ORIGINAL ARTICLE

IJPHY

AEROBIC INTERVAL EXERCISES VERSUS DIETARY CONTROL INDUCED CHANGES OF ADIPOKINES LEVELS, LIPID PROFILE AND QUALITY OF LIFE IN OVERWEIGHT OR OBESE CHILDREN

[*1]Ragab K. Elnaggar
[2]Mohammed A. Shendy

ABSTRACT

Background: Lately, childhood obesity has gained more attention. The present study constructed to compare the effectiveness of aerobic interval exercises and dietary control on plasma adipokines level, lipid profile and the health-related quality of life in overweight or obese children.

Methods: Thirty-seven overweight or obese children at the age from 10-18 years were recruited and randomly classified into aerobic interval exercises (AIE) and dietary control (DC) groups. The Training load for AIE group was eight weeks of an intermittent short high intense burst of exercises throughout a regular training program primarily consisted of treadmill training. Whereas, subjects in the DC group were engaged in a balanced dietary plan. Plasma adipokines, lipid profile, and the health-related quality of life were assessed before and after the intervention.

Results: Both groups were similar at the baseline ($p>0.05$). Within the AIE group; leptin, adiponectin and all lipid profile measures significantly changed ($p<0.05$). But, within the DC group, only leptin, high-density lipoprotein cholesterol (HDL-Cho) and low-density lipoprotein cholesterol (LDL-Cho) levels have been significantly changed ($p<0.05$). Further, the health-related quality of life (HRQL) indicated significant differences within both groups ($p<0.05$) with regard to both physical and psychosocial health. Finally, significant differences of leptin, HDL-Cho, LDL-Cho levels and the psychosocial health ($p<0.05$) were recorded between both groups in favor of the AIE group.

Conclusion: However, both aerobic interval training and balanced dietary controlare useful to improve plasma adipokines level, lipid profile, and the HRQL in overweight or obese children. But, aerobic interval training is more helpful.

Keywords: Childhood obesity, Aerobic interval exercises, Dietary control, Plasma adipokines, Lipid profile, Health-related quality of life

Received 20th August 2016, revised 02nd September 2016, accepted 06th October 2016

www.ijphy.org

10.15621/ijphy/2016/v3i5/117445

[2]Department of Physical Therapy for Cardiovascular, Respiratory Disorders, and Geriatrics, Faculty of Physical Therapy, Cairo University, Cairo, Egypt.

CORRESPONDING AUTHOR

[*1]Ragab K. Elnaggar

Department of Physical Therapy for Disturbances of Growth and Development in Children and Its Surgery, Faculty of Physical Therapy, Cairo University, Egypt.

INTRODUCTION

Pediatric obesity becomes an increasing worldwide epidemic that needs greater attention because of the burden on children and adolescent health status [1]. High-calorie diets, physical inactivity, and genetic predisposition are the main contributing factors of childhood obesity. Preschool Egyptian children who have a tendency to be overweight account for 8.6 % and the overweight prevalence in boys was likely as equal as in girls [2]. Whereas, the prevalence of overweight among school children and adolescents were found to be approximate as 11.5% for boys and 15.2% for girls, and prevalence of obesity was 6.5 % for boys and 7.7% for girls [3,4]. Overweight children are at risk of large number of diseases that may affect the cardiovascular system (hypertension, hypercholesterolemia, or dyslipidemia), the endocrinal system (diabetes mellitus type II, impairment of glucose tolerance, insulin resistance and disruption of the adipocyte-derived hormones level and function), the musculoskeletal system (Joint pain and arthritis), and the respiratory system (sleep apnea and exercise intolerance and asthma), in addition to the psychosocial and emotional health [5-9].

Adipocytes are the cells that primarily compose the adipose tissue; they are specialized in synthesis and secretion of a number of encoded proteins that have been termed adipocytokines or adipokines [10]. Currently, leptin and adiponectin have been demonstrated as cytokine proteins derived from adipose tissue [11]. Leptin is an adipokine characterized as a satiety peptide [12], it has been implicated in themodulation of the physiological responses that include apatite control and energy homeostasis [13]. Leptin receptors in the hypothalamus detect the level of circulating leptin where it inhibits apatite and regulates food intake [14]. Also, evidence suggested that leptin involved in regulation of the resting metabolic rate, and carbohydrate intake [15]. Energy intake is a determinant of leptin levels as energy restriction and fasting acutely reduces leptin concentration while overfeeding acutely raises the level of circulating leptin [16,17]. Similarly, energy hemostasis controlled by another adipokine solely secreted from adipose tissue known as adiponectin. It is involved in breakdown and oxidation of fatty acids and regulation of glucose levels [18]. Plasma adiponectin levels are inversely related to the circulating levels of fatty acids and percentage of body fats. low levels were associated with higher levels of apatite and increased food intake [14]. On the contrary, concentration of the circulating adiponectin increases during restriction of calorie intake and reduction of fatty acid concentration [19].

However, exercises play an indispensable role in the regulation of hormonal activity at the level of adipose tissue and other major organs of the endocrinal system [20]. Although several studies have been analyzed the effect of exercises on leptin and adiponectin concentration in healthy and overweight adults, it remains controversial whether short or long term exercises or either aerobic or resistive exercises change their circulating levels. Moreover, exercise-induced changes of leptin and adiponectin concentration in healthy or overweight children still unclear. Previous studies suggested that aerobic exercises may reduce leptin level adipose tissue accumulation mostly when associated with loss of weight [14,21], even without dietary control [22]. In addition, chronic exercises have been reported to decrease levels of free fatty acids and increase levels of circulating adiponectin [23]. Also, it has been reported that fasting adiponectin levels acutely increased after a two or three bouts of mild to moderate intensity exercises [24]. Conversely, evidence from healthy normal weight individuals suggested that short-term exercises don't modify leptin concentration levels [25,26]. No alteration of the circulating adiponectin levels following long-term exercises [27,28]. The purpose of this study was to elucidate the effect of an aerobic exercise program with intervals of resistive exercises and dietary control on the circulating leptin and adiponectin levels, lipid profile as well as the quality of life in overweight or obese children. We hypothesized that both aerobic interval exercise and dietary control would significantly produce changes of the plasma adipokines level and lipid profile and subsequently would further improve the HRQL. In addition, it was hypothesized that no difference would be indicated between both interventions

MATERIALS AND METHODS

Subjects: Thirty-seven overweight children were recruited from the National Institute of Nutrition and many private obesity and weight management centers, Cairo, Egypt. Participation approval was formally obtained by signing a consent form by children parents or their legal guardians. Eligibility criteria for participation in this study were: 1) age range from 10-18 years, 2) overweight (body mass index > 25 and < 30 kg/m^2) or obese children (body mass index > 30 and < 35 kg/m^2)[29], 3) children who didn't have history of cardiovascular disorders, 4) children who didn't have any metabolic or endocrinal diseases, 5) children who weren't taking any medication that interfere with metabolism or had an effect on plasma adipokine concentration. Children were assigned to either aerobic interval exercise group (AIE group), or dietary control group (DC group). Simple randomization method through flipping a coin to distribute each child to either of the two alternatives of study interventions. Randomization created a set of 21 children for AIE group and 16 children for the DC group. Preliminary familiarization and explanation of the study protocol were provided for children in both groups.

Anthropometric characteristics: All children have undergone some anthropometric measurements (weight, height, and body mass index) prior to and next to the intervention.

Primary outcome measure: Serum leptin and adiponectin levels were the primary outcomes in the present study. Blood samples were taken from both groups from the antecubital veins (the median cubital vein). Samples were assessed after centrifugation and freezing at -20°C. Automatic ELISSA immunoassay analyzer was used for assessment. Radioimmunoassay (RIA) was used to measure and quantify the serum leptin level and recombinant human gAcrp30/Adiponectin ELISA Kits was used for quantification of serum adiponectin level. Leptin levels were expressed in nanogram/milliliter (ng/mL) while adiponectin levels were expressed in microgram/milliliter (μg/mL).

Secondary outcome measure: lipid profile was the secondary outcome. In addition to the aforementioned laboratory assessments, assays for total cholesterol (T-Cho), high-density lipoprotein (HDL-Cho), low-density lipoprotein (LDL-Cho) and triglycerides (TGs) levels were applied for all children before and after the intervention.

Tertiary outcome measure: The health-related quality of life (HRQL) was the third set of measurement. Pediatric Quality of life Inventory (PedsQL™4.0 Generic Core Scales) was used. It is a short modular approach for measurement of HRQL in healthy children and adolescents whose ages ranges from 2-18 years as well as those who have acute or chronic health problems. It comprises binary child self-report based on their own perception and parent's proxy report based on their observation of their child behavior [30]. The PedsQL inventory is a 23 item instrument distributed under four subscales; 8 items for the physical functioning subscale, 5 items for the social functioning subscales, 5 items for the emotional functioning subscale, and 5 items for the school function. Possible responses for each item are five responses from 0-4 where 0 means "never a problem" and 4 means "always a problem". Revers scores of items linearly converted to a 0-100 scale at which 0=100, 1=75, 2=50, 3=25, and 4=0. So, high scores indicate high HRQL [31]. The mean of the 23 items is a contribution of the total score and the mean of the items of the social, emotional and school functioning subscales give acontribution to the psychosocial health [32]. All participants and their parents independently rated the PedsQL inventory after they were demonstrated about the assessment procedure one week before intervention and few days after completion of the assigned intervention. The total score from both children report and parent's proxy report were used for further analysis.

Aerobic interval exercises: Participants in the AIE group were trained on a treadmill under the supervision of two professional physical therapists for 30 minutes, 3times/week for 2 successive months for a maximum of 24 sessions. Heart rate and blood pressure were continuously monitored throughout the training program and frequent rest intervals for few minutes were allowed if they feel fatigued or critical changes of the vital signs were recorded. The training methods involved a short high intense burst of exercises intermittently throughout the regular training. AIE protocol consisted of 1) three minutes warming up before a work out in the form of static and dynamic stretching exercises, marching on the spot, heal digs, knee lifts, knee bends and shoulder rolls. 2) 12 cycle of interval training for a maximum of 27 minutes. Each cycle consisted of 60 second fast walking at maximum speed followed by 75 seconds slow walking at normal walking pace.

Dietary control: Participants in the DC group were committed to a balanced dietary plan (15% protein, 30 % fats, and 55% carbohydrates and fibers) for 2 months [33]. Upon a recommendation from a clinical nutritionist, they received instructions regarding: 1) Energy intake control; using the plate model, parents were asked to reduce the portion of fats and simple carbohydrates for their children. 2) frequency of meals; they were allowed to have their meals regularly at intervals of about 3-4 hours. 3) food composition; low-fat diet at which vegetable oils, low-fat meat or fish, low-fat milk, high fiber diet (vegetables and fruits), and low sugar products were allowed. 4) water intake; two liters of water, mild juices, and light beverages were recommended. Additionally, no exercises were prescribed for participants in the DC group. But, they were instructed to keep their habitual daily physical activities.

Statistical analysis

All data are presented as means ± standard deviations. Data analysis was performed by using IBM® Statistical Package for the Social Sciences (SPSS) for Windows (Version 23.0. Armonk, NY, USA). Shapiro–Wilk test used for assessment of normality of data. Arithmetic log transformation was applied for the extreme positively or negatively skewed data. Then, normally distributed data or transformed data logs were analyzed within and between groups using paired and unpaired t-test respectively. Whereas, the outcomes of PedsQL inventory were analyzed using non-parametric Wilcoxon signed-rank test within groups and Mann-Whitney U test between groups. Statistical significance was set at ($p<0.05$).

RESULTS

A total of 37 children were recruited for participation in the present study; 21 children for the AIE group and 16 children for the DC group. The demographic and baseline characteristics of both groups are summarized in table 1. The comparison between both groups yielded non-significant differences concerning all measures of demographic characteristics, plasma adipokines level and lipid profile ($p>0.05$).

Table 1: Demographic and baseline characteristics (means ± SD) of both AIE and DC groups.

Variables	AIE group (n=21)	DC group (n=16)	P-value
Demographic characteristics			
Age (years)	15.71 ± 2.19	14.25 ± 3.17	0.106
Gender I. Boys II. Girls	 8 (38%) 13 (62%)	 5 (31%) 11 (69%)	0.670
Weight (kg)	71.28 ± 14.89	63.87 ± 20.84	0.215
Height (cm)	155.48 ± 16.65	147.37 ± 18.02	0.166
BMI (kg/m^2)	29.22 ± 1.98	28.53 ± 2.82	0.389
Plasma adipokines level			
Leptin (ng/mL)	17.25 ± 7.14	19.82 ± 6.87	0.278
Adiponectin (μg/mL)	6.88 ± 2.36	8.68 ± 3.47	0.068
Lipid profile			
T-Cho (mg/dl)	182.81 ± 17.41	174.00 ± 18.24	0.141
HDL-Cho (mg/dl)	47.76 ± 8.86	43.62 ± 9.20	0.175
LDL-Cho (mg/dl)	120.05 ± 26.44	134.13 ± 28.09	0.127
TGs (mg/dl)	143.81 ± 40.59	131.44 ± 36.56	0.345

Effects of intervention on children weight, adipokines level, and lipid profile within both groups are shown in table 2. Children in both groups showed significant reduction of their weights and BMI ($P<0.01$). Regarding the plasma adipokine levels, a significant difference between pre and post-treatment plasma leptin concentration was recorded within both AIE (P<0.01) and DC groups (p<0.05). Also, plasma adiponectin level revealed a significant difference within the DC group (P<0.01) but not within the DC group (p>0.05). With respect to the lipid profile, children in AIE showed no changes of T-Cho concentration (p>0.05), increased HDL-Cho level (P<0.01), decreased LDL-Cho level (P<0.01) and decreased TGs plasma concentration level (P<0.01). On the other hand, children in DC group showed no significant changes of the T-Cho and TGs levels (p>0.05), a significant increase of HDL-Cho level (P<0.05) and a significant decrease of the LDL-Cho level (P<0.01).

Table 2: Effect of intervention in AIE and DC groups

Variables	AIE group (n=21)			DC group (n=16)		
	Pre	Post	P-value	Pre	Post	P- value
Weight (kg)	71.28 ± 14.89	64.05 ± 13.58	0.001*	63.87 ± 20.84	60.18 ± 4.64	0.001*
BMI (kg/m2)	29.22 ± 1.98	26.26 ± 2.07	0.001*	28.53 ± 2.82	27.02 ± 2.45	0.002*
Adipokines levels						
Leptin (ng/mL)	17.25 ± 7.14	13.15 ± 5.53	0.003*	19.82 ± 6.87	17.03 ± 4.34	0.042*
Adiponectin (µg/mL)	6.88 ± 2.36	9.25 ± 2.13	0.001*	8.68 ± 3.47	9.57 ± 2.76	0.059
Lipid profile						
T-Cho (mg/dl)	182.81 ± 17.41	175.76 ± 14.90	0.065	174.00 ± 18.24	169.50 ± 16.36	0.057
HDL-Cho (mg/dl)	47.76 ± 8.86	52.24 ± 9.21	0.009*	43.62 ± 9.20	45.93 ± 9.48	0.020*
LDL-Cho (mg/dl)	120.05 ± 26.44	104.81 ±19.56	0.002*	134.13 ± 28.09	120.25 ± 23.71	0.001*
TGs (mg/dl)	143.81 ± 40.59	126.33 ± 33.29	0.001*	131.44 ± 36.56	124.45 ± 26.52	0.083

* Significant,

Differences of post-treatment outcome measures between both groups are demonstrated in table 3. No differences in weight, BMI, plasma adiponectin level, T-Cho level and TGs level between AIE and DC group after intervention (p>0.05). Whereas, significant differences of leptin level (p<0.05), HDL-Cho level (p<0.05) and LDL-Cho level (p<0.05) between both groups were realized in favor of the AIE group.

Table 3: Differences between AIE and DC groups after intervention

Variables	AIE group (n=21)	DC group (n=16)	P-value
Weight (kg)	64.05 ± 13.58	60.18 ± 4.64	0.470
BMI (kg/m^2)	26.26 ± 2.07	27.02 ± 2.45	0.316
Adipokines levels			
Leptin (ng/mL)	13.15 ± 5.53	17.03 ± 4.34	0.027*
Adiponectin (µg/mL)	9.25 ± 2.13	9.57 ± 2.76	0.687
Lipid profile			
T-Cho (mg/dl)	175.76 ± 14.90	169.50 ± 16.36	0.233
HDL-Cho (mg/dl)	52.24 ± 9.21	45.93 ± 9.48	0.048*
LDL-Cho (mg/dl)	104.81 ±19.56	120.25 ± 23.71	0.037*
TGs (mg/dl)	126.33 ± 33.29	124.45 ± 26.52	0.831*

* Significant

Children's self-report and parent's proxy report of the HRQL is presented in table 4. The two reports indicated that both groups were similar at the beginning of the study (p>0.05). After the intervention, children themselves and their parents reported only a significant difference of the psychosocial health scores between both groups (p<0.05) favoring the AIE group. While physical health scores or-generic scores of both reports for the two groups were not different (p>0.05). Within both groups, children and parents reported significant differences in physical health (p<0.05, p<0.01), psychosocial health (p<0.05, p<0.01) and total scores (p<0.05, p<0.01) respectively.

Table 4: Health related quality of life for both groups before and after intervention

	Physical health			Psychosocial health			Generic score		
	Pre	Post	P- value	Pre	Post	P- value	Pre	Post	P-value
Children self-report									
AIE group	79.4 ± 9.6	82.8 ± 10.9	0.013*	78.8 ± 10	84.4 ± 8.3	0.009*	79.2 ± 6.3	83.6 ± 6.9	0.003*
DC group	81.9 ± 11	87.4 ± 11.9	0.020*	75.9 ± 9.8	78.1 ± 8.9	0.039*	78.9 ± 7.9	82.9 ± 8.2	0.015*
P-value	0.342	0.080		0.443	0.043*		0.939	0.797	
Parents proxy report									
AIE group	77.8 ± 9.8	82.3 ± 11	0.002*	76.9 ± 10	85.7 ± 11	0.001*	77.4 ± 8	83.9 ± 9.1	0.001*
DC group	79.7 ± 8.4	83.3 ± 9.8	0.004*	74.6 ± 8.9	79.6 ± 8.3	0.001*	77.1 ± 7.4	81.5 ± 7.5	0.006*
P-value	0.521	0.818		0.490	0.037*		0.782	0.270	

* Significant,

DISCUSSION

Caloric intake restriction and increasing the level of physical activities are substantial objectives of therapies prescribed for overweight or obese children [34]. Lately, there have been multiple studies demonstrated changes in serum adipokines level and lipid profile after different modes of exercise intervention focusing on the intensity or duration of training and/or diet control in young boys or girls who were overweight or obese [14, 23, 25], but no or very little reports have been focused on the effect the aerobic interval training against a balanced diet control regimen on the plasma adipokine levels and lipid concentration in overweight children. The purpose of the present study was to investigate changes of the plasma adipokines level, lipid profile, and HRQL after aerobic interval training and dietary control programs in overweight children.

It was initially hypothesized that aerobic interval exercises, as well as dietary control, would experience changes in our primary, secondary and tertiary outcome measures. We also hypothesized, no differences would be indicated between both groups. Initial hypothesis is partially confirmed by the findings of the present study which clearly demonstrated that aerobic interval exercises produced significant changes in term of weight reduction, hyperleptinemia alleviation and adiponectin level elevation, HDL-Cho level rising, LDL-Cho level drop and TGs reduction, but no significant changes in T-Cho level were recorded following aerobic interval training. While, the dietary control was associated with significant changes only in children's weight, leptin level, HDL-Cho and LDL-Cho concentration, but no changes in adiponectin level, T-Cho or TGs concentration. Besides, children's HRQL significantly improved as reported by the children themselves or upon their parent's report after both aerobic interval exercises and dietary control. Furthermore, the aerobic interval exercise program was found superior to the dietary control program concerning leptin level, HDL-Cho, LDL-Cho concentration and psychosocial health.

The results of the present study concurred with that raised by Kraemer et al. (2002) who attributed the reduction of leptin concentration to aerobic exercises and explicated these changes on the basis that aerobic training induces considerable physiological adaptations and alters the concentration of other hormones such as insulin, cortisol, catecholamine and others which in turn alter leptin concentration [35]. This also in agreement with Kondo et al. (2006) who suggested that changes in circulating adipokine levels are involved in the improvement of the metabolic state (alteration of glucose metabolism, improvement of leptin sensitivity and lipid metabolism) secondary to exercise training [36]. Further, our results were consistent with the finding of a study by Roman et al. (2004) who reported the association of reduction of plasma leptin concentration with the changes of energy balance in children who were engaged in exercise training programs [37]. Additionally, evidence has shown that exercise training enhances adiponectin level [24]. Contrary to the results of this study, some investigators have reported no changes in leptin or adiponectin concentration following short or long term exercise training [25-28]. The controversial leptin and adiponectin responses to exercise training probably caused by variable sample sizes, different age groups, different degrees of obesity and/or different intensities and duration of exercise training.

With respect to blood lipids, the results of the previous studies were conflicting. Nevertheless, the findings of the present study reported improvement of blood lipids with aerobic interval exercises in obese children. These results were harmonious with a study by Zorba et al. (2011) who studied the effect of 12-weeks of aerobic training in the form of walking and jogging for 45-60 minutes on body composition and lipid profile in obese children and clearly demonstrated significant improvement of blood lipids as reduced T-Cho, LDL-Cho, TGs levels and elevated HDL-Cho level [38]. Likewise, Bruckert et al. (2007) observed T-Cho, TGs, and LDL-Cho fall and HDL-Cho elevation after 7-8 hours of skiing [39]. Furthermore, Gutin et al. (1996) indicated an improvement of plasma TGs concentration, HDL-Cho level and T-Cho/HDL-Cho in obese children following exercise training [40]. These findings were contradicted by Bell et al. (2007) who reported no changes in all lipid profile measures in obese children when exercises were used alone [41]. Also, other preceding studies by Linder et al. (1982) and Rowland et al. (1996) have reported non-significant favorable changes of lipids after exercise in obese children [42, 43].

Eventually, the non-surprising improvement of subscores of the children's HRQL mainly the psychosocial health due to aerobic interval exercises may be explained as a secondary effect of weight reduction, body image perception improvement as well as the physical and biological function enhancement. Along with our findings, a review study by Penedo et al. (2005) indicated that engagement in exercise and physical activity programs results in better health outcomes including better HRQL [44].

Comparatively, the present study has some strength. First, randomization of children in the employed study design helps to wash out possible bias. Second, children in AIE group were supervised throughout the study and those in the DC group were also overseen. Furthermore, this study emphasized assessment of physical and psychosocial functioning to identify the functional impact of the changes in the primary and secondary outcome measures. Nonetheless, this study has a number of potential weaknesses to be considered in the forthcoming studies. Loss of follow-up attributed to the intervention. So, long term effects should be investigated in large cohort studies. Also, lacking normal children as a control, the authors acknowledge the involvement of another group of normal children is necessary to draw a valid conclusion from the obtained results. Finally, individual differences in children's response to either aerobic interval exercises or dietary control may arise from being overweight or obese. Thus, delimitation of the scope to either of them or considering representative of different subsets in a cross-sectional study would be helpful to eliminate the potential bias.

CONCLUSION

The findings of the present study highlight the significance of aerobic interval exercises in the treatment of overweight or obese children. It is likely to have been the driving force behind the positive effects on children's weight, plasma adipokine levels, blood lipid concentration and the consequent health-related quality of life. To draw a definitive conclusion, further researches are still necessary.

REFERENCES

[1] Rome ES. Obesity prevention and treatment. Pediatrics in Review-Elk Grove. 2011;32(9):363.

[2] De Onis M, Blossner M. Prevalence and trends of overweight among preschool children in developing countries. The American journal of clinical nutrition. 2000;72(4):1032-9.

[3] Musaiger AO. Overweight and obesity in easternmediterranean region: prevalence and possible causes. Journal of obesity. 2011;2011:407237.

[4] Salem M, El-Samahy M, Moneir E. Prevalence of obesity in school children and its link to type 2 diabetes mellitus. The Egyptian journal of Pediatrics. 2002;19(3):397-416.

[5] Xu S, Xue Y. Pediatric obesity: Causes, symptoms, prevention and treatment. Experimental and therapeutic medicine. 2016;11(1):15-20.

[6] Lutfiyya MN, Garcia R, Dankwa CM, Young T, Lipsky MS. Overweight and obese prevalence rates in African American and Hispanic children: an analysis of data from the 2003-2004 National Survey of Children's Health. Journal of the American Board of Family Medicine : JABFM. 2008;21(3):191-9.

[7] Srinivasan SR, Myers L, Berenson GS. Predictability of childhood adiposity and insulin for developing insulin resistance syndrome (syndrome X) in young adulthood: the Bogalusa Heart Study. Diabetes. 2002;51(1):204-9.

[8] Sinha R, Fisch G, Teague B, Tamborlane WV, Banyas B, Allen K, et al. Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. The New England journal of medicine. 2002;346(11):802-10.

[9] Reybrouck T, Mertens L, Schepers D, Vinckx J, Gewillig M. Assessment of cardiorespiratory exercise function in obese children and adolescents by body mass-independent parameters. European journal of applied physiology and occupational physiology. 1997;75(6):478-83.

[10] Birbrair A, Zhang T, Wang ZM, Messi ML, Enikolopov GN, Mintz A, et al. Role of pericytes in skeletal muscle regeneration and fat accumulation. Stem cells and development. 2013;22(16):2298-314.

[11] Fasshauer M, Klein J, Lossner U, Paschke R. Interleukin (IL)-6 mRNA expression is stimulated by insulin, isoproterenol, tumour necrosis factor alpha, growth hormone, and IL-6 in 3T3-L1 adipocytes. Hormone and metabolic research. 2003;35(3):147-52.

[12] Sato K, Kawamura T, Yamagiwa S. The "Senobi" breathing exercise is recommended as first-line treatment for obesity. Biomedical research (Tokyo, Japan). 2010;31(4):259-62.

[13] Campfield LA, Smith FJ, Guisez Y, Devos R, Burn P. Recombinant mouse OB protein: evidence for a peripheral signal linking adiposity and central neural networks. Science (New York, NY). 1995;269(5223):546-9.

[14] Kraemer RR, Castracane VD. Effect of acute and chronic exercise on ghrelin and adipocytokines during pubertal development. Medicine and sport science. 2010;55:156-73.

[15] Dirlewanger M, di Vetta V, Guenat E, Battilana P, Seematter G, Schneiter P, et al. Effects of short-term carbohydrate or fat overfeeding on energy expenditure and plasma leptin concentrations in healthy female subjects. International journal of obesity and related metabolic disorders. 2000;24(11):1413-8.

[16] Robertson MD, Henderson RA, Vist GE, Rumsey RD. Plasma ghrelin response following a period of acute overfeeding in normal weight men. International journal of obesity and related metabolic disorders. 2004;28(6):727-33.

[17] Vanltallie TB. Resistance to weight gain during overfeeding: a NEAT explanation. Nutrition reviews. 2001;59(2):48-51.

[18] Diez JJ, Iglesias P. The role of the novel adipocyte-derived hormone adiponectin in human disease. European journal of endocrinology. 2003;148(3):293-300.

[19] Ukkola O, Santaniemi M. Adiponectin: a link between

excess adiposity and associated comorbidities? Journal of molecular medicine (Berlin, Germany). 2002;80(11):696-702.
[20] Kraemer RR, Kraemer GR, Acevedo EO, Hebert EP, Temple E, Bates M, et al. Effects of aerobic exercise on serum leptin levels in obese women. European journal of applied physiology and occupational physiology. 1999;80(2):154-8.
[21] Ozcan L, Ergin AS, Lu A, Chung J, Sarkar S, Nie D, et al. Endoplasmic reticulum stress plays a central role in development of leptin resistance. Cell metabolism. 2009;9(1):35-51.
[22] Dinas PC, Markati AS, Carrillo AE. Exercise-induced biological and psychological changes in overweight and obese individuals: a review of recent evidence. ISRN Physiology. 2014;2014.
[23] Kondo T, Kobayashi I, Murakami M. Effect of exercise on circulating adipokine levels in obese young women. Endocrine journal. 2006;53(2):189-95.
[24] Kriketos AD, Gan SK, Poynten AM, Furler SM, Chisholm DJ, Campbell LV. Exercise increases adiponectin levels and insulin sensitivity in humans. Diabetes care. 2004;27(2):629-30.
[25] Weltman A, Pritzlaff CJ, Wideman L, Considine RV, Fryburg DA, Gutgesell ME, et al. Intensity of acute exercise does not affect serum leptin concentrations in young men. Medicine and science in sports and exercise. 2000;32(9):1556-61.
[26] Kraemer RR, Durand RJ, Acevedo EO, Johnson LG, Synovitz LB, Kraemer GR, et al. Effects of high-intensity exercise on leptin and testosterone concentrations in well-trained males. Endocrine. 2003;21(3):261-5.
[27] Hara T, Fujiwara H, Nakao H, Mimura T, Yoshikawa T, Fujimoto S. Body composition is related to increase in plasma adiponectin levels rather than training in young obese men. European journal of applied physiology. 2005;94(5-6):520-6.
[28] Hulver MW, Zheng D, Tanner CJ, Houmard JA, Kraus WE, Slentz CA, et al. Adiponectin is not altered with exercise training despite enhanced insulin action. American journal of physiology Endocrinology and metabolism. 2002;283(4):E861-5.
[29] WHO. Obesity and overweight 2015 [cited 2016 15 March]. Available from: http://www.who.int/mediacentre/factsheets/fs311/en/.
[30] Janicke DM, Finney JW, Riley AW. Children's health care use: a prospective investigation of factors related to care-seeking. Medical care. 2001;39(9):990-1001.
[31] Varni JW, Limbers CA, Burwinkle TM. Parent proxy-report of their children's health-related quality of life: an analysis of 13,878 parents' reliability and validity across age subgroups using the PedsQL 4.0 Generic Core Scales. Health and quality of life outcomes. 2007;5:2.
[32] Varni JW, Seid M, Kurtin PS. PedsQL 4.0: reliability and validity of the Pediatric Quality of Life Inventory version 4.0 generic core scales in healthy and patient populations. Medical care. 2001;39(8):800-12.
[33] Kersting M, Sichert-Hellert W, Lausen B, Alexy U, Manz F, Schoch G. Energy intake of 1 to 18-year-old German children and adolescents. Zeitschrift fur Ernahrungswissenschaft. 1998;37(1):47-55.
[34] Maziekas M, LeMura L, Stoddard N, Kaercher S, Martucci T. Follow-up exercise studies in pediatric obesity: implications for long-term effectiveness. British journal of sports medicine. 2003;37(5):425-9.
[35] Kraemer R, Acevedo E, Synovitz L, Durand R, Johnson L, Petrella E, et al. Glucoregulatory endocrine responses to exercise and the role of a pancreatic-cell peptide, amylin. Metabolism. 2002;51:657-63.
[36] Kondo T, Kobayashi I, Murakami M. Effect of exercise on circulating adipokine levels in obese young women. Endocrine journal. 2006;53(2):189-95.
[37] Romon M, Lafay L, Bresson J, Oppert J, Borys J, Kettaneh A, et al. Relationships between physical activity and plasma leptin levels in healthy children: the Fleurbaix–Laventie Ville Sante II Study. International journal of obesity. 2004;28(10):1227-32.
[38] Zorba E, Cengiz T, Karacabey K. Exercise training improves body composition, blood lipid profile and serum insulin levels in obese children. Journal of Sports Medicine and Physical Fitness. 2011;51(4):664.
[39] Bruckert E, Hansel B. HDL-c is a powerful lipid predictor of cardiovascular diseases. International journal of clinical practice. 2007;61(11):1905-13.
[40] Gutin B, Cucuzzo N, Islam S, Smith C, Stachura ME. Physical training, lifestyle education, and coronary risk factors in obese girls. Medicine and science in sports and exercise. 1996;28(1):19-23.
[41] Bell LM, Watts K, Siafarikas A, Thompson A, Ratnam N, Bulsara M, et al. Exercise alone reduces insulin resistance in obese children independently of changes in body composition. The Journal of Clinical Endocrinology & Metabolism. 2007;92(11):4230-5.
[42] Linder CW, DuRANT RH, Mahoney OM. The effect of physical conditioning on serum lipids and lipoproteins in white male adolescents. Medicine and science in sports and exercise. 1982;15(3):232-6.
[43] Rowland T, Martel L, Vanderburgh P, Manos T, Charkoudian N. The influence of short-term aerobic training on blood lipids in healthy 10-12-year-old children. International journal of sports medicine. 1996;17(7):487-92.
[44] Penedo FJ, Dahn JR. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. Current opinion in psychiatry. 2005;18(2):189-93.

Citation
Elnaggar, R., & Shendy, M. (2016). AEROBIC INTERVAL EXERCISES VERSUS DIETARY CONTROL INDUCED CHANGES OF ADIPOKINES LEVELS, LIPID PROFILE AND QUALITY OF LIFE IN OVERWEIGHT OR OBESE CHILDREN. *International Journal of Physiotherapy,* 3(5), 587-593.