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Original article

Are male patients undergoing bariatric surgery less healthy than female patients?

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Abstract

Background: Male patients are underrepresented in bariatric surgery (BS) despite a relatively equal proportion of men and women experiencing obesity.
Objectives: Differences in frequency and severity of obesity-associated medical problems (OAMPs) between men and women undergoing BS or in a control group (HELIUS [HEalthy Life In an Urban Setting]) were evaluated. The hypothesis was that men undergoing BS are less healthy than women.
Setting: A cross-sectional study of 2 cohorts undergoing BS in 2013 (BS2013) and 2019 (BS2019) and a control group of patients with severe obesity from a general population (HELIUS).
Methods: Characteristics concerning weight and OAMPs, medication usage, intoxications, postoperative complications (for BS2019) were compared between men and women. Members of the HELIUS cohort were tested for eligibility for BS.
Results: Of 3244 patients included, the majority were female (>78.4%). Median (interquartile range) age and body mass index (kg/m^2) in male versus female patients were 47.0 (41.0–53.8) versus 43.0 (36.0–51.0) years and 41.5 (38.4–45.2) versus 42.3 (40.2–45.9), respectively, in BS2013, and 52.0 (39.8–57.0) versus 45.0 (35.0–53.0) years and 40.4 (37.4–43.8) versus 41.3 (39.0–44.1) in BS2019 ($P < .05$). The rates of men with OAMPs were 71.4% and 82.0% compared with 50.2% and 56.9% of women in BS2013 and BS2019, respectively. Overall medication usage was higher in male patients ($P = .014$). In BS2019, male patients exhibited a higher median HbA1C ($P < .001$) and blood pressure ($P = .003$) and used more antihypertensives and antidiabetics ($P = .004$). Postoperative complications did not differ between men and women. In the control cohort, 66.5% of men and 66.6% of women were eligible for BS.
Conclusion: Men undergoing BS more often experience OAMPs than women, and OAMPs are more advanced in men. (Surg Obes Relat Dis 2023; ■:1–10.) © 2023 American Society for Metabolic and

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In 2016, the World Health Organization reported 650 million adults to be obese (body mass index [BMI] >30 kg/m^2) [1]. In 2017, deaths attributable to high BMI (>25 kg/m^2) had more than doubled since 1990, with an estimated number of more than 4 million globally [2]. Urgent calls for intervention, in which prevention should play a pivotal role, were made [3,4]. Bariatric surgery (BS) is currently still the most effective long-term treatment for severe obesity. It has been shown to lead to significant weight loss combined with remission or improvement of obesity-associated medical problems (OAMPs). Subsequently, BS induces a decline in burden of disease and an increase in survival benefits [5–7].

Globally, the incidence of obesity is comparable in men and women, with 11% and 15%, respectively [1]. The two major OAMPs, type 2 diabetes (T2D) and hypertension (HT), are more prevalent in male patients [8–12]. Still, men are heavily underrepresented in the population undergoing BS [13]. The International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) Global Registry reported that from 2016 to 2020, 72.7% to 82.8% of patients were female [14]. Previous studies have suggested that the motivation for BS differs between men and women. Women are motivated to undergo BS due to the social stigma and the emotional burden of obesity, whereas men mostly seek BS due to a decrease in physical functioning and a fear of early death [15]. In addition, primary care physicians have been shown to be less inclined to recommend BS to men than to women [16]. This may lead to men presenting later in the process of severe obesity, possibly with a higher BMI and more frequent and more advanced OAMPs. As the number of years lived with obesity has previously been associated with a higher incidence of all-cause mortality and limited weight loss, the late presentation of men for BS might therefore be an increased health risk [17,18]. Previous studies have explored these sex disparities mainly by focusing on their influence on postoperative complications. Knowledge of the differences in severity and extent of the preoperative OAMPs between sexes is lacking [19,20].

Therefore, the aim of this study was to investigate the differences between men and women undergoing BS concerning preoperative patient characteristics and OAMPs. The hypothesis was that men presenting for BS are medically less healthy than women.

Methods

Study design

This is a cross-sectional study that was based on 3 distinct cohorts. Two bariatric cohorts from 2013 and 2019 were used. These were collected 6 years apart in order to evaluate a possible trend over time in sex differences in OAMPs. Participants with severe obesity from the HELIUS (HEalthy Life In an Urban Setting) study were used as a control group to inquire if trends in patients who underwent BS were also present in a cohort with obesity in the general population. Patients from the HELIUS cohort had not been referred for BS and were only theoretically tested for eligibility for BS in this study. The inclusion criteria for each cohort specifically, including weight specifics, are mentioned in the following. The 3 cohorts were:

1. BS2013 cohort: consists of patients who underwent BS between January 1, 2013, and December 31, 2013, at the Spaarne Gasthuis, the Netherlands, a Dutch bariatric center of excellence.
2. BS2019 cohort: consists of patients who underwent BS between January 1, 2019, and December 31, 2019, in the same bariatric center of excellence.
3. HELIUS cohort: consists of participants with obesity previously included in the HELIUS study.

Inclusion criteria

Participants of BS2013 and BS2019 were both collected at the Spaarne Gasthuis, the Netherlands, a bariatric center of excellence. All included patients underwent either a primary laparoscopic Roux-en-Y gastric bypass (LRYGB), a laparoscopic sleeve gastrectomy (LSG), or a laparoscopic one-anastomosis gastric bypass (LOAGB). All participants met the criteria of the IFSO guidelines prior to surgery: (1) baseline BMI ≥40 or ≥35 kg/m^2 with at least 1 OAMP (HT, T2D, obstructive sleep apnea syndrome [OSAS], osteoarthritis, dyslipidemia); and (2) 18 years of age or older or 65 years of age or younger. Participants with a history of BS were excluded. The BS2013 and BS2019 cohorts were approved by the local medical ethics review board of the Spaarne Gasthuis. Written informed consent was not needed due to the nature of the retrospective database analysis. The principles of the Declaration of Helsinki were followed.

The aims and design of the HELIUS study have been described previously [21]. In brief, the HELIUS study is a multiethnic cohort study conducted in Amsterdam, The Netherlands. Subjects were randomly selected from the Amsterdam municipal registers and stratified by ethnicity. The HELIUS study focuses on the largest ethnic groups in Amsterdam. Baseline data were collected between January 2011 and November 2015. Participants completed a questionnaire and underwent a physical examination at the research location. Of 22,164 participants of whom data from questionnaires and physical examination were available, 1770 participants with a BMI $\geq$35 kg/m^2 and aged between 18 and 65 years were eligible for this study. Participants with a history of BS were excluded. The HELIUS study was approved by the medical ethics review board of the Amsterdam UMC location AMC, The Netherlands. Written informed consent was obtained from all participants involved in the study. The principles of the Declaration of Helsinki were followed.

Outcomes

The primary aim of this study was to investigate the preoperative differences in baseline characteristics and the proportion of men and women experiencing OAMPs before BS. Patients who underwent BS were compared with a group with obesity from the general population (HELIUS).

The secondary aim was to evaluate the severity of T2D and HT in men and women, measured through HbA1C levels, blood pressure, and the use of antihypertensives and antidiabetics during intake. Additionally, the number of 30-day postoperative complications, emergency department visits, readmissions, and reoperations after BS were compared between men and women.

Data collection

BS2013 and BS2019 cohorts. Of all included patients, the following data were collected: sex, age, BMI (kg/m^2), waist circumference, maximum weight loss before surgery in absolute kilograms, maximum weight in kilograms, American Society of Anesthesiologists classifications and self-reported intoxications (use of alcohol, drugs, and smoking), presence of medical problems, and preoperative usage of any medication [22]. For the BS2019 cohort, preoperative HbA1C and blood pressure were collected as well. In addition, the following postoperative data were collected in the BS2019 cohort: postoperative complications, emergency department visits, readmissions, and reoperations within 30 days. All data were collected from the hospital electronic patient files.

HELIUS cohort. The following characteristics were collected at the baseline measurement of the HELIUS study: (1) sex and age were derived from the municipal registry; (2) height, weight, and waist circumference were measured in duplicate and were calculated by taking the mean of the 2 measurements; and (3) intoxications (use of alcohol, drugs, and smoking) and medical history were assessed through self-report during intake. All participants brought their prescribed medications, which were coded using the Anatomical Therapeutic Chemical classification system [23]. In addition, HbA1C values and blood pressure were measured. Based on the number of OAMPs present and BMI, theoretical eligibility for BS according to the IFSO standards was evaluated.

Obesity-associated medical problems

Obesity-associated medical problems were defined as HT, T2D, OSAS, dyslipidemia, and osteoarthritis. Cardiologic diseases were classified as all noncongenital heart diseases diagnosed by a cardiologist (HT excluded). HT was analyzed in 2 ways: (1) dichotomous, with or without any use of medication for HT; and (2) in an ordinal way divided into 3 groups: no HT, elevated systolic blood pressure $\geq$140 mm Hg and/or diastolic blood pressure $\geq$90 mm Hg without medication use, and HT with the use of medication. T2D was analyzed in a dichotomous and ordinal variable: any use of antidiabetic medication, and divided into 5 groups (no T2D; elevated HbA1C [>42 and <53]; elevated HbA1C $\geq$53; non–insulin-dependent diabetes [NIDD]; and insulin-dependent diabetes [IDD]). OSAS was diagnosed by a pulmonologist or ear-nose-throat specialist by means of polysomnography. Osteoarthritis was diagnosed by an orthopedic surgeon through x-rays. Dyslipidemia was defined by the use of lipid-lowering drugs.

Statistical analysis

Baseline characteristics were presented for men and women separately. Data were reported as mean and standard deviation (SD) for normally distributed variables and as median and interquartile range (IQR) for variables with a skewed distribution. The results for men and women were compared statistically. Continuous variables between groups were compared using the independent sample t test or by the nonparametric Mann-Whitney U test or Kruskal-Wallis test, depending on their distribution. The χ^2 test was used for categorical variables. A P value of $<$.05 was considered statistically significant. Data were analyzed using SPSS, version 24, for Windows (IBM Corp., Armonk, NY).

Results

Baseline characteristics

In total, 3244 patients were included in the analysis. Table 1 shows the baseline characteristics and OAMPs for men and women in each cohort.

All cohorts comprised more women than men: 667 (85.6%), 545 (78.4%), and 1445 (81.6%) in BS2013, BS2019, and HELIUS, respectively. In the BS2013 and BS2019 cohorts, men were significantly older at the time of BS than women ($P <$

Table 1
Baseline characteristics, medical problems, and type of operations performed

	Bariatric cohort 2013		Bariatric cohort 2019		HELIUS cohort	
	Male n = 112 (14.4%)	Female n = 667 (85.6%)	Male n = 150 (21.6%)	Female n = 545 (78.4%)	Male n = 325 (18.4%)	Female n = 1445 (81.6%)
Baseline characteristics						
Age during surgery/inclusion in HELIUS	47.00 (41.00–53.75)*	43.00 (36.00–51.00)	52.00 (39.75–57.00)*	45.00 (35.00–53.00)	46.78 ± 12.94	48.79 ± 11.18*
BMI during intake (kg/m^2)	41.50 (38.35–45.20)	42.30 (40.20–45.90)*	40.40 (37.40–43.75)	41.30 (39.00–44.11)*	38.09 ± 3.15	39.01 ± 3.95*
Waist circumference above standard values (cm) (men >102, women >88)	35.32 ± 13.69	36.25 ± 11.43	33.58 ± 10.26	34.85 ± 10.60	20.94 ± 9.55	26.85 ± 10.30*
Maximum BMI ever (kg/m^2)	42.61 (39.87–46.17)	43.77 (41.02–47.07)*	41.97 (39.34–45.29)	42.52 (40.30–46.05)	-	-
Best weight loss ever (kg)	20.00 (13.00–30.00)	20.00 (15.00–30.00)	18.00 (10.00–30.00)	16.00 (10.00–25.00)	-	-
Obesity-associated medical problems						
Hypertension (dichotomous)	53 (47.3%)*	217 (32.5%)	72 (48.0%)*	153 (28.1%)	108 (33.2%)	479 (33.1%)
Type 2 diabetes (dichotomous)	29 (25.9%)*	103 (15.4%)	36 (24.0%)*	66 (12.1%)	53 (16.3%)	221 (15.3%)
OSAS	22 (19.6%)*	28 (4.2%)	64 (42.7%)*	83 (15.2%)	-	-
Dyslipidemia	27 (24.1%)*	82 (12.3%)	26 (17.3%)*	49 (9.0%)	69 (21.2%)*	217 (15.0%)
Osteoarthritis	13 (11.6%)	95 (14.2%)	28 (18.7%)	107 (19.6%)	53 (16.5%)	400 (28.0%)*
Other medical problems						
Cardial diagnosis[†]	12 (10.7%)*	22 (3.3%)	25 (16.7%)*	31 (5.7%)	-	-
Myocardial infarction	5 (4.5%)*	4 (.6%)	16 (10.7%)*	13 (2.4%)	18 (5.6%)*	27 (1.9%)
Venous thromboembolism	3 (2.7%)	20 (3.0%)	3 (2.0%)	17 (3.1%)	-	-
Cerebrovascular disease	2 (1.8%)	7 (1.1%)	6 (4.0%)	14 (2.6%)	20 (6.2%)	98 (6.8%)
Asthma/COPD	0 (0%)	7 (1.0%)	20 (13.3%)	108 (19.8%)	31 (9.5%)	160 (11.1%)
Hypothyroidism	4 (3.6%)	51 (7.6%)	2 (1.3%)	73 (13.4%) *	-	-
Chronic kidney disease	1 (0.9%)	1 (.2%)	7 (4.7%)*	10 (1.8%)	8 (2.5%)	35 (2.4%)
Psychological history	16 (14.3%)	94 (14.1%)	18 (12.0%)	114 (20.9%)*	30 (9.2%)	101 (7.0%)
Abdominal surgery	20 (17.9%)	331 (49.6%)*	28 (18.7%)	136 (25.0%)	-	-
ASA classification	*					
1	4 (3.6%)	28 (4.2%)	0 (0%)	5 (.9%)	-	-
2	85 (75.9%)	567 (85.6%)	44 (29.3%)	165 (30.3%)	-	-
3	22 (19.6%)	67 (10.1%)	106 (70.7%)	375 (68.8%)	-	-
4	1 (.9%)	0 (0%)	0 (0%)	0 (0%)	-	-
Operation						
LRYGB	108 (96.4%)	657 (98.5%)	128 (85.3%)	462 (84.8%)	-	-
LSG	4 (3.6%)	10 (1.5%)	15 (10%)	74 (13.6%)	-	-
LOAGB	0 (0%)	0 (0%)	7 (4.7%)	9 (1.7%)	-	-
Surgery time	56.00 (48.00–65.75)*	52.00 (44.00–61.00)	-	-	-	-

HELIUS = HEalthy Life In an Urban Setting; BMI = body mass index; OSAS = obstructive sleep apnea syndrome; COPD = chronic obstructive pulmonary disease; ASA = American Society of Anesthesiologists; LRYGB = laparoscopic Roux-en-Y gastric bypass; LSG = laparoscopic sleeve gastrectomy; LOAGB = laparoscopic one-anastomosis gastric bypass.

Data are presented as median (interquartile range), mean ± SD, or n (%).

* Significant difference in the cohort between men and women, with the asterisk placed at the highest value.

[†] Includes all noncongenital heart diseases diagnosed by a cardiologist (hypertension excluded).

.001). Median (IQR) age in men versus women was 47.0 (41.0–53.8) versus 43.0 (36.0–51.0) years in BS2013 and 52.0 (39.8–57.0) versus 45.0 (35.0–53.0) years in BS2019 ($P < .001$). During intake at the bariatric outpatient clinic, BMI was higher in women ($P = .001$). Median (IQR) BMI in men versus women was 41.5 (38.4–45.2) versus 42.3 (40.2–45.9) in BS2013 ($P = .034$) and 40.4 (37.4–43.8) versus 41.3 (39.0–44.1) in BS2019 ($P = .023$). In the HELIUS cohort, women were both significantly older and had a higher BMI.

Obesity-associated medical problems

In both BS cohorts, HT (53 [47.3%] versus 217 [32.5%] in BS2013 and 72 [48.0%] versus 153 [28.1%] in BS2019), T2D (29 [25.9%] versus 103 [15.4%] in BS2013 and 36 [24.0%] versus 66 [12.1%] in BS2019), OSAS (22 [19.6%] versus 28 [4.2%] in BS2013 and 64 [42.7%] versus 83 [15.2%] in BS2019), and dyslipidemia (27 [24.1%] versus 82 [12.3%] in BS2013 and 26 [17.3%] versus 49 [9.0%] in BS2019) were significantly more prevalent in men undergoing BS ($P \leq .004$). Also, previous myocardial infarction (5 [4.5%] versus 4 [.6%]) in BS2013 and 16 [10.7%] versus 13 [2.4%] in BS2019) and other cardiologic diagnoses (12 [10.7%] versus 22 [3.3%] in BS2013 and 25 [16.7%] versus 31 [5.7%] in BS2019) were more prevalent in men than in women ($P < .001$).

In the HELIUS cohort, male patients more often had dyslipidemia (69 [21.2%] versus 217 [15.0%]) ($P = .006$) and a history of myocardial infarction (18 [5.6%] versus 27 [1.9%]) ($P < .001$).

Table 2 shows details regarding T2D and HT for the BS2019 and HELIUS cohorts. In the BS2019 cohort, men exhibited higher mean (IQR) HbA1C (38.00 [35.00–49.00] versus 36.50 [33.00–40.00]), more often had an elevated HbA1C >42 (15 [11%] versus 30 [6%]), and had higher percentages of both NIDD (20 [14.6%] versus 44 [8.9%]) and IDD (16 [11.7%] versus 22 [4.4%]) compared with women ($P < .001$). In the HELIUS cohort, sex differences in T2D prevalence were clearly less pronounced than in the group undergoing BS.

In the BS2019 and HELIUS cohorts, a higher proportion of men had an elevated blood pressure without the use of antihypertensive medication compared with women (36 [24.3%] versus 100 [18.9%] in BS2019 and 114 [35.3%] versus 308 [21.4%] in the HELIUS).

The number of OAMPs present during BS intake and baseline visit in the HELIUS cohort is shown in Table 3. In both BS2013 and BS2019, men presented significantly more often than women with 2, 3, or 4 OAMPs. In contrast, in the HELIUS cohort no difference in the number of OAMPs between men and women was found.

Medication use

In BS2019, men with T2D and HT used more antidiabetics and antihypertensives than women with these conditions ($P = .004$). In addition, the mean (SD) number of drugs used in total (2.73 [2.69] versus 2.09 [2.380] in BS2013 and 3.05 [3.17] versus 1.92 [2.44] in BS2019) was significantly higher in men as well ($P = .014$ in BS2013 and $P < .001$ in BS2019). Furthermore, men used more anticoagulants and cholesterol-lowering agents. Other types of medication in use are listed in Table 4 and Supplement 1.

Eligibility for BS

Table 3 summarizes the reasons participants were eligible for BS. Female patients were most often eligible due to a BMI >40 without any OAMPs (305 [45.7%] in BS2013

Table 2
Type 2 diabetes and hypertension

	Bariatric cohort 2019			HELIUS cohort		
	Male	Female	*P* value	Male	Female	*P* value
T2D categorical			<.001			.024
No T2D	86 (62.8%)	400 (80.6%)		168 (52.8%)	834 (58.5%)	
Elevated HbA1C (mmol/mol) <53	12 (8.8%)	28 (5.6%)		79 (24.8%)	331 (23.2%)	
Elevated HbA1C (mmol/mol) ≥53	3 (2.2%)	2 (.4%)		18 (5.7%)	39 (2.7%)	
NIDD	20 (14.6%)	44 (8.9%)		33 (10.4%)	161 (11.3%)	
IDD	16 (11.7%)	22 (4.4%)		20 (6.3%)	60 (4.2%)	
HbA1C (mmol/mol) during intake	38.00 (35.00–49.00)	36.50 (33.00–40.00)	<.001	44.66 ± 12.85	43.71 ± 11.73	.201
Hypertension categorical			<.001			<.001
No HT	41 (27.7%)	281 (53.0%)		101 (31.3%)	653 (45.3%)	
HT without use of medication	36 (24.3%)	100 (18.9%)		114 (35.3%)	308 (21.4%)	
HT with use of medication	71 (48.0%)	149 (28.1%)		108 (33.4%)	479 (33.3%)	
Systolic blood pressure (mm Hg) during intake	137.33 ± 13.91	132.27 ± 14.64	<.001	142.66 ± 17.73	136.25 ± 17.68	<.001
Diastolic blood pressure (mm Hg) during intake	84.71 ± 10.19	82.75 ± 9.29	.033	89.55 ± 11.10	82.27 ± 9.94	<.001

HELIUS = HEalthy Life In an Urban Setting; T2D = type 2 diabetes; NIDD = non–insulin-dependent diabetes; IDD = insulin-dependent diabetes; HT = hypertension.

Data are presented as n (%), median (interquartile range), or mean ± SD.

Table 3
Obesity-associated medical problems and preoperative obesity surgery guidelines

	Bariatric cohort 2013*			Bariatric cohort 2019			HELIUS cohort†		
	Male	Female	*P* value	Male	Female	*P* value	Male	Female	*P* value
Obesity-associated medical problems, n (%)			<.001			<.001			.335
None	32 (28.6%)	332 (49.8%)		27 (18.0%)	235 (43.1%)		132 (40.6%)	623 (43.1%)	
1	35 (31.3%)	194 (29.1%)		49 (32.7%)	182 (33.4%)		105 (32.3%)	416 (28.8%)	
2	23 (20.5%)	92 (13.8%)		45 (30.0%)	95 (17.4%)		42 (12.9%)	235 (16.3%)	
3	17 (15.2%)	41 (6.1%)		21 (14.0%)	28 (5.1%)		35 (10.8%)	131 (9.1%)	
4	5 (4.5%)	7 (1.0%)		8 (5.3%)	5 (.9%)		11 (3.4%)	40 (2.8%)	
5	0 (0%)	1 (.1%)		0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Preoperative obesity surgery guidelines, n (%)			<.001			<.001			.043
BMI ≤40 with obesity-associated medical problems	33 (29.5%)	120 (18.0%)		66 (44.0%)	157 (28.8%)		146 (44.9%)	550 (38.1%)	
BMI ≥40 with obesity-associated medical problems	47 (42.0%)	214 (32.1%)		58 (38.7%)	155 (28.4%)		47 (14.5%)	272 (18.8%)	
BMI ≥40 without obesity-associated medical problems	29 (25.9%)	305 (45.7%)		25 (16.7%)	228 (41.8%)		23 (7.1%)	142 (9.8%)	
Exceptions‡	3 (2.7%)	28 (4.2%)		1 (.7%)	5 (.9%)		-	-	
Not eligible for bariatric surgery	-	-	-	-	-		109 (33.5%)	481 (33.3%)	

HELIUS = HEalthy Life In an Urban Setting; BMI = body mass index; OSAS = obstructive sleep apnea syndrome.

Hypertension was counted as a medical problem if patients used medication or had a systolic blood pressure ≥160 mm Hg and diastolic blood pressure ≥100 mm Hg during intake. Type 2 diabetes was counted as a medical problem if patients used medication or had a HbA1C ≥53.

* For 2013, data for HbA1C and blood pressure during intake were not available. Therefore, diabetes and hypertension without medication use could not be included.

† No data about OSAS were available in the HELIUS cohort.

‡ Exceptions were patients who had already lost weight between referral and actual intake at the bariatric outpatient clinic and therefore no longer met the guidelines during intake.

Table 4
Medication

	Bariatric cohort 2013		*P* value	Bariatric cohort 2019		*P* value
Number of antidiabetics	Male n = 29	Female n = 103	.801	Male n = 36	Female n = 64	.004
1	8 (27.6%)	37 (35.9%)		8 (22.2%)	35 (54.7%)	
2	9 (31.0%)	33 (32.0%)		13 (36.1%)	15 (23.4%)	
3	11 (37.9%)	28 (27.2%)		11 (30.6%)	13 (20.3%)	
4	1 (3.4%)	4 (3.9%)		4 (11.1%)	0 (0%)	
5	0 (0%)	1 (1.0%)		0 (0%)	1 (1.61%)	
Number of antihypertensives	Male n = 53	Female n = 217	.733	Male n = 76	Female n = 164	.004
1	20 (37.7%)	78 (35.9%)		19 (25.0%)	79 (48.2%)	
2	18 (34.0%)	86 (39.6%)		27 (35.5%)	50 (30.5%)	
3	12 (22.6%)	41 (18.9%)		21 (27.6%)	27 (16.5%)	
4	2 (3.8%)	11 (5.1%)		9 (11.8%)	7 (4.3%)	
5	1 (1.9%)	1 (.5%)		0 (0%)	1 (.6%)	
	Male n = 112	Female n = 667		Male n = 150	Female n = 545	
Number of medications used*	2.73 ± 2.69	2.09 ± 2.38	.014	3.05 ± 3.17	1.92 ± 2.44	<.001
Anticoagulants			<.001			<.001
None	95 (84.8%)	632 (94.8%)		115 (76.7%)	499 (91.6%)	
Platelet aggregation inhibitors	7 (6.3%)	24 (3.6%)		23 (15.3%)	33 (6.1%)	
DOAC/vitamin K antagonist	8 (7.1%)	9 (1.3%)		10 (6.7%)	9 (1.7%)	
Dual antiplatelet therapy	2 (1.8%)	2 (.3%)		2 (1.3%)	4 (.7%)	
Cholesterol-lowering agents	36 (32.1%)	99 (14.8%)	<.001	46 (30.7%)	69 (12.7%)	<.001

DOAC = direct oral anticoagulants; COPD = chronic obstructive pulmonary disease.

* Including antidiabetics, antihypertensives, anticoagulants, cholesterol-lowering agents, cardiac medication, asthma/COPD medication, antireflux medications, psychiatric medications, and thyroid medication.

Table 5
Intoxications

Smoking, n (%)	Bariatric cohort 2013		Bariatric cohort 2019			HELIUS cohort	
	Male*	Female	Male*	Female		Male*	Female
No	43 (38.4%)	316 (47.4%)	57 (39.0%)	283 (53.0%)		136 (42.0%)	1080 (75.3%)
Yes	18 (16.1%)	130 (19.5%)	25 (17.1%)	95 (17.8%)		92 (28.4%)	180 (12.6%)
Stopped	51 (45.5%)	221 (33.1%)	64 (43.8%)	156 (29.2%)		96 (29.6%)	174 (12.1%)
Drinking, n (%)	Male*	Female	Male*	Female	Drinking n (%)	Male*	Female
No	35 (31.3%)	358 (53.7%)	55 (36.9%)	291 (53.9%)	No	162 (50.3%)	1017 (71.3%)
Sporadically	16 (14.3%)	77 (11.5%)	30 (20.1%)	120 (22.2%)	Low (men 0–4 gl/wk, women 0–2 gl/wk)	108 (33.5%)	318 (22.3%)
≥7 gl/wk	50 (44.6%)	215 (32.2%)	53 (35.6%)	115 (21.3%)	Moderate (men 5–14 gl/wk, women 3–7 gl/wk)	38 (11.8%)	66 (4.6%)
>7 gl/wk	11 (9.8%)	17 (2.5%)	11 (7.4%)	14 (2.6%)	High (men >14 gl/wk, women >7 gl/wk)	14 (4.3%)	26 (1.8%)

HELIUS = HEalthy Life In an Urban Setting; gl/wk = glasses per week.
* Significant difference in the cohort between men and women.

and 228 [41.8%] in BS2019). In contrast, men most often had OAMPs independent of BMI. In the HELIUS cohort, an equal proportion of men and women were theoretically eligible for BS: 216 (66.5%) versus 964 (66,7%), respectively.

Intoxications

All 3 cohorts showed comparable significant differences in smoking and drinking habits between men and women, as shown in Table 5. Men were more likely to have quit smoking and more often used alcohol on a weekly basis and consumed more units per week.

Per- and postoperative complications

Lastly, in the BS2019 cohort, postoperative complications were equal between male patients and female patients (12 [8.0%] versus 50 [9.2%]) ($P = .655$). Results are included in Table 6. There was no mortality within the first 30 days after surgery.

Discussion

The aim of this study was to gain more insight into the preoperative differences between men and women undergoing BS. Initially it was hypothesized that men undergoing BS are medically less healthy than women. This study is the first to show that male patients who choose BS significantly more often have both a higher number of and more advanced medical problems than female patients. Compared with women, they use more medication; more often have prediabetes, NIDD, and IDD; have a higher HbA1C; and have higher blood pressure. Male patients are older but exhibit a lower BMI at BS intake. Furthermore, an equal

Table 6
Per and postostoperative complications, emergency department visits, readmissions, and reoperations

	Bariatric cohort 2019		
	Male	Female	*P* value
Perioperative complications	6 (4.0%)	20 (3.7%)	.850
Number of patients with ≤1 postoperative complication	12 (8.0%)	50 (9.2%)	.655
Number of patients with ≤1 surgical postoperative complication	10 (6.7%)	41 (7.6%)	.722
Number of patients with ≤1 nonsurgical complication	3 (2.0%)	17 (3.1%)	.468
Leakage	0 (0%)	4 (.7%)	.293
Stenosis	1 (.7%)	11 (2.0%)	.260
Bleeding	6 (4.0%)	16 (2.9%)	.510
Emergency department visit ≤30 d	15 (10%)	73 (13.4%)	.268
Readmission ≤30 d	7 (4.7%)	40 (7.3%)	.248
Reoperation ≤30 d	2 (1.3%)	12 (2.2%)	.503

proportion of men and women in the control group were eligible for BS. As more women than men undergo BS, this indicates that men are still unjustly strongly underrepresented in the bariatric population.

Evidence on differences between men and women choosing BS is limited. Stroh et al. and Kochkodan et al. mentioned the differences in medical problems between male and female patients but mainly focused on postoperative complications and psychological differences, respectively [19,20]. Our main findings are in line with previous studies; men are underrepresented in the bariatric population and OAMPs are more frequently present in men than in women undergoing BS [13,19,20]. Populations of previous studies, however, showed a markedly higher prevalence of OAMPs than the present study population [19,20].

This study shows that men undergoing BS exhibit significantly more and more severe OAMPs than women undergoing BS. This study found that men undergoing BS had been diagnosed with T2D more often, exhibited higher HbA1C levels, had prediabetes more regularly, and were more likely to have IDD compared with women. These are all known risk factors for hypoglycemia and subsequent T2D-related mortality [24]. These sex-based differences were not found in the HELIUS control cohort. Male patients undergoing BS also had higher blood pressure, were more likely to have untreated hypertension, had more dyslipidemia, and exhibited higher usage of any medication compared with women. In addition, a higher rate of cardiologic diagnoses and myocardial infarction was found in men. These findings were also observed in the HELIUS cohort. A feasible explanation might be that central or abdominal adiposity is more common in men and is a well-known risk factor for coronary heart disease, T2D, general morbidity, and overall mortality. This risk is independent of BMI [25,26]. Moreover, previous studies have shown that persons with normal weight and central obesity were at higher risk of mortality than persons with BMI-defined obesity [27]. A difference in men compared with women with regard to waist circumference could not be demonstrated, but the statistically significant BMI difference was deemed not clinically significant with $<$1-point BMI difference. The HELIUS participants, however, did show a significant difference in waist circumference between men and women. These measurements unfortunately did not include measurements such as body composition analyses or a hip-to-waist ratio.

Traditional risk factors, such as smoking and alcohol use, may partially explain the sex differences in OAMPs, as these risk factors were more prevalent in male patients than in female patients. The number of male smokers has always been higher in the Netherlands in recent years. However, it should be considered that a recent study showed that smoking may be more addictive in women. This could negate the aforementioned contribution to the difference between men and women [28].

Regardless of the cause, increased frequency and severity of the OAMPs may impose a serious health risk in male patients. Men generally experience their first acute myocardial infarction 9 years earlier than women, as shown in the INTERHEART study [29].These differences should be interpreted in light of the theory that estrogen may have protective effects in premenopausal women [30]. In addition, previous studies have shown that with the medical treatment of risk factors leading to obesity-related cardiovascular events and mortality, such as high blood pressure, hyperglycemia, and hyperlipidemia, only half of the excess risk of coronary heart disease may be addressed. Management of BMI is needed for the full health benefits [31]. Importantly, based on this study, it seems safe to assume that men present later in the process of severe obesity. This is cause for major concern in itself, as the number of years lived with obesity is directly associated with the risk of all-cause morbidity and mortality and disappointing weight loss results after BS [17,18,31].

A higher preoperative risk for men due to the presence of more medical problems in BS2019 was found. This did not result, however, in an increase in complications in male patients. In contrast, previous studies found male sex to be a risk factor for various postoperative complications, insufficient weight loss, and mortality [19,20]. The absence of an association between the male sex and complication rate in the present study can possibly be attributed to a relatively low sample size and a low statistical impact of the male sex, or the fact that patients were only operated on by specialized bariatric surgeons with at least 5 years of experience. Known possible perioperative technical challenges in men, such as a higher amount of visceral fat, were not scored or evaluated.

In order to mitigate the differences, insight into the differences in motivation between men and women before BS is needed. Previous research has suggested that the reason men are less often referred for BS than women may be related to referring behaviors of physicians and patient motivation. Wee et al. [16] described that physicians were less likely to recommend BS to men, although men were just as likely to consider it when it was recommended to them. Blackburn et al. [32] stated that general practitioners were particularly worried that discussing weight loss might damage the patient relationship with men or discourage them from future engagement with health care services. On the patients' end, there is a difference in motivation for BS between men and women. Jolles et al. [33] found that men are mainly motivated to undergo BS if all other weight loss attempts were exhausted, or by the fear of death. Similarly, Elliot et al. [34] stated that fear of negative consequences from severe obesity was a motivation for change in men, such as newly diagnosed T2D. Lastly, Wee et al. [15] concluded that motivation for BS in men was mainly driven by physical functioning, whereas self-esteem and weight

stigma were the main drivers for women. This may be reflected by the observed increased incidence of psychiatric disorders and high antidepressant use compared with the general Dutch population. This is consistent with the results of Kochkodan et al. [19], in which women significantly more often had psychological disorders and demonstrated lower body image scores and psychological well-being scores and a higher self-reported depression score. Lastly, weight loss programs in general are less attended by men than women [35]. The reasons according to male patients is the feminine character of weight loss programs, perceived stigma around men to talk about weight loss, and the sense of failure by needing help [34].

This study extends previous studies by having included a broader spectrum of medical problems and modifiable risk factors, more accurate clinical measures, and extensive medication usage. Most importantly, this study is the first to compare a preoperative bariatric population with a control group with obesity.

This study has several limitations. Most importantly, it did not include any socioeconomic factors, educational levels, and ethnicity, which may contribute to the fact that men are less likely to choose BS [15,16,33]. This is especially important given that the control group was derived from the HELIUS study, a cohort study that oversampled people from ethnic minority groups. These factors could also give us a better understanding of the group not undergoing surgery. Furthermore, not all data from the HELIUS study were comparable to the bariatric cohort data due to the different setup of the databases. Lastly, the HELIUS cohort did not include data on OSAS, which is 1 of the 5 OAMPs.

Conclusion

The fact that men are strongly underrepresented in BS poses a serious health problem for the male population with obesity. This study showed that male patients compared with female patients planning to undergo BS present later in the process of obesity, are older, exhibit more OAMPs in a more advanced stage, and show more modifiable risk factors such as smoking. This study should prompt physicians to be aware of the unjustified underrepresentation of men in the BS population, at the expense of the individual's obesity-related morbidity and mortality risks. Hence, male patients with severe obesity should be referred for BS sooner, as the number of years lived with obesity is directly associated with the risk of all-cause morbidity and mortality and disappointing weight loss results after BS.

Disclosures

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Supplementary material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.soard.2023.02.015.

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