Psychological wellbeing and biochemical modulation in response to weight loss in obese type 2 diabetes patients

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Abstract

Background: Obesity in type 2 diabetes patients is a serious health issue by itself; it is also associated with other health problems including psychiatric illnesses. The psychological effects of dieting and weight loss have been a matter of controversy in the field of obesity management.

Objective: The aim of this study was to compare the impact of weight loss because of aerobic exercise training and dietary measures on psychological wellbeing and biochemical modulation in obese type 2 diabetes patients.

Material and methods: One hundred obese type 2 diabetes patients of both sexes participated in this study, and were included into two equal groups. The first group (A) received aerobic exercise training, three sessions per week for three months combined with dietary measures. The second group (B) received no training intervention for three months.

Results: There was a significant decrease in body mass index (BMI), leptin, total cholesterol (TC), low density lipoprotein cholesterol (LDL-c), triglycerides (TG), homeostasis model assessment-insulin resistance- index (HOMA-IR), beck depression inventory (BDI) & profile of mood states (POMS) and increase in high density lipoprotein cholesterol (HDL-c) & Rosenberg self-esteem scale (RSES) of group (A) after treatments, but the changes of group (B) were not significant. Moreover, there were significant differences between mean levels of the investigated parameters of group (B) and group (A) at the end of the study.

Conclusion: Physical training and dietary measures can be used as methods of choice for psychological wellbeing and biochemical modulation in obese type 2 diabetes patients.

Keywords: Obesity; type 2 diabetes, aerobic exercise training, dietary measures, psychological wellbeing.

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Introduction

The global prevalence of type 2 diabetes has been rising steadily over the past 3 decades, and is largely attributable to the dramatic increase in obesity rate¹ ². Over 300 million people worldwide live with diabetes now, and if the current prevalence rate continues unabated, over 550 million people will be living with diabetes by 2030³⁴. Diabetes represents a major health problem because of its high prevalence, morbidity and mortality, its influence on patient quality of life, and its impact on the health system⁵. It is now widely accepted that the obesity epidemic continues to be the principal driver for the rising global prevalence of type 2 diabetes mellitus⁶, cardiovascular disease, musculoskeletal disease, cancers and all-cause mortality⁷.

Type 2 diabetes mellitus is a serious chronic disease whereby the body is unable to effectively use glucose as a fuel due to relative insulin deficiency caused by insulin resistance⁸. Untreated acute and chronic states of hyperglycemia could lead to debilitating long-term complications. Heart attacks and strokes are two to three fold higher in people with diabetes, along with increased risks for retinopathy, nephropathy and neuropathy. Life expectancy can be shortened by as much as 10-15 years because of premature and accelerated atherosclerosis, and the attendant medical complications⁹.

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Depression is a health complication that is commonly associated with obesity as risk of depression is 20–50% higher among obese individuals than normal weight persons[14,16]. Extremely obese persons are at even greater risk[12]. The relationship between obesity and depression appears to be bi-directional; some longitudinal studies have shown that depression is associated with subsequent weight gain and obesity[15,16], whereas others have found that obesity is associated with the development of depression[16,17].

As the lifetime risk of diabetes increases substantially and proportionally with the magnitude of overweight and obesity[12], a major effort of the fight against diabetes is focused on diabetes prevention through weight loss and health behavior changes, and aggressive glycemic and overall management of diabetes to prevent the deadly complications[18]. Dietary strategies and regular physical activity[21] is focused on diabetes prevention through weight maintenance only parameters of well-being and prevention of major co-morbidities as respiratory, kidney, liver, neurological disorders and orthopedic problems inhibiting treadmill training or renal disease. Participants were included into two equal groups; the first group (A) received aerobic exercise training, three sessions per week for three months combined with dietary measures. The second group (B) received no training intervention for three months. Informed consent was obtained from all participants. All participants were in sedentary lifestyle prior to the study and they received only oral hypoglycemic drugs and did not receive any medications, which can affect the mood, moreover they were free to withdraw from the study at any time.

Equipment

1) Treadmill (Enraf Nonium, Model display panel Standard, NR 1475.801, Holland) was used in performance of aerobic walking exercise.

2) Commercial kits (Randox, Tokyo, Japan) with Osmosis and urine, HOMA-IR, BDI and POMS were taken before the starting of the study (pre-test) and after three months at the end of the study (post-test).

Procedures

Following the previous evaluation, all patients were divided randomly into the following groups:

1. Patients in Group (A) were submitted to forty minutes moderate intensity aerobic exercise sessions on a treadmill (the initial, 5-minute warm-up phase performed on the treadmill (Enraf Nonium, Model display panel Standard, NR 1475.801, Holland) at a low load, each training session lasted 30 minutes and ended with 5-minute recovery and relaxation phase) either walking or running, based on heart rate, until the target heart rate was reached, according to American College of Sport Medicine guidelines[22]. The program began with 10 min of stretching and was conducted using the maximal heart rate index (HRmax) estimated by 220-age. First 2 weeks = 60–70% of HRmax, 3rd to 12th weeks 70–80% of HRmax. Each session was continued for 30 minutes; 3 sessions / week for 3 months[23].

All subjects of group (A) were instructed to take an individual balanced energy-restricted dietary program to obtain weight loss. The mean daily caloric intake was about1200 kcal/day, based on a macronutrient content <30% fat and 15% protein as recommended by the World Health Organization[24]. At the initial interview with a dietitian, obese subjects was given verbal and written instructions on how to keep diet records, with food weighed and measured. Dietary intake was monitored by the same dietitian. The subjects maintained a detailed record of food intake, and received weekly nutritional counseling. Obese subjects were instructed to substitute low-fat alternatives for typical high-fat foods, to increase the consumption of vegetables and fresh fruits, and to substitute complex carbohydrates, such as whole-grain bread and cereals. Dietetic help was given every 2 weeks by the dietitian when anthropometric measurements were performed; in addition, each subject was seen by a physician monthly to perform a clinical evaluation, standard electrocardiogram, and measurement of blood pressure and heart rate[25].

All measurements of leptin, total cholesterol, triacylglycerol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, BMI, HOMA-IR, BDI and POMS were taken before the starting of the study (pre-test) and after three months at the end of the study (post-test).

Patients and methods

Subjects

One hundred obese type 2 diabetes patients of both sexes (56 males & 44 females) were randomly selected from the Internal Medicine Department at King Abdul Aziz University hospital and other hospitals at Jeddah area. Their age was between 35 - 45 years, the body mass index (BMI) ranged from 32 to 36 Kg/m2, free from other co-morbidities as respiratory, kidney, liver, neurological disorders and orthopedic problems inhibiting treadmill training or renal disease. Participants were included into two equal groups; the first group (A) received aerobic exercise training, three sessions per week.
2. Patients in Group (B) received no training or diet regimen for three months.

Statistical analysis
The mean values of BMI, Leptin, TC, HDL-c, LDL-c, TG, RSES, BDI and POMS obtained before and after three months in both groups were compared using paired "t" test. Independent "t" test was used for the comparison between the two groups (P<0.05).

Results
The two groups were considered homogeneous regarding the baseline characteristics (Table 1).

Table (1): Demonstrates the baseline characteristics of all participants.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean ± SD Group A (N = 50)</th>
<th>Mean ± SD Group B (N = 50)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>36.35 ± 5.11</td>
<td>37.16 ± 4.32</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>107.54 ± 8.38</td>
<td>106.18 ± 7.13</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>113.17 ± 7.82</td>
<td>112.95 ± 8.11</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Waist to hip ratio</td>
<td>0.91 ± 0.14</td>
<td>0.89 ± 0.13</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>94.26 ± 8.27</td>
<td>92.97 ± 7.82</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>142.16 ± 10.54</td>
<td>140.34 ± 11.12</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>87.13 ± 8.23</td>
<td>85.15 ± 7.21</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Fasting glucose (mg/dl)</td>
<td>128.37 ± 10.18</td>
<td>127.87 ± 9.87</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>HbA1c %</td>
<td>7.93 ± 1.86</td>
<td>7.26 ± 1.55</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>192.30 ± 12.86</td>
<td>193.54 ± 11.22</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>HDL-cholesterol (mg/dl)</td>
<td>34.54 ± 2.71</td>
<td>33.73 ± 2.95</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>LDL-cholesterol (mg/dl)</td>
<td>132.93 ± 9.78</td>
<td>133.64 ± 9.03</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Triglyceride (mg/dl)</td>
<td>154.15 ± 10.21</td>
<td>155.18 ± 9.82</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

There was a significant decrease in body mass index (BMI), total cholesterol (TC), low density lipoprotein cholesterol (LDL-c), triglyceride (TG), Homeostasis model assessment-insulin resistance-index (HOMA-IR), Beck depression inventory (BDI) and profile of mood states (POMS) and increase in high density lipoprotein cholesterol (HDL-c) & Rosenberg self-esteem scale (RSES) of group (A) after treatments (Table 2), but the changes of group (B) were not significant (Table 3).

Table (2): Mean value and significance of BMI, Leptin, TC, HDL-c, LDL-c, TG, HOMA-IR, RSES, BDI and POMS of group (A) before and after treatment.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean ±SD Before</th>
<th>Mean ±SD After</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (Kg/m²)</td>
<td>32.86 ± 5.29</td>
<td>30.13 ± 4.32</td>
<td>5.26</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Leptin (Ng/ml)</td>
<td>39.72 ± 5.75</td>
<td>36.21 ± 5.19</td>
<td>6.31</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>TC (mg/dl)</td>
<td>192.30 ± 12.86</td>
<td>176.54 ± 11.66</td>
<td>9.75</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>HDL-c (mg/dl)</td>
<td>34.54 ± 2.71</td>
<td>36.35 ± 2.48</td>
<td>6.24</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>LDL-c (mg/dl)</td>
<td>132.93 ± 9.78</td>
<td>120.27 ± 8.72</td>
<td>7.22</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>154.15 ± 10.21</td>
<td>129.61 ± 9.83</td>
<td>8.35</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>7.21 ± 2.13</td>
<td>5.65 ± 1.94</td>
<td>4.31</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Self-esteem (RSES)</td>
<td>21.12 ± 3.45</td>
<td>26.73 ± 3.22</td>
<td>5.61</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Depression (BDI)</td>
<td>7.98 ± 2.05</td>
<td>5.21 ± 1.97</td>
<td>3.32</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Total mood disturbance (POMS)</td>
<td>23.95 ± 4.42</td>
<td>19.61 ± 4.13</td>
<td>5.11</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

BMI = Body Mass Index; TC = Total cholesterol; HDL-c = High density lipoprotein cholesterol; LDL-c = Low-density lipoprotein cholesterol; TG = Triglyceride; HOMA-IR = Homeostasis Model Assessment-Insulin Resistance Index; RSES = Rosenberg Self-Esteem Scale; BDI = Beck Depression Inventory; POMS = Profile of Mood States.

Table (3): Mean value and significance of BMI, Leptin, TC, HDL-c, LDL-c, TG, HOMA-IR, RSES, BDI and POMS of group (B) before and after treatment.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean ±SD Before</th>
<th>Mean ±SD After</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (Kg/m²)</td>
<td>33.15 ± 4.87</td>
<td>33.45 ± 4.16</td>
<td>0.82</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Leptin (Ng/ml)</td>
<td>38.64 ± 5.16</td>
<td>38.91 ± 4.37</td>
<td>0.98</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>TC (mg/dl)</td>
<td>193.54 ± 11.22</td>
<td>195.12 ± 10.25</td>
<td>1.25</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>HDL-c (mg/dl)</td>
<td>33.73 ± 2.95</td>
<td>32.81 ± 2.74</td>
<td>0.89</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>LDL-c (mg/dl)</td>
<td>133.64 ± 9.03</td>
<td>133.88 ± 8.72</td>
<td>0.95</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>155.18 ± 9.82</td>
<td>156.11 ± 9.23</td>
<td>1.12</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>7.53 ± 2.32</td>
<td>7.81 ± 2.15</td>
<td>0.81</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Self-esteem (RSES)</td>
<td>20.54 ± 3.72</td>
<td>19.82 ± 3.43</td>
<td>0.93</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Depression (BDI)</td>
<td>8.15 ± 2.14</td>
<td>8.41 ± 2.11</td>
<td>0.62</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Total mood disturbance (POMS)</td>
<td>24.04 ± 4.31</td>
<td>24.22 ± 4.16</td>
<td>0.86</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

BMI = Body Mass Index; TC = Total cholesterol; HDL-c = High density lipoprotein cholesterol; LDL-c = Low-density lipoprotein cholesterol; TG = Triglyceride; HOMA-IR = Homeostasis Model Assessment-Insulin Resistance Index; RSES = Rosenberg Self-Esteem Scale; BDI = Beck Depression Inventory; POMS = Profile of Mood States.

Moreover, there were significant differences between (B) and group (A) at the end of the study (Table 4), mean levels of the investigated parameters of group A (P<0.05).
The psychological effects of dieting and weight loss have been a matter of controversy in the field of obesity management. Several early studies (before the 1970s) described negative emotional consequences to dieting and/or exercise training and dietary measures with beneficial effects on obesity type 2 diabetes patients led to decreased Beck depression inventory (BDI) & profile of mood states (POMS) and increased Rosenberg self-esteem Scale (RSES).

This study also showed weight loss because of aerobic exercise training and dietary measures by obese type 2 diabetes patients led to decreased Beck depression inventory (BDI) & profile of mood states (POMS) and increased Rosenberg self-esteem Scale (RSES). In this regard, some studies revealed that the weight loss has a strong impact on psychological wellbeing in obese type 2 diabetes patients.41-43

Grave et al. investigated the effects of weight loss on psychological distress and binge eating in 500 patients that are obese of both sexes remaining in continuous treatment at different centers with slightly different strategies. At baseline and after 12 months all subjects were evaluated by the Symptom Checklist-90 Global Severity Index (SCL-90) and by the Binge eating scale (BES). In both males and females, weight loss was associated with improved psychometric testing of psychological distress.44 However, in a systematic review of 22 studies of long-term non-pharmacological weight loss interventions in type 2 diabetes through health behavior changes for 1 to 5 years, the pooled weight loss was a modest 1.7 kg, or 3.1%.45 The compelling evidence on modest weight loss in the prevention or delay in type 2 diabetes raised the tantalizing question of whether long-term lifestyle intervention exert beneficial health and cardiovascular outcomes in type 2 diabetes46.

Imayama et al. conducted a randomized controlled trial on overweight/obese postmenopausal women randomly for 12 months and found that a combined diet and exercise intervention resulted in weight loss and had positive effects on health-related quality of life and psychological health which included depression, anxiety and social support47. While, Wycherley et al. conducted in a parallel design, a study on 106 obese men and women with type 2 diabetes who were randomized to a prescriptive 16-week caloric restricted diet (6,000–7,000 kcal/day) with supervised exercise training exercise (n = 65) or without supervised exercise training exercise (n = 41) (three times per week) and found that structured caloric restricted diet with or without resistance exercise training improves body weight, glycated hemoglobin, diabetes-specific emotional distress and quality of life questionnaire in overweight and obese patients with type 2 diabetes48. Moreover, Faulconbridge et al. studied the response of depression to changes in body weight and stated that intentional weight loss is often accompanied by improvements in mood of depressed individuals49.

Our results revealed that BMI and serum leptin were significantly decreased upon weight loss among obese type 2 diabetes patients. Our findings were consistent with Sartorio and colleagues who proved that the circulating levels of leptin have been shown to decrease in response to decreases in energy availability,50 also Volck and colleagues suggested that significant decreases in leptin occur as part of an 8-week weight loss program,51 which similarly occurred in the present study.

Leptin is recognized to play an integral role in endocrine regulation of metabolism. The higher serum leptin level in obese subjects was clearly evident to be decreased during calorie restriction.52 Reduction in leptin concentrations is not only due to decreased body fat mass but also potentially through an increase in leptin sensitivity.53 Moreover, leptin signaling to brain stem hypothalamic pathways potentially increases the brain's motor and autonomic responses to satiety signals, leading to smaller individual meals; reduce cumulative food intake, and a lowers body weight.54 The decrease in serum leptin level after weight reduction was correlated with reduction in BMI.55 Weight loss and decrease in BMI in obese diabetics was due to enhanced fat oxidation56.

The results of the present study regarding HOMA-IR showed that weight loss resulted in decrease in HOMA-IR, this result confirmed by Younger and colleagues reported that increased physical activity leads to improvement in insulin resistance and increase in muscle oxidative capacity which are likely contribute to the beneficial effects of exercise training on insulin action.57 Also, Kinca and colleagues confirmed that physical activity in obese non-insulin dependent diabetics mellitus decreased blood glucose level through improving insulin sensitivity and decreasing deposition of total fat and intra-abdominal fat. Also, physical activity is negatively associated with insulin concentration as a defense mechanism.58 However, Roland and colleagues stated that exercise training improves insulin sensitivity.
and glycemic control, increases muscle mass, strength and endurance1. Also, Sato and colleagues and Short et al. found that physical exercise promotes utilization and lowering of blood glucose. This improvement in insulin action was attributed to the increase in insulin sensitive glucose transport on the plasma membrane and oxidative enzymes in skeletal muscle.2,3 While, Allu and colleagues mentioned that lifestyle modifications with diet and exercise are essential part of the management of the diabetes obese patient as weight loss leads to improvement in the glucose tolerance, insulin sensitivity reductions in lipid levels4. Weight reduction program consisted of diet restriction and exercise which was conducted on thirty-five obese NIDDM patients for twelve weeks (diet restriction and exercise) induced significant reductions in body weight, serum leptin levels, improvements in lipoprotein profile, insulin sensitivity and glucose control5. Energy restriction resulting in even modest weight loss suppresses endogenous cholesterol synthesis which leads to a decline in circulating lipid concentrations and as a result increased insulin sensitivity 6-7. Through decreasing deposition of total fat and intra-abdominal fat 8.

Conclusion

Weight loss because of aerobic exercise training and dietary measures can be considered as methods of choice for psychological wellbeing and biochemical modulation in obese type 2 diabetes patients.

Acknowledgment

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References