

Prevalence of Depression 3 Years before and 3 Years after Obesity Surgery: Sex-Stratified Case-Control Study Using German Health Insurance Claims Data between 2009 and 2015

Jelena Epping^a Astrid Müller^b Lieselotte Mond^a Martina de Zwaan^b

^aDepartment of Medical Sociology, Hannover Medical School, Hannover, Germany; ^bDepartment of Psychosomatic Medicine and Psychotherapy, Hannover Medical School, Hannover, Germany

Keywords

Depression · Obesity · Obesity surgery · Bariatric surgery · Claims data

Abstract

Introduction: Obesity shows significant association with depression, elevating morbidity burden. Obesity surgery (OS) has been proven as an effective therapy, reducing weight as well as depression prevalence rates, though the latter decrease appears to be unstable over time. For a better interpretation of the time trend, data on depression prevalence in OS patients for the period before the surgery are needed. Furthermore, sex-stratified analyses can reveal potentials for improvements in mental health care in OS patients. **Methods:** Claims data from a German statutory health insurance provider were used for the estimation of depression prevalence in patients who underwent obesity surgery in 2012 ($n = 340$) and controls with (CGO) and without a diagnosis of obesity (CG; $n = 1,700$ each). The controls were matched to OS patients regarding sex, age, and insurance type. Sex-stratified depression prevalence was calculated between 2009 and 2015. **Results:** Overall, depression rates were higher in women than in men and increased from 2009 to 2015. Depression prevalence rates differed significantly between female OS patients and

controls in every year analyzed, e.g., in 2012: 39.4% in OS (95% CI: 33.4%–45.5%) vs. 19.8% in CGO (17.6%–22.0%) and 15.4% in CG (13.4%–17.4%). In men, no significant differences between OS patients and controls could be observed at any time. After OS, depression prevalence rates dropped in women, then gradually increased until 2015. Also, in male OS patients, depression prevalence decreased in the year after OS and increased in the following years. In both sexes, the prevalence rates in 2015 did not significantly differ from the rates in 2012 (year of OS). **Conclusions:** We found a decrease in depression prevalence rates in the first year after OS in both sexes, followed by an increase in the subsequent 2 years. OS appears to have a short-term effect on the prevalence rates of depression followed by a subsequent increase paralleling the increase over time found in the non-OS control groups. Due to the sex-stratified approach, differential results in the comparison of depression prevalence between OS patients and controls became apparent. Depression prevalence was significantly increased 3 years before and after OS compared to controls in women, but not in men. Measures to perpetuate the decrease in depression prevalence rates after OS should be implemented during post-operative treatment.

© 2025 The Author(s).

Published by S. Karger AG, Basel

Introduction

Obesity is one of the biggest global health burdens of the 21st century [1]. One in five adults in Europe [1] and one in four adults in Germany [2] are affected by obesity. The increase in obesity related disease adjusted life years is estimated to accelerate and to reach 40% from 2020 to 2030 [3]. Obesity is associated with a large number of medical conditions such as hypertension, type 2 diabetes, and cardiovascular diseases [4, 5] as well as with mental disorders such as anxiety and depression [6, 7]. The Global Burden of Disease Study shows an immense impact of obesity and associated diseases on the population health [3, 8].

Obesity surgery (OS) has proven to be an effective therapy option for individuals with severe obesity with regard to weight reduction [9] as well as various health outcomes including mental health [10]. The effects of OS on depression are described in several reviews and meta analyses, showing a consistent association of OS with decreases in the prevalence of depression (8–74% prevalence decrease in a meta-analysis of seven studies by [11]) or reduction in depressive symptoms (large effect in a review based on 46 studies by [12]). A recent meta-analysis of 33 included studies shows that OS ameliorates depression significantly, though in some studies the symptoms appear to worsen in the long term [13]. It remains unclear, however, how depression prevalence develops in the respective general population over time and whether the increase in the years after OS depicts the overall trend in the course of depression prevalence rates.

Depression treatment after OS has been analyzed in several studies as well. Smith et al. [14] could show that OS was associated with a greater risk of post-operative incident depression treatment and greater persistence of post-operative depression treatment. An Australian study based on registry data, discovered an increase in mental health service use during mean time of 5 years after obesity surgery, questioning the effect of OS on mental health [15]. On the other hand, in a survey-based longitudinal assessment of obesity surgery from the USA, a decline in depression treatment rates after OS was reported [16].

Most studies on depression prevalence were based on surveys or clinical interviews and reported results on depression symptoms for baseline (i.e., shortly before OS) and a certain period after surgery [16, 17]. It is unclear how depression prevalence rates evolved in the years prior to OS. To the best of our knowledge, this is the first study analyzing depression prevalence rates over a time span of several years before and after obesity surgery, as well as the first study on OS based on health insurance

claims data. Furthermore, previous studies rarely reported depression prevalence rates or symptom severity results stratified by sex. As Vittengl could show in an elaborated analysis over three time points, obesity predicted depression and vice versa in women, but not in men [18]. Thus, differential effects can be expected depending on sex. The following research questions are addressed:

1. How did depression prevalence in a patient cohort undergoing OS develop 3 years before and 3 years after the surgery, stratified by sex?
2. Did depression prevalence in OS patients differ from depression prevalence in a matched control group without OS?
3. Did the development of depression prevalence in OS patients over time differ from the time trend in matched controls who did not undergo OS?

Due to the explorative nature of the study and the lack of literature regarding the prevalence of depression in certain time periods prior to and following OS, no formal hypotheses were drawn.

Methods

This study is based on claims data of the statutory health insurance (SHI) provider AOK Niedersachsen (AOKN), located in Lower Saxony, Germany. AOKN is the largest SHI provider in Lower Saxony and covers about 37% of the inhabitants of this state [19]. Membership of health insurance is mandatory in Germany with a possibility to choose between private and SHI above a certain income threshold (about 61 Tsd EUR gross income p.a. in 2019). Due to the high level of income threshold for private health insurance, about 89% of the German population are insured within an SHI provider [20], paying a mandatory insurance fee. The provision of health services is free of charge, covering a wide range of services.

Every medical treatment case (inpatient as well as outpatient) has to be registered to get a refund for services from a SHI provider. The registration includes in- and outpatient diagnoses, which are coded according to the International Classification of Diseases and Related Health Problems (ICD-10, German Modification [21]). The data contain sociodemographic variables (sex, birth, and death year) as well as dated information on inpatient health care, including specific codes for procedures. Within German SHI claims data specific procedures are coded according to the International Classification of Procedures in Medicine [22], adapted for Germany based

on the Dutch Extension (ICPM-DE). For accounting purposes between hospitals and SHI providers, diagnosis-related groups (DRGs) are also available. These codes were used for the validation of obesity surgery cases.

Furthermore, it is possible to differentiate between employed persons, pensioners, unemployed persons, and family-insured persons. Family insured persons are spouses of employed persons without their own income and are insured free of charge. Pensioners include persons eligible for old age pension as well as disability pension. The information on insurance status is used for matching controls to obesity surgery cases.

Time Span of the Analysis

The research question focuses on a comparison of depression prevalence before and after obesity surgery events. For such a comparison, obesity surgery cases in 2012 were used as index events. Three years before and 3 years after the surgery event (2009 and 2015) were defined as observation periods for the analysis of depression prevalence.

Case Selection: Obesity Surgery

The selection criteria for the obesity surgery cases were discussed with experts in the field of obesity and obesity surgery (i.e., surgeons and mental health professionals). The codes used to identify cases of obesity surgery (sleeve, bypass and gastric band) are displayed in online suppl. Table S1 (for all online suppl. material, see <https://doi.org/10.1159/000543407>).

Sleeve, gastric band, and bypass cases with DRG codes indicating other causes of health care use than obesity surgery were excluded from the further analysis (32 cases; the list of DRG codes for obesity surgery in online suppl. Table S2). Furthermore, ten cases were excluded since these persons died before the end of the observation period, resulting in a sample of 340 obesity surgery events in 2012.

Case Selection: Depression Diagnosis

The criteria for defining depression cases are based on published analyses of depression based on German SHI claims data [23] and include the diagnoses F32 (depressive episode), F33 (recurrent depressive disorder), and F34.1 (dysthymia). A case was excluded if diagnoses F30 (manic episode) or F31 (bipolar affective disorder) were coded for the same person due to exclusion of obesity surgery for patients with unstable psychopathological states [24].

For outpatient diagnoses, a validation procedure was applied for the definition of depression cases as it is usual for SHI claims data [25]. First, only cases with a diagnosis

label “confirmed” were used. Second, if a diagnosis appeared only in outpatient data, a confirmation through a repeated diagnosis in another quarter of the same year was required. Diagnoses documented in hospitals did not require confirmation.

Control Groups and Matching Procedure

For the comparison of depression prevalence in persons with obesity surgery (OS) with other insured persons, two control groups were defined: (1) persons without a diagnosis of obesity (E66) at any time between 2009 and 2015 (CG) and (2) persons with the diagnosis of obesity, but without obesity surgery at any time between 2009 and 2015 (CGO). All cases analyzed (obesity surgery cases and controls) had to be insured at AOKN in 2012. In other years between 2009 and 2015, the number of insured persons constituted the denominator for the calculation of prevalence rates. Out of both groups, controls were drawn according to sex, age (single year), and insurance status in proportion 1:5 (340 cases and 1,700 controls for each group). The matching was performed using the Stata module *ccmatch* [26].

The analyses were performed with STATA 16 PM and visualized in Excel. For the comparison of depression prevalence rates, a proportion test with 95% CI was used.

Results

In Table 1, the structure of the sample with obesity surgery events in 2012 (OS), as well as insured population without the diagnosis of obesity (basis for drawing CG) and insured population without obesity surgery, but with the diagnosis of obesity (basis for drawing CGO) is displayed before the matching procedure was applied. In online supplementary Table S3, the distribution of obesity surgery events by type of surgery and sex is displayed.

The proportion of women is higher in the sample with OS than in the group without OS before matching. Furthermore, the age structure differs between the three groups in the insurance population. Patients with OS are younger than insured persons with a diagnosis of obesity (but without surgery). Regarding the insurance status, differences in proportions of employed, unemployed persons and pensioners are apparent. Persons with a diagnosis of obesity are less often employed than insured persons without a diagnosis of obesity. The high proportion of pensioners within the population constituting CGO can be explained by the higher median age.

After the application of the matching procedure, the structure of the control groups was exactly equal to the

Table 1. Sociodemographic structure of the sample and populations used for drawing control groups with and without the ICD-10 diagnosis of obesity

	OS		Population without E66 (→CG*)		Population with E66, but without BS E66 (→CGO**)	
	patients with obesity surgery		insured persons without obesity surgery without E66		with E66	
Patients, <i>n</i>	340		1,364,080		620,651	
Sex (female)	251	74%	648,876	48%	375,818	61%
Age, median (IQR)	44	36–51	46	30–61	54	41–68
Insurance status						
Employed	146	43%	733,921	54%	257,144	41%
Family insured	65	19%	112,857	8%	72,832	12%
Pensioners	68	20%	313,465	23%	214,100	34%
Unemployed	46	14%	99,921	7%	50,316	8%
Others	15	4%	103,916	8%	26,259	4%

structure of the sample with obesity surgery regarding sex, age, and insurance status. The number of OS cases was 340 persons and 1,700 persons in each control group (CG and CGO) in 2012. Since the criterion of continuous insurance throughout 2009 and 2015 was not applied due to a possible bias [27], the denominator can differ depending on the year of the prevalence calculation. Minimum and maximum case numbers for cases and controls are displayed in the legend of the figures in 2012; the denominator is at maximum since all cases and controls had to be insured in 2012.

Depression prevalence in female patients with obesity surgery in 2012 is distinctly higher than in both control groups. Furthermore, the 95% confidence intervals between the CO and CGO do not overlap, though the gaps in 2009 and 2014 are very small (0.018 percentage points). Thus, women with a diagnosis of obesity show significantly higher prevalence rates of depression than women without a diagnosis of obesity. Women undergoing obesity surgery have almost two times higher depression prevalence rates than women with a diagnosis of obesity, but without obesity surgery (Fig. 1).

The prevalence of depression rises in women with obesity surgery at a faster pace than in the controls. In 2012 (the year of the surgery), the depression prevalence of OS patients was about 30% higher than in 2009 (vs. +21% in CGO and +23% in CG between 2009 and 2012). Proportions tests showed significant increases in the depression prevalence in OS ($z_p = 0.045 = -2.0078$) and CGO ($z_p = 0.031 = -2.1540$) and a tendency for a significant increase in CG: $z_p = 0.051 = -1.956$) between 2009 and 2012. After the surgery, the depression prevalence in female patients with OS fell clearly, though it

did not reach the level of the controls. In the third year after surgery, the depression prevalence in female patients after OS was almost as high as in the year of the surgery.

In both control groups, depression prevalence rates increased steadily over time. For the whole observation period between 2009 and 2015, the relative increase in depression prevalence in CG was +38.4% (from 12.5% [95% CI: 10.6%–14.3%] to 17.3% [95% CI: 15.2%–19.4%]) and in CGO was +42% (from 16.4% [95% CI: 14.3%–18.4%] to 23.3% [95% CI: 20.9%–25.6%]). These increases over the whole observation period are statistically significant in both control groups (CGO: $z_p < 0.001 = -4.099$ and CG: $z_p = 0.002 = -3.1228$) but not for OS ($z_p = 0.081 = 1.7535$) (Fig. 2).

In males, the prevalence of depression is distinctly lower than in females. The difference between depression prevalence rates of males and females is significant for all groups and all years (non-overlapping 95% CI), excluding only CG in 2011 and 2013. Between male patients with OS and controls there are no significant differences in depression prevalence – all confidence intervals overlap. The relative increase in depression prevalence in the pre-surgery observation period (+27% from 2009 to 2012) is lower than in women, but similar to male controls (+26% in CGO and +29% in CG).

Also, in men, there is a drop in depression prevalence rates in the year after OS. The increase afterward is at a faster pace compared to women after OS. The depression prevalence rate in the second year of the post-surgery observation periods exceeds the prevalence rate in the year of the surgery (though 95% CI overlap). Similarly for women, the relative increase between 2009 and 2015 is

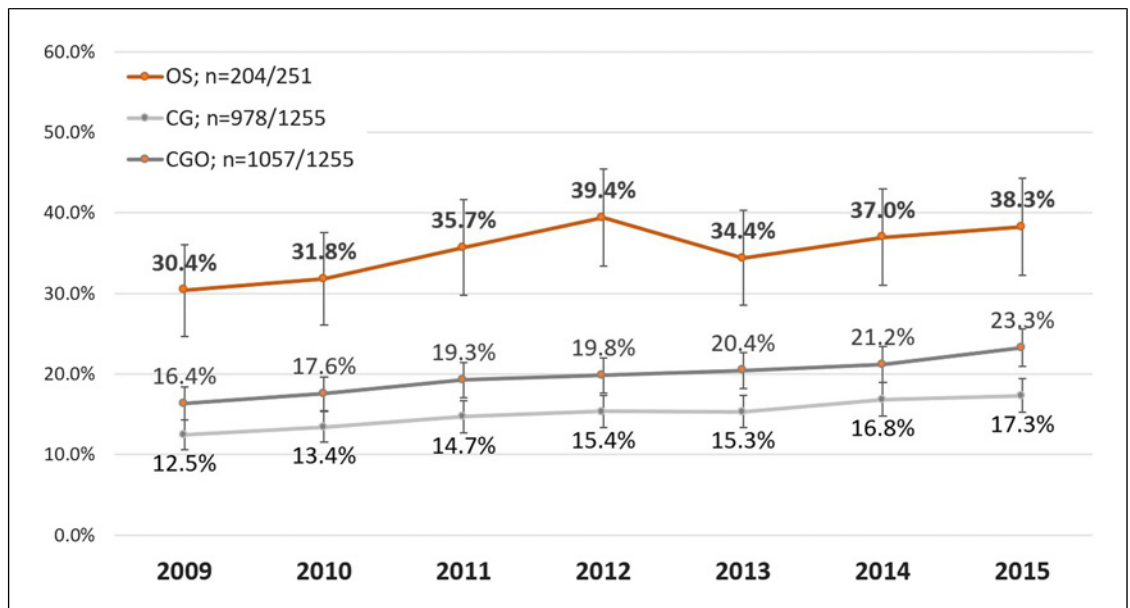


Fig. 1. Depression prevalence in female patients with bariatric surgery (BS), controls with diagnosis of obesity (CGO), and controls without a diagnosis of obesity (CG), including 95% CI. OS, patients with BS in 2012; CG, controls without a diagnosis of obesity between 2009 and 2015; CGO, controls with a diagnosis of obesity between 2009 and 2015.

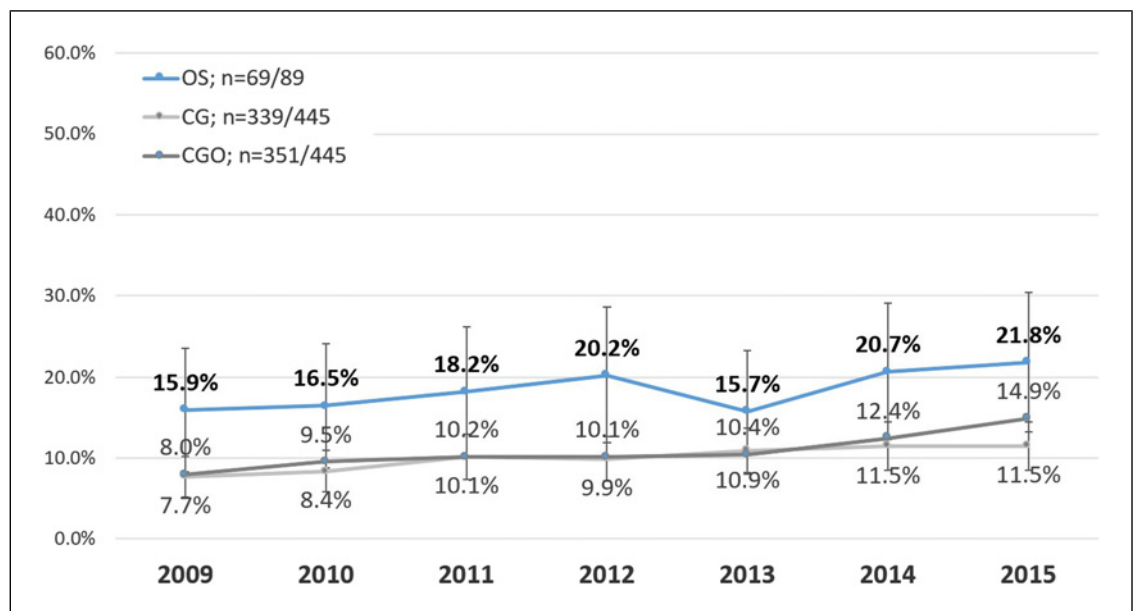


Fig. 2. Depression prevalence in male patients with bariatric surgery (BS), controls with diagnosis of obesity (CGO), and controls without a diagnosis of obesity (CG), including 95% CI. OS, patients with BS in 2012; CG, controls without a diagnosis of obesity between 2009 and 2015; CGO, controls with a diagnosis of obesity between 2009 and 2015.

stronger in control groups (+49% in CG and +86% in CGO) than in the OS-group (+37%). Only for CGO (persons with the diagnosis of obesity and without OS) the increase over time was significant (from 8.0% [95% CI: 5.6%–10.5] to 14.9% [95% CI: 11.6%–18.2%]; $z_p = 0.003 = -2.99$).

Discussion

We estimated depression prevalence rates in patients undergoing OS in comparison to persons without a diagnosis of obesity and persons with a diagnosis of obesity and without OS over a time span of 7 years. To the best of our knowledge, this is the first study based on SHI claims data analyzing OS cases over time. The analyses showed that the prevalence of depression in women undergoing OS is distinctly higher than in female controls and in males with and without OS. Within males, there was no difference in depression prevalence between males with or without a diagnosis of obesity. Furthermore, the depression prevalence dropped slightly in the year after OS in both sexes but subsequently increased again, reaching rates in the year when the OS was done or even exceeding them. As concluded in the review by Spirou et al. [28] at the population level, mental health problems do not disappear after surgery.

The comparison of our results to depression prevalence rates assessed in previous studies is not easy since different assessment tools or post-operative periods were used. In a German sample of OS patients, a reduction of depression prevalence assessed by Structured Clinical Interviews for DSM-IV [29] could be observed from 32.7% at baseline to 16.5% and 14.7% at 1 and 2 years post-operative, respectively [17]. Mitchell et al. [16] reported 33% prevalence of mild-to-severe depressive symptoms according to the Beck Depression Inventory in OS candidates from ten US hospitals at baseline and 8.4%, 12.2%, and 15.6% at 1, 2, and 3 years post-operative, respectively. Another study, also based on an OS sample from US hospitals, showed a 45% prevalence of “clinically significant depressive symptoms” prior to surgery, decreasing to 13% and 18% at 12- and 24-month follow-up [30]. Such consistent post-operative reductions in depression prevalence of up to 74% could be confirmed by a meta-analysis on mental health conditions among patients undergoing obesity surgery [11]. These reported post-operative reductions in depression prevalence are distinctly stronger than in the current study. One of the reasons could be selective dropout of ill persons in follow-up studies [31] which could be avoided in the current study since SHI claims data were used. However, some of these studies mentioned

above also show a tendency for depression prevalence to rise again after a temporary drop. This is confirmed by several studies observing the development of mental health after OS for a longer time period and reporting initial improvements that deteriorated subsequently. Herpertz et al. [32] found that 9 years after baseline mental health was similar or worse than before surgery. A review by Fu et al. [13] also reported that worsening of mental health conditions in the long term was observed in some studies. In our study, however, the initial improvements disappeared already within a 3-year period after OS.

Several studies analyzed proportions of mental health service use instead of depression prevalence. A comparison with our results is possible since the case selection criteria for depression applied in the current study presume mental health service use being recorded in health insurance claims data. The prevalence of depression treatment in the OS sample reported by Mitchell et al. [16] dropped from 40.4% at baseline to 33.1% and 34.6% 2 and 3 years after surgery. On the other side, a large Australian registry-based study reports a post-operative increase in mental health service use for outpatient as well as inpatient and emergency services [15] and argues that the benefits of obesity surgery on the mental health are not clear. Smith et al. [14] report a greater risk of post-operative depression treatment incidence in a large multisite cohort of US veterans, as well. For surgical cases with depression treatment at baseline, a slight decrease in the persistence of depression treatment was observed which turned out to be weaker than in controls. A possible explanation for increased use of mental health services after OS could be more sensitivity to mental health problems or better follow-up and counseling by health care professionals after the surgery than before.

Unfortunately, stratified analyses by sex seem rather rare. None of eleven studies on psychosocial quality of life after obesity surgery, covered by a systematic review of Jumbe et al. [33] reported results stratified by sex. Dawes et al. [11] specify that many studies included in their meta-analysis used sex as a matching variable as well as the adjustment factor in the analyses, but do not report prevalence rates stratified by sex. Since women usually make up about 70–80% of the OS study population, stronger decreases might have occurred in previous studies in female participants than reported overall.

The results of this study confirm a high correlation between depression and obesity, especially in women. This could be related to higher body dissatisfaction in women than in men, e.g., in a study on persons with binge-eating disorder [34]. The rebound of depression after OS may endanger the success of surgery or even call such procedures into question. Long-term monitoring

and support after surgery with a focus not only on weight loss and physical health but also on mental health are therefore of the utmost importance [15, 35].

Strengths and Limitations

As already mentioned, this is the first study analyzing the prevalence of depression over a time span of 3 years before and 3 years after obesity surgery. Such a retrospective estimation of prevalence rates was possible due to the use of SHI claims data for the analyses. SHI claims data show several advantages compared to survey data [36]. First, no response bias applies to claims data. Second, the social desirability effect, e.g., answering survey questions regarding depression diagnosis, is not existent. Third, morbidity bias does not apply since all health care services eligible for refund are part of SHI claims data including health care of highly morbid persons. Fourth, claims data are well suited for the analysis of longer time spans as survey data could be impaired by recall or dropout bias [31].

On the other hand, several limitations apply to this analysis. Persons with obesity might be undetected in the data since not all persons with BMI >30 kg/m² visit a doctor. Thus, it cannot fully be ruled out that some persons in the control group CG (without a diagnosis of obesity) might have a BMI >30 kg/m². Furthermore, there is no information about the assessment tool used by the doctors to identify depressive episodes that are coded in the SHI data. Comparisons with other studies are therefore possibly hampered. Lastly, insured persons with depressive symptoms without contact to a doctor cannot be identified in SHI claims data, which can lead to an underestimation of the prevalence of depression.

Associations between socioeconomic status and obesity surgery outcomes have been described before [37]. In the current study, educational attainment is only available for employed insured persons that would have reduced the sample to 146 persons. Therefore, socioeconomic status was not considered for matching purposes.

Conclusions

For the first time, prevalence rates of depression in obesity surgery patients and matched controls could be assessed for several years before and after the surgery. Depression prevalence in female OS patients is significantly higher than in controls with and without a diagnosis of obesity 3 years before and 3 years after OS. For male OS patients, no significant difference in depression prevalence was observed between OS patients and controls matched

by sex, age, and insurance status. Depression prevalence dropped in the first year after obesity surgery in both sexes and increased afterward, somewhat more rapidly in males. Mental health problems seem to continue or reemerge after surgery and can be one of the reasons for obesity recidivism. Long-term support and mental health care after obesity surgery is therefore of the utmost importance.

Acknowledgment

We thank the AOKN (Statutory Local Health Insurance of Lower Saxony) for providing the data for this study. In particular, the support of Dr. Jürgen Peter, Dr. Jona Stahmeyer, and Dr. Sveja Eberhard made it possible to carry out this study.

Statement of Ethics

Ethical approval is not required for this study in accordance with local or national guidelines. The analyses were performed using a pre-existing claims dataset created as part of the routine administrative activities of a SHI provider. Its scientific use is regulated by German law in the German Social Code “Sozialgesetzbuch.” The need for informed consent was waived by the German Social Code “Sozialgesetzbuch.” The data protection officer of the Local Statutory Health Insurance of Lower Saxony-AOKN (Germany) has given permission for this study to use the data for scientific purposes.

Conflict of Interest Statement

The authors have no conflict of interest to declare.

Funding Sources

This work was supported by German Research Foundation (Deutsche Forschungsgemeinschaft; Grant No. EP 157/2-1).

Author Contributions

J.E. and M.d.Z. developed the research questions of the study. J.E. analyzed the data and wrote the first draft of the manuscript. M.d.Z. and A.M. were major contributors to the final manuscript. A.M. and L.M. contributed to the discussion of the study and reviewed the work critically. All authors read and approved the final version of the manuscript.

Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to protection of data privacy of the insured individuals by the Local Statutory Health Insurance of Lower Saxony (AOKN). Programming code is available upon request from the corresponding author.

References

- 1 Timmis A, Vardas P, Townsend N, Torbica A, Katus H, De Smedt D, et al. European society of cardiology: cardiovascular disease statistics 2021: executive summary. *Eur Heart J Qual Care Clin Outcomes*. 2022;8(4): 377–82. <https://doi.org/10.1093/ehjqcco/qcac014>
- 2 Mensink GB, Schnienkiewitz A, Haftenberger M, Lampert T, Ziese T, Scheidt-Nave C. Übergewicht und Adipositas in Deutschland. Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1). *Bundesgesundheitsbl*. 2013;56: 786–94.
- 3 Chong B, Jayabaskaran J, Kong G, Chan YH, Chin YH, Goh R, et al. Trends and predictions of malnutrition and obesity in 204 countries and territories: an analysis of the Global Burden of Disease Study 2019. *Eclinicalmedicine*. 2023;57:101850. <https://doi.org/10.1016/j.eclinm.2023.101850>
- 4 Lavie CJ, Laddu D, Arena R, Ortega FB, Alpert MA, Kushner RF. Healthy weight and obesity prevention JACC health promotion series. *J Am Coll Cardiol*. 2018;72(13): 1506–31. <https://doi.org/10.1016/j.jacc.2018.08.1037>
- 5 GBD 2015 Obesity Collaborators; Afshin A, Forouzanfar MH, Reitsma MB, Sur P, Estep K, et al. Health effects of overweight and obesity in 195 countries over 25 years. *N Engl J Med*. 2017;377(1):13–27. <https://doi.org/10.1056/NEJMoa1614362>
- 6 Luppino FS, de Wit LM, Bouvy PF, Stijnen T, Cuijpers P, Penninx B, et al. Overweight, obesity, and depression A systematic review and meta-analysis of longitudinal studies. *Arch Gen Psychiatry*. 2010;67(3):220–9. <https://doi.org/10.1001/archgenpsychiatry.2010.2>
- 7 Avila C, Holloway AC, Hahn MK, Morrison KM, Restivo M, Anglin R, et al. An overview of links between obesity and mental health. *Curr Obes Rep*. 2015;4(3):303–10. <https://doi.org/10.1007/s13679-015-0164-9>
- 8 Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, et al. Global burden of cardiovascular diseases and risk factors, 1990–2019 update from the GBD 2019 study. *J Am Coll Cardiol*. 2020;76(25): 2982–3021. <https://doi.org/10.1016/j.jacc.2020.11.010>
- 9 Ahmed B, King WC, Gourash W, Belle SH, Hinerman A, Pomp A, et al. Long-term weight change and health outcomes for sleeve gastrectomy (SG) and matched Roux-en-Y gastric bypass (RYGB) participants in the Longitudinal Assessment of Bariatric Surgery (LABS) study. *Surgery*. 2018;164(4): 774–83. <https://doi.org/10.1016/j.surg.2018.06.008>
- 10 Liao J, Yin YQ, Zhong J, Chen YJ, Chen YB, Wen Y, et al. Bariatric surgery and health outcomes: an umbrella analysis. *Front Endocrinol*. 2022;13:1016613. <https://doi.org/10.3389/fendo.2022.1016613>
- 11 Dawes AJ, Maggard-Gibbons M, Maher AR, Booth MJ, Mlake-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(2):150–63. <https://doi.org/10.1001/jama.2015.18118>
- 12 Woods R, Moga AM, Ribeiro PAB, Stojanovic J, Lavoie KL, Bacon SL. Evolution of depressive symptoms from before to 24 months after bariatric surgery: a systematic review and meta-analysis. *Obes Rev*. 2023;24(5):e13557. <https://doi.org/10.1111/obr.13557>
- 13 Fu RR, Zhang Y, Yu KP, Mao DY, Su H. Bariatric surgery alleviates depression in obese patients: a systematic review and meta-analysis. *Obes Res Clin Pract*. 2022;16(1): 10–6. <https://doi.org/10.1016/j.orcp.2021.11.002>
- 14 Smith VA, Maciejewski ML, Berkowitz TSZ, Mitchell JE, Liu CF, Bradley KA, et al. The effect of bariatric surgery on long-term depression treatment in patients with obesity. *Ann Surg*. 2022;276(2):318–23. <https://doi.org/10.1097/SLA.000000000000520>
- 15 Morgan DJR, Ho KM, Platell C. Incidence and determinants of mental health service use after bariatric surgery. *Jama Psychiatry*. 2020; 77(1):60–7. <https://doi.org/10.1001/jamapsychiatry.2019.2741>
- 16 Mitchell JE, King WC, Chen JY, Devlin MJ, Flum D, Garcia L, et al. Course of depressive symptoms and treatment in the longitudinal assessment of bariatric surgery (LABS-2) study. *Obesity*. 2014;22(8):1799–806. <https://doi.org/10.1002/oby.20738>
- 17 de Zwaan M, Enderle J, Wagner S, Muhlans B, Ditzel B, Gefeller O, et al. Anxiety and depression in bariatric surgery patients: a prospective, follow-up study using structured clinical interviews. *J Affect Disord*. 2011; 133(1–2):61–8. <https://doi.org/10.1016/j.jad.2011.03.025>
- 18 Vittengl JR. Mediation of the bidirectional relations between obesity and depression among women. *Psychiatry Res*. 2018;264: 254–9. <https://doi.org/10.1016/j.psychres.2018.03.023>
- 19 AOK Niedersachsen. Geschäftsbericht 2017 [annual report 2017]. Hannover: AOK - Die Gesundheitskasse für Niedersachsen; 2017.
- 20 Statistisches Bundesamt. Sozialleistungen. Angaben zur Krankenversicherung (Ergebnisse des Mikrozensus 2019). Fachserie 13 Reihe 1.1. Wiesbaden: Statistisches Bundesamt; 2020.
- 21 Bundesinstitut für Arzneimittel und Medizinprodukte. ICD-10-GM. Internationale statistische Klassifikation der Krankheiten und verwandter Gesundheitsprobleme, 10. Revision, German Modification. Version 2022. Systematisches Verzeichnis. Bonn; 2021.
- 22 BfArM. OPS as adaptation of ICPM by WHO 2023. Available from: https://www.bfarm.de/EN/Code-systems/Classifications/OPS-ICHI/OPS/_node.html
- 23 Gerste B, Roick C. Prävalenz und Inzidenz sowie Versorgung depressiver Erkrankungen in Deutschland. In: Klauber J, Günster C, Gerste B, Robra BP, Schmacke N, editors. Versorgungs-report schwerpunkt: depression. Stuttgart: Schattauer; 2013.
- 24 Klein S, Krupka S, Behrendt S, Pulst A, Bleß H-H. Adipositas therapie. In: Weißbuch adipositas. Berlin: MWV; 2016; p. 69–154.
- 25 Epping J, Stahmeyer JT, Tetzlaff F, Tetzlaff J. M2Q oder doch etwas Anderes? Der Einfluss verschiedener Aufgreifkriterien auf die Prävalenzschätzung chronischer Erkrankungen mit ambulanten GKV-Diagnosedaten. [M2Q or Something else? The Impact of Varying Case Selection Criteria on the Prevalence Estimation of Chronic Diseases Based on Outpatient Diagnoses in German Claims Data]. *Gesundheitswesen*. 2023;85:1–8.
- 26 Cook D. CCMATCH: Stata module to match cases and controls using specified variables; 2015. Available from: <https://EconPapers.repec.org/RePEc:boc:bocode:s457372>
- 27 Epping J, Geyer S, Tetzlaff J. The effects of different lookback periods on the socio-demographic structure of the study population and on the estimation of incidence rates: analyses with German claims data. *BMC Med Res Methodol*. 2020;20(1):229. <https://doi.org/10.1186/s12874-020-01108-6>
- 28 Spirou D, Raman J, Smith E. Psychological outcomes following surgical and endoscopic bariatric procedures: a systematic review. *Obes Rev*. 2020;21(6):e12998. <https://doi.org/10.1111/obr.12998>
- 29 American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th ed; 1994.
- 30 White MA, Kalarchian MA, Levine MD, Masheb RM, Marcus MD, Grilo CM. Prognostic significance of depressive symptoms on weight loss and psychosocial outcomes following gastric bypass surgery: a prospective 24-month follow-up study. *Obes Surg*. 2015;25(10):1909–16. <https://doi.org/10.1007/s11695-015-1631-9>
- 31 Beller J, Geyer S, Epping J. Health and study dropout: health aspects differentially predict attrition. *BMC Med Res Methodol*. 2022; 22(1):31. <https://doi.org/10.1186/s12874-022-01508-w>
- 32 Herpertz S, Müller A, Burgmer R, Crosby RD, de Zwaan M, Legenbauer T. Health-related quality of life and psychological functioning 9 years after restrictive surgical treatment for obesity. *Surg Obes Relat Dis*. 2015;11(6): 1361–70. <https://doi.org/10.1016/j.soard.2015.04.008>

- 33 Jumbe S, Bartlett C, Jumbe SL, Meyrick J. The effectiveness of bariatric surgery on long term psychosocial quality of life - a systematic review. *Obes Res Clin Pract.* 2016;10(3):225–42. <https://doi.org/10.1016/j.orcp.2015.11.009>
- 34 Grilo CM, Masheb RM. Correlates of body image dissatisfaction in treatment-seeking men and women with binge eating disorder. *Int J Eat Disord.* 2005;38(2):162–6. <https://doi.org/10.1002/eat.20162>
- 35 Sockalingam S, Leung SE, Wnuk S, Cassin SE, Yanofsky R, Hawa R. Psychiatric management of bariatric surgery patients: a review of psychopharmacological and psychological treatments and their impact on postoperative mental health and weight outcomes. *Psychosomatics.* 2020;61(5):498–507. <https://doi.org/10.1016/j.psym.2020.04.011>
- 36 Geyer S, Jaunzeme J. Möglichkeiten und Grenzen von Befragungsdaten und Daten gesetzlicher Krankenversicherungen [Opportunities and limitations of survey data and claims data from statutory health insurances]. In: Swart E, Ihle P, Gothe H, Matusiewicz D, editors. *Routinedaten im Gesundheitswesen [Routine data in the health care system]*. Bern: Huber Verlag; 2014. p. 223–33.
- 37 Wagner J, Zanker N, Duprée A, Mann O, Izbicki J, Wolter S. Higher socioeconomic status is associated with improved outcomes after obesity surgery among women in Germany. *World J Surg.* 2021;45(11):3330–40. <https://doi.org/10.1007/s00268-021-06252-8>