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. 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.
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\(^{16,17}\). Extremely obese persons are at even greater risk\(^1\). 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\(^{15,18}\), 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\(^1\), 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\(^{19,20}\). However, health behavior modification, aiming at achieving a healthier body weight through dietary therapy and regular physical activity, is the cornerstone therapy for people with diabetes recommended by the American Diabetes Association\(^2\). The 2013 American Diabetes Association standards of medical care in diabetes guidelines recommend a 75% body weight loss for all overweight or obese individuals who have or are at risk for diabetes through dietary strategies and regular physical activity\(^21\). Physical activity combined with calorie restriction improves not only parameters of well-being and prevention of major morbidity but also embeds longer-term weight maintenance\(^{22,23}\).

The aim of this study was to measure 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.

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/m\(^2\), 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 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 K2EDTA was used to measure leptin, total cholesterol, triacylglycerol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol.

3) Rosenberg self-esteem scale (RSES) was used for self-esteem evaluation, the profile of mood states (POMS) was used for mood disturbance evaluation and Beck depression inventory (BDI) was used for Depression evaluation\(^24\).

4) Weight and height scale (JENIX DS 102, Dongsang, South Korea) was used to measure weight and height to calculate the body mass index (BMI). Body mass index was calculated by dividing the weight in kilograms by the square of the height in meters (Kg/m\(^2\)). According to the WHO classification, a BMI of <18.5 Kg/m\(^2\) is under weight, 18.5-24.9 Kg/m\(^2\) is normal 25-29.9 Kg/m\(^2\) is overweight. A BMI of > 30 Kg/m\(^2\) is classified as obese and this group was further divided into moderate obesity (30-34.9 Kg/m\(^2\)), severe obesity (35-39.9 Kg/m\(^2\)) and very severe obesity (>40 Kg/m\(^2\)).

Measurements

1. Laboratory analysis:

Venous blood samples were collected in polystyrene tubes after a 12-h fasting, by venipuncture of the antecubital vein while patients rested in a supine position. The blood samples were transported to a laboratory within 1 h and centrifuged at \(\pm 4^\circ\)C to remove serum (1000 \(\times\) g for 10 min). Plasma sample with K2EDTA was collected after centrifugation (2000 \(\times\) g for 10 min at 4°C) and stored at \(-80^\circ\)C to analyze leptin, total cholesterol, triacylglycerol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol. All analyses were carried out on a Hitachi 7170 Autoanalyser (Tokyo, Japan) or with commercial kits (Randox). Also, kits (Bioclin, Quibasa, Belo Horizonte, MG, Brazil) were used to measure homeostasis model assessment-insulin resistance (HOMA-IR) index for insulin sensitivity.

2. Psychological well-being

Data was collected at baseline and at the end of treatment. Participants were asked to attend two laboratory sessions in order to complete all psychological assessments, in each evaluation period. Self-esteem was assessed with the Rosenberg self-esteem scale (RSES), a 10-item scale that measures global self-worth by measuring both positive and negative feelings about the self. The scale is believed to be unidimensional. All items are answered using a 4-point Likert scale format ranging from strongly agree to strongly disagree. Mood disturbance was assessed with the profile of mood states (POMS). Originally, the POMS included sixty five items which load on seven different scales: “depression”, “anxiety”, “fatigue”, “vigor”, “irritability”, “tension”, and “confusion”. The questions refer to the time period of the “last week including today”. The response scale is divided into five categories ranging from “not at all” to “very strong”. The items are defined from 1 to 5 (“not at all”, “a little”, “moderately”, “quite a bit”, and “extremely”, respectively). The questionnaire assessed six dimensions of mood that can be used to calculate a total mood disturbance score, which was used in the present study. Questions pertain to emotional states of the previous month. Depression was evaluated with the Beck depression inventory (BDI), a 21-item inventory measuring several symptoms of depression. It uses a 4-point ordered scale and results in a total score (Items 1 - 3 assess symptoms that are psychological in nature, while items 14 - 21 assess more physical symptoms. This was rated as follows: 1 - 10: Normal; 11 - 16: Mild mood disturbance; 17 - 20: Borderline clinical depression; 21 - 30: Moderate depression and >30: Severe depression\(^24\).

3. Evaluation of anthropometric parameters

All measurements were performed at pretreatment and after three months at the end of the study. The participants were measured whilst wearing their undergarments and hospital gowns. Height was measured with a digital stadiometer to the nearest 0.1 cm (JENIX DS 102, Dongsang, South Korea). Body weight was measured on a calibrated balance scale to the nearest 0.1 kg (HC4211, Cas Korea, South Korea), and body mass index (BMI) was calculated as BMI = Body weight / (Height)\(^2\).

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\(^25\). 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\(^26,28\).

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\(^27\). 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\(^26,29\).

All measurements of leptin, total cholesterol, triglycerides, 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).
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</th>
<th>p value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Group A (N = 50)</td>
<td>Group B (N = 50)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>36.35 ± 5.11</td>
<td>37.16 ± 4.32</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>107.54 ± 8.38</td>
<td>106.18 ± 7.13</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>113.17 ± 7.82</td>
<td>112.95 ± 8.11</td>
</tr>
<tr>
<td>Waist to hip ratio</td>
<td>0.91 ± 0.14</td>
<td>0.89 ± 0.13</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>94.26 ± 8.27</td>
<td>92.97 ± 7.82</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>142.16 ± 10.54</td>
<td>140.34 ± 11.12</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>87.13 ± 8.23</td>
<td>85.15 ± 7.21</td>
</tr>
<tr>
<td>Fasting glucose (mg/dl)</td>
<td>128.37 ± 10.18</td>
<td>127.87 ± 9.87</td>
</tr>
<tr>
<td>HBA1c %</td>
<td>7.93 ± 1.86</td>
<td>7.26 ± 1.55</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>192.30 ± 12.86</td>
<td>193.54 ± 11.22</td>
</tr>
<tr>
<td>HDL-cholesterol (mg/dl)</td>
<td>34.54 ± 2.71</td>
<td>33.73 ± 2.95</td>
</tr>
<tr>
<td>LDL-cholesterol (mg/dl)</td>
<td>132.93 ± 9.78</td>
<td>133.64 ± 9.03</td>
</tr>
<tr>
<td>Triglyceride (mg/dl)</td>
<td>154.15 ± 10.21</td>
<td>155.18 ± 9.82</td>
</tr>
</tbody>
</table>

BMI = Body Mass index; HbA1c = Hemoglobin A1C; HDLc = High Density Lipoprotein; LDLc = Low Density Lipoprotein

There was a significant decrease in body mass index (BMI), total cholesterol (TC), low density lipoprotein cholesterol (LDL-c), triglycerides (TG), homeostasis model assessment-insulin resistance (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 (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>P &lt;0.05</td>
</tr>
<tr>
<td>Leptin (Ng/ml)</td>
<td>39.72 ± 7.55</td>
<td>36.21 ± 5.19</td>
<td>6.31</td>
<td>P &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>P &lt;0.05</td>
</tr>
<tr>
<td>HDL-c (mg/dl)</td>
<td>43.54 ± 2.71</td>
<td>36.35 ± 2.48</td>
<td>6.24</td>
<td>P &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>P &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>P &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>P &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>P &lt;0.05</td>
</tr>
<tr>
<td>Depression (BDI)</td>
<td>7.98 ± 2.05</td>
<td>21.51 ± 1.97</td>
<td>3.32</td>
<td>P &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>P &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>P &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>P &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>P &gt; 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>P &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>P &gt; 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>P &gt; 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>P &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>P &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>P &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>P &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.

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 (P<0.05).
and regular physical activity are recognized as effective maneuvers in obese type 2 diabetes patients due to enhanced fat oxidation potentially through an increase in leptin sensitivity. Moreover, leptin signaling to brain stem hypothalamic centers 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. The decrease in serum leptin level after weight reduction was correlated with reduction in BMI. Weight loss and decrease in BMI in obese diabetest patients was due to enhanced fat oxidation.

Finally, 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 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. Also, Kinca and colleagues confirmed that physical activity in obese non-insulin dependent diabetes 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. However, Roland and colleagues stated that exercise training improves insulin sensitivity and reduces risk of developing diabetes.

The compelling evidence on the beneficial effects of exercise training on insulin resistance and improved dyslipidemia, hypertension and glycaemia. This study also showed weight loss because of aerobic exercise training and dietary changes by obese type 2 diabetes patients led to decreased Beck depression inventory (BDI) & profile of mood states (POMS) and increased Rosenlberg 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. 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-GSI) and by the Binge eating scale (BES). In both males and females, weight loss was associated with improved psychometric testing of psychological distress. 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% . 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 diabetes.

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 support . 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 calorie restricted diet (6,000–7,000 kJ/day), with supervised resistance exercise training (n = 65) or without supervised exercise training (n = 41) (three times per week) and found that structured calorie 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 diabetes. Moreover, Faulconbridge et al. studied the response of depression symptoms to changes in body weight and stated that intentional weight loss is often accompanied by improvements in mood of depressed individuals.

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, also Volck and colleagues suggested that significant decreases in leptin occur as part of an 8-week weight loss program, 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. Reduction in leptin concentrations is not only due to decreased body fat mass but potentially through an increase in leptin sensitivity. 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. The decrease in serum leptin level after weight reduction was correlated with reduction in BMI. Weight loss and decrease in BMI in obese diabetest patients was due to enhanced fat oxidation.

Discussion

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 , whereas later studies found an improvement or no changes in the symptoms of depression , self-esteem, mood and anxiety in patients that are obese treated by behavior modification combined with moderate caloric restriction. These conflicting results constitute an incentive to conduct our study to the impact of weight loss as a result of aerobic exercise training and dietary measures on psychological wellbeing and biochemical modulation in obese type 2 diabetes patients.

The findings of this study showed that weight loss because of aerobic exercise training and dietary measures by obese type 2 diabetic patients led to decreased BMI, Leptin, TC, HDL-c, LDL-c, TG, HOMA-IR, RSES, BDI and POMS of group (A) and group (B) after treatment.

Table 4: Mean value and significance of BMI, Leptin, TC, HDL-c, LDL-c, TG, HOMA-IR, RSES, BDI and POMS of group (A) and group (B) after treatment.

<table>
<thead>
<tr>
<th></th>
<th>Mean ±SD</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (Kg/m²)</td>
<td>30.13 ± 4.32</td>
<td>33.45 ± 4.16</td>
<td>4.75</td>
</tr>
<tr>
<td>Leptin (Ng/ml)</td>
<td>36.21 ± 5.195</td>
<td>38.91 ± 4.437</td>
<td>5.62</td>
</tr>
<tr>
<td>TC (mg/dl)</td>
<td>176.54 ± 11.66</td>
<td>195.12 ± 10.25</td>
<td>8.55</td>
</tr>
<tr>
<td>HDL-c (mg/dl)</td>
<td>36.35 ± 2.48</td>
<td>32.81 ± 2.74</td>
<td>5.42</td>
</tr>
<tr>
<td>LDL-c (mg/dl)</td>
<td>120.27 ± 8.94</td>
<td>133.88 ± 8.72</td>
<td>6.34</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>129.61 ± 9.83</td>
<td>156.11 ± 9.23</td>
<td>7.61</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>5.65 ± 1.94</td>
<td>7.81 ± 2.15</td>
<td>3.45</td>
</tr>
<tr>
<td>Self-esteem (RSES)</td>
<td>26.73 ± 3.22</td>
<td>19.82 ± 3.43</td>
<td>4.21</td>
</tr>
<tr>
<td>Depression (BDI)</td>
<td>5.21 ± 1.97</td>
<td>8.41 ± 2.11</td>
<td>3.12</td>
</tr>
<tr>
<td>Total mood disturbance (POMS)</td>
<td>19.61 ± 4.13</td>
<td>24.22± 4.16</td>
<td>4.10</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.
and glycemic control, increases muscle mass, strength and endurance. 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 transporter on the plasma membrane and oxidative enzymes in skeletal muscle. While, Albu 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 levels. 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 control. 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. Through decreasing deposition of total fat and intra-abdominal fat.

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.

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