Original Article

DOI: 10.7860/JCDR/2017/24112.9553

Effectiveness of A Four-Week Diet Regimen, Exercise and Psychological Intervention for Weight Loss

Community Medicine Section

TOBIAS WEINREICH[1], HANS-PETER FILZ[2], URSULA GRESSER[3], BARBARA M. RICHARTZ[4]

ABSTRACT

Introduction: Obesity is accompanied by restriction in the quality of life and an increased risk of morbidity and mortality. Cardiovascular, orthopedic, and metabolic disorders are among the possible consequences. In the management of obesity, a combination therapy that includes dietary, exercise, and behaviour modules has proven its worth.

Aim: To evaluate the effect of weight-associated parameters, circulation associated parameters, glucose metabolism, body composition and life quality changes within a four-week inpatient rehabilitation program.

Materials and Methods: Fifty-two patients underwent a 4-week inpatient rehabilitation program consisting of nutrition therapy, behavioural therapy and exercise therapy modules at the Eleonoren Clinic of Winterkasten, Germany.

Results: The mean weight reduction of 52 obese patients 40(76.9%) males, 12(23.1%) females; mean age 46 years; mean Body Mass Index (BMI) 43,79 kg/m^2) achieved was 7.1 kg (from 1.20 kg to 17.50 kg), and the BMI reduction was 2.3 kg/m^2 (from 0.40 kg/m^2 to 5.40 kg/m^2). The excessive weight loss was highly significant ($p<0.001$). Weight reduction was accompanied by an improvement in the diabetic metabolic state (lowering of fasting blood-glucose 20 mg/dl, postprandial blood glucose 26 mg/dl, HbA1 0.27%). In all 73% of the patients suffered from arterial hypertonia. The significant mean decline of systolic and diastolic blood pressure was 12.8 mmHg and 6.8 mmHg, respectively. The resting pulse was reduced by an average of 11 beats per minute. The Bioelectric Impedance Analysis (BIA) revealed a significant reduction of body fat content ($p<0.001$). The subjective impression of impaired life quality (SF-36 questionnaire) improved significantly.

Conclusion: The study clearly shows that the inpatient rehabilitation program at the Eleonoren Clinic was suitable to enhance the physical and mental state of people with obesity. In a two-year follow-up program the patients should take care of a permanent lifestyle change toward an improved dietary, movement, and health behaviour.

Keywords: Bioelectric impedance analysis, Body mass index, Quality of life

INTRODUCTION

Severe obesity is accompanied by limited life quality and increased morbidity and mortality [1,2]. Long-term obesity may lead to secondary diseases such as the excess weight associated orthopedic and cardio-pulmonary overload syndromes as well as type 2 diabetes, arterial hypertension, vascular damage, kidney disease, arthrosis, and liver diseases [3-8].

According to the World Health Organization (WHO), obesity is defined by BMI ≥ 30 kg/m^2 [2,9].

Currently, the prevalence of obesity is increasing globally [1]. According to the "Nationale Verzehrsstudie" (NVS II) conducted between 2005 and 2006 and including nearly 20,000 German citizens, 66.0% of men and 50.6% of women were overweight or obese (BMI ≥ 25 kg/m^2). Every fifth German citizen is obese [10]. For mentally disabled persons, the prevalence increases to 30.5%. Several factors are involved in the development of obesity [11]. On the one hand, there is an increased intake of preferentially fat containing food, on the other hand, lack of exercise.

AIM

The present study analyses the outcome of the four-week inpatient rehabilitation program at the Eleonoren Clinic in Winterkasten, Germany, focusing on the following parameters:

- Weight-associated parameters: body weight, BMI, Excessive Weight Loss (EWL).
- Circulation associated parameters: blood pressure, heart rate.
- Parameters of glucose metabolism: daily profile of blood sugar, HbA1c.
- Body composition (bioelectric impedance analysis, BIA).
- Life quality (SF-36 questionnaire).

MATERIALS AND METHODS

The Eleonoren Clinic is a rehabilitation center of the German Pension Insurance Organization (Hessen) (Deutsche Rentenversicherung Hessen) for gastroenterology and metabolic disorders as well as tumour diseases. The clinic is also a qualified training and treatment center for type 1 and type 2 diabetes (German Diabetes Association Step 1) and a qualified teaching hospital for nutrition medicine (German Academy for Nutritional Medicine).

For the treatment of obesity, the Eleonoren Clinic uses a multi-modular and multi-stage therapeutic process. At the beginning of the two-year treatment program, patients attend a four-week inpatient core program in a closed group of eight to ten participants. The concept includes nutrition, behaviour, and exercise therapy modules. During the first year after the inpatient stay, the aim is further weight reduction. During this time, the Eleonoren Clinic maintains constant contact with the patients by mail and by phone. Patients who were successfully assisted in reducing their body weight by ≥10% could participate in a two-week stabilization therapy. During the stabilization program relapse prevention module, lifestyle changes are checked and motivation is stabilized. During the second year of the program, patients are expected to maintain the attained weight. The program ends with a one-week aftercare module.

To evaluate the changes during the four-week inpatient care program, the following parameters were examined: weight-associated parameters (body weight, BMI, EWL), circulation-associated parameters (blood pressure, heart rate), glucose-metabolism

parameters (blood glucose day profile, HbA1c), body composition (BIA), and life quality (SF-36 questionnaire). A total of 64 patients took part in the study from February 25, 2014 to January 7, 2015. Patients were selected irrespective of age, origin, and profession. They were expected to fulfill the following inclusion criteria: Grade 1 obesity or more (BMI >30 kg/m²), minimum age of 18 years, no physical limitations of the musculoskeletal system, no inappropriate exhaustion during ordinary physical stress, and no diseases with cardiac or pulmonary limitations. Patients with severe acute cardiopulmonary pre-existing diseases (heart attack, pulmonary embolism), severe accompanying diseases (tumour diseases), clinical indications and echocardiographic signs of decompensated heart failure, fatigue, rhythm disturbances, dyspnea or angina pectoris during ordinary physical stress, severe orthopedic disease, addiction (except nicotine abuse), patients undergone bariatric surgery, pregnancy, and secondary obesity were excluded from the study.

The timescale of the examinations during the inpatient stay is summarized in [Table/Fig-1]. The project was examined and approved by the Ethics Committee of the University of Munich.

Time	Examination/Therapeutic Application
First Day	• Examination of inclusion and exclusion criteria • Initial examination • Qualityof life questionnaire
Second Day	• Laboratory testing (fasting) • BIA (fasting) • Resting Electrocardiogra (ECG) • Daily profile of blood glucose (measured at 7:00 a.m., 9:30 a.m., and 11:00 a.m.)
Day 2–27	• Echocardiography (during the first week) • Nutritional counseling • Psychological group therapy • Sports therapy (walking, exercise pool, ergometer training, fitness room) • Lecture on "obesity and sport" • Medical round (weekly)
Day 27	• Final examination (anamnesis, physical examination) • Laboratory testing (fasting) • Quality of life questionnaire • BIA (fasting) • Resting ECG • Daily profile of blood glucose (measured at 7:00 a.m., 9:30 a.m., and 11:00 a.m.)

[Table/Fig-1]: Timescale during inpatient stay.

Elements of Therapy

The aim of the nutrition therapy was to establish a negative energy balance. This was achieved by a hypocaloric mixed diet with a reduced fat content. The desired energy deficit was based on patient basal metabolism and should amounts to 500–800 kcal per day. No hypocaloric diet <1200 kcal per day was realized. The energy consumption was enhanced by exercise therapy to achieve a negative energy balance. During the weight reduction phase, the muscle mass was initially to be maintained as far as possible and should be continued to be increased later. Patient's physical fitness was improved to increase the cardiopulmonary capacity. By improving the nutrition therapy, behavioural therapy and the movement therapy an enhancement of life quality and a stabilization of the introduced lifestyle changes were expected to be achieved. Trained psychologists were entrusted with the behaviour therapy. By changing their own lifestyles, patients were sensitized to their nutrition and exercise habits and were enabled to change these habits independently as required. A primary focus of the obesity program was behavioural therapy offered as an interactive group session. During this therapy, the motivation for weight reduction with short and long term goals and the vicious circle of ineffective dietary efforts were addressed. In addition, the process of an effective dietary regime was elucidated.

Initial Examination (U1)

The physical examination on the first day of rehabilitation included a cardiac inspection and auscultation as well as an auscultation and percussion of the lung. The body size (without shoes) was determined by means of a measuring stick and the body weight in patient's undergarments, by means of a calibrated scale. The collected data were used to calculate the BMI. Blood pressure was measured after five minutes of relaxation on the upper arm using a sphygmomanometer (Riva-Rocci method). Based on the size of the upper arm, different cuff sizes were chosen. The subjectively experienced life quality and physical fitness were recorded using the SF-36 questionnaire [12]. In addition to the full scale, the subscales physical functioning, role physical, role emotional, vitality, mental health, social functioning, bodily pain and general health were analysed separately. The BIA (Multi Frequency Analyser BIA 2000-M; Data Input GmbH, Software Nutri 4) and the resting electrocardiogram (custo card m; custo med GmbH) were conducted under fasting conditions on the morning of the second day of rehabilitation.

Final Examination (U2)

The second round of examinations were performed between the 26th and 29th days of rehabilitation.

STATISTICAL ANALYSIS

The software SPSS/PASW version 18.0 was used for the statistical analysis. For metric variables, the mean and standard deviations were calculated. Potential correlations between metric variables were analysed by means of a Pearson's correlation analysis. Mean differences were examined using t-tests (unpaired and paired samples). In the case of unpaired samples, variance homogeneity was confirmed by a Levene's test. The two sided significance level was set at $\alpha = 0.05$. A p-value <0.05 was defined as significant, whereas, p-value <0.01 as highly significant.

RESULTS

A total of 64 patients participated in the study between February 25, 2014 and January 7, 2015. Twelve patients did not complete the study (n=7) or had to be excluded because of emerging diseases/accidents (n=5). A total of 52 patients with an average age of 46.1±11.0 years (minimum 22 years, maximum 66 years) completed the entire study plan. Forty of these patients (47.1±11.1 years) were males and twelve were females (42.8±10.4 years). The average time interval between the examination at the beginning (U1) and the end (U2) of the inpatient rehabilitation was 26.98 days (from 26 to 28 days).

Changes in Body Weight and BMI

The body weight at U1 (135.04±26.82 kg) was reduced to 127.95±24.75 kg at U2 [Table/Fig-2]. The body weight loss, the percentage weight reduction, the EWL, and the decrease of BMI between U1 and U2 were highly significant (p<0.01). The patients

Parameter	Time		Mean±SD	
Body Weight (kg)	U1		135.04±26.82	
	U2		127.95±24.75	
BMI (kg/m²)	U1		43.79±8.06	
	U2		41.48±7.53	
Differences U1-U2**	**Minimum**	**Maximum**	**mean±SD**	**p-value***
Body Weight (kg)	1.20	17.50	7.10±3.44	<0.001
Body Weight (%)	1.12	11.33	5.15±2.13	<0.001
EWL (%)	3.04	39.72	13.37±7.10	<0.001
BMI (kg/m²)	0.40	5.40	2.30±1.04	<0.001

[Table/Fig-2]: Changes in body weight and BMI at U1 and U2 (n = 52).
*t-Test for connected samples, two-sided significance.
**Negative values reflect an increase from U1 to U2.

achieved a mean EWL of 13% and a maximum EWL of 40%. The BMI was reduced by an average of 2.3 kg/m². Patients with obesity grade 1 at U1 achieved a highly signifcant weight reduction of 4.56% (n=9), patients with obesity grade 2 at U1 achieved a highly significant reduction of 5.53% (n=12), and patients with obesity grade 3 at U1 achieved a highly significant weight reduction of 5.17% (n=31).

Glucose Metabolism

During the rehabilitation program, blood glucose levels dropped dramatically in the study group [Table/Fig-3]. The differences between U1 and U2 were highly significant for blood glucose measured at 7:00 a.m. and 9:30 a.m. for HbA1c and for fasting glucose levels estimated in the laboratory (p<0.001), and significant for blood glucose measured at 11:00 a.m. (p=0.039).

Parameter	Time	Mean±SD	
Blood glucose (mg/dl) #n = 35	U1: 7:00 a.m.	123.25±46.42	
	U2: 7:00 a.m.	104.92±23.82	
Blood glucose (mg/dl) #n = 36	U1: 9:30 a.m.	141.18±66.05	
	U2: 9:30 a.m.	117.33±35.47	
Blood glucose (mg/dl) #n = 36	U1: 11:00 a.m.	110.45±34.36	
	U2: 11:00 a.m.	101.28±16.83	
HbA1c (%) #n = 42	U1	6.34±1.19	
	U2	5.98±0.89	
Glucose (laboratory) (mg/dl) #n = 48	U1	122.94±43.38	
	U2	101.00±25.17	
Paired differences (U1-U2)**	**Time**	**Mean±SD**	**p-value***
Blood glucose (mg/dl)	7:00 a.m.	20.06±29.89	<0.001
Blood glucose (mg/dl)	9:30 a.m.	25.75±40.39	<0.001
Blood glucose (mg/dl)	11:00 a.m.	10.19±28.57	0.039
HbA1c (%)	-	0.27±0.52	<0.001
Glucose (laboratory) (mg/dl)	-	20.33±25.57	<0.001

[Table/Fig-3]: Changes in blood glucose at the beginning (U1) and end (U2) of rehabilitation.
*t-Test for connected samples, two-sided significance.
**Negative values reflect an increase from U1 to U2.
#Though, total sample size considered for the study was 52, during analysis same sample was missing resulting in difference in the "n"value.

A total of 24 of the 52 patients (46.2%) had been diagnosed with diabetes mellitus. Seven patients were treated exclusively through diet. Seventeen patients received an oral medication (e.g., metformin), insulin, or both. In this subgroup, changes in estimated glucose values were also (highly) significant (p- value between 0.001–0.043) [Table/Fig-4]. Patients without diabetes did not show a significant reduction of glucose values during rehabilitation, except the glucose level estimated in laboratory testing (p<0.001) [Table/Fig-5].

Comparison of U1 and U2		
Differences (Δ) (U1-U2)*	**Mean±SD**	**p-value****
Δ-Blood Glucose 7:00 a.m. (mg/dl)	30.10±34.45	0.001
Δ-Blood Glucose 9:30 a.m. (mg/dl)	40.90±44.13	<0.001
Δ-Blood Glucose 11:00 a.m. (mg/dl)	16.57±35.20	0.043
Δ-Hba1c (%)	0.41±0.57	0.006
Δ-Glucose (Lab) (mg/dl)	31.73±29.76	<0.001

[Table/Fig-4]: Statistical comparison of blood glucose values at U1 and U2 in patients with diabetes mellitus.
*t-Test for connected samples, two-sided significance
**Negative values reflect an increase from U1 to U2.

Blood pressure

In the study group, systolic as well as diastolic blood pressure dropped during rehabilitation [Table/Fig-6]. The differences between U1 and U2 were 12.8 mmHg for systolic blood pressure and 6.8 mmHg for diastolic blood pressure. The reductions were highly significant.

Statistical Comparison of the Change in Parameters between U1 and U2		
Differences (Δ) between the Parameters (U1-U2)*	**Mean±SD**	**p-value****
Δ-Blood Glucose 7:00 a.m. (mg/dl)	5.00±10.19	0.089
Δ-Blood Glucose 9:30 a.m.(mg/dl)	4.53±21.70	0.432
Δ-Blood Glucose11:00 a.m.(mg/dl)	1.27±11.14	0.666
Δ-HbA1c (%)	0.17±0.47	0.103
Δ-Glucose (Lab) (mg/dl)	10.69±16.57	0.003

[Table/Fig-5]: Statistical comparison of blood glucose values at U1 and U2 inpatients without diabetes mellitus.
*t-Test for connected samples, two-sided significance
**Negative values reflect an increase from U1 to U2.

Parameter	Time	Minimum	Maximum	mean±SD
Systolic BP (mmHg)	U1	115.0	171.0	135.87±12.46
	U2	105.0	145.0	123.10±8.84
Diastolic BP (mmHg)	U1	62.0	102.0	84.71±6.77
	U2	61	90	77.88±6.32
Paired Differences (U1-U2)				
Parameter		**Mean±SD**		**p-value***
Systolic BP (mmHg)*		12.77±9.01		<0.001
Diastolic BP (mmHg)*		6.83±5.40		<0.001

[Table/Fig-6]: Changes in blood pressure (BP) at the beginning (U1) and end (U2) of rehabilitation (n=52).
*t-test for connected samples, two-sided significance.

A total of 38 of 52 patients (73.1%) had been diagnosed with arterial hypertension. Fourteen patients had normal blood pressure values. Fourteen patients with arterial hypertension were treated with ß-blockers, 19 patients with angiotensin-converting-enzyme (ACE) blockers, 14 patients with calcium-antagonists, 20 patients with diuretics, and 11 patients with angiotensin-1-receptor antagonists. No statistical differences were found in regard to blood pressure values between patients with or without diagnosed arterial hypertension at the beginning and the end of rehabilitation [Table/Fig-7].

Parameter	Time	Minimum	Maximum	Mean±SD
Patients with Arterial Hypertension (n=38)				
Systolic BP (mmHg)	U1	115.0	171.0	135.58±11.87
	U2	105.0	145.0	122.00±8.33
Diastolic BP (mmHg)	U1	66.0	102.0	84.05±5.78
	U2	63	90	76.87±5.81
Patients without Arterial Hypertension (n=14)				
Systolic BP (mmHg)	U1	115.0	160.0	136.64±14.40
	U2	113.0	145.0	126.07±9.82
Diastolic BP (mmHg)	U1	62.0	100.0	86.50±8.93
	U2	61	90	80.64±7.01
Comparison of Patients with or without Arterial Hypertension*				
Parameter		**Mean Difference****	**Standard-Error**	**p-value*****
Systolic BP (mmHg)–U1		–1.06	3.93	0.788
Systolic BP (mmHg)–U2		–4.07	2.73	0.142
Diastolic BP (mmHg)–U1		–2.45	2.11	0.251
Diastolic BP (mmHg)–U2		–3.77	1.92	0.055

[Table/Fig-7]: Blood pressure (BP) in patients with and without arterial hypertension.
* Levene's test did not show a significant difference between the variance in both groups. Therefore, the t-test was used. **Negative values reflect an increase from U1 to U2. *** two-sided significance.

Heart Rate

The heart rate was analysed under resting conditions at the beginning and at the end of the treatment [Table/Fig-8]. During the treatment, the mean heart rate decreased from 77 to 66 beats per minute. The reduction in the heart rate was highly significant (p<0.001).

	Mean±SD (bpm)	p-value**
U1	77.13±14.89	<0.001
U2	65.60±11.84	
U1-U2 (paired difference)*	11.53±11.11	

[Table/Fig-8]: Changes in heart rate [beats per minute (bpm) on electro-cardiography (ECG)] at the beginning (U1) and end (U2) of rehabilitation (n = 47).
* Levene test did not show a significant difference between the variance in both groups. Therefore, the t-test was used. ** two-sided significance.

Bioelectric Impedance Analysis

The BIA revealed a highly significant reduction in the proportion of body fat between the beginning and the end of the program (U1: 38.48%±7.53%, U2: 36.24%±7.83%, p<0.001, see [Table/Fig-9]). In addition, (highly) significant differences between U1 and U2 were detected for body water (p=0.004), lean body mass (p<0.001), cell content (p=0.011), phase angle (p=0.019), and extracellular water (p=0.002). No statistical differences could be found for extracellular mass (p=0.076), body cell mass (p=0.118), basal metabolic rate (p=0.360), and intracellular water (p=0.625).

	U1 mean±SD	U2 mean±SD	U1-U2 mean±SD	p-value***
Body Fat (kg)	52.63±16.22	47.12±15.09	5.51±2.89	<0.001
Body Fat (%)	38.48±7.53	36.24±7.83	2.24±1.11	<0.001
Body Water (liter)	60.74±12.56	59.12±10.85	1.62±3.85	0.004
Lean Body Mass (kg)	83.23±16.72	80.74±14.81	2.48±4.72	<0.001
Extracellular Mass (ECM) (kg)	38.65±8.22	37.91±7.28	0.74±2.92	0.076
Body Cell Mass (BCM) (kg)	43.79±9.29	42.83±8.29	0.96±4.32	0.118
ECM BCM Index	0.87±0.10	0.89±0.11	–0.20±0.54**	0.009
Cell Content (%)	53.54±2.81	53.00±3.00	0.55±1.49	0.011
Basal Metabolic Rate (kcal/day)	1992±309	1969±262	22.94±177.20	0.360
Phase Angle (°)	6.37±0.63	6.26±0.65	0.11±0.33	0.019
Extracellular Water (liter)	29.21±6.53	27.63±6.44	1.58±3.46	0.002
Intracellular Water (liter)	31.70±6.17	31.50±6.11	0.20±0.41	0.625

[Table/Fig-9]: Changes in bioelectric impedance analysis at the beginning (U1) and end (U2) of rehabilitation (n=51).
* Levene test did not show a significant difference between the variance in both groups. Therefore, the t-test was used. **Negative values reflect an increase from U1 to U2. *** two-sided significance.

Life Quality (SF-36 Questionnaire) [12]

SF-36 questionnaire data from 48 patients were evaluated. Four patients did not complete the questionnaire because of insufficient German language skills. The analysis revealed highly significant improvements after rehabilitation for all subscales of the SF-36 questionnaire (physical functioning, role physical, role emotional, vitality, mental health, social functioning, bodily pain, and general health).

DISCUSSION

Obesity

During the four week inpatient obesity rehabilitation program at the Eleonoren Clinic, the present study group achieved a mean body weight loss of 7.1 kg (5.1%). The most extreme weight loss was 13.4%, and the average reduction in BMI was 2.3 kg/m².

One goal of the interdisciplinary guidelines of the German Obesity Society for the prevention and therapy of obesity is an initial reduction in body weight by 5%, for people with obesity Grade 1 within a six to twelve months period. This aim was nearly achieved during the four week inpatient rehabilitation program (4.56% body weight loss for patients with obesity Grade 1). For people with obesity Grade 2 and 3, body weight reduction during the same period should be 10%. In the present study, people already lost one-half of the required weight (5.53% patients with obesity grade 2 and 5.17% patients with obesity Grade 3) during the four week inpatient rehabilitation program. The successful weight reduction is likely due to the combination of behavioural/exercise modules and nutritional education during inpatient therapy. The reduction in weight can be interpreted as a result of an initial lifestyle change towards increased physical activity and calorie-reduced nutrition. Several studies have already confirmed the success of a combination of exercise and nutrition therapy for weight reduction [13-15].

Sufficient compliance of patients is an indispensable prerequisite for successful weight reduction [16]. At the Eleonoren Clinic in Winterkasten, an interdisciplinary team of physicians, psychologists, nurses, physiotherapists, diabetes assistants, diet assistants, and nutrition consultants ensure effective therapy progress.

Glucose Metabolism

During the four week inpatient rehabilitation program, the diabetic metabolic state improved significantly. No correlation was found between weight-associated parameters (BMI-U1, weight reduction) and glucose metabolism-associated parameters (HbA1c-U1, glucose U1).

Blood Pressure

Arterial hypertension is an independent risk factor for cardiovascular diseases such as myocardial infarction, stroke, sudden cardiac death, and (terminal) renal failure. The prevalence of arterial hypertension in the present study group (patients with obesity 1-3) was estimated at 73% and therefore comparable to the results of the Hypertension and Diabetes Risk Screening and Awareness (HYDRA) study [17].

Weight reduction reduces systolic and diastolic blood pressure [3]. A meta-analysis of studies on the correlation between weight loss and blood pressure revealed a significant weight reduction of 5.1 kg accompanied by a mean systolic and diastolic blood pressure decrease of 4.44 mmHg and 3.57 mmHg, respectively, during an average observation period of 66.6 months. The decline per kilogram of body weight lost was equal to 1.05 mmHg and 0.92 mmHg for systolic and diastolic blood pressure, respectively [18]. In the course of a six month intervention program with the object of a lifestyle change, patients were able to reduce their body weight by 4.5 kg and their systolic/diastolic blood pressures by 3.7 mmHg and 2.7 mmHg, respectively [19]. In another trial with 522 patients (aged 40–65 years) with diabetes type 2 and a BMI of ≥ 25 kg/m², participants of a two-year program that included dietary training and an endurance sports program achieved a significant reduction in systolic/diastolic blood pressure of 5 mmHg in each case [14]. In the present study, weight reduction (mean 7.1 kg) during rehabilitation was accompanied by a highly significant decrease in systolic and diastolic blood pressure of 12.8 mmHg (p<0.001) and 6.8 mmHg (p<0.001), respectively.

Heart Rate

Heart rate is said to be an influencing factor in the development of cardiovascular diseases and is associated with body weight, visceral fat proportion, and BMI [20]. The positive correlation between weight-associated parameters and heart rate under resting conditions is likely due to a higher sympathetic activity [20]. In the present study collectively, a significant positive correlation was found between resting pulse and various weight-associated parameters such as BMI, weight reduction (%), and decrease of waist circumference. The heart rate at rest decreased very significantly by more than ten beats per minute.

Life Quality (SF-36 Questionnaire)

In the German National Health Survey of 1998 and the DEGS-1 study conducted from 2008 to 2011, health-related life quality of a

large number of probands (German National Health Survey: n=6964; DEGS study: n=8152) was analysed. The DEGS-1 study revealed that men and women suffering from chronic diseases estimate their personal health-related life quality as significantly lower than people not suffering from the said diseases. The life quality of obese persons determined with the SF-36 questionnaire diminished in all areas when compared to the German general population.

A comparison of the present data with data from the DEGS-1 study showed a highly reduced health-related life quality for patients at the beginning of the rehabilitation program in all areas. On a sex neutral basis, the extent of the reduction was about 30%. At the end of the rehabilitation program, patients estimated their life quality in all areas to be significantly higher. For some areas (e.g., vitality, social functioning, and emotional role), the patients reached the level of the german general population. The effect of weight reduction on the subjectively perceived life quality is likely due to changes in body scheme and to an enhanced self-esteem.

LIMITATION

No control group was considered in this study. Also, the gender distribution was not balanced. Further the exclusion rate was quite high.

CONCLUSION

Obesity is divided into different degrees of severity and the accompanying diseases are always different. It must therefore be decided individually whether an outpatient obesity therapy is sufficient or an inpatient stay is necessary. The results of the present study clearly shows that the four-week inpatient rehabilitation program at the Eleonoren Clinic is suitable to achieve an initial weight reduction and to improve the physiological state of health and life quality. This outcome can serve as a suitable prerequisite for the post-clinic continuation of the acquired lifestyle changes in regard to diet and exercise.

ABBREVIATION

BIA, Bioelectric Impedance Analysis; BMI, Body Mass Index; WHO, World Health Organization; NVS, Nationale Verzehrstudie; EWL, Excessive Weight Loss; ECG, Electrocardiogram; ACE, Angiotensin-Converting-Enzyme; HYDRA, Hypertension and Diabetes Risk Screening and Awareness; DEGS, Studie zur Gesundheit Erwachsener in Deutschland.

DECLARATIONS

Ethics approval and consent to participate:

The project was examined and approved by the Ethics Committee of the University of Munich. Registration number: 546-13

www.ethikkommission.med.uni-muenchen.de

REFERENCES

[1] Hubert H, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham heart study. Circulation. 1983;67:968–77.
[2] World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organization technical report series i–xii, 2000;1–253.
[3] Aucott L, Poobalan A, Smith W, Cairns S, Avenell A, Jung R, et al. Effects of weight loss in overweight/obese individuals and long-term hypertension outcomes: a systematic review. Hypertension. 2005;45:1035–41.
[4] Guh D, Zhang W, Bansback N, Bansback N, Amarsi Z, Amarsi B, et al. The incidence of comorbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Public Health. 2009;9:88–108.
[5] Reijman M, Pols H, Bergink AP, Hazes JM W, Belo N, Lievense AM, et al. Body mass index associated with onset and progression of osteoarthritis of the knee but not of the hip: the Rotterdam Study. Ann Rheum Dis. 2007;66:158–62.
[6] Schulte H, Cullen P, Assmann G. Obesity, mortality and cardiovascular disease in the Munster Heart Study (PROCAM). Atherosclerosis. 1998;144:199–209.
[7] Solomon C, Manson J. Obesity and mortality: a review of the epidemiologic data. Am J Clin Nutr. 1997;66:1044S–50S.
[8] Whitlock G, Lewington S, Sherliker P, Clarke R, Emberson J, Halsey J, et al. Body-mass index and cause-specific mortality in 900,000 adults: collaborative analyses of 57 prospective studies. Lancet. 2009;373:1084–96.
[9] World Health Organization. Obesity and overweight. 2015;311:1–15. http://www.who.int/mediacentre/factsheets/fs311/en/. [Last accessed 4 May 2016].
[10] Max Rubner Institut. Nationale Verzehrs Studie II Ergebnisbericht, Teil 1. 2008;1–93. https://http://www.bmel.de/SharedDocs/Downloads/Ernaehrung/NVS_Ergebnisbericht.pdf?__blob=publicationFile. [Last accessed 4 May 2016].
[11] Bellisari A. Evolutionary origins of obesity. Obes Rev. 2008;2:165–80.
[12] Rand Health. Medical Outcomes Study: 36-Item Short Form Survey Scoring Instructions. 2009;1–3. http://www.rand.org/health/surveys_tools/mos/mos_core_36item_scoring.html. [Last accessed 4 May 2016].
[13] Tuomilehto J, Lindström J, Eriksson JG, Valle TT, Hämäläinen H, Ilanne-Parikka P, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med. 2001;344:1343–50.
[14] Avenell A, Broom J, Brown T, Poobalan A, Aucott L, Stearns S, et al. Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement. Health Technol Assess. 2004;21:1–182.
[15] Wu T, Gao X, Chen M, Dam M. Long-term effectiveness of diet-plus-exercise interventions vs. diet-only interventions for weight loss: a meta-analysis. Obes Rev. 2009;10:313–23.
[16] Gortmaker S, Swinburn BA, Levy D, Carter R, Mabry PL, Finegood DT, et al. Changing the future of obesity: science, policy, and action. Lancet. 2011;378:838–47.
[17] Bramlage P, Pittrow D, Wittchen H, Kirch W, Boehler S, Lehnert H, et al. Hypertension in overweight and obese primary care patients is highly prevalent and poorly controlled. Am J Hypertens. 2004;10:904–10.
[18] Neter JE, Stam B, Kok FJ, Grobbee DE, Geleijnse JM. Influence of weight reduction on blood pressure: a meta-analysis of randomized controlled trials. Hypertension. 2003;42:878–84.
[19] Straznicky N, Grassi G, Esler M, Lambert G, Dixon J, Lambert E, et al. European Society of Hypertension Working Group on Obesity. Antihypertensive effects of weight loss: myth or reality? J Hypertens. 2010;28:637–43.
[20] Chintala KK, Krishna BH, Reddy N. Heart rate variability in overweight health care students: correlation with visceral fat. J Clin Diagn Res. 2015;1:06–08.

PARTICULARS OF CONTRIBUTORS:
1. Study Manager, Department of Internal Medicine, Eleonoren Clinic of Winterkasten, Lindenfels, Hessen, Germany.
2. Scientific Advisor, Head of Hospital, Department of Internal Medicine, Eleonoren Clinic of Winterkasten, Lindenfels, Hessen, Germany.
3. Scientific Advisor Endocrinology, Department of Internal Medicine, Member of the Medical Faculty University of Munich, Sauerlach, München, Germany.
4. Scientific Advisor Cardiology, Department of Internal Medicine, Member of the Medical Faculty University of Munich, Bad Wiessee, München, Germany.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Mr. Tobias Weinreich,
Am Kaiserturm 6, 64678 Lindenfels, Hessen, Germany.
E-mail: tobi@tobi84.de

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Sep 20, 2016**
Date of Peer Review: **Oct 19, 2016**
Date of Acceptance: **Nov 19, 2016**
Date of Publishing: **Mar 01, 2017**