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INFLUENCE OF WEIGHT LOSS PROGRAMMES ON WALKING SPEED AND RELATIVE OXYGEN COST (%VO_2MAX) IN OBESE WOMEN DURING WALKING

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Objective: **The objective was to investigate effects of dieted weight reduction on walking ability in obese women.**
Methods: **Fifty-seven obese women 44.1 $\pm$ 10.7 years, body mass index 37.1 $\pm$ 3.4 kg·m^{-2} performed an indoor walking test. Speed, oxygen consumption and heart rate were measured, perceived exertion and pain graded and oxygen cost calculated. Maximum oxygen uptake (VO_2max/kg) was predicted from a submaximum bicycle ergometry test. All tests were measured at baseline, after 12 weeks' weight reduction and after 52 weeks' maintenance.**
Results: **Despite a partial weight relapse, improvements were seen in body mass index, self-selected walking speed, VO_2max/kg, heart rate, perceived exertion and relative oxygen cost of walking (%VO_2max).**
Conclusion: **A modest weight reduction of 10% in moderately-to-severely obese women significantly improved their walking ability, perceived exertion and %VO_2max. When dealing with obese women, attention should be drawn to these positive effects, instead of focusing only on the magnitude of the weight loss.**

Key words: evaluation, fitness, maximum oxygen uptake, level walking, obese women, oxygen cost, strain, weight reduction

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INTRODUCTION

Obese women have been described as unfit and in poor physical condition (1–3). Many female patients recommended to undertake brisk walking in order to get fitter and lose weight have been unsuccessful. A few studies have pointed out that obese women find walking, outdoors as well as indoors, difficult. Their low compliance with walking training may be explained by pain caused by lower extremity arthritis or chafing problems and exhaustion (1, 4–5).

Several studies have reported improved maximum oxygen uptake (VO_2max/kg) from combinations of diet and exercise (6–7), but few have investigated responses to weight reduction due to physical exercise alone. Katoh et al. (8) studied 14 obese, middle-aged women with body mass index (BMI) 32 kg·m^{-2}. VO_2max/kg increased by 5% as a result of a 3-month programme with 2-hour daily exercise at 60% of VO_2max. The women trained on a bicycle ergometer, jogged, swam and performed gymnastics, and BMI declined by 11%. Donnelly et al. (9) compared the effects of 18 months of a traditional activity programme with one of short bouts of brisk walking in 22 obese women, BMI 30–32 kg·m^{-2}. Both activities improved aerobic capacity, but traditional exercise at 60–75% of VO_2max for 30 min 3 times weekly had an effect on weight loss and body composition that 15-minutes' walking activity twice a day did not.

Foster et al. (10) found that after weight loss 11 obese women, BMI 38.9 kg·m^{-2}, expended less than expected energy on walking. This result did not show after the first 8 weeks' of diet. At week 9 when BMI had decreased to 34.2 kg·m^{-2}, a walking exercise programme was introduced and gradually intensified during the next 13 weeks, which may explain the unexpected size of the decrease. In a previous study we investigated indoor walking ability in 57 obese women, BMI 37.1 (range 30–45) kg·m^{-2} (1). Although they walked at a self-selected and comfortable speed, a majority of these women perceived exertion during a 5-minute walk. They walked more slowly and had higher oxygen consumption (VO_2, l·min^{-1}) than normals. The relative oxygen cost (calculated from oxygen consumption and VO_2max) was as much as 56% VO_2max (range 31–97%) compared with 36% VO_2max in persons of normal weight (11). The high cost was primarily due to very low VO_2max/kg (ml·kg^{-1}·min^{-1}) in the obese women, for whom walking meant heavier work than for others. One reflection is that it seems essential that obese women are encouraged to increase their VO_2max/kg so as to endure necessary daily activities. This can be achieved by weight loss and/or exercising.

Intensive exercising in our experimental group of 57 obese women had however been unrealistic since exercise tolerance reportedly decreases rapidly as BMI increases and, in the severely obese, BMI >35 kg·m^{-2}, physical activity interventions need investigation (3–4). Thus the natural choice seemed to increase VO_2max/kg by decreasing weight and improve daily living and physical activity in this way.

The aim of the present study was to investigate the effects of weight reduction by dieting on walking speed, relative oxygen cost, exhaustion and pain in obese women during level walking.

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The study results could be used in therapeutic communication with obese women to motivate them to lose weight and try a more active lifestyle.

METHODS

Subjects

Obese female outpatients applying for participation in weight loss intervention programmes at the Karolinska Hospital in Stockholm, Sweden were, during 1 year, consecutively invited to take part in this study. Patients with known psychiatric disturbances or drug problems were excluded (12–13). Fifty-seven patients fulfilled the criteria for participating: age between 20–65 years and BMI ≥ 30 kg·m^{-2}.

The patients were informed about this study and gave their consent to participate. The study was approved by the local ethics committee.

All the patients were medically examined before the start of the study. None had any cardiorespiratory symptoms that limited their walking ability or bicycle ergometry tests. They reported more musculoskeletal symptoms from neck, shoulders, back, knees and feet than a comparable reference sample of normal weight (14). At baseline (occasion A) there were 57 patients. Fifty-four patients remained in the weight-loss programme after 12 weeks (occasion B) and 43 after another 52 weeks (occasion C) (Table I). Drop-out reasons, such as pregnancy, side-effects of the diet programme, operation, and not attending the programme, are given in the original studies by Ryttig & Rössner (12) and Ryttig et al. (13). The drop-outs differed from the remaining patients; they were younger, had lower BMI and better baseline values. Moreover, there were some internal drop-outs in the different tests: 40 patients completed all walking tests, 36 all bicycle tests and 34 all tests on occasion C (Table I). Descriptive data on all patients is given in Table II. Internal drop-out reasons were partial and due to technical problems, insecure steady state, medicamental (betablockers) problems, leg fatigue and joint problems.

Table I. *Number of participants during the programme*

Occasions	Baseline (A)	12 weeks (B)	64 weeks (C)
In the programme	57	54	43
Walking tests	55	51	40
Bicycle ergometry tests	51	49	36
Total fulfillers	49	47	34

Weight reduction programmes

The patients were recruited from 2 programmes where the women were randomly selected for very low calorie diet (VLCD) (330–420 kcal/day) or diet (1600 kcal/day) for 8–12 weeks. Thereafter everyone got 1600 kcal/day for 52–104 weeks. All patients got instructions from a dietician and they were told to maintain the same physical activity level during the whole trial period (12–13).

Walking test

The walking test was performed along a 70 metre indoor corridor. Walking speed was measured with a speedometer (1, 15). The patients were asked to walk at a self-selected, comfortable speed for at least 4 minutes to ensure physiological steady-state condition. Self-selected, comfortable walking speed in normal-weight persons is reported to vary between 74 and 83 m·min^{-1} (16).

Oxygen consumption, VO_2 (l·min^{-1}) was measured using the argon gas method described by Linnarsson et al. (17), and a sample of the gas mixture was analysed. Ventilation, VO_2 and carbon dioxide elimination were computed as described by Linnarsson et al. (17). Oxygen cost, VO_2/kg (ml·kg^{-1}·min^{-1} and ml·kg^{-1}·m^{-1}) was calculated from VO_2, speed and body weight (18). At a speed of 76.8 m·min^{-1}, VO_2 in normal-

Table II. *Baseline characteristics of the patients (*n = 57*). Comparisons of drop-outs (*n = 14*) with patients remaining in the programme after 64 weeks (*n = 43*).* t *tests for independent samples for comparisons of parametric and χ^2 for comparisons of nonparametric data*

	Original patients mean (SD) and range or numbers ($n = 57$)	Remaining patients mean (SD) or numbers ($n = 43$)	Drop-outs mean (SD) or numbers ($n = 14$)	p^b
Age (years)	44.1 (10.7) R 23–64	46.2 (10.0)	37.5 (10.4)	*<0.01*
Weight (kg)	104.1 (12.6) R 78–138	106.5 (12.7)	96.8 (9.3)	*0.01*
BMI (kg·m^{-2})	37.1 (3.4) R 30–45	37.8 (3.4)	35.1 (2.1)	*<0.01*
Families	37	29	8	*ns*
Singles	13	9	4	*ns*
Mothers	36	28	8	*ns*
Highest level of education				
High school	23	17	6	*ns*
University	19	15	4	*ns*
Working (paid job)	50	39	11	*ns*
Scheduled exercises >once a week	5	4	1	*ns*
Physical activity >once a week (walking etc.)	24	17	7	*ns*
Current pain problems				
Lower back	22 *p <0.01* [a]	15	7	*ns*
Hips	7 *ns* [a]	5	2	*ns*
Knees	18 *p <0.001* [a]	15	3	*ns*
Feet	13 *p <0.001* [a]	13	0	*<0.05*
Current painkiller intake	16	12	4	*ns*
Current sleep problems due to pain	22	17	5	*ns*
Current physical activity problems due to pain	27	20	7	*ns*
Current social activity problems due to pain	9	6	3	*ns*
Relative oxygen cost of walking (% VO_2max)	56.0 (15.3) R 31–97.5	58.6 (15.2)	45.3 (11.1)	*<0.01*
Maximum oxygen uptake (VO_2max/kg)	21.2 (5.0) R 11.7–33.6	20.1 (4.1)	25.1 (5.6)	*<0.01*
Oxygen consumption walking (VO_2(l·min^{-1})	1.2 (0.2) R 0.8–1.9	1.2 (0.2)	1.0 (0.2)	*=0.01*

[a] Comparisons with a large reference sample of women with normal weight (14). [b] Comparisons of drop-outs with remaining patients.

Table III. *Results from weight loss programme and walking tests on occasions A, B and C* (n = 40)

	Baseline (A)		12 weeks (B)		64 weeks (C)		ANOVA	Multiple comparisons		
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	*p*	*p* (A–B)	*p* (A–C)	*p* (B–C)
Weight (kg) *n* = 43	106.5 (12.7)	78.6–137.8	91.8 (11.7)	70.1–118.0	96.3 (12.8)	72.1–128.5	*<0.001^A*	*<0.001*	*<0.001*	*<0.001*
BMI ($kg{\cdot}m^{-2}$) *n* = 43	37.8 (3.4)	30.3–45.0	32.4 (3.6)	26.1–40.7	34.1 (3.9)	27.9–41.1	*<0.001^A*	*<0.001*	*<0.001*	*<0.001*
Self-selected walking speed ($m{\cdot}min^{-1}$)	71.6 (5.3)	61–83	75.9 (5.4)	65–88	75.2 (5.9)	63–86	*<0.001^A*	*<0.001*	*<0.001*	*ns*
VO_2, ($l{\cdot}min^{-1}$)	1.2 (0.2)	0.8–1.9	1.1 (0.2)	0.6–1.5	1.2 (0.2)	0.9–1.6	*<0.001^A*	*<0.001*	*ns*	*<0.001*
VO_2/kg, ($ml{\cdot}kg^{-1}{\cdot}min^{-1}$)	11.2 (1.5)	8.6–16.0	11.8 (1.7)	7.3–15.8	12.1 (1.2)	8.8–15.6	*<0.01^A*	*<0.01*	*=0.001*	*ns*
VO_2/kg, ($ml{\cdot}kg^{-1}{\cdot}m^{-1}$)	0.16 (0.02)	0.12–0.25	0.16 (0.02)	0.10–0.22	0.16 (0.02)	0.14–0.21	*ns^A*	*ns*	*ns*	*ns*
HR ($beats{\cdot}min^{-1}$)	109 (16)	80–143	94 (14)	60–120	97 (13)	72–136	*<0.001^A*	*<0.001*	*<0.001*	*ns*
Perceived pain (0–10)	Md 0	0–8	Md 0	0–3	Md 0	0–5	*<0.05^F*	*ns*	*ns*	*ns*
Perceived exertion (0–10)	Md 3	0–6	Md 2	0–3	Md 2	0–4	*<0.001^F*	*<0.01*	*=0.001*	*ns*

Md: median. *p* = probability, *ns* = not significant. *A* ANOVA and *F* Friedman's ANOVA and multiple comparisons between visits.

weight persons has been measured to average 0.73 $l{\cdot}min^{-1}$ and VO_2/kg has been calculated to 0.16 $ml{\cdot}kg^{-1}{\cdot}m^{-1}$ (18).

Heart rate (HR) was measured at the finish line (1). The women wore a pulsometer (Sport Tester TM PE-3000, Polar Electro, Kempele, Finland) for HR registration. HR was also controlled manually for 15 seconds. Perceived exertion and pain were graded by the patients using a Category Ratio scale, CR 10, developed by Borg (19).

Bicycle ergometry test

Maximum oxgen uptake, VO_2max ($l{\cdot}min^{-1}$) was predicted from a submaximum test using a bicycle ergometer (1–2, 11). After warming up for 4 minutes on the bicycle, the patient was exposed to a work load, increased in 2 or 3 steps until HR was close to 140 $beats{\cdot}min^{-1}$. The submaximum work was carried out for at least 4–5 minutes to ensure steady state (11). VO_2max/kg ($ml{\cdot}kg^{-1}{\cdot}min^{-1}$) was calculated from the measured HR and corrected for age and bodyweight, using the nomogram and the factors given by Åstrand & Rodahl (11). Perceived exertion, leg fatigue and pain were graded by the patients every minute during the whole ergometry test using the CR 10-scale (19).

Relative oxygen cost of walking

The relative oxygen cost, $\%VO_2max$, was calculated from the measured value of oxygen consumption during walking, VO_2 ($l{\cdot}min^{-1}$) and the maximum oxygen uptake, VO_2max ($l{\cdot}min^{-1}$) calculated from the submaximum bicycle ergometry test.

Procedure

All tests were performed at baseline (A) of the weight-loss programmes, after 12 weeks (B) and after 64 weeks (C). On all 3 occasions walking speed was self-selected and thus varied, whereas the individual workload and pedal rate in the bicycle ergometry tests were constant.

Subjects, methods and baseline procedure have been described fully elsewhere (1).

Statistical analysis

Results are presented as mean ± SD and/or median or range. Comparisons with normal values and between subgroups were made using χ^2 or *t* tests for independent samples. For comparisons over time, one-way ANOVA, repeated measures design, was performed, followed by multiple comparisons between visits for interval data. Friedman's ANOVA followed by multiple comparisons between visits was performed for ordered categorical data. Multiple regressions were used to find important variables to predict which women could be expected to get the best effects from weight reduction programmes. Regression to the mean was made. Logistic regression was performed to find variables to predict which women would manage to maintain positive effects from weight reduction programmes during the maintenance period for 52 weeks.

RESULTS

There was an overall decrease in body weight and BMI ($p < 0.001$) in spite of the apparent relapse from occasion B to C ($p < 0.001$). (Table III, Fig. 1).

Walking test

After 12 weeks, walking speed increased ($p < 0.001$) while VO_2 ($p < 0.001$), HR ($p < 0.001$) and perceived exertion ($p < 0.01$) decreased. (Table III, Fig. 2). Pain vanished ($p < 0.05$) for those 6 patients who had found walking painful at A.

After 64 weeks, improvements were still seen in walking speed, HR and perceived exertion ($p \leq 0.001$).

Bicycle ergometry test

After 12 weeks, improvements were seen in increased VO_2max/

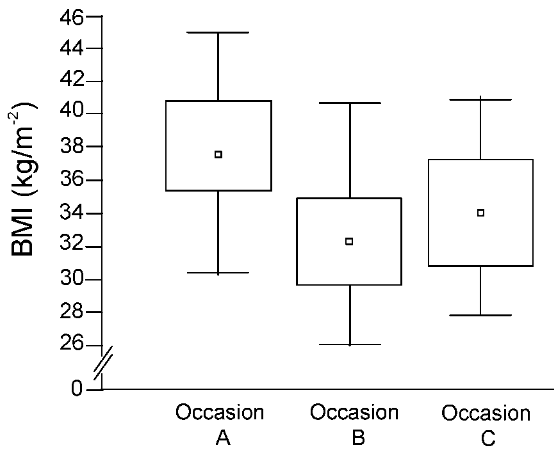

Fig. 1. Development of body mass index (BMI) on occasion A (baseline), B (= 12 weeks) and C (= 64 weeks). Min–max. Box plots indicate the 25th and the 75th percentiles ($n = 43$).

kg ($p < 0.001$), decreased HR ($p < 0.001$) and perceived exertion ($p < 0.01$). (Table IV). Further, pain was assessed by 5 patients instead of 9 at baseline.

After 64 weeks, remaining improvements were seen in VO_2max/kg ($p < 0.001$), HR ($p < 0.001$), and perceived exertion ($p < 0.05$).

Relative oxygen cost of walking

After 12 weeks, %VO_2max improved from 59.3 to 47.6 %VO_2max ($p < 0.001$). (Table IV, Fig. 3).

After 64 weeks, %VO_2max was still less compared with occasion A ($p < 0.01$), despite the relapse from occasion B to C ($p < 0.01$).

Predictive baseline variables

Baseline variables able to predict positive effects from the programme (from occasion A to C) were traced (Table V). The patients who increased walking speed most had low baseline VO_2 and BMI. The largest decrease in HR during walking was seen in patients who started with high VO_2/kg and low VO_2max at A. Those who decreased %VO_2max most started with high VO_2 and high HR during walking at baseline. No variables to predict success in weight loss or improved VO_2max/kg could be seen. The best improvements in walking exertion correlated with low baseline values in VO_2max ($Rs = 0.45$, $p = 0.005$) and high %VO_2max ($Rs = 0.36$, $p = 0.027$). Decreased exertion during bicycling correlated with high walking exertion ($Rs = -0.45$, $p = 0.006$) and leg fatigue ($Rs = -0.49$, $p = 0.003$) at baseline. Decreased leg fatigue correlated with high baseline leg fatigue (mean of first and last value) ($Rs = 0.47$, $p = 0.004$). All these results were independent of weight reduction programme (VLCD or 1600 kcal).

No baseline variables of importance for maintaining positive effects (from occasion B to C) concerning weight loss, walking speed or HR walking were found. Maintained or improved VO_2max/kg and %VO_2max were seen in patients with high baseline values in HR during walking, %VO_2max and BMI ($p < 0.05$).

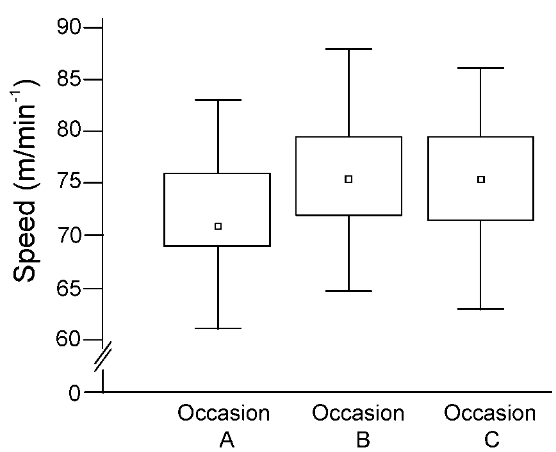

Fig. 2. Development of self-selected, comfortable walking speed on occasion A (baseline), B (= 12 weeks) and C (= 64 weeks). Min–max. Box plots indicate the 25th and the 75th percentiles ($n = 40$).

DISCUSSION

Despite a moderate weight loss of 10% after 64 weeks, our patients showed a remarkable recovery from walking disability. Not only did they manage to increase their comfortable and self-selected walking speed; walking did not imply as high HR or perceived exertion, or as high %VO_2max as before weight loss.

Our results on walking improvement after weight loss are supported by Foster et al. (10). They found that although body weight was the primary determinant of the ambulatory energy expenditure, the reduction of energy expenditure was greater than expected from changes in body weight alone. They speculate on possible reasons, such as less mechanical work needed to overcome friction between thighs and between arms and torso and less extraneous movement as the walking pattern normalizes. Also Freyschuss & Melcher (20) observed that the increase of mechanical efficiency in obese subjects was quantitatively related to the degree of weight reduction. Such reasoning seems plausible to explain why the women in our study increased their self-selected walking speed fully 4 $m \cdot min^{-1}$ and yet reduced %VO_2max by 13%. Their walking speed was not even negatively influenced by the 5% weight gain during the maintenance period. Irrespective of the results from our measurements we witnessed a change in several patients and got spontaneous remarks on their recovery. Just to be able to take a walk together with others can give numerous positive spin-off effects, physically and psychosocially.

According to other studies our results on initial considerable weight loss and later partial relapse during the maintenance period were to be expected (21–24). As many as 10 women managed to reduce their weight further during the maintenance period, although 4 exceeded their baseline weight during the same time. Had the maintenance period been longer, we would

Table IV. *Results from the bicycle ergometry tests and calculated %VO_2max on occasion A, B and C* (n = 36)

	Baseline (A)		12 weeks (B)		64 weeks (C)		ANOVA	Multiple comparisons		
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	*p*	*p* (A–B)	*p* (A–C)	*p* (B–C)
Work load (watts)	86.8 (17.4)	50–125	86.8 (17.4)	50–125	86.8 (17.4)	50–125				
Heart rate (beats·min^{-1})	140 (9)	120–156	133 (9)	112–150	132 (7)	118–148	*<0.001^A*	*<0.001*	*<0.001*	*ns*
VO_2max (l·min^{-1})	2.1 (0.4)	1.2–3.2	2.3 (0.5)	1.3–3.4	2.4 (0.5)	1.3–3.4	*<0.001^A*	*=0.001*	*<0.001*	*ns*
VO_2max/kg (ml·kg^{-1}·min^{-1})	20.0 (4.3)	11.7–28.0	25.5 (5.0)	14.3–36.3	24.8 (4.8)	13.3–33.3	*<0.001^A*	*<0.001*	*<0.001*	*ns*
Perceived pain (0–10)	Md 0	0–6	Md 0	0–4	Md 0	0–5	*ns^F*	*ns*	*ns*	*ns*
Perceived exertion (0–10)	Md 4	0–10	Md 4	0–7	Md 4	0–8	*<0.001^F*	*<0.01*	*<0.05*	*ns*
Leg fatigue (0–10)	Md 4	0–11	Md 3	0–7	Md 3.5	0–9	*ns^F*	*ns*	*ns*	*ns*
%VO_2max (*n* = 34)	59.3 (15.8)	37.3–97.5	47.6 (11.8)	26.2–80.8	51.8 (12.8)	33.6–103.9	*<0.001^A*	*<0.001*	*<0.01*	*<0.01*

Md: medians. *p* = probability, *ns* = not significant. *A* ANOVA and *F* Friedman's ANOVA and multiple comparisons between visits.

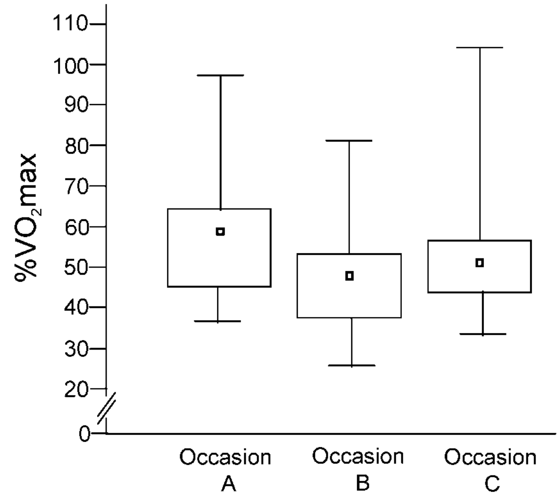

Fig. 3. Development of relative oxygen cost of walking (%VO_2max) on occasion A (baseline), B (=12 weeks) and C (= 64 weeks). Min–max. Box plots indicate the 25th and the 75th percentiles (*n* = 34).

probably have seen more examples of weight regain as it remains a common outcome of obesity treatment (24).

Our results did not reveal any surprising predictors, nor did they tell which women benefited most from weight reduction or which managed to maintain achieved effects for 52 weeks. It was to be expected that the women with the poorest baseline values would profit most by losing weight. This applied to, for example, VO_2max, %VO_2max, HR, walking exertion and leg fatigue, but not to BMI. Clinically it may be simple and useful to measure HR and perceived exertion during a 6-minute walk to be able to predict weight loss effects on energy and stamina. However, it is difficult to foretell long-term weight loss results, since success may depend on many other factors, such as behavioural strategies, motivation and psychosocial conditions (25–26).

On all occasions the women were free to choose the most comfortable walking speed. Every person strives to keep his or her own individual pace, since too fast as well as too slow feels strenuous or uncomfortable. Mattsson (15) reported that the most comfortable speed coincided with the optimum value of VO_2/kg (ml·kg^{-1}·m^{-1}) following a U-shaped curve. Physiologically the most comfortable speed was thus the most economical way of walking. As the increase in speed affected all oxygen measures, we met difficulties in comparing these measures over time. However, had we on the follow-up occasions insisted on keeping the individual speeds chosen at baseline, we would have been deprived of the news value of the present study: that is the increase and adaptation of the comfortable speed to the individual optimum and yet, at the same time, reduced %VO_2max.

Considering ethical, clinical and economical aspects we chose to predict VO_2max from a *sub*maximum bicycle ergometry test instead of performing a maximum or submaximum test on treadmill, where musculoskeletal pain could have been a

Table V. *Baseline variables influencing the results concerning walking speed, heart rate (HR) during walking and %VO_2max*

	Increased walking speed			Decreased HR walking			Decreased %VO_2max		
	B	SE	*p*	B	SE	*p*	B	SE	*p*
Intercept	27.0			24.9			55.1		
Low BMI	−0.3	0.3	*0.327*	–	–	–	–	–	–
Low VO_2 ($l \cdot min^{-1}$)	−10.4	4.5	*0.027*	–	–	–	–	–	–
High VO_2 ($l \cdot min^{-1}$)	–	–	–	–	–	–	−24.3	7.6	*0.003*
High VO_2/kg ($ml \cdot kg^{-1} \cdot m^{-1}$)	–	–	–	−448.7	131.3	*0.002*	–	–	–
High HR walking ($beats \cdot min^{-1}$)	–	–	–	–	–	–	−0.3	0.1	*0.008*
Low VO_2max ($l \cdot min^{-1}$)	–	–	–	15.0	4.7	*0.003*	–	–	–
Adjusted R^2	20%	–	–	33%	–	–	42%	–	–

Multiple regressions in steps. Adjusted R^2 = amount of explanation. B: regression coefficient. SE: standard error of B.

limiting factor (1–2). This possible error can only influence our results at baseline. Certainly, our line of action can be considered a weakness of the study, but since our values were used for individual comparisons over time we consider the method error to be systematic. It can be regarded as a constant and thus be neglected.

Furthermore, we lack reliable measures of the level of leisure-time physical activity and its probable effect on the results on occasion C. In order not to disturb the evaluation of the effect of VLCD, the women were instructed not to change practice concerning physical activities during the programme, but as weight loss apparently stimulated some individuals to normal activity it would have been unethical and against our beliefs to ask them to hold back. According to several studies physical activity facilitates long-term weight maintenance (21–23, 27). Already on occasion B we got self-reports on patients' enjoyment of leisure-time family activities, extended everyday activities and participation in regular group exercises. Increased activity level, even if not combined with weight gain might explain why patients who found themselves relieved of pain by occasion B got some of it back at C. Increased activity can also help explain the improved VO_2max.

It is still interesting that even a modest weight reduction of 10% can give so many positive effects following increased walking ability. In a review Wadden et al. (27) recommended a 10% reduction in body weight to improve psychological and physical health. The effect on VO_2max/kg will be still greater if dieting and exercise are combined (6–7).

Most of our patients were also participating in a study on VLCD (Nutrilett) described by Ryttig et al. (13). They reported that maintenance and drop-out rates were independent of whether the initial treatment commenced with VLCD or a hypocaloric diet. This is in agreement with our results. The drop-outs in our study, irrespective of whether they gave up the programme or were excluded because they had not fulfilled all tests, differed from the remaining patients at baseline as they were younger, had lower BMI, lower %VO_2max during walking, lower VO_2 and higher VO_2max/kg (Table II). Had the drop-outs fulfilled the programme, what impact could their results have had on the total result? Probably walking speed would have been even faster, as baseline predictors for improved walking speed were low BMI and low VO_2. On the other hand, it is likely that the improvement in %VO_2max would have been slightly less, since high, not low, baseline %VO_2max could predict this improvement (Table V). Furthermore, it seems logical to believe that better baseline conditions and function imply less motivation and low expectations of other effects of weight loss than *just* weight loss and thus be one reason for giving up. As moderately obese and fairly fit patients have a shorter way to go to reach realistic goals, we ought to identify these individuals and meet their needs by tailoring weight loss programmes to stimulate them to hold on throughout the maintenance period. Many obese persons hold unrealistic hopes of the magnitude of the expected weight loss. Foster et al. (28) reported actual weight loss effects on physical health and fitness, social life and psychological factors that widely exceeded the patients' initial expectations. Yet the patients remained disappointed with their achieved weight. Consequently we should stress the positive spin-off effects instead of focusing on the weight loss itself.

CONCLUSION

A 10% weight reduction by dieting in severely obese women improved walking speed, HR and perceived exertion during walking. Improvements were also seen in VO_2max/kg and %VO_2max. In spite of a partial weight relapse during the 1-year maintenance period the positive effects remained. Patients with poor baseline conditions concerning VO_2max, %VO_2max, HR and perceived exertion during walking benefited most. Baseline BMI could not predict the functional outcome. Normalized walking ability and increased energy level can give many positive spin-off effects on leisure time activity and well-being. We should highlight these secondary benefits when motivating obese women to lose weight, as they may find the magnitude of a realistic long-term weight loss disappointingly low.

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