Effect of Lifestyle Intervention Program on Metabolic Syndrome in Obese Women

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ABSTRACT

Background: *Rates of obesity have been increasing in many parts of the world to near epidemic proportions. In the United States and Europe, obesity defined as a BMI > 30 occurs in approximately one-third of the total population. Obesity leads to a number of co-morbid conditions, and appears to be a major contributing factor to metabolic syndrome.* ***Objective:*** *The purpose of this study was to assess the effect of weight reduction program (low caloric diet and exercise) on metabolic syndrome in obese women. Subjects and Methods: This study was carried out on a sample of 40 volunteer obese women. They were divided into two groups equal in number. Their age ranged from 35 - 45 years old with metabolic syndrome, selected from the diabetes and weight reduction outpatient clinics of October 6 th University. Group I: included twenty obese women who received lifestyle intervention program (low caloric diet; 1200 k.cal. /day and aerobic exercise in form of walking on electronic treadmill). Duration of exercise was 50 minutes, three times per week for 3 months. Group II: included twenty obese women who received diet regime only. All subjects with BMI (30-34.9 Kg/m2), waist circumference (> 88 cm) , BP > 138/85, FBS > 100 mg/dl, and triglyceride > 159 mg/dl .The program continued for 12 weeks and the weight, BMI, WHR, blood pressure, fasting blood sugar, fasting serum insulin, triglycerides, total cholesterol, LDL and HDL were measured at the beginning and after the end of the study.* ***Results:*** *forty obese women with metabolic syndrome participated in the study, divided into two equal groups. Both groups were similar for age, weight, and BMI. Before the study, there was no statistically significant difference between group I (Ex +D) and group II (D) regarding mean values of anthropometric measurements (weight, BMI, waist circumference and WHR) with P> 0.05. After the lifestyle intervention, both groups (group I, Ex + D) and (group II, D) showed significant reduction in body weight, body mass index, waist circumference, WHR, FBS and insulin, and improvements in lipid profile but the reduction and improvement more in group I (EX+D).* ***Conclusions:*** *Lifestyle intervention in form of low caloric diet and exercise improved anthropometric measurements, insulin resistance and lipid profile in obese women with metabolic syndrome.*

Key words: *Obesity, Metabolic Syndrome, Exercise, Diet restriction.*

INTRODUCTION

The prevalence of obesity is increasing among western populations, bringing about a parallel rise in the prevalence of the metabolic syndrome, which is strictly related to overweight. There is full agreement that lifestyle changes primarily focused on weight reduction are the first-line approach to patients with metabolic syndrome. In short-term trials, even a modest weight reduction has been shown to favorably affect the components of the metabolic syndrome such as hypertension, lipid abnormalities and glycemic control[7]. It is now well established that obesity is an independent risk factor for type 2 diabetes, dyslipidemia, and cardiovascular diseases (CVD). There is also strong evidence that, for a given adiposity, there is a large heterogeneity in the metabolic and cardiovascular risk mainly linked to the location of excessive adipose tissue[12].

Metabolic syndrome is defined as a clustering of risk factors associated with an increased risk for diabetes and cardiovascular disease[8]. Metabolic syndrome is a combination of medical disorders that increase the risk of developing cardiovascular disease and diabetes. It affects one in five people, and prevalence increases with age. Some studies estimate the prevalence in the USA to be up to 25% of the population. Metabolic syndrome is also known as syndrome x, insulin syndrome, Reaven s syndrome (named for Gerald Reaven)[6]. The key components of metabolic syndrome include hypertension, insulin resistance, dyslipidemia, and abdominal obesity, all associated as risk factors for cardiovascular disease. Regardless of how metabolic syndrome is defined, its prevalence is highly age- dependent, and smoking, atherogenic diet; obesity, genetic factors, and physical inactivity contribute for its increasing prevalence[3].

The diagnosis of metabolic syndrome can be made if a person has three of the following five features: increased waist circumference (> 102 cm in men and > 88 cm in women), elevated triglycerides (> 150 mg/dl) , reduced HDL cholesterol (< 40 mg/dl in men and < 50 mg/dl in women), elevated blood pressure (> 130 /85 mm Hg or on treatment for hypertension), and elevated fasting blood sugar (> 100 mg/dl). Weight loss and physical activity alone and in combination can improve several of the components in the metabolic syndrome and have been shown to have beneficial effects in the prevention of type 2 diabetes[5].

Pharmacological interventions are effective in treating dyslipidemia, hypertension, and elevated glucose levels, but they fail to adequately address the risk factors of the 21 the century sedentary obesogenic lifestyle. In contrast, lifestyle changes that directly address inactivity and overeating show encouraging results in treatment of Met Syn.[25]. The Diabetes Prevention Program[20] and other studies[14,19] showed that diet- induced weight loss and exercise were more effective in resolution of metabolic syndrome across the age span. Physical activity is recognized as an integral part of obesity treatment, in association with other therapeutic means.

A major benefit of physical activity is the association with better long term maintenance of weight loss. Physical activity has also positive psychological effects and increase quality of life. Weight loss and physical activity alone and in combination can improve several of the components in the metabolic syndrome and have been shown to have beneficial effects in the prevention of type 2 diabetes[17].

The purpose of this study was to evaluate the effectiveness of lifestyle intervention program (hypo- caloric diet and exercise training program) on metabolic syndrome in obese women.

SUBJECTS AND METHODS

This study was carried out on a sample of 40 volunteer obese women. Their age ranged from 35-45 years old with metabolic syndrome randomly selected from diabetes and weight reduction outpatient clinics of October 6th University hospital. They were divided into two groups equal in number. Group I (Ex. +D): included twenty obese women who received diet regime (low caloric diet = 1200 K. cal) and aerobic exercise for 12 weeks. Group II (D only): included twenty obese women who received diet regime (low caloric diet = 1200 K. cal) only for 12 weeks.

Inclusion Criteria:

1- Their age ranged from 35-45 years old.
2- Subjects were (obese, hypertensive, dyslipidemic and have insulin resistance).
3- Obese Women (BMI between 30-34.9 kg /m 2).
4- Increased waist circumference (> 88 cm in women).
5- Elevated blood pressure (> 138 /85 mm Hg) or on treatment for hypertension.
6- Elevated triglycerides (> 150 mg /dl) and low HDL cholesterol (< 50 mg/dl in women).
7- Elevated fasting blood sugar (100 -125 mg/ dl) or prediabetes.

Exclusion Criteria:

1-Subjects who were low-density lipoprotein cholesterol (LDL-C) (< 100 mg/dl), or TG less than 150 mg/dl.
2- Pregnancy, lactation or use contraceptive pills.
3 -Thyroid problems.
4- Heart disease (coronary artery disease, rheumatic heart disease … etc.).
5- Musculoskeletal disorders.
6- Diabetes or use of medications or supplements relevant to diabetes or CVD such as hypoglycemic or cholesterol-lowering effects

Anthropometric measurements and BP: After obtaining a consent agreement from each participant, baseline weight and height were measured, and body mass index (BMI) was calculated, (Kg/m 2). Waist circumference was measured at the level of the umbilicus using a measuring tape. The measurement was done by the same individual to decrease variability.

Blood pressure was measured on the left arm with subject seated, after at least 5 minutes of rest. Three separate recording were made, and the mean was used.

Laboratory Measurements: After a 12-hour overnight fast, 10 ml of fasting blood was collected from all participants. Plasma was separated from red blood cells after centrifugation and frozen at 3000 rpm. Separated sera were kept frozen at – 20 degree C for further analysis .Fasting blood glucose, fasting insulin, and lipids were measured in a certified Laboratory (October 6th University). 1- Fasting blood glucose level, 2- Fasting insulin level by ELISA, and 3- Plasma lipids: total cholesterol, LDL- C and TG. Each of these laboratory investigations were performed two times (at the start and at the end of the study).

Dietary intake: both groups were subjected to lifestyle modification program (diet restriction regime and exercise in group I and diet only in group II) to reduce their weight. Such diet restriction regime provided about 1200 Kcal / day and divided 3 meals and 2 small (snacks). A diet, in which fruits, non –starch vegetables and dairy products are emphasized, may be useful for people with metabolic syndrome.

Exercise Program: subjects of group I participated in a supervised program 3 days / week every other day for 3 months. The subjects arrived to the session of exercise two hours at least after the breakfast. The aerobic exercise started in a treadmill walking adjusting the time in the computer attached to the treadmill and the velocity was 3- km /h. The exercise program continued for 50 minutes and included three phases:

a- *Warm-up:* each subject started exercise training with a low intensity (50-60%of the patient' maximal heart rate) on treadmill for 5 minutes.

b- *Stimulus phase:* following warming up phase, the speed of the treadmill was to increased to active at least 60% and not more than 75% of the patient' maximal heart rate for 40 minutes with zero inclination, so the intensity of the exercise would be changed only by changing of the speed of the treadmill.

c- *Cool-down period:* the exercise program finished with 5 minutes as a cooling down with low-intensity exercise on treadmill. The patient stayed at least 10 minutes after the end of the program and the same procedure was repeated every session.

Statistical Analysis:

Descriptive statistics for all variables were done. Paired t-test was used for before and after treatment program comparison within each group. Independent t-test with P < 0.05 performed for comparison between group A (diet and exercise) and group B (diet only).

RESULTS

1- Results of Anthropometric Measurements and Blood pressure:

Before the study (table 1), There was no significant difference between both groups in their ages, weights, heights, BMI, waist circumference, hip circumference, WHR, and systolic and diastolic blood pressure, P value > 0.05.

After intervention, (table 2) a highly significant improvement was found in anthropometric measurements and blood pressure (weight, BMI, waist circumference, and WHR, systolic and diastolic blood pressure) in group I (Ex.+ D) compared to before the weight reduction program with P = 0.001. The results also demonstrated a significant statistically differences in the mean values of weight, BMI, Waist circumference, systolic and diastolic blood pressure in group II (D only) compared to before the weight reduction program with P = 0.001.

Table (1): Anthropometrical Measurements (weight, height, BMI, waist circumference, hip circumference, WHR,) and blood pressure measurements (systolic and diastolic) in both groups before the study.

Items	Group I		Group II		Comparison	
	Mean	± SD	Mean	± SD	t-value	p-value
Age (years)	39.3	± 2.36	40.05	±2.45	0.98	0.33
Weight (Kg)	82.5	± 4.66	82.25	±3.89	0.18	0.85
Height (cm)	157.95	± 4.39	156.85	±3.4	0.88	0.38
BMI (Kg/ m2)	33.02	± 0.81	33.42	±0.8	1.57	0.12
W C (cm)	100.55	±4.95	101.00	±4.02	0.31	0.75
Hip C (c)	118. 9	±5.06	118.85	± 4.76	0.03	0.97
WHR	0.84	± 0.05	0.84	±0.03	0.37	0.71
SB P (mm Hg)	147.25	± 18.02	144.0	± 10.58	0.69	0.49
DB P(mm Hg)	92.25	±6.17	93.35	±6.21	0.56	0.57

SD: Standard deviation S: Significance NS: Non Significance BMI: Body Mass Index
WC: Waist Circumference WHR: Waist hip ratio SBP: systolic blood pressure DBP: diastolic blood pressure

Table (2): Anthropometrical Measurements (weight, BMI, WC, and WHR,) and blood pressure measurements (systolic and diastolic) of both groups A and B before and after the study.

Items	Weight (Kg)	BMI Kg/m2	WC (cm)	WHR	SBP (mm Hg)	DBP (mm Hg)
Group I before after	82.5±4.66 70.15±4.2	33.02± 0.81 28.12 ±1.48	100.55±4.9 81.7 ± 2.59	0.84±5.0 0.78 ±0.01	147.25±18. 127 ± 4.97	92.25 ±6.17 82.0 ± 2.51
t-value	17.35	19.36	15.43	5.29	5.0	7.42
p-value	0. 001*	0. 001*	0. 001*	0. 001*	0. 001*	0. 001*
Group II before after	82.25±3.89 76.25±4.12	33.02 ±0.81 30.98 ±1.01	100.55±4.9 87.0 ± 3.25	0.84±0.03 0.78 ±0.01	144.0±10.5 131.5±4.89	93.35±6.21 82.0 ± 2.51
t-value	14.87	16.34	14.02	5.29	4.1	6.24
p-value	0.001*	0.001*	0.001*	0.03	0.03	0.001*

* Significance at P< 0.01.

2- Result of Fasting Blood Sugar:

Before the study, there was no statistically difference between the group I (Ex +D) and group II (D only) regarding mean values of fasting blood sugar, with P > 0.05. After the weight reduction program, a highly significant improvement was found in group I compared to before the program with P = 0.001. The result also demonstrated a highly significant difference in the mean value of FBS which improved in both groups but improved more in group I than group II (table 3).

3- Results of insulin:

Before the study, there was no statistically difference between group I (Ex + D) and group II (D only) regarding mean values of insulin with P> 0.05. After intervention, a highly significance improvement was found in group I compared to before the weight reduction program with P = 0.001 .The results also demonstrated a highly statistically differences in the mean values of insulin which improved in group I than group II (table 3).

4- Results of Lipid Profile:

(Table 4) before the study, there was no statistically difference between group I (Ex + D) and group II (D only) regarding mean values of lipid profile (TG, TC, and LDL) with P> 0.05. After intervention, a highly significance improvement was found in group I compared to before the weight reduction program with P = 0.001.The percentage of improvement in group I was 28.1%, 32.9 and 27.7 respectively. The results also demonstrated a highly statistically differences in the mean values of lipid profile (TG, TC and LDL) which improved in group I than group II. The percentage of improvement in group II was 22.18%, 27.8 and 18.7.respectively.

Table (3): Fasting blood sugar and Fasting insulin of both groups I and II before and after the study.

	Group I	t-value	P- -value	Group II	t-value	P- -value
FBS before after	137.6±21.0 89.75±11.05	9.31	0.001*	137.9±20.56 100.5±10.87	9.07	0.001*
Insulin before after	39.6±5.36 19.95±4.04	14.39	0.001*	37.8±9.7 23.9±3.13	7.74	0.001*

FBS: Fasting blood sugar * Significance at P< 0.01

Table (4): Lipid Profile (Triglycerides, Total cholesterol and Low density lipoproteins) of both groups I and II before and after the study.

	Group I	t-value	P- -value	Group II	t-value	P- -value
TG before after	177.6±18.64 127.75±11.97	13.7	0.001*	181.2±23.33 141.0±18.46	8.56	0.001*
TC before after	262.45±29.38 176.0±20.36	11.84	0.001*	256.9±32.92 187.05±11.11	10.42	0.001*
LDL before after	165.65±16.43 120.3±11.77	10.84	0.001*	160.9±17.7 130.8±17.25	11.43	0.001*

TG: TriglyceridesTC: Total cholesterol LDL: Low density lipoproteins * Significance at P< 0.01

DISCUSSION

The most outstanding of this study, which aimed to examine the effects of lifestyle modification (diet restriction and exercise) on metabolic syndrome (hypertension, dyslipidemia, fasting blood sugar, and fasting insulin) in obese women.

Rates of obesity have been increasing in many parts of the world to near epidemic proportions. In the United States and Europe, obesity defined as a BMI> 30 occurs in approximately one-third of the total populations. Obesity leads to a number of co-morbid conditions, and appears to be a major contributing factor to metabolic syndrome[27]. Metabolic syndrome, while considered a distinct disorder, is made up of a number of components. These include an increased central distribution of body fat, insulin resistance, dyslipidemia (elevated triglycerides, small dense LDL particles and reduced HDL), elevated blood pressure, and an increased hypercoagulable and proinflammatory state in blood[4].

Central obesity is confirmed to be strongly associated with cardiovascular disease. Favorable effects of aerobic exercise program on lowering body weight and body mass index have been demonstrated[21]. Our study is in agreement with the previous findings as we determined significant reductions in body weight, body mass index, waist circumference and waist hip ratio of both groups. The study also agree with James et al.,[11] who reported that program of low caloric diet has significant decrease of body weight and body mass. Van[24] stated that together with diet and behavioral modification, regular exercise is one of the key components of programs for the treatment of obesity. This is also comes in agreement with Shaw et al.,[22] who reported that low carbohydrates diets have been associated with significant loss of weight.

It is well established that weight loss is beneficial for treating all of the components of the metabolic syndrome, including excessive adiposity, dyslipidemia, hypertension, insulin resistance and hyperglycemia[2]. The magnitude of weight loss need not to be drastic; the Finish Diabetes Prevention Study showed that lifestyle intervention with modest weight loss significantly reduced the prevalence of the metabolic syndrome[10]. In addition, a weight loss as small as 5-10% of body weight can significantly reduce triglyceride and increase HDL-C. Furthermore, both hypertensive individuals and individuals at risk for developing hypertension can see a significant reduction in blood pressure with a modest weight loss[26]. Fasting blood glucose, insulin and hemoglobin A1 c can also be decreased with modest weight loss[15]. All the previous findings are in agreement with our results as all parameters in our study improved with life style intervention especially in group I (Ex+ D).

Our result showed improvement in blood pressure in both groups and this agrees with recent meta-analysis of randomized, control trials studying the effects of aerobic exercise on blood pressure suggests that exercise reduces systolic and diastolic blood pressure by approximately 3.8 and 2.mm Hg, respectively. Although the effect of aerobic exercise on blood pressure is small, and not routinely observed in all studies, there may be added benefit when combined with dietary modification and /or weight loss[1].

In fact, for every kilogram of weight loss, the risk of diabetes development was decreased by 16 %. A decrease in caloric intake is an avenue by which to promote a chronic negative energy balance resulting in weight loss. Although the macronutrient classification of the eliminated calories is of lesser importance when addressing overall energy balance, the type of macronutrients habitually consumed can influence the health of the individual with metabolic syndrome. The glycemic index has received considerable attention in terms of classifying which carbohydrates are "good" or "bad" for disease risk. Low glycemic index foods (i.e., those that are minimally processed) have been shown to improve components of the metabolic syndrome including hyperlipidemia and hyperglycemia, whereas a higher glycemic index has been shown to be positively associated with insulin resistance and metabolic syndrome prevalence[18].

Our study agrees with Hamman et al.,[9] who reported that a diet high in complex unrefined carbohydrates with an emphasis on fiber and low in added sugars is recommended for individuals with or at risk of metabolic syndrome.

In the present study, fasting blood sugar and fasting insulin were reduced in both groups, but more reductions were in group I (Ex +D) than group II (D only). This agrees with Jessin et al.,[13] who mentioned that insulin resistance has generally been considered to be an important underlying pathology of the metabolic syndrome. Exercise improves glucose homeostasis by enhancing glucose transport and insulin action in working skeletal muscle. Not only does muscle contraction stimulate uptake of glucose through non-insulin-dependent mechanism during exercise, but sensitivity to insulin-mediated glucose uptake is greatly improved immediately after exercise.

In the present study, dyslipidemia in both groups was improved, but more improvement was in group I (Ex +D) than group II (D only). This agrees with LaMonte et al.,[16] who reported that exercise is particularly effective at reducing insulin resistance and has also been shown to improve dyslipidemia and hypertension, albeit to varying degrees. Whether or not physical activity is accompanied by a change in body weight (particularly abdominal adiposity) is an important mediator in its ability to modify each of the components. Our results also agree with Stafenick et al.,[23] who reported that beneficial effects of exercise training on lipids and lipoproteins are routinely observed and may have additional impact when combined with dietary modification and weight loss.

Conclusions

1- The metabolic syndrome is a clustering of components or risk factors associated with an increased risk for CVD and type 2 DM.
2- Lifestyle Modification and weight loss should be at the core of treating or preventing the metabolic syndrome and its components.
3- It is well established that weight loss with diet and physical activity is beneficial for treating all of the components of metabolic syndrome, including excessive adiposity, dyslipidemia, hypertension, insulin resistance and hyperglycemia.

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الملخص العربي

تأثير برنامج تغيير نمط الحياة على متلازمة التمثيل الغذائي في السيدات البدينات

المقدمة : تعتبر السمنة قي ازدياد مستمر في كثير من دول العالم وخاصة في مصر وتؤدى السمنة لكثير من المضاعفات أهمها متلازمة التمثيل الغذائي . **الهدف من الدراسة :** الهدف من هذه الدراسة هو تقييم التغيرات في نمط الحياة على متلازمة التمثيل الغذائي في السيدات البدينات . **تصميم البحث :** هذه التجربة أجريت لمدة 12 أسبوع علي متلازمة التمثيل الغذائي في السيدات البدينات . وقسم المرضي عشوائيا إلي مجموعتين ، المجموعة الأولي : العدد 20 مريض ، تأخذ برنامج علاجي عبارة عن تمارين هوائية لمدة 50 دقيقة من 60 إلي 75% من أعلي معدل نبض القلب بالإضافة إلي ريجيم غذائي . المجموعة الثانية : العدد 20 مريض .. تأخذ ريجيم غذائي فقط . وكانت القياسات كالأتي وزن الجسم – مؤشر كتلة الجسم – محيط الوسط –السكر في الدم ودهون الدم الثلاثية والكولسترول المنخفض الكثافة والكولسترول العالي الكثافة . **النتائج :** أظهرت الدراسة والتي أجريت علي عدد 40 من السيدات من مرضى السمنة و اللاتي يعانين من متلازمة التمثيل الغذائي نتائج ذات دلاله إحصائية في التقليل من الوزن ومؤشر كتلة الجسم– مستوي السكر والأنسولين في الدم وتحسن في دهون الدم في كلتا المجموعتين ولكن التحسن كان أكثر في المجموعة الأولى . **الخلاصة :** خلصت الدراسة إلى أن التغيرات في نمط الحياة على متلازمة التمثيل الغذائي في السيدات البدينات أدى إلى تحسن واضح في كل الدلالات وخاصة المجموعة الأولى .

الكلمات الدالة : السمنة - متلازمة التمثيل الغذائي – ريجيم غذائي -التمرينات العلاجية .