



Bariatric Surgery

# Changes in relationship status following bariatric surgery

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## Abstract

**Background and objective** Bariatric surgery is a major event associated with psychological changes such as improvements in self-esteem, increased autonomy, and better self-value. Such changes could affect the patient's interpersonal relationships; however, little is known about the impact of bariatric surgery on changes in relationship status. In this paper, we aim to test the hypothesis that bariatric surgery is associated with changes in interpersonal relationships such as becoming single for those who were in a relationship or entering a relationship among those who were single before surgery.

**Methods** This register-based cohort study consisted of 12,493 patients undergoing bariatric surgery (95% gastric bypass) from 2005 to 2013 and a reference group of 15,101 individuals with obesity between the age of 18–63 with a body mass index between 32 and 60 kg/m<sup>2</sup>. Transitions between married, divorced, widowed, never-married single, and living with a partner without being married were analyzed by Poisson regression. Additionally, the outcome was dichotomized, and transitions between being single and being in a relationship were also analyzed. All analyses were weighted using inverse probability of treatment weighting based on propensity scores.

**Results** The overall incidence rate ratio (IRR) of changing status from being single to in a relationship was 2.03 (95% CI: 1.18–2.28), and the overall IRR of changing status from being in a relationship to single was 1.66 (95% CI: 1.50–1.83).

**Conclusion** Bariatric surgery is associated with a higher chance of finding a partner among single individuals, and a higher risk of separating from a partner among individuals in a relationship.

## Introduction

Bariatric surgery is an effective treatment for obesity and also for weight-related health challenges [1]. Several studies have investigated the physical effects of bariatric surgery and weight loss [1, 2], but in recent years, there has been an emerging interest in the psychosocial aspects of obesity and bariatric surgery such as interpersonal relationships [3–9]. Individuals with severe obesity have reported higher levels of relationship strain compared with thinner individuals [10]

and 47% of participants with obesity in a different study reported experiencing critique regarding their weight from their spouses [11]. Therefore, individuals with obesity may - in addition to the health implications - endure difficulties with regards to romantic relationships, an area that for many is an essential part of life as well as a source of well-being and happiness [12].

Qualitative studies have reported that a motivational factor for undergoing bariatric surgery – besides obesity-related complications and health issues – is the desire to increase social activities, find a life partner, and have children [5–7]. Additionally, patients generally report improvements in self-esteem and personal body-image following bariatric surgery [13, 14], which could improve chances of finding a new partner. Other studies have focused on investigating the impact of bariatric surgery on the patient's intimate relationships, and results indicate that patients who are married or in a relationship may experience tension or changes in the dynamics of the relationship as a consequence of surgery, possibly leading to separation or divorce [3, 8, 15]. Only one quantitative study has investigated changes in relationship status following bariatric

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surgery and find that individuals undergoing bariatric surgery were more likely to get married and had higher rates of divorce following surgery compared to the general population (adjusted for age and sex) [9]. Also, similar results were observed in a smaller cohort of bariatric surgery patients when compared with reference individuals with obesity [9]. These findings need to be confirmed in a large cohort study using methods accounting for the impact of confounding factors. Therefore the aim of this study was to test the hypothesis that individuals in a relationship undergoing bariatric surgery have a higher risk of becoming single; and single individuals undergoing bariatric surgery have a higher chance of entering a relationship, in a large cohort of bariatric surgery patients compared with individuals with obesity who have not received bariatric surgery, using propensity scores to account for between group differences.

## Methods

### Design

This study is a prospective register-based cohort study using the unique personal identification number given to all residents of Denmark at birth or immigration allowing for individual level linkage across national registers.

### Study population

All individuals receiving bariatric surgery in Denmark between January 1st, 2005 and December 31st, 2013 were identified via the Danish National Patient Registry [16], in total 14,309. The reference group consisted of 53,279 participants of four national surveys, conducted between 2005 and 2013, with a BMI of  $\geq 30$  kg/m<sup>2</sup> above the age of 18 who have not received bariatric surgery. The four surveys consisted of The Danish Health and Morbidity Survey 2005, The Danish Health Examination Survey 2007/2008, and The Danish National Health Surveys 2010 and 2013, described in detail elsewhere [17–19].

### Outcome measures

Data on relationship status was obtained from the Population Register via Statistics Denmark containing information on marital status as well as information on cohabitation with a partner. Data is updated on January 1st every year. Relationship status was defined as being either married, divorced, widowed, never-married single, or never-married living with a partner (cohabiting). Relationship status was also dichotomized into being either single (never-married single, divorced, or widowed) or in a relationship (married

or cohabiting). Relationship status at baseline was obtained January 1st the year of bariatric surgery (bariatric surgery group) or the year of participation in a national survey (reference group).

### Covariates

Information on sex, age, and country of origin (Denmark, Western countries, non-Western countries) was obtained from Statistics Denmark [20]. Information on pre-surgery BMI, calculated as weight in kilograms divided by height in meters squared, was obtained from the Danish Register of Bariatric Surgery or by manual chart reviews for the bariatric surgery group. For the reference group, self-reported BMI was collected from the national surveys of which they participated. The length of highest obtained education was extracted from the Population's Education Register [21] and divided into three categories: primary school (<10 years), upper secondary/vocational school (10–12 years), and higher education ( $\geq 13$  years). Disposable income (available income after taxes) was obtained from the Income Statistics Register [22] and divided into quartiles. Comorbidity was included as a covariate by calculating the Charlson comorbidity index [23] defined according to 19 diseases (data from the National Patient Registry) and classified into two levels: none and any kind of comorbidity ( $\geq 1$ ). Finally, year of inclusion into the study was included as a covariate.

### Statistical analysis

As a consequence of non-randomization, the bariatric surgery population and the non-surgery reference population were two non-comparable groups with observed differences in most baseline characteristics. To overcome this issue, we applied inverse probability of treatment weighting (IPTW), a propensity score methodology, to balance baseline characteristics between the two groups. First, individual propensity scores were calculated using logistic regression including the following covariates: age, BMI, sex, educational level, disposable income, country of origin, Charlson comorbidity index, and year of baseline. Propensity score trimming was applied in order to exclude those participants who were treated or not treated most contrary to prediction [24]. The cut points were set at the 1st and 99th percentiles of the propensity score distribution in the treated and untreated participants, respectively.

Incidence rate ratios (IRRs) were computed by Poisson regression using the time from baseline until a potential change in relationship status occurred, as exposure time. Transitions were analyzed one by one, and individuals with a change in status during follow-up were no longer followed from the time of the change. The maximum follow-up time was 12 years. Individuals with no change in relationship

status were followed up until January 1st, 2019. Additionally, we examined the joined effect of age and bariatric surgery, as well as educational level and bariatric surgery with changes in relationship status.

### Final study population

In order to ensure overlap between the two groups, we computed distribution plots of age and BMI, resulting in the exclusion of individuals over the age of 63 and individuals with a BMI <32 or >60 kg/m<sup>2</sup>. This resulted in the exclusion of 90 bariatric surgery patients and 14,861 non-surgery references above the age of 63; and 192 bariatric surgery patients and 16,461 non-surgery references with a BMI <32 or >60. Additionally, 176 individuals in the bariatric surgery group and 112 in the non-surgery group with missing information on potential confounders were excluded. Finally, propensity score trimming excluded in total 8102 individuals. The final study population therefore consisted of 12,493 in the bariatric surgery group and 15,101 non-surgery references.

## Results

Baseline characteristics of the bariatric surgery group and the reference group before and after propensity score trimming and IPTW are presented in Table 1. Before IPTW the two groups differed in many baseline characteristics. The bariatric surgery group had a larger proportion of women, had a larger mean BMI, were younger, were more likely to have an income in the lower quartiles, were less educated, and were more likely to have a Charlson comorbidity index of 1 or more. After IPTW, all baseline characteristics were balanced with standardized differences <10% (Fig. 1).

Table 2 presents 5-year risks and IRRs with corresponding 95% CIs of transitions between married, divorced, widowed, never-married single, and cohabiting; as well as for the transitions between the combined states of being either single (never-married single, divorced, or widowed) or in a relationship (married or cohabiting).

### Transition from single to in a relationship

For those who were never-married and living alone at baseline, bariatric surgery patients had a higher chance of cohabiting with a partner (IRR = 2.13 (95% CI: 1.85–2.45)) and a higher chance of getting married (IRR = 3.09 (95% CI: 2.30–4.16)) compared with never-married single references with obesity. Additionally, for those who were divorced or widowed at baseline the IRR of getting married was 1.57 (95% CI: 1.23–2.00) for divorced individuals and 2.29 (95% CI: 1.11–5.60) for widowed individuals.

When merging all singles at baseline together (never-married single, divorced, or widowed), the median follow-up time was 8 years in the bariatric surgery group and 8 years in the reference group. Compared with the reference group, bariatric surgery patients who were single at baseline had an IRR of 2.03 (95% CI: 1.81–2.28) of entering a relationship during follow-up (Table 2). The chance of entering a relationship did not differ for men and women (results not shown).

When considering the joint effect of bariatric surgery and age on the relative risk of entering a relationship, results showed a decreasing risk with increasing age in both groups, however, the risk was higher for bariatric surgery patients in all age-groups (Fig. 2A). Additionally, educational level did not seem to influence the effect of bariatric surgery, as the probability of entering a relationship was equally high for bariatric surgery patients compared with references in all strata of educational level (Fig. 2B).

### Transition from in a relationship to single

Bariatric surgery was associated with a higher risk of divorce during follow-up among individuals who were married at baseline (IRR = 1.93 (95% CI: 1.70–2.20)). For individuals who were cohabiting but not married at baseline, the relative risk of becoming single was 1.62 (95% CI: 1.31–2.01). When combining those who were married with those cohabiting with a partner at baseline into “being in a relationship”, the median follow-up time for bariatric surgery patients was 8 years and for the reference group it was 9 years. For all individuals in a relationship, undergoing bariatric surgery was associated with a higher risk of becoming single during follow-up compared with non-surgery references with obesity (IRR = 1.66 (95% CI: 1.50–1.83)) (Table 2). The risk of becoming single was similar for both men and women (results not shown). The effect of bariatric surgery on becoming single was evident in all age-groups, with a slightly smaller effect observed in those in the oldest age-group (50+) (Fig. 3A). Length of education seemed to have an effect on the risk of becoming single, with those with the shortest education representing the highest risk, however, the effect of bariatric surgery was largest in those with the longest education (>12 years), although an effect was present in all groups (Fig. 3B).

## Discussion

In this prospective cohort study, we found that bariatric surgery patients who were single before surgery (divorced, widowed, or living alone), were more likely to enter a relationship during a follow-up period of up to 12 years, compared with reference individuals with obesity. Additionally,

**Table 1** Baseline characteristics before and after inverse probability of treatment weighting.

Characteristics	Before propensity score trimming <sup>a</sup> and IPTW		After propensity score trimming <sup>a</sup> and IPTW <sup>b</sup>	
	No surgery (n = 21,845)	Bariatric surgery (n = 13,851)	No surgery (n = 15,101)	Bariatric surgery (n = 12,493)
BMI, mean (SD)	35.7 (3.86)	41.3 (5.03)	38.8 (5.16)	38.8 (3.74)
Women, No. (%)	12,436 (56.9)	10,617 (76.7)	10,136 (72.4)	9661 (71.0)
Age, mean (SD), y	46.1 (11.6)	40.5 (9.79)	42.4 (11.8)	42.6 (9.72)
Education, No. (%)				
Primary school education <sup>c</sup>	6244 (28.6)	4920 (35.5)	4631 (33.1)	4318 (31.7)
Upper secondary/vocational education <sup>d</sup>	10,413 (47.7)	6514 (47.0)	6394 (45.7)	6534 (48.0)
Higher education <sup>e</sup>	5188 (23.8)	2417 (17.5)	2967 (21.2)	2749 (20.2)
Disposable income, No. (%) <sup>f</sup>				
Q 1 (Lowest quartile)	4104 (18.8)	3314 (23.9)	3220 (23.0)	2814 (20.7)
Q 2 (Second quartile)	4987 (22.8)	4085 (29.5)	3479 (24.9)	3764 (27.7)
Q 3 (Third quartile)	6097 (27.9)	3990 (28.8)	3953 (28.3)	4054 (29.8)
Q 4 (Highest quartile)	6657 (30.5)	2462 (17.8)	3341 (23.9)	2970 (21.8)
Country of origin, No. (%)				
Denmark	20,753 (95.0)	13,348 (96.4)	13,333 (95.3)	13,090 (96.2)
Western countries <sup>g</sup>	420 (1.92)	179 (1.29)	248 (1.77)	192 (1.41)
Non-western countries <sup>h</sup>	672 (3.08)	324 (2.34)	411 (2.94)	320 (2.35)
Charlson comorbidity index $\geq 1$ , No. (%)	2066 (9.46)	2219 (16.0)	1980 (14.2)	3920 (14.3)
Relationship status, No. (%)				
Married	13,145 (60.2)	7200 (52.0)	7445 (53.2)	7724 (56.8)
Divorced	2183 (9.99)	1841 (13.3)	1296 (9.26)	1927 (14.2)
Widow(er)	419 (1.92)	154 (1.11)	230 (1.64)	172 (1.26)
Cohabiting	2346 (10.7)	1784 (12.9)	1894 (13.5)	1476 (10.9)
Never-married single	3752 (17.2)	2872 (20.7)	3127 (22.4)	2303 (16.9)

*IPTW* inverse probability of treatment weighting, *BMI* body mass index.

<sup>a</sup>Propensity scores were created using logistic regression based on the following variables: sex, BMI, age, income, education, comorbidity, country of origin, year of entry into the study. Trimming at the 1st and 99th percentiles of the propensity score was applied, excluding 1358 individuals in the bariatric surgery group and 6744 individuals in the reference group.

<sup>b</sup>Proportions, means and numbers are weighted using *IPTW*.

<sup>c</sup><10 years of education.

<sup>d</sup>10–12 years of education.

<sup>e</sup>>12 years of education.

<sup>f</sup>The total income available after taxes.

<sup>g</sup>All 28 EU countries (except Denmark) and Andorra, Lichtenstein, Monaco, Norway, San Marino, Switzerland, The Vatican City State, Canada, USA, Australia, and New Zealand.

<sup>h</sup>All other countries.

for those in a relationship (married or cohabiting), bariatric surgery was associated with a higher incidence of exit from that relationship following surgery.

Our results are in line with findings from another study of two cohorts in Sweden [9]. In the first cohort, relationship status was compared during follow-up between bariatric surgery patients and a matched control group of individuals with obesity receiving usual care. The HR of entering a relationship was 2.03 (95% CI: 1.52–2.71) and

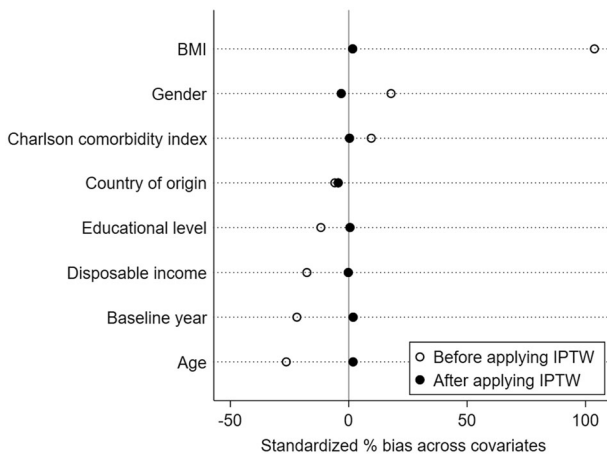
the HR of separation or divorce was 1.28 (95% CI: 1.03–1.60). In the second cohort, bariatric surgery patients were compared with the general population (no information on BMI); and here, the HR of getting married was 1.35 (95% CI: 1.28–1.42) and the HR of divorce was 1.41 (95% CI: 1.33–1.49). The outcome only included legal marriages and divorces, not covering individuals living in a relationship without being married. We are adding to the literature by confirming these results in a large cohort of bariatric

surgery patients with a reference cohort of individuals with obesity using propensity scores to account for between group differences in baseline characteristics. Additionally, we had valid information on confounding variables and a comprehensive outcome measure.

The higher probability of entering a relationship after bariatric surgery is in agreement with other findings suggesting that part of the motivation for many individuals undergoing bariatric surgery, is to find a partner, have children, or increase social life [7]. Additionally, studies find that bariatric surgery is associated with increased quality-of-life [13, 25], higher self-esteem [14], and a more

positive body image [13] which could lead to increased social activity and romantic interest from others [26, 27]. Although some psychological parameters seem to improve in the period after bariatric surgery, empirical results regarding long-term mental health changes are mixed [28, 29]. It is therefore possible that new relationships entered after bariatric surgery may not persist.

For patients in a relationship, the surgically induced changes in one partner may put tension on the relationship. Losing a large amount of weight is a life-changing event and going through bariatric surgery not only causes physical changes, but also psychological changes such as improvement in self-esteem, increased autonomy, and better self-value [30]. These changes are generally regarded as positive but could also change the dynamics of a relationship, causing feelings of envy and insecurity in the other partner [30]. Studies show that having a supportive partner is important for a successful weight loss, but also for maintaining a good relationship [31], and a lack of understanding and support from the partner could cause further tension. Additionally, some patients experience unwanted outcomes of bariatric surgery such as weight-regain [32], complications and re-hospitalization [33], problematic alcohol consumption [34], excess skin [35], depression [36], and some even become suicidal [36, 37]. These issues are difficult to deal with and might affect the patient’s interpersonal relationships in a negative way. On the other hand, increased self-value following surgery may give patients the courage to leave an unhealthy relationship as they are no longer willing to settle for less or realizes that they no longer need



**Fig. 1 Balance of covariates.** Standardized percent bias across covariates before and after applying inverse probability of treatment weighting.

**Table 2** IRR and 95% CI of transitions between all relationship states, as well as transitions between the combined states “single” (divorced, widowed, never married) and “in a relationship” (married or cohabiting)<sup>a</sup>.

Transition	No surgery		Bariatric surgery		IRR (95% CI) <sup>b</sup>
	Events/total	5-year risk (%)	Events/total	5-year risk (%)	
Divorced → married	194/1247	9.9	504/1854	18.1	1.57 (1.23–2.00)
Widowed married	18/235	4.8	38/176	14.9	2.29 (1.11–5.60)
Never-married single → married	97/3142	2.2	144/2313	5.1	3.09 (2.30–4.16)
Never-married single → cohabiting	833/3142	18.6	979/2313	34.3	2.13 (1.85–2.45)
<b>Single → in a relationship<sup>c</sup></b>	1134/4608	16.7	1663/4359	28.0	<b>2.03 (1.81–2.28)</b>
Married → divorced	855/7447	7.1	1745/7727	14.6	1.93 (1.70–2.20)
Cohabiting → never-married single	542/1941	27.2	642/1512	45.7	1.62 (1.31–2.01)
<b>In a relationship → single<sup>d</sup></b>	1692/9388	12.0	2602/9239	19.4	<b>1.66 (1.50–1.83)</b>

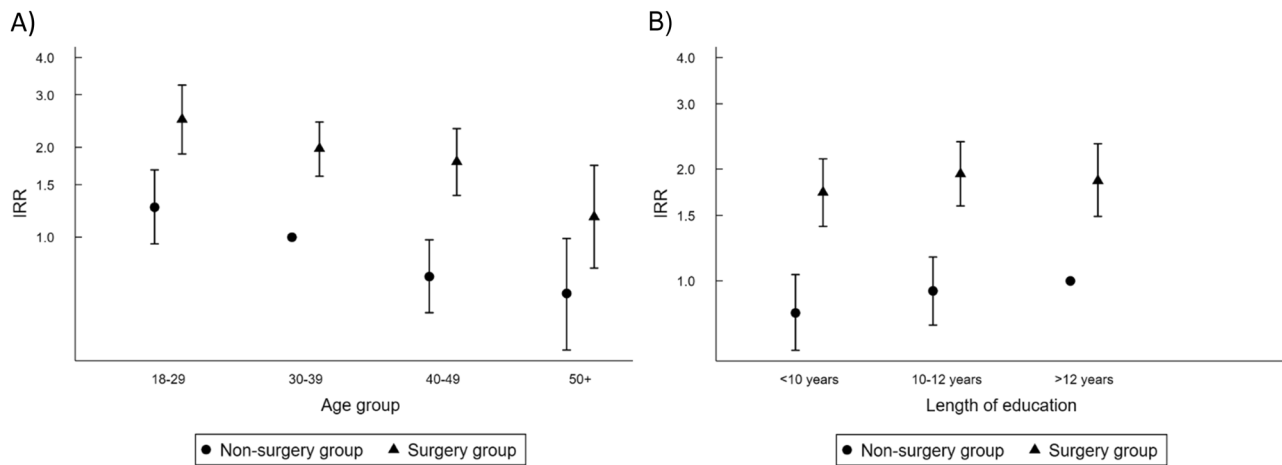
IRR incidence rate ratio, CI confidence interval.

<sup>a</sup>All events, numbers, 5-year risks, and IRRs are weighted using inverse probability of treatment weighting.

<sup>b</sup>Adjusted for BMI, sex, age, educational level, disposable income, country of origin, Charlson comorbidity index, and year of entry into the study.

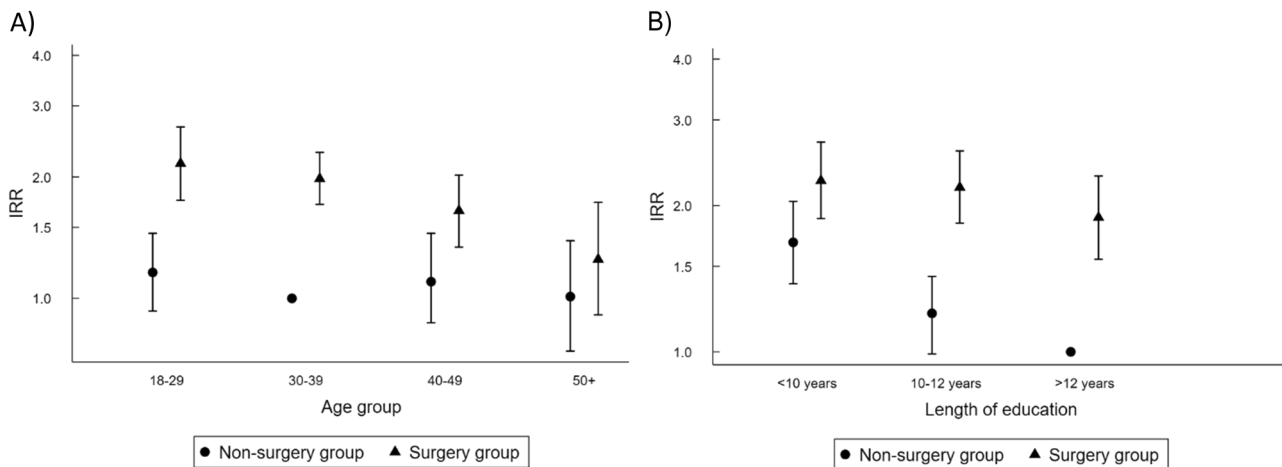
<sup>c</sup>Further adjusted for relationship status at baseline (divorced, widowed, never-married single).

<sup>d</sup>Further adjusted for relationship status at baseline (married or cohabiting).



**Fig. 2 The effects of age and education on chances of entering a new relationship.** IRRs and 95% CIs for the joint effects of (A) age and bariatric surgery, and (B) educational level and bariatric surgery on chances of entering a new relationship in single individuals. IRRs

were adjusted for BMI, sex, age, educational level, disposable income, country of origin, Charlson comorbidity index, year of entry into the study, and relationship status at baseline (divorced, widowed, never-married single).



**Fig. 3 The effects of age and education on the risk of becoming single.** IRRs and 95% CIs for the joint effects of (A) age and bariatric surgery, and (B) educational level and bariatric surgery on risk of becoming single in individuals in a relationship. IRRs were adjusted

for BMI, sex, age, educational level, disposable income, country of origin, Charlson comorbidity index, year of entry into the study, and relationship status at baseline (married or cohabiting).

their partner [30]. Exiting an already unhealthy or toxic relationship should therefore be viewed as a positive outcome of bariatric surgery.

Married individuals live on average longer than unmarried individuals and generally make less use of health care services [38]. Additionally, individuals in happy relationships report higher levels of subjective well-being than individuals in unhappy relationships; however, higher ratings of well-being were reported for individuals in relationships, regardless of happiness, compared with single individuals [12]. Therefore, from a public health perspective, it is important to be aware of possible risk factors for separation or divorce. The higher risk of separation and divorce reported in this paper could be a consequence of

lack of support and guidance to deal with possible conflicts arising after bariatric surgery. Bariatric surgery patients and their partners should be aware of the negative impact surgery can have on the relationship, and be guided to ways of dealing with issues, in order to ensure the maintenance of a healthy relationship following surgery.

A limitation of the study is the lack of information on the level of relationship strain at baseline. It is possible that individuals with obesity living in strained relationships are more likely to undergo bariatric surgery as an attempt to fix issues within the relationship. Therefore, the higher risk of separation is not an effect of bariatric surgery, but rather a consequence of higher baseline levels of relationship strain within this group. Future studies should include measures of



relationship strain or relationship happiness in order to draw conclusions on the effect of bariatric surgery on divorce and separation. Another important limitation is the possibility of misclassification of relationship status at baseline, since data is only updated once every year on January 1st. Therefore, individuals defined as being single or in a relationship January 1st of the year of baseline, could potentially change status before receiving surgery or participating in a national health survey later during the year. However, the degree of misclassification should in theory not differ between bariatric surgery patients and reference individuals and will therefore not affect the relative risks significantly. Lastly, we do not have information on the physical or psychological outcomes of bariatric surgery such as the degree of weight loss, weight re-gain, post-surgery complications, re-hospitalization, skin issues (excess skin), alcoholism, depression, and quality of life. These factors could be potential mediators of changes in relationship status and this study is therefore unable to conclude on the mechanisms behind the association of bariatric surgery and relationship status.

## Conclusion

The results of this study suggest that bariatric surgery is associated with changes in interpersonal relationships. Individuals who are single might benefit from bariatric surgery beyond surgery-induced weight loss and relief from medical conditions, as they have a better chance of finding a partner. Individuals in a relationship are at higher risk of divorce or separation which could be viewed as a negative outcome of bariatric surgery if the reason for breaking up is a consequence of insufficient means to deal with post-surgery tension and strain within the relationship. However, exiting an unhealthy relationship after receiving bariatric surgery, due to better self-worth and increased autonomy, is a positive outcome. More studies are needed to fully understand the relationship between bariatric surgery and relationship status.

**Author contributions** MB and JST designed the study. JST performed analysis. MB and JST interpreted data and MB, SSH, and JST drafted the article. All authors actively contributed to the final manuscript by revising it critically for important intellectual content and approved the final version to be published. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

## Compliance with ethical standards

**Conflict of interest** The authors declare no competing interests.

**Ethical approval** The study was approved by the Danish Data Protection Agency reference number 2015-57-0008. Manual chart review with data collection was performed with the approval of Danish Patient

Safety Authority (former National Board of Health) with reference number 3-3013-770/1.

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