

# Gender Differences in the Outcome of Obesity Treatments and Weight Loss Maintenance - A Systematic Review

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## Abstract

Obesity is one of the major health concerns of today. The aim of the study was to review existing literature comparing gender differences in Weight Loss (WL) and Weight Loss Maintenance (WLM). A systematic review of published studies (to November 2009) examining WL and WLM and provided results separated by gender was conducted. Two reviewers selected studies for inclusion, assessed quality, and extracted data.

The database search identified 1072 references for screening and 229 were selected for possible inclusion. A search update in August 2011 identified an additional 186 references and 62 were selected for possible inclusion. Fifty-four studies were included. Seventeen studies included surgical WL procedures and 37 studies examined non-surgical WL treatments. For both types of WL treatment, about half of the studies reported higher absolute WL in men whereas the other half of the studies reported no gender differences. The majority of the 12 studies on WLM reported no gender differences. Meta-analysis revealed higher relative weight loss in men compared to women. WL treatment outcome appears to be in favour of WL in men. More research attention should be paid to gender specifics regarding WL treatment and WLM.

**Keywords:** Obesity; Gender; Therapy; Treatment; Weight loss

**Abbreviation:** BMI: Body Mass Index; LGBP: Laparoscopic Gastric Bypass; LSG: Laparoscopic Sleeve Gastrectomy; RYGB: Roux-en-Y Gastric Bypass; WL: Weight Loss; WLM: Weight Loss Maintenance; WMD: Weighted Mean Difference

## Introduction

The prevalence of obesity is alarmingly high across the world [1] and affects both genders although it is higher in women than in men [2]. However, obese men are at a higher risk for obesity-related chronic diseases because of fat accumulation in mainly abdominal and visceral body regions.

The treatment of obesity can be mainly divided into two categories: conventional behavioural therapy focusing on dietary and physical activity changes or surgical therapy. The popularity of weight loss surgery has increased [3,4] and surgery for severe obesity appears to improve risk factors and decrease overall mortality [5]. Different types of surgery tend to report different levels of weight loss success [6] and more women than men tend to undergo weight loss surgery and enter any type of treatment in general [7]. However, given the diversity of patients including their starting weight or already existing co-morbidities, there has been no definite answer for the support of one surgical method over the other [8-10]. One systematic review, nonetheless, revealed results in favour of gastric bypass procedures compared to gastric banding to treat obesity in the U.S. [11]. One consistent factor for success in surgical patients appears to be younger age whereas divergent results on gender have been found [7]. Even less is known about factors for success in patients choosing conventional therapies. Pre-treatment weight loss and initial weight loss [12,13], psychological factors such as body satisfaction, mood or self-efficacy [14-16], or social support all appear to be factors that positively influence treatment outcome.

Consistent knowledge about successful long-term weight loss maintenance is lacking but the method of weight loss – surgical or conventional methods – appears to be unrelated to success. A meta-analysis of US studies revealed that 44% of the participants maintained their initial weight loss at two years and only 28% at four years [17]. Results from the National Weight Control Registry show the importance

of dietary restraint and weight monitoring as well as eating breakfast, and adhering to a relatively intensive exercise regime [18-21]. Other mentioned factors for long-term success in weight loss maintenance seem to be certain medications, regular consultations with physicians and other support sources as well as social support [22,23].

Not many studies have further investigated subgroups and individual differences such as possible gender differences in the successful treatment and maintenance of weight loss.

The aim of this review was to look systematically at the differences in weight loss and weight maintenance after weight loss treatments between men and women including both surgical and conventional methods. The review's objective is to determine whether men or women are more successful in either weight loss or weight loss maintenance and whether possible differences can be found between treatment types.

## Materials and Methods

A systematic search for the published literature in the languages English and German was undertaken with Medline, Embase and Cochrane Database of Systematic Reviews (all dates starting with citations indexed 1980 to November 2009) [24]. An additional systematic search was conducted with citations indexed December 2009 to August 2011. Also, a hand search of reference lists identified by the systematic search of the literature was conducted. Search terms included obesity, overweight, surgery, weight loss program, weight maintenance, weight loss, psycho-education, dietetic counselling, diet,

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and caloric restriction. Eligible study types were cross-sectional, cohort and case-control studies, clinical trials, meta-analysis and systematic reviews with adult human subjects. Studies with subjects with pre-existing medical conditions (e.g., diabetes, metabolic syndrome) were also included. Types of outcome measures were not specified but the article had to mention results on weight loss and maintenance of weight loss of both men and women. Excluded were studies addressing participants under the age of 18 years, participants with existing psychiatric disorders, studies without information on gender as well as case studies, abstracts, and editorials.

From a reading of the titles and abstracts, identified by the literature search, each eligible publication was selected if the inclusion criteria were met. The content was reviewed by two independent investigators to determine eligibility. When there were discrepancies, other investigators conducted additional evaluation of the study and discrepancies were resolved in conference. Assessment of methodology was made independently by both reviewers evaluating whether there was a clear research question with specific results, a clear description of inclusion and exclusion criteria, a sound methodology, generalizability and a mentioning of limitations. For each eligible study a checklist based on the PRISMA statement was filled out [24] and the following data was abstracted: Title, authors, publication year, journal title, country where the study was conducted, recruitment period, treatment indication, research question, setting, selection criteria, number of groups, study design, randomization, study length, primary study outcome, statistical methods, number of analysed subjects separated by gender and on gender reported results, weight related results (mean baseline weight in kg and/or BMI, mean weight change).

Hedges' g statistics as a formulation for the Weighted Mean Difference (WMD) were used for the meta-analysis of studies with a continuous measure (comparison of relative mean weight loss between men and women) where data was available. The overall WMD with a 95% confidence interval was given. Based on the variability regarding participants and treatment within the included studies, the random effects model was considered. Heterogeneity was evaluated using the I<sup>2</sup> statistic, which describes the percentage of variation as a result of heterogeneity rather than chance. For the analyses the statistical program STATA/IC 12 was used.

## Results

### General characteristics of included and excluded studies

The database search identified 1072 references for screening. Based on reading the title and the abstracts of all found references, 229 full-text articles were reviewed for possible inclusion. Thirteen studies were selected mentioning weight loss separated by gender as outcome after weight loss surgery and 31 studies included results on weight loss separated by gender after other non-surgical treatments.

The additional more recent database search further identified 186 references for screening and 52 references were selected for full-text review. Ten studies were included, 4 studies reported results on weight loss separated by gender after weight loss surgery and 6 studies reported results on weight loss separated by gender after non-surgical treatments.

Taking together both systematic searches, the majority of the excluded 214 studies did not match the main criteria such as the analysis of weight loss (excluded studies examined e.g. complications during and after surgery, dietary habits without analyzing weight, hormonal changes after surgery, characteristics of people choosing surgery, psychological or behavioural variables affecting weight loss). The other excluded studies lacked comparison of men and women

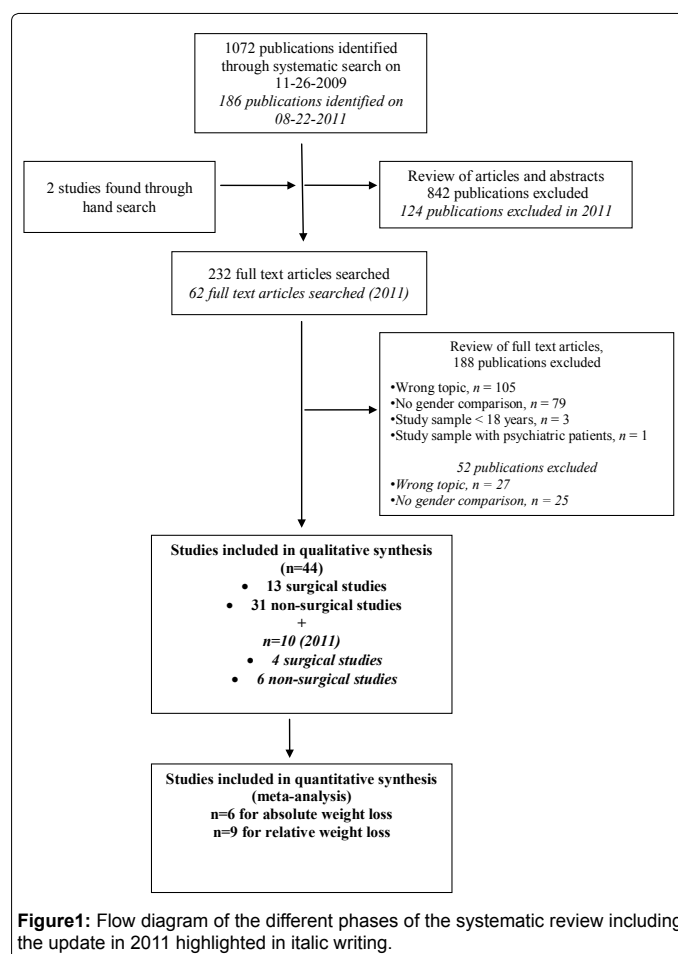
regarding weight (103 articles). An additional three studies had a sample population of less than 18 years of age and two studies investigated obese psychiatric patients (Figure 1). In the recent systematic search, one publication was identified that reported the same weight loss results separated by gender already mentioned in an earlier publication [25] and was therefore excluded [26].

### Surgical studies

All except one [27] of the 17 included surgical weight loss studies [27-43] were cross-sectional prospective or retrospective studies (5 studies [31,37,41-43]). The follow-up years ranged from 0.5 up to 22.9 years. The majority of the studies ranged from 0.5-1 year follow-up (9 studies [28-30,32-38,40,42]) and the remaining studies ranged from 2 up to 5.7 years when leaving out the one retrospective analysis of 22.9 years of follow-up [31].

Of the 17 surgical weight loss studies, two studies were considered to have low quality due to either a small sample size with a weak methodology or missing inclusion criteria description [30,35].

Overall, of the 17 included studies, seven investigated the effects after some version of the gastric bypass (hand-assisted, open, stapled, transacted, laparoscopic RYGB) [28-33,41]. Seven studies published results using gastric banding [27,34,36,37,39,42,43]. Two studies used laparoscopic sleeve gastrectomy (LSG) [38,40] while one of the two included both LGBP and LSG (40). One publication did not specify the surgical procedure [39]. General study characteristics for the included surgical studies are presented in Table 1.



1. Author, Year, Location	Study Design	Type of surgery	Population	Outcome Parameter	Results	Gender Differences	Data
Andreu et al. [40] Spain	Cross-sectional prospective study for 12 months	LGBP & LSG	101 patients (25 men, 76 women)	WL (+ influence of protein intake)	Greater FFM loss in men (FFM: male 26.7±1.4% vs. female 20.6±0.8%)	Yes (men)	#
Barhouch et al. [41] Brazil	Retrospective cross-sectional study (5 years)	RYGB surgery	93 patients (17 men, 76 women)	WL	no gender differences (but no data)	No	•
Machado et al. [33] Brazil	Cross-sectional prospective study for 6 months	RYGB surgery	71 patients (29 men, 42 women)	WL	Greater WL in men and younger patients.	Yes (men)	□
Dixon et al. [36] Australia	Cross-sectional prospective study for 12 months	LAGB surgery	440 patients (57 men, 383 women)	Predictors for WL	Higher starting BMI, diabetes mellitus but not gender as predictor.	No	•
Frezza et al. [38] USA	Cross-sectional prospective study for 12 months	LSG	20 patients (2 men, 18 women)	WL	Greater WL in men.	Yes (men)	•
Günther et al. [31] Germany	Cross-sectional retrospective study (22.9 years)	Horizontal gastroplasty, stapled RYGB, transected RYGB surgery	98 patients (16 men, 82 women)	BMI and % of excess WL	Horizontal gastroplasty has the least WL. No gender differences in WL.	No	□
Infanger et al. [34] Switzerland	Cohort study for 2 years	Gastric banding	154 obese after bariatric surgery (26 men, 128 women) 158 never obese controls (39 men, 119 women) 863 obese controls (243 men, 620 women)	WL, serum leptin levels, %FM, %FFM, lean mass (%)	No gender difference in WL or serum leptin levels. More decrease in %FM in men. More increase in %FFM + % lean mass of extremities in men. Better body composition changes in men.	Yes (men for fat mass)	#
Kinzl et al. [37] Austria	Cross-sectional retrospective study (30-50 months)	LAGB surgery	300 patients (80 men, 220 women)	Predictors for WL	No gender differences in WL.	No	#
Lee et al. [35] Taiwan	Cross-sectional prospective study for 2 years	LAGB	74 patients (22 men, 52 women)	Predictors for successful WL	27 patients had successful WL (excess WL > 50%), 47 did not. Female gender as predictor (+ lower insulin & albumin, two genes)	Yes (women)	□
Löfgren et al. [27] Sweden	Longitudinal clinical trial, 2+3 year follow-up	Adjustable gastric banding	23 obese & healthy patients (10 men, 13 women) - 42 healthy & never obese subjects	Adipocyte lipolytic capacity of abdominal subcutaneous fat cells	No gender differences in WL or fat cell volume following surgery.	No	•
Melton et al. [32] USA	Cross-sectional prospective study for 12 months	RYGBP	495 patients (91 men, 404 women)	Percentage of suboptimal WL	55 had suboptimal WL, 444 with successful WL. Suboptimal WL was associated with higher starting BMI, male gender & diabetes mellitus.	Yes (women)	#
Powers et al. [39] USA	Cross-sectional prospective study for 2+5.7 years	Gastric restriction surgery (not specified)	86 patients (13 men, 73 women)	WL	Men had a greater total WL. (Low quality rating)	Yes (men)	#
Ranasinghe et al. [43] Australia	Cross-sectional retrospective study (10 years)	LGB	176 patients (34 men, 142 women)	WL	Greater WL in men but higher percentage of WL and greater BMI loss in women	Yes (women)	#
Roberts et al. [28] USA	Cross-sectional prospective study for 6+12 months	LRYGB surgery	320 patients (59 men, 261 women)	Relationship between pouch size and percentage of excess WL	Male gender and increased preoperative BMI as predictors for larger pouch size and therefore less % of excess WL.	Yes (women)	•
Shermak et al. [30] USA	Cohort study for 6+18 months	Open gastric bypass & LRYGB surgery	64 gastric bypass patients & 6 exercise and diet patients (13 men, 57 women)	WL (lbs)	Higher WL and WLM for surgery group compared to WL with exercise and diet. No gender differences in both groups. No gender differences in WL or WLM (Low quality ratings)	No	•
Tymitz et al. [29] USA	Cross-sectional prospective study for 6+12 months	Hand-assisted LRYGB surgery	319 patients (54 men, 265 women)	WL (lbs)	Men weigh significantly more before surgery and lost more lbs at 6+12 months assessment.	Yes (men)	#
Weichman et al. [42] USA	Retrospective cross-sectional study (6 years)	LAGB	2,909 patients (980 men, 1,989 women)	WL	higher percentage of excessive WL in women	Yes (women)	•

**Abbreviations.**

BMI – Body Mass Index; FFM – Fat free mass; LRYGB – Laparoscopic Roux-en-Y gastric bypass; LAGB – Laparoscopic adjustable gastric banding; LSG – Laparoscopic sleeve gastrectomy; N – Number of participants; SD – Standard deviation; WL – Weight loss; WLM – Weight loss maintenance

\* studies used in the meta-analysis; pre-post N, means, SD available

□ missing SD or N

# only statistical data about total weight loss, or loss of FFM or dichotomous data (success yes or no) etc.

• no gender-specific statistical data about weight loss available

**Table 1:** Study characteristics for weight loss surgery studies

## Results on gender differences in the surgical studies

Of the 17 studies that included surgical weight loss procedures, six studies reported higher absolute weight loss in men [28,29,33,38,39,43] whereas two studies reported greater absolute weight loss in women [32,35]. But one of the six studies that showed higher weight loss in men reported greater absolute weight loss in men but greater BMI loss in women [43]. One additional study revealed female gender as a significant predictor for percentage of excessive weight loss [42]. Six studies reported no gender differences [27,30,31,36,37,41]. One additional study examined changes in percentage of fat mass and fat free mass after bariatric surgery and found higher percentage loss of fat mass and higher percentage increases in fat free mass in men compared to women [34]. Further, one recent study only reported gender differences in fat free mass loss with a higher proportion of weight loss as fat free mass in men compared to women [40].

Five of the 17 included studies also looked at weight loss maintenance after surgery and four studies found no gender difference [27,31,34,37] whereas one study found better weight loss maintenance in men [39].

## Non-surgical studies

Of the 37 included studies, 21 had a cross-sectional study design investigating the effect of behavioural interventions on weight loss [44-66]. Ten studies were randomized controlled trials or studies with at least two- group comparisons [25,30,65-73]. Three publications compared selected studies using meta-analytical techniques [17,73,74] and two publications were cross-sectional surveys (investigating weight loss strategies and other weight loss related variables) [75,76]. Further, one study looked at the effect of having different nutritionist as part of the intervention and its effect on weight loss [77]. Table 2 presents the study characteristics of the 37 included non-surgical studies.

The study quality was determined to be low in only three of the included studies with the main reason being missing information such as length of treatment, definition of program effectiveness or a small sample size [30,46,54].

The majority of the included non-surgical studies used behavioral modification as treatment choice including diet, exercise and psychological counselling treatment components (22 studies [30,45-50,54,66,68,52,53,55,57-59,63,64,68-71]). Only seven publications conducted studies with diet treatment only [25,44,56,60-62,70]. The meta-analysis by Ballor and Poehlman [74] included both diet only and diet and exercise interventions.

## Results on gender differences in the non-surgical studies

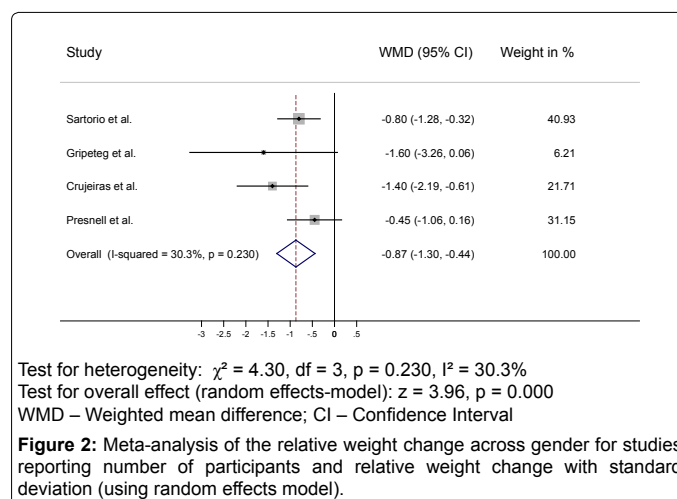
Sixteen studies found no gender differences in weight loss treatments [30,45,48-54,58,59,63,65,66,69,74] whereas 16 study results showed better weight loss in men compared to women [25,44,46,47,55-57,60-63,66,68,70,71,73]. Two of those 16 studies, however, showed either only better absolute weight loss in men using any type of fish supplement compared to a control intervention which was not the case in women [25], or better weight loss in men compared to women within one treatment group [70]. Furthermore, one cross-sectional survey of the Danish population found more men than women reporting to be successful in weight loss and weight loss maintenance [76]. One of the two meta-analysis using survey results showed that although women were twice as likely to attempt to lose weight, men were 40% more likely to have success in these attempts [73]. One of the other included meta-analysis investigated gender differences and the influence of exercise on diet induced weight loss but could not detect any gender differences [74].

Only one study found better weight loss in women across four different intervention groups varying in fish and fish oil content [25] but the significance disappeared when comparing the intervention groups separately.

Regarding weight loss maintenance, seven studies mentioned results on gender differences. Four studies revealed no gender difference [17,30,54,65], one of them a meta-analysis [17]. Two studies reported better weight loss maintenance in men [57,76] and two other studies revealed less regain in women than men [53,72]. One of these studies, however, compared Orlistat treatment with a placebo group [72].

Some studies, especially those with cross-sectional surveys did not include statistical results on weight loss or weight loss maintenance but rather asked participants about their weight loss strategies and practices [50,73]. One retrospective phone survey by Williamson et al. [75] revealed a self-reported average weight loss in men of 10-12lbs and an average weight loss in women of 8-9lbs but it was also reported that men started with a higher initial weight than women. The other study on predictors of adherence to diet and exercise programs revealed that men were more likely to complete a program than women [50].

A comprehensive meta-analysis separating surgical and non-surgical studies and including the relatively large number of selected studies could not be conducted given the lack of available data in the publications. For a description of data available see Table 1 and 2. Most studies did not report mean changes in weight or changes in BMI including the standard deviation. Most studies' focus were not on gender difference in WL or WLM but rather mentioned existing difference or the lack of in a brief paragraph or sentence in the result section without providing data, only four studies were suitable to compare relative weight loss between men and women providing means with standard deviation and the number of participants (Table 3, Figure 1). The weighted mean difference of the random effects model at -0.87 for relative weight loss indicated significant ( $p < 0.001$ ) but small effects with males losing more percentage weight than females. The meta-analysis revealed slight heterogeneity with  $I^2 = 30.3\%$  ( $p = 0.230$ ). Post-hoc exploration identified one study to differ from the others by a considerably lower mean BMI [61]. Excluding this study from the meta-analysis, the overall effect size was lowered to -0.71 (95% confidence interval = -1.08 to -0.35,  $p < 0.001$ ) but removed heterogeneity completely ( $I^2 = 0\%$ ).





1. Author, Year, Location	Study Design	Type of treatment	Population	Outcome Parameter	Results	Gender Differences	Data
Anderson et al. [17] USA	Meta-analysis	Long-term WLM (> 2 years)	- 29 studies from 1970-1999	-WLM (and comparison of VLCD with hypoenergetic balanced diet)	- No gender differences in WLM, percentage of WLM and reduced weight.	No	•
Assaf et al. [73] USA	Non-systematic meta-analysis	Changes in CVD risk factor behaviors	- 3 different surveys within the PHHP with total of > 112,000 contacts	-Gender differences in attempts to change CVD risk factor behaviors	- Women were more likely than men: <ul style="list-style-type: none"> <li>- to have repeated contacts regarding exercise.</li> <li>- to increase the amount of physical activity (49.%% vs. 39.2%) but no gender differences in successful</li> <li>- increase in physical activity.</li> <li>- to report attempts to increase exercise but men were more likely to maintain the increase in exercise.</li> <li>- to join WL contest but more men were successful at WL</li> <li>- to attempt to lose weight (twice as likely) but men were 40% more likely to have success in these attempts.</li> </ul>	Yes (men)	•
Ballor and Poehlman [74] USA	Meta-analysis	Diet induced WL	- 46 studies from 1964-1991	-Influence of exercise and gender on composition of diet induced WL	- No gender differences <ul style="list-style-type: none"> <li>- (less FFM loss with exercise than dietary restriction in both genders).</li> </ul>	No	•
Bautista-Castano et al. [50] Spain	Cross-sectional, prospective study for 4 years	Hypocaloric, Mediterranean diet with exercise recommendations (until WL was achieved)	- 1018 overweight subjects (230 men, 788 women) seeking help to lose weight at clinic	-Predictors of adherence	- 717 subjects did not complete program <ul style="list-style-type: none"> <li>- Predictors for completion: male gender, previous diet programs, initial higher BMI, younger age, absence of parental obesity &amp; adult onset obesity.</li> </ul>	Yes (men)	•
Bendixen et al. [76] Denmark	Cross-sectional surveys in 1992 and 1998	Slimming behavior	- 2446 randomly selected Danish subjects (1258 men, 1188 women)	-Slimming behavior	- More women attempted WL <ul style="list-style-type: none"> <li>- More men changed their habitual diet during slimming treatment.</li> <li>- More women had their physician supervise their slimming treatment. Over the counter diet pills or meal replacements were more prevalent in women (which was related to a negative outcome).</li> <li>- More men (37%) than women (31%) used increased exercise as slimming method.</li> <li>- More men (66%) than women (61%) reported to be successful in WL.</li> <li>- More men (32%) than women (30%) were successful in WLM</li> </ul>	Yes (men)	#
Crujeiras et al. [61] Spain	Cross-sectional prospective study	8-week hypocaloric diet	- 104 participants (55 men, 49 women)	-Involvement of ghrelin, leptin and insulin plasma levels in weight regain	- Average WL of 5.0±2.2% body weight <ul style="list-style-type: none"> <li>- Higher % of WL in men (-4.5±1.9% for women, -5.9±2.2% for men)</li> </ul>	Yes (men)	*
Dalle Grave et al. [59] Italy	Observational study	25 obesity centers, 3-6 months treatment periods (diet & exercise), 2-4 months follow-up	- 500 participants (106 men, 394 women)	-Psychological effect of WL	- WL was associated with improved psychometric testing <ul style="list-style-type: none"> <li>- No significant differences in WL between men and women</li> <li>- (9.0%WL in men, SD 7.7 vs. 7.6%WL in women, SD 8.5)</li> </ul>	No	#
De Panfilis Et al. [58] Italy	Cross-sectional prospective study	6-month behavioral WL program	- 92 obese patients (12 men, 80 women)	-Personality and attrition to WL treatment	- No gender differences between completers and non-completers.	No	•
Graffagnino et al. [55] USA	Cross-sectional retrospective study for 2 years	2 year WL program (introduced into a managed care setting)	- 962 employees of a managed care organization (228 men, 674 women)	-Changes made in diet and physical activity for WL	- Both genders decreased fat intake + increased exercise levels during 2 year period. <ul style="list-style-type: none"> <li>- In women, increases in exercise without changes in dietary fat intake conferred almost no WL benefit. Increases in exercise were beneficial for men. Moderate or substantial increases in exercise were needed in women to enhance effects of dietary changes, all levels of fat restriction enhance effect of exercise. No differences in men.</li> </ul>	No	#

Eriksson et al. [52] Finland (& USA)	Cross-sectional, prospective study for 5 years	Lifestyle intervention (Data from 1-year follow-up)	- 69 obese subjects with IGT	-Changes in serum leptin concentrations	- WL was associated with reduction in leptin concentrations in both genders. (Serum leptin concentrations higher in women at baseline)	No	•
Forster and Jeffery [53] USA	Cross-sectional prospective study for 16 weeks	Behavioral WL program with 12 months follow-up	- 113 overweight participants (55 men, 58 women)	- WL - WL associated behaviours	- No gender differences in short-term WL but women maintained WL better than men. (Predictors of WL was prior WL attempts, higher weight at age 25)	Yes (women for WLM but not WL)	□
Graffagnino et al. [55] USA	Retrospective database analysis from 2001 to 2004	6 month community based WL program	- 418 overweight participants (study cohort = 198 completers (56 men, 142 women))	- WL - Changes in cardiovascular risk factors	- Greater WL in men (also changes in glucose, triglycerides and LDL-C).	Yes (men)	#
Gripeteg et al. [60] Sweden	Cross-sectional prospective study	12 week VLCD	- 148 participants (73 men, 148 women)	-WL	- Mean WL = 13.5±5.6% in women and 15.1±6.1% in men (p=0.054)	Yes (men)	*
Handjjeva-Darlenska et al. [62] European countries	Cross-sectional prospective study (but part of RCT)	8-week low-calorie diet	- 801 participants (279 men, 522 women)	-Predictors of WL	- greater WL in men (men: 12.67±0.24kg, women: 9.87±0.13kg, p<.01 and men:11.6±0.22%, women: 10.4±0.11%, p <.01)	Yes (men)	□
Hoie and Bruusgaard [44] Norway	Cross-sectional, prospective study for 8 weeks	VLCD	- 253 obese subjects (101 men, 152 women)	- Pre-operative predictors of WL - WL	- Men lost more weight and waist circumference than women. (Other significant predictors: initial BMI + weight)	Yes (men)	#
Hollis et al. [71] USA	Four-center randomized trial over 30 months	20 weekly group sessions on WL (results of initial 6-months WL program)	- 1685 participants (551 men, 1134 women)	-Predictors of WL	- Greater WL in men. - More physical activity and food records in men. - Amount of physical activity is better predictor of WL for men than women.	Yes (men)	+
Hubbert et al. [66] USA	Cohort follow-up study	12-week WL program with & without reimbursement	- 25 obese participants in reimbursement group (5 men, 20 women) - 100 obese participants without reimbursement (21 men, 79 women)	- Program attrition - WL	- More WL in reimbursement group. - Odds of losing weight higher for men and higher for regular attendees.	Yes (men)	#
Kaukua et al. [49] Finland	Cross-sectional, prospective study for 4 months	4 month WL program (10 weeks of VLCD + 17 weeks of behavior modification) + 2 year follow-up	- 126 obese participants (43 men, 83 women)	-WL, health-related quality of life	- No gender differences of mean weight change (including follow-up).	No	•
Kotchen et al. [46] USA	Cross-sectional, prospective study	Very low calorie diet & education	- 155 patients (40 men, 115 women)	-Gender differences in obesity related cardiovascular risk factors	- Greater WL in men (29.1+ 2.4kg) than women (17.9 + 1.2kg), but no differences in percentage change in body weight. (Low study quality)	Yes (men)	#
Lafortuna et al. [69] Italy	Randomized, controlled clinical trial for 3 weeks	BMI reduction program with diet, nutritional education, psychological counselling & exercise	- 30 obese in -patients (12 men, 18 women) - Group 1: non-specific exercise training - Group 2: individualized exercise training	-Weight loss	- Both groups lost weight. - No gender differences in weight loss within or between groups.	No	#
Leenen et al. [64] Netherlands	Cross-sectional, prospective study for 13 weeks	Individualized diet & activity program	- 78 healthy obese subjects (38 men, 40 women)	-Changes in body composition including visceral fat accumulation & energy expenditure	- No gender differences in weight loss and fat mass. - Amount of visceral fat in men was related to WL but not in women.	No	#
Lok et al. [63] China	Cross-sectional prospective study	12-week lifestyle modification program (with 4 different nutritionists)	- 645 participants (145 men, 500 women)	-Differences in WL across the 4 nutritionists	- Significant differences in WL across nutritionists - Smaller weight reduction in women (9.2%) compared to men (10.1%), p<.001)	Yes (men)	□
Mauriège et al. [56] Canada	Cross-sectional prospective study for 25 weeks	15 week dietary restriction with 4-6 week follow-up	- 32 healthy obese subjects (14 men, 18 women)	-Changes in adipose tissue lipolysis	- Men lost more weight - Fat cell weight decreased in both genders.	Yes (men)	#

Nicklas et al. [45] USA	Cross-sectional, prospective study for 6 months	6-months hypocaloric WL intervention (diet + exercise) (after 8 week of weight stabilization period)	- 70 obese patients (23 men, 47 women)	-Changes in leptin concentrations & body weight (% body fat, FFM)	- At Baseline: women had 3-fold higher leptin levels for a given fat mass than men. - Diet intervention: both genders lost sign amount of weight; men lost sign amount of lean tissue mass, but not women; No gender differences in changes in % body fat and fat mass; leptin levels declined sign in both genders but more in women. After 6 months of caloric restriction, leptin levels decrease in proportion to FM loss in older man but in older women, leptin concentrations decrease more than proportionally.	No (for body fat and fat mass), yes (women for body weight)	□
Presnell et al. [48] USA	Cross-sectional, prospective study for 4 weeks	4 week dietary WL program with 12 months follow-up	- 297 obese participants (74 men, 223 women)	-Effect of self-efficacy, binge eating & depressive symptoms on WL	- No gender differences in WL. In men: - higher baseline level of self-efficacy as significant predictor of weight change (not in women). - higher baseline level of binge eating symptoms predicted greater WL (marginally in women). - higher baseline depressive symptoms predicted greater reduction in BMI (not for women).	No	*
Richelsen et al. [72] Norway, Sweden, Finland, Denmark	3-year randomized, placebo-controlled trial	8 weeks of VLCD with 3 year maintenance treatment	- 209 participants - 153 in Orlistat group (36 men, 77 women) - 156 in placebo group (76 men, 80 women)	-Weight regain	- Weight regain higher in placebo than orlistat. - Greater WL in women in orlistat vs. placebo group, not so in men.	Yes (women)	•
Richman et al. [65] Australia	Matched control clinical trial	Shared Care vs. established hospital based programme (control) for 26 weeks	- -37 patients in shared care program (8 men, 29 women) - 101 patients in hospital based programme (20 men, 81 women)	- Absolute & relative weight loss - Retention rate	- No group differences in WL. - Women in shared care programme achieved greater WL than women in control group at week 10 (but not week 26). - No weight differences in men. - No gender differences in WL in week 26.	No	+
Sartorio et al. [47] Italy	Cross-sectional, prospective study for 3 weeks	VLCD & daily exercise & nutrition education & psychological counselling for 3 weeks	- 95 obese subjects (28 men, 67 women)	-Changes in body composition and motor functionality	- Greater WL in men (5.12 vs. 4.27%kg). - More fat mass loss in women. - More FFM loss in men. - No gender difference in changes in muscle strength. - Higher power output in men.	Yes (men)	*
Shermak et al. [30] USA	Cohort study for 6+18 months	Open gastric bypass & LRYGB surgery	- 64 gastric bypass patients & 6 exercise and diet patients (13 men, 57 women)	-WL (lbs)	- Better WL and WLM for surgery group compared to WL with exercise and diet. - No gender differences in both groups. - No gender differences in WL or WLM. - (Low quality rating)	No	•
Thorsdottir et al. [25] Iceland, Spain, Ireland (see also Ramel et al. [26])	Randomized controlled clinical trial for 8 weeks	Energy restricted diet with varying in fish and fish oil content for 8 weeks	- 66 controls (24 men, 42 women) with sunflower oil capsules - 70 with lean fish (31 men, 39 women) - 74 with fatty fish (37 men, 37 women) - 68 with fish oil capsules (28 men, 40 women)	-WL	- Average WL for women 6.5kg, for men 4.2kg on all diets. - In all 3 intervention groups more WL than in control group in male subjects only.	Yes (both in different ways)	#
West et al. [70] USA	Secondary analysis of DDP data from 1996-1999 (randomized controlled trial)	Intensive lifestyle program vs. Metformin vs. placebo	- 2,921 overweight participants with IGT (1012 men, 1881 women)	-WL	- No gender differences overall. - No gender differences in metformin group. - Men lost more weight in lifestyle group than women. - Lifestyle group lost more weight than metformin group.	Yes (men) and No	+

Williamson et al. [75] USA	Retrospective cross-sectional phone survey (secondary analysis)	WL practices	- 21 673 participants that are currently trying to lose weight (6758 men, 14 915 women)	-WL practices	- Men lost on average 10-12 lbs. - Women lost 8-9 lbs but men started with higher initial weight.	Not clear	#
Wing 1990 USA	Cross-sectional, prospective study for 12-20 weeks + 1 year follow-up	Behavioral weight control program with weekly group meetings	- 178 patients with type II diabetes (55 men, 123 women)	-WL	- Greater WL in men. - Men were more likely to maintain.	Yes (men)	#
Wing et al. [67] USA	Randomized controlled trial for 72 weeks	20 week behavioural WL program with 1 year follow up	- Group 1: 23 obese diabetic patients alone (10 men, 13 women) - Group 2: 20 obese diabetic patients with spouses (8 men, 12 women)	-WL	- No gender differences WL - Men did better when treated alone and women did better when treated together.	No	•
Wing and Jeffery [68] USA	Randomized controlled clinical trial for 18 months	18 months of behavioural WL treatment	- 131 overweight participants (68 men, 63 women) in 4 different behavioural WL programs - 28 overweight controls	-Effect of modest WL on changes in cardiovascular risk factors	- Men showed greater decrease in blood pressure, triglycerides, waist-to-hip ratio & greater increase in HDL-cholesterol no differences after adjustment for baseline values and changes in BMI. - Waist-to-hip ratio better in women at 18 months. - More WL in men.	Yes (men)	#
Wirth and Steinmetz [51] Germany	Cross-sectional, prospective study for 15 weeks	3 week WL program with 12 weeks follow-up	- 32 obese subjects (16 men, 16 women)	Changes in subcutaneous and intra-abdominal fat	- No gender differences WL. - No gender differences in body fat mass changes. - Men lost more visceral fat than women. - Women lost more subcutaneous fat than men.	No	♦
Wood [54] USA	Cross-sectional, retrospective study	Individual counseling with behaviour modification program (at least 2 visits)	- 73 participants (≥2 visits; 30 men, 43 women)	-Program effectiveness after 1 year of WL maintenance	- No gender differences in WL or WLM (Low quality rating)	No	#

\*study also included in surgical studies

**Abbreviations:**

- BMI – Body Mass Index
- BRFSS – Behavioral Risk Factor Surveillance System
- CD-TI – Cardiovascular Disease Targeted Initiative
- CVD – Cardiovascular disease
- DDP – Diabetes Prevention Program
- FFM – Fat free mass
- IGT – Impaired glucose intolerance
- N – Number of participants
- PHHP – Pawtucket Heart Health Program
- RCT- Randomized controlled trial
- SD – Standard deviation
- VLCD – Very low calorie diet
- WL – Weight loss
- WLM – Weight loss maintenance

\* studies used in the meta-analysis; pre-post N, means, SD available

□ missing SD or N

+ only available for subgroups

# only statistical data about total weight loss, or loss of FFM or dichotomous data (success yes or no) etc.

♦ weight loss intervention goal based on gender

• no gender-specific statistical data about weight loss available

**Table 2:** Study characteristics for non-surgical weight loss studies.

Study	Men		Women		Treatment length in weeks
	N	Mean %WL (SD)	N	Mean %WL (SD)	
Sartorio et al. [47]	28	5.1 (0.91)	67	4.3 (1.42)	3
Gripeteg et al. [60]	73	15.1 (6.1)	148	13.5 (5.6)	12
Crujeiras et al. [61]	49	5.9 (2.2)	55	4.5 (1.9)	8
Presnell et al. [48]	74	6.02 (2.47)	223	5.57 (1.79)	4

WMD – Weighted Mean Difference; CI – Confidence Interval; N – Number of participants; WL – Weight loss; SD – Standard Deviation

**Table 3:** Characteristics of studies used in the meta-analysis.



## Discussion

Given the small number of studies included in the meta-analysis, the results can not indicate a definite answer to the posed question of existing gender differences in weight loss and weight loss maintenance after weight loss treatments. For surgical procedures, six studies detected better results for men but six other studies detected no gender differences. Similar patterns could be observed for the included non-surgical studies. Sixteen studies reported no gender differences whereas 16 studies found better weight loss in men compared to women. Where available, the difference in relative weight loss between men and women, as shown in figure 2, show results in favor of weight loss in men. The majority of extracted study results were reported in absolute weight loss although for the purpose of comparing men and women relative weight loss is a more accurate measure of detecting gender differences. Nevertheless, concluding from this systematic review, it seems apparent that women mostly do not achieve better weight loss than men.

The results looking at gender differences for weight loss maintenance are even less conclusive. The majority (8 studies) of all included studies mentioning weight loss maintenance reported no gender differences. Only three studies reported better weight loss maintenance in men and two studies reported better weight loss maintenance in women.

Some general limitations need to be mentioned. The research only included studies in English and German, which might cause underrepresentation of non-English and non-German reporting studies. In addition, the heterogeneity of the selected studies made it difficult to draw a convincing conclusion. Most of the included studies did not look at gender differences as their primary outcome and failed to report actual numbers separated by gender (such as age, weight, BMI, etc.). The studies not only varied widely in sample size but also in length and type of treatment as well as follow-up years. Given the heterogeneity of the studies found, and more specifically the outcome methodologies, and the lack of statistical results in some of the studies, the meta-analysis has only limited explanatory power of the results.

Overall, when generalizing the findings, it can be suggested that more attention should be paid when treating women for weight loss. In support of this conclusion is a recent systematic review of weight loss interventions comparing ethnic groups and gender which revealed that African-American women lose less weight than other subgroups [77]. The authors, however, could not explain the difference in weight loss outcome between African-American women and African-American men.

One necessary action step is to conduct further research with a focus on gender differences in weight loss and weight loss maintenance in particular to provide additional insight in possible underlying reasons and potential solutions for treatment outcome improvements.

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