Management of overweight and obesity in Egyptian school children-An intervention study

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Abstract: Background: Increasing rates of overweight and obesity in children & adolescents in Egypt signal a very alarming trend indicating an urgent need for development of strategies to address this new problem. **Objective:** To examine the individual and combined effects of dietary weight loss and exercise interventions on body mass index (BMI), various lab. parameters &dietary habits. Methods: This longitudinal intervention study was done in 30 randomly selected elementary & secondary schools of two governorates; Cairo & El Behaira. A total of 841 over weight & obese adolescent school children were randomly assigned to either diet modification or diet & exercise program. All Participants were subjected to baseline assessment (weight, height, waist circumference - hemoglobin concentration, fasting blood sugar & lipid profile - dietary intake including "Twenty four-hour recall" method & food frequency questionnaire). The intervention strategy aimed to decrease the energy consumption, adopting healthy eating habits and increase physical activity. All baseline assessments were repeated at 6 and 12 months. **Results:** A total of 718 cases continued 12 months follow up with dropout rate of 14.6 %. The results indicated that 27.9% of our total participants lost 5% or more of their initial body weight after 12 months of follow-up especially among the group who followed diet & exercise regimen. All lab parameters improved significantly by the end of the study. The mean total daily caloric intake, mean total Fat energy ratio & Carbohydrates energy ratio have been significantly decreased by visit 12 especially among the group who followed diet & exercise regimen. Conclusion: Our findings suggest that diet alone can have a beneficial effect on reducing weight; however, a combination of weight loss and regular exercise may provide greater improvement in reducing weight, improving lipid profile & dietary intake on long scale programs.

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1. Introduction

Overweight is considered to be a global epidemic and the marked increase in childhood obesity is alarming. Preventing the development of obesity in school children is therefore a world-wide health priority[**1**]. In developed countries, the prevalence of overweight and obesity in children & adolescents increased by a magnitude of two to five times in the last quarter of the twentieth century[**1-4**]. Not only developed countries but also developing countries are adversely affected[**5,6**]. Obesity and overweight among this age strongly predict the risk for obesity and metabolic syndrome in later adulthood[**7-9**]. In school age children, overweight is an emerging concern in Egypt, increasing rates of overweight and obesity in children & adolescents signal a very alarming trend as seen in the comparison between the two national surveys 2004 and 2001[**10**], indicating an urgent need for Egypt to develop strategies to address this new problem.

As the direct measurement of body fat is difficult, Body Mass Index (BMI), a simple weight to height ratio (kg/m2), is typically used to classify overweight and obese adults. Adult BMI cut-off points cannot be used for assessing children and adolescents, as BMI varies throughout childhood,. BMI-for-age charts, such as those developed by the World Health Organization (WHO), can be used in clinical practice to assess and monitor BMI over time in children. Overweight is defined as BMI between the 85th and 95th percentiles, and obesity as BMI > 95th percentile[**11**]. In children and adolescents, as in adults, waist circumference is strongly correlated with abdominal fat and markers for co morbidities, such as adverse lipid and glucose profiles and hypertension[**12**]. However, there are no internationally accepted criteria for waist circumference in this age group. While reduced energy intake is the major method of losing weight, it has been shown that a high level of physical activity is essential to assist with maintaining weight loss. Irrespective of its impact on weight, physical activity has wider benefits on well-being, including improved cardiovascular fitness [**13**].

Therefore, obesity treatment cornerstones are to reduce energy intake and increase energy expenditure by promoting healthy eating and physical activity, yet approaches to modifying these behaviors among school children on long scale in Egypt are not well investigated[**14**]. Modification of these cornerstones needs to be effective to help this age group in making and sustaining positive lifestyle changes [**15,16**]. We therefore posit that school children provides a unique opportunity to establish lifestyle habits that will promote health and minimize the risk of the development of obesity and longitudinal intervention studies are needed to recommend proper strategies to overcome this problem. The primary aim of this study was to examine the individual and combined effects of dietary weight loss and exercise interventions on the study outcomes (BMI, lab. investigations &dietary habits) by the end of 12 months follow up in overweight & obese 12-18 year-old Egyptian students in order to provide necessary recommendations for proper obesity prevention strategies directed to this age group.

2. Methodology

Ethical considerations

This study is a part of a larger study, that included other age groups, which was carried out in collaboration with Academy of Scientific Research and Technology& Research Unite of Ministry of Health & National Nutrition Institute from 2003-2007. Written informed consent from all participant families was sort prior to their enrolment into the study.

Participants

The data was collected from 30 randomly selected elementary & secondary schools of two representing governorate; Cairo & El Behaira governorates. 841 cases were eligible to continue the study, 617 in Cairo governorate and 224 in Beheira governorate. Eligibility criteria for participants were being overweight & obese, as defined by WHO percentile body mass index "BMI"/age for males and females cut points[**11**]. Exclusion criteria included being extremely obese (BMI *z* score > 4), having syndromal obesity, having a chronic illness, or taking medications associated with weight change. Eligible participants were randomly assigned, stratified by gender and location, to one of the two groups: a diet modification group (DM) & a diet &exercise group (D&E).

The study has no control group in the conventional sense of 'no treatment'. There were two compelling reasons for this: (i) every overweight or obese adolescent participant is deserving of an intervention and is unlikely to remain at a stable level of overweight, providing a strong ethical case against a non-intervention control group; and (ii) extensive recent publicity related to childhood obesity has markedly increased awareness [**17**] and 'no intervention' is likely to be unacceptable to participants,potentially resulting in poor retention and follow-up, thus compromising the study integrity.

Anthropometric measurements

Weight is measured with the adolescent barefoot and wearing light clothing, using platform Bath room Scale to 0.1 kg. Height is measured to 0.1 cm using the Raven Minimetre. Non-extensible steel tapes are used to assess waist circumference, which is measured at the level of the midpoint between the lower costal border and the iliac crest. Anthropometric measures are measured according to standardized methods of WHO[**11**] & conducted by a well trained & adjusted staff of National Nutrition Institute.

The WHO percentile body mass index "BMI"/age for males and females charts was used to determine the body status as follows:

Normal weight: 5^{th} - <85^{th} percentile
Overweight: 85^{th} - <95^{th} percentile
Obese: ≥ 95^{th} percentile.

In order to ensure accurate and consistent measurements, the study scales were professionally calibrated once a month & the equipments used at each site were identical.

Metabolic profile measures

Blood is collected after the participants have fasted overnight.A venous blood sample of 5 ml was collected in heparinized tubes from the selected subjects. Blood heamoglobin was immediately determined and the rest of the blood was centrifuged to obtain the plasma. The plasma was divided into aliquots in 5 Eppendorf vials and stored at -20^0C for analysis, according to standardised procedures [**18**].

On each vial the ID and the name of the subject was recorded. With the collected plasma, the following parameters were determined.

Determination of hemoglobin:

According to the kit of Stanbio procedure No. 0320, 0321, 0325. Quantitative colorimetric determination of hemoglobin in the whole blood.

Determination of blood sugar: according to Enzymatic Colorimetric method of **Trinder** [**19**].

Lipid profile

Total cholesterol: **according to Stanbia cholesterol liquicolor. Quantitative Enzymatic–Colorimetric Determination of Stein[20].**

Triglycerides: Serum triglycerides were determined according to the colorimetric method of Fossati and Principe [**21**] using the Biocon enzymatic kit.

Serum HDL-Cholesterol (HDL-C): determined according to the method of **Gordon et al**., [**22**] using Biocon enzymatic kit.

Serum LDL-cholesterol (LDL-C):LDL-C was estimated from total cholesterol concentration after subtracting the measured HDL-C and VLDL-C which was estimated as serum triglycerides divided by 5 according to the method of **Friedewald et al.**, [**23**].

Dietary intake

Methods used for measuring food consumption of the surveyed participants was classified into two major groups [24]. The first group, known as quantitative daily consumption method, consisted of recalls or records designed to measure the quantity of foods and beverages consumed over one day period "Twenty four-hour recall" method. The second group of methods included the dietary pattern and food frequency questionnaire. Adequacy of the diet consumed was assessed by comparing the energy and nutrient intake of the person with his recommended dietary allowances "RDA[25-27]

Statistical analysis:

SPSS was used for data management and analysis and Harvard Graphics package was used for the figures. Quantitative data were summarized as means and standard deviations. Comparisons between two groups means were performed using the students T-test.All reported p-values are two - sided. p- values ≤ 0.05 was considered significant.

Weight change was calculated at the end of the follow-up period according to the following formula;

$$\text{Weight change} = \frac{\text{initial weight - weight after 12 months}}{\text{initial weight}} \times 100$$

Treatment Goals:

The general goals of weight loss and management are to reduce body weight, and prevent further weight gain. According to WHO guidance overweight and obese patients can achieve a weight loss of as much as 10% which would be considered a reasonable individualized goal. 841 cases were eligible to continue the study, 617 in Cairo governorate and 224 in Beheira governorate.

In every visit each individual was subjected to anthropometric measurements (weight, waist, and height). body mass composition was also calculated.

In each visit also the total caloric intake was calculated, at first 500 kcal were reduced from the diet consumed according to WHO guidance [**1**] then in each following visit the basal metabolic rate was measured using the body mass composition balance and each individual is then given accordingly a diet regimen.

Nutrition education was done at two levels the first level was at personal level directed to each individual and help in solving any constrains met in the regimen. In the second level nutrition education was done in groups with the physicians and the dieticians.

All individuals were advised to follow physical activity regimen either by doing it by their own as 30 minutes walking three times a week according to WHO guidance [**1**] or attending the fitness classes at the National Nutrition Institute three times per week.

Follow up Assessments:

All baseline assessments were repeated at 6 months and 12 months, with the exception of the 24 hour recall for food analysis, which was repeated only at 12 months.

3. Results

A total of 718 cases continued the 12 months follow up with dropout rate of 14.6 %. Of these 718 participants randomized to the two study groups (435 in diet group &283 in diet &exercise group), 312 were males & 406 were females.

Anthropometric changes in response to intervention

The percentage decrease in weight was calculated individually and the results of the study revealed that 5.6% of the whole sample their weight did not change, while 66.5% lost less than 5% of their weights, 19.1% lost from 5-10 % of their weight and 8.8% lost more than 10% of their weight. Tables 1&2 illustrated the significant decrease in the mean of the BMI & mean waist in cm respectively among both males &females adolescents by the last visit after 12 months of follow-up especially among the group who followed diet &exercise regimen.

Laboratory changes in response to intervention

Laboratory parameters were done at the sixth visit and at the end of the study. Tables 3& 4 showed that, most of the laboratory parameters done were within the normal range. However, the lipid profile, in males &females obese group, all parameters (TC,LDL,TG)) were significantly decreased by visit 12 except HDL-C showed significant increase. Like obese male adolescents, all the levels of hemoglobin concentration & fasting blood sugar among obese female adolescents in all examined groups were within the normal range however hemoglobin concentration has been improved significantly as illustrated in figures 1& 2 respectively.

Dietary intake in response to intervention

The mean total caloric daily food intake, mean total Fat energy ratio & Carbohydrates energy ratio of daily food intake in the 1st & last visit of the follow-up of overweight & obese males& females adolescents with different regimens followed are shown in figures 3 & 4. Among all the studied groups the dietary figures has been significantly decreased at the end of the study.

4. Discussion

To date, conventional weight management strategies for childhood obesity have only shown at best moderate success short-term [**28**]. Few studies have looked at intervention effects in the medium or long-term [**29**] In this 1-year, longitudinal intervention trial, in which 12-18 year-old obese &overweight school children were enrolled, two behavioral interventions — one involving diet modification & the other involving diet &exercise regimen — achieved clinically relevant weight loss. According to WHO guidance[**1**], overweight and obese patients can achieve a weight loss of as much as 10% which would be considered a reasonable individualized goal. Recent data indicate that that modest (5-10%) weight reduction in obese persons are attainable and result in clinical improvements of several health-related parameters, even if the individual remains clinically obese [**30-35**]. A considerable percentage (27.9%) of our total participants lost 5% or more of their initial body weight, an amount of weight loss that has been associated with numerous health benefits, including a reduced risk of incident diabetes and hypertension, and lower levels of risk factors for cardiovascular disease[**34,36,37**]. The extent of weight loss was similar to that achieved in many efficacy studies[**38-40**]. In contrast with the findings in most weight-loss trials[**41,42**] however, participants sustained weight loss to the end of the trial.

In addition, in our follow up study all anthropometric measurements of obese &overweight adolescents, even their BMI declined. The laboratory parameters showed a lot of improvements. Their mean hemoglobin increased while their mean fasting blood sugar decreased. Also their lipid profile had some changes, as total cholesterol, triglycerides and low density lipoprotein deceased while the high density lipoprotein remain stationary. These changes have a positive impact on their health. Regarding the food intake, their total caloric intake decreased dramatically, even the fat energy ratio decreased**.** It is obvious that physical exercise played an important role in regulating the metabolic profile parameters in our participants as the significant decrease of most of these parameters was more among those who followed diet and exercise regimen.

The association between reduced physical activity and obesity has been well established[**43**]. Recent meta-analysis results suggested that, from a public health perspective, school-based physical activity is important, because of the significant health benefits that have been demonstrated. These include reducing blood pressure, increasing lean muscle mass, increasing bone mineral density, increasing aerobic capacity and improving insulin sensitivity[**44-46**]. It is therefore important to promote school-based physical activity for its demonstrated health benefits, even though there is currently no evidence that it is an effective method to reverse the trend of increasing school children obesity[**47**].

The study described in this paper is one of the first longitudinal trial of its kind in Egypt and important on national level. It incorporates a large sample size; has a 12-month follow-up period, thereby allowing assessment of medium-term program effectiveness; includes several important secondary outcomes (lab measurement, diet quality and food habits) and requires only minimal, readily accessible and inexpensive equipment to assist transferability to community settings. However our trial has some limitations, its duration, although longer than that of many weight-loss trials, was only 1 year. Still, to our knowledge, it is one of the longest trials including two representative governorates in Egypt. The failure to follow up on regular bases & to achieve target weight loss among school aged children was attributed to poor knowledge of parents about healthy diet and obesity complication, unhealthy food items sold at school canteen and the heavy curriculum that prevent the children from practicing physical activity during and after the school hours.In this regard, it would be advisable to encourage healthy habits among children at earlier stages in order to create healthy students; the present study involved children at a stage during which certain habits are difficult to change.

Our results showed that weight reduction was not observed among all individuals, on the contrary some groups showed increase in weight at the end of the intervention in spite of that they followed diet and or exercise regimen. Due to the multi-dimensional nature of obesity, the condition is often described as complex and particularly resistant to treatment. This may be due to the failure, in most situations, to provide the necessary multi-disciplinary support[**47**]. Obesity prevention is a cross-cutting issue that does not naturally fall under one department. It encompasses health concerns central to the mission of MOHP, nutrition, nutrition education, and food-related issues for which the ministry of Agriculture has responsibilities; and school curriculum and school environment concerns that the ministry of Education addresses, in addition numerous other ministries include transportation, housing, and many other issues that are key to increasing physical activity levels and improving dietary quality and patterns.

Finally, Whether or not the study ultimately yields enough positive long-term results, the information provided will allow other research groups to benefit from the collective experience of the study team and facilitate the implementation of well-

designed randomized control trials to address the lack of quality interventions in this important public health issue.

Table (1) Mean BMI change among males& females adolescents in the 1st & last visit of the follow-up according to their weight status & different regimens followed

Weight status	Males		P (t)	Females		P
	V0 (X±SD)	V12 (X±SD)		V0 (X±SD)	V12 (X±SD)	
Over-Weight						
Regimen1	25.3± 4.3	23.7± 3.1	0.024*	26.6± 5.4	26.2± 6.8	0.059
Regimen2	28.2± 6.1	25.3± 5.4	0.022*	26.2± 5.1	23.9± 4.3	0.020*
Obese						
Regimen1	38.2± 6.8	33.4± 5.4	0.062	34.1± 4.3	34.0± 3.1	0.074
Regimen2	39.0± 7.3	30.2± 6.4	0.000**	35.1± 6.7	29.1± 5.9	0.000**

V0=First visit V12=Last visit after 12 months Regimen1=Diet only Regimen2=Diet& exercise

Table (2) Mean waist in cm change among males& females adolescents in the 1st & last visit of the follow-up according to their weight status & different regimens followed

Weight status	Males		P (t)	Females		P
	V0 (X±SD)	V12 (X±SD)		V0 (X±SD)	V12 (X±SD)	
Over-Weight						
Regimen1	81.3± 13.2	77.0± 12.5	0.030*	79.6± 11.4	75.5± 13.4	0.067
Regimen2	87.2± 16.1	84.2± 14.2	0.040*	79.0± 11.1	77.0± 10.3	0.045*
Obese						
Regimen1	96.3± 11.4	89.0± 13.4	0.035*	93.1± 12.7	91.2± 11.4	0.042*
Regimen2	98.0± 11.1	91.1± 10.3	0.000**	90.0± 11.1	81.1± 10.3	0.000**

V0=First visit V12=Last visit after 12 months Regimen1=Diet only Regimen2=Diet& exercise

Table (3) Lipid profile of obese adolescent males initially & in the last visit of the follow-up with diet regimen and or diet& exercise regimen

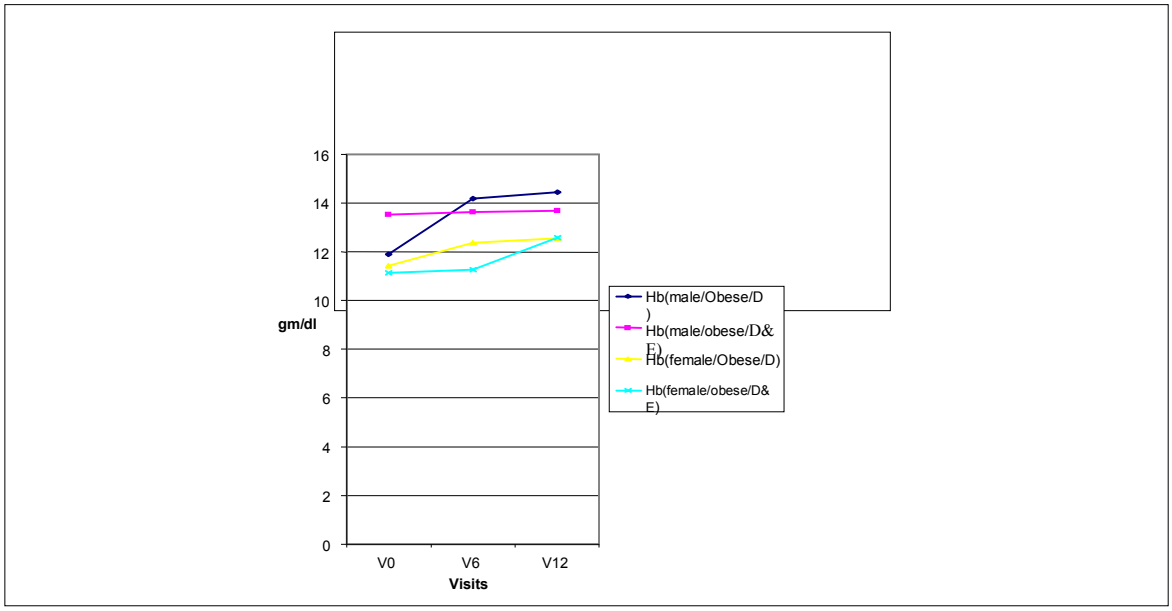
Lipid profile	Regimens	V0(X±SD)	V12(X±SD)	*P*
TCh (mg/dl)	Regimen1	116.5±19.1	147.6±21.1	0.006**
	Regimen2	160.1±34.1	135.4±25.3	0.000**
HDL (mg/dl)	Regimen1	32.7±7.3	49.6±8.2	0.040*
	Regimen2	35.1±6.5	45.2±7.5	0.043*
LDL (mg/dl)	Regimen1	65.6±11.2	89.5±17.3	0.000**
	Regimen2	90.3±20.0	76.7±13.1	0.000**
TGs (mg/dl)	Regimen1	88.0±11.3	85.3±14.1	0.031*
	Regimen2	125.2±10.3	112.6±7.8	0.020*

V0=First visit V12=Last visit after 12 months, X= Mean, SD= Standard deviation
Regimen1=Diet only Regimen2=Diet& exercise HDL=High density lipoprotein
LDL=Low density lipoprotein TCh= Total Cholesterol TGs= Triglycerides
*There is a significant difference between the 2 visits by using paired t-test at $p<0.05$
** =There is a highly significant difference between the 2 visits by using paired t-test at $p<0.01$

Table (4) Lipid profile of obese adolescent females initially & in the last visit of the follow-up with diet regimen and or Diet& exercise regimen

Lipid profile	Regimens	V0(X±SD)	V12(X±SD)	*P*
TCh (mg/dl)	Regimen1	115.2±22.3	147.6±30.1	0.000**
	Regimen2	165.1±15.4	149.2±11.1	0.000**
HDL (mg/dl)	Regimen1	34.1±9.1	40.5±9.3	0.031*
	Regimen2	37.5±6.4	45.0±5.1	0.046*
LDL (mg/dl)	Regimen1	66.7±13.4	91.4±19.4	0.000**
	Regimen2	122.3±10.5	105.1±9.7	0.010*
TGs (mg/dl)	Regimen1	70.6±17.5	74.6±18.7	0.041*
	Regimen2	80.6±9.6	57.4±8.4	0.000**

V0=First visit V12=Last visit after 12 months, X= Mean, SD= Standard deviation
Regimen1=Diet only Regimen2=Diet& exercise HDL=High density lipoprotein
LDL=Low density lipoprotein TCh= Total Cholesterol TGs= Triglycerides
*There is a significant difference between the 2 visits by using paired t-test at $p<0.05$
= **There is a highly significant difference between the 2 visits by using paired t-test at $p<0.01$



Figure(1) Mean hemoglobin concentration of obese adolescent males & females initially and in the last visit of the follow-up with diet &/or exercise regimens

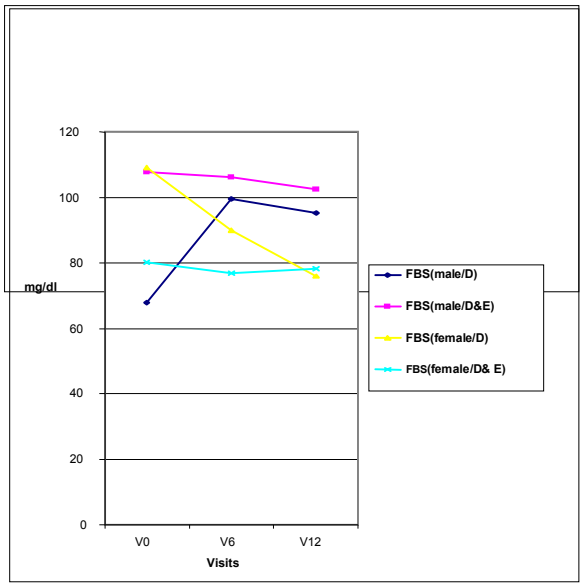


Figure (2) Mean fasting blood sugar levels of obese adolescent males & females initially & in the last visit of the follow-up with diet &/or exercise regimens

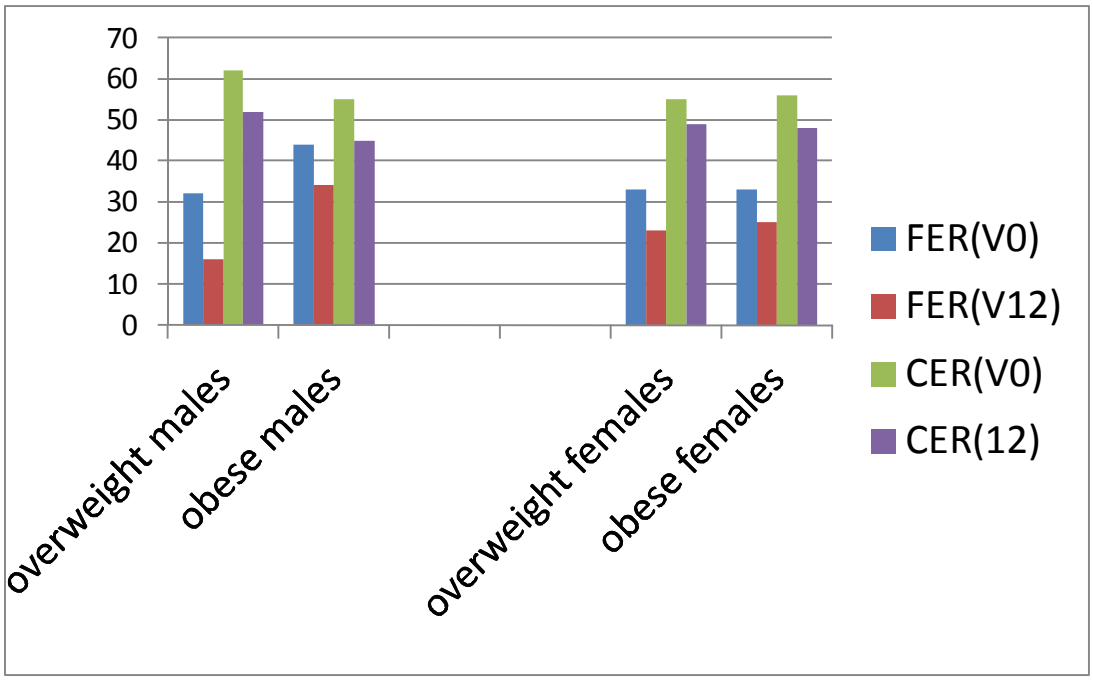


Fig (3) Mean fat energy ratio (FER) & carbohydrate energy ratio (CER) of overweight & obese adolescent males &females in the 1st & last visit of the follow-up with diet & exercise intervention

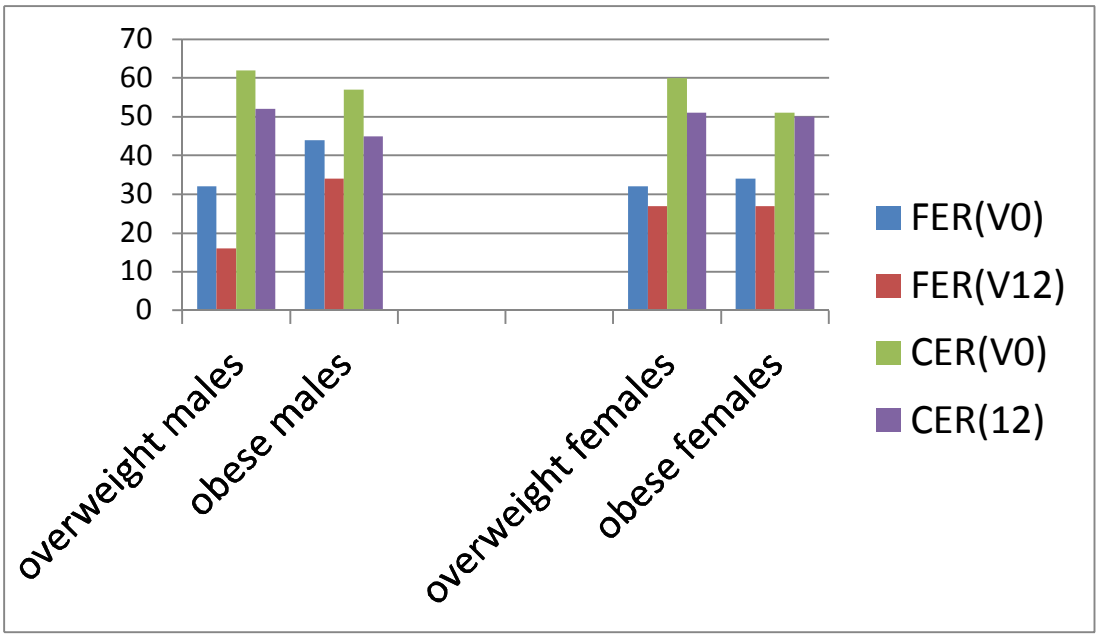


Fig (4) Mean fat energy ratio (FER) & carbohydrate energy ratio (CER) of overweight & obese adolescent males & in the 1st & last visit of the follow-up with diet intervention

5. Conclusion

Our findings suggest that the combination of dietary weight loss and exercise can have a beneficial effect on reducing weight, improving lipid profile & dietary intake on long scale programs. Future obesity prevention research must now move towards identifying how effective intervention components can be embedded within health, education and care systems and achieve long term sustainable impacts. Physical activity should be included and promoted within schools, as it is an important component of a healthy lifestyle and improves many aspects of

health. Effective interventions to overcome adolescent obesity by promoting healthy life style should be pursued, and the school setting is an important setting in which to initiate change.

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