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THE EFFECTIVENESS OF DIFFERENT INTERVENTIONS ON BODY WEIGHT AND FAT OF OBESE ADULT FEMALES

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ABSTRACT

Purpose: The aim of this study was to evaluate the impact of short term interventions on body weight and fat of obese adult females. More specifically the aim was to evaluate the synergistic effect between the consumption of a low caloric diet and either physical activity, weight lowering medication or nutrition education on the rate of losing body weight and fat.

Design/Methodology: The subjects of this study ($n = 260$) were overweight (BMI >25 kg/m^2) and obese (BMI 30 kg/m^2 or more) adult females who were assigned to Four (4) different interventions including dieting only or in addition to physical exercise, intake of Orlistat or a nutrition education program. Body weight, height, Body Mass Index (BMI), waist circumference and percent body fat were assessed at the beginning of the trial and every two weeks for a period of six weeks. Energy and nutrients intake were assessed during the second visit using a 24 hr recall method.

Findings: Several factors affected the females' choice of the intervention program. Young females less than 30 years with lower BMI preferred physical exercise, older females with the highest BMI selected intake of weight loss medication in addition to dieting. The mean daily caloric intake was least by the physical exercise and education groups. Females from the last two groups achieved the highest loss in body weight, 8.4% and 6.84%, respectively. The least body weight loss was recorded in the diet and medication group (5.2%). The change in the BMI and waist circumference followed a similar pattern. The

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initial body fat percent was highest among the group who selected the diet and medication regimen (42.26%). However they achieved the least loss in body fat percent (5.01%). The highest reduction in the body fat percent was recorded in the groups that followed a low calorie diet with either nutrition education or physical exercise program.

Originality/Value: This study presents for the first time a comparison of the effectiveness of four intervention measures on the body weight and fat of obese adult females and the factors affecting the females, selection of the intervention method. The results confirm that following a low calorie diet could be effective in achieving a mild reduction in body weight and fat of obese adult females. The best results were achieved when dieting was accompanied with either nutrition education or exercise. Intake of medication that inhibits fat absorption had no synergestic effect when taken with a low fat diet. The results stress the importance of behaviour modification through nutrition education of the obese patients which may guarantee the sustainability of the reduction in body weight and fat.

***Keywords*:** obesity; females; education; dieting; weight; body fat; medication.

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INTRODUCTION

Obesity is the most prevalent nutritional problem in Egypt. Galal (2002) and Asfaw (2007), reported that the prevalence rate is particularly high among adult females in the age group 20–60 years. A WHO survey carried out in 2012 showed that the Body Mass Index (BMI) of 66.2% of Egyptian females in the age group 15–65 years was $>$30 kg/m^2. The most recent demographic health survey carried out in 2014 reported a sharp increase in the prevalence of obesity among females in the age group 30–39 years to 50.9% and to 65.3% in the age group 40–49 years.

Obesity has long been associated with increased morbidity and mortality. Among the well documented complications of severe obesity are increased risks of developing diabetes, hypertension, hyperlipidemia and cardiovascular disease (Ezzat, 2014; Nguyen et al., 2008; Wilson et al., 2002). The increased awareness about the health hazards induced by overweight and obesity motivated adult females to seek nutritional advice to lose weight. The lack of adequate number of well trained dietitian and nutritionist represents one of the main obstacles in achieving this goal.

Svetkey et al. (2012) and Akers et al. (2010) reported that nutrition interventions aimed at reducing obesity have mainly focused on weight loss treatment in obese adults, with limited interest in the change of body fat. The most common approach to treat obesity included interventions that are based on either dieting or both diet and physical activity. Diets formulated to promote weight loss are generally divided into four categories: low fat, low carbohydrate, low calorie and very low calorie diet. A meta-analysis of six randomised controlled trials carried out by Strychar (2006) found no difference in weight loss between subjects consuming the main diet types. A long term trial implemented by Sacks et al. (2009) proved that all calorie reduced diet types resulted in equal weight loss irrespective of macronutrients contents. Stuart (2013) indicate that the majority of individuals who have dieted regained virtually all of the weight that was lost after dieting and up to two-thirds of dieters were even heavier that they were prior to the beginning of their regimen. However, Harrington et al. (2009) concluded that well-designed intervention studies are needed to disentangle the influence of physical activity, diet strategy on body weight and composition.

As early as, Sweeney et al. (1993) reported that physical exercise as an isolated weight reduction intervention to lose weight resulted in only modest weight loss since considerable energy should be expanded to achieve a reduction in body weight in the absence of dietary therapy. However, Tate et al. (2007) in their study on the association between long-term weight loss and physical activity reported that participants who continued engaging in high level of physical exercise maintained a significantly high level ($p < 0.001$) of weight loss. Exercise as carried out in the general population has only modest effect. However, Lee et al. (1994) reported that intense exercise could lead to substantial weight loss. They

reported that military training with no dietary restriction produced an average loss of 12.5 kg over a period of 20 weeks. The decrease in body weight loss was attributed to a reduction in body fat as determined by skin fold measurements.

Several types of medicine such as Phentermine, Locraserin, Sibutramine and Naltrexone are currently available on the market and are used in the treatment of obesity. The mode of action of such drugs varies and some drugs may produce serious side effects. Finer (2002) reported that appetite suppressants such as Sibutramine principally act on the center of the hypothalamic region of the brain to reduce hunger and limit the drop in metabolic weight. Narkiewiez (2002), reported that patients may experience cardiovascular side effects. As a result, it was consequently prohibited. Kelley et al. (2004) reported the results of their study on Orlistat which showed that the drug inhibits gastrointestinal lipase which approximately reduces fat absorption by one third. Metformin is a commonly prescribed medication for glycemic control and induces weight loss as a side effect. Jung et al. (2006) reported that herbal medicines such as Catechine and Chistosan are presumed to be safe in the treatment of obesity, harmless and without side effects. However, Ernst (2003) concluded that common problems affecting the safety of herbal medicines include the lack of standardisation, incorrect preparations toxicity and adulteration.

Devaux et al. (2011) explored the relationship between education and obesity pointed out that the existing evidence concerning the relationship between nutrition education and obesity is relatively limited, as the main focus of most research has been more broadly on the link between socio-economic factors on health and nutrition status. Speakman et al. (2005) reported that the lack of education about the energy content of food may contribute to the development of obesity. Non-obese females had better food knowledge than those who were obese from the same social class. Cross sectional estimates from a study of twins carried out by Webbink et al. (2008) confirmed the negative relationship between education and the probability of being overweight. More specifically, a study by Yoon et al. (2006) reported that women with higher level of education showed significantly decreased ORs, with inverse trends for obesity and abdominal obesity across all education levels. Compared with the lowest education group, the adjusted ORs for obesity and abdominal obesity were 0.66 and 0.40, respectively, among women with 7 to 12 years of schooling and 0.27 and 0.15, respectively, among women with 13 or more years of schooling.

The aim of this study was to compare the effectiveness of different short term intervention measure in reducing body weight and body fat of overweight and obese adult females. More specifically the aim was to evaluate the synergistic effect between the consumption of a low caloric diet and either physical activity, weight lowering medication or nutrition education on body weight, BMI, waist circumference and percent body fat.

SUBJECTS AND METHODS

The subjects of this study were obese adult females in the age group 20–60 years. They were recruited from a private clinic in Alexandria, Egypt to guarantee their commitment to lose weight and that they will comply to the assigned treatment. Employing G power program and using 95% confidence, 5% error and a power of 80% and assuming a medium to small effect size of 0.4, the resulting minimum sample size amounted to 55 subjects per group; this sample size was increased to 65 to allow for possible drop out during the follow up period of the study.

Each possible subject was exposed to a thorough medical examination including collecting information on medical history to assure their eligibility to participate in the study. Initial body weight was measured to the nearest 0.1 kg using a digital scale and height was measured to the nearest 0.1 cm using standard techniques (Gibson, 2005),and were used in the calculation of the BMI. Only subjects with BMI above 25 kg/m^2 were included in the study. Other exclusion criteria included the presence of any metabolic or cardiovascular disorders including heart disease, arrhythmias, diabetes, thyroid disease or a history of hypertension or if they have taken weight loss medication within six month prior to the start of the study. In addition to the initial body weight and height measurements, the waist circumference of eligible subject was measured to the nearest 0.1 cm and the body fat percent was determined by Multi-Frequency Bioimpedence Analysis (MFBIA) using In Body 720 device (Volgyi et al., 2008).

A pre-coded questionnaire was developed, pretested on a subsample of 20 subjects, modified and used in the collection of data on socioeconomic variables including level of education, employment, the nature of their work, marital status and the age of each subject was recorded.

Four types of intervention programs were applied in this study. The first program was based on a dietary approach only by prescribing a low caloric diet to each subject that induces a caloric deficit leading to a reduction in body weight. The diet was prescribed to each subject to provide around 1400 calories per day taking in account to the food likes and dislikes and food allergy if present. The prescribed diet was limited in fat and sugar with adequate supply of protein. The diet was planned to provide plenty of cooked vegetables and fresh salad. The major protein sources either fish, chicken or meat were cooked by roasting or boiling to reduce their fat content. Carbohydrate was provided in the form of dark bread, and the fat content of the diet was reduced to less than 15% of the total caloric intake. The subjects were requested to reduced their sugar intake to the minimum level or to use artificial sweeteners when needed. Oriental sweets and deserts were omitted from the diet. The second approach included both dieting and exercise. Subjects following this intervention program were advised to join a health club to exercise for one hour three (3) times weekly. Because of their heavy weight, subjects were advised to practice a mild form of exercise. If joining a health club was not feasible they were asked to walk briskly for one hour daily. The third program included both dieting and the intake of weight reducing medication. Orlistat was prescribed to members of this group. Orlistat is a lipase inhibitor that acts by inhibiting the absorption of dietary fats. It exerts its therapeutic effect in the lumen of the stomach and small intestine by forming a covalent bond with the active serine residue site of the gastric and pancreatic lipases. The prescribed dose was 60 mg three times a day with each meal. This dose is better tolerated with minimal gastrointestinal side effects especially when the individual consumes less than 30% of the energy from fat. The fourth intervention included both dieting and nutrition education. Subjects enrolled in the latter intervention were grouped in classes and were given information on the caloric value of different foods, how to plan a meal, healthy methods of food preparation such as grilling or boiling to reduce the caloric contents, importance of including low calorie green salad in the meal, how to reduce intake from sugar and other sweets and the importance of changing old dietary pattern and food habits that led to the development of obesity. Subjects were allowed to use phone calls to ask questions regarding their diet.

Eligible participants were briefed about the objectives of the study, its duration and the four different interventions that could be followed to lose weight were fully explained. When the female agreed to participate in the study, she was allowed to enroll in the intervention program of her choice. When the total number of a particular group reached the target of 65 subjects, the group was closed.

After the initial assessment, and the initiation of the intervention program, each female was followed every two weeks for a total period of six weeks. Such duration would illustrate the short term impact of the different interventions. During each visit the same set of anthropometric measurement were made. During the second visit the food intake of each subject was determined using a 24 hr recall method. The assessment of food intake was made during the second week to avoid the irregularities in food intake that could have happened during the early phase of the study and would reflects the diet consumed throughout of the study. The data were analysed using the Egyptian food composition table issued by the National Nutrition Institute (2006). Daily caloric intake was calculated and the intake from protein, carbohydrate and fat was estimated and expressed as gram intake per day. The nature of the fat consumed whether saturated or unsaturated was determined by calculating the intake of different types of fats. The intake from some micronutrients including calcium, iron, sodium, vitamins A and C was determined. The study was carried out during the period from January to December 2015.

The data was entered and verified for errors and data analysis was done using PC with IBM SPSS Statistics version 21.0. The 0.05 level was used as the cut off value for statistical significance and the following statistical measures were used. Counts and percentages, which were used for describing and summarising qualitative data, Arithmetic

mean ($\overline{X}$), Standard Deviation (SD) were used as measures of central tendency and dispersion, respectively for quantitative data. The Chi square (χ^2) was used to test the association between two qualitative variables or to detect difference between two or more proportions. Kruskal Wallis test was used for comparing more than two independent quantitative variables. The data was tested for normality using Kolmogorov-Smirnov *Z* test. The data showed to be mostly skewed, consequently the Wilcoxon signed rank *Z* test was used for the comparison between measurements made during the initial and the final visits.

The study plan and the various intervention measures applied in the study were approved by the ethics committee of the High Institute of Public Health, Alexandria University. Ethically no subject was forced to participate in the study, all participants were allowed to select the intervention measure freely after briefing them about the four available interventions. Females were allowed to call the author whenever they have any inquiry regarding their case. In additions females were informed regularly about the change in their body weight and fat.

Table 1 Socio-demographic characteristics of adult females enrolled in different interventions to lose weight

Sociodemographic characteristics	*Type of Intervention*								*Total (n = 260)*		*Test of significance*	
	Diet only (n = 65)		*Diet and exercise (n = 65)*		*Diet and medication (n = 65)*		*Diet and education (n = 65)*					
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	χ^2	*p*
Age in years												
20	21	32.3	25	38.5	5	7.7	20	30.8	71	27.3		
30	13	20.0	10	15.4	20	30.8	12	18.5	55	21.2		
40	7	10.8	17	26.2	19	29.2	15	23.1	58	22.3	26.33	0.002
50–60	24	36.9	13	20.0	21	32.3	18	27.7	76	29.2		
Mean ± SD	39.43 ± 13.61		36.38 ± 12.55		43.12 ± 8.87		38.82 ± 13.08		39.44 ± 12.34			
Education												
Primary/ Preparatory/ Secondary	14	21.5	15	23.1	13	20.0	11	16.9	53	20.4	0.83	0.842
University	51	78.5	50	76.9	52	80.0	54	83.1	207	79.6		
Employment												
House wife	24	36.9	19	29.2	31	47.7	26	40.0	100	38.5		
Employed	28	43.1	32	49.2	33	50.8	24	36.9	117	45.0	16.67	0.011
Student	13	20.0	14	21.5	1	1.5	15	23.1	43	16.5		
Nature of work												
Not Working	37	56.9	33	50.8	32	49.2	41	63.1	143	55.0		
Office Work	24	36.9	24	36.9	18	27.7	9	13.8	75	28.8	17.94	0.006
Technical work	4	6.2	8	12.3	15	23.1	15	23.1	42	16.2		
Marital Status												
Single	22	33.8	21	32.3	4	6.2	23	35.4	70	26.9		
Married	34	52.3	41	63.1	55	84.6	41	63.1	171	65.8	27.18	0.000
Divorced/ Widowed	9	13.8	3	4.6	6	9.2	1	1.5	19	7.3		

RESULTS

The socio-demographic characteristics of obese adult females following different intervention measures to lose weight are presented in Table 1. The age of the females varied significantly between intervention groups ($X^2 = 26.33$, $P = 0.002$). The mean age of females who selected diet and exercise ($\overline{X} = 36.38 \pm 12.55$ years) was significantly lower than that of the diet and medicine group ($\overline{X} = 43.12 \pm 8.87$ years). The mean age of the diet and education group was 38.82 years which was slightly lower than that of the group who followed a diet regime ($\overline{X} = 39.43 \pm 13.61$ years). The results also show that the largest proportion of the females who selected diet and exercise (38.5%) was younger than 30 years while the largest proportion of females (36.9%) who selected dieting only were older than 50 years.

The data indicate that the education of the selected sample did not have a significant effect on the intervention measure followed to lose weight. The largest proportion of the sample (79.6%) were university graduates while only 20.4% had lower level of education, such difference in educational level did not affect the intervention measure selected to lose weight. Dieting with either education or exercise was more frequently selected by students, 23.1% and 21.5%, respectively. The employment status of the females had a significant effect on the selection of the intervention measure followed, ($X^2 = 16.67$, $P = 0.011$). House wives and employed females preferred to follow a diet and medication regimes, 47.7% and 50.8%, respectively. On the other hand, dieting with either education or exercise was more frequently selected by students, 23.1% and 21.5%, respectively. Employment of the females also had a significant impact on the intervention measure selected ($X^2 = 17.984$, $P = 0.006$). The results show that the majority (63.1%) of the non-working females preferred dieting and education, while those having office work evenly preferred either dieting or dieting and exercise regimen. Females having a technical gob were more likely to follow dieting with either medication or education (23.1%). The data also show that a diet and education was the preferred regimen by single females, dieting and medication was more frequently selected by married females while divorced or widowed females were more likely to follow dieting only.

Table 2 presents the mean daily caloric intake and the consumption from different macro and micronutrients by females following different interventions to lose weight. The results show that the mean daily caloric intake was least by females following dieting with either exercise or education, 1233.6 and 1275.3 calories, respectively. This was significantly lower ($F = 4.29$, $P = 0.006$) than the caloric intake by the diet only group (1445.6 Calories) or the diet and medication group (1429.4 Calories). This was reflected on a significant variation in the consumption of protein ($F = 3.55$, $P = 0.015$) and carbohydrate ($F = 3.29$, $P = 0.021$) as the consumption of both nutrients was higher in the last two groups. The same trend was also noted in the significant variation in the consumption of both calcium and sodium while the consumption of other nutrients did not show any significant variation. It was also noted that the mean daily consumption of fat was least by the diet and exercise group (45.06 g/day) and highest by the diet only group (53.67 g/day), however the difference was not statistically significant.

The mean change in body weight of obese females following different interventions to lose weight is illustrated in Table 3. The results show that the mean initial body weight was significantly different between groups. The least body weight was recorded among the diet and education group (84.23 kg), increased to 85.57 kg among the diet and exercise group and was significantly higher among the diet only group (90.95 kg) and was highest among females following a diet and medication regimen (96.29 kg). The results show that the mean loss in body weight varied significantly between groups. The largest weight loss was noted in the diet and exercise group (8.4%), ($Z = 6.99$, $P = 0.000$) followed by the diet end education group (6.84%), ($Z = 7.01$, $P = 0.000$). The least loss in body weight was recorded among the diet and medication group (5.2%), however, such loss was statistically significant, $Z = 6.91$, $P = 0.000$).The results also show that the weekly weight loss varied between groups. The diet only group recorded the highest loss (1.94 kg) during the first two weeks, a similar large weight loss was recorded during the first two weeks in the diet and medication group (2.11 kg). The largest weight loss was recorded in the diet and exercise group between two and four weeks (3.13 kg) followed by the diet end education group (2.61 kg) over the

Table 2 Mean daily caloric intake and consumption from different macro and micronutrients by females following different intervention measures to lose weight

	Type of Intervention				*Test of Significance*	
	Diet only (n = 65)	*Diet and exercise (n = 65)*	*Diet and medication (n = 65)*	*Diet and education (n = 65)*		
	Mean ± SD	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*F*	*p*
Energy Kcal	1445.60 ± 445.14	1235.59 ± 369.39	1429.39 ± 480.71	1275.28 ± 349.48	4.29	0.006
Protein (g)	57.06 ± 26.06	49.96 ± 22.15	55.13 ± 25.38	44.82 ± 20.13	3.55	0.015
Carbohydrate (g)	196.40 ± 61.68	162.41 ± 51.16	190.97 ± 65.30	181.19 ± 83.41	3.29	0.021
Dietary Fiber (g)	16.37 ± 7.77	15.05 ± 7.93	17.88 ± 8.13	16.49 ± 7.71	1.40	0.244
Fat (g)	53.67 ± 25.07	45.06 ± 20.06	51.46 ± 26.11	47.46 ± 24.29	1.70	0.168
Saturated (g)	18.11 ± 8.77	16.07 ± 7.83	16.73 ± 7.61	15.27 ± 7.03	1.54	0.205
Monounsaturated (g)	15.08 ± 9.81	13.57 ± 6.65	15.55 ± 9.92	15.00 ± 8.45	0.62	0.604
PUFA (g)	7.99 ± 6.78	5.98 ± 5.40	8.23 ± 8.20	9.04 ± 9.69	1.85	0.138
Cholesterol (mg)	162.28 ± 150.39	157.65 ± 133.19	146.36 ± 117.60	113.78 ± 111.59	1.87	0.136
Calcium (mg)	714.69 ± 347.35	606.45 ± 299.51	751.54 ± 399.16	622.66 ± 295.79	2.82	0.040
Iron (mg)	11.74 ± 7.37	10.04 ± 5.54	10.89 ± 5.03	10.07 ± 5.86	1.18	0.320
Folic Acid	218.53 ± 171.24	224.94 ± 230.52	169.31 ± 70.93	209.59 ± 226.24	1.17	0.321
Sodium (mg)	2293.67 ± 788.70	2032.63 ± 859.14	2418.79 ± 1060.28	2068.37 ± 666.26	3.02	0.030
Vitamin A (IU)	380.27 ± 289.80	368.03 ± 275.01	378.42 ± 275.98	330.42 ± 212.55	0.50	0.684
Vitamin C (mg)	58.50 ± 64.91	72.51 ± 75.38	65.02 ± 59.66	68.09 ± 83.39	0.44	0.724

same period of time. The results also show that the weight loss between four and six weeks was lower when compared with weight loss during the first four weeks in all groups.

The change in the mean BMI over the study period is presented in Table 4. The initial BMI was highest among the diet and medication group (38.05 + 6.04) followed by the diet only group (35.52 + 7.81), was lower to 33.83 + 7.16 and 32.66 + 6.08 among the groups following diet with either education or exercise regimen, the differences were statistically significant (X^2 = 57.97, P = 0.000). The percent reduction in the BMI varied significantly between groups. The largest drop in BMI was recorded in the groups that followed diet with either exercise or education, 8.42% and 8.12%, respectively. The least reduction in BMI was noted in the diet and medication group (5.20%) followed by the diet only group (5.41%), the differences were statistically significant. As

Table 3 Mean change in body weight of obese adult females following different intervention measures to lose weight

Intervention	Initial	Change in body weight during follow up period					Z test between initial and final Body weight
		Week 2	Week 4	Week 6	Total weight loss (kg)	Percent change	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	(%)	
Diet only ($n = 65$)	90.95 ± 22.52 [a]	89.04 ± 21.45[a]	87.93 ± 21.68[a]	86.03 ± 21.13[a]	−4.92 ± 2.65[a]	−5.40 ± 2.61[a]	$Z = 6.84$ $P = 0.000$
Diet and exercise ($n = 65$)	85.57 ± 16.42[ab]	83.26 ± 16.97[ab]	80.13 ± 16.13[ab]	78.83 ± 15.47[ab]	−7.19 ± 3.49[b]	−8.40 ± 3.42[b]	$Z = 6.99$ $P = 0.000$
Diet and medication ($n = 65$)	96.29 ± 16.77[ac]	94.18 ± 17.31[ac]	92.96 ± 16.23[ac]	91.28 ± 15.93[ac]	−5.01 ± 2.29[ac]	−5.20 ± 2.31[ac]	$Z = 6.91$ $P = 0.000$
Diet and education ($n = 65$)	84.23 ± 20.85[abd]	81.72 ± 19.92[b]	79.11 ± 19.57[bd]	77.38 ± 18.98[bd]	−6.85 ± 3.30[bd]	−6.84 ± 3.28[d]	$Z = 7.01$ $P = 0.000$
Kruskal Wallis χ^2, p	28.99 0.000	52.18 0.000	46.38 0.000	52.18 0.000	52.18 0.000	54.01 0.000	

[a,b,c,d]All means without a common superscript differ significantly at $p < 0.05$.

Table 4 Mean and percent reduction in BMI of females following different intervention measures to lose weight

Intervention	Initial	Change in BMI during follow up period					Z test between initial and final BMI
		Week 2	Week 4	Week 6	Total	Percent change	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	(%)	
Diet only ($n = 65$)	35.52 ± 7.81[a]	34.78 ± 0.55[a]	34.34 ± 0.60[a]	33.60 ± 0.86[a]	−1.92 ± 1.45[a]	−5.41 ± 2.57[a]	$Z = 6.85$ $P = 0.000$
Diet and exercise ($n = 65$)	32.66 ± 6.08[ab]	31.77 ± 1.9[b]	30.58 ± 0.85[b]	29.91 ± 0.88[b]	−2.75 ± 0.90[b]	−8.42 ± 3.16[b]	$Z = 7.00$ $P = 0.000$
Diet and medication ($n = 65$)	38.05 ± 6.04[ac]	37.23 ± 0.35[c]	36.74 ± 0.51[c]	36.07 ± 1.02[c]	−1.98 ± 0.70[ac]	−5.20 ± 2.23[ac]	$Z = 6.90$ $P = 0.000$
Diet and education ($n = 65$)	33.83 ± 7.16a[bd]	32.82 ± 0.94[bd]	31.77 ± 1.06[d]	31.08 ± 1.01[d]	−2.75 ± 1.12[bd]	−8.12 ± 3.11[bd]	$Z = 7.01$ $P = 0.000$
Kruskal Wallis χ^2, p	57.97 0.000	228.01 0.000	228.38 0.000	228.38 0.000	47.84 0.000	56.05 0.000	

[a,b,c,d]All means without a common superscript differ significantly at $p < 0.05$.

noted with the reduction in body weight, the least drop in BMI was observed between four and six weeks in all groups.

The waist circumference of all studied groups was high but was highest among the diet and medication group ($\overline{X} = 105.02$ cm), and was significantly lower to 94.12 cm in the diet and exercise group ($\overline{X} = 95.64, P = 0.000$). By the end of the trial period all groups recorded a significant reduction in waist circumference. The most significant drop was recorded among the diet and exercise group (8.62%) which was slightly but insignificantly higher than that recorded in the diet and medication group (7.99%). The diet and medication group and the diet only group recorded a lower reduction in waist circumference, 5.33% and 5.37%, respectively which was significantly lower than that reported in the other two groups (Table 5).

The change in the mean body fat percent of the obese females following different interventions is shown in Table 6. As was observed with other anthropometric measurements, the mean body fat percent was significantly higher among the diet and medication group (42.26%) while the least body fat percent was recorded among the diet and education group (34.57%) that was slightly but insignificantly lower than that reported for the diet only group (35.13%). Throughout the trial period all investigated groups showed a gradual decline in body fat percent. However, the rate of loss varied significantly between groups.

The highest reduction in body fat percent was recorded in the diet and exercise group (8.14%), slightly but insignificantly lower to 7.98% among the diet and education group. The lease reduction in body fat was reported among females following a diet and medication regimen (5.01%) which was comparable to the reduction in the body fat in the group that followed a low calorie diet (5.22%).

DISCUSSION

The prevalence of overweight and obesity among adult females in Egypt is escalating and is expected to increase in the Future. The risk of being overweight or obese is associated with long term ill health and reduced life quality. Jakicic et al. (2001), recommended that effective weight loss strategies be developed. Lowe et al. (2008) and Heshka et al. (2003) reported that healthy and sustained weight loss relies on consuming a balanced hypocaloric diet, engaging in regular physical activity and employing a cognitive skills and a supportive environment to maintain a healthy life style. The results of this study presents

Table 5 Mean and percent change in waist circumference of obese adult females following different intervention measures to lose weight

Intervention	*Initial*	*Change in waist circumference (cm) during follow up period*					*Z test between initial and final WC*
		Week 2	*Week 4*	*Week 6*	*Total*	*Percent change*	
	Mean ± SD	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*%*	
Diet only ($n = 65$)	99.71 ± 15.63[a]	97.82 ± 15.21[a]	95.30 ± 14.91[a]	94.36 ± 154.76[a]	−5.35 ± 2.66[a]	−5.37 ± 2.64[a]	$Z = 6.91$ $P = 0.000$
Diet and exercise ($n = 65$)	94.12 ± 11.50[ab]	91.56 ± 10.98[b]	89.97 ± 10.29[ab]	86.01 ± 9.71[ab]	−8.11 ± 3.01[b]	−8.62 ± 2.78[b]	$Z = 7.01$ $P = 0.000$
Diet and medication ($n = 65$)	105.02 ± 11.65[ac]	102.73 ± 10.71[c]	100.81 ± 10.64[c]	99.42 ± 10.65[ac]	−5.60 ± 2.52[ac]	−5.33 ± 2.31[ac]	$Z = 6.92$ $P = 0.000$
Diet and education ($n = 65$)	95.64 ± 13.20[abd]	92.77 ± 11.99[bd]	89.91 ± 11.01[bd]	87.99 ± 10.81[bd]	−7.65 ± 3.91[bd]	−7.99 ± 4.12[bd]	$Z = 6.96$ $P = 0.000$
Kruskal Wallis χ^2, p	52.18 0.000	60.17 0.000	54.93 0.000	55.14 0.000	53.09 0.000	50.09 0.000	

[a,b,c,d]All means without a common superscript differ significantly at $p < 0.05$.

Table 6 Mean and percent change in body fat percent of obese adult females following different intervention measures to lose weight

Intervention	*Initial*	*Change in body fat percent during follow up period*					*Z test between Initial and final BFP*
		Week 2	*Week 4*	*Week 6*	*Total*	*Percent*	
	Mean ± SD	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*	*%*	
Diet only ($n = 65$)	37.95 ± 12.90[a]	37.19 ± 11.71[a]	36.75 ± 12.13[a]	35.97 ± 1.16[a]	−1.98 ± 0.90[a]	−5.22 ± 2.94[a]	$Z = 6.76$ $P = 0.000$
Diet and exercise ($n = 65$)	35.13 ± 10.31[ab]	34.18 ± 10.27[ab]	33.28 ± 9.98[ab]	32.27 ± 9.93[ab]	−2.86 ± 0.96[b]	−8.14 ± 3.45[b]	$Z = 7.01$ $P = 0.000$
Diet and medication ($n = 65$)	42.26 ± 11.23[ac]	41.432 ± 11.52[ac]	40.69 ± 11.61[ac]	40.14 ± 11.14[ac]	−2.12 ± 1.14[ac]	−5.01 ± 2.26[ac]	$Z = 6.90$ $P = 0.000$
Diet and education ($n = 65$)	34.57 ± 12.11[abd]	33.37 ± 11.62[abd]	32.79 ± 11.50[abd]	31.81 ± 11.41[abd]	−2.76 ± 1.10[bd]	−7.98 ± 3.18[bd]	$Z = 6.96$ $P = 0.000$
Kruskal Wallis χ^2, p	52.18 0.000	52.17 0.000	52.18 0.000	18.14 0.000	46.38 0.000	47.84 0.000	

[a,b,c,d]All means without a common superscript differ significantly at $p < 0.05$.

the outcome of several short term interventions on body weight and fats of obese adult females and the factors affecting the selection the type of intervention. The data show that the age of obese adult females had a significant effect on the choice of the intervention measure followed to lose weight. Older females preferred to follow a low calorie diet or a diet and medication regimens, 36.9% and 32.3%, respectively. Diet and exercise was the preferred choice by females younger than 30 years of age (38.5%). It is evident that young females have the energy required to enroll in a physical exercise program contrary to the limited proportion of females older than 60 years who selected to follow such regimen (20.0%). This may be also attributed to other factors such as the health status of older females that may prevent them from enrolling in such a program. The rate of the selection of the diet and education regimen varied with the age of the females.

The data show that the level of education did not affect the choice of weight loosing regimen, this may be attributed to the nature of the sample of the study who were mostly university graduates (78.5%). On the other hand, the results show that both employment and its nature had a significant effect on their choice. Students who were mostly from the younger age group preferred a diet with either education or exercise regimen (23.1% and 21.5%, respectively) while only 1.5% preferred a diet and medication regimen, the latter was the regimen of choice for both the housewives and the employed females (Table 1). The nature of the work also affected the choice of the regimen. Those employed in an office work that involves minimum physical effort preferred a low calorie diet only or a diet and exercise regimen (36.9%), while those involved in a technical work that requires more physical activity during the working hours equally preferred a low calorie diet accompanied with either medication or education (23.1%). Lleras-Muney (2005) concluded that education has a positive impact on health and well-being. Previously, Cawley (2004) reported that obesity is associated with both wages and employment particularly for women. The results also show that diet and medication regimen was mostly preferred by married females who usually do not have enough time to enroll in an exercise or education program (84.6%). Single females who are mostly younger in age were the least group to follow a diet and medication regimen (6.2%).

The results presented in Table 2 show that the daily caloric intake of all groups was relatively low and did not exceed 1445 calories suggesting a strong compliance with the prescribed diet,

however, significant variation was observed between groups. The data show that the education program led to a significant reduction in the caloric intake when compared with the other groups ($F = 4.29$, $P = 0.006$), however, it was also noted that obese females who were more keen to lose weight by following both a low caloric diet and exercise recorded the least caloric intake during the study period (1235 Cal/day). Those who relied on low caloric intake with or without medication reported a significantly higher daily caloric intake. The difference in the caloric intake was reflected on the intake from some nutrients such as protein, carbohydrate and sodium intake which followed a pattern similar to that of the caloric intake, however, the intake from other nutrients was not significantly modified. This may be related to the nature and composition of the diet consumed by members of each group. The results confirm the importance of education in controlling caloric intake which is consistent with those reported by Sánchez-Vaznaugh et al. (2009) and Arendt (2004).

The results presented in Table 3 show that the initial body weight of the different groups varied significantly. The data show that females with the heaviest body weight (96.29 kg), selected the diet and medication intervention. They believed that using medication would accelerate body weight loss especially when accompanied by dieting. Dieting associated with either education or exercise were selected by females with lower body weight. We cannot exclude the fact heavy body weight may represent a serious obstacle for the female to practice physical exercise especially females from the older age group who may have a knee or other joint problems.

The results show that the body weight of females from all groups decreased significantly by the end of the trial. However, the percent loss in body weight varied significantly between groups. The largest drop was recorded in the diet and exercise group (8.40%) followed by the diet and education group (6.84%). A comparable but lower reduction in body weight (slightly above 5.2%) was recorded in the groups following a diet regimen only or when associated with medication intake. This may be explained by the fact that the caloric intake of both groups was relatively high. In addition, Stiegler and Cunliffe (2006), confirmed that practicing physical exercise will lead to excess energy expenditure which will ultimately leads to a higher loss in body weight. The data also indicate that the education program was effective in convincing the subjects to reduce their caloric intake which led to a large loss in body weight. The results also show that weight loss during the first two weeks was highest and declined by time to the extent that the least weight loss was recorded during the last two weeks of the trial. This is due to the loss of enthusiasm by the participants which may reduce their adherence to the program or the changes in metabolism leading to the adaptation to the low caloric intake.

The results presented in Table 4 show that the extent of body weight loss was reflected on the change in the BMI. The highest percent loss was recorded among the group that followed a regimen of dieting accompanied with either exercise or education, 8.42% and 8.12%, respectively. This was significantly higher than that recorded by females following a dieting regimen only (5.41%) or when accompanied by intake of weight lowering medicine (5.20%). The difference in the percent reduction of the BMI between the last two groups was not significant and suggesting that the intake of medication did not increase the rate of weight loss. The lack of change may be attributed to the assumption that when obese females believed that medicine intake will accelerate weight loss and hence did not stick completely to the prescribed diet. The lack of the synergistic effect of medicine intake may be also related to the nature of the drug used in this trial 'Orlistat' which reduces the absorption of the dietary fat by 30%. And since the prescribed diet was a low fat diet, the effect of the medicine intake was not significant.

The association between body weight or BMI and body fat percent was previously reported by Millstein (2014), however, there were discrepancies in the degree of significance between measures. the results of this study show that the body weight loss was associated with a significant reduction in waist circumference and abdominal fat (Table 5). The highest reduction in waist circumference was recorded among obese females following a dieting and exercise regimen (8.62%), slightly lower in the education group and was significantly but

significantly lower in the groups following either only dieting regimen or when accompanied by medicine intake (5.37–5.33%). The results clearly illustrate the importance of including physical exercise as an integral part of any program, not only for the sake of weight loss but also to reduce the abdominal fat.

Body fat is best captured by measures other than weight and BMI. Measuring percent body fat as a part of weight loss intervention is a common but not a universal practice. Since body fat is the most metabolically harmful tissue type, it is very important to measure percent body fat rather than or in addition to weight or BMI. The reduction in the abdominal fat will have a clear health benefit and in the mean time improve the physical configuration of the obese female. The results presented in Table 6 show that the group that followed a dieting and medication regimen had the highest initial body fat percent (42.26%) and recorded the least loss in percent in body fat (5.01%). On the contrary, the initial body fat percent of the dieting and exercise group was significantly lower (35.13%) but recorded the largest decrease in body fat percent (8.14%). The results also show that the rate of loss of body fat was consistent over the study period among members of the latter group and showed a significant decline during the last two weeks of the trial when compared with the other groups who recorded a limited loss in body fat during the last period of the trial. It is clear that the gradual loss in body weight and fat and the improvement in the configuration of the obese females represent a strong motive to encourage them to stick to the weight losing regimen.

The results show that the dieting and education intervention group came second in the order of loss in body weight and fat. They consumed less calories (1275 Calories) than the prescribed diet. Unlike other interventions, education will induce behavioural modification in the dietary pattern of the subjects which may have a long lasting effect. The impact of other interventions such as exercise or intake of medicine will be reduced gradually once the intervention is terminated.

The results of this study confirms that, in the short term, physical exercise and education in addition to the consumption of a low calorie diet are effective in achieving the objective of the weight losing regimen when compared with other intervention. However, a long term study is needed to evaluate the medium and long term impact of the investigated intervention measures. Truby et al. (2006) studying the effectiveness of four commercial weight loss diets reported that all diets resulted in significant body fat and weight loss over six months without significant difference between groups. Future studies are also needed to investigate the effect of varying combinations of diets which restrict energy intake and various levels of exercise over a longer period of time to evaluate the efficacy of those interventions on body weight and fat.

None of the authors have any conflict of interest to declare.

REFERENCES

Akers, J., Estabrooks, P.A. and Davy, B.M. (2010) 'Translational research: bridging the gap between long term weight loss maintenance research and practice', *Journal of the American Dietetic Association*, Vol. 110, No. 10, pp.1511–1522.

Arendt, J.N. (2004) 'Does education cause better health? A panel data analysis using school reforms for identification', *Economics of Education Review*, Vol. 24, No. 2, pp.149–160.

Asfaw, A. (2007) 'Micronutrient deficiency and the prevalence of mothers' weight/obesity in Egypt', *Economics and Human Biology*, Vol. 5, pp.471–483.

Cawley, J. (2004) 'The impact of Obesity on Wages', *Journal of Human Resources*, Vol. 39, pp.451–474.

Devaux, M., Sassi, F., Church, M. and Borgonoi, F. (2011) 'Exploring the relationship between education and obesity', *OECD Journal Economic Studies*, Vol. 11, pp.122–159.

Egypt demographic and health survey (2014) *Ministry of Health and Population Cairo*, Egypt.

Ernst, E. (2003) 'Adulteration of Chinese herbal medicines with synthetic drugs; a systematic review', *Journal of Internal Medicine*, Vol. 252, pp.107–113.

Ezzat, S. (2014) 'Factors affecting the development of dyslipidemia among overweight and obese adult females', *Australian Journal of Basic and Applied Sciences*, Vol. 8, No. 18, pp.217–226.

Finer, N. (2002) 'Sibutramine: Its mode of action and efficacy', *International Journal of Obesity*, Vol. 26, (Suppl. 4), pp.S29–S33.

Galal, O. (2002) 'The nutrition transition in Egypt: Obesity, under nutrition and the food consumption context', *Public Health Nutrition*, Vol. 5, pp.141–146.

Gibson, R.S. (2005) *Principles of Nutrition Assessment*, 2nd Edition, Oxford University Press, p.28.

Harrington, M., Gibson, S. and Cottrell, R.C. (2009) 'A review and meta analysis of the effect weight loss on all-cause mortality risk', *Nutrition Research Review*, Vol. 22, No. 1, pp.93–103.

Heshka, S., Greenway, F., Anderson, J.W., Atkinson, R.L., Hill, J.O., Phinney, S., Kolotkin, R.L., Milter-Kovach, K. and Pi-Sunyer, X. (2003) 'Weight loss with self help compared with a structured commercial program: a randomized controlled trail', *Journal of the American Medical Association*, Vol. 289, No. 14, pp.1792–1798.

Jakicic, J.M., Clark, K., Coleman, E., Donnelly, J.E., Foreyt, J., Melanson, E. and Volek, S. (2001) 'Appropriate intervention strategies for weight loss and prevalence of weight regimen in adults', *Medicine and Science in Sport and Exercise*, Vol. 33, pp.2145–2156.

Jung, J., Clausen, M.H. and Weinmann, W. (2006) 'Anorectic sibutramine detected in Chinese herbal drug for weight loss', *Forensic Science International*, Vol. 161, pp.221–222.

Kelley, D.E., Kuller, L.H., Mckolanis, T., Harper, P., Mancino, J. and Kalhan, S. (2004) 'Effects of moderate weight loss and orlistat on insulin resistance, regional adiposity and fatty acids in type 2 diabetes', *Diabetes Care*, Vol. 27, pp.33–40.

Lee, L., Kumar, S. and Leong, L.C. (1994) 'The impact of five month basic military training on the body weight and body fat of 197 moderately to severely obese Singaporean males aged 17 to 19 years', *International Journal of Obesity and Related Metabolic Disorders*, Vol. 18, No. 2, pp.105–109.

Lleras-Muney, A. (2005) 'The relationship between education and mortality in the US', *Review of Economic Studies*, Vol. 72, No. 1, pp.189–221.

Lowe, M.R., Kral, T. and Milter Kovach, K. (2008) 'Weight-loss maintenance 1, 2 and 5 years after successful competition of a weight loss programme', *British Journal of Nutrition*, Vol. 99, No. 4, pp.925–930.

Millstein, R.A. (2014) 'Measuring outcomes in Adult weight loss studies that include diet and physical activity. A systematic review', *Journal of Nutrition and Metabolism*, Vol. 16, pp.1–13.

Narkiewiez, N. (2002) 'Sibutramine and its cardiovascular profile', *International Journal of Obesity*, Vol. 26, (Suppl. 4), pp.S38–S41.

National Nutrition Institute (2006) *Egyptian Food Composition Tables*, Cairo Egypt: MOPH, p.115.

Nguyen, N.T., Magno, C.P. and Lane, K.T. (2008) 'Association of hypertension, diabetes, dyslipidemia and metabolic syndrome with obesity: findings from the national health and nutrition examination survey, 1999 to 2004', *Journal of the American College of Surgeons*, Vol. 207, No. 6, pp.928–934.

Sacks, F.M., Bray, G.A. and Carey, V.J. (2009) 'Comparison of weight loss diets with different compositions of fat, protein and carbohydrates', *New England Journal of Medicine*, Vol. 360, No. 9, pp.859–873.

Sánchez-Vaznaugh, E.J., Kawachi, I., Subramanian, S.V., Sánchez, B.N. and Acevedo-Garcia, D. (2009) 'Do socioeconomic gradients in body mass index vary by race/ethnicity, gender and birthplace?' *American Journal of Epidemiology*, Vol. 169, pp.1102–1112.

Speakman, J.R., Walker, H. and Jackson, D.M. (2005) 'Association between BMI, Social strata and the estimated energy contents of foods', *International Journal of Obesity*, Vol. 29, No. 10, pp.1281–1288.

Stiegler, P. and Cunliffe, A. (2006) 'The role of diet and exercise for the maintenance of fat-free mass and resting metabolic rate during weight loss', *Sports Medicine*, Vol. 36, No. 3, pp.239–262.

Strychar, I. (2006) 'Diet in the management of weight loss', *Canadian Medical Association Journal*, Vol. 174, No. 1, pp.56–63.

Stuart, W. (2013) *Dieting Does Not Work, UCLA Researchers Report*, UCLA Newsroom, UCLA, Vol. 12, pp.12–22.

Sweeney, M.E., Hill, J.O., Heller, P.A., Baney, R. and DiGirolamo, M. (1993) 'Severe vs moderate energy restriction with and without exercise in the treatment of obesity: efficiency of weight loss', *American Journal of Clinical Nutrition*, Vol. 57, pp.127–134.

Tate, F., Jeffery, R.W., Sherwood, N.E. and Wing, R.R. (2007) 'Long-term weight losses associated with prescription of higher physical activity goals. Are higher levels of physical activity protective against weight regain?' *American Journal of Clinical Nutrition*, Vol. 85, No. 4, pp.94–99.

Truby, H., Baic, S., Delooy, A., Fox, K.R., Livingstone, M.B., Logan, C.M., Macdonald, I.A., Morgan, L.M., Taylor, M.A. and Millward, D.J. (2006) 'Randomized controlled trial of four commercial weight loss programmes in the UK: initial findings from the BBC diet trials', *British Medical Journal*, Vol. 332, No. 7553, pp.1309–1314.

Volgyi, E., Tylavsky, F.A., Lyytikäinen, A., Suominen, H., Alén, M. and Cheng, S. (2008) 'Assessing body composition with DXA and bioimpedance. Effects of obesity, physical activity and age', *Obesity*, Vol. 16, pp.700–705.

Webbink, D., Martin, N. and Visscher, P.M. (2008) 'Does education reduce the probability of being overweight', *CPB Discussion Paper 102*, CPB Netherlands Bureau for Economic policy analysis.

Wilson, P.W., D'Agostino, R.B., Sullivan, L., Parise, H. and Kannel, W.B. (2002) 'Overweight and obesity as determinants of cardiovascular risk: the Framingham experience', *Archives of Internal Medicine*, Vol. 162, No. 16, p.1867.

World Health Organization, Egypt steps survey (2011–2012) *WHO chronic disease risk factors surveillance 6-3c-1 fact sheet*, WHO Eastern Mediterranean Office.

Yoon, Y.S., OH, S.W. and Park, H.S. (2006) 'Socio-economic status in relation to obesity in Korean adults. A focus on sex differences', *Obesity*, Vol. 14, No. 5, pp.909–919.

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