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Changes in Serum Vaspin, Metabolic Parameters, and Body Mass Index After Weight Loss in Obese Females Following Low-Energy Diet and Aerobic Exercise: A Prospective Observational Study

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Abstract

Objective: To study the effect of weight loss on the levels of vaspin, insulin, lipid profile and anthropometric indices in obese females participating in a low-energy dietary regimen combined with aerobic exercise. **Materials and methods:** This prospective observational study included 256 adult females aged (20-50) years were divided into 192 obese females with BMI ≥30 kg/m^2 and 64 normal weight females, with BMI 18.5-24.9 kg/m^2 as obese and control group respectively. The obese females were subgroups based on duration of dietary regimen as: Group I (3 months), Group II (6 months), and Group III (> 6 months). Each group consisted of 64 obese females and followed a low-calorie diet of 1200 to 1500 calories/day, combined with aerobic exercise training for 30 min/day all over the study period. Body mass index and waist circumference were measured post-weight loss. Serum vaspin, insulin, glucose levels, and lipid profiles were measured and analyzed statistically. **Results:** Baseline comparison revealed that body weight, waist circumference, BMI, vaspin, insulin, glucose, triglycerides, total cholesterol, and LDL of obese group were significantly increased compared to controls (P ≤ 0.05). Low-energy diet and aerobic exercise led to significant decrease in body weight, waist circumference, BMI, vaspin, insulin, glucose, especially with longer period of dietary regimen. Lipid profile showed improvement attitude but without statistical significance. BMI was positively correlated with most studied parameters and negatively correlated with HDL. **Conclusions:** Low-calorie diet accompanied with aerobic exercise were associated with body mass index, vaspin, insulin, and lipid profile level. Dieting and weight reduction, especially in longer periods, particularly for six months or more than six months, appear to normalize these parameters toward control values and improve metabolic status.

Keywords: obesity; aerobic exercise; obese females; vaspin; insulin

1. Introduction

Obesity represent a worldwide health challenging marked by excess fat accumulation that result from a prolonged imbalance between calories consumed and calories burned [1], that disturbs metabolic balance and raise the risk of many diseases, such as type 2 diabetes mellitus, cardiovascular disorders, and metabolic syndrome [2]. Globally, obesity rate have raised dramatically, reaching pandemic levels that affect millions worldwide [3]. Females obesity rates have increased markedly in recent years, especially in developing countries including Palestine [4], where sedentary lifestyles and changing dietary habits contribute significantly to this attitude [5].

The World Health Organization reported that, in 2022, 2.5 billion adults aged 18 and older worldwide were overweight, with 890 million classified as obese (BMI ≥ 30 kg/m^2), a figure that has

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doubled over three decades [6, 7]. Adipose tissue is now understood as an active endocrine organ that release various bioactive peptides known as adipokines [8]. These substances play critical roles in controlling insulin sensitivity, inflammation, and energy metabolism [9]. Among these adipokines, vaspin (visceral adipose tissue-derived serine protease inhibitor) has gained growing consideration due to its potential insulin-sensitizing and anti-inflammatory properties [10].

Vaspin expression is believed to be increased in obesity as a compensatory mechanism to counteract metabolic disturbances, especially insulin resistance [11]. Several studies have shown that vaspin levels are associated with obesity, insulin resistance, and metabolic syndrome components [12, 13]. These associations remain controversial, as some studies report increase vaspin levels in obese people, while others show decrease after metabolic improvement. These variations may be attributed to differences in study populations, intervention strategies, and duration of weight loss programs.

Weight reduction through lifestyle change, particularly caloric restriction and aerobic exercise, is considered a cornerstone in the management of obesity and its metabolic complications. A low-energy diet combined with regular aerobic exercise has been shown to improve body composition, enhance insulin sensitivity, and normalize lipid profiles [14]. Moreover, weight loss programs may affects adipokine profiles, including vaspin, contributing to metabolic improvements beyond simple fat mass reduction [15].

Despite increasing interest in vaspin as a metabolic biomarker, limited evidence exists about its response to structured weight reduction programs in obese females, particularly in prospective observational studies. Because there is not much research has been done on serum levels of vaspin in obesity in Gaza strip, the authors interested in carrying out this research. Therefore, this study investigates the effect of weight reduction induced by a low-energy diet and aerobic exercise on serum vaspin levels, metabolic parameters, and body composition in obese females.

2. Materials and Methods

2.1. Study Design and Participants

This prospective observational study included 256 adult females aged 20-50 years, divided into obese and control groups. Obese group consisted of 192 obese females with BMI ≥30 kg/m^2 (aerobic group) and 64 normal weight females with BMI 18.5-24.9 kg/m^2 as a control. The obese females were divided into three subgroups based on diet duration: Group I (3 months), Group II (6 months), and Group III (> 6 months). Each group included 64 obese females without chronic diseases or hormonal disorders, and maintained on a calorie-restricted diet of 1200 to 1500 calories daily, combined with regular aerobic exercise training for 30 minutes/ day, throughout the study period. All participants were randomly selected according to the inclusion criteria from private nutritional centers and clinical nutritional center distributed across Gaza strip five governorates; North Gaza, Gaza, Middle area, Khanyounis and Rafah. The sample size was calculated using EPI-INFO statistical package version 3.5.1 that was used with 95% CI, 80% power and 50% proportion as conservative and OR>2. The sample size is in a case of 1:1 ratio of case to control was 60. For a no-response expectation, the sample size was taken as 64 in each aerobic obese female group and 64 normal controls.

2.2. Exclusion Criteria

The criteria included male gender, females aged out of the range, less than 20 year and more than 50 years. Overweight and obese females who were free of chronic diseases and hormonal disorders. Females who received steroid eradication therapy, immunosuppressive or chemotherapeutic drugs, and females taking medications that might affect body weight or glucose metabolism. Pregnant or lactating female, anemic patients with primary diseases such as hepatic disease, anemia, cancer, leukemia, kidney disease and diabetic or hypertensive female.

2.3. Ethics

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Ethical approval was obtained from Palestinian Health Council, Helsinki committee for ethical approval in Gaza strip under approval number PHRC/HC/571/19 and the study procedures were therefore done in accordance to the accepted ethical standards of research involving human subjects. All participants provided an informed consent after the research protocols were carefully explained to them. The informed consent form was signed by all the participants before joining the study.

2.4. Follow-Up and Weight Reduction Program

The study participants in case groups were participated in a weight-management program and aerobic exercise training under the supervision of nutritionist in the private clinical nutrition center. The main aims of the weight-management program were; removal of body's toxins and clearance of blood's chylomicrons, fast burning of the accumulated and obsolete fats, removal of the fats distributed in specific areas, and reshaping the body appearance, and maintaining the improved body mass index.

For accomplishing these goals, the overweight and obese participants were maintained in a low-calorie diet program (1200–1500 Kcal/day) combined with aerobic exercise for three, six or more than six months. The average macronutrient content as a percentage of the assimilated energy was 55% carbohydrates, 15% proteins, and 30% fats. The intake calories have been varying from one participant to another in accordance with the weight and age. Generally, the calories were partitioned per day into, breakfast ≈ 350 kcals, lunch ≈ 600 kcals, dinner ≈ 350 kcals, snacks ≈ 200 kcals and aerobic exercise: walking for 30 minutes daily. The diet program contained herbs, spices, and other food stuff such as apple cider vinegar, green tea extracts, Schumer, dandelion and hawthorn leaves in order to improve fat burning, furthermore, it also recommended to drink 2-3 liters of water per day.

In every visit, participants were asked about health and/or any problem that may have during the study. The program was based on group therapy that was thought to be effective as the psychological aspect of the problem and exchange of experience between group members would act as a motivating factor that would increase compliance with therapeutic programs and enhance weight reduction.

2.5. Body Mass Index Measurements

BMI measurements were taken with each participant in light clothing and without shoes. Waist circumference was measured in centimeter using a metric ribbon, height and weight were measured by automatic height-weight scale (Detecto DR400C, USA), to the nearest 0.1 cm and 0.1 kg, respectively. Weight (kg) divided by height (m^2) was used to compute BMI.

2.6. Specimen Collection and Processing

Blood samples were collected at the morning after 12 hours overnight fast. Serum was directly separated by centrifugation at 2500 rpm for 10 minutes. The human serum vaspin and insulin were y a solid phase enzyme-linked immune sorbent assay (ELISA) DRG Diagnostic international, USA, according to the manufacture instruction [16, 17]. Glucose [18], cholesterol [19], triglycerides [20], and HDL-C [21] were measured by enzymatic colorimetric methods.

2.7. Data Analysis

The IBM SPSS program The IBM SPSS program for Windows, version 28.0, was used to tabulate, and statistically analyze the data. Data analysis was carried out as follows: data cleaning, frequency table for all the study variables. Frequency and proportions were used to express qualitative data, defining and recording of certain variables and cross tabulation and advanced statistical analysis. The following tests were applied; ANOVA test, the significance of difference was checked by one-way ANOVA test, Pot Hoc test - Scheffe test, significant at $P \leq 0.05$. Chi-square test was used to determine how the proportions differed. Pearson correlation coefficient and Spearman correlation coefficient and independent-samples t-test were also used to calculate the variance in means across

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groups. P-values less than 0.05 were regarded as the statistically significant limit. Percentage change was calculated according to the following formula:

$$\textbf{Change percentage } (\%) = \frac{\textbf{mean of cases} - \textbf{mean of control}}{\textbf{mean of control}} \textbf{x100}$$

3. Results

Sociodemographic characteristics of study participants illustrated in Table 1. The age of the study population ranged from 20-50 years with mean of (31.60±6.9) years for control and (34.25±9.14, 34.34±7.90 and 35.90±5.82) years for other cases groups respectively. The difference between control and case groups according to the age of participants was non-significant as (p-value= 0.053). Most of the participants in both case and control groups were married, and the difference between the different groups in accord with their marital status was not significant (p-value= 0.155). Geographical distribution (residency) also showed no significant variation, and the largest number of participants in all groups were from Gaza city, except females in the second aerobic group that perform a six months-diet program were from Khanyounis. However, the difference between groups based on the place of residency was also not significant (, p-value= 0.207). The absence of statistically significant differences across sociodemographic variables confirms that the study groups are well-matched at baseline, strengthening the internal validity of subsequent comparisons.

Table 1. Sociodemographic characteristics of study population.

Parameter		Non-Obese female		Obese female Group 1 (3-months diet)		Obese female Group 2 (6-months diet)		Obese female Group 3 (> 6-months diet)		*P*-value
		N	%	N	%	N	%	N	%	
Age (years)	20 – 27	22	34.4	18	28.1	14	21.9	8	12.5	0.053
	28 – 35	20	31.3	12	18.8	20	31.3	20	31.2	
	36 – 43	16	25.0	24	37.5	24	37.5	30	46.9	
	44 – 50	6	9.3	10	15.6	6	9.3	6	9.4	
Mean ± SD		**31.60 ± 6.94**		**34.25 ± 9.14**		**34.34 ± 7.90**		**35.90 ± 5.82**		
Marital status	Single	8	12.5	22	34.4	18	28.1	10	15.6	0.155
	Married	56	87.5	42	65.6	46	71.9	54	84.4	
Residency	North Gaza	4	12.5	10	15.6	6	9.4	8	12.5	0.207
	Gaza	22	34.4	26	40.6	12	18.8	30	46.9	
	Middle area	10	15.6	4	6.2	14	21.9	12	18.8	
	Khan Younis	14	21.9	12	18.8	26	40.6	6	9.4	
	Rafah	10	15.6	12	18.8	6	9.4	8	12.5	

N: number of the subject = 64 subject per each group, **SD:** standard deviation. The significant of difference was checked by checked by chi square test, significant at $P \leq 0.05$.

Baseline comparison in Table 2 revealed that body weight, waist circumference, and BMI were significantly increased in obese participants compared to controls ($P \leq 0.05$). Serum vaspin, insulin, glucose, levels were significantly increased in obese females compared to controls, particularly in early-stage dieting groups ($P \leq 0.01$) table 3. Triglycerides, total cholesterol, and LDL levels were higher in obese females compared to controls, while HDL levels showed a slight increase in later stages of dieting, which is a favorable outcome table 4.

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After low-energy diet accompanied with aerobic exercise for 30 minutes daily, the mean value of weight in obese female of group 1 (3-month diet) was decreased from 96.3 ± 17.3 to 90.4 ± 16.5 kg, WC from 93.4 ± 11.8 to 91.3 ± 11.7 cm, and BMI from 38.51 ± 5.9 to 36.17 ± 5.8 kg/m², with mean decreases of 5.9 ± 3.4 kg, 2.1 ± 16.6 cm, and 2.34 ± 1.3 kg/m², respectively. Better improvements were observed in Group 2 (6-month diet), where body weight decreased from 86.5 ± 14.2 to 78.2 ± 13.5 kg, WC from 86.0 ± 9.8 to 83.3 ± 9.9 cm, and BMI from 33.98 ± 4.7 to 30.74 ± 4.8 kg/m², with mean reductions of 8.32 ± 6.0 kg, 2.7 ± 13.9 cm, and 3.25 ± 2.2 kg/m², respectively. demonstrated the marked variations was established in group 3, with body weight decreasing from 99.5 ± 15.6 to 82.8 ± 14.4 kg, WC from 90.6 ± 11.3 to 85.0 ± 11.0 cm, and BMI from 38.59 ± 6.9 to 32.06 ± 5.9 kg/m², corresponding to mean reductions of 16.7 ± 8.4 kg, 5.6 ± 15.8 cm, and 6.53 ± 3.49 kg/m², respectively (Table 2).

Table 2. Changes in anthropometric measurements of study populations.

Parameters	Non-Obese female	Aerobic-case groups (Obese female)						Change (%)	P-value
		Group 1 (3-month diet)		Group 2 (6-month diet)		Group 3 (>6-month diet)			
		Before	After	Before	After	Before	After		
Height (m)	1.62 ± 007	1.58 ± 0.05	1.58 ± 0.05	1.59 ± 0.07	1.59 ± 0.07	1.61 ± 0.9	1.61 ± 0.9	47.30 [a] 27.45 [b] 34.88 [c]	0.028 0.166 0.612
Weight (kg)	61.4 ± 7.3	96.3 ± 17.3	90.4 ± 16.5	86.5 ± 14.2	78.2 ± 13.5	99.5 ± 15.6	82.8 ± 14.4	47.30 [a] 27.45 [b] 34.88 [c]	≤0.001
Mean weight Difference		5.9 ± 3.4 decrease		8.32 ± 6.0 decrease		16.7 ± 8.4 decrease		≤0.01	
Waist circumference (cm)	76.4 ± 5.9	93.4 ± 11.8	91.3 ± 11.7	86.0 ± 9.8	83.3 ± 9.9	90.6 ± 11.3	85.0 ± 11.0	19.6 [a] 9.04 [b] 11.33 [c]	≤0.001
Mean WC Difference		2.1 ± 1.1 decrease		2.7 ± 1.2 decrease		5.6 ± 1.4 decrease		≤0.01	
BMI (kg/m²)	23.24 ± 1.4	38.51 ± 5.9	36.17 ± 5.8	33.98 ± 4.7	30.74 ± 4.8	38.59 ± 6.9	32.06 ± 5.9	55.64 [a] 32.27 [b] 37.95 [c]	≤0.001
Mean BMI Difference		2.34 ± 1.3 decrease		3.25 ± 2.2 decrease		6.53 ± 3.49 decrease		≤0.01	

Each reading represents Mean ±SD of 64 subjects. The significance of difference was checked by one-way ANOVA test, Independent T-Test, significant at $P \leq 0.05$;. [a] Compares obese female before after 3month dieting *vs* non-obese female; [b] Obese female after 6 months diet *vs* non-obese female & [c] Obese female after more than 6 months diet *vs* non-obese female.

Serum vaspin level was 84.84±33.35 pg/ml, 80.14±25.79 pg/ml, and 62.25±19.0 pg/ml in obese females who followed dieting program for three, six and more than six months showed significant decreased, specifically in extended period of dieting system, where values nearly normalized compared with nonobese control females 62.25±19.0, (P ≤0.01) and with percentage changes were 39.04%, 31.33%, and 2.02% after performing the dieting program, respectively. The mean levels of insulin, glucose levels showed a considerable decline, especially in longer-duration groups, where values nearly normalized compared to non-obese females. The percentage of change of insulin was 235.95%, 187.26% and 1.92%, while the percentage of change for glucose was 7.92%, 2.75% and 6.79%, after performing the dieting program. These parameters showed gradual significant reductions, particularly with three and six months of intervention duration (P ≤ 0.01) (Table 3).

Table 3. Serum vaspin, insulin, and glucose levels before and after diet program.

Parameter	Non-Obese female	Aerobic-case groups (Obese female)				
		Group 1 (3-month diet)	Group 2 (6-month diet)	Group 3 (>6-month diet)	Change (%)	P-value
Vaspin (pg/ml)	61.02 ± 15.74	84.84 ± 33.35	80.14 ± 25.79	62.25 ± 19.0	39.04 31.33 2.02	*0.006 *0.01 0.853
Insulin (ng/ml)	5.73 ± 1.85	19.25 ± 1.59	16.46 ± 1.28	5.62 ± 0.91	235.95 187.26 1.92	*≤0.001 *≤0.001 0.488
Glucose (mg/dl)	76.31 ± 8.27	82.35 ± 10.51	78.41 ± 6.86	81.49 ± 11.96	7.92 2.75 6.79	*0.026 0.358 0.067

Each reading represents Mean ±SD of 64 subjects. The significance of difference was checked by one-way ANOVA test, Independent T-Test, significant at $P \leq 0.05$; Compares all *vs* control.

Table 4 revealed that the lipid profile demonstrates a trend toward improvement following dietary intervention, although most changes did not reach statistical significance. The findings indicate that prolonged dieting, particularly for 6 months or more, was associated with improvement in metabolic parameters and normalization toward control values.

Table 4. Changes in lipid profile after diet program.

Parameter	Non-Obese female	Aerobic-case groups (Obese female)				
		Group 1 (3-month diet)	Group 1 (6-month diet)	Group 1 (>6-month diet)	Change (%)	P-value
TG (mg/dl)	68.95 ± 27.65	85.48 ± 38.60	82.20 ± 38.93	78.22 ± 27.65	23.80 19.21 13.44	0.081 0.124 0.262
TC (mg/dl)	169.9 ± 25.48	185.47 ± 30.31	183.63 ± 38.04	178.4 ± 19.92	9.16 8.08 5.00	0.053 0.195 1.000
LDL (mg/dl)	111.40 ± 23.61	121.25 ± 28.50	117.80 ± 35.14	114.95 ± 17.92	8.84 5.75 3.19	0.184 0.437 0.511
HDL (mg/dl)	43.35 ± 11.27	42.25 ± 13.48	45.17 ± 12.95	46.59 ± 12.96	-2.45 4.20 7.47	0.753 0.596 0.346

LDL: Low-density lipoprotein; HDL: High-density lipoprotein; TG: Triglyceride; TC; cholesterol. Each reading represents Mean ±SD of 64 subjects. The significance of difference was checked by one-way ANOVA test, Independent T-Test, significant at $P \leq 0.05$; Compares all *vs* control.

Analyses using the Pearson correlation coefficient in table 5 revealed that BMI showed a significant positive correlation with body weight, waist circumference, vaspin, glucose, triglycerides, total cholesterol and LDL. The strongest associations were observed with body wight, waist circumference and fasting glucose (r= 0.934, r= 0.466, r= 0.461, P=0.001, respectively), indicating a close link between adiposity and metabolic dysfunction. A significant negative correlation was identified

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between BMI and HDL (r= -0.266, P=0.002), suggesting that increased body mass is associated with reduced protective lipid levels. The correlation findings confirm that higher BMI is associated with adverse metabolic profiles, particularly dyslipidemia and impaired glucose regulation.

Table 5. Correlation between current BMI and main parameters.

Parameters	BMI	
	Pearson correlation (r)	***P*-value**
Body weight (kg)	0.934*	0.001
Waist circumferences (cm)	0.466*	0.001
Vaspin (pg/ml)	0.262*	0.003
Insulin (ng/ml)	0.013	0.885
FBS (mg/dl)	0.461*	0.001
TG (mg/dl)	0.179*	0.043
Cholesterol (mg/dl)	0.312*	0.001
LDL (mg/dl)	0.286*	0.001
HDL (mg/dl)	-0.266*	0.002

* Correlation is significant at the 0.05 level (2-tailed); **r**: Pearson correlation; FBS: Fast blood sugar; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; TG: Triglycerides; TC: Total cholesterol.

4. Discussion

The present study evaluates the effects of a low-calorie diet regimen combined with 30 minutes aerobic exercise daily on anthropometric indices, serum vaspin, metabolic parameter, and lipid profile in obese females. The results revealed that obesity was associated with significant variations in body composition and metabolic biomarkers, while dietary intervention and regular physical activity had significant improvements in different parameters.

Anthropometric assessment showed significant increase in body weight, waist circumference, and BMI among obese females compared with non-obese controls. Following dietary intervention, a gradual decrease in these measurements were observed, especially after extended periods of dieting and exercise. These findings are in agreement with previous reports indicating that caloric restriction combined with moderate physical activity efficiently decrease adiposity and central obesity [22]. Waist circumference is considered an vital indicator of visceral fat accumulation and cardiometabolic risk; therefore, its decrease may reflect improved metabolic health [23].

One of the important findings of the present study was the increase in serum levels of vaspin in obese females. Vaspin is an adipokine secreted mainly by visceral adipose tissue, and is proposed compensatory molecule associated with obesity and insulin resistance [24]. Significant positive correlation between BMI and vaspin levels was observed, suggesting that vaspin secretion induced by increases in excessive adiposity and metabolic imbalance. Similar findings were reported by Youn et al. (2008), who revealed that elevated vaspin concentrations in obese indiveduals and suggested its involvement in insulin sensitivity and glucose regulation [16]. After long-term dieting the decrease in vaspin levels may indicate improvement in adipose tissue dysfunction and inflammatory status. Vaspin serum concentrations are decreased after one hour of acute physical exercise as well as after 4 weeks of training in individuals without antioxidants by exercise-induced oxidative stress [25].

Serum insulin concentrations were significantly increased in obese females and its level was decrease after dietary management. Obesity is associated with insulin resistance due to chronic low-level inflammation, changes in adipokine secretion, and impaired insulin signaling pathways [26]. Changes in insulin levels observed with weight loss may reflect enhanced insulin sensitivity induced by caloric restriction and physical activity. Interestingly, BMI in the present study did not show a

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significant correlation with insulin levels, which may be due to interindividual differences in insulin responsiveness or the effect of exercise duration on glucose metabolism.

Fasting blood glucose levels showed a positive correlation with BMI, indicating deterioration in glycemic control with increasing adiposity. Excessive adipose tissue has a negative effect on glucose uptake and increased hepatic glucose production, which increases the risk of hyperglycemia and metabolic syndrome in obese individuals [27]. Dietary intervention decreased glucose levels; however, the changes were less marked than those observed for insulin, indicating that dietary intervention may need to be longer periods to normalize blood glucose levels completely.

Obese females showed higher triglycerides, total cholesterol, and LDL levels compared with non-obese controls, while HDL levels tended to decrease with increase of BMI. These findings are in agreement with other study showing that obesity is associated with dyslipidemia in which there are increases in atherogenic lipids and lower levels of cardioprotective HDL cholesterol [28]. The positive correlations between BMI and triglycerides, cholesterol, and LDL reported in this study, support the association between obesity and cardiovascular risk factors. In contrast, the negative correlation between BMI and HDL reveals the adverse impact of obesity on lipid metabolism. After dieting and exercise, there were certain changes in lipid parameters, which were not statistically significant. This may be related to the period of intervention, dietary compliance, genetic factors, or baseline metabolic alterations among participants. Previous study have revealed that significant improvements in lipid metabolism may need extended lifestyle change and sustained weight loss [29].

The strong positive correlation between BMI and body weight was expected as BMI is directly related with body mass. Additionally, the positive association between BMI and waist circumference emphasizes the contribution of abdominal obesity to metabolic disturbances. Obesity has been shown to be an important factor in insulin resistance, systemic inflammation, and cardiovascular disease [30].

5. Conclusions

Low-calorie diet accompanied with aerobic exercise were associated with body mass index, vaspin, insulin, and lipid profile level. Dieting and weight reduction may need to be longer periods to normalize the studied parameters. Further study where needed.

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Informed Consent Statement: All participants provided an informed consent after the research protocols were carefully explained to them. Written informed consent form was obtained from all participants prior to their inclusion in the study.

Clinical Trial Number: not applicable.

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Conflicts of interest: The authors declare no conflicts of interest.

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