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Original Article

The benefits of body weight loss on health-related quality of life

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Abstract

Background: Obesity is a worldwide public health issue, and the prevalence of obesity is also increasing steadily in Taiwan. Obesity leads to several chronic diseases. Often, impaired quality of life is a consequence of obesity. The aim of this study was to determine if body weight-loss could improve health-related quality of life (HRQOL) in Taiwan.
Methods: The cutoff for obesity is body mass index (BMI) = 27 as compared with 30 in US and Europe. We enrolled 67 participants with BMI ≥ 27 and more than one criterion of the metabolic syndrome, who underwent 3 months of body weight-loss intervention by diet control and regular exercise. We performed anthropometric measurements and blood tests, and administered the WHOQOL-BREF questionnaire Taiwanese version to assess HRQOL before and after the weight loss intervention. This is the first study using the WHOQOL-BREF to examine HRQOL in Taiwan. The questionnaire included D1 physical, D2 psychological, D3 social relationships and D4 environmental domains; each was scored from 4 to 20.
Results: Obese subjects had lower D1 and D2 scores as compared with the Taiwan healthy population reference group at baseline. In this study, 38 participants completed the 3-month intervention program and 29 participants dropped out. Twenty-five participants reached the 5% of initial BMI goal. Among them, significant statistical improvements were found both in medical comorbidities and in the four domains of the HRQOL questionnaire.
Conclusion: Obesity can cause impaired HRQOL, which can be improved through BMI intervention. In addition to the benefits of biomedical aspect, this could be an incentive goal for keeping body weight control.

Keywords: Comorbidity; Health-related quality of life (HRQOL); Metabolic syndrome; Obesity; WHOQOL-BREF questionnaire Taiwanese version

1. Introduction

The prevalence of obesity is increasing largely due to lifestyle changes.[1,2] Several metabolic abnormalities are associated with obesity, including elevated blood pressure, hyperlipidemia, and hyperglycemia.[3] The concept of insulin resistance was first proposed by Reaven as a pathophysiological construct,[4,5] and in 1998, World Health Organization (WHO) coined the term metabolic syndrome to represent several interrelated abnormalities that increase the risk for cardiovascular disease and diabetes mellitus.[6–8] The impact of metabolic syndrome on physical health is well understood; as we all know, chronic disease can further impaired the quality of life, the same condition may occur in obesity, hence several measurement instruments have been used to evaluate the quality of life in obesity.[9] In this study, the WHOQOL-BREF Taiwanese version questionnaire was employed to assess the effects of body weight control on the physical, psychological, social and environment function in obese subjects. Our study aim was to confirm whether this poor quality of life could be improved through body weight loss.

1.1. Epidemiology of metabolic syndrome in Taiwan

In Taiwan, the prevalence of obesity has increased steadily. Using the criteria defined by the Department of Health in

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Taiwan [overweight as body mass index(BMI $\geq$ 24 and obese as BMI $\geq$ 27], the age-adjusted prevalences of obesity were 10.5% and 15.9% for men and 13.2% and 10.7% for women from 1993–1996 to 2000–2001.[10] The prevalence of metabolic syndrome in the adult population in developed countries is 22–39% and varies depending on the definition used and on ethnicity.[11] This syndrome has become increasingly common in Taiwan. In Chuang et al's hospital-based study, the prevalence of metabolic syndrome was 12.9% (15.5% in men and 10.5% in women, respectively) with the Asian criteria for waist circumference.[12] In a study in Kinmen, Taiwan,[13] the metabolic syndrome was present in 21.2% of the population (where 17.7% of men and 23.8% of women). In a hospital-based study in central Taiwan, the prevalence of metabolic syndrome was 30.0% in men and 22.9% in women.[14]

1.2. Psychiatric consequences

Several recent reviews have disclosed that obesity is also associated with an increased risk for psychiatric comorbidity, stress, and impaired health-related quality of life (HRQOL) based on physical, social, and psychological domains.[15–17] For instance, in a study of 293 obese patients compared to 293 lean individuals, results revealed obesity was associated with a significant lifetime major risk both for axis I (OR = 3.47, $p < 0.001$) and axis II disorders (OR = 2.27, $p < 0.001$). Obesity was also associated with significantly lower measures of subjective quality of life. Comorbidity with psychiatric axis I/II disorders, particularly among obese patients, was associated with lower quality of life measures on the WHOQOL-BREF questionnaire.[18] Another study also showed that an abnormally high BMI was associated with an increased likelihood of having serious psychological distress, independent of obesity-related comorbidities, lifestyle factors, or emotional support.[19–21]

The global emergence of obesity and diabetes is as much an economic issue as it is a health issue.[22,23] The ever-growing number of obesity cases not only increases the social burden but also interferes with personal life. This is the first study to use the WHOQOL-BREF questionnaire Taiwanese version to assess quality of life in obese persons in Taiwan. We predicted that body weight loss would lead to improvement in the HRQOL.

2. Methods

2.1. Subjects

We recruited obese individuals from Family Medicine Body Weight Control Clinics of Kaohsiung Veterans General Hospital from January 2008 till July 2008. Inclusion criteria were a BMI $\geq$ 27 kg/m^2 with more than one factor of the metabolic syndrome criteria and between 20 and 65 years old. To make sure the quality of life was not influenced because of underlying disease, those patients with major systemic disease and psychiatric disease history were excluded. At the initial consultation, participants were screened for study eligibility and informed consents were obtained. We enrolled 67 participants, all of whom had central obesity according to Asian WHO criteria. Among them, 39 were male and 28 were female. The mean age was 40.3 $\pm$ 10 years, mean body weight was 88.8 $\pm$ 16.4 kg, and mean BMI was 32.4 $\pm$ 4.0 kg/m^2 (Table 1).

2.2. Procedure

All procedures were performed following 12 hours of overnight fasting. The participants came to the laboratory at 9 AM and wore a hospital gown and no shoes. They completed a pre-intervention checkup, including anthropometric measurements, vital signs, and the WHOQOL-BREF questionnaire Taiwanese version. A fasting blood sample was obtained to perform laboratory tests. All staff were trained and certified for doing the measurements. Participants signed an IRB approved consent.

2.3. Anthropometric measurements

Body weight was measured with a Tanita TBF-410 Pro body composition analyzer, which records body weight to the nearest 0.1 kg and body fat to 0.1% based on bioimpedance analysis. A calibrated digital scale (Super-View HW2020) was used to measure body height to the nearest 0.1 cm. BMI was then calculated from weight and height. The neck, upper forearm, waist, hip, thigh, and calf circumference were measured. The circumferences of the neck, upper forearm, and calf were measured at the mid-point, and the thigh at the groin. Waist circumference was measured between the lower rib margin and the iliac crest, with participants standing with their heels together.[24]

2.4. Body composition

Body fat was also measured with dual-energy X-rays (DXA, QDR4500A; Hologic Delphi, Bedford, MA, USA) using DXA software version 8.21 (Hologic). All systems were routinely calibrated, and quality control measures were followed as recommended by the respective manufacturers.

2.5. Blood tests

Serum glucose, glycated hemoglobin(HbA1c), glutamcic oxaloacetic transaminase(GOT), glutamic pyruvic transaminase(GPT), total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride, creatinine, and uric acid were measured by the hospital chemistry lab. Insulin was measured with ELISA (IMMULITE 2000) in the endocrine laboratory.

2.6. HRQOL

We used the self-administered WHOQOL-BREF questionnaire Taiwanese version to assess HRQOL. The internal consistency (Cronbach α) coefficients ranged from 0.70 to 0.77 for the four domains. The questionnaire has good test-retest reliability coefficients over intervals of 2–4 weeks, which

Table 1
Baseline characteristics of 67 obese participants and the comparison between completers and drop-outs[a]

	Min	Max	Average	Drop-out ($n = 29$)	Completer ($n = 38$)	p
Age (yr)	21.0	63.0	40.3 ± 10.0	41.4 ± 9.8	39.6 ± 10.3	0.447
Weight (kg)	64.2	126.5	88.8 ± 16.4	89.0 ± 17.0	88.6 ± 16.1	0.911
Height (cm)	149.5	189.6	165.0 ± 9.0	166.5 ± 10.1	164.0 ± 8.1	0.257
BMI (kg/m^2)	27.4	45.7	32.4 ± 4.0	31.9 ± 3.6	32.8 ± 4.4	0.348
Tanita body fat (%)	23.6	63.1	39.7 ± 9.1	39.7 ± 9.5	39.7 ± 8.9	0.987
DXA whole body fat (%)	19.8	50.2	34.5 ± 6.8	34.4 ± 7.1	34.6 ± 6.7	0.940
DXA trunk body fat (%)	21.5	50.2	36.5 ± 6.3	36.0 ± 6.6	36.9 ± 6.1	0.555
Neck circum. (cm)	34.0	50.5	40.1 ± 3.6	39.8 ± 3.7	40.4 ± 3.5	0.522
Upper forearm circum. (cm)	28.5	43.5	34.8 ± 3.4	34.6 ± 3.4	35.1 ± 3.4	0.585
Waist (cm)	83.0	134.0	101.1 ± 10.1	100.2 ± 9.3	100.2 ± 10.7	0.417
Hip (cm)	95.5	129.0	108.7 ± 8.4	109.2 ± 8.1	108.3 ± 8.7	0.669
Thigh (cm)	43.0	71.0	56.2 ± 5.6	56.4 ± 5.5	56.1 ± 5.8	0.850
Calf (cm)	34.0	49.0	40.6 ± 3.3	40.5 ± 3.2	40.7 ± 3.4	0.784
SBP (mmHg)	100.0	190.0	133.4 ± 20.0	132.1 ± 21.0	134.4 ± 19.6	0.657
DBP (mmHg)	60.0	120.0	91.2 ± 12.1	91.4 ± 11.6	90.9 ± 12.7	0.869
GOT (mg/dL)	13.0	114.0	30.6 ± 16.9	31.8 ± 20.9	29.7 ± 13.4	0.612
GPT (mg/fL)	13.0	413.0	56.8 ± 59.6	64.1 ± 79.7	51.1 ± 32.1	0.364
Uric acid (mg/dL)	4.1	11.7	7.0 ± 1.7	6.6 ± 1.7	7.3 ± 1.7	0.123
Creatinine (mg/dL)	0.6	1.5	1.0 ± 0.2	1.0 ± 0.2	1.0 ± 0.2	0.536
T. CHOL (mg/dL)	117.0	305.0	200.7 ± 38.8	199.9 ± 35.7	201.4 ± 41.5	0.882
HDL (mg/dL)	24.0	62.0	40.4 ± 9.1	41.2 ± 10.8	39.9 ± 7.8	0.546
LDL (mg/dL)	49.0	201.0	116.1 ± 31.8	111.2 ± 28.5	119.9 ± 34.0	0.275
TG (mg/dL)	47.0	1243.0	214.2 ± 208.0	238.9 ± 262.5	195.3 ± 155.5	0.400
Glucose (mg/dL)	68.0	243.0	110.0 ± 35.4	110.2 ± 36.2	109.8 ± 35.3	0.967
Insulin (U/mL)	3.9	45.5	17.6 ± 8.7	18.3 ± 9.7	17.0 ± 8.1	0.536
IR (HOMA index)	0.0	74.0	5.9 ± 9.2	5.2 ± 4.5	6.4 ± 11.7	0.599
HbA1c (%)	4.7	14.4	6.5 ± 1.8	6.8 ± 2.4	6.2 ± 1.2	0.264
Sat. of HRQOL	5.0	90.0	62.5 ± 15.8	64.6 ± 13.3	60.9 ± 17.5	0.353
Sat. of BHRQOL	5.0	95.0	67.5 ± 16.9	65.2 ± 17.9	69.2 ± 16.2	0.345
D1	9.1	18.9	13.77 ± 2.02	13.83 ± 2.16	13.71 ± 1.94	0.815
D2	5.3	19.3	12.62 ± 2.43	13.03 ± 2.65	12.30 ± 2.22	0.221
D3	7.0	19.0	13.82 ± 2.22	13.86 ± 2.49	13.79 ± 2.03	0.896
D4	8.9	17.3	13.69 ± 1.74	13.67 ± 1.45	13.71 ± 1.96	0.932

[a] Data are presented as n or mean ± standard deviation.
Independent samples test was used to compare characteristics of completers and drop-outs.
BMI = body mass index; D1 = physical domain; D2 = psychological domain; D3 = social relationships domain; D4 = environmental domain; DBP = diastolic blood pressure; DXA = dual energy X-ray absorptiometry; GOT = glutamcic oxaloacetic transaminase; GPT = glutamic pyruvic transaminase; HbA1c = glycated hemoglobin; HDL = high-density lipoprotein; IR = insulin resistance; LDL = low-density lipoprotein; Sat. of BHRQOL = satisfied with health related quality of life before body weight gain; Sat. of HRQOL = satisfied with health related quality of life; SBP = systolic blood pressure; T. CHOL = total cholesterol; TG = triglyceride.

ranged from 0.41 to 0.79 at item level and 0.76 to 0.80 at domain level (all $p < 0.01$). Content validity coefficients were in the range of 0.53–0.78 for item-domain correlations and 0.51–0.64 for inter-domain correlations (all $p < 0.01$).[25]

The WHOQOL-BREF questionnaire Taiwanese version has 28 items, consisting of 26 standard items from the original WHOQOL-BREF and two newly developed Taiwanese items.[25,26] One item was included in the social relationships domain ("Do you feel respected by others?"). The other item was contained in the environmental domain ("Are you usually able to get the things you like to eat?"). These 28 items were classified into four domains: D1 physical domain (7 items), D2 psychological domain (6 items), D3 social relationships domain (5 items) and D4 environmental domain (10 items). The domain scores were calculated by multiplying the mean of all item scores by a factor of 4, thus scores ranged from 4 to 20. Higher scores indicated better quality of life. Another two questions were added on to assess satisfaction of HRQOL. The first was "How satisfied are you with your HRQOL?" The second was "How satisfied were you with your HRQOL before your body weight gain?" The score ranged from 0, the worst, to 100, the best. The norms of healthy population reference group for the WHOQOL-BREF questionnaire Taiwanese version were obtained by using the data from the 2001 National Health Interview Survey (NHIS; Atlanta, GA, USA) in Taiwan.

2.7. Body weight loss intervention program

The dietary prescription was for reduction of daily food intake by 500 kcal and 30 minutes of aerobic exercise 5 days a week. Participants returned to the clinic every 2 weeks and body weight, waist circumference and blood pressure were measured. They met with a physician for a 20 minutes nutritional and exercise consultation. The intervention program was for 3 months, at which time there was a post-intervention assessment repeating the same tests as at the beginning.

Table 2
The changes between pre- and post-intervention in completers (n=38)

	Mean ± SD	95% CI		p
		Lower	Upper	
Weight (kg)	6.9 ± 5.2	5.2	8.6	0.000[a]
BMI (kg/m^2)	2.5 ± 1.8	1.9	3.1	0.000[a]
Tanita body fat (%)	4.6 ± 5.0	3.0	6.3	0.000[a]
DXA whole body fat (%)	2.1 ± 2.6	1.2	2.9	0.000[a]
DXA trunk body fat (%)	2.6 ± 3.4	1.5	3.8	0.000[a]
Neck circum. (cm)	1.5 ± 1.2	1.1	1.8	0.000[a]
Upper forearm circum. (cm)	1.8 ± 1.6	1.2	2.3	0.000[a]
Waist (cm)	5.9 ± 4.7	4.4	7.5	0.000[a]
Hip (cm)	4.1 ± 5.0	2.4	5.7	0.000[a]
Thigh (cm)	0.9 ± 3.6	−0.3	2.1	0.141
Calf (cm)	1.0 ± 1.3	0.6	1.4	0.000[a]
SBP (mmHg)	7.0 ± 18.0	1.1	12.9	0.022
DBP (mmHg)	6.1 ± 11.3	2.4	9.8	0.001
GOT (mg/dL)	5.4 ± 12.4	1.3	9.4	0.011
GPT (mg/fL)	18.3 ± 28.8	8.8	27.7	0.000[a]
Uric acid (mg/dL)	0.5 ± 1.7	0.0	1.1	0.069
Creatinine (mg/dL)	0.0 ± 0.1	−0.1	0.0	0.644
T. CHOL (mg/dL)	15.9 ± 32.8	5.1	26.7	0.005[a]
HDL (mg/dL)	−1.1 ± 4.5	−2.6	0.4	0.138
LDL (mg/dL)	15.4 ± 25.9	6.8	23.9	0.001[a]
TG (mg/dL)	47.0 ± 125.7	5.7	88.4	0.027[a]
Glucose (mg/dL)	−1.1 ± 27.5	−10.2	7.9	0.801
Insulin (U/mL)	1.7 ± 6.1	−0.3	3.7	0.091
IR (HOMA index)	0.2 ± 2.1	−0.5	0.9	0.572
HBA1c (%)	0.1 ± 0.5	−0.1	0.2	0.530
Sat. of HRQOL	−7.3 ± 14.6	−12.1	−2.4	0.040[a]
Sat. of BHRQOL	−0.5 ± 12.0	−4.4	3.4	0.798
D1	−0.7 ± 1.7	−1.2	−0.1	0.023[a]
D2	−0.9 ± 1.7	−1.5	−0.3	0.003[a]
D3	−0.7 ± 1.4	−1.2	−0.2	0.040[a]
D4	−0.5 ± 1.2	−0.9	−0.1	0.012[a]

[a] Two-tailed $p \leq 0.05$ with statistical significance, paired-samples t test. Abbreviations as in Table 1.

2.8. Statistics

One-sample t test was used to compare the mean of HRQOL scores of our participants with the healthy population reference group mean. Independent-samples t test was used to compare the demographics between the participants who completed the study and those who dropped out. Paired-samples t test was used to compare the data pre- and post-intervention. Two-tailed $p \leq 0.05$ was required for statistical significance (SPSS).

3. Results

Of the 67 participants, 38 (56.7%) participants completed the 3-month-intervention and had the post-intervention assessment; 29 (43.3%) participants dropped out. However, there were no significant baseline demographic differences noticed between completers and drop-outs (Table 1). As shown in Table 2, on average, there were significant changes from pre- to post-intervention in body weight, BMI, body fat, and all the circumferences measurements except thigh. For the blood tests, statistical changes were also found in GOT, GPT, total cholesterol, high-density lipoprotein cholesterol (HDL), low-density lipoprotein (LDL), and triglycerides. Of these, 25 (65.8%) participants reached or exceeded the 5% of initial body weight loss goal.

The baseline scores of quality of in the 67 participants were relatively lower compared with those of the healthy population reference: D1 physical domain [13.77 ± 2.02 *vs.* 15.31 ± 1.93, $p < 0.001$; 95% confidence interval (CI) of the difference, −2.04 to −1.05], D2 psychological domain (12.62 ± 2.43 *vs.* 13.80 ± 2.19, $p < 0.001$; 95% CI of the difference, −1.78 to −0.59), D3 social relationships domain (13.82 ± 2.22 *vs.* 14.22 ± 2.22, $p = 0.146$; 95% CI of the difference, −0.94 to 0.14), D4 environmental domain (13.69 ± 1.74 *vs.* 13.33 ± 2.05, $p = 0.094$; 95% CI of the difference, −0.06 to 0.79) (Table 3). More significant improvements in thigh circumference, uric acid, fasting sugar, insulin and insulin resistance were found in the 25-case group that lost ≥5% of initial body weight (Table 4). No matter how much body weight was lost, the four domain scores' improvement was found in both groups, but only those who lost ≥5% of initial body weight group showed a significant change.

4. Discussion

The National Heart, Lung and Blood Institute (NHLBI) issued clinical guidelines about successful body weight

Table 3
WHOQOL-BREF questionnaire Taiwanese version score compared with norm references

Baseline (n = 67)	Mean ± SD	p		
D1	13.77 ± 2.02	0.000[a]		
D2	12.62 ± 2.43	0.000[a]		
D3	13.82 ± 2.22	0.146		
D4	213.69 ± 1.74	0.094		
≥ 5%BWL (n = 25)	Pre-intervention	p	Post-intervention	p
D1	13.87 ± 1.86	0.001[a]	14.63 ± 1.59	0.043
D2	12.53 ± 1.69	0.652	13.44 ± 1.73	0.309
D3	13.92 ± 1.69	0.381	14.56 ± 1.78	0.349
D4	13.94 ± 1.87	0.116	14.42 ± 1.60	0.002[a]

[a] Two-tailed $p \leq 0.05$ with statistical significance.
One-sample t test compared with healthy population reference group, the norms were D1: 15.31 ± 1.93, D2: 13.80 ± 2.19, D3: 14.22 ± 2.05, D4: 13.33 ± 2.05.

control.[27] According to NHLBI, loss of 10 percent of initial body weight in overweight and obese adults appears to reduce various chronic disease risk factors (e.g., hypertension, hyperlipidemia, hyperglycemia) and may decrease morbidity and mortality.[28] One surprising finding in our study was that 5% of initial body weight loss was good enough to improve liver function, total cholesterol, HDL-cholesterol, LDL-cholesterol, blood pressure, glycemic control, and a concomitant improvement in HRQOL. In addition, more anthropometric reductions were also found in the neck, upper forearm, waist, hip, thigh, and calf circumference. Why does as little as 5% of initial body weight loss result in these benefits? One interpretation is that this may be due to an ethnic difference; further investigation in future studies is needed.

With conventional life style intervention, ideal body weight loss is achievable. The Diabetes Prevention Program have demonstrated that modest weight loss achieved by lifestyle changes (diet and exercise) can significantly reduce the risk of developing type 2 diabetes in obese patients with impaired glucose tolerance.[29] Evidence-based studies showed weight-loss strategies using dietary, physical activity, or behavioral interventions produced significant improvements in weight among persons with pre-diabetes, and a significant decrease in diabetes incidence.[30] Besides the physiological benefits, weight-loss also promotes HRQOL as showed in one study which enrolled overweight adults diagnosed as having type 2 diabetes who experienced significant improvement in HRQOL by weight-loss strategies.[31]

Several studies have brought awareness to the psychological comorbidity in obesity,[18] and a significant improvement in quality of life after weight-loss was also documented, especially in studies that investigated the effects of gastric bypass surgery where there is a dramatic body weight loss.[32] Table 3 depicts the significantly lower baseline scores of quality of life (D1, D2) in our study participants as compared with a healthy population reference group; but no more difference was noticed after 3 months of body weight loss intervention.

The WHOQOL-BREF questionnaire Taiwanese version is an established and widely used tool to measure HRQOL in Taiwan in different disease groups, but it had not been applied to obesity before. It was used in this study to assess the aspects of physical and spiritual well-being of obesity. The D1 physical domain includes the extent of physical pain, discomfort, energy, fatigue and quality of sleep. In Taiwan, excess weight is related to worse physical condition.[33] Among these ailments, musculoskeletal problems are very common, affecting up to 20% of adults,[34] which have an overall economic impact that can be measured by the use of health care and social care resources, and by work disability.[35] Obese patients tend to have musculoskeletal problems, such as a strong association between knee osteoarthritis and obesity, which has been revealed in several studies.[36] Furthermore, in the Framingham longitudinal study, high BMI predicted development of knee osteoarthritis in later life.[37] However, this condition could be improved by weight loss; the benefits of weight control in reducing the occurrence and severity of knee osteoarthritis were documented in previous studies.[38] Apart from physical discomfort, sleep apnea is also one of the comorbidities of obesity; it is an effect of the cytokines released from fat cells.[39] Hence, daytime fatigue and lower energy are easily found in obese patients. These could explain the cause of the lower D1 physical domain baseline score in our study subjects. The D2 psychological domain includes the extent of positive and negative feelings, thinking, self-esteem, body image and spirit. Hence, it's reasonable that the D2 score improved along with the body weight loss.

A particularly surprising finding from the study was that the 25 participants with $\geq 5\%$ of initial body weight loss had raised D4 scores as compared with healthy population reference group, despite no difference in pre-intervention condition (Table 3). The D4 environment domain evaluates the following aspects: safety, opportunity to take leisure time, financial resources, the convenience of getting information and medical service, home environment and transportation. This suggested that body weight loss somehow associated with the satisfaction in one's environment.

Among the assessment questions focusing on satisfaction of HRQOL, the first, "How satisfied are you with your HRQOL?", had an initial score of 61.4 in 38 participants and after the

Table 4
The changes between pre- and post-intervention in different body weight loss group

(pre - post-) intervention				
Body weight loss group	$\geq 5\%$ ($n = 25$)		$< 5\%$ ($n = 13$)	
	Mean ± SD	p	Mean ± SD	p
Weight (kg)	9.5 ± 4.6	0.000[a]	1.8 ± 1.1	0.000[a]
BMI (kg/m^2)	3.5 ± 1.4	0.000[a]	0.7 ± 0.4	0.000[a]
Tanita body fat (%)	5.7 ± 3.6	0.000[a]	2.7 ± 6.6	0.172
DXA whole body fat (%)	3.2 ± 2.4	0.000[a]	−0.1 ± 1.2	0.852
DXA trunk body fat (%)	3.7 ± 3.5	0.000[a]	0.2 ± 1.6	0.646
Neck circum. (cm)	1.9 ± 1.1	0.000[a]	0.7 ± 0.8	0.008[a]
Upper forearm circum. (cm)	2.5 ± 1.6	0.000[a]	0.5 ± 0.9	0.047[a]
Waist (cm)	8.1 ± 4.2	0.000[a]	1.9 ± 2.0	0.005[a]
Hip (cm)	5.9 ± 4.9	0.000[a]	0.4 ± 2.7	0.568
Thigh (cm)	1.7 ± 4.0	0.049[a]	−0.6 ± 1.9	0.257
Calf (cm)	1.2 ± 1.2	0.000[a]	0.5 ± 1.5	0.253
SBP (mmHg)	11.0 ± 17.7	0.005[a]	−0.7 ± 16.6	0.883
DBP (mmHg)	5.4 ± 11.8	0.031[a]	7.5 ± 10.6	0.024[a]
GOT (mg/dL)	7.3 ± 13.8	0.014[a]	1.7 ± 8.3	0.477
GPT (mg/fL)	24.6 ± 32.8	0.001[a]	6.2 ± 12.8	0.105
Uric acid (mg/dL)	0.9 ± 1.8	0.018[a]	−0.2 ± 1.5	0.681
Creatinine (mg/dL)	0.0 ± 0.1	1.000	0.0 ± 02	0.538
T. CHOL (mg/dL)	23.7 ± 28.5	0.000[a]	0.8 ± 36.3	0.934
HDL (mg/dL)	−2.6 ± 4.5	0.008[a]	1.8 ± 3.0	0.053
LDL (mg/dL)	19.6 ± 22.8	0.000[a]	7.3 ± 30.5	0.405
TG (mg/dL)	49.9 ± 124.1	0.062	41.9 ± 128.9	0.264
Glucose (mg/dL)	9.08 ± 12.5	0.001[a]	−20.8 ± 37.2	0.067
Insulin (U/mL)	3.4 ± 6.0	0.008[a]	−1.6 ± 5.1	0.291
IR (HOMA index)	0.9 ± 1.7	0.020[a]	−1.1 ± 2.1	0.079
HBA1C (%)	0.1 ± 0.4	0.068	−0.1 ± 0.7	0.582
Sat. of HRQOL	−6.2 ± 14.9	0.048[a]	−9.2 ± 14.5	0.041
Sat. of BHRQOL	−0.6 ± 9.3	0.752	−2.6 ± 16.1	0.569
D1	−0.8 ± 1.9	0.006[a]	−0.5 ± 1.3	0.211
D2	−0.9 ± 1.7	0.015[a]	−0.9 ± 1.9	0.101
D3	−0.6 ± 1.4	0.036[a]	−0.8 ± 1.5	0.059
D4	−0.5 ± 1.0	0.027[a]	−0.5 ± 1.4	0.212

[a] Two-tailed $p \leq 0.05$ with statistical significance, paired-samples t test. Abbreviations as in Table 1.

3-month intervention the score increased to 68.7 (-7.3 ± 14.7, $p = 0.004$). With regard to "How satisfied were you with your HRQOL before your body weight gain?", in the same group of 38 participants, the initial score was 68.8 and at the end of the 3-month intervention the score was 69.3 (-0.5 ± 12.0, $p = 0.798$). This validates the consistency which with participants perceive themselves before weight gain.

The recent WHO report, "Preventing Chronic Diseases: A vital investment", highlights the need for global action to address the major risks associated with chronic disease worldwide.[40] The optimal management is continuous healthy life style; however, controlling body weight is a daunting task and long journey, with some loss of perseverance in the course, just like our drop-out study group of 29 participants. The high drop-out rate in this study reflects an important issue, the difficulty of behavioral change. How can we encourage people to keep healthy life style in today's parenting obesogenic environment is a big challenge. Apart from the physiological benefits after weight loss, further improvement in quality of life may be an incentive to obese patients to keep implementing a body weight control regimen.

The limitations of the study were both the small number of participants and short study period. In view of chronic disease management, obesity-control should be followed up for a longer time period, and follow-up of study participants will continue.

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