Current Sexual Health Reports (2019) 11:52–59
https://doi.org/10.1007/s11930-019-00192-0

UROLOGY, GYNECOLOGY, AND ENDOCRINOLOGY (J SIMON AND M LURIA, SECTION EDITORS)

Effect of Body Weight on Sexual Function in Men and Women

Jenna N. Bates[1] · Alexander W. Pastuszak[2] · Mohit Khera[3]

Published online: 19 January 2019

Abstract

Purpose of Review Obesity is a growing problem worldwide. This review aims to summarize the literature on the effects of weight on sexual function in both men and women from the past 5 years.

Recent Findings In recent population-based studies of men and women, no relationship between weight and sexual function was identified. However, in studies of special populations such as women with gestational diabetes, polycystic ovarian syndrome (PCOS), pelvic organ prolapse, or urinary incontinence, weight affected some aspects of sexual function. In women, surgical, but not non-surgical, weight loss was associated with resolution of some aspects of sexual dysfunction. In contrast, in men, both surgical and non-surgical weight loss improved sexual function.

Summary Weight plays a role in sexual dysfunction in both men and women. Bariatric surgery is linked to improved sexual function in both genders. However, more work is needed to fully understand the relationship between weight and sexual function.

Keywords Sexual dysfunction · Bariatric surgery · Female sexual dysfunction · Weight · Weight loss

Introduction

The proportion of individuals who are overweight or obese, which is defined as a body mass index (BMI) 25–29.9 kg/m^2 and ≥ 30 kg/m^2 respectively, is increasing. Within the USA, the rate of obesity reached nearly 40% in adults in 2015–2016 [1]. Increased weight has been identified as a risk factor for a number of diseases including heart disease, stroke, type 2 diabetes mellitus, sleep apnea, infertility, and some forms of cancer [2]. Available data on the effect of excess weight on sexual function are less abundant. However, weight has been hypothesized to have a negative impact on sexual function via hormonal, metabolic, and psychological parameters [3, 4].

In order to quantify sexual dysfunction in men, the International Index of Erectile Function (IIEF), a survey validated across cultures, is considered the gold standard. It contains five domains: erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall satisfaction [5, 6]. Currently, the best tool for evaluating female sexual dysfunction (FSD) is considered to be the Female Sexual Function Index (FSFI), a self-report survey validated across several languages [7]. It contains six subcategories: desire, arousal, lubrication, orgasm, satisfaction, and pain [8].

A handful of reviews have investigated the relationship between weight and sexual function [9–11]. We aim to update the literature with a review of the literature published during the past 5 years.

Methods

A PubMed search was performed for all English articles published between January 2013 and August 2018 using the following search terms and their combinations: male sexual function, female sexual function, sexual dysfunction, erectile dysfunction, weight, weight loss, obese, overweight, and bariatric. Articles were included if they assessed the impact of weight on sexual function.

This article is part of the Topical Collection on *Urology, Gynecology, and Endocrinology*

✉ Alexander W. Pastuszak
alexander.pastuszak@hsc.utah.edu

[1] Baylor College of Medicine, Houston, TX, USA

[2] Department of Surgery – Urology, University of Utah School of Medicine, 30 North 1900 East, Rm #3B420, Salt Lake City, UT 84132, USA

[3] Scott Department of Urology, Baylor College of Medicine, Houston, TX, USA

Weight and Sexual Function in Men

In a 2017 study by Steffen et al. of 474 men seeking bariatric surgery, sexual function was measured using a survey based on The Sexual Function Questionnaire. Additionally, weight-related sexual quality of life was assessed using the Impact of Weight on Quality of Life-Lite (IWQOL-lite) survey. Body mass index (BMI) was associated with higher degree of physical health limiting sexual activity ($p = 0.01$) and lower IWQOL-lite sexual life score (p 0.02), but not frequency of sexual desire ($p = 0.37$), frequency of sexual activity ($p = 0.86$), or satisfaction with sex life ($p = 0.54$) [12••] (Table 1).

Weight and Sexual Function in Women

Several studies have investigated the relationship between weight and sexual function in women without finding a relationship between the two. In the same Steffen et al. study discussed earlier, 1751 women were given a questionnaire based on the FSFI. BMI was associated with women reporting physical health limiting sexual activity ($p = 0.004$) but not frequency of sexual desire ($p = 0.16$), frequency of sexual activity ($p = 0.19$), satisfaction with sex life ($p = 0.19$), or IWQOL-lite sexual life score ($p = 0.58$) [12••]. In a 2013 cross-sectional study of 193 women, Erbil et al. used the FSFI and body image scale (BIS), finding no effect of being overweight or obese on total FSFI score ($p = 0.395$) or any individual domain scores. However, a BMI ≥ 25 kg/m^2 was associated with lower BIS score than BMI < 25 kg/m^2 ($p = 0.007$). In turn, lower BIS score was associated with worse total FSFI scores as well as lower desire, arousal, lubrication, orgasm, and satisfaction ($p = 0.001$ for all) scores, but not pain scores ($p = 0.547$). Thus, the authors concluded that BMI alone does not affect sexual function, but high BMI can result in lower body image, which can affect sexual functioning in significant ways [13]. Javadnoori et al. studied 330 fertile women in Iran using the FSFI. The authors found no difference in mean FSFI scores between subjects with normal BMI and overweight ones ($p = 0.756$). Additionally, there were no significant differences in any domain scores between the two groups [14] (Table 2).

Costa et al. investigated the role of waist circumference in orgasm in 120 Portuguese women. When controlling for age, social desirability, relationship status, and cohabitation status, waist circumference was inversely related to likelihood of vaginal orgasm ($r = -0.18$, $p = 0.05$). However, orgasm from clitoral stimulation during penile-vaginal intercourse was not related to waist circumference ($p = 0.08$). The authors hypothesized that this difference was not due to any anthropomorphic, hormonal, or metabolic difference in the women studied, but instead higher weight resulted in decreased attractiveness and thus male partners were not able to sustain an erection for long enough to bring the female partner to vaginal orgasm. The authors theorized that clitoral orgasm was not affected due to the relative lack of necessity for penile-vaginal sex to induce clitoral orgasm [15]. However, no additional evidence exists to support this hypothesis.

In all, recent population-based studies found no effect of BMI on sexual function with the exception of Costa et al. who

Table 1 Summary of articles on weight and male sexual function. "✓" indicates significant relationship between weight and variable. "×" indicates no significant relationship between weight and variable. "-" indicates variable not investigated or reported. Single asterisk indicates IWQOL-Lite but not IIEF was used

Author	Study group	*N*	IIEF	Intercourse satisfaction	Desire	Erectile function	Orgasm	Overall satisfaction
Weight and sexual function								
Steffen et al.	Men seeking bariatric surgery	474	✓*	-	×	-	-	×
Non-surgical weight loss								
Collins et al.	Men with diet/exercise resources vs control	96 experimental vs 39 controls	✓	-	-	-	-	-
Moran et al.	Men on weight loss diet	118	✓	-	-	×	-	-
Bariatric surgery								
Kun et al.	Bariatric surgery patients	39 (baseline vs 1 year post-op)	✓	-	-	-	-	-
Efthymiou et al.	Bariatric surgery patients	30 (baseline vs 1 year post-op)	-	✓	✓	✓	×	✓
Groutz et al. 2017	Bariatric surgery patients	55 (baseline vs 3 months post-op)	-	✓	×	✓	×	✓
Mora et al. 2017	Bariatric surgery patients	39 (baseline vs 1 year post-op)	✓	×	✓	✓	×	✓

Table 2 Summary of articles on weight and female sexual function. "✓" indicates significant relationship between weight and variable. "×" indicates no significant relationship between weight and variable. "-" indicates variable not investigated or reported. Single asterisk indicates survey based on FSFI but not FSFI was used. Double asterisks indicate PISQ-12 but not FSFI was used. Triple asterisks indicate that variable was significant at 2 years but not at 1 year

	Study group	*N*	FSFI	Arousal	Pain	Desire	Lubrication	Orgasm	Satisfaction
Weight and sexual function									
Erbil et al.	Women at a OB/GYN clinic	193	×	×	×	×	×	×	×
Javadnoori et al.	Iranian women	330	×	×	×	×	×	×	×
Steffen et al.	Women seeking bariatric surgery	1751	×*	–	–	×	–	–	×
Special groups									
Ribeiro et al.	Third trimester women with gestational diabetes	67 normal weight vs 76 overweight pre-pregnancy	✓	×	×	✓	✓	×	×
Bilgic et al.	Women with pelvic organ prolapse and/or urinary incontinence	187 non-obese vs 200 obese women	✓**	-	-	-	-	-	-
Benetti-Pinto et al.	Women with PCOS	56 women with PCOS VS 102 control	✓	×	×	×	×	×	✓
Non-surgical weight loss									
wing et al.	Women with type 2 diabetes	375 women randomized to intensive lifestyle intervention vs control	×	×	×	×	✓	×	×
Bariatric surgery									
Efthymiou et al.	Bariatric surgery patients	50 (baseline vs 12 months post-op)	✓	✓	✓	✓	✓	✓	✓
Hernandez Hernandez et al.	Bariatric surgery patients	80 (baseline vs 6 and 12 months post-op)	✓	✓	✓	✓	✓	✓	✓
Sarwer et al.	Bariatric surgery patients	106 (baseline vs 1 and 2 years post-op)	✓	✓***	×	✓	✓***	×	✓
Janik et al.	Bariatric surgery patients	153 post-op vs 23 controls	×	✓	×	✓	×	×	×

found an inverse relationship between vaginal orgasm and waist circumference [15]. However, it is important to acknowledge that older studies show more heterogeneity with several studies failing to find a relationship between obesity and FSD [16, 17, 18, 19], while others found increased sexual dysfunction in overweight or obese women [20–22].

Special Populations

Several studies have examined the effect of weight on specific populations. Ribeiro et al. performed a cross-sectional study of 143 women in the third trimester of pregnancy with gestational diabetes. Of these, 67 had a normal pre-pregnancy weight while 76 had been overweight or obese prior to pregnancy. The authors found that those who were overweight before pregnancy were at increased risk for sexual dysfunction symptoms, defined as a FSFI score ≤ 26, when compared to normal pre-pregnancy weight peers ($p = 0.038$). The mean FSFI score was lower in the overweight/obese group compared to the normal weight group (21.7 ± 9.2 vs 24.9 ± 8.0, $p = 0.029$). Additionally, women who were overweight/obese before pregnancy had lower scores in the desire and lubrication domains ($p = 0.007$ and 0.023 respectively). No significant differences in pain ($p = 0.251$), satisfaction ($p = 0.118$), orgasm ($p = 0.210$), or arousal ($p = 0.052$) domain scores were observed, although the arousal score approached significance. However, this study is difficult to extrapolate to the whole population in light of the niche population studied, especially given that this group had several reasons to have sexual dysfunction including hormonal and anthropomorphic changes associated with third trimester pregnancy, and metabolic changes associated with diabetes [23]. In a 2018 study of women with pelvic organ prolapse and/or incontinence, 187 non-obese women were compared to 200 obese women. Sexual function was studied using the Pelvic Organ Prolapse/Urinary Incontinence Sexual Function Questionnaire (PISQ-12), a validated instrument for measuring sexual function [24]. Significant differences were observed in PISQ-12 score between obese and non-obese women, even when controlling for several confounding factors including age, education, type of incontinence, and frequency of incontinence ($p < 0.05$). Further, higher BMI was correlated with

lower PISQ-12 score ($r = -0.181$, $p < 0.001$), suggesting worse symptoms in overweight women [25]. Benetti-Pinto et al. investigated the relationship between weight and sexual function in women with polycystic ovarian syndrome (PCOS), comparing 56 women with PCOS and 102 healthy control women. BMI was significantly different between the two groups (31.9 ± 8.5 vs 28.5 ± 5.4 kg/m^2, $p < 0.02$). In the PCOS group, significantly lower scores in arousal ($p = 0.03$), lubrication ($p = 0.04$), satisfaction ($p = 0.001$), pain ($p = 0.01$), and total FSFI score ($p = 0.005$) were observed. However, when controlling for age differences between the two groups, only satisfaction ($p = 0.002$) and total FSFI score remained significant ($p = 0.02$). When controlling for age, orgasm was negatively correlated to BMI ($r = -0.225$, $p = 0.02$); all other domains and total FSFI scores were not correlated with BMI [26]. Studies of specific groups indicate that even with additional comorbidities or medical conditions, weight remains a factor in determining sexual functioning in women (Table 2).

Effects of Weight Loss on Sexual Function

Another avenue that researchers have used to determine the effects of weight on sexual function is studies comparing sexual function in patients before and after weight loss. Four such studies have been published recently: two in men, one in women, and one including both sexes.

Effects of Non-Surgical Weight Loss on Sexual Function: Men

Both weight loss studies in men were randomized controlled trials. In the first, Collins et al. randomized 145 overweight or obese men to an experimental group that received the Self Help Exercise and Diet Using IT (SHED IT) resources and a control group that was added to the wait list for the program. The IIEF was administered at baseline and 6 months. The experimental group lost significantly more weight than the control group ($p < 0.05$). Men in the SHED-IT program had a significant increase in IIEF score compared to control men over the 6-month study period (+ 1.4 points; 95% CI 0.3–2.4, $p = 0.018$). When focusing on the subset of men who began the study with erectile dysfunction (ED), the effect was even more pronounced (+ 4.2 points, 95% CI 1.7–6.6, $p = 0.004$). Unfortunately, IIEF domain scores were not reported [27]. Importantly, the "noseebo" effect could be at play in this study due to the use of wait list patients as controls, potentially resulting in lower scores within the "control" group and overstating of the effect of the treatment. In a randomized controlled study, 118 overweight and obese men were given either an energy-restricted higher protein, a low fat diet, or a higher carb; low fat diet to determine if the type of weight loss diet affected sexual function. Subjects were followed for 52 weeks, which included 12 weeks of weight loss and 40 weeks of weight maintenance. Participants lost a significant amount of weight during the "weight loss" portion of the study (− 8.9 ± 0.4 lbs, $p < 0.001$) and overall (− 10.5 ± 0.8 lbs, $p < 0.001$). No significant difference in weight between the two groups was observed over the study period, ($p = 0.924$). However, an increase in total IIEF score in both groups ($p = 0.017$) at 12 weeks with no significant difference between the two groups was observed ($p = 0.76$). Furthermore, there was no significant difference in erectile function at either 12 or 52 weeks. Other domains of the IIEF were not reported [28•] (Table 1).

Effects of Non-Surgical Weight Loss on Sexual Function: Women

Wing et al. performed a multicenter randomized control trial of women with type 2 diabetes as part of the Look AHEAD study. Three hundred seventy-five women participated in the sexual function ancillary sub-study in which one group was given intensive lifestyle intervention while the control group was given only diabetes support and education. The FSFI questionnaire was administered at baseline and 1 year. At baseline, women in both groups had significantly lower total FSFI and all domain scores compared to a group of healthy women of a similar age ($p < 0.001$ for all). However, at baseline, BMI was not significantly associated with FSD ($p > 0.05$). At 1 year, the intervention group had lost significantly more weight than the control group ($p < 0.0001$), and had a small increase in total FSFI score compared with a small decrease in the control group though these differences were not significant (+ 1.1 vs − 0.09 points, $p = 0.073$) With regard to differences in FSFI domain scores, a significant difference was only observed in the lubrication domain ($p = 0.02$). However, if only women who had FSD at baseline were examined, there were significant differences in total FSFI ($p = 0.01$) and all domain scores ($p < 0.05$ for all) except the satisfaction domain. When controlling for parameters such as race and depression, the only variable associated with an increased likelihood of women with FSD remaining sexually active at 1 year was amount of weight lost (OR 1.149; 95% CI, 1.018–1.297, $p = 0.025$) [29] (Table 2).

Effects of Non-Surgical Weight Loss on Sexual Function: Women and Men

A multicenter randomized controlled trial compared naltrexone/bupropion, an FDA-approved weight loss drug, plus a lifestyle program to a control group with minimal lifestyle intervention. Over the 26-week study period, the experimental group lost significantly more weight than the control group ($p < 0.0001$). Sexual function was determined by Arizona Sexual Experiences Scale (ASEX) score, with dysfunction defined as a total score ≥ 19, any individual score ≥ 5, or three

individual scores ≥ 4. Of those participants with sexual dysfunction at baseline, 19% of the control group versus 58% of experimental group no longer met the criteria [30•].

Effects of Bariatric Surgery Weight Loss on Sexual Function

Several studies use bariatric surgery patients—most commonly comparing pre-operative to post-operative survey results of the same patients—as a method to investigate the relationship between sexual function and weight. This study design has the unique advantage of comparing the same patients at drastically different weights within a short timeframe.

Effects of Bariatric Surgery Weight Loss on Sexual Function: Men

Four similarly sized studies investigated the effect of bariatric surgery and the subsequent resulting weight loss on sexual function in men, but reported slightly different outcomes. All of these studies compared IIEF scores at baseline and post-operatively. The shortest duration study was of 55 obese Israeli men who underwent sleeve gastrectomy. As expected, participants lost a significant amount of weight ($p < 0.001$). When comparing the cohort on a whole, significant increases in scores of erectile function ($p = 0.02$), intercourse satisfaction ($p = 0.01$), and overall satisfaction ($p = 0.02$) domains were observed. No significant differences in orgasmic function and sexual desire domain scores were observed. However, when data were analyzed using a paired *t* test for the 39 sexually active participants, significant score increases were observed in all IIEF domains ($p < 0.045$ for all) [31••]. The three remaining studies compared baseline to 1-year post-operative IIEF scores. In a study of 30 obese men who underwent Roux-en-Y, biliary pancreatic diversion with Roux-en-Y reconstruction, or sleeve gastrectomy, Efthymiou et al. found a significant increase in total satisfaction ($p < 0.001$), contact satisfaction ($p < 0.001$), desire ($p = 0.001$), and erectile function ($p = 0.002$) domain scores post-operatively. However, multivariate and univariate analysis showed that BMI improvement was not significantly associated with improvement in sexual satisfaction [32••]. Similarly, Mora et al. studied sexual function of 39 obese men at baseline and 1 year after bariatric surgery. At baseline, an inverse correlation between total IIEF score and weight ($r = -0.516$, $p = 0.001$) was observed. Participants had a significant decrease in weight, BMI, and waist circumference ($p < 0.001$ for all), as well as a significant increase in IIEF score ($p = 0.006$). On bivariate analysis, weight ($r = 0.562$, $p < 0.001$), waist circumference ($r = 0.460$, $p = 0.006$), and BMI ($r = 0.363$, $p < 0.001$) were all associated with changes in IIEF score. No correlation with hormonal or metabolic factors and changes in IIEF were observed. When investigating IIEF domain scores, significant increases in erectile function, sexual desire, and overall satisfaction domain scores were observed ($p = 0.002$, 0.013, and 0.047 respectively), while no differences in orgasmic function or intercourse satisfaction were seen. No changes in the rates of severe dysfunction in each of the IIEF domains were observed ($p > 0.477$ for all) [33]. Finally, Kun et al. studied 39 obese men who underwent Roux-en-Y surgery and had IIEF scores < 21 at baseline, with IIEF testing repeated 1 year post-operatively. Men lost a significant amount of weight during the study (BMI 41.2 ± 8.5 vs 32.1 ± 7.3 kg/m^2, $p = 0.013$). A significant increase in mean IIEF-5 score at 1-year post surgery was observed when compared to baseline ($p = 0.004$). However, percent of excess weight lost was not correlated with increase in IIEF score ($p = 0.213$) [34]. In all, studies of bariatric surgery in men observe an increase in overall satisfaction and erectile function with none finding an impact on orgasm. The effects on intercourse and desire domains were mixed (Table 1).

Effects of Bariatric Surgery Weight Loss on Sexual Functioning: Women

Four studies investigate the effect of weight loss through bariatric surgery on female sexual function. Three of these use pre- and post-operative data from the same patients, while one compares post-operative patients to unrelated pre-operative controls. Efthymiou et al. prospectively studied 50 obese women who underwent Roux-en-Y, biliary pancreatic diversion with Roux-en-Y reconstruction or sleeve gastrectomy. Participants lost a significant amount of weight ($p < 0.0005$) and all domains of the FSFI (desire $p < 0.001$, arousal $p < 0.001$, lubrication $p = 0.005$, orgasm $p = 0.001$, pain $p = 0.021$) and total FSFI score ($p = 0.001$) increased at 1 year when compared to baseline values [32••]. In another prospective study of morbidly obese women with FSD, Hernandez found that total FSFI increased significantly at 6 and 12 months post-surgically ($p < 0.001$ for both). Additionally, scores for all domains of the FSFI significantly improved ($p < 0.001$). At 12 months, 100% of FSD resolved in all participants [3]. In a prospective cohort study, Sarwer et al. used data from the Longitudinal Assessment of Bariatric Surgery (LABS) consortium, which included 106 women undergoing Roux-en-Y or adjustable gastric banding bariatric surgery. One year after surgery, participants had a significant increase in total FSFI ($p = 0.04$) and desire ($p < 0.001$) and satisfaction ($p < 0.001$) domain scores. At 2 years post-op, a continued increase in total FSFI, satisfaction and desire ($p = 0.002$, $p = 0.002$, and $p < 0.001$ respectively) domain scores was observed, with arousal ($p = 0.01$) and lubrication ($p = 0.045$) domains also increasing when compared to baseline. No significant changes in other FSFI domain scores were observed [35]. A later study by the same authors followed the same patients to 4 years post-surgery. At year 3, total FSFI, arousal,

desire, and satisfaction ($p = 0.01$, 0.02, 0.01, and 0.001 respectively) remained significantly increased from baseline levels. Lubrication, orgasm, and pain were not significantly different than baseline ($p = 0.14$, 0.06, and 0.17 respectively). At year 4, sexual function deteriorated, with no domains significantly improved from baseline ($p > 0.05$ for all) [36]. A cross-sectional study comparing 153 women 12–18 months after bariatric surgery, sleeve gastrectomy, or Roux-en-Y, to a control group that consisted of 23 pre-operative bariatric surgery patients found no difference in total FSFI ($p = 0.44$), lubrication ($p = 0.25$), orgasm ($p = 0.67$), satisfaction ($p = 0.91$), or pain domain scores ($p = 0.21$). However, significantly higher desire and arousal scores (both < 0.01) were observed in the post-operative group, which also had a significant negative correlation between BMI and FSFI ($r = -0.697$, $p < 0.0001$). However, no relationship was seen between BMI and FSFI in the pre-operative group ($r = -0.362$, $p = 0.15$) [37]. With the exception of the Janik et al. study, which is the only study that did not use the same patients for pre- and post-operative data, all studies found increases in total FSFI, arousal, desire, and satisfaction domain scores post-operatively. However, studies differed on the effect of bariatric weight loss surgery on pain and orgasm (Table 2).

Mechanism of Sexual Dysfunction in Obese Men

The mechanism by which obesity results in sexual dysfunction is not clearly delineated. However, insulin resistance, sex hormone level derangements, peripheral vascular disease, low-grade systemic inflammation, depression, sleep apnea, and medication use for disorder associated with obesity such as antidepressants and antihypertensive have all been indicated [12••, 31••, 33]. Sex hormone imbalance has been of recent interest. Moran et al. investigated diet-based weight loss, observing significant changes in total testosterone, sex hormone binding globulin (SHBG), and calculated free testosterone ($p < 0.001$) along with significant changes in total IIEF score ($p = 0.017$) in men who lost weight via energy restricted diet. However, the authors did not correlate the changes in hormones to changes in sexual function [28•].

Mora et al. performed the most complete investigation to date into the relationship between sex hormones and sexual function in men who underwent bariatric surgery. As described above, 39 men were studied and only total IIEF, erectile function, sexual desire, and overall satisfaction were significantly increased at 1 year post-operative ($p < 0.05$). Additionally, men had significant improvements in total testosterone, free testosterone, bioavailable testosterone, SHBG, and follicle stimulating hormone (FSH) ($p < 0.001$ for all) but not estradiol or luteinizing hormone (LH) ($p = 0.2$ and 0.35 respectively). However, only sexual desire and free testosterone were correlated ($r = 0.412$, $p = 0.015$). Even when considering multiple metabolic factors in multiple regression analysis, other hormonal changes were not associated with changes in sexual function [33].

Kun et al. investigated the effect of bariatric surgery on endothelial function via the L-arginine test which was quantified using a 0–10-point score and corporal cavernosal peak systolic velocity. Both endothelial function and cavernosal peak systolic velocity indicators of penile vascular dysfunction. At 1-year post-bariatric surgery, men had a significant increase in cavernosal peak systolic velocity (23 ± 8.4 vs 37 ± 11.6 cm/s, $p = 0.002$) and endothelial function (6.1 ± 2.1 vs 8.2 ± 2.3 points, $p = 0.008$) when compared to baseline [34].

In all, both sex hormones and endothelial function appear to mediate at least some of the effects of obesity on sexual function; however, the exact link between sex hormones and sexual function remains elusive.

Mechanism of Sexual Dysfunction in Obese Women

Some studies have investigated the relationship between sex hormones, weight, and sexual function. Kadioglu et al. compared obese women to healthy controls, observing significant differences in free testosterone levels between the two groups ($p = 0.02$). However, LH ($p = 0.21$), FSH ($p = 0.06$), estradiol ($p = 0.90$), and dehydroepiandrosterone (DHEA) ($p = 0.16$) were not significantly different between the two groups. Free testosterone was negatively correlated with total FSFI ($r = -0.329$, $p = 0.02$), lubrication ($r = -0.329$, $p = 0.002$), orgasm ($r = -0.345$, $p = 0.001$), satisfaction ($r = -0.272$, $p = 0.01$), and pain ($r = -0.364$, $p = 0.001$). However, it was not associated with desire ($p = 0.64$) or arousal ($p = 0.06$). Total testosterone was negatively correlated with orgasm ($r = -0.251$, $p = 0.02$) [18]. Similarly, Yaylali et al. compared obese women to controls with respect to sexual function and sex hormone levels including free testosterone, total testosterone, estradiol, SHBG, FSH, LH, prolactin, and DHEA-S. Total testosterone levels were negatively correlated to the satisfaction domain of the FSFI ($r = -0.385$). However, no further correlations were observed between the hormones investigated and FSFI total or domain scores [19].

Sarwer et al. investigated the relationship between hormone levels, psychosocial factors, obesity, and sexual function. They used questionnaires including Impact of Weight on Quality of Life-Lite (IWQOL-Lite), which measures how weight impacts work, physical function, public distress, sex life, and self-esteem; The Body Image Quality of Life Inventory (BIQOL), which shows how body image effects several aspects of life; The Body Shape Questionnaire (BSQ), which measures opinion on body shape; and Beck's Depression Inventory (BDI), which measures depressive

symptoms. They found a significant decrease in estradiol and total testosterone at years 1 and 2 compared to baseline ($p < 0.01$). Testosterone levels remained significantly different than pre-operative in years 3 and 4 ($p < 0.001$). However, estradiol increased in years 3 and 4 to levels that exceeded pre-operative levels ($p > 0.05$). Significant increase in FSH, LH, and SHBG at years 1–4 compared to baseline ($p < 0.01$). DHEA-S was not significantly different from baseline at year 1 ($p = 0.29$) but significantly increased at years 2–4 when compared to baseline ($p < 0.01$). In all 4 years, there was significant increase in IWQOL-Lite scores in all domains including sex life ($p < 0.001$ for all). Women reported better satisfaction with body shape via BSQ, and BIQOL and fewer depressive symptoms via BDI, at all time points when compared to baseline levels ($p < 0.001$ for all) [35, 36]. Thus, along with increased sexual function in several domains of FSFI as reported above, obese women who underwent bariatric surgery had normalization of some sex hormones along with psychological benefits including improved body image and decreased depression. However, exact relationships between hormonal and emotional factors and sexual function are not completely delineated. It is important to note that while sexual function declined at post-operative year 4, sex hormone levels, depressive symptoms, self-esteem, and body shape satisfaction did not see the same decline.

Several other studies in women have found a link between psychosocial factors and sexual dysfunction. Wing et al. found a decrease in depression as measured by BDI was correlated with improvement in sexual function (OR = 1.54, p-0.005) in 229 women who lost weight through intensive lifestyle changes [29]. Erbil et al. evaluated body image with the body image score (BIS) in a cross-sectional study of 193 women. They found a negative correlation between BIS and BMI ($r = -0.157$, $p = 0.029$). Additionally, there was a positive correlation between BIS and FSFI total ($r = 0.343$), desire ($r = 0.351$), arousal ($r = 0.335$), lubrication ($r = 0.242$), orgasm ($r = 0.335$), and satisfaction ($r = 0.339$), all $p < 0.001$. However, there was no significant relationship between BIS and pain ($r = 0.044$, $p > 0.05$) [13].

In women, psychosocial factors including body image and depression along with sex hormones have been shown to play a role in mediated weight related sexual dysfunction.

Conclusions

Most recent studies show a relationship between weight and sexual function, but leave several details of the relationship unclear. Bariatric surgery is linked with resolution of sexual dysfunction in men with the exception of orgasm. In women, several studies have found bariatric surgery resulted in a decrease in FSD. However, non-surgical weight loss studies and studies comparing obese/overweight women to control populations have not shown a decrease in FSD despite a decrease in weight.

The mechanisms by which excess weight results in sexual dysfunction are not completely elucidated in either men or women. In men, some sex hormone levels change after weight loss, but only free testosterone is correlated with sexual function. Additionally, endothelial dysfunction appears to be responsible for at least some weight-related sexual dysfunction in men. In women, psychosocial factors such as depressive symptoms and body image play a role in weight related sexual dysfunction. In women, testosterone levels have also been correlated to sexual function.

More research is needed to determine if bariatric surgery alone or the weight loss resulting from bariatric surgery is the driver for improvements in sexual function in these patients. Studies comparing bariatric surgery patients who lose weight to those that fail to lose weight could shed important light on the interplay between weight loss, bariatric surgery, and sexual function. Furthermore, additional work is needed to fully elucidate the interplay between the hormonal, metabolic and psychosocial changes that result from increased weight and sexual function.

Role of the Funding Source A.W.P. is a National Institutes of Health K08 Scholar supported by a Mentored Career Development Award (K08DK115835-01) from the National Institute of Diabetes and Digestive and Kidney Diseases. This work is also supported in part through a Urology Care Foundation Rising Stars in Urology Award (to A.W.P.)

Compliance with Ethical Standards

Conflict of Interest Jenna Bates declares no potential conflicts of interest. Alexander Pastuszak reports serving as a consultant to Antares, Endo Pharmaceuticals, and Boston Scientific. Mohit Khera reports serving as a consultant to AbbVie, Coloplast, Endo Pharmaceuticals, and Boston Scientific.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. Hales CM, Carrol MD, Fryar CD, Ogden CL. Prevalence of obesity among adults and youth: United States. NCHS data brief, no 288. Hyattsville, MD: Nathional Center for Health Statistics, 2017.

2. Colquitt JL, PIckett K, Loveman E, Framptom GK. Surgery for weight loss in adults. Cochrane Database Syst Rev. 2014;8: CD003641.
3. Hernandez Hernandez JR, Lopez-Tomassetti Fernandez E, Caballero Diaz Y, Molina Cabrillana J, Morales Garcia D, Nunez Jorge V. Remission of female sexual dysfunction in morbidyl obese female patients with the Scopinaro procedure. Surg Obes Relat Dis. 2013;9:987–90.
4. Assimakopoulos K, Panayiotopoulos S, Ikonomou G, Karaivazoglou K, Matzaroglou C, Vagenas K, et al. Assesing sexual function in obese women preparing for bariatric surgery. Obes Surg. 2006;16(8):1087–91.
5. Rosen RC, Riley A, Wagner G, Osterloh IH, Kirkpatrick J, Mishra A. The international indez of erectile function (IIEF): a multidimensional scalre for assessment of erectile dysfunction. Urologia. 1997;49(6):822–30.
6. Rosen RC, Cappelleri JC, Gendrano N 3rd. The international index of erectile function (IIEF): a state-of-the-science review. Int J Impot Res. 2002;14(4):226–44.
7. Rehman KU, Asif Mahmood M, Sheikh SS, Sultan T, Khan MA. The female sexual function index (FSFI): translation, validation and cross-cultural adaptation of an Urdu version "FSFI-U". Sexual Med. 2015;3(4):244–50.
8. Rosen R, Brown C, Heiman J, Leiblum S, Meston C, Shabsigh R, et al. The female sexual function index (FSFI): a multidimensional self-report instrument for the assessment of female sexual function. J Sex Marital Ther. 2000;26(2):191–208.
9. Corona G, Rastrelli G, Filippi S, Vignozzi L, Mannucci E, Maggi M. Erectile dysfunction and central obesity: an Italian perspective. Asian J Androl. 2014;18:581–91.
10. Larsen SH, Wagner G, Heitmann BL. Sexual function and obesity. Int J Obes. 2007;31:1189–98.
11. Wingfield LR, Kulendran M, Lewis G, Chahal H, Scholtz S, Purkayastha S. Change in sexual dysfunction following bariatric surgery. Obes Surg. 2016;26:387–94.
12.•• Steffen KJ, King WC, White GE, Subak LL, Mitchell JE, Courcoulas AP, et al. Sexual funcitoning of men and women with severe obesity before bariatric surgery. Surg Obes Relat Dis. 2017;13:334–44 **This is the largest study to date to assess the relationship between BMI and sexual functioning in both women and men.**
13. Erbil N. The relationships between sexual function, body image, and body mass index among women. Sex Diasbil. 2013;31:63–70.
14. Javadnoori M, Faridi H, Najar S. The relationship between ovesity/overweight and female sexual function. Maturitas. 2015;81(1):202.
15. Costa RM, Brody S. Orgasm and women's waist circumference. Eur J Obstet Gynecol. 2014;182:112–22.
16. Adolfsson B, Elofsson S, Rossner S, Unden AL. Are sexual dissatisfaction and sexual abuse associated with obesity? A population-based study. Obes Res. 2004;12:1702–9.
17. Bajos N, Wellings K, Laborde C, Moreau C. Sexuality and obesity, a gender perspective: results from French national random probability survey of sexual behaviors. BMJ. 2010;340:c2573.
18. Kadioglu P, Yetkin DO, Sanli O, Yalin AS, Onem K, Kadioglu A. Obesity might not be a risk factor for female sexual dysfunction. BJU Int. 2009;106:1357–61.
19. Yaylali GF, Tekekoglu S, Akin F. Sexual dysfunction in obese and overweight women. Int J Impot Res. 2010;22(4):220–6.
20. Kolotkin RL, Binks M, Crosby RD, Ostbye T, Gress RE, Adams TD. Obesity and sexual quality of life. Obesity. 2006;14:472–9.
21. Esposito K, Ciotola M, Giugliano F, Bisogni C, Schisano B, Autorino R, et al. Association of body weight with sexual function in women. Int J Impot Res. 2007;19:353–7.
22. Ostbye T, Kolotkin RL, He H, Overcash F, Brouwer R, Binks M, et al. Sexual functioning in obese adults enrolling in a weight loss study. J Sex Marital Ther. 2011;37(3):224–35.
23. Ribeiro MC, Nakamura MU, Torloni MR, de Tubino Scanavino M, Scomparini FB, Mattar R. Female sexual function overweight women with gestational diabetes mellitus – a cross sectional study. PLoS One. 2014;9(4):e95094.
24. Rogers RG, Kammerer-Doak D, Villarreal A, Coates K, Qualls C. A new instrument to measure sexual funciton in women with urinary incontinence or pelvic organ prolapse. Am J Ostet Gynecol. 2001;184:552–8.
25. Bilgic D, Gokyildiz S, Beji NK, Yalcin O, Ugurlucan FG. Quality of life and sexual function in obese women with pelvic floor dysfunction. Women Health. 2018;6:1–13.
26. Benetti-Pinto CL, Ferreira SR, Antunes A, Yela DA. The influence of body weight on sexual function and quality of life in women with polycystic ovary syndrome. Arch Gynecol Obstet. 2015;291:451–5.
27. Collins CE, Jensen ME, Young MD, Callister R, Plotnikoff RC, Morgan PJ. Improvement in erectile function following weight loss in obese men: the SHED-IT randomized controlled trial. Obes Res Clin Pract. 2013;7:e450–4.
28.• Moran LJ, Brinkworth GD, Martin S, Wycherley TP, Stuckey B, Lutze J, et al. Long-term effects of a randomised controlled trial comparing high protein or high carbohydrate weight loss diets on testosterone, SHBG, erectile and urinary function in overweight and obese men. PLoS One. 2016;11(9):e0161297 **This study investigates the role of non-surgical weight loss on sexual function.**
29. Wing RR, Bond DS, Gendrano IN, Wadden T, Bahson J, Lewis CE, et al. Effect of intensive lifestyle intervention on sexual dysfunction in women with type 2 diabetes: results from an ancillary Look AHEAD study. Diabetes Care. 2013;36(10):2937–44.
30.• Halseth A, Shan K, Gilder K, Malone M, Acevedo L, Fujioka K. Quality of life, binge eating and sexual function in participatns treated for obestiy with sustained release naltrexone/bupropion. Obes Sci Pract. 2018;4(2):141–52 **This study highlights the use of weight-loss medications and the subsequent effects on sexual function.**
31.•• Groutz A, Gordon D, Schachter P, Amir H, Shimonov M. Effects of bariatric surgery on male lower urinary tract symptoms and sexual function. Neurourol Urodyn. 2017;36(3):636–9 **This study shows mixed effects of weight loss through bariatric surgery on male sexual function.**
32.•• Efthymiou V, Hyphantis T, Karaivazoglou K, Gourzis P, Alexandrides TK, Kalfarentzos F, et al. The effect of bariatric surgery on patient HRQOL and sexual health during a 1-year postoperative period. Obes Surg. 2015;25(2):310–8 **This study shows that weight loss through bariatric surgery increases female sexual function in all domains.**
33. Mora M, Aranda GB, de Hollanda A, Flores L, Puig-Domingo M, Vidal J. Weight loss is a major contributor to improved sexual function after bariatric surgery. Surg Endosc. 2013;27:3197–204.
34. Kun L, Pin A, Jianshong D, Xiaodong H, Haoyong Y, Yuqian B, et al. Significant improvements of erectile function after Roux-en-Y gastric bypass surgery in obese Chinese men with erectile dysfunction. Obes Surg. 2015;25:838–44.
35. Sarwer DB, Spitzer JC, Wadden TA, Mitchell JE, Lancaster K, Courcoulas A, et al. Changes in sexual functioning and sex hormone levels in women following bariatric surgery. JAMA Surg. 2014;149(1):26–33.
36. Sarwer DB, Wadden TA, Spitzer JC, Mitchell JE, Lancaster K, Courcoulas A, et al. 4-year changes in sex hormone functioning, and status in women who underwent bariatric surgery. Obes Surg. 2017;28:892–9.
37. Janik MR, Bielecka I, Pasnik K, Kwiatkowski A, Podgorska L. Female sexual function before and after bariatric surgery a cross-sectional study and review of literature. Obes Surg. 2015;25:1511–7.