients were selected from a waiting-list for bariatric surgery in the St. Antonius Hospital, Nieuwegein, The Netherlands (*n* = 192). All patients were screened according to the IFSO-criteria [21]. Of the 192 patients invited, a total of 160 preoperative patients completed the questionnaires.

Participants signed an informed consent form prior to inclusion in the study. Ethical approval was obtained from The Research and Ethics Committee (METC) of the St. Antonius Hospital Nieuwegein. The study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Control group and general population

The *control group* from the general population was a matched sample selected from a database of 41,119 people who participated in a study on body image between March 2007 and June 2008 [22]. Aim of this study in the general population was to gain insight into body image in adolescence and adulthood. Data were collected online and participants were recruited via the website of a television documentary. The entire database was also used to calculate reference values of body image, which in this study are referred to as *the general population*.

Multidimensional Body-Self Relations Questionnaire

The Dutch version of the Multidimensional Body-Self Relations Questionnaire-Appearance Scales (MBSRQ-AS) was used to assess body image in all participants [23,24]. In the *pre-bariatric group,* this questionnaire was completed before surgery. The MBSRQ-AS was developed as a self-report instrument to assess affective, behavioral and cognitive dispositions to one's body [25]. The response format is a 5-point Likert scale, from 'definitely disagree' to 'definitely agree'. For the present study, the following subscales were assessed:

1. 'Appearance evaluation': to assess feelings of physical attractiveness (higher score indicates a more positive judgment about appearance);
2. 'Appearance orientation': to assess extend of investment in appearance (higher score indicates a greater importance to appearance, presentation and grooming).

The discrepancy score (appearance orientation score minus appearance evaluation score) was calculated and used as a measure of body image dissatisfaction [13]. Participants with a high discrepancy score place high importance on looks and grooming activities, while they have a more negative judgment about their appearance, i.e., body image dissatisfaction. In the current study, internal consistencies were adequate to good. Cronbach's α for appearance evaluation were .76 and .86 and for appearance orientation .86 and .85 in the *pre-bariatric* and *control groups*, respectively.

Additional data

Demographic characteristics, level of education, and height and weight measurements at time of questionnaire were collected. Psychiatric and psychological conditions such as mood, eating and anxiety disorders were not part of the study data.

Statistical analysis

Each patient in the *pre-bariatric group* was matched by hand to a subject from the general population, based on age, gender and body-mass index (BMI). When there were more persons with similar demographic characteristics in the general population sample, the person with the lowest random number (generated in SPSS) was selected. When a perfect match of age or BMI was not feasible, a person from the preoperative group was matched to someone in the same age category within a range of 5 years for age and 5 kg/m^2 for BMI. In case a match could not be produced, the patient in the *pre-bariatric group* was excluded. After matching, both groups consisted of 132 patients. Finally, completeness of questionnaires was reviewed: One patient in the *pre-bariatric group* and six patients in the *control group* did not complete the MBSRQ-AS questionnaire. Consequently, these patients and their respective matches were excluded leaving 125 patients in each group.

Statistical analyses were performed using the SPSS (version 25) statistical software. A p-value of <.05 was considered statistically significant. Normality was tested. Independent samples t-tests and X^2 tests were used to compare baseline characteristics and scores on the MBSRQ-AS subscales of the *pre-bariatric group* vs. the *control group*.

Logistic regression analysis was performed using the PROCESS macro [26] to identify possible predictors of belonging to the *pre-bariatric group* vs. the *control group*. Predictor variables of group membership were appearance evaluation, appearance orientation, their interaction and level of education. Level of education was dichotomized for analysis: Primary education, lower vocational education and secondary vocational education were combined, as well as higher general and pre-university education, higher professional education, and academic education.

To express the magnitude of differences for appearance evaluation and appearance orientation of both groups compared with the *general population* one samples t-tests were used and Cohen's *d* effect sizes were calculated, using the mean and standard deviation of the whole general population sample [22] as reference values. Values of 0.20, 0.50 and 0.80 represent small, medium and large deviations respectively [27].

3

RESULTS

Patient characteristics

A total of 125 patients from the *pre-bariatric group* were matched to persons from the general population, i.e., the *control group* (Table 1). Gender ($\chi^2 < 0.001$, $p = 1.00$), age (t = -0.043; $p = .97$) and BMI (t = 1.43; $p = .15$) did not differ between the groups. Education level of the *control group* was significantly higher ($\chi^2 = 32.11$, $p < .001$). Therefore, education level was entered as a covariate in the regression analysis. The general population ($n = 41{,}119$) consisted primarily of women (84.3%), with a mean age of 32±12.83 years and a mean BMI of 23.09±4.10 kg/m^2.

Body image

A total of 125 patients completed the MBSRQ-AS questionnaire in the *pre-bariatric group* and in the *control group* (Table 1). From the general population ($n = 41{,}119$), 39,440 persons completed the MBSRQ-AS questionnaire.

Appearance evaluation scores were significantly lower in the *pre-bariatric group* compared with the *control group* (mean 2.23±0.65 vs. mean 2.54±1.06, t = -2.83, $p = .005$); thus, the *pre-bariatric group* evaluated their appearance as less attractive. In the general population the mean appearance evaluation score was 3.66±1.00.

Appearance orientation scores were significantly higher in the *pre-bariatric group* compared with the *control group* (mean 3.33±0.69 vs. mean 3.04±0.90, t = 2.81, $p = .005$); thus, the *pre-bariatric group* was more focused on their appearance. Mean appearance orientation score in the general population was 3.52±0.81.

The discrepancy score between appearance orientation and appearance evaluation was significantly larger in the *pre-bariatric group* compared with the *control group* (mean 1.10±1.00 vs. mean 0.50±1.45, t = 3.80, $p < .001$), which reflects that body image dissatisfaction was higher in the *pre-bariatric group*. The mean discrepancy score in the general population was -0.15±1.36.

Pre-bariatric group compared with control group

Table 2 shows the results of the regression analysis examining associations with group-membership (*pre-bariatric group* vs. *control group*). In the *pre-bariatric group*, appearance evaluation scores were lower, appearance orientation scores were higher and education level was lower than in the body-weight-matched *control group.* Thus, patients who evaluated their appearance as less positive or invested more in their appearance were more likely to be *pre-bariatric patients*. The interaction between appearance evaluation and appearance orientation did not predict group membership, which reflects that the effect of both a low appearance evaluation score and a high appearance orientation score was additive and not multiplicative (both scores added up to the chance to be in the *pre-bariatric group* but did not amplify this chance).

Table 1. Demographic characteristics of the pre-bariatric and control groups.

	Pre-bariatric group n = 125	Control group n = 125
Gender, n (%)		
Female	93 (74.4)	93 (74.4)
Male	32 (25.6)	32 (25.6)
Age (yrs), mean (SD)	43.9±10.5	44.0±10.3
Body Mass Index, kg/m^2	45.6±6.9	44.3±6.5
Education level, n (%) [a, b]		
Primary- , lower- and secondary vocational education	97 (78.2)	59 (47.2)
Higher general and pre-university education, higher professional and academic education	27 (21.8)	66 (52.8)
MBSRQ-AS, mean (SD)		
Appearance evaluation [b]	2.23±0.65	2.54±1.06
Appearance orientation [b]	3.33±0.69	3.04±0.90
Discrepancy score [b]	1.10±1.00	0.50±1.45

Note: MBSRQ-AS = Multidimensional Body Self-Relations Questionnaire – Appearance Scales
[a] Education level of one participant in the pre-bariatric group was missing
[b] Significant difference, $p < .05$

Table 2. Predictors of group membership (pre-bariatric vs, control group) using a multiple regression analysis.

					95% confidence interval	
Predictors	B	SE B	log of odds ratio	p	Lower	Upper
Constant	0.49	0.17	2.89	.004	0.16	0.82
Appearance evaluation (AE)	-0.33	0.16	-2.09	.037	-0.65	-0.021
Appearance orientation (AO)	0.44	0.17	2.53	.012	0.010	0.78
AE * AO interaction	-0.001	0.19	-0.007	1.00	-0.37	0.38
Level of education	-1.39	0.29	-4.78	<.001	-1.96	-0.82

Study groups compared with the general population

The magnitude of differences between the groups and the general population expressed in Cohen's *d* effect sizes showed large reduced appearance evaluation deviations for both the *pre-bariatric group* and the *control group* (t = -87.81, d = -1.43±0.65, $p < .001$; t = -50.54, d = -1.12±1.06, $p < .001$, respectively). Appearance orientation was reduced as well; this effect size was small for the *pre-bariatric group* (t = -49.53, d = -0.23±0.85, $p < .001$) and medium for the *control group* (t = -41.22, d = -0.58±1.11, $p < .001$).

Compared with the general population, lower scores on appearance evaluation were overrepresented in both groups. More than 90% of patients in the *pre-bariatric group* and over 70% of the *control group* rated their appearance less attractive – more than

0.5 standard deviations – compared with the general population (Figure 1.a). Also, for appearance orientation both groups were overrepresented in the low score category of appearance orientation (Figure 1.b).

3

DISCUSSION

The present study compared body image in a pre-bariatric sample and a weight-, gender-, and age-matched control group. Our results showed that pre-bariatric obese patients evaluate their appearance as less attractive than the matched controls and place more importance on their appearance. Additionally, body image dissatisfaction (discrepancy score between appearance orientation and appearance evaluation) was higher in the *pre-bariatric group*. Both groups of persons with obesity had significantly lower scores on appearance evaluation and appearance orientation in comparison with a sample from the general Dutch population.

The observed differences between the *pre-bariatric group* and the *control group* add to findings in a previous case-control study indicating that people participating in a commercial weight-loss program invested more strongly in their appearance and experienced more body image distress than the matched control group [28] and to previous research evaluating motives for bariatric surgery [15–19]. In a retrospective evaluation of motives for gastric banding, appearance/embarrassment was the most frequently chosen (32%) primary motivation, especially in women [16]. Other motivational factors included medical condition, health concerns, physical fitness and physical limitation (together

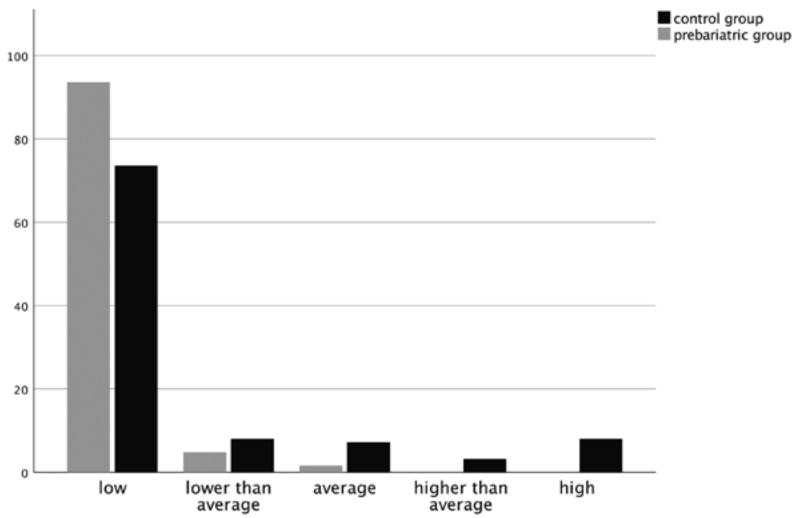

Figure 1.a Percentages of participants with low to high scores on appearance evaluation by group, based on individual effect sizes (Cohen's d). Categories were derived from score distribution in the general population. Meaning of labels: low: $d \leq -0.5$, lower than average: $> -0.5\ d \leq -0.2$, average: $> -0.2\ d < 0.2$, higher than average: $\geq 0.2\ d < 0.5$, high: $d \geq 0.5$

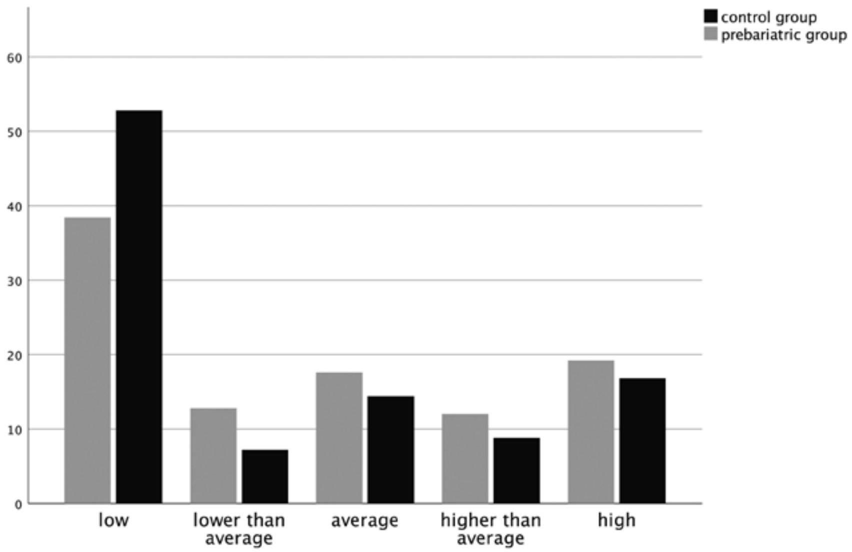

Figure 1.b Percentages of participants with low to high scores on appearance orientation by group, based on individual effect sizes (Cohen's d). Categories were derived from score distribution in the general population. Meaning of labels: low: $d \leq -0.5$, lower than average: > -0.5 $d \leq -0.2$, average: > -0.2 $d < 0.2$, higher than average: ≥ 0.2 $d < 0.5$, high: $d \geq 0.5$

accounting for 68%). When comparing body image dissatisfaction in the appearance/embarrassment group with the groups with other primary motives, the discrepancy score between appearance evaluation and appearance orientation was larger in the 'appearance motive group', supporting our findings. Taken together, these results suggest that body image might play a role in seeking surgical treatment and, more specifically, that patients who evaluate their appearance as less attractive but also consider appearance important might opt for surgical treatment. However, we should bear in mind that other motivational factors also play a role in the final decision to opt for bariatric surgery, such as a low (mental and physical) quality of life and health, longevity, psychosocial factors and work-related factors [19,29,30].

In comparison with the non-weight-matched general population, both groups showed lower appearance evaluation scores, with even lower scores in the *pre-bariatric group*. Appearance orientation scores were higher in the *pre-bariatric group* compared with the *control group* and both groups had lower scores than the general population. These results confirm previous observations that people with obesity in general regard themselves as less attractive and tend to invest less in their appearance [13,31–36]. Furthermore, we observed patients in the *control group* who evaluated their appearance higher than community norms. These people might have a positive distorted body image in terms of underestimation of weight and size, which might be a reason for them to not seek surgical treatment. The general population in our study was representative as it included people with body weight ranging from underweight to extreme obesity, whereas most previous research used normal-weight controls or did not assess the weight of the control group [13,31–36].

Although the health benefits of bariatric surgery are evident, only a small portion of eligible patients chooses bariatric surgery [37,38]. Understanding the role of body image in the obese population and especially in this population can be used to communicate realistic expectations regarding treatment and may optimize treatment outcome. For example, by recognizing patients with low body image and by adding psychological interventions to enhance their body image postoperatively, outcome after treatment can be improved. Body image and obesity have a complex relationship. Body image is suggested to play a role in the origin of obesity, it can be a motivational catalyst for appearance enhancing behavior and it affects regulating body weight over time after weight loss [14, 39–43]. Body image generally improves after bariatric surgery [44–46], however it fails to reach population norms [13,34,35] and body image also affects the desire for post-bariatric body contouring surgery [47]. Body image plays a role in outcome expectations, it can be seen as a predictor to seek subsequent body contouring surgery and is a mediator in other outcomes, such as weight management. Thus, recognizing body image and adding psychological interventions may affect outcome of bariatric surgery and postoperative satisfaction. Hence, body image should be considered a parameter in assessment of HRQL in bariatric patients [48–50].

Strengths of this study were the large number of participants and the matched control group, which showed no significant differences in BMI, gender, and age. It might be considered a limitation that our cohort predominantly consisted of women: women are more prone to body concerns than men [50]. Since bariatric surgery patients are often female, our cohort is representative of this group [51]. However, our results may be less generalizable to men. Body image is a multidimensional construct [12]. In this study we only collected the appearance scales of body image. For a more complete overview, future research could add other aspects such as body checking, perceived body size, perceived body space, body awareness, and body acceptance.

Moreover, there are some limitations to our data. We could not control for comorbid conditions such as mood disorders, eating disorders and anxiety disorders since these data were not part of this study. Additionally, it is unknown whether the people in the control group were participating in any form of weight loss treatment. The difference in education level, with higher education in the control group, might have affected body image. However, correlations of education level with appearance evaluation or appearance orientation were trivial and non-significant (data not shown), and the results of regression analyses were adjusted for differences in education level between groups.

CONCLUSION

This study shows differences in body image between both obese groups and the general population, substantiating the importance of body image in obese patients. In order to optimize treatment outcome after bariatric surgery, doctors/physicians should be aware of this construct because of its potential effects on well-being, desire for subsequent body contouring surgery and long-term weight maintenance. Our study indicated that body image might also play a role in choosing treatment for obesity. Patients who consider appearance important and evaluate their appearance negatively might seek bariatric surgery to reduce weight. Knowledge about motivations will enable surgeons to communicate realistic expectations, improve consult efficacy and improve patient satisfaction. In assessments of bariatric patients, body image should be considered a parameter of HRQL. Future research should focus on whether interventions that increase satisfaction with body image, either pre- or postoperatively, could improve well-being and reduce weight regain.

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CHAPTER 4

BODY IMAGE AND WEIGHT LOSS OUTCOME AFTER BARIATRIC SURGERY: A MIXED MODEL ANALYSIS

D.J.S. Makarawung
P.J. Dijkhorst
C.E.E. de Vries
V.M. Monpellier
M.J. Wiezer
R.N. van Veen
R. Geenen
A.B. Mink van der Molen

Submitted

ABSTRACT

Background

As in non-surgical weight loss populations, body image may partly explain differences in weight loss outcome after surgery. The aim of this study was to determine the association between body image and weight loss in a prospective cohort of patients up to three years after bariatric metabolic surgery.

Methods

In this longitudinal cohort study, the BODY-Q self-report questionnaire was used to assess body image. Linear mixed models evaluated associations of baseline body image with weight loss in the first year as well as associations of body image at 12 months and first year change in body image with weight loss 12 to 36 months after surgery.

Results

Available body image data included 400 (100%), 371 (93%), 306 (77%), 289 (72%) and 218 (55%) patients at baseline, and 4, 12, 24 and 36 months, respectively. Body image scores improved significantly until 12 months, followed by a gradual decline. Scores remained improved in comparison with baseline (β 31.49, 95% CI [27.8, 35.2], $p < .001$). Higher baseline body image was associated with less weight loss during the first year, the effect-size was trivial (*β* -0.05, 95% CI [-0.09, -0.01], $p = .009$). Body image and change in body image were not associated with weight loss 12 to 36 months after surgery.

Conclusion

Body image improved after bariatric metabolic surgery. Although no clinically relevant associations of body image with weight loss were demonstrated, the gradual decline in body image scores underlines the importance of long-term follow-up with regular assessment of this aspect of quality of life.

INTRODUCTION

Bariatric metabolic surgery is the most effective weight loss treatment for people with obesity [1–3]. Demonstrated effects include weight loss, remission of associated medical problems, and improvements in health-related quality of life (HRQL). Despite overall positive results, there is heterogeneity in weight loss outcome and weight loss maintenance [4,5]. Identification of factors associated with weight loss may facilitate optimizing these outcomes. Similar to non-surgical weight loss populations [6,7], a more positive body image may be associated with increased weight loss after bariatric metabolic surgery. Body image is a complex multidimensional construct that describes one's body-related self-perceptions and self-attitudes, including feelings, beliefs, thoughts and behaviors [8,9]. Concerns with body image are assumed to play a role in the origin of obesity [10] and obesity is associated with body image concerns [11–13]. Particularly, patients undergoing bariatric metabolic surgery experience more body image concerns than people with normal weight [14–21].

While after bariatric metabolic surgery generally improvement of body image is observed [14,15,18–34], a higher body-mass index (BMI) is not necessarily related to more body image concerns before surgery [18,22,29,35]. Though, a positive relationship between BMI and body image before surgery was found in a study with a small sample [32]. It is believed that body image concerns are the motivational catalyst to weight changing behavior [36]. Indeed, patients undergoing bariatric metabolic surgery reported enhancing body image as a motivator to pursue surgery [37] and showed a greater dissatisfaction with body image in comparison with matched controls from the general population [16]. Moreover, more body image concerns before surgery were associated with higher weight loss [27,38]. However, others studies found no relationship of preoperative body image with weight loss [22,29]. The apparently contradicting results of studies that examined the relationship between body image and BMI may be explained by the small sample sizes and short follow-up times of the studies [22,27,29,38]. A study in a large sample with a longer follow-up is needed to get a more final answer.

While improvement of body image after bariatric metabolic surgery has been frequently observed, knowing whether body image and changes in body image are associated with more favorable weight loss may help to detect patients that benefit from tailored guidance before and after bariatric metabolic surgery. As yet, there is some support for the hypothesis that a better preoperative body image is associated with higher weight loss, as well as for the opposing hypothesis that it is associated with a poorer weight outcome. In addition to body image before surgery, post-bariatric changes in body image may be associated with long-term weight loss, a hypothesis that has not been previously investigated. Therefore, the objective of this study was to examine the contradicting hypotheses by determining the association between body image and weight loss, in a large longitudinal sample up to three years after bariatric metabolic surgery.

METHODS

Participants

The data were collected in an ongoing prospective, multicenter study conducted in two bariatric metabolic surgery hospitals: the OLVG West, Amsterdam and St. Antonius Hospital, Nieuwegein, the Netherlands. Eligible patients were 18 years or older and had undergone either a laparoscopic sleeve gastrectomy (SG) or a laparoscopic Roux-en-Y gastric bypass (RYGB). An exclusion criterion was insufficient proficiency of the Dutch language. All participants were recruited prior to surgery between December 2017 and November 2018 at the outpatient clinics. Before enrollment, an informed consent form was signed. Ethical approval was obtained from each site's ethics committee (registration number NL60699.100.17). All patients were previously screened according to the IFSO criteria at one of the largest outpatient clinics for bariatric metabolic surgery in the Netherlands: the Dutch Obesity Clinic (Nederlandse Obesitas Kliniek, NOK). The NOK provides a specialized multidisciplinary approach to assist patients in adopting and sustaining a healthy lifestyle during a five-year follow-up program [39].

Data collection

Participants completed the BODY-Q questionnaire before surgery, and 4, 12, 24 and 36 months after surgery. Non-responders received two reminders spaced a week apart. A secure web-based application (CASTOR) was used to send the online questionnaires and store data [40]. All participants completed the questionnaire at baseline and at least once during follow-up.

Questionnaire data: BODY-Q

The BODY-Q – a patient-reported outcome measure (PROM) for people with obesity, and people who underwent surgical or non-surgical weight loss interventions – was developed according to international standards [41,42]. It includes input from patients and experts in the field of obesity treatment and was psychometrically validated in multiple studies [43,44]. The BODY-Q measures the domains appearance, HRQL and healthcare experiences, using scales that can be applied separately. BODY-Q scale scores can be converted into a Rasch score that ranges from 0 (worst) to 100 (best) [45]. For this study, we used data from the 'Body Image' and 'Excess Skin' scales, both response formats contained a 4-point Likert scale:

- Body Image: this scale includes seven items which ask respondents to indicate how much they disagree/agree that they are happy with their body, proud of their body and feel positive towards their body (e.g., "My body is not perfect, but I like it" or "I am happy with my body" [45]). A higher score indicates more positive feelings. Cronbach's α was .96 [43].
- Excess Skin: this scale contains seven items that measure how much an individual is bothered by their excess skin (extremely bothered/not at all) (e.g., "The amount of

excess skin you have" or "Having to dress a certain way to hide your excess skin"). A higher score indicates less complaints of excess skin. Cronbach's α was .95 [43].

Patient demographics

Demographic characteristics including age, gender, height and weight measurements, medical history, and % total weight loss (%TWL) were derived from the electronic patient file of the NOK. Weight data were available preoperatively, and at 6, 12, 24 and 36 months after surgery. If data regarding weight (loss) were not available, it was supplemented with self-reported data provided by the additional questionnaire that was sent to the patients. This questionnaire also included questions concerning level of education, migration background, work, marital and smoking status.

Statistical analysis

All analyses were conducted using SPSS software version 26. A two tailed $p < .05$ was considered statistically significant. Variables were checked for normality. Normally distributed variables are presented as mean (standard deviation) and non-normally distributed variables as median (interquartile range, IQR). To investigate multivariate outliers, residuals of regressions models were examined, and Cook's distances were calculated; a value exceeding one was considered divergent. Level of education was transformed into two categories: elementary or secondary school and intermediate-, higher vocational education, or university. Employment status was divided into parttime, fulltime, or self-employed and no paid work, looking for work, or student. Marital status was dichotomized into married, living together, or in a relationship and divorced, widowed, or single. Smoking status was divided into never smoked and active smoker or quit smoking. Migration background was transformed into Dutch or non-Dutch. Bariatric metabolic surgery type was split into RYGB or SG; patients with secondary procedures were not included.

Patient characteristics were presented with descriptive statistics. Baseline associations of body image with baseline variables were examined using univariable linear regression analyses for each variable. Descriptive statistics were used to present BMI at baseline and at 6, 12, 24 and 36 months postoperatively and %TWL at 6, 12, 24 and 36 months postoperatively.

Linear mixed-model analysis (LMM) is suitable for the analysis of longitudinal datasets because an adjustment is made for the correlation between repeated observations within the subject [46]. Also, all available data points are used without the need for imputation methods [47]. LMM compared %TWL between all timepoints (Bonferonni correction, six comparisons, $p < .008$). Body image scores were presented preoperatively and at 4, 12, 24 and 36 months after surgery and differences were evaluated by LMM (Bonferonni correction, 10 comparisons, $p < .005$).

To examine the association of body image with weight loss, two follow-up periods were analyzed: first, the period of massive weight loss and second, the weight stabilization phase. After evaluation of %TWL, the transition between these phases was set at 12 months. The association of body image with weight loss was analyzed under three conditions: 1) the association between baseline body image and the massive weight loss phase (change in %TWL between 6 and 12 months postoperatively), 2) the association between body image at 12 months and the weight stabilization phase (change in %TWL from 12 to 24 and 36 months postoperatively), and 3) the association of the improvement in body image from baseline to 12 months with the weight stabilization phase (change in %TWL from 12 to 24 and 36 months postoperatively). All models contain a crude variant and one with predetermined confounders, which are based on previously investigated factors that were associated with weight loss (baseline BMI, type of bariatric metabolic surgery and any obesity associated medical problem). Change in body image (baseline to 12 months after surgery) was calculated by subtracting the baseline score from the 12 months score. To correct for regression to the mean, baseline body image was added to the model.

In all models an interaction of the dependent variable (body image) with time was added to assess whether the association of body image with %TWL differed between specific follow-up moments. In analyses of change in %TWL scores after the first post-surgical year (12, 24 and 36 months), the excess skin score at 12 months, indicating to what extend patients were bothered by their excess skin, was included as a confounder.

RESULTS

Patient characteristics

Patient characteristics are presented in Table 1. The study sample consisted of 400 patients with a mean age of 45.2±11.0 years, mostly women (85.8%) with a mean preoperative BMI of 42.9±4.6 kg/m^2. Most patients had a primary RYGB (63.5%).

Weight change after surgery

Data regarding BMI and %TWL were available from 400 (100%), 376 (94%), 367 (92%), 329 (82%) and 266 (67%) patients at baseline and 6, 12, 24 and 36 months, respectively (Figure 1). The lowest weight was achieved 24 months postoperatively with a mean %TWL of 33.6±9.0; however, mean %TWL varied from 32.7% and 33.6% to 31.7% in the follow-up interval from 12 to 36 months after surgery. In this period, LMM showed only a significant difference from 24 to 36 months (*ß* -1.88, 95% CI [-3.18, -0.57], p = .005).

Body image

Body image data were available from 400 (100%), 371 (93%), 306 (77%), 289 (72%) and 218 (55%) patients at baseline, and 4, 12, 24 and 36 months, respectively (Figure 2). Body image scores were highest 12 months after surgery with a mean score of 55.7±23.5, followed by a gradual decline in the following years. LMM showed only a significant difference from 12

Table 1. Baseline characteristics of the included population (n = 400).

Gender, *n* (%)	
Female	343 (85.8)
Male	57 (14.2)
Age (years), mean (SD)	45.2 (11.0)
Baseline BMI (kg/m^2), mean (SD)	42.9 (4.6)
Level of education, *n* (%)	
Elementary or secondary school	62 (15.5)
Intermediate vocational education	212 (53.0)
Higher vocational education or university	125 (31.3)
Employment status, *n* (%)	
Parttime, fulltime, or self-employed	302 (75.5)
No paid work, looking for work, or student	97 (24.3)
Marital status, *n* (%)	
Married, living together, or in a relationship	281 (70.3)
Divorced, widowed, or single	118 (29.5)
Any obesity-associated medical problem, *n* (%)	346 (86.5)
History of eating disorder, *n* (%)	7 (1.8)
History of depression, *n* (%)	38 (9.5)
Smoking status, *n* (%)	
Never	193 (48.3)
Active smoker or quitted	207 (51.7)
Migration background (*n* = 257), *n* (%)	217 (84.4)
Dutch	205 (79.8)
Non-Dutch	52 (20.2)
Bariatric surgery type, *n* (%)	
Roux-en-Y gastric bypass [a]	265 (66.2)
Sleeve gastrectomy [b]	135 (33.8)

[a] Includes ten procedures secondary to gastric banding and one procedure secondary to Mason vertical gastroplasty.
[b] Includes one procedure secondary to gastric banding.

to 36 months (*ß* -7.40, 95% CI [-11.29, -3.51], $p < .001$). Scores at 36 months were much higher than baseline scores (*ß* 31.49, 95% CI [27.8, 35.2], $p < .001$).

Associations with body image before surgery

No significant associations between baseline variables and body image at baseline were demonstrated (Supplementary table S1). There was no significant relationship between BMI and body image before surgery (*ß* -0.05, 95% CI [-0.43, 0.33], $p = .81$), which is exemplified in the scatterplot (Supplementary Figure S1). Around 40% percent of the participants, evenly distributed across the range of BMI, had the lowest possible body image score (0).

Relationship between baseline body image and weight loss

The results of the LMM on the association between baseline body image and change in %TWL between 6 and 12 months after surgery are presented in Table 2. Higher

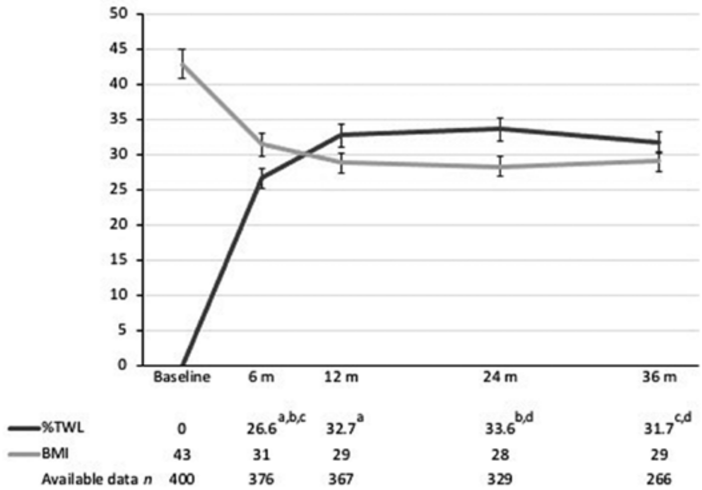

Figure 1. Mean body-mass index (kg/m^2) [95% confidence interval bars] and percentage total weight loss (%TWL) at baseline and during follow-up in months. Significant differences (Bonferonni correction, six comparisons, p<.008) between timepoints are indicated by similar superscripts.

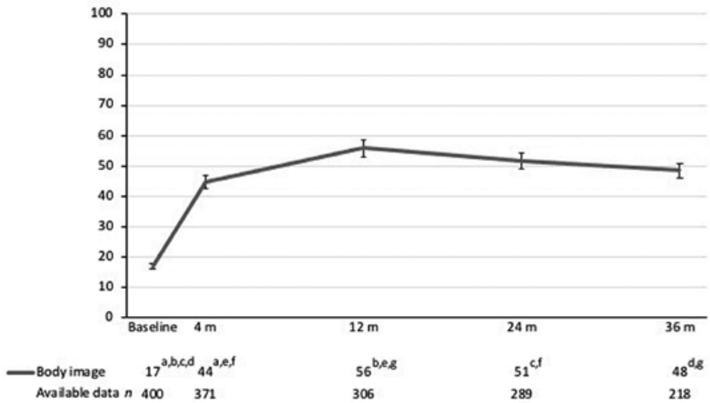

Figure 2. Mean body image scores [95% confidence interval bars] at baseline and during follow-up in months. Significant differences (Bonferonni correction, 10 comparisons, p<.005) between timepoints are indicated by similar superscripts.

baseline body image was related to significantly less change in %TWL up to 12 months postoperatively (*ß* -0.05, 95% CI [-0.09, -0.01], p = .009). One point change in baseline body image was associated with -0.05-point difference in change in %TWL up to 12 months after surgery. The association between baseline body image and change in %TWL was not different when comparing 12 to 6 months (model 2). When adjusting for the other confounders the association between baseline body image and TWL was not significant (model 3, *ß* -0.03, 95% CI [-0.07, 0.009], p = .14).

Table 2. Multivariable linear mixed model analyses of associations between baseline body image and change in percentage total weight loss (%TWL) from 6 to 12 months after surgery (crude and with confounders).

				95% confidence interval	
Model	Variable	Beta	*p*	Lower	Higher
1	Baseline body image	-0.05	.009	-0.09	-0.01
2	Baseline body image	-0.04	.03	-0.08	-0.003
	*Baseline body image * Time 6 months* [a]				
	Baseline body image * Time 12 months	-0.02	.10	-0.04	0.003
3	Baseline body image	-0.03	.14	-0.07	0.009
	*Baseline body image * Time 6 months*				
	Baseline body image * Time 12 months	-0.02	.11	-0.04	0.004
	Baseline body-mass index	0.11	.16	-0.04	0.25
	Bariatric surgery type [b]	-3.47	<.001	-4.91	-2.03
	Any associated medical problem [c]	-2.76	.005	-4.71	-0.82

[a] The interaction term body image * time evaluates whether the association between baseline body and change in %TWL 6 to 12 months is significantly different between follow-up moments.
[b] Bariatric surgery type was categorized into Roux-en-Y gastric bypass (reference 0) and sleeve gastrectomy (1).
[c] Any associated medical problem was categorized into absent (reference 0) and present (1).

Relationship of body image and weight loss

The association of body image 12 months after surgery with change in %TWL from 12 to 24 and 36 months postoperatively was examined via LMM (Table 3). There was no association of body image with change in %TWL (*ß* 0.009, 95% CI [-0.03, 0.05], p = .69). Also, the interaction with time did not yield a significant association, nor did the addition of confounders.

Similarly, the analyses evaluating the relationship between change in body image from baseline to 12 months and change in %TWL from 12 to 24 and 36 months did not show significant associations (*ß* 0.02, 95% CI [-0.02, 0.07], p = .22) (Table 4).

DISCUSSION

The objective of this study was to determine the association of body image with weight loss in patients undergoing bariatric metabolic surgery. Preoperative body image and BMI were not related. There was a statistically significant, but not clinically relevant, association between preoperative body image and weight loss in the first year after surgery. Neither the level of body image at 12 months nor the change in body image from baseline to 12 months were associated with change in weight loss 12 to 24 and 36 months postoperatively.

Our results showed that body image scores significantly improved after surgery. The highest body image scores were found 12 months postoperatively, with a gradual, however statistically significant, decline from 12 to 36 months. It is unclear if this decline of 7.4 points is also clinically relevant for individual patients, since the minimum clinically

Table 3. Multivariable linear mixed model analyses of associations between body image one year postoperatively and change in percentage total weight loss (%TWL) 12 to 24 and 36 months after surgery (crude and with confounders).

Model	Variable	Beta	*p*	95% confidence interval Lower	Higher
1	Body image	0.009	.69	-0.03	0.05
2	Body image	0.02	.49	-0.03	0.06
	*Body image * Time 12 months* [a]				
	Body image * Time 24 months	-0.01	.47	-0.04	0.02
	Body image * Time 36 months	-0.01	.38	-0.04	0.02
3	Body image	0.03	.35	-0.04	0.10
	*Body image * Time 12 months*				
	Body image * Time 24 months	-0.01	.41	-0.04	0.02
	Body image * Time 36 months	-0.02	.18	-0.05	0.01
	Bariatric surgery type [b]	-5.48	<.001	-7.60	-3.37
	Any associated medical problem [c]	-3.98	.009	-6.95	-1.01
	Baseline body-mass index	0.20	.07	-0.2	0.42
	Excess skin 12 months postoperatively	-0.03	.28	-0.09	0.03

[a] The interaction term body image * time evaluates whether the association between body image one year postoperatively and change in %TWL 12 to 36 months after surgery is significantly different between follow-up moments.

[b] Bariatric surgery type was categorized into Roux-en-Y gastric bypass (reference 0) and sleeve gastrectomy (1).

[c] Any associated medical problem was categorized into absent (reference 0) and present (1).

important difference (MCID) of the BODY-Q has not yet been determined. Previous longitudinal studies with at least measurements at baseline, 12 and 24 months also indicated relatively stable body image scores after 1 year [17,18,20,23,34]. Thus, while durable improvements in body image are demonstrated, the deterioration that follows the first postbariatric year warrants further investigation. Determining how many individuals experience a clinically meaningful improvement or deterioration of body image will be possible after establishing the MCID for the BODY-Q, which is planned in future studies.

At baseline, no association of body image with BMI was demonstrated. Many participants (41%), evenly distributed across the range of BMI, had the lowest possible body image score (0). Even though there seems to be a relation of higher weight with more body image concerns [48], it could be this is not true for people with obesity and a very low body image [18,22,29,35]. Weight may be related to specific body image dimensions, whereas the items of the BODY-Q reflect mostly cognitive and affective aspects. Also, the BODY-Q might not be sensitive enough to detect inter-individual differences in the lower range of the scale due to the items included; while its items show overlap with the appearance evaluation scale of the Multidimensional Body-Self Relations Questionnaire-Appearance Scales (MBSRQ-AS) reflecting satisfaction with appearance, the MBSRQ-AS also addresses

Table 4. Multivariable linear mixed model analyses of associations between first year change in body image [a] and change in percentage total weight loss (%TWL) from 12 to 24 and 36 months after surgery (crude and with confounders).

Model	Variable	Beta	*p*	95% confidence interval	
				Lower	Higher
1	Change in body image	0.023	.22	-0.02	0.07
	Baseline body image	-0.05	.10	-0.11	0.009
2	Change in body image	0.03	.28	-0.02	0.07
	Baseline body image	-0.05	.10	-0.11	0.01
	*Change in body image * Time 12 months* [b]				
	Change in body image * Time 24 months	0.003	.82	-0.02	0.03
	Change in body image * Time 36 months	0.004	.74	-0.02	0.03
3	Change in body image	0.04	.21	-0.02	0.11
	Baseline body image	-0.03	.49	-0.11	0.05
	*Change in body image * Time 12 months*				
	Change in body image * Time 24 months	0.001	.92	-0.03	0.03
	Change in body image * Time 36 months	-0.006	.69	-0.04	0.02
	Bariatric surgery type [c]	-2.66	<.001	-4.08	-1.25
	Any obesity associated medical problem [d]	-3.43	.02	-6.38	-0.49
	Baseline body-mass index	0.29	.008	0.08	0.50
	Excess skin 12 months postoperatively	-0.03	.37	-0.08	0.03

[a] The first-year change in body image was calculated by subtracting the raw scores of baseline body image and one year body image.
[b] The interaction term change in body image * time evaluates whether the association between change in body image and change in %TWL 12 to 36 months after surgery is significantly different between follow-up moments.
[c] Bariatric surgery type was categorized into Roux-en-Y gastric bypass (reference 0) and sleeve gastrectomy (1).
[d] Any associated medical problem was categorized into absent (reference 0) and present (1).

satisfaction with appearance when dressed, opinions of other people and reversed (negative) items [49]. The body image items of the BODY-Q are all verbalized positive with words such as happy, proud and positive. Because there are no reversed (negative) items, the scale may be prone to acquiescence bias [50].

There was an association between baseline body image and weight loss the first year post-surgery: higher body image was related to lower weight loss. However, the beta effect-size was very small and therefore, considered not clinically relevant. Two prospective studies with large sample sizes found no associations of preoperative body image and weight loss the first year post-surgery [29,38]. Hence, the combination of results indicates that there is probably no or only a trivial association between higher baseline body image and less weight loss the first year after surgery. Regarding the change in weight loss 12 to 24 and 36 months post-surgery, our results did not show an association with body image at 12 months, nor with first year change in body image. These associations have not been previously evaluated in a bariatric metabolic surgery population. The findings in our study cannot be generalized beyond the measurement of body image, which emphasized the emotional appreciation of the body.

The results in this study support previous observations of lasting improvement of body image after bariatric metabolic surgery, but could not confirm either hypothesis regarding the association between body image and weight loss suggested by previous studies. While the courses of mean body image and weight show an about similar slope and direction, our results suggest that changes in body image and changes in weight loss are accounted for by distinct processes. Even though the BODY-Q was designed for patients undergoing bariatric metabolic surgery, the assessment of body image emphasizes positive emotional feelings towards one's body, while in this group also negative feelings, and other features of body image are important (e.g., body (dys)functionality and body shape or size perception). Moreover, comparison of body image outcomes with other literature is hampered by the wide variety of questionnaires used, as well as the limited number of BODY-Q validation studies and comparison materials. Thus, there is a need to standardize body image questionnaires used in bariatric metabolic surgery. To achieve this goal a broad group of clinicians, scientists, and people living with obesity, have started an initiative to reach consensus about standard instruments to measure HRQL, including relevant domains such as body image, in bariatric metabolic surgery [51].

Strengths of this study were the prospective nature, the large number of participants and the use of a questionnaire validated for people undergoing bariatric metabolic surgery. Some limitations must be considered too. There were missing data with the longer-term follow-ups, but LMM is suitable for handling longitudinal databases with missing data. Missing data regarding weight measurements were corrected by adding self-reported weight data, which may be less accurate [52]. Moreover, almost half of our sample had the lowest body image score before surgery; therefore, we could not differentiate within the group of people who are dissatisfied with their body.

CONCLUSION

This prospective study evaluated the course of body image and its associations with weight loss in the first three years after bariatric metabolic surgery. A higher baseline body image was associated with weight loss the first year after surgery, but this effect was too small to be considered clinically relevant. Body image was not associated with longer-term weight loss. Although the mean body image remained very much improved during the postbariatric interval, the gradual decline of body image between one and three years after surgery, underlines the importance of long-term follow-ups with regular assessment of this aspect of quality of life.

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SUPPLEMENTARY FILES

Table S1. Univariable regression model of variables at baseline associated with body image.

Variable	Beta	*p*	95% confidence interval	
			Lower	Higher
Age	-0.07	.40	-0.23	0.09
Body-mass index	-0.05	.81	-0.43	0.33
Gender [a]	4.44	.08	-0.57	9.45
History of depression [b]	-0.26	.93	-6.25	5.74
History of eating disorder [c]	4.09	.55	-9.31	17.49
Bariatric surgery type [d]	2.65	.17	-1.09	6.39
Any associated medical problem [e]	3.39	.20	-1.74	8.52
Marital status [f]	0.58	.77	-3.28	4.44
Level of education [g]	0.25	.92	-4.61	5.11
Employment status [h]	-2.11	.31	-6.22	1.99
Smoking status [i]	1.43	.43	-2.09	4.94
Migration background [j] (n = 257)	-0.28	.92	-5.60	5.03

[a] Gender was categorized into female (reference 0) and male (1).
[b] History of depression was divided into no history (reference 0) and positive history (1).
[c] History of eating disorder was categorized into no history (reference 0) and positive history (1).
[d] Bariatric surgery type was transformed into Roux-en-Y gastric bypass (reference 0) and sleeve gastrectomy (1).
[e] Any associated medical problem was categorized into absent (reference 0) and present (1).
[f] Marital status was transformed into single, divorced, or widowed (reference 0) and married, living together, or in a relationship (1).
[g] Level of education was divided into lower vocational education (reference 0) and intermediate-, higher vocational education or university (1).
[h] Employment status was transformed into parttime, fulltime, or self-employed (reference 0) and no paid work, looking for work, or student (1).
[i] Smoking status was categorized into never (reference 0) and active or quitted (1).
[j] Migration background was transformed into non-Dutch (reference 0) or Dutch (1).

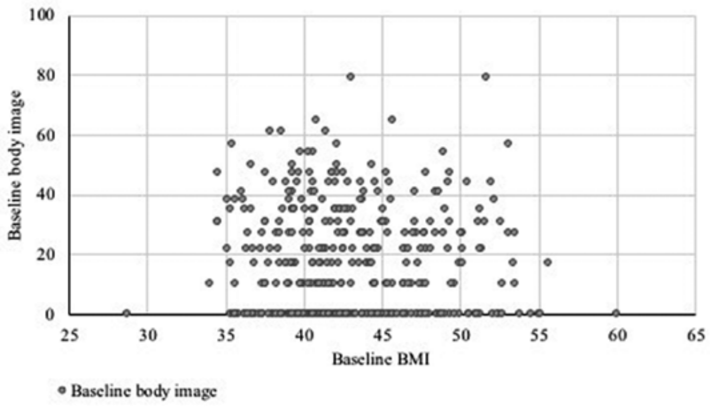

Figure S1. Scatterplot of baseline body image with body-mass index (BMI, kg/m2). A higher score indicates better body image.

PART II

PATIENT-RELATED AND CLINICAL OUTCOMES AFTER BARIATRIC SURGERY

CHAPTER 5

PATIENT-LEVEL FACTORS ASSOCIATED WITH HEALTH-RELATED QUALITY OF LIFE AND SATISFACTION WITH BODY AFTER BARIATRIC SURGERY: A MULTICENTER, CROSS-SECTIONAL STUDY

D.J.S. Makarawung
C.E.E. de Vries
E.B. List
V.M. Monpellier
D. Mou
A.F. Klassen
A.L. Pusic
R.N. van Veen
A.B. Mink van der Molenk

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ABSTRACT

Background

Health-Related Quality of Life (HRQL) is a key outcome of success after bariatric surgery. Not all patients report improved HRQL scores postoperatively, which may be due to patient-level factors. It is unknown which factors influence HRQL after surgery. Our objective was to assess patient-level factors associated with HRQL after surgery.

Methods

This international cross-sectional study included 730 patients who had bariatric surgery. Participants completed BODY-Q scales pertaining to HRQL and satisfaction with body, and demographic characteristics were obtained. The sample was divided into three groups based on time since surgery: 0 – 1 year, 1 – 3 years and more than 3 years. Uni- and multivariable linear regression analyses were conducted to identify variables associated with the BODY-Q scales per group.

Results

The 0 – 1 year postoperative group included 377 patients (50.9%), the 1 – 3 years postoperative group 218 (29.4%) and the more than 3 years postoperative group 135 patients (18.2%). Lower current body-mass index (BMI), more weight loss (%TWL), being employed, having no comorbidities, higher age and shorter time since surgery were significantly associated with improved HRQL outcomes postoperatively. None of these factors influenced all BODY-Q scales. The effect of current BMI increased with longer time since surgery.

Conclusion

Factors including current BMI, %TWL, employment status, presence of comorbidities, age and time since surgery were associated with HRQL postoperatively. This information may be used to optimize patient-tailored care, improve patient education and underline the importance of long-term follow-up with special attention to weight regain to ensure lasting improvement in HRQL.

INTRODUCTION

Bariatric surgery is considered the most effective treatment modality for extreme obesity [1–3]. Traditionally, the success of bariatric procedures has been defined by clinical outcomes including percentage total weight loss (%TWL) and remission of medical comorbidities. A complete assessment of surgical success, however, should incorporate the patient's experience. Therefore, a key outcome of bariatric surgery is health-related quality of life (HRQL), a complex multidimensional construct that encompasses an individual's perception of health and general well-being [4,5]. Patient-reported outcome measures (PROMs) are the standard measurement tools to assess HRQL and focus on health-status from the patient's perspective [6,7].

The most frequently applied measure in bariatric surgery is the SF-36 (or RAND-36) [8]. Most studies that used this questionnaire demonstrated improvements in HRQL, especially with regard to physical functioning, with a peak improvement 1 to 2 years after surgery, followed by a gradual decline [9–13]. Importantly, after surgery, variability in HRQL was significant and low HRQL scores were reported [10,14,15]. Factors that may influence HRQL include the amount of weight loss, socioeconomic and demographic variables (age, sex, level of education, marital status, work status), (psychiatric) comorbidities, postoperative complications and time since surgery [10,16–23]. However, a major shortcoming of aforementioned studies is that they mostly applied PROMs with limited evidence of validity, reliability or responsiveness for use in bariatric surgery [8,24]. More specifically, as demonstrated, the RAND-36 may be insensitive to measure change in HRQL and thereby over- or underestimating the treatment effect [25].

In a prior review, the BODY-Q contained the best quality of measurement properties to measure HRQL in bariatric surgery [24,26]. Previous research found that a higher current BMI and the subjective assessment of more excess skin postoperatively correlated with lower HRQL scores [27]. They could, however, not account for confounding variables. Another study identified patient-level factors such as gender, ethnicity, income level, and baseline BMI as predictors of increased body image and psychological well-being scores [15]. However, body image and psychological function only cover two domains of HRQL.

To conclude, HRQL outcomes vary widely across patients after bariatric surgery, and scores seem to decrease over time. Few research teams studied the impact patient-level factors have on HRQL outcomes after bariatric surgery using validated questionnaires. Recognizing this impact will help us better to understand differences in effect of obesity treatment on the daily lives of our patients. This information could be used to provide appropriate preoperative counseling and to optimize patient selection. Also, attending to patient-level factors reflects patient-centered care, which has the potential to improve HRQL outcomes by tailoring healthcare to the needs of the individual patient to ensure long-lasting improvements [28]. Therefore, the purpose of this study was to gain more insight into the patient-level factors associated with HRQL after bariatric surgery.

METHODS

Participants

This cross-sectional study used data collected in a multicenter study that included St. Antonius Hospital, Nieuwegein and OLVG West in Amsterdam, the Netherlands; and Brigham and Women's Hospital in Boston, MA, USA. Ethical approval was obtained from each site's respective ethics committee. Patients eligible for inclusion were 18 years and older and previously received either a laparoscopic sleeve gastrectomy (SG) or a laparoscopic Roux-en-Y gastric bypass (RYGB). Exclusion criteria were insufficient proficiency of the primary language of the site (i.e., Dutch or English).

Data collection

Data collection differed per study site as described below. All patients were recruited between July 2019 and January 2020.

St. Antonius Hospital and OLVG West

The data were provided by a single postoperative assessment of BODY-Q scales in an ongoing prospective, multicenter BODY-Q study conducted in OLVG West and St. Antonius Hospital in the Netherlands. Patients were asked via e-mail if they would be willing to fill out newly developed BODY-Q scales. In the same assessment, patients completed the scales used in this study. Interested patients received an individual URL link to complete the BODY-Q in Castor EDC (Amsterdam, the Netherlands), a secure web-based application. Non-responders received two reminders sent a week apart.

Brigham and Women's Hospital

Eligible post-operative patients who had bariatric surgery and presented at the Center of Metabolic and Bariatric Surgery (CMBS) were informed about the study. Interested patients provided verbal and online informed consent and participated in a single postoperative assessment of BODY-Q scales. A secure web-based application (Redcap, Nashville, TN) was used to collect the data. Participants could complete the questionnaire on electronic tablets at the clinic or received a URL link to complete the survey at home. Non-responders were sent up to two reminders sent a week apart.

General population

Normative data acquired in the USA, Canada and Europe was added as a reference in this manuscript. The collection of these data is described elsewhere [29].

Patient demographics

The questionnaire included a variety of demographic variables such as age, gender, current BMI, time since surgery, comorbidities, employment status, ethnicity, and smoking status.

BODY-Q

The BODY-Q – a PROM for the obese, bariatric and other weight loss populations – has been developed following rigorous international standards, including significant input from patients and experts in the field of obesity treatment, and it has been psychometrically validated and further applied in studies globally [26,30,31]. This PROM measures domains such as appearance, HRQL and healthcare experience via independently functioning scales. For this study, the following scales were used: 'Satisfaction with Body', 'Excess Skin', 'Body Image', 'Psychological function', 'Social function', 'Physical function', and 'Sexual function'. The response format for every question is a 4-point Likert scale that ranged from "very dissatisfied" to "very satisfied" or "I completely disagree" to "I completely agree" (score 1-4). Raw scores from each scale were converted into a Rasch score that ranged from 0 (worst) to 100 (best) [26].

Patient-level factors

Variables that were examined for their association with the BODY-Q scales scores included age, gender, type of bariatric procedure, current BMI, %TWL, time since bariatric surgery, ethnicity, history of body contouring surgery, employment status, smoking status, type 2 diabetes, gastro-esophageal reflux disease (GERD) and other obesity-related comorbidities at time of questionnaire. The variable ethnicity was divided into two groups, people that identified themselves as white and non-white. Employment status was split into employed (full-time, part-time, self-employed, volunteer, student) and unemployed (retired, unable, caring for family, unemployed and currently looking and not looking for employment). Patients who had never smoked were compared to those who currently smoked or used to smoke. Comorbidities included type 2 diabetes, hypertension, hyperlipidemia, obstructive sleep apnea, osteoarthritic disease, and cardiovascular disease. For the regression analysis one variable was created: presence or absence of (one of) these comorbidities. Type 2 diabetes and GERD (defined as subjectively experiencing symptoms of acid reflux) also formed two independent variables that were separately examined. The variables presence of comorbidity and presence of diabetes were not simultaneously assessed.

Statistical analysis

For analyses, the study population was divided into three groups based on time since surgery when the questionnaire was completed: 0 – 1 year, 1 – 3 years and more than 3 years. This decision was based on prior work which demonstrated improvements 1 to 2 years after bariatric surgery, with a gradual decline in the following years [13,32,33]. Scores for the separate BODY-Q scales were presented for each group and results were compared using analysis of variance (ANOVA). The preoperative data were only used for referencing and were not included in analyses.

For each group, uni- and multivariable linear regression analyses were performed to determine which patient-level factors were associated with the BODY-Q scales. For the univariable regression models, the same variables were examined as specified below. For the multivariable regression analysis, stepwise regression with backward elimination was performed until the final regression models consisted only of independent variables with significant p-values ($p < .05$) after Bonferroni correction. The patient-level factors age, gender, type of bariatric surgery, current BMI, %TWL, ethnicity and history of body contouring surgery were added as independent variables to the full regression models of all scales. The variable time since surgery was added only in the group 'more than 3 years' since surgery, due to variation in time in this group. Other patient-level factors were added if considered applicable by the researchers. Employment status was included in the models for the 'Psychological function', 'Social function', 'Physical function' and 'Sexual function' scales. Smoking status was added to the models for the 'Excess Skin', 'Physical function', and 'Sexual function' scales. Diabetes was supplemented to the model for the 'Excess Skin' scale. Presence of comorbidities was added to the models for the 'Psychological function', 'Social function', 'Physical function' and 'Sexual function' scales, and GERD was included in the model for 'Physical function'. Analyses were conducted using SPSS software version 26.

RESULTS

Patient characteristics

This study included 730 postoperative patients (Table 1). Participants were mostly female (81.2%) and from the USA (54.9%), with a mean age of 47.1 years (±11.8) at time of questionnaire. The mean current BMI was 32.3 kg/m^2 (±7.0), while the average pre-bariatric surgery BMI was 44.1 kg/m^2 (±6.9). This corresponded to an average %TWL of 26.3% (±11.8). Median time since surgery was 11 months IQR 7 (range 0 – 288). Most bariatric procedures where SG (51.8%). The majority of patients self-identified as white (71.4%), were employed (75.4%) and did not have an obesity-related comorbidity (50.9%). Only 49 patients (6.6%) had a history of body contouring surgery.

The groups were divided as follows: 377 patients (50.9%) were 0-1 year postoperatively, 218 patients (29.4%) 1 – 3 years postoperatively, and 135 patients (18.2%) more than 3 years after their bariatric procedure. The group more than 3 years after surgery consisted of patients with the highest mean age (50.9±12.1 years), highest pre-surgical BMI (47.3±9.6 kg/m^2), highest current BMI (34.4±8.1 kg/m^2) and were mostly from the USA (90.4%).

The preoperative group consisted of 171 patients, mostly female (71.9%) and from the USA (89.5%), with a mean age of 43.1 years (±12.7) and mean BMI of 45.0 kg/m^2 (±8.8).

BODY-Q scales

Table 2 presents the BODY-Q scores for the whole sample, per group and includes normative and pre-bariatric surgery scores for referencing. For the scales 'Satisfaction with Body', 'Body Image', 'Social function', 'Physical function' and 'Sexual function' mean scores improved up until 1 – 3 years post-surgery, followed by a substantial decline. For

Table 1. Patient characteristics per group based on years since bariatric surgery, data presented as mean (SD) unless stated otherwise.

	0 – 1 year n = 377	1 – 3 years n = 218	> 3 years n = 135
Gender (female), *n* (%)	309 (82.0%)	177 (81.2%)	107 (79.3%)
Age (years)	45.7 (11.7)	47.3 (11.3)	50.9 (12.1)
USA, *n* (%)	189 (50.1%)	90 (41.3%)	122 (90.4%)
The Netherlands, *n* (%)	188 (49.9%)	128 (58.7%)	13 (9.6%)
Ethnicity (white), *n* (%)	270 (71.6%)	162 (74.3%)	90 (66.7%)
Employment (yes), *n* (%)	294 (78.0%)	173 (79.4%)	85 (63.0%)
Any comorbidity (yes) [a], *n* (%)	185 (49.1%)	91 (41.7%)	82 (60.7%)
History of smoking (never), *n* (%)	200 (53.1%)	112 (51.4%)	78 (57.8%)
Roux-en-Y gastric bypass, *n* (%)	167 (44.3%)	102 (46.8%)	83 (61.5%)
Sleeve gastrectomy, *n* (%)	210 (55.7%)	116 (53.2%)	52 (38.5%)
Pre-bariatric surgery BMI (kg/m^2)	43.4 (6.0)	43.3 (5.9)	47.3 (9.6)
Current BMI (kg/m^2)	33.2 (6.7)	29.5 (5.7)	34.4 (8.1)
Current total weight loss (%)	23.5 (10.8)	31.2 (10.8)	26.1 (13.8)
Months since surgery, median (range)	7 (0 – 11)	14 (12 – 24)	60 (36 – 288)
History of body contouring surgery (yes), *n* (%)	21 (5.6%)	6 (2.8%)	22 (16.3%)

[a] Presence of comorbidity includes diabetes, hypertension, hyperlipidemia, obstructive sleep apnea, osteoarthritic disease or cardiovascular disease.

Table 2. BODY-Q scores per scale: normative, preoperative and study population data.

Scale (available data)	Normative	Pre-operative n = 171	Study population n = 730	Group 0 – 1 year n = 377	Group 1 – 3 years n = 218	Group > 3 years n = 135
Satisfaction with Body [a] (*n* = 701)	46.1 (19.8)	20.2 (19.0)	53.5 (22.9)	56.2 (21.6)	57.6 (21.7)	38.8 (22.8)
Excess Skin [a, b] (*n* = 589)	N.A.	N.A.	49.1 (26.9)	51.9 (26.5)	49.1 (27.1)	40.6 (26.4)
Body Image [a] (*n* = 702)	46.3 (24.1)	21.5 (20.7)	50.3 (25.6)	52.0 (24.3)	55.3 (23.6)	37.0 (27.6)
Psychological [a] (*n* = 694)	58.1 (22.1)	62.2 (24.3)	73.1 (22.0)	75.0 (21.0)	74.4 (20.6)	65.4 (25.3)
Social [a] (*n* = 690)	55.2 (18.3)	63.6 (21.9)	74.5 (21.5)	75.4 (21.1)	76.7 (20.1)	68.2 (24.0)
Physical [a] (*n* = 696)	80.5 (20.0)	56.6 (24.2)	81.3 (23.0)	81.7 (22.5)	86.4 (20.2)	71.7 (26.0)
Sexual (*n* = 394)	59.7 (22.7)	45.4 (23.8)	61.0 (24.1)	61.8 (22.9)	61.9 (24.3)	54.5 (27.0)

Note: Data presented as mean (standard deviation).
[a] Significant difference between groups 0 – 1 year, 1 – 3 years and > 3 years since surgery, $p < .05$.
[b] Excess skin only applies to postoperative patients.

the scales 'Excess Skin' and 'Psychological function', peak scores were found in the group 0 – 1 year postoperatively. There was a significant difference between study groups for all scales except 'Sexual function' (p = .13).

Univariable analysis

Lower current BMI and/or higher %TWL were significantly associated with improved scores on 'Satisfaction with Body', 'Body Image', 'Psychological function', 'Social function' and 'Physical function' in most groups (p < .05). The 'Physical function' scale in the group 0 – 1 year postoperatively included the most significantly associated variables: employment status, presence of comorbidity, age, current BMI, %TWL and ethnicity (p < .05). A comprehensive overview of the univariable analyses is added as a supplementary file (Supplementary Table S1).

Patient-level factors

In the multivariable regression models for the different BODY-Q scales, several significant variables were found per group for all scales except 'Excess Skin' and 'Sexual function'.

Group 0 – 1 year

All results are presented in Table 3. The first year after surgery, lower current BMI and higher %TWL were significantly associated with 'Satisfaction with Body' and explained 17% of the variance in scores. Lower current BMI and being employed were significantly related to the higher 'Physical function' scores, and explained 15% of the variance in scores. Lower current BMI was associated with higher scores of 'Psychological function' and 'Social function'. Higher %TWL corresponded to better scores on the 'Body Image' scale.

Group 1 – 3 years

Table 4 presents all results. In this group, lower current BMI was significantly associated to higher 'Satisfaction with Body' scores and explained 15% of the variance in scores. The absence of a comorbidity and being employed related significantly to improved 'Physical function' scores and accounted for 12% of the variance. Lower current BMI and being employed were significantly related to higher scores on 'Body Image' and 'Psychological function', respectively.

Group > 3 years

The results are presented in Table 5. Higher age, higher %TWL and less time since surgery were significantly associated with improved 'Satisfaction with Body'. This model explained 30% of the variance in scores (R^2 = .30). Lower current BMI and being employed were significantly related to higher 'Physical function' scores and accounted for 22% of

Table 3. Overview of significant variables by multivariable analyses per BODY-Q scale 0 – 1 year after bariatric surgery, *n* = 377.

Scale (available data)	Variable	B	95% CI Lower	95% CI Upper	p	Adjusted R-squared
Satisfaction with Body (*n* = 360)	BMI	-0.69	-1.11	-0.27	.001	.17
	%TWL	0.46	0.20	0.73	.001	
Excess Skin (*n* = 297)	None	-	-	-	-	-
Body Image (*n* = 361)	%TWL	0.65	0.43	0.88	< .001	.08
Psychological (*n* = 355)	BMI	-0.51	-0.83	-0.19	.002	.03
Social (*n* = 357)	BMI	-0.62	-0.94	-0.30	< .001	.04
Physical (*n* = 361)	BMI	-0.83	-1.15	-0.51	< .001	.15
	Employed	14.59	9.40	19.78	< .001	
Sexual (*n* = 206)	None	-	-	-	-	-

Note: BMI = current body mass index; %TWL = percentage total weight loss.

Table 4. Overview of significant variables by multivariable analyses per BODY-Q scale 1 – 3 years after bariatric surgery, *n* = 218.

Scale (available data)	Variable	B	95% CI Lower	95% CI Upper	p	Adjusted R-squared
Satisfaction with Body (*n* = 213)	BMI	-1.47	-1.95	-1.00	< .001	.15
Excess Skin (*n* = 194)	None	-	-	-	-	-
Body Image (*n* = 212)	BMI	-1.12	-1.67	-0.57	< .001	.07
Psychological (*n* = 212)	Employed	9.86	2.99	16.73	.005	.03
Social (*n* = 212)	None	-	-	-	-	-
Physical (*n* = 209)	Comorbidity	-10.49	-15.83	-5.15	< .001	.12
	Employed	10.74	4.13	17.36	.002	
Sexual (*n* = 136)	None	-	-	-	-	-

Note: BMI = current body mass index; %TWL = percentage total weight loss.

the variance. Lower current BMI was associated with improved scores on 'Body Image' and 'Psychological function'.

DISCUSSION

This cross-sectional study assessed patient-level factors associated with HRQL outcomes during different phases of the weight loss journey after bariatric surgery. The findings demonstrate that lower current BMI, more weight loss, being employed, not having comorbidities, higher age and shorter time since surgery were significantly related to improved HRQL and 'Satisfaction with Body' scores. However, none of the studied factors were significantly associated with all BODY-Q scales. Also, factors were not always similar

Table 5. Overview of significant variables by multivariable analyses per BODY-Q scale > 3 years after bariatric surgery, *n* = 135.

Scale (available data)	Variable	B	95% CI Lower	95% CI Upper	p	Adjusted R-squared
Satisfaction with Body (*n* = 124)	Age	0.62	0.30	0.94	< .001	.30
	%TWL	0.66	0.39	0.93	< .001	
	Time since bariatric surgery	-1.32	-2.00	-0.63	< .001	
Excess Skin (*n* = 96)	None	-	-	-	-	-
Body Image (*n* = 124)	BMI	-1.35	-1.89	-0.80	< .001	.16
Psychological (*n* = 122)	BMI	-0.92	-1.44	-0.40	.001	.09
Social (*n* = 117)	None	-	-	-	-	-
Physical (*n* = 121)	BMI	-0.98	-1.48	-0.48	< .001	.22
	Employed	18.73	10.07	27.39	< .001	
Sexual (*n* = 50)	None	-	-	-	-	-

Note: BMI = current body mass index; %TWL = percentage total weight loss.

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at each time point after surgery. These findings indicate that HRQL is not determined by a clear set of variables, but depends on multiple factors that change over time.

In general, our results demonstrated a peak in HRQL scores within 3 years of surgery. The most substantial improvements were found the first year followed by a gradual decline. This is supported by previous studies that used different PROMs [9,13,32,33]. The most apparent decline was found in 'Satisfaction with Body' (mean -18.8 points), 'Body Image' (mean -18.3 points) and 'Physical function' (mean -14.7 points).

Overall, the findings show that a higher current BMI and less weight loss negatively influenced HRQL, affecting 'Satisfaction with Body', Body Image', 'Psychological function', 'Social function' and 'Physical function'. The impact of current BMI increased with longer time since surgery. Our results extend those of Poulsen et al., who found correlations between a higher BMI and lower HRQL scores using 5 BODY-Q scales in a cross-sectional study of patients before and after bariatric surgery [27]. This relationship has also been demonstrated by several studies that applied other HRQL questionnaires [9,14,17,22]. However, the validity of previous RAND-36 results can be questioned since a validation study of the RAND-36 in bariatric surgery found weak correlations between BMI or %TWL and all subscales of the RAND-36, except physical functioning. This finding indicates that – when measured by the RAND-36 – patients with higher BMI or less %TWL did not necessarily have lower HRQL scores [25]. With regard to 'Body Image' and 'Psychological function', a higher current BMI was significantly related to lower scores. This is in accordance with prior work, which found that a higher BMI was associated with lower body image [34,35]. A study by DeMeireles et al., who previously assessed 'Body Image' and 'Psychological function' in a bariatric surgery cohort, demonstrated that predictors for improved 'Body Image' included lower baseline 'Body Image', higher age, white race, higher income level, higher baseline BMI and higher percentage excess bodyweight loss (%EBWL) [15]. Predictors for improved 'Psychological function' included lower baseline 'Psychological function', higher age, male gender, higher income level, more %EBWL, higher total body weight loss, and less complications. However, different variables were integrated in the assessment of predictors, which could explain the different results. For example, our most significant predictor, current BMI, was not included.

Higher age and shorter time since surgery were significantly associated with improved 'Satisfaction with Body' in the group 'more than 3 years' since surgery. This is in accordance with previous work that showed older women have a higher appreciation for the appearance of their body [36]. The effect of time since surgery may be mediated by a higher BMI, since research has shown that usually (some) weight regains over time [37]. Also, hedonic adaptation may play a role: after positive events – in our case rapid weight loss in the first postoperative years – and a subsequent increase in positive feelings (higher satisfaction with their body), people tend to return to a relatively stable baseline of affect [38]. Previous research found time since surgery to be negatively associated with HRQL, supporting our results [19,20].

Unemployed patients had significantly lower 'Physical function' scores in all groups. Additionally, unemployed patients – in the group 1 – 3 years since surgery – had significantly lower 'Psychological function' scores. These results may have been influenced by patients who were unemployed due to psychological or physical illness and therefore, already experienced less psychological well-being or more physical discomfort. Another explanation could be that specific jobs or having a job contribute to better physical health. Employment status has previously been associated with HRQL in studies using the SF-36 [16,20].

Having a comorbidity was significantly associated with lower 'Physical function' scores in the group 1 – 3 years since surgery. Many studies support these results by demonstrating associations of worse physical functioning with having comorbidities [39–45].

By elucidating patient-level factors associated with lower HRQL scores, healthcare providers can identify patients that may benefit from targeted preoperative and postoperative interventions. This patient-tailored clinical care may result in better outcomes and higher patient satisfaction with outcome. Furthermore, knowledge of associated variables provides insight into the impact of obesity treatment on the daily lives of our patients, and may help to improve patient education by setting realistic expectations in the preoperative trajectory. Finally, our findings implicate that long-term follow-up with special attention to weight regain is needed to ensure lasting improvement in HRQL. Interestingly, even though improvements were seen in all aspects of HRQL after surgery, BMI and amount of weight loss were not significantly related to all. Furthermore, significant variables changed over time, which would suggest that the importance patients attached to their weight changed over time.

Strengths of this study were the multicenter and large sample size, which makes the results more generalizable. Furthermore, the use of a validated PROM enhanced the reliability of our results. However, some limitations should be acknowledged too. First, due to the lack of baseline data, our results were not corrected for these values. Second, the cross-sectional design hampered our ability to track change over time. A prospective study is needed to identify predictors from baseline scores. However, our data are part of a prospective study and therefore, predictors will be assessed in future studies. Furthermore, the patient characteristics (mostly RYGB and USA patients in group > 3 years post-surgery) and group sizes were different, which could have influenced results. However, type of bariatric surgery was not significantly associated with HRQL in either of the groups. The small number of Dutch patients in the group more than 3 years post-surgery limits the interpretation of the results in this group; the variables that were significantly associated with HRQL may have been influenced by the large number of USA patients and therefore, may be a result of cultural differences. Also, there is a risk of selection bias in the group more than 3 years post-surgery. Patients that presented in this group may do so due to complaints rather than a regular follow-up. Lastly, there are inherent limitations in the use of self-reported survey data, such as the accuracy of self-reported weight.

CONCLUSION

This cross-sectional study demonstrated that lower current BMI, more weight loss, being employed, having no comorbidities, higher age and shorter time since surgery were associated with improved scores on different aspects of HRQL and satisfaction with body during several phases of the weight loss journey. Lower current BMI had a positive influence on almost all scales. These results can be used to optimize perioperative care by improving patient education and identifying patients who can benefit from additional targeted interventions. Also, our results emphasize the importance of long-lasting follow-up.

DECLARATIONS

Conflict of interest

A.F. Klassen and A.L. Pusic are co-developers of the BODY-Q and, as such, obtain a share of any license revenues as royalties based on their institutions inventor sharing policy. All other authors report no relevant conflicts of interest.

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SUPPLEMENTARY FILES

Table S1. Overview of significant variables by univariable analyses per BODY-Q scale.

Scale	0 – 1 year	1 – 3 years	> 3 years
Satisfaction with Body	Type BS -4.50 [-8.98, 0.02] p = .05 BMI -1.22 [-1.52, -0.91] p < .001 %TWL 0.76 [0.57, 0.95] p < .001	Type BS -6.10 [-11.92, -0.28] p = .04 BMI -1.47 [-1.95, -1.00] p < .001 %TWL 0.60 [0.34, 0.87] p < .001	Age 0.62 [0.30, 0.94] p < .001 BMI -1.34 [-1.78, -0.90] p < .001 %TWL 0.69 [0.41, 0.96] p < .001 Gender 11.61 [1.67, 21.54] p = .02
Excess Skin	Age 0.33 [0.06, 0.60] p = .02 BMI -0.51 [-1.00, -0.005] p =.05	Gender 13.80 [3.75, 23.85] p = .007	Gender 19.44 [5.58, 33.30] p = .006 Ethnicity 12.94 [1.94, 23.94] p = .02
Body Image	BMI -1.04 [-1.39, -0.68] p < .001 %TWL 0.65 [0.43, 0.88] p < .001	BMI -1.12 [-1.67, -0.57] p < .001 %TWL 0.39 [0.09, 0.70] p = .01	BMI -1.35 [-1.89, -0.80] p < .001 %TWL 0.63 [0.28, 0.97] p < .001 Gender 13.60 [1.55, 25.65] p = .03
Psychological	BMI -0.51 [-0.83, -0.19] p = .002 Comorbidity -5.82 [-10.17, -1.48] p = .009 Employed 6.84 [1.57, 12.11] p = .01	Employed 9.86 [2.99, 16.73] p =.005 Comorbidity -5.98 [-11.58, -0.37] p = .04	BMI -0.92 [-1.44, -0.40] p = .001 %TWL 0.42 [0.09, 0.74] p = .01
Social	BMI -0.62 [-0.94, -0.30] p < .001 Employed 5.70 [0.43, 10.96] p = .03 Comorbidity -7.02 [-11.36, -2.68] p = .002 %TWL 0.34 [0.14, 0.54] p = .001	Employed 8.48 [1.72, 15.23] p = .01	Gender 10.94 [0.21, 21.66] p = .05 BMI -0.66 [-1.17, -0.14] p = .01
Physical	Employed 15.95 [10.60, 21.29] p < .001 Comorbidity -8.75 [-13.33, -4.17] p < .001 Age -0.25 [-0.45, -0.05] p = .01 BMI -0.92 [-1.25, -0.59] p < .001 %TWL 0.36 [0.15, 0.58] p = .001 Ethnicity 5.47 [0.22, 10.72] p = .04	Employed 13.33 [6.63, 20.03] p < .001 Comorbidity -12.21 [-17.56, -6.86] p < .001	Employed 19.46 [10.31, 28.62] p < .001 Comorbidity -10.68 [-20.16, -1.20] p = .03 Type BS 11.50 [2.13, 20.87] p = .02 BMI -1.02 [-1.56, -0.49] p < .001

Table S1. (continued)

Scale	0 – 1 year	1 – 3 years	> 3 years
Sexual	Comorbidity -6.50 [-12.82, -0.18] *p* = .04	None	%TWL 0.58 [0.008, 1.15] *p* = .05 Ethnicity 18.47 [1.63, 35.32] *p* = .03

Note: Data presented as variable; *B [95% CI], p-value.* BS = bariatric surgery, BMI = body-mass index, %TWL = percentage total weight loss.
Variables included per scale (all scales included age, gender, type of bariatric surgery, current BMI, %TWL, ethnicity and history of body contouring surgery):
Satisfaction with Body: -; Excess skin: smoking status and diabetes; Body image: -; Psychological: employment status and presence of comorbidities;
Social: employment status and presence of comorbidities; Physical: employment status, smoking status, reflux disease and presence of comorbidities.
Sexual: employment status, smoking status and presence of comorbidities.

CHAPTER 6

PREDICTORS OF IMPROVED PSYCHOLOGICAL FUNCTION AFTER BARIATRIC SURGERY

P.J. Dijkhorst
D.J.S. Makarawung
J.W. Vanhommerig
S.C. Kleipool
F. Dalaei
C.E.E. de Vries
A.B. van der Molen
L. Poulsen
J.A. Sorensen
H.J. Bonjer
S.M.M. de Castro
R.N. van Veen

Accepted by Surgery for Obesity and Related Diseases

ABSTRACT

Background

Negative psychological sequelae have been reported after bariatric surgery. It is unclear which factors affect psychological function in the first postoperative years. The objective of this study was to evaluate significant predictors of improved psychological function following bariatric surgery by analyzing data from the BODY-Q questionnaire.

Methods

The BODY-Q questionnaire was used to assess six domains of health related quality of life. The domain of interest, psychological function, consists of ten questions from which a converted score of 0 (low) to 100 (high) can be calculated. Linear mixed models were used to analyze which patient characteristics were most predictive of the psychological function score. Secondary outcomes of interest were cross-sectional scores of psychological function and the impact of weight loss, and the effect of major short-term complications on psychological function.

Results

Data were analyzed from 836 patients who underwent bariatric surgery from 2015 to 2020. Patients with lower expectations concerning weight loss (<40% desired TWL), higher educational level, no history of psychiatric illness and employment before bariatric surgery demonstrated the highest psychological function scores after bariatric surgery. At one and two years after bariatric surgery, more weight loss was associated with significantly higher psychological function scores. Experiencing a major short-term complication did not significantly impact psychological function.

Conclusion

Several relevant predictors of improved post-operative psychological function have been identified. This knowledge can be used to enhance patient education pre-operatively and identify patients at risk for poor psychological functioning post-operatively.

INTRODUCTION

Improvement in health-related quality of life (HRQL) is a key aspect of patients' motivation to undergo bariatric surgery [1]. HRQL is a multidimensional concept that describes the patients' experience of health and includes several domains such as physical function, mental- or psychological function, social function, and sexual function [2]. Patient-reported outcome measures (PROMs) are the standard measure to assess one or more of these domains. As previously demonstrated, the BODY-Q is the most promising questionnaire regarding measurement properties to assess patients' HRQL after bariatric surgery [3]. The BODY-Q consists of several independently functioning scales related to different domains such as HRQL and was based on a literature review, patient interviews and input from experts. This PROM has been psychometrically validated and used in many international studies [4,5].

Although HRQL generally improves after bariatric surgery [6], the impact varies considerably across studies and greater improvements are observed in physical compared to mental domains of HRQL [7]. Qualitative research has identified expectations of patients undergoing bariatric surgery, these include among others, a significant impact on psychosocial health [1]. Due to the increased risk of mental health conditions in people with obesity, a multidisciplinary approach to improve psychological health should be desired [8].

Previously published systematic reviews evaluating the effect of bariatric surgery on HRQL demonstrated improved psychological function after bariatric surgery [6,7]. However, a recent systematic review on randomized controlled trials by Szmulewicz et al. (2019) compared bariatric surgery to non-surgical weight loss interventions and found no additional benefit of bariatric surgery on mental health function, despite increased weight loss [9]. This finding raises questions with regard to the negative effect that bariatric surgery might have on psychological function. In another study, a subgroup of patients was identified that experienced increased depressive symptoms and a higher risk of suicide after bariatric surgery [10]. Potentially, a subgroup of patients exists in whom bariatric surgery results in increased psychological distress, warranting a better understanding of factors that influence psychological function after bariatric surgery. This knowledge could improve pre-operative counseling and promote identification of patients at risk who could benefit from supplemental interventions in the post-operative period.

Data regarding predictive factors for improved psychological function are scarce and studies demonstrate inconsistent results. Factors that may have a positive impact on psychological function include absence of complications, female sex, type 2 diabetes mellitus, higher pre-surgical scores in other HRQL domains and no history of psychiatric illness (mood disorder) [11–14]. However, these studies suffer from small sample sizes (<500 patients), cross-sectional data analyses and short term follow-up (less than three years). Studies with larger sample sizes and longer follow-up also found a positive effect of younger age, higher educational level, employment, more weight loss, absence of depression and absence of surgical complications [15,16]. Unlike earlier findings, however, they found a positive effect of male gender [16]. Other studies investigating predictive factors found no association between psychological function and weight loss, type 2 diabetes mellitus or age [17,18]. With regard to weight loss, it may also be possible that increased weight loss and subsequent excess skin negatively impacts psychological function [19]. Moreover, the previously described impact of type 2 diabetes mellitus on psychological function might be explained by psychological improvement when a reduction in comorbidity medication or remission of obstructive sleep apnea is achieved. This relationship could be exposed when all comorbidities requiring medication or therapy are analyzed as one variable. Besides the heterogeneity in reported outcomes, all of these studies suffer from the major shortcoming of using PROMs with poor measurement properties for use in the bariatric surgery population, of which the SF-36 is most common [3]. The SF-36 was not supported by sufficient validation evidence and, therefore, does not accurately measure HRQL [20]. In a recent global consensus meeting evaluating the most suitable HRQL instruments for use in bariatric surgery, the BODY-Q was selected by patients and experts as the standard PROM to be used for measurement of psychological function [21]. DeMeireles et al (2019) used this PROM to measure psychological function in 4062 patients and found a positive impact of higher age, male sex, higher income, more weight loss and absence of complications but no impact of serious complications [22]. This study, however, was limited by only one year follow-up and did not assess the influence of having any comorbidities or demographic characteristics such as educational level, marital status or employment status on psychological function. To conclude, several factors including age, gender, weight loss and complications seem to impact psychological function after bariatric surgery, but more research with longer follow-up is needed to confirm these associations.

The purpose of this study was to assess pre-operative factors associated with improved psychological function after bariatric surgery, and to examine the effect of weight loss and major surgical complications on psychological function. We aim to overcome the limitations of prior work by using the BODY-Q to analyze psychological function scores from baseline up to three years after bariatric surgery with longitudinal data analyses. Based on previous research, it was hypothesized that older age, employment, increased weight loss (above average), no history of psychiatric illness and absence of surgical complications would be associated with improved post-operative psychological function. In addition, we considered a potential relationship between psychological function and pre-operative BMI, desired weight, educational level, having any comorbidity, type of surgery, marital status and pre-operative scores of other BODY-Q domains.

METHODS

Participants

This study included a subgroup of patients who underwent bariatric surgery and participated in an international multi-center prospective cohort study examining HRQL using the BODY-Q questionnaire. Data from patients operated at OLVG Hospital in Amsterdam, the Netherlands (OLVG), St. Antonius Hospital in Nieuwegein, the Netherlands (SAH), and

Hospital of Southwest Jutland in Esbjerg, Denmark (DNK) were included. The national Medical Ethics Review Committee and the local review committee of the individual hospitals approved the protocol of this study. Patients eligible for this study were 18 years or older and met the latest IFSO criteria for bariatric surgery (BMI ≥40 or BMI ≥35 with at least one comorbidity) [23]. For this study, data were included if BODY-Q results were available pre-operatively and at least at one time point post-operatively. Exclusion criteria included absence of informed consent or inability to speak the primary language (Dutch or Danish). A detailed description of the data collection is provided elsewhere [24].

Outcome definition

The primary outcome was the assessment of variables predictive of the longitudinal psychological function score. Secondary outcomes included: 1) cross-sectional psychological function scores, 2) difference in psychological function between various weight loss quartiles, and 3) difference in psychological function between patients with a major short-term complication less than four months after surgery versus patients without a complication. A major short-term complication was defined as either an internal bleeding, anastomotic leakage, perforation, internal herniation, stenosis, or any other complication related to bariatric surgery requiring surgical or endoscopic/radiological intervention (Clavien-Dindo classification IIIa or IIIb) that occurred within four months after surgery.

BODY-Q

The BODY-Q questionnaire consists of six independently functioning HRQL domains including body image, physical function, physical symptoms, psychological function, sexual function and social function. Patients completed the BODY-Q questionnaire preoperatively and four months, twelve months and yearly after bariatric surgery up until five years. This PROM was sent through email and data were collected using two secure web-based applications: Castor EDC and REDcap [25,26]. This study focused on the domain psychological function, which includes ten items (e.g., 'I feel happy' or 'I feel confident'). Patients were asked to indicate how much they agree or disagree with every item (four outcome options: definitely disagree (1), somewhat disagree (2), somewhat agree (3), definitely agree (4). These responses were added up to a sum score ranging from 10 to 40, which was converted to a rasch score that ranged from 0 (=sum score of 10) to 100 (=sum score of 40). Higher scores are indicative of better psychological function and lower scores of worse psychological function [4]. The BODY-Q applies a modern psychometric approach, Rasch Measurement Theory analysis, which enhances the reliability.

Data collection

In the Netherlands, all patients were previously screened according to the IFSO-criteria and received treatment at the Dutch Obesity Clinic. Demographic characteristics (including comorbidities), current weight, amount of weight loss, and psychological comorbidities (e.g., depression, binge eating disorder, obsessive compulsive disorder, post-traumatic stress disorder, substance abuse, auto mutilation or suicidal attempts) were collected from medical records of the Dutch Obesity Clinic. Hypertension, diabetes and hypercholesterolemia were defined as a comorbidity requiring medication. Patients underwent a sleep study as part of the regular screening program (OLVG) or when indicated in presence of symptoms (SAH) of obstructive sleep apnea syndrome (OSAS). OSAS was defined as having an apnea hypopnea index (AHI) of higher than five. Osteoarticular disease was defined as requiring chronic pain lowering medication or having signs of arthrosis on imaging. Gastro-esophageal reflux disease (GERD) was defined as requiring acid inhibiting medication or having typical symptoms (e.g., heartburn) assessed by a physician specialized in obesity treatment. Medical records of all patients were assessed for short-term complications (within one month after surgery) related to bariatric surgery. Self-reported weight loss data were only used if no data were available from the Dutch Obesity Clinic or medical record from the hospital.

All data from Denmark were self-reported and gathered through the BODY-Q and demographic questionnaires. This included weight, comorbidities, (history of) psychiatric illness and complications. In contrast to the Netherlands, Denmark included a question regarding (history of) psychiatric illness at baseline and a question pertaining to any complications related to bariatric surgery (which is assessed at every post-operative follow-up moment). The research teams confirmed these data by checking medical records.

Statistical analysis

The data analyses were performed using IBM SPSS Statistics 27. Normally distributed values were presented as mean (± standard deviation; SD) and non-normally distributed as median (interquartile range; IQR). Descriptive statistics were used for demographic variables. Linear mixed models were performed to determine which patient characteristics (independent variables) were most predictive (strongest predictors) of mean psychological function scores over time (dependent variable) using a backward selection procedure and *p*-value of <0.1. Setting a higher *p*-value of 0.1 reduces the chance of removing less significant variables that may be clinically relevant to the outcome [27]. Linear mixed models makes use all available data points and provides an average post-operative psychological function score over time. The following variables were analyzed as predetermined potential risk factors: age, gender, pre-operative body-mass index (BMI), type of surgery (laparoscopic Roux-en-Y gastric bypass (RYGB) or laparoscopic sleeve gastrectomy (SG)), presence of any comorbidity (hypertension, diabetes mellitus type 2, hypercholesterolemia, osteoarticular disease, OSAS or GERD), history of psychiatric illness, marital status, educational level (elementary or secondary school, intermediate vocational education, higher vocational education or university) and desired percentage total weight loss after surgery (desired %TWL). Continuous variables that were statistically significant predictors were converted into categorical variables (quartiles). Employment status (unemployed versus employed) was only available for the Dutch cohort and therefore, was analyzed separately. The effect of other HRQL domains (body image, physical function, physical symptoms, sexual function, social function) on psychological function was analyzed separately due to a potential strong correlation with the outcome. Corresponding correlation scores were calculated by multiplying the regression coefficient (of the respective domain for the longitudinal psychological function score) by the standard deviation of the respective domain divided by the standard deviation of the longitudinal psychological function score. Baseline psychological function scores and country of residence were added to the model to control for baseline differences. BODY-Q psychological function scores were compared to normative European BODY-Q scores [28]. The difference in psychological function between weight loss quartiles and patients with or without major short complications was calculated using linear mixed models by adding an interaction term with time to the model. Missing data were not accounted for since mixed models makes use of all available data points. A *p*-value of <0.05 indicated statistical significance for all analyses except the prediction model.

RESULTS

Primary outcome

Predictors of longitudinal psychological function scores

Of the 2513 persons that were approached for inclusion, 2040 were interested to participate in the prospective multicenter cohort study. Of these, 836 (33%) were eligible for inclusion in this study (OLVG, *n* = 241; SAH, *n* = 159; DNK, *n* = 436). Reasons for exclusion were 1) less than four months follow-up or not completing the BODY-Q questionnaire pre-operatively and one time point post-operatively (*n* = 1204), 2) absence of informed consent, not undergoing bariatric surgery or withdrawal from the study (*n* = 473). An overview of baseline characteristics is presented in Table 1. Baseline differences between patients who were included and excluded are provided in Supplementary Tables 1 and 2. For the longitudinal data analyses, 2782 psychological function assessments were available from 836 participants.

The predetermined potential predictors for the longitudinal psychological function score were analyzed and are presented in Table 2. Variables included in the final prediction model are shown in Table 3. The strongest predictors for lower post-operative psychological function scores were history of psychiatric illness (*ß* -4.8, 95% CI [-8.9, -0.8], *p* = .018), higher desired %TWL (*ß* -0.2, 95% CI [-0.3, 0.0], *p* = .094) and primary school/secondary school (*ß* -0.8, 95% CI [-6.0, 0.01], *p* = .061) or intermediate vocational education (*ß* -3.7, 95% CI [-6.9, -0.5], *p* = .023) compared to higher vocational education/university.

After converting desired %TWL into quartiles, the highest psychological function scores were predicted for patients in the second quartile with a desired %TWL of 35-40% (reference) followed by the first quartile with a desired %TWL of 15-35% (*ß* -0.8, 95% CI

[-4.5, 3.0], $p = .693$), the third quartile with a desired %TWL of 40-45% (ß -5.4, 95% CI [-9.2, -1.8], $p = .004$) and fourth quartile with a desired %TWL of 45-65% (beta -6.0, 95% CI [-9.8, -2.3], $p = .002$). Data on employment status were only available from the Dutch cohort and were analyzed separately. In a multivariable model created through backward selection, being unemployed ($n = 88$, 23%) before bariatric surgery predicted lower post-operative psychological function scores compared to being employed ($n = 302$, 77%) (ß -6.6, 95% CI [-10.5, -2.6], $p < .001$).

The univariable linear mixed model including baseline scores of other HRQL domains demonstrated that higher social function rasch score (ß 0.59, 95% CI [0.54, 0.64], $p < .001$), higher body image rasch score (ß 0.47, 95% CI [0.40, 0.54], $p < .001$), higher sexual function rasch score (ß 0.31, 95% CI [0.26, 0.36], $p < .001$), higher physical function rasch score (ß 0.21, 95% CI [0.15, 0.27], $p < .001$) and higher physical symptoms sum score (ß 1.0, 95% CI [0.85, 1.20], $p < .001$) all significantly predicted higher post-operative psychological function scores. The corresponding correlation scores for these domains were 0.59 for social function, 0.35 for body image, 0.30 for sexual function, 0.18 for physical function and 0.29 for physical symptoms.

Secondary outcomes

Cross-sectional psychological function scores

The mean psychological function score before bariatric surgery and at four months, one year, two years and three years after surgery was 45.3 (95% CI [43.9, 46.7], 63.7 (95% CI [62.5, 65.0], 64.5 (95% CI [63.1, 65.8], 62.8 (95% CI [61.2, 64.5], and 60.5 (95% CI [58.2, 62.7], respectively (Figure 1). In the entire sample ($n = 836$), mean time since bariatric surgery was 3.1 years (±0.9). Data on psychological function at 4 months, 1 year, 2 years and 3 years after bariatric surgery were available in 76%, 73%, 72% and 54% of patients, respectively. The mean postoperative scores were higher than the normative European BODY-Q psychological function score of 57.89 (95% CI [56.7, -59.1]) [28]. The psychological function scores were significantly higher in the Dutch cohort at every time point ($p < .05$). At the latest follow-up moment in comparison to their baseline score, 654 (79%) participants experienced improved psychological function scores, 28 (3%) had exactly the same scores and 151 (18%) participants had deteriorated psychological function scores. Patients with improved scores, on average, were older (+3 years, $p = .002$) and more often underwent RYGB surgery (71% RYGB vs 59% SG, $p = .003$), compared to the group with decreased scores.

Weight loss quartiles

Percentage TWL was divided into quartiles for each follow-up moment. The quartile cutoff points for %TWL were 7-23%, 23-27%, 27-30%, 30-50% at four months ($n = 635$), 8-28%, 28-33%, 33-38%, 38-63% at one year ($n = 679$), 5-28%, 28-34%, 34-41%, 41-64% at two years ($n = 315$), -12-25%, 25-32%, 32-39%, 39-56% at three years ($n = 272$) after bariatric surgery. Quartile one corresponded with the lowest %TWL group (e.g., 7-23% at four

One year postoperatively, persons in the third quartile (*ß* 6.1, 95% CI [1.60, 10.56], *p* = .008) and fourth quartile (*ß* 4.7, 95% CI [0.24, 9.17], *p* = .039) achieved significantly higher psychological function scores compared to the first quartile. At two years after

Table 1. Baseline characteristics.

	Data available n (%)	Netherlands	Denmark	Sample
Total number of patients, *n* (%)		400	436	836
Age at operation, years	835 (99.9)	45.2 (11.0)	45.9 (10.0)	45.6 (10.5)
Gender, *n* (%)	836 (100)			
Female		343 (85.6)	340 (78.0)	683 (81.7)
Male		57 (14.3)	96 (22.0)	153 (18.3)
Weight before surgery, kg	834 (99.7)	123.2 (19.0)	136.3 (26.1)	130.0 (23.9)
BMI before surgery, kg/m^2	834 (99.7)	42.9 (4.6)	46.4 (6.9)	44.7 (6.2)
Type of surgery, *n* (%)	836 (100)			
Primary Roux-en-Y gastric bypass		256 (64.0)	316 (72.5)	572 (68.4)
Primary sleeve gastrectomy		134 (33.5)	116 (26.6)	250 (29.9)
Other [a]		10 (2.5)	4 (0.9)	14 (2)
Comorbidities, *n* (%)	836 (100)			
Diabetes Mellitus type 2		62 (15.5)	70 (16.1)	132 (15.8)
Hypertension		133 (33.3)	76 (17.4)	209 (25.0)
Dyslipidemia		56 (14.0)	21 (4.8)	76 (9.1)
Obstructive sleep apnea		293 (73.3)	47 (10.8)	340 (40.7)
Osteoarticular disorder		81 (20.3)	19 (4.4)	100 (12.0)
Gastroesophageal reflux disease		155 (38.8)	7 (1.6)	162 (19.4)
Having any comorbidity		346 (86.5)	166 (38.1)	512 (61.2)
History of psychiatric illness, *n* (%)	836 (100)	83 (20.8)	32 (7.3)	115 (13.8)
Educational level, *n* (%)	835 (99.9)			
Elementary or secondary school		98 (24.6)	189 (43.3%)	287 (34.4)
Intermediate vocational education		176 (44.1)	108 (24.8)	284 (34.0)
Higher vocational education or university		125 (31.3)	139 (31.9)	263 (31.5)
Marital status, *n* (%)	832 (99.5)			
Single, never married		71 (17.8)	80 (18.5)	151 (18.1)
In relationship, not living together		21 (5.3)	0 (0)	21 (2.5)
In relationship, living together		64 (16.0)	93 (21.3)	157 (18.9)
Married		196 (49.1)	220 (50.5)	416 (50.0)
Divorced		41 (10.3)	39 (8.3)	80 (9.6)
Other		6 (1.5)	0 (0)	7 (0.8)
Employment status, *n* (%)	390 (46.7)			
Unemployed		88 (22.6)	N.A.	302 (77.4)
Employed		302 (77.4)	N.A.	88 (22.6)
Desired percentage total weight loss	691 (82.7)	38.1 (6.0)	41.6 (7.6)	40.3 (7.2)

Note: data are presented as mean (standard deviation) unless stated otherwise
BMI body-mass index, *N.A* Not available
[a] Secondary Roux-en-Y gastric bypass (*n* = 8) or secondary sleeve gastrectomy (*n* = 2) after previous gastric banding

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Table 2. Univariable analysis of potential predictors of the longitudinal psychological function score.

	Univariable model corrected for country		
	Beta	95% CI	p
Age	0.15	-0.04, 0.26	.008
Gender			
Male	Reference		
Female	-2.91	-5.92, 0.10	.058
Pre-operative BMI	-0.08	-0.28, 0.12	.444
Type of surgery			
Sleeve gastrectomy	Reference		
Roux-en-Y gastric bypass	2.24	-0.18, 4.91	.068
Any preoperative comorbidity	0.75	-2.02, 3.52	.595
History of psychiatric illness	-5.89	-9.25, -2.53	<.001
Marital status			
Widow	Reference		
Single	3.45	-10.3, 17.2	.622
In relationship (not living together)	5.75	-9.44, 20.93	.458
Living together (not married)	6.75	-6.97, 20.47	.334
Married	7.72	-5.81, 21.26	.263
Divorced	5.29	-8.64, 19.22	.456
Education			
Higher vocational education or university	Reference		
Elementary school or secondary school	-2.29	-5.52, 0.59	.119
Intermediate vocational education	-2.54	-5.41, 0.33	.082
Desired percentage total weight loss	-0.16	-0.34, 0.02	.084

BMI Body mass index, *CI* confidence interval

Table 3. Final model with strongest predictors of psychological function.

	Multivariable model corrected for country created through backward selection		
	Beta	95% CI	p
Desired percentage total weight loss	-0.16	-0.34, 0.03	.094
History of psychiatric illness	-4.84	-8.87, -0.82	.018
Education			
Higher vocational education or university	Reference		
Elementary school or secondary school	-2.84	-6.03, 0.14	.061
Intermediate vocational education	-3.72	-6.87, -0.52	.023

CI Confidence interval

months) and quartile four with the highest %TWL group (e.g., 30-50% at four months). Linear mixed models were used to assess significant associations for the psychological function scores at different time points between these %TWL quartiles (Figure 2).

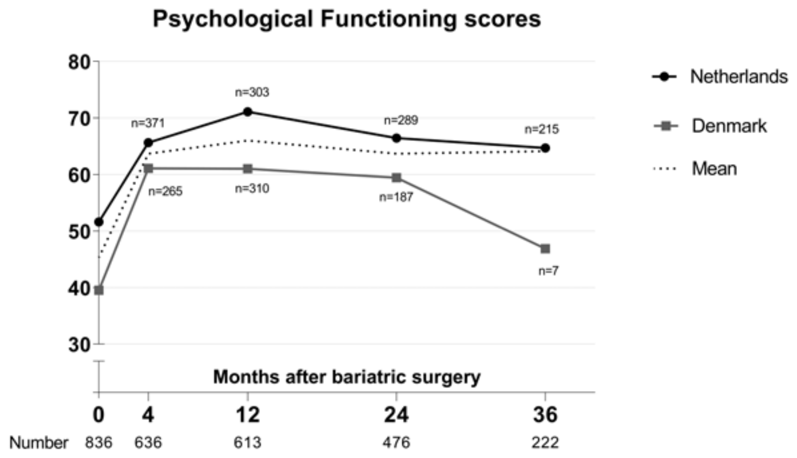

Figure 1. Change in psychological function scores over time.

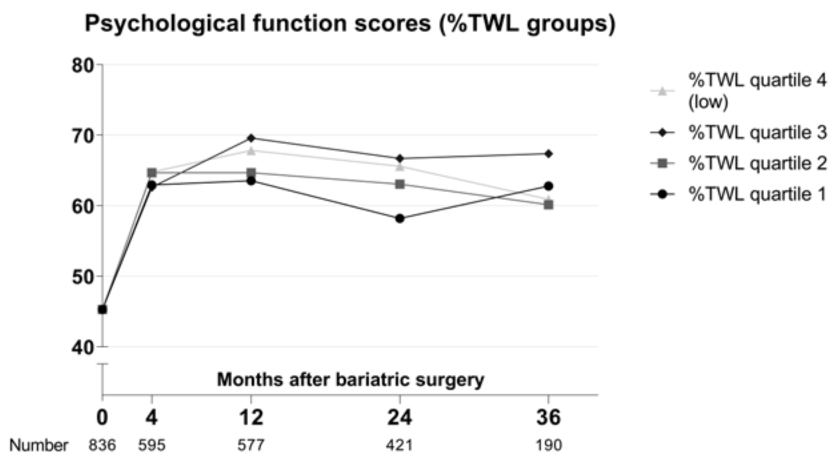

Figure 2. Difference in psychological function scores between percentage total weight loss groups (quartiles) calculated with linear mixed models.

bariatric surgery, persons in the second quartile (*ß* 6.2, 95% CI [0.88, 11.50], *p* = .022), third quartile (*ß* 8.4, 95% CI [3.10, 13.65], *p* = .002) and fourth quartile (*ß* 9.5, 95% CI [4.20, 14.76], *p* < .001) achieved significantly higher psychological function scores than the first quartile. Self-reported weight data were used for all Danish participants. For Dutch participants, the use of self-reported weight data was only necessary three years after bariatric surgery in 82/266 (31%) patients. Additional analyses of Dutch weight data comparing clinical and self-reported weight showed lower reported weight on average: 1.17 (-5.0 – 11.2), 0.75 (-10.0 – 12.1) and 0.86 (-6.0 – 15.2) kilograms lower at one, two and three years, respectively.

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Major short-term complications

A total of 34 (4.1%) patients experienced a major short-term complication. This included 20 patients from the Netherlands and 14 patients from Denmark. Of these 14 patients from Denmark, the complication was confirmed by the electronic patient file in 8 patients. In the other six patients the electronic patient file had restricted access and thus, the complication could not be confirmed. The following complications occurred in patients: bleeding (*n* = 12, 1.4%), anastomotic leakage (*n* = 8, 0.9%), perforation (*n* = 3, 0.4%), re-operation (*n* = 3, 0.4%; self-reported, reason unknown), stenosis of the gastrojejunal anastomosis treated with balloon dilatation (*n* = 2, 0.2%), internal herniation (*n* = 2, 0.2%) and other complications requiring surgical or endoscopic/radiological intervention (*n* = 4, 0.5%). Figure 3 displays the difference in psychological function scores at different time points between the complicated versus uncomplicated recovery group. All comparisons were not significant.

DISCUSSION

The objective of this multicenter study was to assess predictors of psychological function after bariatric surgery by using the BODY-Q, a validated questionnaire for people living with obesity undergoing treatment. Consistent with literature, this study demonstrated the most substantial improvement in psychological function one year after bariatric surgery, followed by a gradual decline [6,29,30]. Patients with lower expectations for weight loss (<40% desired TWL), higher educational level (finished higher vocational education/university), no history of psychiatric illness and who were employed before bariatric surgery achieved the highest psychological function scores after bariatric surgery. Higher preoperative scores on other domains of the BODY including social function, sexual function, body

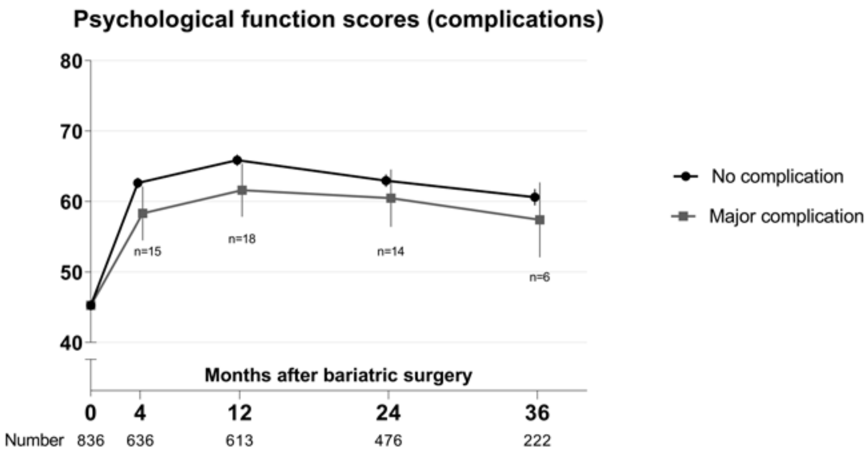

Figure 3. Difference in psychological function scores between patients who experienced a major short-term complication versus no complication calculated with linear mixed models.

image and physical symptoms also predicted higher post-operative psychological function scores. Major short-term complications did not affect psychological outcomes.

Our results extend those of other studies that found preoperative psychiatric symptoms or a history of psychiatric illness, lower educational level, unemployment and high or unrealistic expectations were related to lower psychological function scores [13,15,31–33]. Research remains inconclusive with regard to the effect of age, gender and preoperative BMI on psychological function [34–36]. Univariable analyses demonstrated that older and male patients achieved higher postoperative psychological function scores. However, age and gender were not significant predictors in the multivariable model created through backward selection. This may be explained by desired %TWL, since a post hoc analyses showed higher desired %TWL in patients that were younger, female and had a higher preoperative BMI ($p < .01$). Interestingly, a significant amount of patients (18%) experienced a decrease in their psychological function score compared to their baseline score. This subgroup – i.e., these 18% - was significantly younger (-3 years $p = .002$), which might suggest that a patients' expectation for weight loss, a variable rarely examined in previous research, is more predictive for psychological function than either age, gender or preoperative BMI [37].

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At one and two years after bariatric surgery, patients in the third and fourth highest %TWL quartile experienced significantly higher psychological function scores than patients in the lowest %TWL quartile. While the majority of research has focused on the effect of psychosocial predictors on weight loss, few have examined the effect of weight loss on psychological function. Our results are in line with a previous study that found higher %TWL predicts higher psychological function one year postoperatively ($p = .002$) [22]. Similarly, increased excess weight loss was associated with improved psychological outcomes and increased mental health scores on the SF-36 questionnaire [15,38]. It should be noted that the observed effect does not exclude a bi-directional relationship between weight loss and psychological function. It remains possible that increased postoperative psychological function leads to increased weight loss and improved weight loss maintenance.

A major short-term complication was not related to worse psychological function scores in our study. The few studies that reported on this relationship found conflicting results. While some described a negative effect of complications on only physical quality of life [11], others found lower scores also in mental domains of the SF-36 and BODY-Q in patients with complicated recoveries [16,22]. Interpretation of our results should be with caution, since they may be explained by the small number of patients who experienced a major short-term complication. Also, it could not be evaluated if patients experienced a deterioration in psychological function the first month postoperatively. In other fields of surgery, the impact of complications is better described. Archer et al (2019) reported that major short-term complications of elective gastrointestinal-, vascular- and cardiothoracic surgery predicted worse physical and mental quality of life at one month after surgery, but not at four months or at one year after surgery [39]. This may hold also for bariatric surgery.

To date, predictors of psychological function have been poorly described. There is a lack of understanding on which subgroup of patients is at risk of decreased psychological function. Consequently, this limits the ability to optimize informed consent, to adequately inform our patients pre- and postoperatively, and to identify patients at risk who could benefit from additional therapy. The current findings suggest that a subgroup of patients, those who have high expectations for weight loss (>40% TWL), low educational level, a history of psychiatric illness and are unemployed are at risk of adverse outcomes in psychological function after bariatric surgery. These relevant findings should be considered when giving preoperative counseling and may allow healthcare professionals to provide targeted supplemental cognitive and behavioral interventions focusing on resolving psychological issues. Previous research has already described that people living with obesity believe bariatric surgery will result in drastic changes across a range of life domains resulting in a positive psychosocial impact. A multidisciplinary team should explicitly examine patient expectations in the pre- and postoperative setting to develop realistic outcomes. This includes calculating realistic expected weight loss targets and informing on the risk of weight regain in the years following massive weight loss [40]. As a result, preoperative counseling and realistic expectation setting in the postoperative period will likely lead to improved psychological function [41]. Moreover, patients with decreased or notably lower than normative psychological function scores should be identified in the postoperative setting. Analyzing individual psychological function scores in clinical practice as a physician or psychologist could assist in identifying these patients. Providing additional consultations or psychological support to this group by a multidisciplinary team, in particular a psychologist specialized in obesity treatment, is necessary to improve psychological function and optimize the quality of care.

Strengths of this study include the use of longitudinal data and measurement of psychological function with the most suitable measurement instrument for quality of life after bariatric surgery, namely the BODY-Q [3]. Limitations that should be considered include the lack of data three years after bariatric surgery (available only for 222 out of 836 patients). A further study with more focus on predictors for improved long term psychological function is therefore suggested. Second, all data from Denmark were self-reported, and data from The Netherlands on weight loss was supplemented with self-reported weight in the absence of clinical weight data. Self-reported data might be subject to recall bias and patients might not always provide accurate measurements. This may have been reflected in our data as patients from Denmark less frequently had a history of psychiatric illness and were less likely to have any comorbidity. Still, when comparing clinical weight with self-reported weight for the Dutch cohort, only a mean difference of 0.75 – 1.17 was found, indicating that these patients reported their weight very accurately. The same may hold for Denmark. Third, data on desired %TWL was missing for 17.3% of patients, thus these patients were removed from the prediction analyses. However, to account for this limitation, we ran the multivariable model through backward selection without desired %TWL and still found history of psychiatric illness and educational level as predictors, including age and gender which was expected.

CONCLUSION

This study evaluated factors that were predictive of improved psychological function scores up until three years after bariatric surgery. Patients with lower expectations regarding weight loss (<40% desired TWL), higher educational level (finished higher vocational education/university), no history of psychiatric illness and who were employed before bariatric surgery demonstrated the highest postoperative psychological function scores. Also, more weight loss and higher psychological function scores were related. Psychological function was not significantly affected by experiencing a major short-term complication. These findings provide valuable insight into psychological function after bariatric surgery and should be considered in pre- and postoperative clinical care.

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6

SUPPLEMENTARY FILES

Table 1. Difference in baseline characteristics between patients who were in- and excluded (Netherlands).

	Included	Excluded	*p*
Total number of patients, *n*	400	182	
Age at operation, years	45.2 (11.0)	40.6 (12.2)	<.001
Gender, *n* (%)			.016
Female	343 (85.6)	131 (77.5)	
Male	57 (14.3)	38 (22.5)	
Weight before surgery, kg	123.2(19.0)	127.0 (21.4)	.038
BMI before surgery, kg/m^2	42.9 (4.6)	44.1 (5.4)	.007
Type of surgery, *n* (%)			.101
Primary Roux-en-Y gastric bypass	256 (64.0)	91 (58.7)	
Primary sleeve gastrectomy	134 (33.5)	64 (41.3)	
Other [a]	10 (2.5)		
Comorbidities, *n* (%)			
Diabetes mellitus type 2	62 (15.5)	19 (11.2)	.184
Hypertension	133 (33.3)	31 (18.3)	<.001
Dyslipidemia	56 (14.0)	15 (8.9)	.091
Obstructive sleep apnea	293 (73.3)	106 (62.7)	.012
Osteoarticular disorder	81 (20.3)	24 (14.2)	.089
Having any comorbidity	346 (86.5)	117 (64.3)	<.001
History of psychiatric illness, *n* (%)	83 (20.8)	51 (28.0)	.053
Educational level, *n* (%)			.290
Elementary school or secondary school	98 (24.6)	27 (32.9)	
Intermediate vocational education	176 (44.1)	32 (39.0)	
Higher vocational education or university	125 (31.3)	23 (28.0)	
Marital status, *n* (%)			.546
Single, never married	71 (17.8)	19 (23.2)	
In relationship, not living together	21 (5.3)	5 (6.1)	
In relationship, living together	64 (16.0)	16 (19.5)	
Married	196 (49.1)	33 (40.2)	
Divorced	41 (10.3)	9 (11.0)	
Other	6 (1.5)	0 (0)	
Employment status, *n* (%)			.024
Unemployed	88 (22.6)	27 (34.6)	
Employed	302 (77.4)	51 (65.4)	

Note: data presented as mean (standard deviation) unless stated otherwise
N.A. Not available, *SD* Standard deviation
[a] Secondary Roux-en-Y gastric bypass or secondary sleeve gastrectomy after previous gastric banding

Table 2. Difference in baseline characteristics between patients who were in- and excluded (Denmark).

	Included	Excluded	*p*
Total number of patients, *n*	436	1022	
Age at operation, years	45.9 (10.0)	44.6 (10.9)	.031
Gender, *n* (%)			.006
Female	340 (78.0)	725 (71.1)	
Male	96 (22.0)	295 (28.9)	
Weight before surgery, kg	136.3(26.1)	138.1 (26.6)	.242
BMI before surgery, kg/m^2	46.4 (6.9)	46.4 (7.4)	.933
Operation, *n* (%)			
Primary Roux-en-Y gastric bypass	316 (72.5)	N.A.	
Primary sleeve gastrectomy	116 (26.6)	N.A.	
Other [a]	4 (0.9)		
Comorbidities, *n* (%)			
Diabetes mellitus type 2	70 (16.1)	177 (17.3)	.556
Hypertension	76 (17.4)	129 (12.6)	.016
Dyslipidemia	21 (4.8)	29 (2.8)	.072
Obstructive sleep apnea	47 (10.8)	77 (7.5)	.042
Osteoarticular disorder	19 (4.4)	5 (0.5)	<.001
Having any comorbidity	166 (38.1)	307 (30.0)	.002
History of psychiatric illness, *n* (%)	32 (7.3)	91 (8.9)	.325
Educational level, *n* (%)			.019
Elementary school or secondary school	189 (43.3)	528 (52.0)	
Intermediate vocational education	108 (24.8)	200 (19.7)	
Higher vocational education or university	139 (31.9)	281 (27.7)	
Marital status, *n* (%)			.019
Single, never married	80 (18.5)	207 (20.3)	
In relationship, not living together	N.A.	N.A.	
In relationship, living together	93 (21.3)	262 (25.6)	
Married	220 (50.5)	435 (42.6)	
Divorced	39 (8.3)	101 (9.9)	
Other	0 (0)	9 (0.9)	

Note: data presented as mean (standard deviation) unless stated otherwise

N.A. Not available, *SD* Standard deviation

[a] Secondary Roux-en-Y gastric bypass or secondary sleeve gastrectomy after previous gastric banding

CHAPTER 7

IS THE RAND-36 AN ADEQUATE PATIENT-REPORTED OUTCOME MEASURE TO ASSESS HEALTH-RELATED QUALITY OF LIFE IN PATIENTS UNDERGOING BARIATRIC SURGERY?

C.E.E. de Vries
D.J.S. Makarawung
V.M. Monpellier
I.M.C. Janssen
S.M.M. de Castro
R.N. van Veen

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ABSTRACT

Background

The RAND-36 is the most frequently used patient-reported outcome measure (PROM) to evaluate health-related quality of life (HRQL) in bariatric surgery. However, the RAND-36 has never been adequately validated in bariatric surgery. The purpose of this study was to validate the RAND-36 in Dutch patients undergoing bariatric surgery.

Methods

To validate the RAND-36, the following measurement properties were assessed in bariatric surgery patients: validity (the degree to which the RAND-36 measures what it purports to measure (HRQL)), reliability (the extent to which the scores of the RAND-36 are the same for repeated measurement for patients who have not changed in HRQL), responsiveness (the ability of the RAND-36 to detect changes in HRQL over time).

Results

Two thousand one hundred thirty-seven patients were included. Validity was not adequate due to the irrelevance of some items and response options, the lack of items relevant to patients undergoing bariatric surgery, and the RAND-36 did not actually measure what it was intended to measure in this study (HRQL in bariatric surgery patients). Reliability was insufficient for the majority of the scales (the scores of patients who had not changed in HRQL were different when the RAND was completed a second time (intraclass correlation coefficient (ICC) values .10–.69)). Responsiveness was insufficient.

Conclusion

The RAND-36 was not supported by sufficient validation evidence in patients undergoing bariatric surgery, which means that the RAND-36 does not adequately measure HRQL in this patient population. Future research studies should use PROMs that are specifically designed for assessing HRQL in patients undergoing bariatric surgery.

INTRODUCTION

The most effective treatment modality for severe obesity is bariatric surgery, which can lead to substantial improvements in patients' health and well-being [1,2,3]. Although percent total weight loss (%TWL), morbidity, and mortality have often been the primary outcomes, they may not capture the impact of bariatric surgery on patients' symptoms, functional and psychological aspects of health, and overall health-related quality of life (HRQL) [4]. Analysis of HRQL data can provide valuable information on the patient's perspectives of bariatric surgery and can best be measured with patient-reported outcome measures (PROMs) [5]. High-quality PROMs provide a useful tool for clinical and research purposes. The quality of a PROM is determined by assessing measurement properties, including validity, reliability, and responsiveness [6]. If the measurement properties of a PROM are insufficient, the PROM will not reliably measure what it is supposed to measure, leading to uncertainties about the results.

While HRQL is considered to be a key outcome in bariatric surgery, no consensus exists as to which PROMs should be used to assess HRQL in bariatric surgery [7,8]. A previous systematic review showed that 68 different PROMs were used in bariatric surgery studies [4,9]. The RAND-36 was found to be one of the most frequently used measures in the bariatric surgery population [7,8,10,11,12]. The RAND-36 assesses generic HRQL and is widely used in various health conditions [13]. It covers core health domains such as physical and mental health that is determined by both weight and other factors.

Although the RAND-36 is considered a reliable, valid, and responsive PROM to assess HRQL in many other populations than patients undergoing bariatric surgery [14], it has only been validated for use in patients with obesity who were scheduled for bariatric surgery in a single institution in Bahrain [15]. Furthermore, two other studies showed some validation evidence in a population with severe obesity who received conservative treatment [16,17]. The measurement properties of the RAND-36 for patients who undergo bariatric surgery are largely unknown, which is a major limitation to its use in research and clinical practice. In order to interpret the treatment effect of bariatric surgery using this PROM, it is essential that the RAND-36 is valid, reliable, and responsive to change in this specific population. The purpose of this study was to validate the RAND-36 in patients undergoing bariatric surgery.

METHODS

Design and Study Population

The current study was a combination of a retrospective analysis of prospectively collected data and a prospective study.

For the retrospective analysis, patients were selected from the database of the Nederlandse Obesitas Kliniek (Dutch Obesity Clinic, NOK), which is the largest outpatient clinic for bariatric surgery in the Netherlands. All patients at the NOK were screened according to the International Federation of Surgery for Obesity (IFSO) criteria [18] and follow an interdisciplinary treatment program in addition to surgery [19]. Patients were selected if they underwent bariatric surgery before 2014 and if the RAND-36 results were available before surgery or at least at one follow-up moment after surgery. The data were previously used to assess the relationship between weight loss and HRQL in patients who underwent bariatric surgery [20].

For the prospective part of the study, 125 patients who either started their treatment at the Nederlandse Obesitas Kliniek (NOK, Dutch Obesity Clinic) or who were one year postoperative were invited to participate in a test–retest study. Patients who were 18 years or older and who could read Dutch were included. In addition, patients and healthcare providers were sent a questionnaire about the RAND-36 to evaluate content validity, with up to two email reminders.

Ethical approval was obtained by the regional and local institutional review boards (registration number W17.138). Patients signed an online informed consent form prior to participation in the study. All collected patient data were coded to ensure subject privacy. The study was conducted in accordance with the Handbook for Good Clinical Research Practice of the World Health Organization and the Declaration of Helsinki principles.

Data collection

The following patient demographics were collected from the prospective database of the NOK: gender, age, weight, length, body mass index (BMI), and comorbidities (hypertension, diabetes mellitus, obstructive sleep apnea syndrome, hypercholesterolemia, and osteoarthritis) at baseline. HRQL was routinely assessed in the treatment program. Since 2012, the RAND-36 has been used and the impact of weight on quality of life (IWQOL) lite was subsequently added. This treatment program was enrolled over the different clinics during 2012 and 2013. The questionnaires were administered at the preoperative screening and each year postoperatively. Furthermore, the 15-months follow-up of the questionnaires was chosen because the lifestyle group trajectory was up until 15 months, and HRQL was evaluated at the end of this treatment program.

For the prospective study (test–retest), patients completed the RAND-36 twice: first as part of their regular treatment program and second at least 2 weeks after this first assessment. For the second questionnaire, an email with a URL that linked directly into a secure web-based application (Castor EDC) was sent to the participants of the test–retest study [21]. Up to two weekly reminders were sent. Data collection of the prospective study took place between April 2018 and May 2019.

Measures

The RAND-36

The RAND-36 is a PROM that assesses general health in patients with different kinds of medical conditions and is one of the most widely used PROMs for assessing general health [22]. It contains 36 questions and eight scales: physical functioning, role limitations due to physical problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and mental health. Two subscales can be generated from these eight scales: physical health summary (PHS) and mental health summary (MHS). Each scale has a total score that ranges from 0 (extremely poor) to 100 points (no complaint) [23]. The RAND-36 is different from the SF-36 in scoring algorithm (different scoring algorithms for two of the eight subscales).

The Impact of Weight on Quality of Life Questionnaire Lite

The IWQOL-lite is a disease (obesity) specific, 31-item PROM that assesses the impact of weight on quality of life in five domains: physical functioning, self-esteem, sexual life, public distress, and work [24]. This PROM showed sufficient validity and reliability in patients with obesity (Internal consistency, Cronbach's alpha > .80; test–retest reliability, ICC > .81; discriminative validity, correlations with treatment-seeking status in patients with obesity) [25].

Analysis

Patient characteristics with regard to age, gender, BMI, comorbidities, and follow-up were described as the mean ± SD or by percentages. All analyses were performed with SPSS 25.0 for Windows (SPSS Inc. Chicago Illinois, USA) [26]. A two-tailed significance level of ≤ .05 was considered significant.

The COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) standards for design requirements and preferred statistical methods was used for evaluating the measurement properties of the PROMs [27]. The following measurement properties were evaluated in bariatric surgery patients:

1. Validity, which refers to the degree to which the RAND-36 measures what it purports to measure (HRQL) [28]. More specifically, the measurement properties content validity and construct validity were evaluated. In this study, content validity refers to whether bariatric surgery patients and healthcare providers consider the items of the RAND-36 relevant, comprehensive, and comprehensible to measure HRQL in patients undergoing bariatric surgery [28]. Construct validity refers to whether the RAND-36 actually measures what it is intended to measure, i.e., HRQL in patients undergoing bariatric surgery [28].
2. Reliability, which refers to the extent to which the scores of the RAND-36 are the same for repeated measurement for patients who have not changed [28]. In this regard, internal consistency and test–retest reliability were evaluated. In this study, internal consistency describes how reliably the items in the RAND-36 that are designed to measure the same aspect of HRQL (e.g., physical functioning) actually do this [28]. Test–retest reliability measures whether the scores of the RAND-36 are the same when a patient whose HRQL has not changed completes the RAND-36 the second time [28].

3. Responsiveness, which describes whether the RAND-36 is able to measure changes in HRQL before and after bariatric surgery [28].

The definitions, interpretations, statistical tests, and quality criteria of the measurement properties are shown in the Supplementary Information, Table S1.

Content validity is considered the most important measurement property. Content validity was assessed by an online survey sent to patients and healthcare providers (bariatric physicians, bariatric surgeons, bariatric nurses, endocrinologists, psychologists, movement therapists, dieticians, and researchers). Patients were asked to give feedback on the comprehensiveness, comprehensibility, and relevance, while healthcare providers were asked to provide feedback on the comprehensiveness and relevance of the RAND-36.

RESULTS

A total of 2,137 patients completed the RAND-36 preoperatively or at least once postoperatively. The majority of patients were female (*n* = 1762, 82,5%), mean age was 46 SD 11 years, mean BMI preoperatively was 44.5 SD 5.8 kg/m^2. Patient characteristics are displayed in Table 1. The RAND-36 was completed by 2074 patients (97.1%) 15 months postoperatively and by 1036 patients (48.5%) 24 months postoperatively.

Validity

Content Validity

The online survey was completed by 53 patients and 50 healthcare providers. The results of the online survey are shown in Table 2. The majority of the patients (92.5%) and healthcare providers (76.0%) noted that most items and response options were relevant to measure HRQL, but not as relevant for patients undergoing bariatric surgery (73.6% of the patients and 68% of the healthcare providers). The recall periods of the questions were not appropriate according to 47.0% of the patients and 52.0% of the caregivers. For example, one question has a recall period of 1 year, which does not always reflect the timeframe that changes have occurred during the total weight loss journey. The majority of the healthcare providers (52.0%) and a selection of the patients (20.8%) indicated that key concepts of patients undergoing bariatric surgery were missing in the RAND-36. Patients reported that items on issues such as eating behavior, body image, obesity-specific symptoms, and symptoms after surgery were missing. Furthermore, healthcare providers stated that the RAND-36 lacks items on aspects important to patients undergoing bariatric surgery including excess skin, stigma, sexual functioning, work life, and appearance. Patients generally did not have any problems with the comprehensibility of the items. However, some patients asked for shorter sentences and simplified language. Thus, content validity of the RAND-36 was not sufficient for patients undergoing bariatric surgery.

Table 1. Demographics of included population at baseline (n = 2137), 15 months (n = 2093) and 24 months (n = 1079), adapted from Monpellier et al. 2017.

Baseline	
Age, years, mean (SD)	46 (11)
Female, *n* (%)	1762 (82.5)
BMI baseline, kg/m^2, mean (SD)	44.5 (5.8)
Diabetes Mellitus, *n* (%)	503 (23.5)
Hypertension, *n* (%)	838 (39.2)
Obstructive sleep apnea, *n* (%)	237 (11.1)
Hypercholesterolemia, *n* (%)	429 (20.1)
Osteoarthritis, *n* (%)	274 (12.8)
No comorbities, *n* (%)	925 (43.3)
Follow-up	
15 M BMI, kg/m^2, mean (SD)	30.7 (5.1)
24 M BMI, kg/m^2, mean (SD)	30.7 (5.2)
15 M ΔBMI, kg/m^2, mean (SD)	13.8 (4.1)
24 M ΔBMI, kg/m^2, mean (SD)	13.9 (4.3)
15 M %TWL, mean (SD)	31.0 (7.9)
24 M %TWL, mean (SD)	31.1 (8.4)

15 M 15 months follow-up, *24 M* 24 months follow-up, *BMI* body mass index, *ΔBMI* change in BMI, *%TWL* % total weight loss.

Table 2. Content validity of the RAND-36 (online survey) in numbers (%).

		Patients (n = 53)	Caregivers (n = 50)
Relevance	*The included items are relevant for the construct of interest.*	49 (92.5)	38 (76.0)
	The included items are relevant for the target population of interest.	39 (73.6)	34 (68.0)
	The included items are relevant for the context of use of interest.	46 (86.8)	34 (68.0)
	The response options are appropriate.	41 (77.4)	40 (80.0)
	The recall period is appropriate.	25 (47.2)	26 (52.0)
Comprehensiveness	*There are no key concepts missing.*	42 (79.2)	24 (48.0)
Comprehensibility	*The PROM instructions are understood by the population of interest as intended.*	50 (94.3)	
	The PROM items and response options are understood by the population of interest as intended.	46 (86.8)	
	The PROM items are appropriately worded.	48 (90.6)	
	The response options match the question.	47 (88.7)	

Construct Validity

Only 13 of the 21 hypotheses (61.9%) were confirmed (Supplementary Information, Table S2). Therefore, construct validity was not considered sufficient.

Convergent and Divergent Validity

For convergent and divergent, the majority of the RAND-36 subscales and IWQOL lite subscales measuring the same construct had moderate to high correlations, and scales measuring a different construct had lower correlations. However, for discriminative validity, none of the a priori hypotheses were confirmed by the data. The RAND-36 scales could not adequately discriminate between gender, comorbidities, age or BMI.

Reliability

Internal Consistency

Internal consistency was good with Cronbach's alpha values ranging from .86 to .89 for the different subscales of the RAND-36.

Test–Retest Reliability

The results of test–retest reliability are shown in Table 3. Test–retest reliability was not sufficient in six of the nine scales, only the physical functioning, general health perceptions, and health change scales had sufficient ICC values higher than .70.

Responsiveness

For responsiveness, three of the nine hypotheses (33.3%) were confirmed by the data (Supplementary Information, Table S3). The changes on the RAND-36 subscales were only weakly or moderately correlated (<.50) with changes on the IWQOL lite subscales measuring the same construct (exception physical functioning ($r>.50$, $p<.001$).

Table 3. Test-retest reliability of the RAND-36.

RAND-36 subscale	ICC value	95% confidence interval
Physical functioning	.880	.827, .918
Role limitations due to physical problems	.624	.489, .730
Bodily pain	.687	.568, .778
General health	.857	.794, .902
Vitality	.096	.000, .258
Social functioning	.630	.495, .734
Role limitations due to emotional problems	.430	.240, .589
Mental health	.422	.003, .671
Health change	.868	.810, .909

ICC intraclass correlation coefficient.

The RAND-36 subscales correlated weakly ($r < .30$) with %TWL and change in BMI after surgery. The change scores of the RAND-36 could not discriminate between subgroups (gender, age, BMI, and comorbidities).

DISCUSSION

While the assessment of the validity of measures such as blood pressure is common, the awareness of the importance of validation evidence of PROMs is less common. This study assessed the measurement properties of the RAND-36 in a large population of patients who underwent bariatric surgery. The quality of a PROM is crucial when used in research or clinical practice and should be evaluated by assessing measurement properties [6]. It is important to consider that in case of insufficient measurement properties the PROM is not adequate for its purpose.

This study only demonstrated evidence of sufficient internal consistency, meaning good interrelatedness among the items of the RAND-36. The most important result was that content validity was not adequate due to the irrelevance of some items and response options, and the lack of other items that are relevant to patients undergoing bariatric surgery. Resultant low test–retest reliability values, insufficient construct validity, and responsiveness limit the ability of the RAND-36 to be used in bariatric surgery. These results indicate that the RAND-36 lacks items important to patients undergoing bariatric surgery and is limited in its ability to measure HRQL and detect relevant changes in HRQL after bariatric surgery. Furthermore, the scores of the RAND-36 in patients undergoing bariatric surgery may not be reliable.

Content validity is considered the most important measurement property and refers to the extent to which the items of the RAND-36 measure all relevant aspects of HRQL in the bariatric population. Nearly one-third of the participants noted that a number of items and response options were irrelevant for patients undergoing bariatric surgery. Approximately half of the patients and healthcare providers answered that the recall period was not adequate for this population. Irrelevant content can lead to insufficiency to measure relevant changes over time and inconsistency among patients in answering the questions. This may be reflected in the insufficient results with regards to test–retest reliability and responsiveness in this study.

Another issue with the content validity was that participants noted that key concepts of HRQL in bariatric surgery patients were missing in the RAND-36. The RAND-36 was developed in a general population, and, therefore, the items lack particular issues relevant to bariatric surgery patients, such as eating behavior, stigma, sexual functioning, appearance, body image, and excess skin. Some of these issues add substantially to the well-being of patients with obesity or undergoing bariatric surgery.

Interestingly, there were weak correlations between BMI or %TWL and RAND-36 scores in this study, which means that patients with higher BMI or less %TWL were not necessarily the patients with lower HRQL scores. Only the physical functioning scales of the RAND-36 correlated strongly with the IWQOL-lite and could discriminate between patients with different BMI or %TWL. To adequately assess the effect of bariatric surgery, an effect of BMI or %TWL should be reflected in change in HRQL. Other questionnaires specifically developed for people living with obesity, such as the IWQOL-Lite and BODY-Q, demonstrated strong evidence for discriminative validity in patients with different BMI categories and differences in weight loss [29,30,31,32,33,34]. While previous clinical studies (not clinimetric/psychometric studies) showed associations or correlations between BMI or %TWL and the RAND-36 [35,36], we tested a priori hypotheses that specified the expected relative magnitude of the differences between different BMI groups and correlations with %TWL in this study. The interpretation of these results is different in that we did not test statistical significance, but whether the RAND-36 truly measured changes in HRQL and whether it measured the right amount of change [27].

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The results of this study contradict the only evidence of validity of the RAND-36 in patients who were scheduled for bariatric surgery [14]. In our study, we did not repeat the same analyses, but assessed the additional measurement properties in patients undergoing bariatric surgery. The major limitation of the study by Al Amar is that they did not assess the most important measurement property, content validity [14]. The use of a PROM in a different patient population than the population for which it was developed requires new supporting evidence of content validity. Moreover, the additional measurement properties (construct validity, reliability, and responsiveness) are important to ensure that studies adequately evaluate treatment effects as in bariatric surgery.

Strengths of the study include the large number of participants, the inclusion of patients in the evaluation of content validity, and the generation of a priori hypotheses to assess construct validity. Previous studies included only smaller samples of patients with obesity. However, there were some limitations to this study. First, part of the study data was retrospective and only included data of patients that filled out the questionnaires (even though all patients in the treatment program were expected to complete the questionnaires). This may have introduced selection bias to this study. Furthermore, the follow-up rate at 24 months after surgery was less than 50%, which may have introduced further bias to the results of responsiveness. Second, the content validity of the RAND-36 was assessed with an online survey with patients and healthcare providers. Qualitative methods to assess content validity would have improved the quality of evidence of this measurement property. Third, this study was performed in the Netherlands using the Dutch RAND-36. Different language versions of the RAND-36 may show different results.

Bariatric surgery can be evaluated by many different outcomes, including clinical endpoints such as weight loss and improvements in comorbidities, and patient-reported outcomes (PROs) such as HRQL. Even though the SF-36 and RAND-36 are frequently chosen measures in bariatric surgery, these PROMs are designed for general use. They allow for comparison across different patient groups, but they lack sensitivity to measure changes in patients undergoing bariatric surgery. This means that the use of the RAND-36 alone may not be sufficient to assess the effects of bariatric surgery from the patients' perspective. The RAND-36 is useful to compare patients undergoing bariatric surgery with other patient populations to demonstrate the burden of disease, but a PROM specifically designed for assessing HRQL in bariatric surgery patients should be used to discriminate at another level among subgroups of these patients.

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SUPPLEMENTARY FILES

Table S1. Definition of measurement properties and quality criteria.

Measurement property	Definition [a]	Interpretation	Statistical test [b]	Quality criteria [c]
Content validity	The degree to which the content of a health-related PROM is an adequate reflection of the construct to be measured	The items in the RAND-36 should be considered relevant, comprehensive and comprehensible by healthcare providers and patients to measure HRQL in patients undergoing bariatric surgery	Feedback from patients and healthcare providers on the comprehensiveness, comprehensibility and relevance	The target population and healthcare providers consider the items relevant, comprehensive and comprehensible
Internal consistency	The degree of interrelatedness among the items	The items in each RAND-36 scale that are meant to measure the same construct (e.g. physical functioning), should produce similar scores	Cronbach's alpha coefficients	Cronbach's alpha value of .70 and higher
Test-retest reliability	The extent to which scores for patients who have not changed are the same for repeated measurement over time	The scores of the RAND-36 should be the same when a patient whose HRQL has not changed completes the RAND-36 the second time	Intraclass correlation coefficients (ICC), using a two-way random effects model	ICC values of ≥.70

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Table S1. (continued)

Measurement property	Definition [a]	Interpretation	Statistical test [b]	Quality criteria [c]
Construct validity	The degree to which the scores of a health-related PROM are consistent with hypotheses based on the assumption that the health-related PROM validly measures the construct to be measured	The RAND-36 should actually measure what it is intended to measure, i.e. HRQL in patients undergoing bariatric surgery	Predefined hypotheses (Supplementary information, Table 2) regarding: 1. The relationships of the RAND-36 to scores of the IWQOL-Lite that measure the same construct (i.e., divergent/ convergent validity) (Spearman's or Pearson correlation coefficients) 2. The differences in scoring between relevant groups (i.e., discriminative validity) (t-test or Mann-Whitney U test (depending on normality)	At least 75% of the results in concordance with the a priori hypotheses Correlation coefficient values below .3 were considered low, between .3 and .6 moderate, and above .6 high
Responsiveness	The ability of a health-related PROM to detect change over time in the construct to be measured	The RAND-36 to should be able to measure changes in HRQL before and after bariatric surgery	Predefined hypotheses (Supplementary information, Table 3) regarding changes in the RAND-36 were compared to changes in the IWQOL-lite (Pearson or Spearman's correlation coefficients)	At least 75% of the results in concordance with the a priori hypotheses or correlation with changes on PROMs measuring the same construct was >.50

[a] Definition of properties adapted from Mokkink et al. 2010 and [b] statistical tests adapted from Mokkink et al. 2010 [c] quality criteria adapted from Terwee et al. 2007
PROM patient-reported outcome measure, *HRQL* health-related quality of life, *ICC* intraclass correlation coefficient, *IWQOL-Lite* impact of weight on quality of life -Lite

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Table S2. Hypotheses of construct validity.

	Hypothesis	Results	Hypothesis confirmed
1.	A high correlation (≥ .60) between RAND-36 physical functioning and IWQOL-Lite physical functioning	.724, p = .001	Yes
2.	A high correlation (≥ .60) between RAND-36 social functioning and IWQOL-Lite public distress	.318*, p = .001	No
3.	A high correlation (≥ .60) between RAND-36 physical health summary (PHS) scores and IWQOL-Lite physical	.683, p = .001	Yes
4.	A moderate correlation (≥ .40) between RAND-36 role limitations due to physical problems and IWQOL-Lite physical	.494, p = .001	Yes
5.	A moderate correlation (≥ .40) between RAND-36 role limitations due to physical problems and IWQOL-Lite work	.479*, p = .001	Yes
6.	A moderate correlation (≥ .40) between RAND-36 social functioning and IWQOL-Lite self-esteem	.413*, p = .001	Yes
7.	A moderate correlation (≥ .40) between RAND-36 mental health summary (MHS) scores and IWQOL-Lite self-esteem	.470, p = .001	Yes
8.	A moderate correlation (≥ .40) between RAND-36 vitality and IWQOL-Lite physical functioning	.462, p = .001	Yes
9.	A stronger correlation of the RAND-36 mental health summary (MHS) with IWQOL Lite public distress compared to the correlation with RAND-36 role limitations due to emotional problems and IWQOL Lite self-esteem. This difference will be at least .05 higher.	.338, p = .001 .283*, p = .001	Yes

Table S2. (continued)

	Hypothesis	Results	Hypothesis confirmed
10.	A stronger correlation of the RAND-36 PHS with the IWQOL Lite physical compared to the correlation of the RAND-36 MHS and the other subscales of the IWQOL Lite. This difference should be at least .05 higher.	RAND physical, IWQOL physical (.724, *p* = .001) RAND MHS, IWQOL physical (.462, *p* = .001) RAND MHS, IWQOL Self-esteem (.470, *p* = .001) RAND MHS, IWQOL Public Distress (.338, *p* = .001) RAND MHS, IWQOL Work (.530, *p* = .001) RAND MHS, IWQOL Sexual (.392*, *p* = .001)	Yes
11.	A stronger correlation of the RAND-36 role limitations due to physical problems with IWQOL Lite work to the correlation with RAND-36 role limitations due to emotional problems and IWQOL Lite work. This difference will be at least .05 higher.	RAND physical, IWQOL work (.479*, *p* = .001) RAND emotional, IWQOL Work (.366*, *p* = .001)	Yes
12.	Low correlations (≤ .30) between RAND-36 bodily pain and IWQOL-Lite self-esteem.	RAND bodily pain, IWQOL self-esteem (.228, *p* = .001)	Yes
13.	Low correlations (≤ .30) between RAND-36 subscales and IWQOL-Lite sexual life.	RAND emotional, IWQOL sexual .218*, *p* = .001 RAND social, IWQOL sexual .355*, *p* = .001 RAND vitality, IWQOL sexual .319*, *p* = .001 RAND physical, IWQOL sexual .281*, *p* = .001 RAND mental health, IWQOL sexual .355*, *p* = .001 RAND bodily pain, IWQOL sexual .241*, *p* = .001 RAND general health, IWQOL sexual .226*, *p* = .001 RAND health change, IWQOL sexual .155*, *p* = .001 RAND physical role, IWQOL sexual .268*, *p* = .001	No

Table S2. (continued)

	Hypothesis	Results	Hypothesis confirmed
14.	Low correlations (≤ .30) between RAND-36 subscales and IWQOL-Lite work.	RAND emotional, IWQOL work .366*, p = .001 RAND social, IWQOL work .473*, p = .001 RAND vitality, IWQOL work .411, p = .001 RAND physical, IWQOL work .415, p = .001 RAND mental health, IWQOL work .440, p = .001 RAND bodily pain, IWQOL work .371, p=.001 RAND general health, IWQOL work .353, p = .001 RAND health change, IWQOL work .185*, p = .001 RAND physical role, IWQOL work .479, p = .001	No
15.	A higher number of comorbidities is associated with lower RAND-36 total score.	PHS -0.178*, p = .001 MHS -0.070*, p = .001	Yes
16.	A mean difference of >10 points on a scale from 0 to 100 on the RAND-36 between patients with comorbidities and without comorbidities.	RAND vitality -2.05, p = .012 RAND physical -7.80, p = .001 RAND mental health 0.14, p = .856 RAND pain -7.11, p = .001 RAND general health -4.71, p = .001 RAND PHS -6.91, p = .001 RAND MHS -1.95, p = .022 RAND emotional p = .017 RAND social p = .246 RAND health change p = .052 RAND physical role p = .001	No

Table S2. (continued)

	Hypothesis	Results	Hypothesis confirmed
17.	Low correlation (≤ .5) between RAND-36 scores and age.	RAND role emotional, age -.038*, *p* = .078 RAND social, age -.027*, *p* = .207 RAND vitality, age -.034, *p* = .114 RAND physical, age -.242, *p* = .001 RAND mental, age .034, *p* = .112 RAND pain, age -.161, *p* = .001 RAND general, age .022, *p* = .320 RAND health change, age -.072*, *p* = .001 RAND physical role, age -.109*, *p*= . 001	Yes
18.	A mean difference of ≥10 points on a scale from 0 to 100 on the RAND-36 between men and woman.	RAND vitality 2.25, *p* = .033 RAND physical 4.77, *p* = .001 RAND mental 2.51, *p* = .010 RAND pain 5.58, *p* = .001 RAND general health -0.80, *p* = .456 RAND PHS 3.14, *p* = .009 RAND MHS 2.78, *p* = .007 RAND emotional 3.12, *p* = .279 RAND social 3.25, *p* = .035 RAND health change 2.12, *p* = .077 RAND physical role 3.02, *p* = .169	No

Table S2. (continued)

	Hypothesis	Results	Hypothesis confirmed
19.	A mean difference of <10 points on a scale from 0 to 100 on the RAND-36 between age<40 and age>40.	RAND vitality 1.71, p = .058 RAND physical 8.98, p = .001 RAND mental -1.37, p = .097 RAND pain 6.48, p = .001 RAND general health -1.78, p = .052 RAND PHS 4.58, p = .001 RAND mental 0.50, p = .598 RAND emotional role 1.94, p = .621 RAND social -0.30, p = .828 RAND health change 2.98, p = .013 RAND physical role 4.63, p = .021	No
20.	A mean difference of >10 points on a scale from 0 to 100 on the RAND-36 between BMI<50 and BMI≥50.	RAND vitality -1.24, p = .24 RAND physical 9.73, p < .001 RAND mental 1.23, p = .20 RAND pain 2.19, p = .003 RAND general health 1.98, p = .188 RAND PHS 4.43, p = .056 RAND MHS 1.44, p = .048 RAND emotional role 1.64, p = .411 RAND social 4.12, p = .020 RAND health change 1.63, p = .150 RAND physical role 3.80, p = .139	No

Table S2. (continued)

	Hypothesis	Results	Hypothesis confirmed
21.	A high correlation (≥ .6) between RAND-36 scales physical functioning, role limitations due to physical problems, bodily pain, general health and vitality and patients with BMI≥50.	RAND vitality, BMI .040, p = .062 RAND physical, BMI -.158, p = .001 RAND pain, BMI -.029, p = .182 RAND general health, BMI -.009, p = .669 RAND physical role, BMI 1,000, p = .356	No

Table S3. Hypotheses of responsiveness.

	Hypothesis	Results	Hypothesis confirmed
1.	A positive moderate correlation (≥ .50) between changes in the scores comparing the RAND-36 and the IWQOL-Lite	The changes on the RAND-36 subscales were only weakly or moderately correlated (< .50) with changes on the IWQOL-Lite subscales measuring the same construct (exception physical functioning (*r* > .50, *p* = .001)	No
2.	Change scores of the RAND-36 will be ≥ 0.10 lower compared with the change scores of the IWQOL-Lite	15 months: RAND emotional role 0.10 RAND social 0.15 RAND vitality 0.17 RAND physical 0.24 RAND mental 0.07 RAND pain 0.19 RAND general health 0.28 RAND health change 0.57 RAND physical role 0.40 RAND PHS 0.28 RAND MHS 0.12 IWQOL physical 0.47 IWQOL self-esteem 0.39 IWQOL sexual 0.29 IWQOL public distress 0.32 IWQOL work 0.24 24 months: RAND emotional role 0.07 RAND social 0.12 RAND vitality 0.14 RAND physical 0.34 RAND mental 0.05 RAND pain 0.17 RAND general health 0.27 RAND health change 0.42 RAND physical role 0.28 RAND PHS 0.27 RAND MHS 0.09 IWQOL physical 0.47 IWQOL self-esteem 0.38 IWQOL sexual 0.28 IWQOL public distress 0.32 IWQOL work 0.24	No

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Table S3. (continued)

	Hypothesis	Results	Hypothesis confirmed
3.	Change scores of the RAND-36 PHS will be ≥0.10 higher compared with the change scores of the RAND-36 MHS	15 M: PHS 0.28, MHS 0.12 24 M: PHS 0.26, MHS 0.09	Yes
4.	The highest change score on physical functioning of the RAND-36	15 M: Physical functioning 0.35, Health change 0.57 24 M: Physical functioning 0.34, Health change 0.47	No
5.	The lowest change score on the RAND-36 MHS	15 M: Mental health summary 0.12, Mental health 0.07 24 M: Mental health summary, 0.09, Mental health 0.05	No
6.	A mean difference of <10 points on a scale from 0 to 100 in change scores on the RAND-36 between men and woman	15 months: RAND emotional role -2.53, *p* = .32 RAND social -0.67, *p* = .60 RAND vitality 0.65, *p* = .85 RAND physical -2.80, *p* = .02 RAND mental -0.81, *p* = .41 RAND pain -2.89, *p* = .13 RAND general health 0.23, *p* = .95 RAND health change -1.78, *p* = .15 RAND physical role -2.89, *p* = .35 RAND PHS -1.93, *p* = .12 RAND MHS -0.84, *p* = .45 24 months: RAND emotional role 1.23, *p* = .68 RAND social 1.46, *p* = .67 RAND vitality 4.21, *p* = .03 RAND physical -3.91, *p* = .07 RAND mental 0.15, *p* = .76 RAND pain -1.94, *p* = .52 RAND general health 3.32, *p* = .15 RAND health change 0.41, *p* = .97 RAND physical role -2.19, *p* = .59 RAND PHS -1.18, *p* = .75 RAND MHS 1.76, *p* = .60	Yes

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Table S3. (continued)

	Hypothesis	Results	Hypothesis confirmed
7.	A mean difference of <10 points on a scale from 0 to 100 in change scores on the RAND-36 between age<40 and age>40	15 months: RAND emotional role 0.007, *p* = .33 RAND social 1.75, *p* = .36 RAND vitality -3.42, *p* = .003 RAND physical -2.59, *p* = .02 RAND mental 0.73, *p* = .54 RAND pain -0.30, *p* = .57 RAND general health 0.06, *p* = .83 RAND health change -2.62, *p* = .38 RAND physical role -0.29, *p* = .83 RAND PHS -0.78, *p* = .42 RAND MHS -0.23, *p* = .84 24 months: RAND emotional role 0.47, *p* = .76 RAND social -3.22, *p* = .13 RAND vitality -4.84, *p* = .004 RAND physical -3.05, *p* = .16 RAND 1.01, *p* = .40 RAND pain -4.13, *p* = .01 RAND general health -0.86, *p* = .92 RAND health change -6.87, *p* = .02 RAND physical role -3.25, *p* = .41 RAND PHS -2.82, *p* = .11 RAND MHS -1.64, *p* = .31	Yes

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Table S3. (continued)

	Hypothesis	Results	Hypothesis confirmed
8.	A mean difference of >10 points on a scale from 0 to 100 in change scores on the RAND-36 between patients with comorbidities and without comorbidities	15 months: RAND emotional role 2.95, *p* = .20 RAND social -0.38, *p* = .87 RAND vitality 1.71, *p* = .08 RAND physical 2.03, *p* = .05 RAND mental -1.25, *p* = .09 RAND pain 1.86, *p* = .09 RAND general health 2.95, *p* = .004 RAND health change 3.47, *p* = .006 RAND physical role 3.44, *p* = .06 RAND PHS -2.57, *p* = .009 RAND MHS 0.76, *p* = .49 24 months: RAND emotional role 5.23, *p* = .11 RAND social 0.94, *p* = .97 RAND vitality 2.98, *p* = .09 RAND physical 2.17, *p* = .22 RAND mental 0.04, *p* = .54 RAND pain 3.82, *p* = .02 RAND general health 2.06, *p* = .23 RAND health change 5.93, *p* = .02 RAND physical role 6.19, *p* = .04 RAND PHS 3.56, *p* = .02 RAND MHS 2.30, *p* = .17	No

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Table S3. (continued)

	Hypothesis	Results	Hypothesis confirmed
9.	A mean difference of >10 points on a scale from 0 to 100 in change scores on the RAND-36 between patients between BMI<50 and patients with a BMI≥50	15 months: RAND emotional role -5.15, *p* = .04 RAND social -4.14, *p* = .05 RAND vitality 0.45, *p* = .98 RAND physical -5.55, *p* = .001 RAND mental -1.59, *p* = .08 RAND pain -2.26, *p* = .19 RAND general health 1.93, *p* = .13 RAND health change -3.04, *p* = .05 RAND physical role -1.97, *p* = .42 RAND PHS -1.97, *p* = .17 RAND MHS -2.61, *p* = .04 24 months: RAND emotional role -3.38, *p* = .37 RAND social -4.46, *p* = .13 RAND vitality -0.49, *p* = .84 RAND physical -4.39, *p* = .06 RAND mental -2.54, *p* = .22 RAND pain -4.53, *p* = .05 RAND general health 1.19, *p* = .44 RAND health change -6.90, *p* = .02 RAND physical role -3.32, *p* = .33 RAND PHS -2.77, *p* = .17 RAND MHS -2.76, *p* = .25	No

CHAPTER 8

COMPLICATIONS IN POST-BARIATRIC BODY CONTOURING SURGERY USING A PRACTICAL TREATMENT REGIME TO OPTIMIZE THE NUTRITIONAL STATE

D.J.S. Makarawung
M. Al Nawas
H.J.M. Smelt
V.M. Monpellier
L.M. Wehmeijer
W.B. van den Berg
M.M. Hoogbergen
A.B. Mink van der Molen

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ABSTRACT

Background

Post-bariatric body contouring surgery (BCS) treats redundant skin after massive weight loss; however, the complication risk is relatively high (23-70%). Most complications are wound-related, which may be partly due to a poor nutritional status after bariatric surgery. The objective of this observational study was to optimize nutrition preoperatively and assess the prevalence of wound-related complications after BCS.

Methods

This prospective cohort study included 140 patients. Patients were treated according to the post-bariatric BCS guideline. Nutritional parameters were collected via pre- and perioperative blood sampling; any deficiencies were treated. A protein-enriched diet was prescribed by a dietician 4 weeks preoperatively up until closure of all wounds. Complications were recorded using the Clavien-Dindo classification. Univariate and multivariate regression analyses were performed to identify variables associated with wound-related complications.

Results

The overall wound-related complication rate was 51%. Most complications were minor, with only 4.3% was considered major. No significant differences in patient characteristics were found between patients with and without complications. Variables indicating an optimized nutritional state were not significantly associated with a decreased risk of complications; the most influential factor was a sufficient postoperative protein intake (OR 0.27, 95% CI [0.07, 1.02], p = .05).

Conclusion

The overall wound-related complication rate was in accordance with previous literature; however, major complications were few. This study showed a weak correlation between optimizing nutritional state and better outcome after BCS, especially following a protein enriched diet postoperatively. Therefore, we recommend continuing research on nutrition and wound-related complications, using homogeneous study populations and well-defined complications.

INTRODUCTION

Post-bariatric body contouring surgery (BCS) has a relatively high complication rate. Studies reported complication rates of 23% to 70%, mostly wound-related [1–7]. Several factors are associated with wound-related complications: smoking, higher age, higher pre-weight loss body mass index (BMI), more weight loss, higher current BMI, unstable weight, hypothermia, and larger weight of resected tissue [2,4,5,7–13]. It is also suggested that patients after bariatric surgery have increased risks of complications in comparison to conservative weight loss patients, due to a higher prevalence of nutritional deficiencies caused by inadequate intake and malabsorption [14–17].

Nutrients play a variety of roles in wound healing and can effect wound tensile strength, collagen synthesis, and immune function, all essential elements in this process [18]. In fact, suboptimal nutrition is associated with wound-related complications in other fields of medicine [18–22]. Nutrients that may influence wound healing include: vitamin A, vitamin B, vitamin C, vitamin E, copper, iron, zinc and protein [18,23–26]. Furthermore, damage to the body triggers the stress response which results in hypermetabolism and increases glucose and protein utilization [27]. Therefore, nutritional support is already integrated in the treatment of burns (increased caloric intake and supplementation of vitamins A and C and copper) and malignancies [28,29]. After bariatric surgery, patients often develop nutritional deficiencies of vitamins, minerals and protein. Therefore, standard care includes regular assessment of dietary protein intake by a dietician and lifelong supplementation of vitamins and minerals [30–32]. Regardless, deficiencies can still occur years after surgery [33]. The most common deficiencies include anemia, ferritin, folate, protein, vitamin B12 and vitamin D. Lower levels of vitamin A, vitamin B1, zinc, and copper are reported less frequently [30,32,34].

Several studies suggested that malnutrition may be a risk factor for wound-related complications in post-bariatric BCS [14,15,35–39]. Moreover, two studies reported fewer wound-related complications in patients who received protein supplementation 3 to 4 weeks preoperatively [14,15]. However, no prospective studies evaluated this relationship and previous studies have lacked well-defined follow-up time and definitions of complications.

In summary, post-bariatric BCS has a high risk of wound-related complications, which might be associated with nutritional deficiencies. Our objective was to optimize protein intake and vitamin levels perioperatively, and subsequently assess the prevalence of wound-related complications and explore variables associated with wound-related complications. We hypothesized that an optimal nutritional state would result in fewer wound-related complications postoperatively, in comparison to existing literature. Furthermore, variables indicating optimal nutritional state were related to decreased risks of wound-related complications.

METHODS

Patient selection

This is an observational, prospective, multicenter study that was conducted in three high-volume obesity care centra in the Netherlands. Patients were included between December 2016 and October 2020. Eligible patients had a history of bariatric surgery and underwent a body contouring procedure afterwards. Previous known or suggested risk factors for complications and wound healing disturbances were exclusion criteria (Supplementary Table S1).

In consultation with clinical epidemiologists, a minimal sample size of 120 patients was calculated. At least 30 patients with a complication were needed to evaluate factors influencing complications by logistic regression. Based on previous studies in our center, a complication rate of 25% was assumed for the sample size calculation [7,38]. Consequently, inclusion of 120 patients would lead to 30 patients with complications.

Ethical approval was obtained from the National Research and Ethics Committee (registration number NL53259.100.15) and the board of directors in all participating hospitals. The study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Study procedure

All eligible patients were informed by the plastic surgeon during their first consultation. Interested patients were contacted by the researcher and signed an informed consent form. Data were collected from the electronic patient record by the investigators, trained medical students, and dieticians. Data were anonymously stored using a password protected web-based application (Research Manager).

Evaluation of nutritional status and treatment

Patients were treated according to the Clinical Practice Guideline (CPG) on Post-Bariatric Surgery of the Dutch association of Plastic Surgery (NVPC) [40]. Based on the most common deficiencies in patients after bariatric surgery and their influence on wound healing, a preoperative assessment of albumin, ferritin, folate, hemoglobin, vitamin B12 and vitamin D, and a nutritional work-up was conducted.

Approximately 8 weeks prior to BCS nutritional status was assessed by a clinical dietician. Normally, patients who had bariatric surgery require a minimum of 60 grams protein per day [41]. After consultation of experts (NUTRIM), the recommended intake was 1.5 g/kg actual body weight, based on the high prevalence of protein deficiencies after bariatric surgery and the higher requirement of protein during/after extensive surgery [41]. If patients had a BMI > 27 kg/m^2, the target intake was set to 1.5 g x height (m^2) x 27, due to the relatively higher fat free mass in persons with obesity and the relative decrease in fat free mass with increasing BMI [42]. Patients were advised to start their protein-enriched diet 4 weeks preoperatively up to 6 weeks postoperatively or up until complete healing of all wounds. At the discretion of the dietician a second consultation, either pre- or postoperatively, was planned.

After the first consultation, blood sampling was performed as stated in the CPG. Any deficiencies were treated according to the bariatric surgery department protocols (Supplementary Table S2). To interpret deficiencies, the reference values of local protocols were applied, and as such, even the smallest deviation was considered a deficiency. For study purposes, a second blood sample was obtained perioperatively to evaluate any persisting or new deficiencies. New perioperative deficiencies were treated similarly.

Six weeks postoperatively, patients received a questionnaire to assess compliance to the treatment regime (Supplementary File S1).

Standardized post-operative care

All postoperative patients were mobilized within 24 hours and received prophylactic antithrombotic therapy until discharge. After abdominoplasty and lower body lift, any drains were removed when production yielded less than 50 mL per day, and all patients were advised to wear a supportive band for 3 weeks. Following brachioplasty or thigh lift procedures, any drains were removed 1 day postoperatively, and patients received compression bandages for 1 week. After reduction mammaplasty, drains were removed the first postoperative day, and patients were advised to wear a supportive bra during 6 weeks.

Two and six weeks after BCS, a standard consultation by the plastic surgeon, physician or a trained staff nurse was planned. In case complications arose, follow-up period was extended until all complications were treated.

Instruments

Primary outcome variables included nutritional status, wound-related complications, and other complications arising within 30 days of surgery (Supplementary Table S3). All interventions that treated wound-related complications were recorded. Additionally collected variables were patient demographics, weight history, and type of BCS. The history of bariatric surgery, use of anti-diabetic medication and smoking status were evaluated prior to inclusion.

Clavien-Dindo classification

Wound-related complications and the respective interventions were graded following the Clavien-Dindo classification, which is a validated instrument for bariatric surgery that includes a therapy-orientated grading system that depends upon the therapeutic implications [43,44,45]. Major complications were considered grade 3b or higher.

Questionnaire

A questionnaire assessed compliancy to the protein-enriched diet (Supplementary File S1). There were three possible answers: not compliant, compliant only pre- or postoperatively, and compliant during the whole study period, including the number of weeks. No validated questionnaires for assessing compliancy to diets exist; therefore, a self-developed, non-validated questionnaire was used.

Statistical analysis

Patients' characteristics were summarized using descriptive statistics. Normality was tested. To assess differences between patients with wound-related complications and patients without, parametric (independent T-test) or nonparametric (Mann-Whitney U) tests were used to compare continuous variables. Chi-square tests were used for nominal variables. For study purposes, the variable BCS was transformed into three categories: 1) (fleur-de-lis) abdominoplasty, 2) (fleur-de-lis) lower body lift and 3) mammareduction/-pexy, thigh lift procedures, brachioplasty, upper body lift, and lateral thigh lift combined with mini-abdominoplasty. A new variable 'any deficiency' was created for analyses. If one individual parameter of the blood sampling was missing, whereas all other parameters were within normal range, the whole blood sample was considered not deficient. If more than one variable was missing, the sample was discarded for analyses. To identify nutritional factors that influenced wound-related complications, uni- and multivariable logistic regression analysis was performed. In the multivariate model, history of smoking, location, bariatric surgery type and BCS type were added as possible confounders. All statistical analyses were performed using the SPSS (version 25) statistical software. A two-tailed *p*-value of $< .05$ was considered statistically significant.

RESULTS

Patient demographics

A total of 158 patients were included. Of these, 17 were excluded due to incorrect inclusion (e.g., in case not all comorbidities were correctly available at time of inclusion) and one patient decided to withdraw from the study. This resulted in 140 patients (Table 1). Patients had a mean age of 47 (SD 9.1) years, 94% were female and 79% underwent Roux-en-Y gastric bypass. The participants had a mean percentage total weight loss (%TWL) of 40% (SD 9.9). Two patients were active smokers and quitted a minimum of four weeks preoperatively.

A total of 124 patients underwent a single procedure, five patients had two serial procedures, and two patients had three serial procedures. The most frequently performed body contouring procedures were abdominoplasty (29%) and fleur-de-lis abdominoplasty (26%) (Table 2).

Table 1. Patient characteristics (*n* = 140).

	Mean (SD)	Range
Gender, n (%)		
Male	8 (5.7)	
Female	132 (94.3)	
Age (years)	47 (9.1)	26 – 71
Body mass index (kg/m^2)		
Pre-body contouring surgery	27.9 (3.2)	19.0 – 35.0
Pre-bariatric surgery	46.7 (5.9)	36.5 – 68.8
Total weight loss (%)	39.7 (7.9)	20.5 – 58.6
Stable weight pre-body contouring surgery (months)	18.8 (7.5)	12 – 40
History of diabetes, n (%)	11 (7.9)	
History of smoking, n (%)	18 (12.9)	
Type of bariatric surgery, n (%)		
Roux-en-Y gastric bypass	110 (78.6)	
Sleeve gastrectomy	22 (15.7)	
Adjustable gastric banding	8 (5.7)	

Note: Presented as mean (SD) unless stated otherwise.

Table 2. Type of body contouring procedures.

	Number (%)
Abdominoplasty	40 (28.6)
Fleur de lis abdominoplasty	36 (25.7)
Lower body lift	5 (3.6)
Fleur de lis lower body lift	21 (15.0)
Mammoplasty/mastopexie	12 (8.6)
Brachioplasty	8 (5.7)
Cruroplasty	16 (11.4)
Upper body lift	1 (0.7)
Lateral cruroplasty and mini abdominoplasty	1 (0.7)
Total	140 (100.0)

Nutritional status

Of the 129 patients who reported protein base intake, 93 patients (72%) achieved the minimum intake of 60 grams before protein supplementation. Preoperatively, 53 patients (38%) had multiple consultations with the dietician. In 84 patients (60%), information regarding preoperative compliancy to the diet was documented by the clinical dietician. Of these, 68 patients (81%) adhered to the advised diet with an average of 5.5 (SD 1.9) weeks before surgery. Postoperatively, 55 patients (39%) had a consultation with the dietician. In this group, sufficient protein intake was achieved by 35 patients (64%) up until an average of 4.1 (SD 1.9) weeks after surgery. A total of 108 patients (77%) completed the questionnaire that evaluated compliancy to the diet. Of these, 81 patients (75%) stated they were compliant the whole study period, while 27 patients (25%) were not.

Preoperatively, a vitamin deficiency was present in 40% of all patients, with the most frequent being vitamin D (33%) (Table 3). In 77% of these patients, vitamin D was still deficient at the time of surgery. Of all perioperative blood samples (n = 126), 59 samples (47%) were obtained before the start of surgery and 67 (53%) after surgery. Perioperatively, in 65% of samples a deficiency was present, with the most frequent being anemia (42%). Most of these samples (66%) were drawn postoperatively.

Wound-related complications

According to the Clavien-Dindo classification, the overall wound-related complication rate was 51%, which included grade 1: 26%, grade 2: 19%, grade 3a: 2.1%, grade 3b: 3.6% and grade 4: 0.7% (Table 4). There was no postoperative mortality. There were four reoperations due to postoperative bleeding, of which one patient was admitted to the intensive care unit for stabilization. One of these patients also had a later reoperation due to a wound abscess. One patient required two reoperations: first a full thickness skin graft for a large tissue defect, and subsequent removal of the graft which had become necrotic. One patient developed a wound infection with necrosis, and a debridement was performed. The fleur-de-lis lower body lift and thigh lift procedure were most frequently associated with wound-related complications (71% and 75% respectively) (Table 5). Mammoplasty/mastopexy was least associated with complications (8.3%).

Other complications

There were 31 other complications in 23 procedures. Seven patients received a blood transfusion due to postoperative anemia without active blood loss. Other complications were atrial fibrillation, neuropathic pain, pneumonia and minor complications, such as obstipation, allergic reaction, and thrombophlebitis. In addition, two patients had an internal herniation related to the bariatric procedure during follow-up.

Risk factor analysis

There were no associations between non-nutrition related variables and complications (Table 6).

Uni- and multivariate logistic regression analysis was performed to identify nutritional variables associated with wound-related complications (Table 7). After adjusting for confounders, a preoperative sufficient diet (odds ratio (OR) 0.81; 95% CI [0.25, 2.63]; p = .72) and postoperative sufficient diet (OR 0.27; 95% CI [0.07, 1.02]; p = .05) as reported by the dietician were associated with a decreased risk of wound-related complications. Compliancy to the diet as answered by the patients (OR 0.70; 95% CI [0.26, 1.90]; p = .49) also was associated with a reduced risk. Patients who had multiple preoperative consults with a dietician correlated with higher risks of complications (OR 1.67; 95% CI

Table 3. Preoperative, perioperative and persistent pre- and perioperative deficiencies.

	Preoperative	Perioperative	Pre- and peri-op
Albumin	2.3% (3/130)	17.3% (19/110)	33.3% (1/3)
Hemoglobin	9.5% (13/137)	42.1% (53/126)	69.2% (9/13)
Ferritin	9.1% (12/132)	5.3% (6/113)	20.0% (2/10)
Folic acid	3.8% (5/130)	10.8% (12/111)	66.7% (2/3)
Vitamin B12	3.8% (5/132)	None	None
Vitamin D	32.6% (43/132)	39.4% (41/104)	77.4% (24/31)
Any deficiency [a]	40.2% (53/132)	65.2% (73/112)	79.5% (35/44)

Due to missing data, results are presented as a percentage (number of deficiencies/number of available tests)
[a] Any deficiency per procedure (yes/no).

Table 4. Clavien-Dindo classification of wound related complications.

Grade		Percentage (n)
1	No pharmacological intervention, only local wound treatment	25.7 (36)
2	Pharmacological intervention	18.6 (26)
3a	Surgical, radiological, endoscopic intervention	2.1 (3)
3b	Intervention under general anesthesia	3.6 (5)
4	Life threatening complication	0.7 (1)
5	Death of patient	None
		50.7 (71)

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Table 5. Percentage (number) of wound related complications according to the Clavien-Dindo classification per type of procedure.

	Grade 1	Grade 2	Grade 3a	Grade 3b	Grade 4	Total %
Abdominoplasty	35.0 (14)	10.0 (4)	2.5 (1)	2.5 (1)	None	50.0
FdL abdominoplasty	33.3 (12)	8.3 (3)	None	5.6 (2)	2.8 (1)	50.0
Lower body lift	40.0 (2)	None	None	None	None	40.0
FdL lower body lift	14.3 (3)	47.6 (10)	4.8 (1)	4.8 (1)	None	71.4
Breast surgery	None	None	None	8.3 (1)	None	8.3
Brachioplasty	12.5 (1)	25.0 (2)	None	None	None	37.5
Cruroplasty	25.0 (4)	43.8 (7)	6.3 (1)	None	None	75.0
Upper body lift	None	None	None	None	None	None
Lateral cruroplasty and mini-abdominoplasty	None	None	None	None	None	None

Note: FdL = fleur-de-lis.

[0.78, 3.59]; $p = .19$). Perioperative deficiencies of vitamins related to a reduced chance of complications (OR 0.70; 95% CI [0.28, 1.75]; $p = .45$).

Table 6. Univariate analysis of wound-related complications according to the Clavien-Dindo classification.

	No complication (n = 69)	Complication (n = 71)	*p*
Age, years	45.9 (9.1)	48.0 (9.5)	.18
Pre-BS BMI, kg/m^2	46.2 (5.6)	47.2 (6.2)	.33
Pre-BCS BMI, kg/m^2	27.6 (3.1)	28.2 (3.3)	.22
%TWL	39.9 (7.4)	39.5 (8.4)	.78
Previous smoker, n (%)	6 (33.3)	12 (66.7)	.15
History of diabetes [a], n (%)	6 (54.5)	5 (45.5)	.72
Weight time stable, months	18.3 (6.9)	19.2 (8.1)	.52
Type of BS, n (%)			.26
RYGB	54 (49.1)	56 (50.9)	
SG	9 (40.9)	13 (59.1)	
AGB	6 (75.0)	2 (25.0)	
Type of BCS, n (%)			.18
Abdominoplasty	38 (50.0)	38 (50.0)	
Lower body lift	9 (34.6)	17 (65.4)	
Other [b]	22 (57.9)	16 (42.1)	

Note: Data are presented as mean (SD) unless stated otherwise. BS: bariatric surgery; Pre-BS BMI: pre-bariatric surgery body mass index; Pre-BCS BMI: pre-body contouring surgery BMI; %TWL: percentage total weight loss; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy; AGB: adjustable gastric banding.

[a] Previously cured diabetes

[b] Other: mammareduction/-pexy, thigh lift, brachioplasty, upper body lift and lateral thigh lift combined with mini-abdominoplasty

Table 7. Uni- and multivariate analysis of the association of nutritional variables with wound-related complications according to the Clavien-Dindo classification.

	Crude Odds Ratio [95% CI]	*p*	Adjusted Odds Ratio [95% CI]	*p*
Base intake good [a]	0.80 [0.37, 1.74]	.58	0.79 [0.34, 1.84]	.58
Preoperative sufficient diet [a]	0.96 [0.32, 2.87]	.94	0.81 [0.25, 2.63]	.72
Postoperative sufficient diet [a]	0.40 [0.13, 1.25]	.12	0.27 [0.07, 1.02]	.05
Compliant to protein diet [b]	0.63 [0.26, 1.55]	.32	0.61 [0.23, 1.61]	.32
Multiple consults dietician	1.23 [0.62, 2.45]	.55	1.67 [0.78, 3.59]	.19
Any deficiency pre-operatively	1.21 [0.60, 2.43]	.59	0.98 [0.46, 2.14]	.95
Any deficiency peri-operatively	1.27 [0.58, 2.76]	.55	0.70 [0.28, 1.75]	.45

Note: Adjusted Odds Ratio is adjusted for location, history of smoking, bariatric surgery type, body contouring surgery type.

[a] Protein intake according to protocol as documented by dietician

[b] Compliancy to the protein diet according to the questionnaire completed by patients

DISCUSSION

Post-bariatric BCS is associated with a relatively high wound-related complication rate. This may partly be due to nutritional deficiencies, which are common after bariatric surgery. Therefore, the aim of this study was to optimize the nutritional state of patients preoperatively and to evaluate the prevalence of wound-related complications postoperatively. Second, we explored variables associated with wound-related complications. Our study demonstrated overall wound-related complications in 51% of all patients, but only 4.3% had overall major complications. With regard to nutrition, 75% of patients followed the recommended diet. Perioperative vitamin deficiencies were found in 65% of patients. Variables indicative of optimal nutrition had weak associations with a reduced risk of complications. However, none of these associations were statistically significant.

The overall wound-related complication rate of 51% is consistent with existing literature (23%-70%) [1–7]. Previous retrospective work performed in one of our centra found wound-related complications in 40% and 28% of patients [7,38]. However, comparison should be made with caution due to heterogeneity of the study populations. In these studies, more patients after gastric banding and less extensive procedures, such as scar corrections and liposuctions, were included.

The rate of major complications requiring surgical reintervention under general anaesthesia (Clavien-Dindo 3b) or admission to the intensive care unit (Clavien-Dindo 4) (4.3%) stands out positively in comparison to other studies that used the Clavien-Dindo classification (4.4% - 15%) [7,46].

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Variables that indicated optimal nutrition, such as proper base intake, pre- and postoperative diet compliancy, were associated with a decreased risk of wound-related complications. Notably, a sufficient diet after surgery greatly reduced chances of complications. Similarly, multiple dietary consults, which can be interpreted as suboptimal nutrition, was correlated to increased risks. These findings, however, were not significant, which may be a consequence of the smaller sample size due to missing data. Our results support previous work that suggested a relationship between nutrition and enhanced wound healing; however, the associations found are weak and warrant further investigation [14,15].

Before surgery, protein intake was sufficient (>60g/day) in most patients; however, vitamin deficiencies were present in 40% of patients. Despite standardized treatment, a high rate of these deficiencies persisted perioperatively, especially of vitamin D. This may be due to the low compliancy with supplements in post-bariatric surgery patients [47]. Two deficiencies stood out perioperatively: anemia and hypoalbuminemia. However, the reliability of these parameters as a marker for nutrition is questionable. Most blood samples with anemia were drawn postoperatively, which could be the result of intraoperative blood loss. With regard to albumin, which can be seen as a negative acute-phase protein, reduced plasma concentrations are measured in response to tissue injury and inflammation [48]. Consequently, albumin deficiencies may be explained by the surgery itself [49,50].

Earlier research found risk factors such as higher age, higher pre-weight loss BMI, higher %TWL, higher BMI before BCS, and unstable weight [2,4,5,7–13]. These variables were no risk factors for complications in our study. Exclusion criteria included a BMI > 35 kg/m^2 and a stable weight less than one year, which partly explains our findings.

Moreover, the literature is quite variable about the relationship of abovementioned factors and complications [5,7,8,51].

Prior work found an association between distorted wound healing and nutritional deficiencies [14,15,39]. After bariatric surgery, deficiencies are common and there is general consensus to treat any deficiencies and follow a protein-rich diet [30,32,41]. Consequently, the CPG on post-bariatric surgery of the NVPC recommends a preoperative optimization of nutrition with regard to vitamins, minerals and protein, to minimize wound-related complications [40]. Our results suggest a weak association between an optimal nutritional state, mainly a protein-rich diet postoperatively, and a reduced risk of complications. Despite the weak association and considering the relatively low impact of the recommendations on patients, we propose to maintain the recommendation of the CPG to optimize nutritional status of patients before elective post-bariatric BCS and to conduct more research on this topic. Future studies should incorporate well-defined complications and follow-up time – similar to our definitions – and strive for homogeneous populations. A blood sample should be taken close to, but certainly prior to surgery, to assess any deficiencies before surgical intervention. Moreover, compliancy to the diet should be routinely assessed by a dietician using an eating journal. In these fixed conditions, predictors of complications and the effect of nutrition on wound healing should be further evaluated. Even under optimal study circumstances, it will remain challenging to establish a direct relationship of nutrition on wound healing due to multicausality of complications [52].

Strengths of this study were the prospective, multicenter nature, and the large number of procedures. Furthermore, the hospitals were high-volume obesity care centra with much experience in (post-)bariatric surgery. At last, the assessment of compliancy was a useful addition. Some limitations should be considered too. First, the ideal study design would be a randomized controlled trial. However, it was considered unethical to withhold patients proper treatment in case of nutritional deficiencies. Therefore, in consultation with clinical epidemiologists, a prospective, observational design was conducted. Furthermore, the electronic patient file was used to assess complications, which made our results dependent of accurate documentation of the (trained) plastic surgery department staff. Moreover, we failed to properly treat all preoperative deficiencies, which led to more perioperative deficiencies. In addition, most blood samples were obtained during or shortly after surgery, which severely hampered interpreting clinical significant differences, such as differentiating between chronic or acute anemia. Also, there were missing blood samples and questionnaires. At last, patients with known risk factors were excluded, which could positively skew complication rates.

CONCLUSION

The aim of this study was to optimize nutrition with regard to vitamins, minerals and protein and to evaluate wound-related complications in patients undergoing BCS. This study showed 51% overall wound-related complications, while only 4.3% overall major complications. Our results suggest a weak association between optimal nutritional state and reduced risk of complications. These correlations, however, did not reach statistical significance, which may be a result of our sample size and missing data. Despite the weak link, we propose to maintain the current recommendation of the Dutch CPG on post-bariatric surgery regarding optimization of nutritional status preoperatively and advise to conduct more research. Future studies on this topic should use well-defined complications and follow-up time and strive for homogeneous populations. In these fixed conditions, the effect of nutrition on wound healing should be reassessed.

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SUPPLEMENTARY FILES

Table S1. Inclusion and exclusion criteria.

Inclusion	Exclusion
18 years of age or older	Weight loss due to dieting or exercise
History of bariatric surgery	Active smoker
Roux-en-Y gastric bypass	Body mass index > 35 kg/m^2
Sleeve gastrectomy	Unstable weight in the past 12 months
Adjustable gastric banding	Diabetes (defined by using medication)
Body contouring surgery	Coagulopathy
Abdominoplasty	Vasculitis
Lower or upper body lift	Connective tissue disorder
Brachio- or curoplasty	Kidney failure (glomerular filtration rate <30 ml/min/1,73 m^2)
Mammoplasty/mastopexy	Liver failure
	Use of immunosuppressive drugs
	Use of anticoagulants other than acetylsalicylic acid

Table S2. Overview of parameters, normal values and standard treatment.

Parameter	Normal value	Treatment
Sint Antonius Hospital		
Albumin	35-55 g/l	Assess protein intake (dietician)
Hemoglobin	M 7.8-10.2 mmol/l F 7.0-9.3 mmol/l	Ferrofumarate 200mg 3 per day with vitamin C for 6 months
Ferritin	10-300 ug/l	Ferrofumarate 200mg 3 per day with vitamin C for 6 months
Folic acid	10-40 nmol/l	Folic acid 0.5mg 1 per day for 6 months
Vitamin B12	140-490 pmol/l	Hydroxocobalamin 1000 µg 1 per day for 6 months
Vitamin D	50-120 nmol/l	Colecalciferol 50.000IE/ml, 1ml every week for 6 weeks, Than 1ml every month for 6 months
Catharina Hospital		
Albumin	30-35 g/l	Assess protein intake (dietician)
Hemoglobin	7.5-10.0 mmol/l	
Ferritin	10-245 ug/l	Ferrofumarate 200mg 2 per day with vitamin C
Folic acid	>10nmol/l	Folic acid 0.5mg 1 per day for 6 months
Vitamin B12	140-700 pmol/l	<140: intramuscular Hydroxocobalamine 500 µg/ml, 3 doses of 1000 µg 140-300: check methylmalonic acid, when >300nmol/l, than start treatment
Vitamin D	>75nmol/l	Colecalciferol 50.000IE/ml, 1ml every week for 6 weeks,Than 1ml every month

Table S2. (continued)

Parameter	Normal value	Treatment
Rijnstate Hospital		
Albumin	30-35 g/l	Assess protein intake (dietician)
Hemoglobin	7.5-10.0 mmol/l	Ferrofumarate 200mg 2 per day with vitamin C for 6 months
Ferritin	10-245 ug/l	Ferrofumarate 200mg 3 per day with vitamin C
Folic acid	>10nmol/l	Folic acid 0.5mg 1 per day for 6 months
Vitamin B12	140-700 pmol/l	<200: intramuscular Hydroxocobalamine 500 µg/ml, 3 doses of 1000 µg
Vitamin D	>75nmol/l	Colecalciferol 50.000IE/ml, 1ml every week for 6 weeks, Than 1ml every month

Table S3. Definition of wound-related complications.

Complication	Definition
Hematoma	Localized collection of extravasated blood
Wound infection	One of the following symptoms: Pain or tenderness, localized swelling, redness/heat, purulent discharge
Seroma	Pocket of clear serous fluid, either clinically (physical examination or aspiration) or radiologically diagnosed
Wound healing disturbance	Necrosis and/or dehiscence (rupture of surgical wound along the suture line)
Abscess	Collection of fluid containing pus

File S1. Postoperative questionnaire assessing compliancy to diet.

The following questions concern your consult(s) with the dietician and the recommendations you received. Please answer the questions as thoroughly as possible.

1. Have you visited the dietician once or twice?
2. Did you find the recommendations useful? If not, why not?
3. Did the recommendations include a lot of changes to your diet?
4. Wat did you had to change?
   a. I needed to eat more
   b. I needed to eat less
   c. I needed to change food products
   d. Else, for example…..
5. Was it easy to comply with the recommendations of the dietician? If not, why not?
6. It was advised to change your diet and start 4 weeks preoperatively.
   How many weeks did you comply with the recommendations?
   a. All 4 weeks
   b. 3 – 4 weeks
   c. 2 – 3 weeks
   d. 0 – 1 weeks
7. Why did you not comply with the recommendations preoperatively?
   a. I found it hard to change my diet
   b. I did not find it useful to change my diet
   c. I forgot to change my diet
   d. My weight gained
   e. Else, for example…..
8. It was advised to change your diet postoperatively up until healing of all wounds.
   How many weeks did you comply with the recommendations?
   a. The whole time
   b. 4 – 5 weeks
   c. 2 – 3 weeks
   d. 0 – 2 weeks
9. Why did you not comply with the recommendations postoperatively?
   a. I found it hard to change my diet
   b. I did not find it useful to change my diet
   c. I forgot to change my diet
   d. My weight gained
   e. Else, for example…..

TO CONCLUDE

CHAPTER 9

GENERAL DISCUSSION AND FUTURE PERSPECTIVES

The outcome of bariatric metabolic surgery (BS) can be measured via clinical parameters, and by assessment of the patient's experience before and after surgical intervention. The focus of this thesis is on the perspective of the patient. The patient's perspective is captured by patient-reported outcomes (PROs), which are measured by patient-reported outcome measures (PROMs): instruments (often questionnaires) designed to comprehensively measure the patient's experience. PROMs have the ability to evaluate the outcome of a treatment from the patient's perspective and allow for comparison between different groups or treatments. Subsequently, PROM data provide us with the means to tailor healthcare to the individual patient. The objective of this thesis was to contribute in the guidance of tailored healthcare with the means to optimize outcome after BS. The relationship between body image and weight was investigated, and factors associated with patient-reported and clinical outcomes were identified. This chapter provides a clinical context for the obtained results in this thesis and includes suggestions for applications of these results in optimizing patient selection, improving pre- and postoperative psycho-education, developing patient-tailored healthcare, and mediating long-lasting success after BS. Additionally, suggestions for future research are presented.

BODY IMAGE AND WEIGHT

Body image is part of individual quality of life and related to obesity [1–3]. Particularly, patients undergoing BS experience more body image concerns than people with normal weight [4–6]. In patients undergoing BS, body image is associated with depression, low self-esteem, and eating disorders. Additionally, it is suggested that body image may be related to weight loss outcome after surgery [7–9]. This section will discuss the studies on the association of body image with weight as reported in **chapters 2, 3 and 4**.

Chapter 2 assessed multiple aspects of body image in a female sample of the Dutch population and found significant differences between weight groups regarding evaluation of one's appearance (medium effect size), investment in appearance (small effect size) and the discrepancy between current and ideal body size (large effect size). Women with underweight and normal weight reported the most positive evaluation of their physical appearance, in contrast to women with overweight and obesity, who were less positive about their appearance. This association of evaluation of appearance and BMI is in accordance with previous studies [2,10]. Together, these results suggest that one's appraisal of physical appearance is correlated with weight. Women with lower BMI invested more in appearance than women with higher BMI. This indicates that women with obesity were less concerned with appearance, grooming and presentation. Although, previous findings on this association are mixed [5,11], our study contributes to these findings by its large sample including all weight groups. Also, our sample included women from the general population, regardless of any illness. Our results concerning current-ideal body size perception discrepancy showed a desire for a smaller body, except for women with underweight, and were in accordance with other studies [12,13]. Of note, interpretation of the body size discrepancy score was severely hampered by floor and ceiling effects of the scale; participants with underweight most often already identified with the lowest category, thus, were not able to choose a thinner desired figure.

This chapter also identified eight distinct body image profiles reflecting evaluation of and investment in appearance as well as desired body size, and reported their prevalence per weight group. Especially our findings in the groups with obesity were interesting: people in the two most dominant profiles all had a low evaluation of their appearance and desired a smaller body, but showed a large variance in their investment in appearance (low vs. high). It is suggested that particularly the combination of low evaluation of appearance and high investment in appearance promotes appearance enhancing behavior [14]. Low investment in appearance may obstruct people with obesity in obtaining a healthy lifestyle, a possibility healthcare providers should be aware of. Furthermore, interventions to enhance body image, such as cognitive behavioral therapy [15], prior to weight interventions can be initiated to improve compliance to a healthy lifestyle. Future research should replicate our findings with the addition of questionnaires that assess whether individuals are motivated to start weight treatment and how likely they perceive themselves to attain their goals (self-efficacy cognitions). This information will hopefully identify whether body image profiles are related to increased compliance to weight changing behavior or whether certain profiles would benefit from body image enhancing therapies to improve the chance of success prior or next to weight treatment. Especially individuals with low evaluation of appearance and concurrent low investment in appearance may feel indifferent towards their appearance and may benefit from cognitive behavioral therapy prior to discussing weight treatment.

Previous studies that assessed motivations to undergo BS reported improving body image as one of the reasons to undergo BS [16,17]. The case-control study in this thesis (**chapter 3**) evaluated body image disparities between patients on a waiting-list for BS and a control group from the general population matched by age, gender and BMI. The results showed that patients who desired BS experienced more dissatisfaction with their appearance (defined as a discrepancy between higher investment in appearance and low evaluation of one's appearance) than the control group. Furthermore, in comparison to population norm scores, both groups with obesity reported lower evaluation of appearance and invested less in appearance. Similar to the findings in **chapter 2** on body image profiles in persons with obesity, the patients on the waiting list for BS may reflect the people that fit the profile with low feelings of attractiveness and high investment in appearance, while the control group consists of people who fit the profile with low feelings of attractiveness and low investment in appearance. While motivations to undergo BS were not assessed in this chapter, our findings suggest that in people with obesity, the combination of a low evaluation of appearance and low investment in appearance may obstruct the start of weight reduction treatment.

As suggested by previous studies, in addition to improving physical health, which is reported by most people as the primary reason to undergo BS, there are patients who reported improving body image or appearance as their primary motivator [16–18]. Healthcare providers should be aware of these motivations, since it may allow them to start a dialogue addressing weight reduction treatment. Persons with obesity who do not experience health concerns and who are not invested in their appearance may be delayed to seek help, regardless of future consequences. Furthermore, insights into reasons for people to undergo surgery will enable healthcare providers to adequately inform patients and help set realistic expectations. Most healthcare providers for BS in the Netherlands offer an educational program before patients undergo surgery. This program includes a variety of topics and is developed to prepare patients by educating them on expected outcome as well as lifestyle changes. Our results suggest it would be helpful for patients to gain insight into their body image by completing body image assessments before surgery. Patients should be educated on the relationship of body image with obesity, depression, self-esteem, and eating disorders. A healthcare provider may help in linking the results of the body image assessment to psychosocial concerns people experience. Furthermore, the preoperative program could be used to explore patient's expectations regarding changes in body image and assess whether these expectations are realistic by showing results on body image changes after surgery.

Chapter 4 evaluated the course of body image, as measured by the BODY-Q, and its associations with weight loss in the first three years after BS. A higher baseline body image was associated with less weight loss the first year after surgery, although, this effect size was too small to be considered clinically relevant. While there is some support for the hypothesis that more body image concerns at baseline is associated with greater weight loss after six months post-surgery [19], two prospective studies with large sample sizes found no associations of preoperative body image and weight loss the first year post-surgery [7,20]. The small relationship between higher baseline body image and less weight loss the first year after surgery reflects the mean of the group of patients. There may exist a subgroup, i.e., people with a certain body image profile as suggested in chapter 2, with a stronger association of preoperative body image and weight loss. Patients who are satisfied with but not invested in their appearance may have different results. The body image scale of the BODY-Q is limited to measuring positive feelings towards the body and lacks items that reflect investment in appearance or other dimensions of body image. All items include positive appreciation of the body, which is not necessarily the opposite of a negative view of the body. People with a strong negative attitude may behave differently than people without a positive attitude. Taken together, these results suggest that there is probably no or only a trivial association between body image and weight loss the first year for the group of patients. Future research may assess whether this association is different for subgroups of patients by applying questionnaires that measure multiple aspects of body image, such as the Multidimensional Body Self-Related Questionnaire (MBSRQ). Furthermore, body image was not associated with longer-term weight loss. Although a more positive body image was associated with greater weight loss in non-surgical weight loss populations, our results suggest that changes in body image and changes in weight loss are accounted for by distinct processes after BS. Weight loss after BS results from changes in physiological processes (alterations in gut hormones and peptides, bile acid levels and microbiota), which may explain weight loss is not so much associated with psychosocial variables [21].

Regarding the course of body image, the highest body image scores were found 12 months postoperatively, with a gradual decline from 12 to 36 months. Although body image remained very much improved during the postbariatric interval, it is unclear if the decline in body image is clinically meaningful. Therefore, future studies should determine the minimum clinically important difference of the BODY-Q, after which it can be ascertained how many individuals experience a clinically meaningful improvement or deterioration of body image. There may be a subgroup of patients who experience a substantial decline of body image that explains the gradual decline of the group. Regardless of these suggestions, the deterioration of body image between one and three years after surgery, underlines the importance of long-term follow-up with regular assessment of this aspect of quality of life. This will allow healthcare providers to identify patients at risk for further deterioration of body image and initiate additional therapy to address these concerns. Though these concerns appear not to be related to weight loss (or regain) in the years after BS, body image concerns are related to lower HRQL, psychological distress and eating-related problems and therefore, should be addressed by the multidisciplinary clinical team [22–24]. In some patients, the deterioration in body image may be associated with excessive skin which is common after BS [8,25]. Improvement of body image concerns is reported after post-bariatric body contouring surgery (BCS), the only treatment for the redundant skin, and may be a viable option in this subgroup of patients [26]. There is some evidence in the form of case-studies that virtual reality exposure therapy may help in improving body image after BS [27], which is currently investigated in a randomized-controlled trial in France [28]. Furthermore, the results in this chapter can be used in patient education; patients who are primarily motivated to undergo surgery to improve their body image should be educated on the positive changes of body image the first year after surgery, however, should also be aware of the potential decline that may follow the first year.

FACTORS ASSOCIATED WITH PATIENT-REPORTED OUTCOMES

Health-related quality of life (HRQL) is considered a key outcome of BS. Insight into factors associated with HRQL enables healthcare providers to optimize patient selection, improve patient education and identify patients who may benefit from additional therapy. Thus, recognizing these factors will facilitate the development of patient-tailored healthcare to improve outcome for all patients. This section will discuss the results from **chapters 5 and 6** which focused on identifying factors associated with HRQL. Both chapters applied the BODY-Q, a questionnaire developed to assess HRQL and appearance in people with obesity and (non-) surgical weight loss populations. All participants in these chapters completed BODY-Q scales pertaining to HRQL (physical function, psychological function, sexual function, social function and body image) and appearance (satisfaction with body, excess skin).

Chapter 5 investigated patient-level factors associated with HRQL and appearance (including 'excess skin' and 'satisfaction with body') in 730 patients who had previously undergone BS, divided into three groups based on time since surgery (0 – 1 year, 1 – 3 years and more than 3 years). The patient-level factors examined include fixed characteristics like sociodemographics (e.g., age, gender, type of bariatric procedure, current BMI) [29]. The results showed that lower current BMI, greater total weight loss (%TWL), being employed and the absence of obesity-related medical problems were associated with higher body image, physical function and psychological function after surgery as well as social function the first year postoperatively. Lower current BMI, greater %TWL, higher age and shorter time since surgery were associated with a higher satisfaction with body. However, these associations were not consistently demonstrated in all scales, nor within all groups. No patient-level factors were associated with sexual function and excess skin. Associations with the largest effect sizes included being employed with physical function (in all groups) and with psychological function (one to three years after surgery). Interpretation of these results may be hampered by patients who were unemployed due to psychological or physical illness since we could not control for baseline data. Moreover, specific jobs may require or facilitate in a better physical health.

Results from this chapter can be used to improve patient education by communicating realistic expectations: in comparison to the group of preoperative patients, the group within the first year and the group within the second and third year after surgery had higher scores. The group of patients longer than three years postoperatively had lower scores for all HRQL scales in comparison to the group one to three years after surgery. Additionally, knowledge of factors that may be negatively associated with HRQL enables healthcare providers to identify patients who may benefit from additional interventions or counseling. Although our results could not explain causality of the associations, healthcare providers can use this information in clinical practice. A postoperative follow-up patient that presents with weigh regain may also experience lower HRQL, an association the patient may not be aware of until informed on. Future research with long-term prospective data is needed to track change over time and correct associations for baseline scores.

Chapter 6 aimed to increase our understanding of changes in psychological function after BS as measured by the BODY-Q. The items of the psychological function scale of the BODY-Q ask respondents to indicate how much they disagree/agree that they feel happy, confident, proud of themselves, and in control of their life [30]. This chapter identified factors associated with improved psychological function in the first three years after surgery. There was a positive association between psychological function and lower desired weight loss as was preoperatively assessed (<40% desired TWL), higher educational level, no history of psychiatric illness and patients with employment preoperatively. Consistent with previous studies, our results showed a substantial improvement of psychological function the first year [31–33], followed by a moderate decrease [31,34]. A meta-analysis of randomized clinical trials (BS vs. non-surgical weight loss treatment) demonstrated small and variable improvements in mental HRQL up to three years, regardless of the type of intervention, by applying the RAND-36 or SF-36 [35]. The RAND-36 is provided with an algorithm for constructing composite scores including a mental health summary score, which is composed of four subscales that have shown to be primarily indicative of mental health (vitality, social functioning, emotional role functioning, and mental health) [36]. The meta-analysis presented a general mental health score, although, the authors did not elaborate whether this score is similar to the mental health summary score, or which scales were included otherwise.

High, often unrealistic, weight loss expectations or desires are common in patients undergoing BS and the majority of patients does not reach their desired weight [37,38]. Patients who experience less weight loss than desired may experience feelings of unhappiness, disappointment, or shame, which may be reflected by the lower psychological function score.

The course of psychological function scores as well as the association of higher desired weight loss with lower psychological function can be used to optimize patient education pre- and postoperatively. Any multidisciplinary team concerned with the preoperative screening of patients with obesity should explicitly examine patient's desires or expectations regarding weight loss. Furthermore, the team should assist in discussing realistic expectations and counsel on the risk of weight regain in the years after surgery. Regular assessment of PROs could help in identifying patients with lower psychological function and enable the multidisciplinary team to address potential concerns. In the Netherlands, patients who undergo BS routinely complete PROMs during the 5-year follow-up program in most clinics. These data can be monitored by a healthcare provider and help identify patients with potential psychological concerns. Then, this may lead to better communication with the patient during the follow-up visit and may provide a means to start additional therapy or counseling. Several programs in cancer care have also implemented PROMs in their standard care to serve, next to research purposes or benchmarking, patient-centered care [39]. One of these programs described an increase in physician's awareness of their patients HRQL and an impact on physician–patient communication resulting in better HRQL and emotional functioning for some patients [40].

THE MEASUREMENT PROPERTIES OF THE RAND-36 IN BARIATRIC SURGERY

PROMs are used to assess the patient's perspective and can include a patient's functional status, health-related quality of life (HRQL), or (severity of) symptoms [41]. In BS, 68 different PROMs are used to measure HRQL since there is no consensus on a standard PROM to assess HRQL in patients undergoing BS [1,42]. Studies on the quality of measurement properties of a PROM can facilitate the identification of a suitable PROM. This section will discuss the results of **chapter 7**, which assessed the measurement properties of the RAND-36 in measuring HRQL in patients who undergo BS.

The domains validity (the degree to which the RAND-36 measures what it purports to measure, i.e., HRQL), reliability (the degree to which the scores of the RAND-36 are the same in repeated measurements in patients who have not changed in HRQL) and responsiveness (the ability of the RAND-36 to detect changes in HRQL over time) were examined regarding their measurement properties. The results showed that only internal consistency included sufficient evidence to be considered adequate. Important limitations included the lack of key items relevant to patients undergoing BS (content validity), inconsistent measurement of HRQL (test re-test reliability) and insufficient sensitivity to measure relevant change in HRQL in patients undergoing BS (responsiveness). Regarding content validity, the majority of the patients (92.5%) and healthcare providers (76.0%) agreed with the relevance of most items and response options to measure HRQL, however, not as relevant for patients undergoing BS (73.6% of the patients and 68% of the healthcare providers). The majority of the healthcare providers (52.0%) and a selection of the patients (20.8%) reported that important concepts were missing. Items regarding eating behavior, body image, obesity-specific symptoms, and symptoms after surgery were missing according to patients. Healthcare providers reported excess skin, stigma, sexual functioning, work life, and appearance as important missing concepts.

The RAND-36 scales correlated weakly with %TWL and change in BMI postoperatively, thus, patients with a higher BMI or less weight loss did not necessarily have lower HRQL scores, which may be due to the phrasing of the items. For example, regarding physical activities, the RAND-36 asks how the respondent is limited by their health; thus, it is about functioning as determined by the respondent without the attribution of the possible cause of weight.

The only study that assessed the measurement properties of the RAND-36 in a BS population found sufficient construct validity and internal consistency, but did not assess content validity, test re-test reliability, nor responsiveness [43]. The RAND-36 is a well-validated, widely adopted generic measure to assess HRQL in many populations. It is valuable in comparing generic HRQL of patients undergoing BS with other patient populations to show the burden of disease. Although, in discriminating subgroups of patients undergoing BS, the RAND-36 may not be sufficient enough to assess the effects of BS from the patients' perspective. A PROM specifically designed to measure HRQL, including relevant concepts to patients undergoing BS, is needed for clinical and research purposes. A systematic review evaluated the most frequently applied PROMs in BS for quality criteria and concluded that currently none were highly recommended, due to gaps in their validation [44]. Based on quality standards and criteria, the BODY-Q demonstrated positive evidence regarding content validity, internal consistency, reliability and adequate structural validity and could be recommended in future studies pending further validation of responsiveness [44–46]. Moreover, the studies in this thesis experienced that the scales of the BODY-Q are prone to acquiescence bias, lack negatively phrased items (which is not the opposite of positively phrased) and specifically, the body image scale was limited by floor effects (was not able to differentiate between patients with very low body image).

Data collected via PROMs can be used on a patient-level to track outcomes, health, and well-being longitudinally, to support and improve shared decision making, to facilitate communication between a patient and his/her clinical team, and to identify patients who may benefit from additional therapy [41,47]. Moreover, data from PROMs can be utilized to compare hospitals, explore differences in health gains across demographic groups or alternative surgical techniques, evaluate clinical trials, develop and tailor guidelines, calculate predictive analytics and facilitate value-based healthcare [41,48–50]. The use of PROM data in meta-analyses and interpretation across studies is hampered by the wide variety of generic and disease-specific PROMs used in BS. This leads to difficulties in determining what treatments are best from the patient's perspective and, in turn, impedes evidence-based clinical decision making [42]. Thus, there is a need to standardize PROMS measuring HRQL in BS. With this goal a broad group of clinicians, scientists, and people living with obesity, have started an initiative to reach consensus about standard instruments to measure HRQL in people who undergo weight treatment (surgical and non-surgical) [1]. Hopefully, these efforts will enable improvement of the assessment of outcomes that are relevant for this specific group of patients.

OPTIMIZING POST-BARIATRIC BODY CONTOURING SURGERY

Up to 90% of the patients develops redundant skin after BS which can severely impact physical and mental HRQL [51–53]. The only treatment for the excessive skin is post-bariatric BCS, which involves large soft tissue undermining procedures and is known for its high prevalence of wound-related complications [54–56]. The clinical practice guideline of the Dutch Society of Plastic Surgeons (NVPC) states that every patient who previously had BS and who is scheduled for BCS, should have a nutritional assessment and optimization of nutritional status. **Chapter 8** assessed the occurrence of wound-related compilations after BCS since the implementation of the guideline in 2014. This prospective study showed 51% overall wound-related complications and 4.3% overall major complications. Variables indicative of an optimized nutritional state were not significantly associated with a reduced risk of complications; most influential was a sufficient postoperative protein intake (OR 0.27, 95% CI [0.07 – 1.02], p = .05). While our overall wound-related complication rate of 51% was in accordance with existing literature, which did not include standard optimization of the nutritional status (23%-70%) [54,55,57,58], the rate of major complications (Clavien-Dindo 3b and 4) requiring surgical reintervention under general anaesthesia or admission to the intensive care unit (4.3%) compared positively to other studies (4.4% - 15%) [58,59]. Although, interpretation of and comparison with other literature is hampered due to heterogeneous study populations (e.g., inclusion of patients after gastric banding or less extensive procedures such as scar corrections) and varying definitions of complications as well as follow-up time. Taken together, this chapter proposed to continue to adhere to this guideline and in the meanwhile conduct more research. Future studies should use homogenous populations and include only patients who had a Roux-en-Y gastric bypass or sleeve gastrectomy and focus on a single body contouring procedure, e.g., abdominoplasty. Our clinical epidemiology department advised us to include at least 30 patients with a complication to evaluate factors influencing complications with logistic regression. Since the complication rate in abdominoplasties in our sample was 50%, a minimum of 60 patients is needed. The relative scarcity of eligible patients warrants a multicenter study; based on the frequency of abdominoplasties in our sample (40 procedures in 5 years in two hospitals), participation of approximately 15 centers will provide sufficient eligible patients in one year. This study should then assess compliancy to the diet routinely by a clinical dietician using an eating diary, collect a blood sample at least six weeks prior to surgery so any deficiencies can be treated sufficiently, and collect a blood sample close to, but certainly prior to surgery to check if any deficiencies are present on the day of surgery.

CONCLUSION

Obesity remains one of the greatest challenges in public health. Bariatric surgery is the most effective treatment for eligible patients with obesity and has shown positive effects on long-term weight loss, improvement of obesity-associated medical problems and HRQL. This thesis assessed body image and other relevant factors associated with short and long-term outcome to guide the development of tailored healthcare and improve outcome of patients undergoing BS. Hopefully, these efforts promote long-lasting success in the majority of patients. The use of PROMs in healthcare may increase a healthcare provider's awareness of their patients HRQL, improve physician–patient communication and result in more satisfied patients.

While this thesis focused primarily on the surgical treatment of obesity, the best treatment would be preventive medicine. Regardless of all specialized healthcare, healthcare providers should not refrain from treating (or counseling) the whole patient. This includes the treatment of obesity, but also smoking, unhealthy lifestyle or a low quality of life. The observed associations between body image and weight, as well as the identification of distinct body image profiles, may enable healthcare providers to initiate a conversation regarding health when people are (still) overweight.

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APPENDIX

SAMENVATTING (SUMMARY IN DUTCH)

LIST OF PUBLICATIONS

ACKNOWLEDGMENTS

CURRICULUM VITAE

PERSOONSGEBONDEN FACTOREN IN BARIATRISCHE CHIRURGIE

Verder gaan dan gewichtsverlies

OVERGEWICHT EN DAARMEE SAMENHANGENDE MEDISCHE PROBLEMEN

Over de hele wereld zijn er meer mensen met een te hoog gewicht dan mensen met een te laag gewicht. Gewicht dat afwijkt van normaal wordt uitgedrukt in de body-mass index (BMI). Dit is een maat waarbij het gewicht wordt weergegeven ten opzichte van iemands lengte. Er is sprake van obesitas als het lichaamsgewicht in kilogram (kg) gedeeld door de lengte in meters in het kwadraat (m^2) groter of gelijk is aan 30 kg/m^2. Obesitas is een complexe, chronische ziekte. Bij obesitas is er sprake van een afwijkende vetverdeling, of een overschot aan vet dat de gezondheid vermindert. Obesitas hangt samen met een verhoogd risico op het ontstaan van medische problemen: een te hoge bloeddruk (hypertensie), suikerziekte (diabetes), hart- en vaatziekten, slijtage van gewrichten (artrose) en slaapapneu syndroom. Verschillenden soorten kanker komen vaker voor bij mensen die obesitas hebben. Momenteel is obesitas de 5e belangrijkste risicofactor voor wereldwijde sterfgevallen. Rond 2030 zal naar schatting één op de vijf vrouwen en één op de zeven mannen met obesitas leven.

Het ontstaan van obesitas wordt bepaald door een combinatie van factoren: genetische aanleg, lichamelijke factoren, omgevingsfactoren, gedrag, cultuur, sociale status en welvaartstatus. Al deze oorzaken tellen samen mee en bepalen of iemand wel of geen obesitas ontwikkelt. Obesitas is ook in verband gebracht met een lagere kwaliteit van leven, minder geestelijk en sociaal welzijn. Wanneer we het in deze samenvatting over kwaliteit van leven hebben, wordt dit vaak bedoeld in relatie tot iemands gezondheid. Kwaliteit van leven omvat lichamelijk en emotioneel welbevinden en aspecten die daarmee samenhangen (onder andere lichaamsbeeld, sociaal en economisch welbevinden). Mensen met obesitas kunnen problemen ervaren met hun lichaamsbeeld.

DE BEHANDELING VAN OBESITAS

De basis van de behandeling van obesitas bestaat uit aanpassingen van de levensstijl. Die aanpassingen omvatten een combinatie van gezonde voeding, beweging en soms ook psychologische behandeling. Bij mensen met een BMI boven de 40 kg/m^2 (of boven de 35 met een bijkomend medisch probleem) kan bariatrische metabole chirurgie een optie zijn. Dit zijn operaties voor mensen met ernstige obesitas met als doel om af te vallen en gezonder te worden. Bariatrische metabole chirurgie is de meest effectieve behandeling om langdurig gewichtsverlies te realiseren. Daarnaast hebben deze operaties een positief effect op de medische problemen en de met gezondheid samenhangende kwaliteit van leven.

Bariatrische metabole chirurgie heeft de afgelopen 20 jaar een grote technische ontwikkeling doorgemaakt. Er worden verschillende soorten operaties uitgevoerd. De meest voorkomende technieken zijn op dit moment de sleeve gastrectomie en de Roux-en-Y gastric bypass. Bij beide operaties worden blijvende veranderingen gemaakt

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aan het maagdarmkanaal. Het is niet precies duidelijk waardoor deze operaties leiden tot gewichtsverlies en verbetering in bijkomende medische problemen. Duidelijk is wel dat beide procedures leiden tot wijzigingen in darmhormonen en eiwitten, galzuren, en het microbioom (de samenstelling van darmbacteriën). Deze verandering hangen samen met de positieve effecten.

DE UITKOMST VAN BARIATRISCHE METABOLE CHIRURGIE

De uitkomst van bariatrische metabole chirurgie kan op verschillende manieren worden gemeten. Hoeveel gewicht heeft iemand verloren? Waren er bijkomende medische problemen zoals een hoge bloeddruk, en zijn deze problemen verbeterd? Bij het meten van succes wil je ook weten wat de patiënt zelf heeft ervaren. Dat wordt gemeten met patiënt-gerapporteerde uitkomsten. Deze uitkomsten kunnen gaan over de kwaliteit van leven of de mate van functioneren van de patiënt. Er zijn verschillende manieren op deze patiënt-gerapporteerde uitkomsten te meten. De meest gebruikte methode is een vragenlijst.

In het algemeen verbetert de kwaliteit van leven na bariatrische metabole chirurgie. Dit geldt echter niet voor iedereen. Ook lijken lichamelijke aspecten meer te verbeteren dan de psychische aspecten na de operatie. Het is niet goed bekend welke factoren samenhangen met een verbetering in kwaliteit van leven. Duidelijker inzicht in deze patiënt-gerapporteerde uitkomsten biedt mogelijkheden om de zorg te verbeteren. Deze informatie kan gebruikt worden om mensen voor de operatie nauwkeuriger in te lichten over de te verwachten veranderingen. Of om de selectie van mensen die een operatie willen ondergaan te verbeteren. Door het vroegtijdig herkennen van mensen met een grotere kans op een minder gunstige uitkomst na de operatie, kan er een aanvullende behandeling gestart worden. Hierdoor neemt de kans op een positieve uitkomst na de operatie mogelijk weer toe. Samengevat kunnen deze inzichten bijdragen aan op maat gemaakte zorg voor de patiënt. Dit leidt hopelijk tot een verbetering van de uitkomsten.

DE ROL VAN HET LICHAAMSBEELD BIJ OBESITAS EN AFVALLEN

Het eerste deel van dit proefschrift ging over het lichaamsbeeld. Het lichaamsbeeld is een definitie die de eigen kijk op het lichaam beschrijft. Hierbij horen gedachten, gevoelens, waarnemingen en gedrag die met het lichaam te maken hebben. Het verbeteren van het lichaamsbeeld is genoemd als reden voor mensen om bariatrische metabole chirurgie te ondergaan. Ook spelen problemen met het lichaamsbeeld mee in het ontstaan van obesitas, en is het hebben van obesitas in verband gebracht met meer problemen met het lichaamsbeeld. Hieronder wordt de inhoud van de hoofdstukken besproken die gaan over de samenhang tussen het lichaamsbeeld en gewicht, het lichaamsbeeld als reden om voor chirurgie te kiezen en de relatie van het lichaamsbeeld met gewichtsverlies na de operatie.

Hoofdstuk 2 onderzocht de relatie tussen het lichaamsbeeld en gewicht in een steekproef bestaande uit 27.896 vrouwen uit de algemene bevolking. De deelnemers beantwoordden vragen over hun uiterlijk: 1) de beoordeling van het uiterlijk (de mate waarin iemand positieve of negatieve gevoelens ervaart over zijn of haar uiterlijk), en 2) het belang dat gehecht wordt aan het uiterlijk (de mate waarin iemand moeite doet voor zijn of haar uiterlijk, tijd investeert en aandacht besteed aan zijn of haar uiterlijk). Ook beoordeelden de deelnemers hun huidige en hun ideale lichaamsgrootte. Hieruit werd berekend of de deelnemer liever een groter of kleiner lichaam had. Deze scores werden vergeleken tussen verschillende gewichtsgroepen, samengesteld op basis van BMI: ondergewicht, normaal gewicht, overgewicht en obesitas klasse I (BMI 30 – 35), klasse II (BMI 35 – 40) en klasse III (BMI groter dan 40). De groepen met ondergewicht en normaal gewicht meldden de meest positieve beoordeling van het uiterlijk. De groep met ondergewicht hechtte het grootste belang aan het uiterlijk en de groep met ernstig obesitas (obesitas klasse III) het kleinste belang. De wens voor een kleiner lichaam (het verschil tussen de huidige en ideale lichaamsgrootte) was het grootst in de groepen met obesitas.

Daarnaast werd onderzocht of er verschillende lichaamsbeeldprofielen bestonden. Elk lichaamsbeeldprofiel bevatte een combinatie van drie factoren: 1) de beoordeling van het uiterlijk 2) het belang van het uiterlijk en 3) het verschil tussen de huidige en ideale lichaamsgrootte. Er werden acht lichaamsbeeldprofielen gevonden. Bij vrouwen met obesitas kwamen twee profielen het vaakst voor: personen in beide profielen hadden een voorkeur voor een kleiner lichaam en beoordeelden het uiterlijk negatiever, maar verschilden in de mate van belang dat zij hechtten aan hun uiterlijk (groot of klein). De meeste vrouwen met ondergewicht behoorden tot profielen die een groot belang hechtten aan het uiterlijk, een voorkeur hadden voor een groter lichaam, maar verschilden in hun beoordeling van het uiterlijk het uiterlijk (neutraal of positief). Het is niet onderzocht of in geval er een groter belang aan het uiterlijk gehecht wordt, dat een gevolg is van ontevredenheid over het uiterlijk. Het kan ook het gevolg zijn van weinig zelfvertrouwen, of een verstoorde relatie met eten.

In **hoofdstuk 3** werd het lichaamsbeeld onderzocht van 125 patiënten op een wachtlijst voor bariatrische metabole chirurgie (chirurgiegroep). Ook het lichaamsbeeld van 125 mensen in een controlegroep uit de Nederlandse bevolking werd onderzocht (controlegroep). De controlegroep was qua geslacht, leeftijd en BMI gelijk aan de chirurgiegroep. Het doel was om te bepalen of het lichaamsbeeld verschilde tussen deze groepen, en mogelijk een reden is voor mensen om chirurgie te ondergaan. Alle deelnemers beantwoordden vragen over de beoordeling van hun uiterlijk en het belang dat men hecht aan het uiterlijk. Het verschil tussen deze twee scores werd verondersteld

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een afspiegeling te geven van iemands ontevredenheid over het uiterlijk. Een hogere score betekende meer ontevredenheid.

De chirurgiegroep beoordeelde hun uiterlijk negatiever, en hechtte een groter belang aan het uiterlijk in vergelijking met de controlegroep. Daarnaast was de ontevredenheid over het uiterlijk groter in de chirurgiegroep. De scores van beide groepen met obesitas werden ook vergeleken met een steekproef uit de algemene Nederlandse bevolking waarin alle gewichtsgroepen voorkwamen. Vergeleken met de algemene bevolking was de beoordeling van het uiterlijk negatiever in beide groepen. Ook het belang dat werd gehecht aan het uiterlijk was kleiner in beide groepen. Beide groepen waren minder tevreden met het uiterlijk.

Mensen die bariatrische metabole chirurgie willen ondergaan waren gemiddeld ontevredener met hun uiterlijk dan mensen van hetzelfde gewicht die niet voor een operatie kozen. Mogelijk betekent dit, dat patiënten die chirurgie willen, gedeeltelijk gemotiveerd zijn door hun lichaamsbeeld. Als we begrijpen waarom een patiënt kiest voor een operatie, kunnen we, voor de ingreep, aan de patiënt de juiste verwachtingen over het te verwachten resultaat na de operatie schetsen.

In **hoofdstuk 4** werd het lichaamsbeeld gemeten van een groep patiënten die bariatrische metabole chirurgie ondergingen. Het lichaamsbeeld werd gemeten voor de operatie, na vier maanden, en één, twee en drie jaar na de operatie. Hiervoor werd gebruikt gemaakt van de BODY-Q: een vragenlijst ontwikkeld voor mensen met obesitas die een behandeling ondergaan. Dit hoofdstuk onderzocht of er een verband was tussen het lichaamsbeeld en het gewichtsverlies na de operatie.

Het lichaamsbeeld was het beste één jaar na de operatie. Daarna daalde het lichaamsbeeld tot drie jaar na de operatie, maar werd het lichaamsbeeld nooit slechter dan voor de operatie. We vonden een relatie tussen een beter lichaamsbeeld voor de operatie en minder gewichtsverlies in het eerste jaar na de operatie. Dit effect was te klein om belangrijk te zijn in de praktijk. Zoals we vaststelden in hoofdstuk 2 zijn er groepen patiënten die verschillende lichaamsbeeldprofielen hebben. Mogelijk is de relatie – tussen het lichaamsbeeld voor de operatie en het gewichtsverlies het eerste jaar na de operatie –anders tussen mensen met verschillende lichaamsbeeldprofielen. Om hierover meer te weten te komen, zou in een vervolgonderzoek een andere vragenlijst gebruikt kunnen worden, die zowel positieve als negatieve gevoelens over het lichaamsbeeld meet. En ook gedachten, waarnemingen en gedrag die met het lichaam te maken hebben meet. Er werd geen relatie gevonden tussen het lichaamsbeeld en het gewichtsverlies tussen één en drie jaar na de operatie.

Deze resultaten laten zien dat het belangrijk is om lichaamsbeeld met enige regelmaat te meten na de operatie. Zorgverleners kunnen dan op tijd patiënten herkennen die een verhoogd risico op een verslechtering in lichaamsbeeld hebben. Mogelijk kan er dan op tijd gestart worden met een aanvullende behandeling, met als doel om het lichaamsbeeld te verbeteren.

FACTOREN DIE SAMENHANGEN MET DE UITKOMST NA DE OPERATIE

Het tweede deel van dit proefschrift onderzocht factoren die samenhingen met de kwaliteit van leven, gemeten met vragenlijsten. Ook werd de werkzaamheid beoordeeld van een behandelrichtlijn voor chirurgie om huidoverschot na het afvallen te herstellen.

In **hoofdstuk 5** werden factoren onderzocht die samenhangen met de kwaliteit van leven en het uiterlijk na de operatie. Er werden gegevens gebruikt van drie ziekenhuizen, twee in Nederland en één in de Verenigde Staten. In totaal werden 730 patiënten onderzocht die eerder bariatrische metabole chirurgie hadden gehad. Alle deelnemers beantwoordden vragen over de kwaliteit van leven (lichamelijke activiteit, psychisch welbevinden, seksuele functie, sociale functie en lichaamsbeeld) en uiterlijk (tevredenheid met het lichaam en huidoverschot). Onderzocht werd of een verband bestond tussen de kwaliteit van leven en onder andere leeftijd, geslacht, BMI, type operatie en werk.

Het onderzoek vond dat een lager BMI, meer gewichtsverlies, het hebben van een baan en de afwezigheid van een medisch probleem samenhingen met een beter lichaamsbeeld, meer lichamelijke activiteit, beter sociaal welzijn en psychisch welbevinden na de operatie. En ook een relatie tussen een lager BMI, meer gewichtsverlies, een hogere leeftijd, een kortere tijd sinds de operatie en een hogere tevredenheid met het lichaam. Geen van de onderzochte factoren had een verband met seksueel welzijn en huidoverschot.

In **hoofdstuk 6** werd onderzocht hoe psychisch welbevinden zich ontwikkelde na bariatrische metabole chirurgie. Ook werd bepaald welke factoren samenhingen met een verbetering in psychisch welbevinden na de operatie. De schaal psychisch welbevinden van de BODY-Q werd gebruikt. Deelnemers vulden deze vragenlijst in voor de operatie, na vier maanden en na één, twee en drie jaar na de operatie.

Net als in andere onderzoeken toonden onze resultaten een verbetering in psychisch welbevinden in het eerste jaar na de operatie. Hierna volgde een geleidelijke afname in psychisch welbevinden tot drie jaar na de operatie. Mensen die voorafgaand aan de operatie streefden naar minder gewichtsverlies, voelden zich psychisch beter na de operatie. Ook mensen met een hoger opleidingsniveau, zonder verleden van psychiatrische ziekte en mensen die een baan hadden voorafgaand aan de operatie ervoeren een hoger psychisch welbevinden na de operatie. Mensen die minder gewichtsverlies behaalden dan waar zij naar streefden, ervoeren mogelijk gevoelens van ongelukkigheid, teleurstelling of schaamte, wat een mogelijke verklaring is van onze bevindingen. Mensen met een psychiatrische aandoening ervoeren minder verbetering in psychisch welbevinden na de operatie dan mensen zonder een psychiatrische ziekte. Mogelijk wordt een lager psychisch welbevinden dat samenhangt met psychiatrische ziekte niet beïnvloed door de operatie zelf. Zorgverleners zouden de wensen van de patiënt ten aanzien van het gewichtsverlies moeten onderzoeken, voorafgaand aan de operatie. Vervolgens zouden zij realistische verwachtingen kunnen bespreken over het gewichtsverlies na de operatie.

Dit zou mogelijk bijdragen in een grotere verbetering van psychisch welbevinden na de operatie.

In **hoofdstuk 7** werden de meeteigenschappen van de RAND-36 beoordeeld om de kwaliteit van leven te meten van patiënten die bariatrische metabole chirurgie ondergingen. In deze groep mensen is de RAND-36 één van de meest gebruikte vragenlijsten om de kwaliteit van leven te meten. Voldoende kwaliteit van de meeteigenschappen vergroot de betrouwbaarheid van de vragenlijst. Een belangrijke uitkomst van dit onderzoek was dat zowel patiënten als zorgverleners aangaven relevante onderwerpen te missen, om de kwaliteit van leven na een bariatrische metabole operatie te meten. Onderwerpen zoals eetgedrag, lichaamsbeeld, klachten na de operatie en overtollige huid ontbraken volgens hen in de RAND-36. Daarnaast was de RAND-36 mogelijk onvoldoende betrouwbaar om kwaliteit van leven, en veranderingen hierin, te meten in deze patiëntengroep: de antwoorden verschilden als een zelfde persoon, de vragenlijst kort achter elkaar tweemaal beantwoorde. Er is één ander onderzoek dat de meeteigenschappen van de RAND-36 heeft onderzocht om kwaliteit van leven te meten in patiënten die bariatrische metabole chirurgie ondergingen. Dit onderzoek achtte de RAND-36 voldoende geschikt voor dit doel. Echter, het merendeel van de meeteigenschappen was niet gemeten in dit onderzoek.

De RAND-36 is een bewezen vragenlijst om de kwaliteit van leven te meten in veel verschillende groepen mensen. Ook is de vragenlijst waardevol bij het vergelijken van algemene kwaliteit van leven tussen verschillende patiëntengroepen. Om de RAND-36 te gebruiken voor onderzoek binnen bariatrische metabole chirurgie, bijvoorbeeld, om verschillen tussen twee type operaties te vergelijken, is de RAND-36 waarschijnlijk onvoldoende geschikt. Er is behoefte aan een vragenlijst die relevante onderwerpen meet voor patiënten die bariatrische metabole ondergaan. Uit ander onderzoek blijkt dat er geen vragenlijst bestaat die aan alle criteria voor kwaliteit voldoet om de kwaliteit van leven te meten van patiënten die bariatrische metabole chirurgie ondergaan.

In **hoofdstuk 8** werd een groep van 140 patiënten na bariatrische metabole chirurgie onderzocht. Deze groep onderging een operatie om huidoverschot na het afvallen te herstellen. Na deze operaties ontstaan er vaak wondgenezingsstoornissen. Alle patiënten werden behandeld volgens de Nederlandse richtlijn. Deze adviseert om voor de operatie de voedingstoestand van patiënten te verbeteren. Mogelijk zou het verbeteren van de voedingstoestand samenhangen met minder wondgenezingsproblemen.

Er was bij 51% van de patiënten een mild probleem met de wondgenezing en bij 4.3% een ernstig probleem. Mensen met een goede voedingstoestand hadden net zo veel wondproblemen als mensen zonder een goede voedingstoestand. In vergelijking met ander onderzoek waarin de voedingstoestand niet werd verbeterd voorafgaand aan de operatie, waren er evenveel wondgenezingsstoornissen in ons onderzoek. Echter, de vergelijking met andere onderzoeken is ingewikkeld. Deze onderzoeken bestaan bijvoorbeeld uit verschillende patiëntengroepen. Of er worden minder complexe operaties

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meegenomen in het onderzoek. Ook zijn er verschillen in de definities van complicaties en de tijdsduur die mensen worden vervolgd na de operatie. Vooralsnog is het voorstel om de richtlijn te blijven volgen en in de tussentijd meer onderzoek te doen. Dit onderzoek moet zich concentreren op patiënten die dezelfde bariatrische metabole operatie hebben ondergaan, en dezelfde hersteloperatie voor huidoverschot ondergaan. Er werd een voorstel gedaan voor een nieuw onderzoek.

MOGELIJKHEDEN VOOR DE TOEKOMST

De onderzoeken uit dit proefschrift maken aannemelijk dat een hoger gewicht verband houdt met meer zorgen over het lichaamsbeeld. Ook lijken er verschillende lichaamsbeeldprofielen te bestaan in elke gewichtsgroep. Toekomstig onderzoek is nodig om de betekenis van deze profielen voor de kliniek te duiden. In dit onderzoek zou bijvoorbeeld onderzocht kunnen worden waardoor iemand een groter belang hecht aan zijn of haar uiterlijk. Is dit een uiting van ontevredenheid met het uiterlijk, weinig zelfvertrouwen of komt dit voort uit een verstoorde relatie met eten. Daarbij zou het uitvragen van de motivatie en vaardigheden van mensen om hun gedrag te veranderen mogelijk verduidelijken of gedragsverandering samenhangt met de lichaamsbeeldprofielen.

Mensen die een bariatrische metabole operatie wilden, ervoeren meer ontevredenheid met hun uiterlijk dan mensen van hetzelfde gewicht die niet voor een operatie kozen. Deze ontevredenheid met het uiterlijk – een negatiever lichaamsbeeld - zou een reden kunnen zijn om bariatrische metabole chirurgie te ondergaan. In toekomstig onderzoek zou de motivatie(s) van een patiënt om voor een operatie te kiezen uitgevraagd kunnen worden. De uitslag van dat onderzoek zou mogelijk bevestigen dat een deel van de patiënten voor de operatie kiest om hun lichaamsbeeld te verbeteren.

In het algemeen trad er na een bariatrische metabole operatie een verbetering op van het lichaamsbeeld en psychisch welbevinden. Er was geen verband tussen lichaamsbeeld en gewichtsverlies na de operatie. Huidige BMI, hoeveelheid gewichtsverlies, het hebben van wel of geen werk, de aan- of afwezigheid van medische problemen en tijd sinds de operatie hingen samen met de kwaliteit van leven en tevredenheid met het uiterlijk na de operatie. Daarnaast was er een verband tussen verwachtingen over het gewichtsverlies na de operatie, het hebben van wel of geen werk, de aan- of afwezigheid psychiatrische ziekte en psychisch welbevinden na de operatie. Kennis van factoren die samenhangen met het lichaamsbeeld en de kwaliteit van leven, waaronder psychisch welbevinden, na de operatie, stelt zorgverleners in staat patiënten vroegtijdig te herkennen die een risico hebben op een mindere uitkomst. Deze patiënten kunnen mogelijk geholpen worden door een aanvullende behandeling. Bovendien maken deze resultaten de gevolgen van de behandeling van obesitas op het dagelijks leven van onze patiënten inzichtelijk. Ook kunnen zorgverleners hun patiënten beter voorlichten en voorbereiden op de verwachtingen na de operatie. Deze resultaten benadrukken het belang om patiënten langdurig te vervolgen.

Om de kwaliteit van leven te meten voor en na de operatie, is het raadzaam om niet alleen de RAND-36 te gebruiken, maar deze aan te vullen met een vragenlijst, specifiek ontwikkeld voor mensen die een bariatrische metabole operatie ondergaan. Er worden dan geen belangrijke onderwerpen gemist voor deze groep mensen.

Als laatste werd geobserveerd dat de adviezen uit de Nederlandse richtlijn voor operaties om huidoverschot na bariatrische metabole chirurgie te herstellen, niet leidde tot minder problemen met de wondgenezing. De beperkingen van dit onderzoek werden erkend en suggesties werden gedaan voor toekomstige onderzoeken.

Obesitas blijft een van de grootste uitdagingen van de volksgezondheid. Bariatrische metabole chirurgie is de meest effectieve behandeling van obesitas. Hoewel dit proefschrift zich vooral richtte op de chirurgische behandeling van obesitas, is de beste behandeling preventie van obesitas. Elke zorgaanbieder zou zich bezig moeten houden met adviezen over algemene gezondheid. Denk aan gezond eten, bewegen, stoppen met roken en een voldoende mentale gezondheid. Daarnaast dragen de bevindingen van dit proefschrift mogelijk bij aan een gepersonaliseerde aanpak van zorg voor de individuele patiënt, en verbetert de zorg in het algemeen voor iedereen met obesitas.

LIST OF PUBLICATIONS

SUBMITTED OR UNDER REVISION

Makarawung DJS, Dijkhorst PJ, de Vries CEE, Monpellier VM, Wiezer MJ, van Veen RN, Geenen R, Mink van der Molen AB. Body image and weight loss outcome after bariatric metabolic surgery: a mixed model analysis. *Under revision.*

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CURRICULUM VITAE

Dennis Jeroen Sebastiaan Makarawung was born on September 16th, 1989, in Rheden, the Netherlands. After graduating from het Stedelijk Gymnasium Arnhem in 2007, he went to Amsterdam to study Medicine at the University of Amsterdam. During his studies, Dennis migrated to Boston, Massachusetts, USA, to attend a scientific research internship via Harvard University at the Hand and Upper Extremity Service of the Massachusetts General Hospital, supervised by dr. David C. Ring. During his five months in Boston, Dennis contributed to multiple studies that resulted in four publications. In the two years that followed, he completed his medical study where he developed his passion for (plastic) surgery.

After obtaining his medical degree, he started working as a surgery resident not in training at the St. Antonius hospital, during which he involved himself in research under the supervision of prof. dr. Aebele B. Mink van der Molen and dr. Valerie M. Monpellier. His supervisors introduced Dennis to prof. dr. Rinie Geenen, who altogether supported Dennis in his ambition to obtain a PhD. Dennis continued his research combined with a part-time function as a medical doctor not in training at the Nederlandse Obesitas Kliniek. Dennis' interest in obesity and weight loss treatment, as well as his affinity with research, laid the foundation of this thesis. In the years that followed, Dennis kept combining his clinical work as a doctor with his research, which led to more residencies in the Rode Kruis hospital in Beverwijk and the Amsterdam UMC at the surgery department.

In June 2022, Dennis came to the realization that working as a surgeon was not his lifelong dream. After years of combining work and research, the lack of time to spend on others things he loved made him chase a different dream. In January 2023 he started working as a medical doctor for GEDI Health, a startup company focused on optimizing health, by leveraging genetics and artificial intelligence, to create personalized treatment plans for people, inspired to change current healthcare.

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