Quality of life in bariatric patients up to twelve years after surgery - Results from a nationwide retrospective cohort study

Oliver Riedel, Malte Braitmaier, Mark Dankhoff, Michel Hornschuch, Melanie Klein, Wiebke Zachariassen, Jana Hoyer

DOI
10.1016/j.orcp.2023.08.001

Published in
Obesity Research & Clinical Practice

Document version
Accepted manuscript

Online publication date
15 August 2023

Corresponding author
Oliver Riedel

Citation
Riedel O, Braitmaier M, Dankhoff M, Hornschuch M, Klein M, Zachariassen W, et al. Quality of life in bariatric patients up to twelve years after surgery - Results from a nationwide retrospective cohort study. Obes Res Clin Pract. 2023;17(4):353-60.

Quality of life in bariatric patients up to twelve years after surgery - Results from a nationwide retrospective cohort study

Oliver Riedel[1], M. Braitmaier[1], Mark Dankhoff[2], Michel Hornschuch[1], Melanie Klein[3], Wiebke Zachariassen[3], Jana Hoyer[4]

[1] Leibniz Institute for Prevention Research and Epidemiology – BIPS, Bremen, Germany
[2] Hamburg, Germany
[3] DAK Gesundheit, Hamburg, Germany
[4] Adipositas-Zentrum, Städtisches Klinikum Dresden, Dresden, Germany

Corresponding author:
Oliver Riedel, PhD
Leibniz Institute for Prevention Research and Epidemiology – BIPS
Achterstrasse 30, 28359 Bremen, GERMANY
Phone: ++ 49 421/21856883
Email: riedel@leibniz-bips.de
ORCID ID: 0000-0002-1721-502X

Word count:	4,316	
Tables:	2	(+2 Suppl. Tables)
Figures:	3	(+1 Suppl. Figure)
References:	42	

Declaration of conflict of interests: OR, MB and MH are working at an independent, non-profit research institute, the Leibniz Institute for Prevention Research and Epidemiology – BIPS. Unrelated to this study, BIPS occasionally conducts studies financed by the pharmaceutical industry. Almost exclusively, these are post-authorization safety studies (PASS) requested by health authorities. The design and conduct of these studies as well as the interpretation and publication are not influenced by the pharmaceutical industry. The study presented was not funded by the pharmaceutical industry and was performed in line with the ENCePP Code of Conduct. All authors declare no conflict of interests

Acknowledgements: The authors would like to thank the statutory health insurance provider “DAK-Gesundheit”, which provided data for this study. Moreover, the authors thank Heike Gerds for proof-reading the manuscript. Our further thanks go to Willempje Hummel-Bartenschlager and Birgit Wolter for supporting the data entry as well as Philipp Alexander Volkmar and Anja Gabbert for the statistical programming of the data sets.

Author contributions: OR and JH wrote the first draft of the manuscript and conceptualized the statistical analyses. MB conducted the statistical analyses including sensitivity analyses and reviewed the draft of the manuscript. MD, MH, MK and WZ reviewed the draft of the manuscript and provided critique.

Abstract

Background: Bariatric interventions (BI, including surgical interventions) are effective in patients with massive obesity, i.e., a body mass index (BMI) ≥40, and their number has steadily increased during the past decade. Yet, the stability of improvements in quality of life (QoL) in post-interventional patients is understudied and restricted to studies with small samples and short follow-ups.

Methods: Patients with BI between 2004 and 2018 were identified in a health claims database and invited to fill in a survey, comprising sociodemographic and lifestyle information and psychometric scales. QoL was assessed with the Bariatric QoL (BQL) scale with lower scores denoting worse QoL. BMI and excess weight loss (EWL) were calculated for the time soon after intervention (EWL-T1) and when filling the survey (EWL-T2).

Results: The majority of n=2,151 patients were female (80.7%), had a mean age of 54.5 years and a mean BMI of 34.8. The mean EWL_T1 was 79% (EWL-T2: 64.6%). The mean BQL score was 47.6 and decreased with BMI (18.5–24.9: 52.6 vs. ≥40: 38.7), EWL-T2 (>66%: 51.3 vs. <65%: 42.1) and years since intervention (3-4: 48.2 vs ≥8: 45.1, each p<.001). For EWL-T1, the association between higher EWLs and higher BQL scores was stronger in females than in males (p<.005); for EWL at T2, both sexes did not differ in this regard (p=.848). Among normal-weight persons, males scored significantly lower on the BQL than females (44.9 vs. 54.9).

Conclusions: Post-interventional QoL improvements diminish over time and depend on the weight loss, with significant differences between men and women.

Keywords: Obesity, bariatric surgery, quality of life, weight loss

1. Introduction

Clinical obesity, defined by a body mass index (BMI) of more than 30 kgs/m², is frequently associated with unfavored health outcomes including diabetes, hypertension, cancer and an overall substantially decreased life expectancy [1, 2]. Affecting more than 13% of the world population, its prevalence has tripled from 1975 to 2016, with more than 4 million people dying annually [3, 4]. The increasing prevalence has also been recently reported for children and adolescents [5], thus posing also a substantial socioeconomic burden. In 1997, the World Health Organization declared obesity as a worldwide epidemic [6]. According to the Global Burden of Disease Study, obesity rates increased up to 36.9% in men and 38.0% in women worldwide. Although the increase of obesity has slowed down since 2006 in developed countries [7], the percentage of patients suffering from Class III obesity has increased by 70% [8].

While there are various medical and non-medical interventions available for the treatment of obesity, for severe cases (i.e., with a BMI≧40 kgs/m²), bariatric surgeries have become a treatment alternative, when lifestyle interventions have not had sufficient impact. The global number of bariatric surgeries increased eightfold between 2014 and 2019 alone [9]. Their effectiveness for long-term weight loss is well documented, as is their positive impact on obesity-related comorbidities, such as reductions in cardiovascular diseases [10], diabetes incidence [11] and even lower risk of certain cancers [12]. Patients undergoing bariatric surgery show a reduced hazard rate of death of 49% and an increase in median life expectancy by 6 years [13]. In addition, bariatric surgery also leads to higher remission rates of type 2 diabetes and metabolic syndrome [14]. However, results of those studies are often limited due to a restricted number of years of follow-up.

Adverse mental health effects, including depression and anxiety disorders [15] also contribute to obesity effects on disability, morbidity and mortality [16]. Furthermore, the risk of the occurrence of major depressive episodes is increased in patients undergoing bariatric surgery as compared to non-surgery patients [17]. Similar to other diseases, quality of life

(QoL) can also be considered as having an impact on the management of obesity, which is as relevant as other comorbidities of the disease and should be addressed as such in a holistic approach [18, 19]. Quality of life in these populations has in fact been investigated in the recent past. These studies, however, have mostly been limited to short observation periods or small samples of patients [20], restricting the possibilities for stratified analyses. In particular, sufficient stratification by gender has been lacking so far due to sample sizes, so there is still some uncertainty about different patterns of progression for men and women. In addition to this lack of data, recent studies suggested, that men and women differ in several outcomes of bariatric surgeries, including the extent of post-surgical weight loss [21], the occurrence of intra- and post-operative complications [22], or mortality [23, 24] - all of which can be, at least indirectly, associated with QoL.

Therefore, this paper aims at describing the medium- and long-term patterns of QoL in obese patients after bariatric interventions (i.e. surgical interventions and gastric balloon), based upon survey data and health claims data of a large sample of treated patients.

2. Subjects, Materials and Methods

2.1 Data sources

The present analyses were based on a linked data set comprising longitudinal health claims data and cross-sectional data from a patient survey as described below (for more details on the study design, see section 2.2).

The **longitudinal data** were obtained from the German Pharmacoepidemiological Research Database (“GePaRD”). GePaRD is based on claims data from four statutory health insurance (SHI) providers in Germany and currently includes information on approximately 25 million persons who have been insured with one of the participating providers since 2004 or later. Please note that since one of the SHIs also initiated the project, only data from this SHI were used in this case, comprising approx. 12 million insured individuals. In addition to demographic data, GePaRD contains information on drug dispensations as well as outpatient

(i.e., from general practitioners and specialists) and inpatient procedures and diagnoses. Per data year, there is information on approximately 20% of the general population and all geographical regions of Germany are represented [25].

The **patient survey** collected additional information, including data on sociodemographics (e.g., current and pre-interventional body weight), post-interventional complications, medical care, eating behavior, physical activities, intake of dietary supplements and over-the-counter ("OTC") medication. Additionally, **health-related quality of life** was assessed with the *Bariatric Quality of Life* (BQL) index, which comprises 13 items, each of which can be answered on a five-point Likert scale, ranging from 1 to 5. The total score can vary between 13 and 65, with lower scores denoting lower QoL [26, 27].

Each patient was screened for **mental health** outcomes with the Mini-Symptom-Checklist (MINI-SCL). It consists of three scales, each of which comprising six items from the Symptom Checklist (SCL-90). The MINI-SCL measures the presence of depression, anxiety, and somatization, based on the seven days prior to filling the survey [28]. Each scale assesses specific symptoms (e.g. for depression: loss of interest, feelings of loneliness, worthlessness or hopelessness). A global severity of impairment score can be calculated by summing all scores from all three scales. The sum score of each scale can be converted into T-values, based upon age- and sex-standardized norms representative for the German general population.

The **Body Mass Index (BMI)** was calculated as the reported body weight (in kilograms) divided by the square of height in meters. Based upon WHO recommendations, it was categorized as "normal weight" (18.5–24.9), "overweight" (25.0–29.9), "obesity class I" (30.0–34.9), "obesity class II" (35.0–39.9) and "obesity class III" ($\geq$40). It was calculated for the time points: prior to intervention (T0), soon after intervention (T1) and at the time of survey (T2). The **excess weight loss (EWL, in %)** was calculated by dividing the number of kilograms lost by the number of kilograms in the patients' excess weight (related to a BMI of 25). The EWL was calculated for T1 and T2. The **total weight loss (TWL, in %)** was calculated for T1

and T2 by dividing the number of kilograms lost by the number of kilograms in the patients' pre-interventional weight. Both measures were chosen because they are commonly used to describe proportional weight losses. However, a particular focus for the main analyses was on the EWL because it refers to a fixed ideal weight. Because achieving such an explicit ideal weight is likely to be an important goal of bariatric patients, the EWL is supposed to be more sensitive in analyzing associations between weight loss and quality of life.

2.2 Study design

The data were obtained from the previously mentioned data sources as follows (see also Figure 1). First, persons insured with one SHI in GePaRD with at least one bariatric intervention anytime between 2004 and 2018 who were still alive at the end of 2018 were identified as potentially eligible survey recipients (n=6,913). Of these, n=1,691 patients were not feasible for contact for various reasons (e.g., n=1,011 were no longer insured with the SHI at the time of study conduction, n=214 had expressly objected to receiving any non-administrative mail, n=190 were under guardianship and not capable of giving consent). Thus, the survey was sent out to n=5,222 patients and n=2,521 participated (response rate: 48.3%). Data from n=103 responders were deleted due to missing informed consent declarations (n=2,418, corrected response rate 46.3%).

As the analyses required patients to have at least three years of baseline prior to the first bariatric intervention, patients not meeting this requirement were removed from the GePaRD data (n=1,076) and survey data (n=267), respectively. Thus, the **linked data set** comprised n=2,151 patients for whom both survey and health claims data were available (=survey responders). Responders and non-responders of the survey did not differ in terms of sex, years since surgery or comorbidity profiles. However, responders were significantly older than non-responders (54.6 years vs. 51.5 years, data not shown, tables available upon request).

2.3 Statistical analyses

Depending on the data levels, summary statistics consisted of counts, percentages, means and standard deviations (SD), medians and quartiles (Q1, Q3), where appropriate. Subgroups were tested for differences with t-tests, χ^2-tests, ANOVAs and linear regression models, where appropriate. A p-value <.05 was considered statistically significant. While p-values were interpreted descriptively, multiple group comparisons within the same analysis were corrected for α-inflation using the Bonferroni-method. Effect sizes (ES) for differences were calculated as Cohen's D and Cohen's W, respectively, considering ES of .20 as "small", .50 as "medium" and .80 as "large" ES [29, 30]. In a sensitivity analysis, missing values of the BQL items were imputed via multiple imputation using linear models with LASSO variable selection from all available predictor variables. Continuous predictor variables were categorized using quintile strata and missing values in variables other than BQL items were included as distinct category. Pooling of imputed means and standard deviations was done using Rubin's rules [31]. Multiple imputation was done using the mice *R* package [32]. All statistical analyses were conducted using *R* version 4.2.0 [33], *R* version 4.0.5 for imputation of missing values and SAS 9.4.

2.4 Ethics

The study was approved by the Hamburg Medical Chamber Ethics Committee (October 11, 2021, No. 2021-10543-BO-ff) and has been performed according to ethical standards laid down in the 1964 Declaration of Helsinki. Written informed consent was obtained from all participating patients.

3. Results

3.1 Sample Characteristics

The characteristics of the study sample are depicted in Table 1. The vast majority of study participants were female (80.7%) with a mean age of 47.9 years at bariatric intervention and a mean age of 54.5 years at the conduction of the survey. The mean years since bariatric intervention were 6.5 (SD: 3.1); for 33.1% of participants, the intervention had occurred 3 to 4 years earlier, for 32.7%, it had occurred 5 to 7 years earlier, and for 34.2%, it had occurred more than 8 years earlier, respectively. For the vast majority of particpants (98.5%) the intervention required surgery (i.e. gastric bypass, gastric sleeve or gastric band). Correspondingly, the proportion of reversible interventions was less than 6% (gastric band or gastric balloon). The mean pre-interventional BMI (at T0) was 51.9 (SD: 8.7) with no significant differences between men and women (p=.063). The proportion of patients who still (or again) had a BMI $\geq$40 after the intervention (at T2) ranged between 22.1% and 22.3%. Of note, following intervention, 12.5% of all patients reported a BMI $\geq$ 40 as lowest BMI.

Compared to males, female participants were significantly younger at the conduction of the study as well as at bariatric intervention and had gastric band or bypass surgery significantly more often. They also achieved higher scores indicating more depressive symptoms as well as more severe global mental impairment than males. All differences between males and females were associated with an effect size <.20 (median ES 14.5, Q1: 14.0, Q3: 17.7). No differences between sexes were found regarding time since intervention, anthropometrics at T1 or T2 or anxiety and somatization symptoms, respectively.

3.2 Quality of life

A total BQL score could not be computed for n=1,359 due to missings of single items on the scale, predominantly the “I feel restricted because of my weight….” subscales with n=1,116 missings on “…at work”, n=774 missings on “…privately” and n=781 missings on “…at home”. Thus, a total BQL score was computable for n=792. Differences between completers and non-completers of the BQL scale can be seen in Suppl. Table S1. Compared to completers, non-completers were significantly older, left the workforce significantly more

often and reported lower scores regarding social activities. Both groups did not differ regarding the other BQL items, other psychometric values or anthropometric parameters. Missing BQL values were imputed in a sensitivity analysis. Imputed mean values, stratified by sample characteristics, are given in Suppl. Table S2. Only slight differences to the values reported in Table 2 were observed with no qualitative changes.

The overall mean BQL score in the study sample was 47.6 (SD: 11.3). It decreased significantly with increasing BMI, with significant differences between all BMI categories ($p<.001$ each) except between normal weight and overweight ($p=.795$) and normal weight and obesity class I ($p=.094$). It also decreased with time, with no sex differences. Regarding EWL as well as TWL, higher losses at T1 and at T2 were associated with significantly higher scores on the BQL at the time of survey conduction (see Table 2). When testing the common impact of marital status, BMI and years since intervention on the BQL in a linear regression model, significance remained for BMI ($p<.001$, adjusted β-weight -0.48) and being married ($p<.05$, adjusted β-weight 0.08). Patients who reported more than one bariatric intervention ($n=363$) did not differ in BQL score from patients who had only one ($p=.198$).

While the BQL scores did not differ between male and female patients, interactions were found between sex and BMI and sex and EWL, respectively. Males with normal weight scored significantly lower on the BQL as compared to females with normal weight, while in overweight patients, females scored significantly lower than males (see Figure 2). In terms of their own satisfaction with their current body weight, among normal-weight patients, 85.7% of men and 98.2% of women reported being satisfied with their current body weight; among overweight patients, this proportion was 97.3% for men and 89.3% for women.

Figure 3 displays the associations between the BQL score and the extent of EWL soon after intervention (see Figure 3a) and between the extent of EWL until the time of survey conduction (see Figure 3b). For both time periods, it was observed that higher EWL was

associated with higher BQL scores years later. When analyzing potential interactions with sex, a significant interaction ($p<.001$) was observed for the association between EWL soon after intervention and the BQL score such that in women, higher EWL during this period was associated more strongly with higher BQL scores than in men (see Figure 3b). Considering the association between EWL up to the time of the survey conduction and BQL score, males and females did not differ ($p=.848$, see Figure 3d). Including type of bariatric intervention and the MINI-SCL depression score as potential confounders into the regression models did neither change the significance status of the interactions observed at T1 ($p<.01$) nor at T2 ($p=.389$). The same analyses were also conducted with the TWL instead of EWL, revealing no interactions at T1 and T2 ($p=.797$ and $p=.692$, see Suppl. Figure S1).

4. Discussion

We investigated the medium- and long-term quality of life after bariatric interventions, including surgical and non-surgical procedures, based upon a large sample of patients, identified in health claims data; in more than 98% of patients the intervention was surgical. Several findings were derived from our data.

First, our results suggest that body weight in terms of BMI was inversely associated with QoL, indicating that higher weight still reduces QoL in patients after bariatric interventions, especially in those with a post-interventional BMI higher than 35. Also, the extent of EWL—both soon after intervention as well as years later at the time of study conduction—was positively correlated with QoL, i.e., patients with higher EWL also reported a better QoL. This contrasts findings from a recently published longitudinal multicenter study on bariatric patients over 10 years, where no effect of EWL on QoL as measured with the BQL was found [34]. One possibility for the difference between the results of this study and ours could be that the sample size in the study of Felsenreich et al. was smaller. This assumption is supported by the fact that differences did exist, but they remained above the significance threshold. Likewise, Warkentin et al. [35] conducted a systematic review and meta-analysis with 53 randomized control studies on persons with weight loss interventions and could not

find QoL improvements. However, these findings have to be interpreted very cautiously as the included studies were not restricted to persons after bariatric interventions but covered a wide range of weight modifying interventions and therefore were not restricted to severely obese patients. In fact, the authors rated the overall quality of the included studies as poor and very heterogeneous [35], which possibly also explains the lack of effect.

Second, QoL significantly (though not excessively) decreased over time with higher self-reported QoL in patients whose bariatric intervention was less than five years before as compared to patients, whose intervention was more than ten years before. This is in line with findings from previous studies reporting strongest improvements soon after surgery, with diminishing effects over time [20, 36, 37]. This also aligns with the first finding, as longer periods of time were also associated with a mild regain of weight after surgery. After an initial EWL of almost 80% soon after intervention, the EWL at the time of the study conduction was still 64%, which equals a mean weight regain of 3–4 BMI points between intervention and filling the survey. The post-interventional weight, however, was still clearly below the pre-intervention level (67%) underlining long-term effectiveness of bariatric interventions in this population [38, 39]. Notably, however, more than 1 in 10 patients never reached a post-interventional BMI below the threshold indicative for surgery in the first place. Although the efficacy of bariatric surgery has been widely and unequivocally documented [39], the 10% proportion of treatment-resistant patients is a cause for concern and should be further investigated.

Male and female patients did not differ regarding pre-/post-interventional BMI, EWL, number of years since intervention or reported QoL. The latter is noteworthy since women also scored significantly higher on the depression subscale of the MINI-SCL. Yet, this did not translate into lower QoL, which is a common observation in other populations. However, on two occasions, we found interactions between sex and these anthropometrics with respect to QoL. First, among patients with normal weight, men reported significantly lower QoL than females, whereas among patients with overweight (yet not obesity), females reported significantly lower QoL than males. We have no clear evidence of how this gender difference

occurred, as men and women in these weight categories did not differ in terms of somatic comorbidities or pain. One possible explanation could lie in the different body image of men and women. Weight loss is also achieved by reducing muscle mass, so that when men reach normal weight, at least initially, they not only weigh less but also appear "lankier" instead of having an apparently ideal body figure. In fact, our results point in this direction, as men were significantly more likely to be dissatisfied with their body weight than women, despite having normal weight.

The second interaction relates to the extent of EWL at T1 and T2 with QoL at T2. While EWL at both time points was generally associated with better QoL years later, this association differed between men and women. At T1, the EWL in females was more strongly associated with QoL years later than the EWL in males at T1, whereas both sexes did not differ in this regard when considering the EWL at the time of the intervention (T2). The significance status of these interactions was not changed when including type of bariatric intervention and depression status into the models, suggesting that these variables could not explain the observed interactions.

One can only speculate about the reasons for this interaction. These finding suggest that immediate weight loss after intervention is of higher importance to women than men, as they have more pronounced issues with body image [40]. Also, women often spend many years of (failed) attempts to reduce weight before bariatric intervention. Thus, they experience high pressure to finally lose weight, which could explain the massive relief (and increase in QoL) upon eventual success. However, it remains unclear why this interaction is not observed when using the EWL of the entire period from intervention to survey. Speculatively, weight reduction in women could be associated with immediate reinforcement by compliments and positive feedback from the social environment but those decrease as the weight loss slows down or stops over time. Also, time may play a role here, such that both sexes develop a different (more positive) attitude to the still present overweight in the years after bariatric intervention, leading to a higher QoL. Since such attitude changes usually occur slowly, this could account for the lack of interaction effect over a longer period of time. However, this

cannot be confirmed with our data and must therefore remain speculative. Of note, no interactions were detected when the TWL was used instead of the EWL. This is, however, plausible for reasons related to content as well as for methodological reasons, since the TWL has a smaller variation range than the EWL. Moreover, it seems reasonable that for the assessment of QoL the comparison of the body weight with the normal weight (as an ideal weight that one would like to achieve) can be of higher importance than the relative total loss of weight.

The overall strength of our study lies in the large sample size of bariatric patients, the high survey response rate of almost 50% and the long observation period of up to 12 years, providing insight into the medium-term as well as the long-term development of QoL in such populations. Moreover, from a methodological perspective, it should be noted that the study design was based on the utilization of health claims data which were available on an individual level, irrespective of the patients' survey response status. By comparing these data between responders and non-responders, we are fairly confident that both groups do not differ significantly with respect to key demographic and clinical parameters, so that response bias, which is usually unknown in other studies, can be largely ruled out. It should be noted, however, that the study design required the identified bariatric patients to be still approachable for the survey in 2021. As reported, 1,011 (14.6%) out of 6,913 potentially eligible survey recipients could not be contacted as they were not insured with the SHI provider anymore at the time of the survey conduction. For these patients, no further information is available and it cannot be ruled out that they left the provider due to dissatisfaction with the services, which might also have affected they bariatric QoL.

Further limitations have to be acknowledged when interpreting our findings. First and foremost, due to the retrospective identification of patients in our study, we were not able to determine the QoL prior to intervention, which would have enabled us to conduct a pre-post-comparison. This limitation was also present in another longitudinal study on the long-term development of QoL in surgically treated patients [36]. Similar to this study, we also found a largely stable QoL which only decreased mildly over the years, suggesting that the QoL

substantially improved after bariatric interventions. In addition to this limitation, it should also be kept in mind that we have a minimum gap of 3 years between surgery and QoL assessment in 2021, as our data source allowed no identification of patients with bariatric surgeries after 2018. However, since QoL has repeatedly been proven to be very stable over the medium term in our study as well as in other investigations [20], we assume only a minimal loss of information in this regard. The third limitation refers to the large number of patients, who had to be excluded from the analyses as a BQL total score could not be computed due to missing items. Our comparison analyses between completers and non-completers suggest, that mostly the item relating to restrictions at work was omitted, potentially due to lacking applicability for this study population. We estimate the potential bias to be small because we either did not find any other differences between completers and non-completers or the few differences had only small effect sizes. Furthermore, a multiple imputation did not lead to substantial differences in overall (imputed) BQL score in strata defined by sex, marital status, BMI, EQL at T1 and T2 or years since surgery. Nonetheless this is a limitation inherent to the test construction of the BQL instrument. Finally, further limitations concerning the data source should be noted when interpreting our findings. First, GePaRD does not contain data from individuals with private health insurance, which in Germany is only available for individuals with a high gross annual income or selected occupation groups (e.g. civil servants). Thus, insured persons with higher incomes may be underrepresented. However, the proportion of privately insured individuals is approximately 11 percent only, since a large proportion of those who could choose private health insurance due to their income nevertheless voluntarily remain covered by statutory health insurance [25]. Moreover, although four SHIs contribute to GePaRD, only data from one SHI were considered since this SHI initiated the underlying research project and data access for the other SHI data were not requested. However, since the used data based covered almost 50% of the GePaRD data, we do not expect substantial bias in this regard. We also note that despite the extensive use of survey information, for both technical and space reasons, other potential factors influencing weight loss and QoL could not be considered, such as

geographic factors or socioeconomic status [41, 42]. Also a finer differentation between different types of gastric sleeve (e.g. RYGB, OAGB) could not be realized in our study. These aspects should therefore be the subject of future studies using similar methodology.

Overall, this study provides a comprehensive overview of the middle-term and long-term impact of bariatric interventions on quality of life. In summary, QoL improvements after bariatric interventions diminish with time passed since surgery and depend on the weight loss, with subtle differences between men and women.

Funding

The underlying study ("ABARO") was funded by the German Innovation Fund (grant number: 01VSF19045). The sponsor was neither involved in the design of the study nor in the collection, analysis or interpretation pf data, nor in the writing of the manuscript or in the decision to submit it for publication.

Acknowledgements

The authors would like to thank the statutory health insurance provider "DAK-Gesundheit", which provided data for this study. Moreover, the authors thank Heike Gerds for proof-reading the manuscript. Our further thanks go to Willempje Hummel-Bartenschlager and Birgit Wolter for supporting the data entry as well as Philipp Alexander Volkmar and Anja Gabbert for the statistical programming of the data sets.

References

[1] Sarma S, Sockalingam S, Dash S. Obesity as a multisystem disease: Trends in obesity rates and obesity-related complications. Diabetes Obes Metab. 2021;23:3-16.

[2] Whitlock G, Lewington S, Sherliker P, Clarke R, Emberson J, Halsey J, et al. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. Lancet. 2009;373:1083-96.

[3] Stival C, Lugo A, Odone A, van den Brandt PA, Fernandez E, Tigova O, et al. Prevalence and correlates of overweight and obesity in 12 European Countries in 2017-2018. Obes Facts. 2022:24.

[4] World Health Organization. European Regional Obesity Report 2022. Geneva, Switzerland: WHO; 2022.

[5] Fan H, Zhang XY. Recent trends in overweight and obesity in adolescents aged 12 to 15 years across 21 countries. Pediatr Obes. 2022;17:8.

[6] World Health Organization. Division of Noncommunicable Diseases & World Health Organization. Programme of Nutrition FaRH. Obesity : preventing and managing the global epidemic : report of a WHO Consultation on Obesity. WHO Consultation on Obesity Geneva, Switzerland1997.

[7] Ng M, Fleming T, Robinson M. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013 (vol 384, pg 766, 2014). Lancet. 2014;384:746-.

[8] Williams E, Mesidor M, Winters K, Dubbert P, SB W. Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. Curr Obes Rep. 2015;4:363-70.

[9] Troisi A. Emergence of bariatric psychiatry as a new subspecialty. World J Psychiatr. 2022;12:108-16.

[10] Oliveira SC, Neves JS, Souteiro P, Pedro J, Magalhaes D, Guerreiro V, et al. Impact of bariatric surgery on long-term cardiovascular risk: Comparative effectiveness of different surgical procedures. Obes Surg. 2020;30:673-80.

[11] Lee PC, Tan HC, Pasupathy S, Ganguly S, Eng AKH, Nadkarni N, et al. Effectiveness of bariatric surgery in diabetes prevention in high-risk Asian individuals. Singap Med J. 2018;59:472-5.

[12] Schauer DP, Feigelson HS, Koebnick C, Caan B, Weinmann S, Leonard AC, et al. Bariatric surgery and the risk of cancer in a large multisite cohort. Ann Surg. 2019;269:95-101.

[13] Syn N, Cummings D, Wang L, Lin D, Zhao J, Koh Z, et al. Association of metabolic bariatric surgery with long-term survival in obese adults with and without diabetes: A patient-level meta-analysis of 174,772 patients with 1.2 million years of follow-up Type 2 diabetes and metabolic surgery. Obes Surg. 2022;32:62-3.

[14] Gloy VL, Briel M, Bhatt D, Kashyap S, Schauer P, Mingrone G, et al. Bariatric surgery versus non-surgical treatment for obesity: A systematic review and meta-analysis of randomized controlled trials. BMJ. 2013;347:f5934.

[15] Dawes AJ, Maggard-Gibbons M, Maher AR, Booth MJ, Miake-Lye I, Beroes JM, et al. Mental health conditions among patients seeking and undergoing bariatric surgery - A meta-analysis. JAMA-J Am Med Assoc. 2016;315:150-63.

[16] Avila C, Holloway A, Hahn M, Morrison K, Restivo M, Anglin R, et al. An overview of links between obesity and mental health. Curr Obes Rep. 2015;4:303-10.

[17] Müller A, Hase C, Pommnitz M, de Zwaan M. Depression and suicide after bariatric surgery. Curr Psychiatry Rep. 2019;21:6.

[18] Taylor VH, Forhan M, Vigod SN, McIntyre RS, Morrison KM. The impact of obesity on quality of life. Best Pract Res Clin Endoc Metab. 2013;27:139-46.

[19] Vallis M. Quality of life and psychological well-being in obesity management: improving the odds of success by managing distress. Int J Clin Pract. 2016;70:196-205.

[20] Andersen JR, Aasprang A, Karlsen TI, Natvig GK, Vage V, Kolotkin RL. Health-related quality of life after bariatric surgery: a systematic review of prospective long-term studies. Surg Obes Relat Dis. 2015;11:466-73.

[21] Risi R, Rossini G, Tozzi R, Pieralice S, Monte L, Masi D, et al. Sex difference in the safety and efficacy of bariatric procedures: a systematic review and meta-analysis. Surg Obes Relat Dis. 2022;18:983-96.

[22] Thaher O, Croner RS, Driouch J, Stroh C. Are there substantial sex-based differences in the results of bariatric and metabolic surgery? Multicenter and nationwide analysis from the German Bariatric Surgery Registry. Bariatr Surg Pract Patient Care. 2023:7.

[23] Beiglbock H, Morth E, Reichardt B, Stamm T, Itariu B, Harreiter J, et al. Sex-specific differences in mortality of patients with a history of bariatric surgery: A nation-wide population-based study. Obes Surg. 2022;32:8-17.

[24] Kauppila JH, Santoni G, Tao WJ, Lynge E, Jokinen J, Tryggvadottir L, et al. Risk factors for suicide after bariatric surgery in a population-based nationwide study in five Nordic countries. Ann Surg. 2022;275:E410-E4.

[25] Haug U, Schink T. German Pharmacoepidemiological Research Database (GePaRD). In: Sturkenboom M, Schink T, editors. Databases for Pharmacoepidemiological Research. Cham, Switzerland: Springer; 2021.

[26] de Figueiredo IR, Vasques MC, Cunha N, Martins D, Silva-Nunes J. Quality of life in obese patients from a multidisciplinary bariatric consultation: A cross-sectional study comparing to a non-bariatric population and to the general population. Int J Environ Res Public Health. 2022;19:9.

[27] Weiner S, Sauerland S, Fein M, Blanco R, Pomhoff I, Weiner RA. The bariatric quality of life (BQL) index: A measure of well-being in obesity surgery patients. Obes Surg. 2005;15:538-45.

[28] Franke GH. Mini-Symptom-Checklist. Göttingen: Hogrefe; 2017.

[29] Cohen J. The statistical power of abnormal-social psychological research: A review. The Journal of Abnormal and Social Psychology. 1962;65:145-53.

[30] Sullivan G, Feinn R. Using effect size—or why the p value is not enough. Journal of Graduate Medical Education. 2012:279-82.

[31] Carpenter J, Kenward M. Multiple imputation and its application: John Wiley & Sons; 2012.

[32] van Buuren S, Groothuis-Oudshoorn K. mice: Multivariate Imputation by Chained Equations in R Journal of Statistical Software. 2011;45:1-67.

[33] R Core Team. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing; 2022.

[34] Felsenreich DM, Prager G, Kefurt R, Eilenberg M, Jedamzik J, Beckerhinn P, et al. Quality of life 10 years after sleeve gastrectomy: A multicenter study. Obes Facts. 2019;12:157-66.

[35] Warkentin LM, Das D, Majumdar SR, Johnson JA, Padwal RS. The effect of weight loss on health-related quality of life: systematic review and meta-analysis of randomized trials. Obes Rev. 2014;15:169-82.

[36] Felsenreich DM, Artemiou E, Steinlechner K, Vock N, Jedamzik J, Eichelter J, et al. Fifteen years after sleeve gastrectomy: Weight loss, remission of associated medical

problems, quality of life, and conversions to Roux-en-Y gastric bypass-long-term follow-up in a multicenter study. Obes Surg. 2021;31:3453-61.

[37] Karlsson J, Taft C, Ryden A, Sjostrom L, Sullivan M. Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. Int J Obes. 2007;31:1248-61.

[38] Anderson JW, Konz EC, Frederich RC, Wood CL. Long-term weight-loss maintenance: a meta-analysis of US studies. Am J Clin Nutr. 2001;74:579-84.

[39] Chang SH, Stoll CRT, Song J, Varela JE, Eagon CJ, Colditz GA. The effectiveness and risks of bariatric surgery - An updated systematic review and meta-analysis, 2003-2012. JAMA Surg. 2014;149:275-87.

[40] Kochkodan J, Telem DA, Ghaferi AA. Physiologic and psychological gender differences in bariatric surgery. Surg Endosc. 2018;32:1382-8.

[41] Melendez-Araujo MS, Berber LCL, de Sousa KMQ, Figueiredo A, Lamarca F, Dutra ES, et al. New insights on the association between socioeconomic status and weight loss after bariatric surgery: A sys-tematic review and meta-analysis. Obes Surg. 2022;32:3752-70.

[42] Pouchucq C, Menahem B, Le Roux Y, Bouvier V, Gardy J, Meunier H, et al. Are geographical health accessibility and socioeconomic deprivation associated with outcomes following bariatric surgery? A retrospective study in a high-volume referral bariatric surgical center. Obes Surg. 2022;32:1486-97.

Tables and Figures (Captions)

Table 1. Characteristics of the study sample.

Table 2. Scores on the BQL measure (at T2), stratified by selected sample characteristics.

Figure 1. Ascertainment of the linked data set / study sample.

Figure 2. Mean BQL score stratified by body mass index and sex.

Figure 3. Associations between the BQL score and the extent of excess weight loss (a) immediately after bariatric intervention and (c) until the survey conduction, with interactions by sex at both times (b, d).

Suppl. Table S1. Comparison of scores on the BQL items between completers and non-completers of the BQL scale.

Suppl. Table S2. Scores on the BQL measure after multiple imputation, stratified by selected sample characteristics.

Suppl. Figure S1. Associations between the BQL score and the extent of total weight loss (a) immediately after bariatric intervention and (c) until the survey conduction, with interactions by sex at both times (b, d).

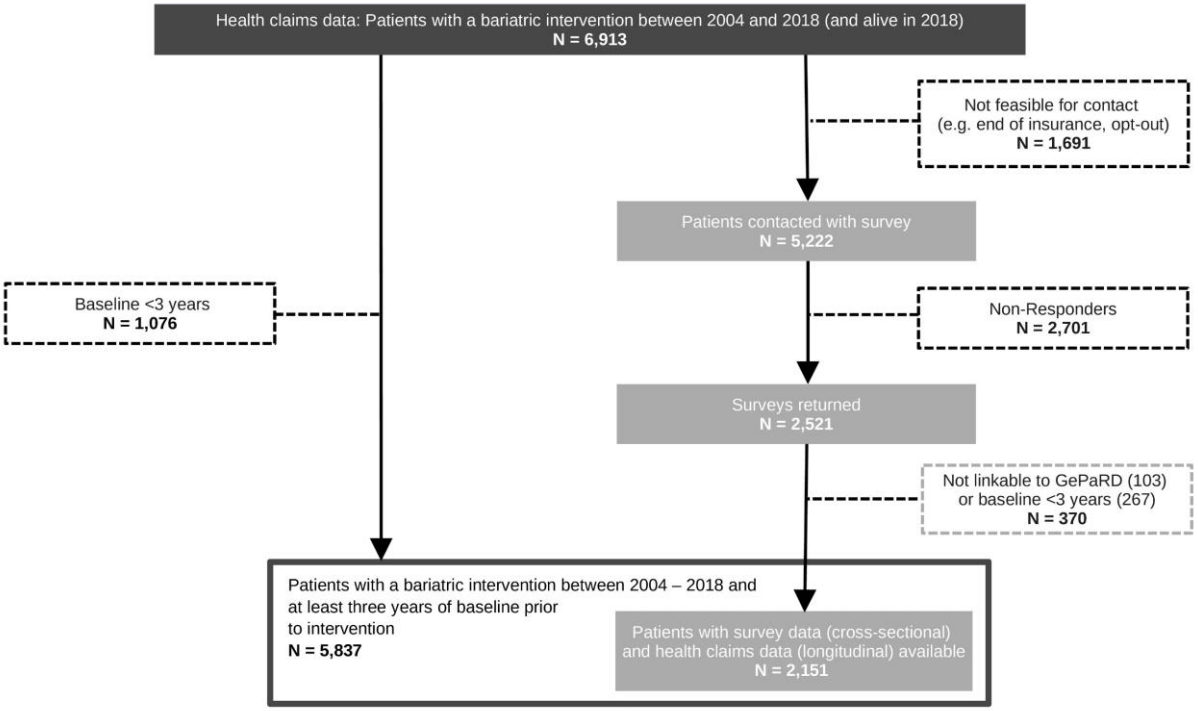
Table 1. Characteristics of the study sample.

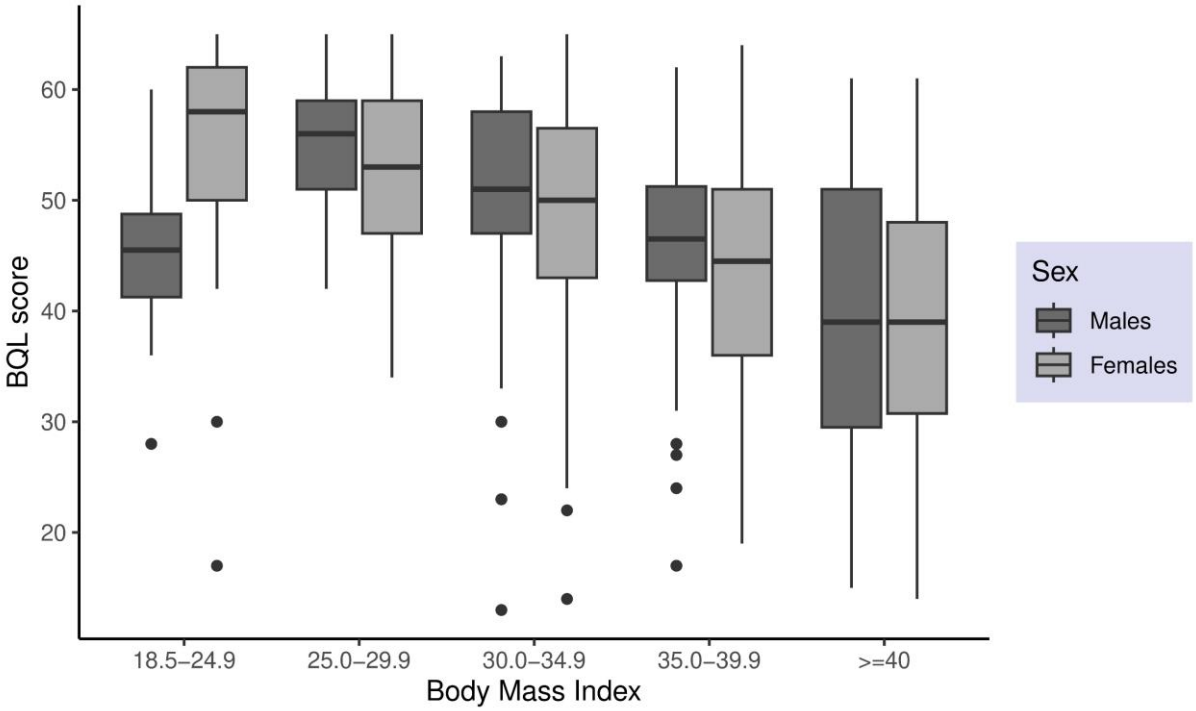
	Males	Females	p-value	Total
Sociodemographics:				
N (%)	416 (19.3)	1,735 (80.7)		2,151 (100.0)
Age, years	56.1 (11.0)	54.1 (10.8)	<.001*	54.5 (10.9)
Marital status				
Married	60.5	51.8		53.5
Unmarried	19.6	16.5		17.1
Divorced	8.8	14.8	<.001*	13.6
Partnership	8.6	10.2		9.9
Widowed	2.5	6.7		5.8
Clinical parameters:				
Age at bariatric intervention, in years	49.7 (11.0)	47.5 (10.7)	<.001*	47.9 (10.8)
Years since surgery	6.4 (3.0)	6.6 (3.1)	.228	6.5 (3.1)
Body Mass Index (T2)				
Mean (SD)	35.2 (7.1)	34.7 (7.7)	.209	34.8 (7.5)
>40 (in %)	22.1	22.3	.988	22.3
Excess Weight Loss (in %)				
T1	76.2 (35.1)	79.7 (28.3)	.064	79.0 (29.8)
T2	61.6 (34.8)	65.3 (29.9)	.050	64.6 (30.9)
Total Weight Loss (in %)				
T1	39.1 (10.1)	39.4 (10.8)	.568	39.4 (10.8)
T2	32.2 (13.2)	32.5 (12.6)	.674	32.4 (12.7)
Type of bariatric intervention (in %)				
Gastric bypass	36.3	39.6		50.0
Gastric sleeve	57.3	53.3		43.0
Gastric band	4.1	5.8	<.001*	5.5
Gastric balloon	0.5	0.3		0.4
Other	1.8	1.0		1.1
Neuropsychological parameters:				
Mini-SCL T-Scores, mean (SD)				
Depression	53.0 (11.6)	54.5 (11.0)	<.05*	54.4 (11.1)
Anxiety	52.9 (10.8)	53.2 (10.7)	.638	53.2 (10.7)
Somatization	54.8 (10.9)	55.6 (10.5)	.207	55.4 (10.6)
Global severity index	53.1 (11.6)	54.7 (11.0)	<.05*	54.4 (11.1)

* small ES (<.20)

Table 2. Scores on the BQL measure (at T2), stratified by selected sample characteristics.

Parameter		**BQL-Score** Mean (SD)	**p-value**
Sex			
Male		47.0 (11.8)	0.645
Female		46.5 (11.2)	
Marital status			
Married		47.8 (10.9)	<.001
Unmarried		44.2 (11.8)	
Divorced		43.8 (12.2)	
Partnership		48.0 (10.7)	
Widowed		44.2 (12.6)	
Body Mass Index			
18.5–24.9	(normal weight)	52.6 (11.4)	<.001
25.0–29.9	(overweight)	53.0 (7.9)	
30.0–34.9	(obesity class I)	49.0 (10.4)	
35.0–39.9	(obesity class II)	44.4 (10.4)	
≥40	(obesity class III)	38.7 (11.1)	
Excess weight loss at T1:			
≤79%		43.3 (11.1)	<.001
≥80%		50.1 (10.6)	
Excess weight loss at T2:			
≤65%		42.1 (11.4)	<.001
≥66%		51.3 (9.4)	
Total weight loss at T1:			
<39.5%		44.5 (11.2)	<.001
≥39.5%		48.8 (11.2)	
Total weight loss at T2:			
<32.7%		42.7 (11.4)	<.001
≥32.7%		50.8 (9.7)	
Years since bariatric intervention			
3–4		48.2 (10.8)	<.001
5–7		46.7 (11.2)	
≥8		45.1 (11.8)	


Health claims data: Patients with a bariatric intervention between 2004 and 2018 (and alive in 2018)
N = 6,913
Not feasible for contact
(e.g. end of insurance, opt-out)
N = 1,691
Patients contacted with survey
N = 5,222
Baseline <3 years
N = 1,076
Non-Responders
N = 2,701
Surveys returned
N = 2,521
Not linkable to GePaRD (103)
or baseline <3 years (267)
N = 370
Patients with a bariatric intervention between 2004 – 2018 and
at least three years of baseline prior
to intervention
N = 5,837
Patients with survey data (cross-sectional)
and health claims data (longitudinal) available
N = 2,151


BQL score
60
50
40
30
20
18.5–24.9
25.0–29.9
30.0–34.9
35.0–39.9
>=40
Body Mass Index
Sex
Males
Females

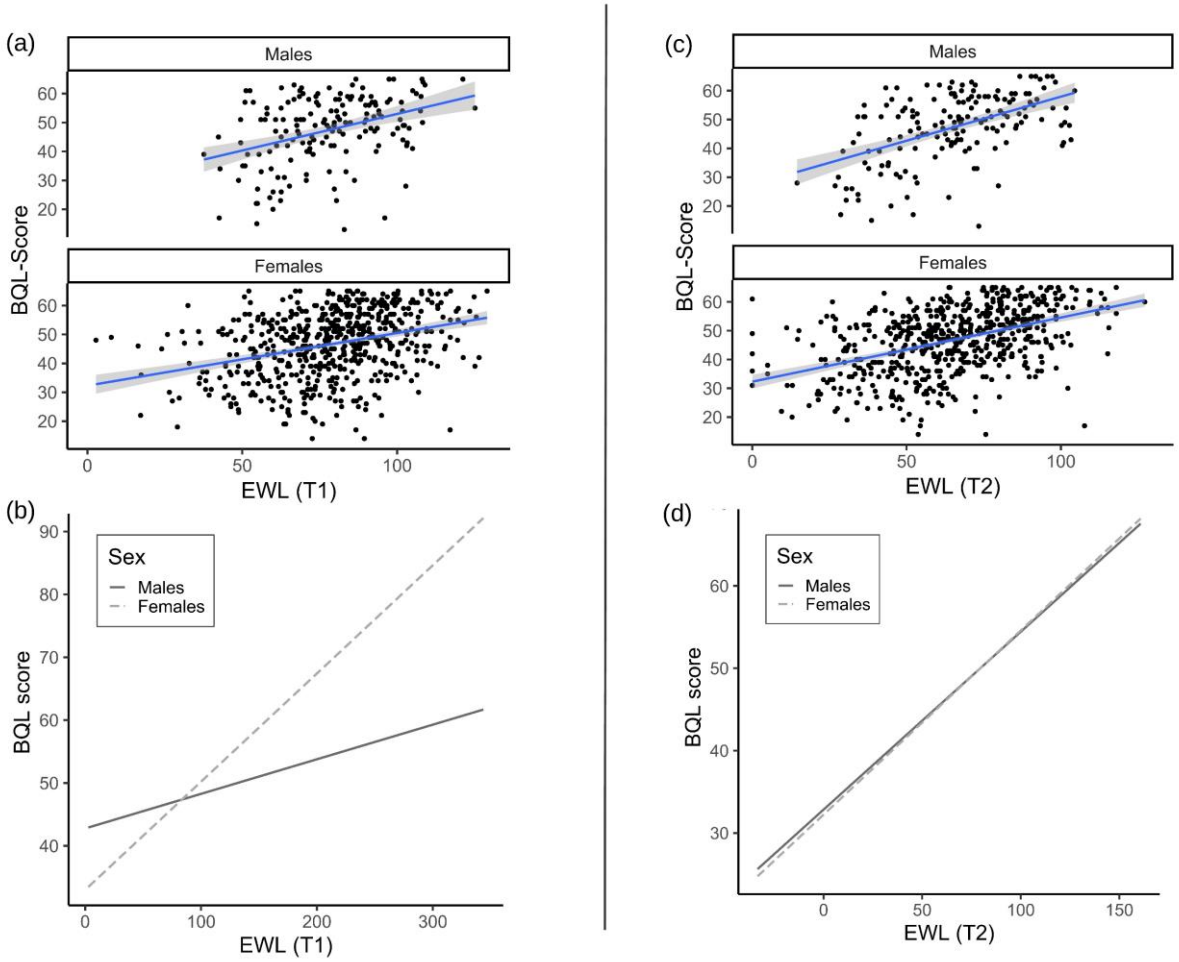

(a)
Males
Females
BQL-Score
EWL (T1)
(b)
Sex
Males
Females
BQL score
EWL (T1)
(c)
Males
Females
BQL-Score
EWL (T2)
(d)
Sex
Males
Females
BQL score
EWL (T2)

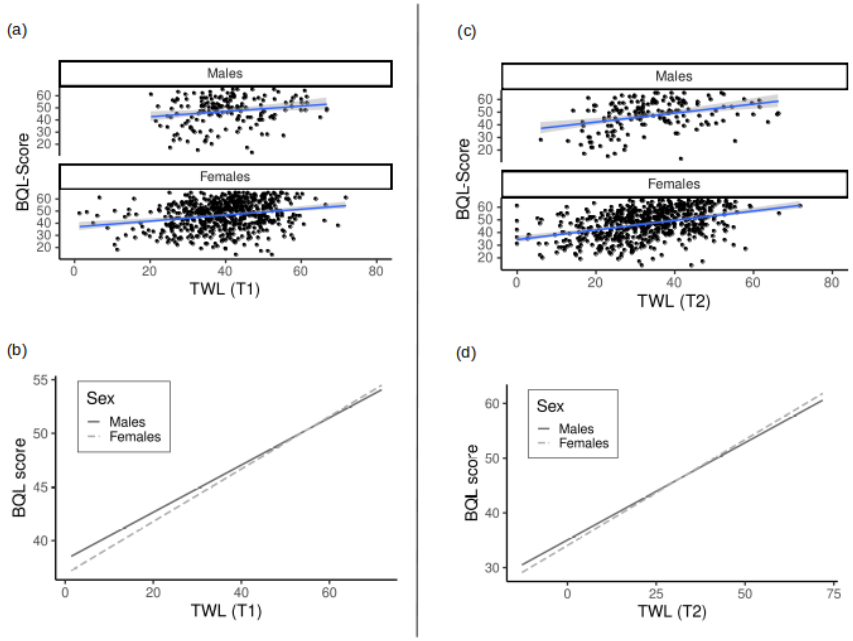
Table S1. Comparison of scores on the BQL items between completers and non-completers of the BQL scale

	Bariatric Quality of Life (BQL) scale			
	Non-Completers (N=1,359)	**Completers (N=792)**	**p-value**	**ES**
Clinical / sociodemographic parameters:				
Male : Female ratio, %	17.9 : 82.1	21.7 : 78.3	<.05	.046
Current age, in years	56.3 (10.9)	51.6 (10.1)	<.001	.434
Age at surgery, in years	49.5 (10.9)	45.2 (10.1)	<.001	.413
Years since operation	6.6 (1.1)	6.4 (3.1)	.251	n. d.
Current Body Mass Index (BMI)	34.6 (7.6)	35.03 (7.3)	.236	n. d.
%-EWL at T1	79.0 (33.2)	79.2 (22.7)	.947	n. d.
%-EWL at T2	63.7 (45.1)	64.7 (23.7)	.516	n. d.
Current occupational status				
Currently employed, %	45.7	76.2	<.001	.298
Disability pension, %	24.6	12.0	<.001	.155
Psychometric values:				
EDE-Global score	2.46 (1.51)	2.35 (1.46)	.118	n. d.
MINI-SCL Global score (T-Value)	54.89 (11.14)	53.59 (11.04)	.064	n. d.
MINI-SCL Depression score (T-Value)	54.31 (10.68)	54.08 (10.06)	.644	n. d.
BQL items:				
I like my weight.	2.99 (1.38)	2.92 (1.35)	.302	n. d.
I can accept my weight.	3.15 (1.34)	3.13 (1.32)	.373	n. d.
How is your actual quality of life?	3.36 (1.12)	3.44 (1.08)	.114	n. d.
I am participating in social activities.	3.51 (1.40)	3.78 (1.30)	<.001	.154
I often meet friends or family.	3.90 (1.20)	4.08 (1.14)	<.001	.154
I feel excluded from social life.	4.21 (1.13)	4.22 (1.11)	.843	n. d.
I feel under pressure because of my weight.	3.59 (1.35)	3.58 (1.33)	.824	n. d.
Sometimes, I feel depressed.	3.19 (1.46)	3.18 (1.42)	.906	n. d.
All in all, I feel satisfied in my life.	3.59 (1.11)	3.64 (1.05)	.289	n. d.
I feel self-confident.	3.51 (1.19)	3.52 (1.15)	.895	n. d.

Values denote means (standard deviations), if not indicated otherwise
ES = Effect size (n. d. = not determined, if p-value $\geq$.05), EWL = Excessive weight loss (T1 = after the surgery, T2 = at the survey), EDE = Eating disorders examination, MINI-SCL = Mini Symptom-Check-List

Table S2. Scores on the BQL measure after multiple imputation, stratified by selected sample characteristics.

Parameter	Imputed BQL-Score Pooled Mean (Pooled SD)
Sex	
Male	46.7 (11.3)
Female	45.7 (11.3)
Marital status	
Married	46.8 (11.1)
Unmarried	43.7 (11.2)
Divorced	43.1 (11.9)
Partnership	48.0 (10.9)
Widowed	46.2 (11.3)
Body Mass Index	
18.5–24.9 (normal weight)	52.1 (10.7)
25.0–29.9 (overweight)	52.1 (9.2)
30.0–34.9 (obesity class I)	47.6 (10.0)
35.0–39.9 (obesity class II)	43.7 (10.1)
≥40 (obesity class III)	38.1 (10.8)
Excess weight loss at T1:	
<79%	43.1 (11.0)
≥80%	49.1 (10.9)
Excess weight loss at T2:	
<65%	41.8 (10.9)
≥66%	50.4 (10.0)
Years since bariatric intervention	
3–4	47.4 (11.0)
5–7	46.3 (11.4)
≥8	44.0 (11.3)


(a)
Males
Females
BQL-Score
TWL (T1)
(c)
Males
Females
BQL-Score
TWL (T2)
(b)
Sex
Males
Females
BQL score
TWL (T1)
(d)
Sex
Males
Females
BQL score
TWL (T2)