Cardiovascular Response to Body Weight Reduction for Pre-Diabetic Obese Females

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ABSTRACT

The aim of this study was to determine the efficacy of weight reduction program in avoidance of cardiovascular diseases and improving cardiovascular state in pre diabetic obese female subjects. Thirty pre diabetic obese volunteer females selected from Internal Medicine Department of Kasr El Ainy and October 6th University Hospitals. Their age ranged between 35-45 years, attended a program of weight reduction (aerobic exercises and diet), within 12 weeks. Before and after the program the BMI, blood pressure, pulse rate and blood glucose level were measured. The results were revealed highly statistical significance (P<0.01) reduction of SBP, DBP and PR, also there were highly statistical significance (P<0.01) reduction of fasting blood glucose level also there was significant (P<0.05) positive correlation between BMI, and all of cardiovascular variables and fasting blood glucose level. The results can be used as a reference for the present study to show the efficacy of weight reduction program in avoidance of cardiovascular diseases and improvement of cardiovascular state in pre diabetic obese females. Whenever there's high value of body mass index change reduction, it gives the expected improvement of cardiovascular system.

INTRODUCTION

Obesity is an excess of body fat that frequently results in a significant impairment of health. It results when the size or number of fat cells in a person's body increases. A normal sized person has between 30 and 35 billion fat cells. When a person gains weight, these fat cells first increase in size and later in number (1).

Obesity is a chronic disease with a multifactor etiology including genetics, environment, metabolism, life style and behavioral components. A chronic disease treatment model involving both life style interventions and, when appropriate, additional medical therapies delivered by an inter disciplinary team including physicians, dietitians therapists and behavior therapists offers the best chance for effective obesity treatment. This team should coordinate life style factors such as proper nutrition, regular physical activity and change in eating behaviors[2].

Pre diabetes is a term applied to people who have blood glucose levels that are elevated but not high enough to warrant the diagnosis of diabetes. At least 21.1% of the population ages from 40 to 74 have a pre diabetic condition[3].

Pre diabetes is most often a silent condition with no symptoms. However certain risk factors such as obesity or lack of exercises may put at higher risk developing pre diabetes. It occurs when the body does not respond properly to insulin and therefore cannot keep glucose levels within a normal range Blood sugar is higher than normal but not high enough to be diabetic[4]. Obesity is diagnosed by taking the medical and family history, a physical examination and by using body mass index (BMI) to determine whether you are obese or not[5]. A BMI below 18.5 kg/m²is considered underweight, between 18.5 – 25

kg/m² is considered a healthy weight, between 25 – 30 kg/m² is considered overweight and 30 kg/m² is considered obese[6].

Obesity is an important risk factor for coronary heart disease, ventricular dysfunction, congestive heart failure, stroke, cardiac arrhythmias, insulin resistance and type II diabetes, hypertension and inflammation[7]. Obesity management includes primary weight loss, prevention of weight regain and management of associated risk factors such as smoking, hyperlipidaemia and hypertension[8].

Treatment for obesity will be most successful by making life style changes by increasing physical activity (aerobic exercises) and limiting calories[9]. A low calorie diet for a person who is obese provides 500 to 1000 fewer calories per day. The duration of exercises should vary from 20-60 minutes to gain significant cardio-respiratory and fat burning benefits[10]. Numerous studies have shown that the combination of proper nutrition and regular physical activity is the most effective intervention for weight loss and maintenance of weight loss[2].

Aim of the Study

The aim of this study was to determine the efficacy of weight reduction program in improving cardiovascular system in pre diabetic obese females.

SUBJECTS MATERIALS AND METHODS

Subjects

This study was conducted on thirty volunteers pre diabetic obese females selected from Internal Medicine Department of Kasr El Ainy and 6th October University Hospitals,

Their age ranged from 35-45 years old and their weights were within the range of obesity section (i.e. their BMI ranged between 30: 39.9 kg/m²).and they have not engaged in any organized sporting activities, or any cardiovascular problems

Instruments for evaluation
1- Weight height scale.
2- Blood glucose analyzer, Oral glucose tolerance test is used to determine the blood glucose level.
3- Mercurial sphygmomanometer (MAC 300) and stethoscope (3m Littmann Classic II S.E.).
4- Pulsemeter (CH 606, Wrist Measuring Automatic Model).

Treatment Instrument

Electronic Treadmill (Pro-sport, C 309): Used in performance of aerobic exercises.

Methods
Evaluative Procedures:
1- Weight and height of every subject was measured to calculation of the initial BMI for each subject as the following equation:
$$BMI = weight\ (kg)/height\ (m)^2$$
2- The blood glucose was measured by using the oral glucose tolerance test.

The blood glucose level of pre diabetic subjects was ranged from 140-199 mg/dl.
3- The blood pressure and pulse rate of each subject was measured.

Treatment Procedures:

Each subject in this study performed a weight reduction program (diet program + aerobic exercises program) for 3 months, 3 times weekly for aerobic exercises as follow:

1- Aerobic exercise program:

Walking on treadmill for duration of 40 minutes with intensity of exercise 60 to 70% of THR which will be calculated by Karvonen equation:

THR = 60 to 75% (AAMHR- RHR)

AAMHR = 220 – age

With frequency of exercise →3 times / week for 3months.

This program included the following phases:

A- The warm-up phase: Performing a slow movement in form of walking on treadmill without inclination with slow fixed speed for 5 minutes as a preparation for the more strenuous activity in the second phase of the exercise program.

B- The main exercise phase: This phase had been conducted through using the electronic treadmill for 30 minutes. in a rhythmic, repetitive and dynamic manner within the subject's exercise intensity.

C- The cool down phase: This phase had been conducted through performing slow movements, for 5 minutes, as a recovery from the more strenuous activities of the main exercise phase.

2- Diet regimen program

On a base of nutritional principles to decrease the daily requirements of calories from 2200 Kcal/day to be 1200 cal/day, the diet regimen program had been conducted for 12 weeks (same period of exercise program). At the end of the period of intervention (12 weeks) the same procedures of evaluation has been conducted as before program.

RESULTS

I- Results of anthropometric characteristics:

As observed in table (1), and fig (1,a & b), the anthropometric measurements of weight, BMI, revealed that: The mean value of body weight Pre- program was (88±4.55 Kg) and it decreased significantly (P<0.05) after diet + aerobic exercises program for three months to (73.6±5.62Kg), with associated mean rate of improvement (reduction) of 16.4%. And the mean value of BMI (Pre) was (32.34±1.46 Kg/m^2) and it decreased significantly (P<0.05) to (27.09±1.9Kg/m^2) after three months of program with mean percentage of improvement (reduction) of 16.2%.

Table (1): Mean value of weight (Kg), and BMI (Kg/m^2) measurements at base line (Pre) and after three months (Post) and improvement ratio for study group.

Variables		X±SD	MD	T-value	P-value	%IR
Weight (Kg)	Pre	88±4.55	14.4	25.65	0.001	16.4%
	Post	73.6±5.62				
BMI(Kg/m^2)	Pre	32.34±1.46	5.25	22.12	0.001	16.2%
	Post	27.09±19				

X=mean   SD=Standard deviations   MD=mean difference   Kg=Kilogram
Kg/m^2= Kilogram per meter square   %IR=Percentage improvement ratio
Pre=at base line measurement   Post=after three months

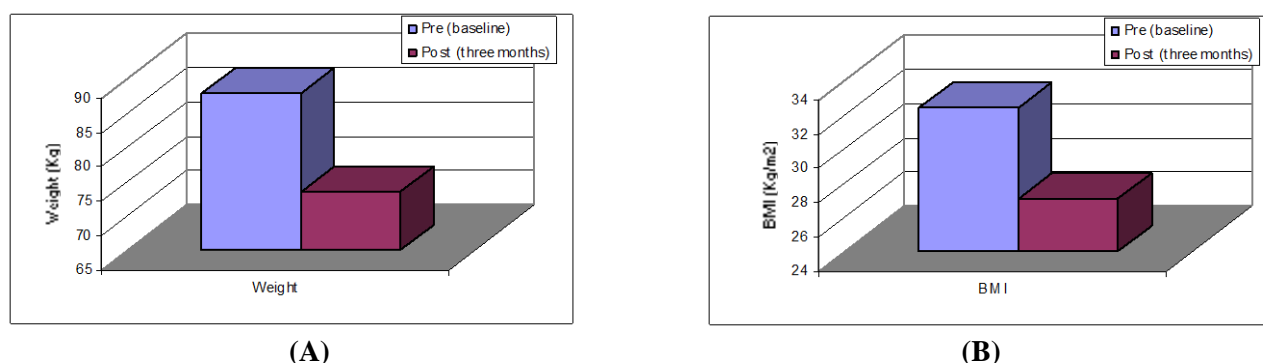(A)   (B)

Fig. (1): Shows mean value of (A); weight (Kg), (B); Body mass index (Kg/m2), at baseline (Pre) after three months (Post) for study group.

II- Statistical analysis of cardiovascular variables:

Systolic Blood Pressure (SBP): As showed in table (2), and fig. (2), the mean value of SBP (Pre) program was (129.33±8.06mmHg), and it reduced to (117.67±6.26mmHg) after three months which revealed highly statistical significance (P<0.01) reduction of SBP, with associated mean rate of improvement 9 %.

Diastolic Blood Pressure (DBP): Regarding to table (2), and fig. (2) the mean value of DBP Pre- program was (88±6.37mmHg), after application of program (diet+ aerobic exercises) it was decreased to (79±6.74mmHg) with highly significantly (P<0.01) reduction with rate of reduction of 10.3%.

Pulse Rate (PR): Also table (2), and fig. (3) represented the mean value of PR Pre-program which was (79.36 ±3.75bpm) and it was decreased to (76.63±3.48bpm) with highly significantly (P<0.01) reduction of PR after three months with rate of improvement of 14.8%.

Table (2): Mean value of SBP. DBP, and PR, at base line (Pre) and after three months (Post) for study group.

	SBP (mmHg)		DBP (mmHg)		PR (bpm)	
	Pre	Post	Pre	Post	Pre	Post
X	129.33	117	88	79	79.36	67.63
±SD	8.06	6.26	6.37	6.74	3.75	3.48
MD	11.66		9		11.73	
T-Value	13.32		12.24		31.09	
P-Value	0.001		0.001		0.001	
Significance	Sig.		Sig.		Sig.	
%IR	9%		10.3%		14.8	

SBP=Systolic blood pressure   DBP=diastolic blood pressure   PR=Pulse rate
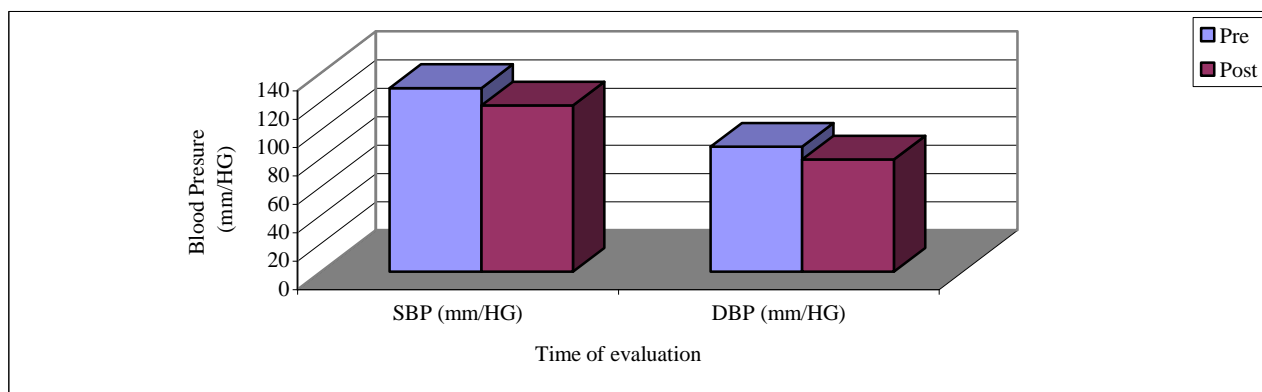mmHg=millimeter mercury   bpm=Beats per minutes

Fig. (2): Shows the mean value of systolic blood pressure SBP (mmHg) and diastolic blood pressure DBP (mmHg) at base line (Pre) and after three months (Post) for study group.
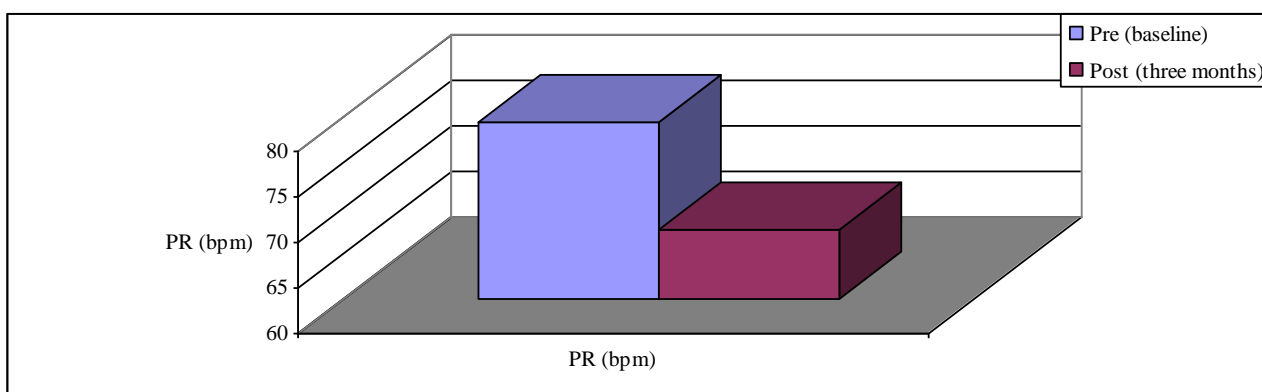

Fig. (3): Shows the mean value of pulse rate PR (bpm) at base line (Pre) and after three months (Post) for study group.

III- Statistical analysis of Metabolic Variables

Fasting Blood Glucose level: Table (3), and fig. (4) showed that, the mean value of fasting glucose level before program was (108.07±5.72 mg/dl) and after three months it was decreased to (87.8±5.64 mg/dl) with highly statistical significance (P<0.01) reduction of fasting blood glucose level with 18.75 %, of improvement.

Blood glucose level after one hour: As Table (3), and fig. (4) the mean value of glucose level after one hours was (222.5±9.51 mg/dl) before program and it decreased to (189.73±8.49 mg/dl) after three months with highly statistical significance (P<0.01) reduction with 14.68 % of improvement.

Blood glucose level after two hours: As observed in table (3), and fig. (4), the mean value of glucose level after two hours was (193.27±7.810 mg/dl) before program and it decreased to (160.23±12.95 mg/dl after three months with highly significance (P<0.01) reduction with 17 % of improvement.

Table (3): Mean value of fasting blood glucose, after one and two hours, at base line (Pre) and after three months (Post) for study group.

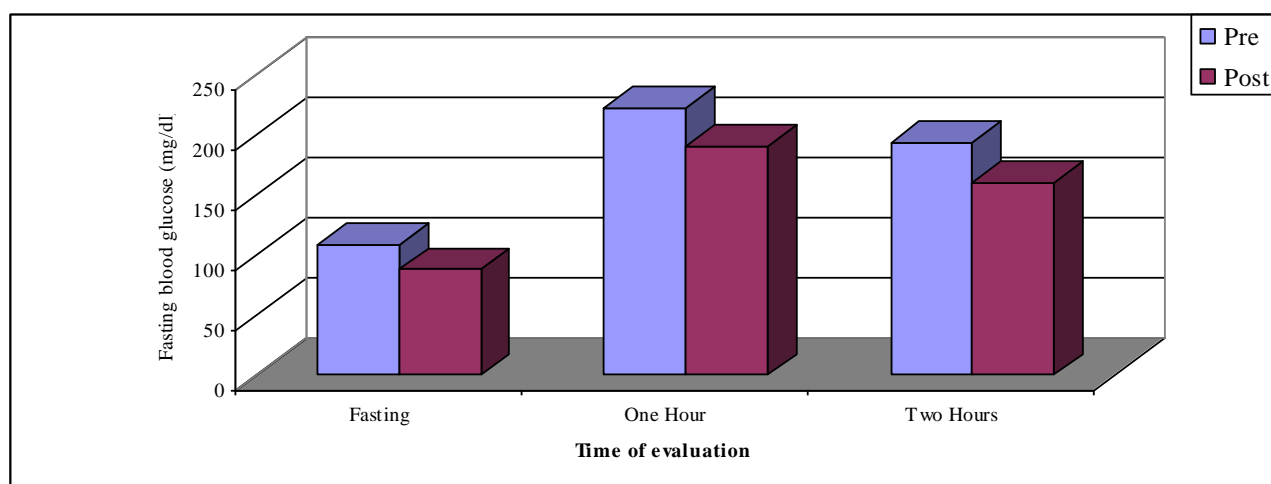|	Fasting Blood Glucose		One hours Blood Glucose		Two hours Blood Glucose	
	Pre	Post	Pre	Post	Pre	Post
X	108.07	87.8	222.4	189.73	193.27	160.23
±SD	5.752	5.64	9.51	8.49	7.81	12.95
MD	20.27		32.67		33.03	
T-Value	34.4		31.51		27.26	
P-Value	0.001		0.001		0.001	
Significance	Sig.		Sig.		Sig.	
%IR	18.75%		14.68%		17%	

Fig. (4): Shows the mean value fasting glucose, after one and two hours, at base line (Pre) and after three months (Post) for study group.

IV-   Correlative analysis between Studied variables:

Correlative analysis between BMI and cardiovascular variables (SBP, DBP, PR).

As revealed from table (4); there was significant ($P<0.05$) positive correlation between BMI, and all of cardiovascular variables before and after program of treatment.

Table (4): Correlation between BMI and cardiovascular variables (SBP, DBP, and PR) at base line (Pre) and after three months (Post).

			SBP		DBP		PR	
			Pre	Post	Pre	Post	Pre	Post
BMI	Pre	r	0.75	-	0.7	-	.75	-
		p	0.01*		0.01*		0.01	
	Post	r	-	0.5	-	0.67	-	0.66
		p		0.01*		0.01*		0.01*

r=Correlation, P=Probability level   *=Highly significant ($P<0.01$).

Correlation between BMI and metabolic variable (Glucose level):

As revealed from table (5) and fig. (7, 8); there was significant (P<0.05) positive correlation between BMI, and Glucose level, before and after program of treatment.

Table (5): Correlation between BMI and glucose level at base line (Pre) and after three months (Post).

			Fasting glucose		One hour Glucose test		Two hours Glucose test	
			Pre	Post	Pre	Post	Pre	Post
BMI	Pre	r	0.75	-	0.80	-	0.76	-
		p	0.01*		0.01*		0.01	
	Post	r		.66		.57		.70
		p	-	0.01*	-	0.01*	-	0.01*

DISCUSSION

Obesity not only increases the risk of development of type 2 diabetes, but also complicates its management. The presences of obesity exacerbate metabolic abnormalities of type 2 diabetes; including hyperglycemia, hyperinsulinemia, and dyslipidemia. Obesity also increase insulin resistance and glucose intolerance, and this makes type 2 diabetes in obese patients more difficult to treat[11]. The prevention of the obesity and its impact on co-morbid conditions such as type 2 diabetes is very important. Therefore this current study was conducted to evaluate the benefits of weight reduction program (Dieting + aerobic training) in improving cardiovascular response and glycemic conditions, as risk factors in Pre-diabetic obese females. The results of the current study showed highly significance (P<0.01) reduction in mean value of body weight and highly significance (P<0.01) reduction in mean value of BMI, which revealed that transferring of all patients from class I obesity to overweight level where (BMI ≤29.9Kg/m^2).These results of weight & BMI reduction was in agreement with Mariana, A., et al. (2002)[12] who found that eight weeks of aerobic training on type 2 diabetes patients was significantly, reduce weight and BMI.

As well as Wilmore, J., et al. (2002)[13] showed significance decrease in BMI, in diabetic patients when trained on cycle erogometer for three days per week for six weeks. The results of present study was similar to the findings of Alsayed, A. (1999)[14] who found that six weeks of aerobic training with moderate intensity (treadmill walking), produced significant reduction in body weight and BMI. On the other hand the results of this study contradicted with Boule, N., et al. (2001)[15], who found that resistance exercise training for eight weeks on type 2 diabetes did not cause significance changes in BMI. Also, Weinstock, R., et al. (1998)[16] did not find any effect in 22 months weight maintenance between women randomized into group of diet alone or diet plus aerobic exercises training. As well as Lehmann, R., et al. (1995)[17] concluded that exercises training for six months in type 2 diabetes did not significantly changed body weight or BMI.

The exercises promote favorable energy balance and reduce visceral fat deposition through enhanced basal metabolism and activity level, and increase energy expenditure[18].

The results of cardiovascular variables for SBP, DBP, and PR, showed highly significance reduction (P<0.01) of their mean values[19] concluded that low to moderate

intensity treadmill exercises for hypertensive patients lead to significance reduction of blood pressure. This due to increase in cardio respiratory fitness, and decrease left ventricular wall thickness. This causes decrease in stroke volume and left ventricular end diastolic volume. This in turn lead to decrease in blood pressure. While Hinderliter, A., et al. (2002)[20], proved that aerobic exercises on obese hypertensive patients lead to decrease in blood pressure. These attributed to significance association of weight loss and favorable changes in left ventricular wall thickness[14]. Found significance decreased in SBP and DBP in type 2 diabetes mellitus patients in response to moderate aerobic exercise treadmill for six weeks. The results of the present study coincided with the majority of the previous studies.

The results of the present study revealed highly and steady significance (P<0.01) reduction in oral glucose tolerance test for fasting, one and two hours test. Which was in agreement with findings of Simonsen, L., et al. (2004)[21] who found a steady decreased in oral glucose concentration with associated improvement ratio equal to 18.3% in six obese subjects (BMI $32\pm2.6Kg/m^2$), after exercising on bicycle erogometer at 60% of peak oxygen uptake for 60 minutes. This improvement was continuated post exercises for three hours.

The results of the present study were supported by Ludwig, D., et al. (1999)[22], who found strong association between dietary fiber consumption, on weight reduction, glucose and insulin level, SBP, DBP, and lipid profile. The author confirmed that: dietary fiber consumption was associated with decrease in SBP, DBP and insulin level and therefore it may protect against obesity and cardiovascular disorders.

The results of the present study was confirmed by work of Lynch, J., et al. (1996)[23]

who found strongest evidence about the effectiveness of moderately intense physical training (5.5 metabolic unit, e.g. brisk walking), against development of type 2 diabetes, with associated significance reduction in oral glucose level, and also found strong correlation between SBP measured at base line and glucose level and BMI.

Regarding to results of the current study; there were mild to moderate correlation between BMI and cardiovascular variables and diabetes mellitus as manifested by metabolic variables (glucose level).

These results are in agreement with Aronnee, L. and Segal, K. (2002)[25] who found strong significant correlation between BMI and systolic and diastolic blood pressure, independent of age. The results of the present study supporter by Flegal, K., et al. (1998)[26] who found strong liner positive correlation between BMI and prevalence and incidence of diabetes as manfiastated by glucose level test. Which reach to 13% at BMI> $30Kg/m^2$. More over[26], found that risk of diabetes begin to liner increased in women when the BMI exceeds 22 Kg/m^2.

Finally: it can be concluded that combination of an aerobic training (treadmill walking) and dieting produce significant reduction in body weight, and body mass index, with associated improvement (reduction) in cardiovascular risk factor systolic and diastolic blood pressure as well as PR, in addition to improvement significantly in the level of plasma glucose, therefore therapist should commence on the role of exercise as well dieting in prevention of and treatment of diabetes in obese.

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الملخص العربي

استجابة الجهاز الدوري لإنقاص الوزن للسيدات البدينات المعرضات لمرض البوال السكري

الهدف من أجراء هذه الدراسة هو بيان تأثير برنامج خاص لإنقاص الوزن الذى يعتمد على النظام الغذائى منخفض السعرات الحرارية والتدريبات الهوائية من أجل تحسين استجابة الجهاز الدورى والأوعية والشرايين الدموية وتأثيرها على الوقاية من مرض البوال السكرى لدى السيدات البدينات . أجريت هذه الدراسة على عينه من ثلاثين سيدة بدينة أعمارهم تتراوح بين 35 إلى 45 عاماً و معدل كتله الجسم بلغ (32 إلى 34 ± 1 كيلو جرام على المتر المربع) والتى يمثل السمنة من الفئة الأولى بينما اختبار الجلوكوز قد أشار إلى متوسط قيمه هذه المادة فى بداية الدراسة (108 ± 5 مللى جرام فى الدسيلتر) . تم تقدير معدل كتلة الجسم بالكيلو جرام على المتر المربع وكذلك. المتغيرات الخاصة بالجهاز الدورى (ضغط الدم + نبض القلب) وكذلك اختيار نسبة الجلوكوز فى الدم وقد تمت جميع هذه القياسات فى بداية الدراسة وبعد ثلاثة أشهر . جميع أفراد العينة شاركوا فى برنامج للتدريب على التمارين الهوائية بأستخدام سير المشى الكهربائى والتى تمثل الإحماء خلال 5 دقائق والمشى خلال 30 دقيقه (نسبه 75% من معدل ضربات القلب المحدد) والاسترخاء لمدة 5 دقائق وإجراء هذه التمارين ثلاثة مرات فى الأسبوع لمده 12 أسبوع علاوة على النظام الغذائى المنخفض فى السعرات الحرارية والفيتامينات . أشارت نتائج الدراسة إلى الانخفاض الملحوظ فى وزن وكتلة الجسم والمتغيرات الخاصة بالجهاز الدورى مع الانخفاض فى نسبه الجلوكوز فى الدم كما أتضح من الاختبار الخاص وأشارت نتائج الدراسة إلى التلازم الملحوظ بين وزن وكتلة الجسم ومستوى الجلوكوز عنه فى بداية الدراسة . نتائج الدراسة تشير إلى انخفاض الوزن بفضل التدريبات الهوائية والنظام الغذائى مما كان لهم من آثار مفيدة على نظام الجهاز الدورى ومستوى الجلوكوز كما انخفضت نسبة مخاطر واحتمالات الإصابة بمرض البوال السكرى من النوع الثانى. كما أظهرت النتائج وجود علاقة ذات دلاله إحصائية بين نقصان الوزن وتجنب مرض البوال السكرى وتحسن حاله الجهاز الدورى وتجنب نسبه كبيره من أمراضه لدى السيدات التى تمت عليهن الدراسة وذلك من خلال مقارنه نتائج ما بعد نهاية التجربة بما كانت عليه قبل إجرائها .