

Sex Hormones and Sexual Function in Obese Men Losing Weight

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Abstract

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Objective: To study the impact of a weight-loss program on sex hormones and sexual function among 38 middle-aged obese men (BMI ≥ 35 kg/m²).

Research Methods and Procedures: A randomized controlled clinical trial was conducted. The treatment group ($n = 19$) participated in a 4-month weight-loss program including 10 weeks on a very-low-energy diet (VLED) and 17 behavior modification visits. There was no intervention in the control group ($n = 19$). Both groups were followed for 8 months, i.e., 22 weeks after the active weight loss in the treatment group. The outcome measures (weight, sex hormones, sexual function, leptin, and metabolic variables) were obtained at baseline and at three time-points during follow-up.

Results: The mean weight loss in the treatment group was 21 kg at the end of the 10-week VLED. At the end of follow-up, the maintained weight loss was 17 kg of baseline weight. The control group was weight stable throughout the study. In the treatment group, increases in sex hormone-binding globulin, testosterone, and high-density lipoprotein-cholesterol, as well as decreases in insulin and leptin, were maintained until the end of follow-up, although with VLED, the level of several hormones and metabolic variables improved transiently during the rapid weight loss. There were no significant changes in the questionnaire scores on sexual function in either group.

Discussion: We conclude that obese men lose weight and increase their serum testosterone level on a weight-loss

program with VLED and behavior modification. However, they do not change their sexual function scores.

Key words: weight loss, very-low-energy diet, sex hormones, sexual function, risk factors

Introduction

Studies of the effect of weight loss on testosterone level have had contradictory results, with some studies showing increases (1–5), other studies showing no change (6–8), and one small study showing decreases in testosterone (9). The aim of this trial was to study the impact of a weight-loss program on serum total testosterone and sexual function in obese men. Other sex hormones, metabolic variables, and leptin were also measured.

Research Methods and Procedures

This was a randomized, controlled trial. We calculated the sample size using the anticipated 30% increase in serum total testosterone level after weight loss (4). The treatment group (TG)¹ took part in a 4-month program, including the initial 10 weeks on a very-low-energy diet (VLED), after which there was a 22-week weight-maintenance phase. The weight-loss program has been described previously (10). The parallel control group (CG) received no intervention during the study.

Anthropometric measurements, blood samples, and questionnaires on sexual function were obtained in both groups at week 0 (baseline), at week 11 (last week with VLED in TG), at week 17 (last group visit in TG), and at week 32 (end of study). A detailed description of the laboratory methods is available on request from the corresponding author of this report. The subjects filled in two questionnaires on sexual function. The International Index of Erectile Function addresses erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall satisfaction (11). The higher the score, the less impairment in the

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¹ Nonstandard abbreviations: TG, treatment group; VLED, very-low-energy diet; CG, control group; SHBG, sex hormone-binding globulin; HDL, high-density lipoprotein.

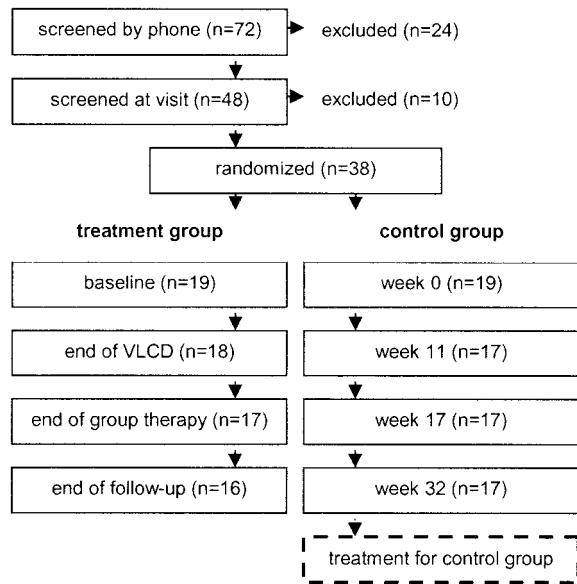


Figure 1: The study design and disposition of subjects. Treatment included 10 weeks on VLCD and 17 behavior-modification visits.

respective sexual function. The Sexual Activity Scale comprises one item: “How often do you and your partner engage in sexual activity, with or without intercourse?” (12). It has a scale range from 1 to 8, corresponding from “never” to “every other day”.

We used the general linear modeling, repeated measure procedure, with one factor for comparisons between subjects (TG or CG) and one factor for comparisons within subjects (time with four levels). We reported all results in the intention-to-treat population, which included all of the randomized subjects; the results were similar in the completer population. The Peijas Hospital Ethical Committee approved the study protocol, and all subjects signed an informed consent form after receiving written and oral information.

Results

Thirty-eight men were randomly assigned to two groups: 19 in the TG and 19 in the CG (Figure 1). The dropout rates during the study were 16% ($n = 3$) and 11% ($n = 2$) in the TG and CG, respectively. Table 1 presents the baseline data of the randomized subjects. Note that only one man in the TG and three men in the CG had type 2 diabetes. Table 2 presents the weight change in the TG and CG during the study.

The rapid weight loss during VLCD resulted in temporary changes in several hormonal and metabolic parameters (Figures 2 and 3). The increases in sex hormone-binding globulin (SHBG), testosterone, and high-density lipoprotein (HDL)-cholesterol, as well as decreases in insulin and lep-

Table 1. The baseline characteristics of the randomized subjects

Characteristics	Treatment ($n = 19$)	Control ($n = 19$)
Age	45.9 (9.0)	47.2 (10.7)
Number of chronic diseases	0.9 (0.9)	1.4 (0.9)
Chronic diseases (n)		
Type 2 diabetes	1	3
Hypertension	7	6
Coronary heart disease	0	1
Sleep apnoea	3	9
Osteoarthritis	3	1
Asthma or COPD*	0	7
Other	4	3
Married or living together (%)	84	100
Smoking† (%)	26	26
Alcohol consumption‡ (%)	58	53
Cardiovascular risk factors‡		
Glucose (mM)	6.4 (1.5)	5.9 (1.2)
Glycosylated haemoglobin (%)	6.0 (1.1)	6.2 (1.18)
Insulin (mU/L)	19.8 (10.3)	20.3 (10.0)
Total cholesterol (mM)	5.7 (1.4)	6.0 (1.3)
LDL-cholesterol (mM)	3.73 (1.14)	3.79 (1.00)
HDL-cholesterol (mM)	1.08 (0.23)	1.29 (0.43)
Triglycerides (mM)	2.18 (1.18)	1.92 (1.13)
Hormones‡		
Leptin ($\mu\text{g/L}$)	15.74 (6.53)	16.54 (6.60)
LH (IU/L)	3.55 (2.21)	3.82 (1.83)
FSH (IU/L)	4.92 (2.81)	4.66 (1.93)
Prolactin (mU/L)	225 (144)	178 (82)
SHBG (nM)	29 (14)	30 (12)
Testosterone (nM)	11.1 (3.4)	13.7 (3.3)
Free testosterone (pM)	201.3 (58.9)	249.4 (59.1)
Estrone (nM)	337 (54)	324 (124)
Estradiol (pM)	90 (2)	90 (3)

All values are mean (SD) unless stated otherwise.

* Chronic obstructive pulmonary disease.

† At least once a week.

‡ Measured from serum at fasting state.

LDL, low-density lipoprotein; LH, luteinizing hormone; FSH, follicle-stimulating hormone.

tin, were maintained until the end of follow-up. The 95% confidence intervals of the differences between groups at 8 months were 2.8 to 10.7 for SHBG, 1.1 to 4.3 for testosterone, 0.15 to 0.55 for HDL-cholesterol, -12.1 to -5.2 for

Table 2. Weight, BMI, and waist circumference in the treatment and control groups during the study

	BL	W11	W17	W32	<i>p</i> *
Weight (kg)					
Treatment group	124.0 (8.9)	-21.0 (9.8)	-21.1 (9.9)	-17.3 (10.2)	
Control group	126.5 (15.6)	-1.02 (2.9)	-1.3 (3.9)	0.2 (4.8)	<0.001
BMI (kg/m ²)					
Treatment group	39.3 (3.3)	-6.7 (3.2)	-6.7 (3.2)	-5.5 (3.4)	
Control group	39.4 (3.7)	-0.3 (0.9)	-0.4 (1.2)	0.1 (1.5)	<0.001
Waist (cm)					
Treatment group	126.4 (7.6)	-14.7 (6.4)	-15.9 (7.2)	-10.9 (6.6)	
Control group	133.4 (19.3)	-1.2 (3.3)	-0.8 (3.3)	-0.9 (4.4)	<0.001

BL, the mean (SD) at baseline; W11, 17, and 32: the mean (SD) change in measure from baseline at weeks 11, 17, and 32.
 * *p* value for test-of-treatment effect (group × time interaction) in general linear modelling, repeated measure procedure.

insulin, and -5.16 to -0.07 for leptin. The lowest total testosterone tertile at baseline showed the largest increase in total testosterone during the study ($F = 6.046, p = 0.001$ in one-way ANOVA). In the backward stepwise linear regres-

sion analysis, when the changes (differences between baseline and 8 months) in weight, insulin, HDL-cholesterol, triglycerides, SHBG, and leptin were entered into the model, the decrease in insulin was most strongly associated

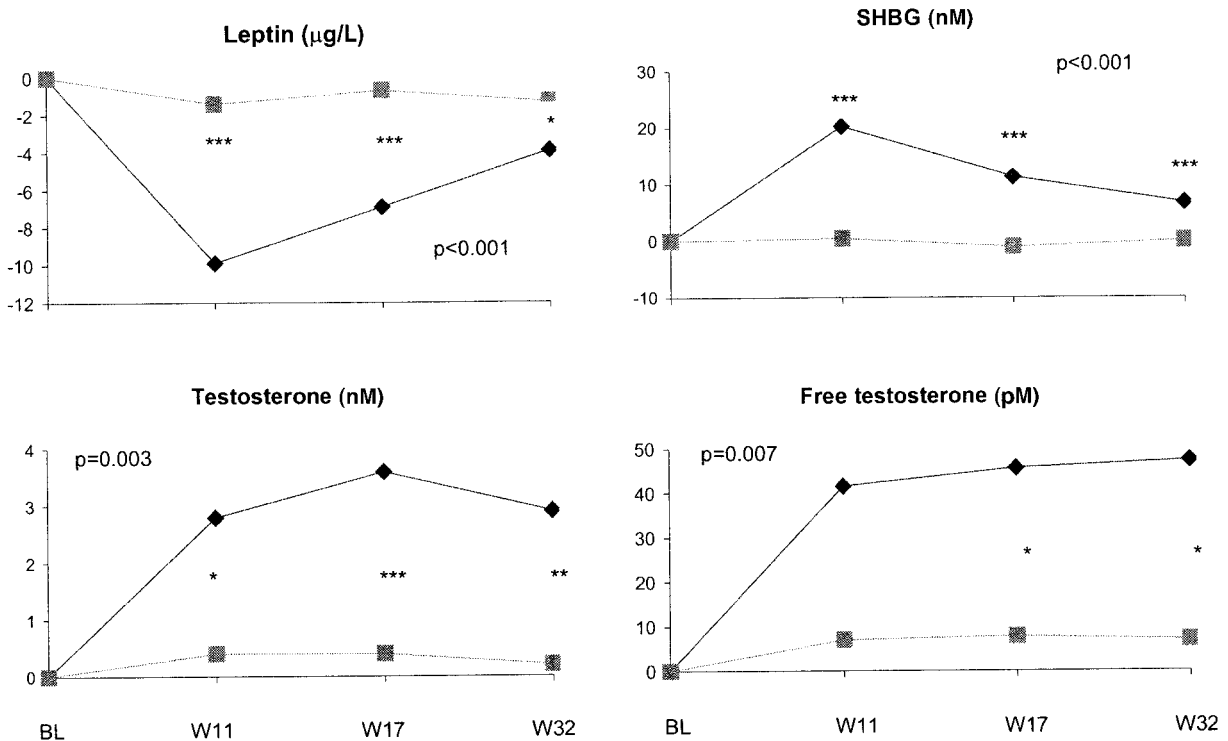


Figure 2: The mean change in sex hormones and leptin in TG and CG during the study. ◆, TG; ■, CG; BL, baseline; W11, W17, and W32: mean change at weeks 11, 17, and 32, respectively. *p* values for test-of-treatment effect (group × time interaction) in general linear modeling, repeated measure procedure. **p* < 0.05; ***p* < 0.01; ****p* < 0.001; these *p* values are for the comparisons between groups using the repeated factor to compare each follow-up point with baseline.

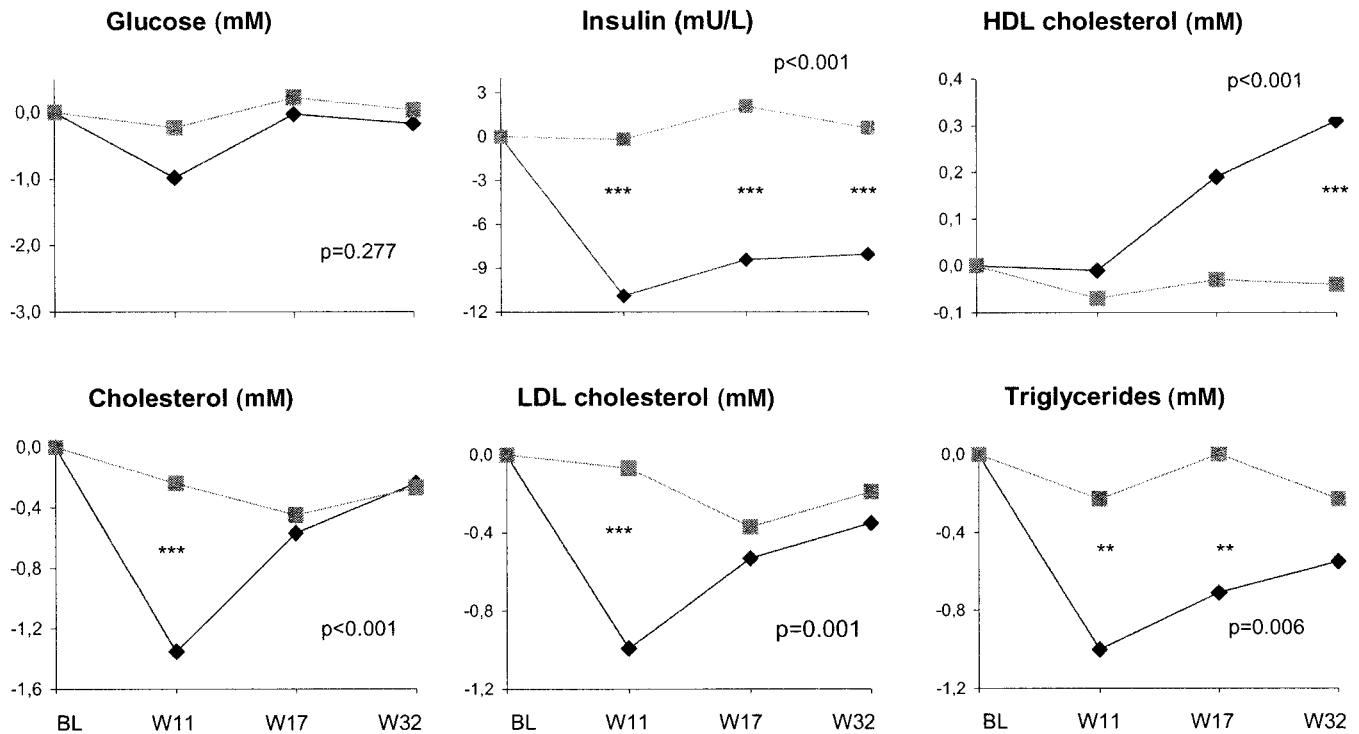


Figure 3: The mean change in the metabolic variables in TG and CG during the study. ◆, TG; ■, CG; BL, baseline; W11, W17, and W32: mean change at weeks 11, 17, and 32, respectively. *p* values for test-of-treatment effect (group × time interaction) in general linear modeling, repeated measure procedure. **p* < 0.05; ***p* < 0.01; ****p* < 0.001; these *p* values are for the comparisons between groups using the repeated factor to compare each follow-up point with baseline.

with the increase in total testosterone [$r = -0.205$ (95% confidence interval = -0.425 to 0.015 ; $p = 0.066$)].

There were no changes in the scores of erectile function, orgasmic function, sexual desire, intercourse satisfaction, overall satisfaction, or sexual activity in either group (Table 3).

Discussion

Previous studies have often used a small sample size in an uncontrolled design and measured the outcome only during an active weight-loss phase. The studies have contradictory results, with some studies showing increases (1–5) and other studies showing no change (6–8) in serum testosterone level. One small study showed a decrease in testosterone (9). These discrepancies are probably related to differences in study populations, variations in age, metabolic profiles, degree of obesity and weight loss, or differences in time points of hormone determinations (during active weight loss or during maintenance of lost weight). Studies among men indicate that weight loss decreases insulin resistance and increases SHBG (7,13). During active weight loss, SHBG seems to increase more than would be expected based on cross-sectional studies (13). In our study, SHBG increase

peaked at the end of the VLED phase, but started to decline during the weight-maintenance phase, although there was a significant difference between groups until the end of follow-up. Insulin and testosterone reacted with the largest differences at the end of VLED, and during the follow-up there was less tendency for the levels to return to baseline levels. When the changes in metabolic and hormonal variables induced by maintained weight loss were studied in a stepwise backward regression analysis, it was the decrease in insulin resistance that was most significantly related to the increase in testosterone. The repeated measurement of multiple outcomes in a small study population poses the possibility of statistically significant differences without true effect. Therefore, the less markedly significant results ($p = 0.01$ to 0.05) merely indicate possible treatment effects and need to be explored in further studies with larger populations.

There is limited information on the prevalence of sexual dysfunction in the general population and among obese subjects. In a Swedish population study, loss of male erectile function was as common in diabetes (30%) as in angina pectoris (29%) and significantly higher than in the general population (20%) (14). Few case reports of decreased libido

Table 3. The scores of sexual functions in the treatment and control groups during the study

	BL	W11	W17	W32	<i>p</i> *
Erectile function (score 1 to 30)					
Treatment group	28.1 (2.2)	0.2 (2.0)	-1.6 (6.0)	-1.1 (5.8)	
Control group	22.5 (8.8)	-0.4 (7.3)	-1.7 (5.6)	-1.7 (5.4)	0.984
Orgasmic function (score 0 to 10)					
Treatment group	9.7 (0.7)	-0.4 (0.9)	-0.8 (2.3)	0.7 (1.6)	
Control group	8.8 (2.7)	-0.5 (2.9)	-1.1 (2.5)	-0.9 (2.4)	0.940
Sexual desire (score 2 to 10)					
Treatment group	6.5 (2.0)	0.7 (1.2)	0.5 (1.2)	0.9 (1.7)	
Control group	6.4 (2.1)	-0.1 (2.2)	-0.4 (1.7)	-0.3 (1.0)	0.188
Intercourse satisfaction (score 0 to 15)					
Treatment group	11.9 (2.2)	0.4 (1.5)	-0.7 (2.8)	0.2 (2.0)	
Control group	8.9 (5.2)	0.1 (3.7)	-0.3 (2.9)	-0.4 (2.8)	0.884
Overall satisfaction (score 2 to 10)					
Treatment group	8.2 (2.0)	0.1 (1.7)	-0.1 (0.8)	0.0 (1.2)	
Control group	6.6 (2.3)	0.5 (1.7)	0.0 (1.9)	0.0 (1.9)	0.868
Sexual activity (score 1 to 8)					
Treatment group	4.8 (1.0)	0.3 (0.6)	0.2 (0.5)	0.4 (0.7)	
Control group	4.3 (1.4)	-0.1 (1.2)	-0.1 (1.1)	0.1 (0.7)	0.712

BL, the mean (SD) score at baseline; W11, 17, and 32: the mean (SD) change in score from baseline at weeks 11, 17, and 32.

* *p* value for test-of-treatment effect (group × time interaction) in general linear modelling, repeated measure procedure.

The higher the score the less impairment.

and impotence in extremely obese men have been published (15), but no relationship between obesity and abnormalities in libido have been apparent in larger studies (13). One study with surgically induced weight loss reported improvement in sexual function, but serum testosterone levels were not examined (16). Among poorly controlled diabetics, weight loss and related metabolic improvement have been associated with improved sexual function (17). Despite the weight loss and the increase in both total and free testosterone, there was no significant treatment effect in any sexual function measures in our study.

We conclude that among men, intentional weight loss in a program including VLED and behavior modification decreases serum insulin and increases leptin, HDL-cholesterol, SHBG, and (total and free) testosterone; the changes are maintained after 6 months of maintenance of reduced weight, even though the subjects are still obese. However, we did not find any treatment effect in the scores of questionnaires measuring sexual function.

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References

1. Pritchard J, Després J-P, Gagnon J, et al. Plasma adrenal, gonadal, and conjugated steroids following long-term exercise-induced negative energy balance in identical twins. *Metabolism*. 1999;9:1120–7.
2. Bastounis EA, Karayiannakis AJ, Syrigos K, Zbar A, Makri GG, Alexiou D. Sex hormone changes in morbidly obese patients after vertical banded gastroplasty. *Eur Surg Res*. 1998;30:43–7.
3. Pasquali R, Casimirri F, Melchionda N, et al. Weight loss and sex steroid metabolism in massively obese man. *J Endocrinol Invest*. 1988;11:205–10.
4. Strain GW, Zumoff B, Miller LK, et al. Effect of massive weight loss on hypothalamic-pituitary-gonadal function in obese men. *J Clin Endocrinol Metab*. 1988;66:1019–23.
5. Stanik S, Dornfeld LP, Maxwell MH, Viosca SP, Korenman SG. The effect of weight loss on reproductive hormones in obese men. *J Clin Endocrinol Metab*. 1981;53:828–32.
6. Kraemer WJ, Volek JS, Clark KL, et al. Influence of exercise training on physiological and performance changes with weight loss in men. *Med Sci Sport Exerc*. 1999;9:1320–9.

7. **Leenen R, van der Kooy K, Seidell JC, Deurengerg P, Koppeschaar H.** Visceral fat accumulation in relation to sex hormones in obese men and women undergoing weight loss therapy. *J Clin Endocrinol Metab.* 1994;78:1515–20.
8. **Hoffer LJ, Beitins IZ, Kyung N-H, Bistrrian BR.** Effects of severe dietary restriction on male reproductive hormones. *J Clin Endocrinol Metab.* 1986;62:288–92.
9. **Klibanski A, Beitins IZ, Badger T, Little R, McArthur JW.** Reproductive function during fasting in men. *J Clin Endocrinol Metab.* 1981;53:258–63.
10. **Kaukua J, Pekkarinen T, Sane T, Mustajoki P.** Health-related quality of life in WHO Class II-III obese men losing weight with very-low-energy diet and behaviour modification: a randomised clinical trial. *Int J Obes Relat Metab Disord.* 2002;26:487–95.
11. **Raymond CR, Riley A, Wagner G, Osterloh IH, Kirkpatrick J, Mishra A.** The International Index of Erectile Function (IIEF): a multidimensional scale for assessment of erectile dysfunction. *Urology.* 1997;49:822–30.
12. **Kreuter M, Sullivan M, Siösteen A.** Sexual adjustment and quality of relationship in spinal paraplegia: a controlled study. *Arch Phys Med Rehab.* 1996;77:541–8.
13. **Strain G, Zumoff B, Kream J, et al.** Mild hypogonadotropic hypogonadism in obese men. *Metabolism.* 1982;31:871–5.
14. **Wändell PE, Brorsson B.** Assessing sexual functioning in patients with chronic disorders by using a generic health-related quality of life questionnaire. *Qual Life Res.* 2000;10:1081–92.
15. **Blum H, Marilus R, Barasch E, Sztern M, Bruhis S, Kaufman H.** Severe sexual impairment produced by morbid obesity. Report of a case. *Int J Obes.* 1988;12:185–9.
16. **Larsen F.** Psychosocial function before and after gastric banding surgery for morbid obesity. A prospective psychiatric study. *Acta Psych Scand.* 1990;80:1–55.
17. **Fairburn C, McCulloch D, Wu F.** The effects of diabetes on male sexual function. *Clin Endocrinol Metab.* 1982;11:749–67.