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Effect of 8-Week Short-Term Sprint Interval Training on Serum Levels of Adipokines, Inflammatory Markers and Lipid Profile in Overweight Boys

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Abstract

Purpose: the etiology of children obesity can be varied. Adipose tissue is an active tissue that secretes proteins such as TNF-α, IL-6, leptin, and adiponectin. The purpose of this study was to investigate the effect of short-term sprint interval training on serum levels of adiponectin, leptin, TNF-α, IL-6, insulin, and lipid profile in overweight boys. **Method:** a number of 30 overweight male students (with a mean age of 9.93±0.2 and BMI of 27.73±0.2) were randomly assigned to the control group (n=15) and sprint interval training (n=15). The subjects of the experimental group did the training for eight weeks, as the control group was engaged in doing their daily activities without intervention. Measurement of anthropometric indices and fasting blood collection were performed (to measure insulin, leptin, adiponectin, TNF-α, IL-6, cholesterol, LDL, HDL and TG) one day before and one day after the training program. **Results:** the results of the present study indicated that 8 weeks of sprint interval training significantly decreased weight and BMI in overweight children ($P<0.001$). In addition to weight and BMI reduction, levels of TNF-α, IL-6, leptin, insulin, cholesterol, triglyceride, and LDL significantly reduce the following eight weeks of the sprint interval workout ($P< 0.001$ for all), while adiponectin and HDL levels increase ($P<0.001$, $P<0.01$, respectively). **Conclusions:** in general, the present study demonstrate that sprint interval training which is a new way of physical activity exerted a positive effect on most of components contributing to children obesity.

***Keywords**:* Overweight, Sprint interval training, Leptin, Adiponectin, TNF-α, IL-6

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INTRODUCTION

Obesity has been characterized as an independent cardiovascular risk factor (Ezquerra, Vázquez & Barrero, 2008; Gomes et al., 2010), and this phenomenon has been discussed by the World Health Organization as an epidemic owing to its high prevalence in children (Monteiro, 2010). In the same vein, childhood obesity is viewed as one of the most important risk factors to cardiovascular disease (Sypniewska, 2015).

The etiology of childhood obesity can be varied (Sypniewska, 2015); however, in biological terms, adipose tissue is an active tissue that secretes proteins such as TNF-α , IL-6, leptin, and adiponectin (Forsythe, Wallace & Livingstone, 2008). As for leptin, some researchers defined it as an alarming mechanism for regulating body fat levels; and it has found that its level rises as a result of obesity (Bouassida et al., 2010). Leptin has shown to be an independent factor associated with cardiovascular disease, as the increase in its level is linked with poor vascular function (Cooke & Oka, 2002; Kraemer, Chu & Castracane, 2002; Lawlor, Smith, Kelly, Sattar & Ebrahim, 2007). In contrast, it has been shown that adiponectin concentration decrease in the samples of obese human, guinea pigs and mice (Jacobi et al., 2004; Fu, Luo, Klein & Garvey, 2005). Studies on rodents have demonstrated that adiponectin lower blood sugar level, preventing adipose tissue from accumulating in skeletal muscle (Bouassida et al., 2010; Bruun, Helge, Richelsen & Stallknecht, 2006; Liu et al., 2008). In comparison with other adipocyte-derived molecules, the protein has protective metabolic effects and anti-inflammatory properties. In addition, adiponectin level in human blood is inversely correlated with insulin resistance level (Fuentes et al., 2010).

In addition to the interplay between obesity with leptin and adiponectin, inflammatory markers also alter body composition and endocrine function (Forsythe, Wallace & Livingstone, 2008; Prestes et al., 2009). In this regard, high concentrations of TNF-α and IL-6 has been reported among overweight youth (Balagopal et al., 2011). Likewise, increased release of TNF-α and interleukin-6 through adipose tissue in obesity is associated with cardiovascular disease (Sypniewska, 2015). Additionally, obesity-related insulin resistance is very common in children and adolescents, contributing to the increased risk of type-II diabetes and cardiovascular diseases throughout life (Henderson et al., 2012). The data of the studies altogether indicated that there is a triangle in obesity, particularly in childhood obesity, in which sit in the first side extra adipose and substances secreted from it, on the second side insulin resistance and probability of diabetes, and in in the third side increased risk of cardiovascular disease. In the meantime, multifaceted therapies—diet, exercise and behavior change—have proved effective. One of the programs is to become involved in physical activity and exercise, which proved useful to some extent. It is evident that physical activity has a significant effect on the treatment of obesity. However, there is controversial data about the effects of physical activity on leptin, adiponectin, and inflammatory markers (TNF-α, IL-6). Alternatively, training programs lay more emphasis on consistent training that require a great deal of time during a week, which may seem tedious and frustrating (Shaw, Gennat, O'Rourke & Mar, 2006). But interval training may be a better option than continuous training because of the inclusion of rest span or reduction of training intensity during exercise; that is to say, less time spent for doing activity so that less fatigue is felt in this case (Nilsson, Hellesnes, Westheim & Risberg, 2008). Therefore, the use of an exercise training that entails challenge and excitement, while involving short time, can more likely to tempt children to take part in physical activities (Verbeken, Braet, Goossens & Oord, 2013). To this end, we decided to do a research in which a new short-term training is used; that is, we used short-term sprint interval training. In addition, an attempt was made in this research to investigate the three sides involved in children's obesity— substances secreted from adipose tissue, insulin resistance, and cardiovascular risk factors (lipid profile)— and the effect of the training program on them. Therefore, the purpose of this research is to investigate the effect of short-term sprint interval training on serum levels adipokines (adiponectin, leptin), inflammatory markers (TNF-α and IL-6) lipid profile (cholesterol, LDL , HDL , and TG) and insulin in obese boys.

METHOD

Subjects

A number of 30 overweight male students (with a mean age of 9.93±0.2 and BMI of 27.73±0.2) from elementary schools in Kerman, who were all healthy and inactive, were assigned to this research through a participation invitation. Initially, a consent form for participation in this research was filled out by their parents, and then some information on the terms and manner of implementing this research was given to the subjects. Having been assured of their willingness and ability to participate in the workout program, and initial assessment (height, weight, age, and BMI) was performed to the individuals.

Research plan

Inclusion criteria of the research: none of the subjects shouldn't have a history of chronic or metabolic disease and shouldn't take part in any regular workout activity particularly sprint interval training. Having made sure that the inclusion criteria to the research plan are met and initial assessment was completed, the subjects were randomly assigned to the control group (n=15) and sprint interval training (n=15). The subjects of the experimental group did the training for eight weeks, as the control group were busy doing their daily activities without intervention. The measurement of anthropometric indices and fasting blood sampling were performed to measure insulin, leptin, adiponectin, TNF-α, IL-6, cholesterol, LDL , HDL and TG one day before and one day after the training course.

Training protocol

The subjects in the sprint interval training group did the training for eight weeks and three sessions per week (Ezquerra, Vázquez & Barrero, 2008). On the first day of the training program, the subjects attended a session on the introduction of the procedure. All the subjects were asked to run as fast as possible and travel the path at maximum time of 10 and 30 seconds. This process was iterated/repeated several times, and it was stressed that everyone should run as fast as possible. The maximum distance traveled by any of them was recorded, and hence everyone should strived to repeat his record during the training course. The training program required all the subjects to do warm up for 10 minutes, and try to run in the course of three 10-second sprint intervals with 30-second break between the intervals. Following this, they performed three 30-second sprint interval with 90-second break intervals. At the end of each session, the subjects went for a slow jog and stretching exercise for ten minutes in order to cool down and return to baseline. In order to increase training load, one interval was added to the number of the sprint intervals every two weeks (Table 1).

Table 1: Sprint interval training program

Week	Exercise duration		
	Warm up (10 min)	**Exercise**	**Cool down (10 min)**
1	Stretching and jogging	3x10 secs of exercise, 30 secs of rest 3x30 secs of exercise, 90 secs of rest	Stretching and jogging
2	Stretching and jogging	3x10 secs of exercise, 30 secs of rest 3x30 secs of exercise, 90 secs of rest	Stretching and jogging
3	Stretching and jogging	4x10 secs of exercise, 30 secs of rest 4x30 secs of exercise, 90 secs of rest	Stretching and jogging
4	Stretching and jogging	4x10 secs of exercise, 30 secs of rest 4x30 secs of exercise, 90 secs of rest	Stretching and jogging
5	Stretching and jogging	5x10 secs of exercise, 30 secs of rest 5x30 secs of exercise, 90 secs of rest	Stretching and jogging
6	Stretching and jogging	5x10 secs of exercise, 30 secs of rest 5x30 secs of exercise, 90 secs of rest	Stretching and jogging
7	Stretching and jogging	6x10 secs of exercise, 30 secs of rest 6x30 secs of exercise, 90 secs of rest	Stretching and jogging
8	Stretching and jogging	6x10 secs of exercise, 30 secs of rest 6x30 secs of exercise, 90 secs of rest	Stretching and jogging

Biochemical measurements

Biochemical tests were run on the blood samples which were collected after a 12-hour fast. Measurement of plasma levels of leptin, adiponectin, NF-α and IL-6 was performed by means of ELISA method and by using the kit (Adipogen, Seoul, Korea). The serum levels of cholesterol, HDL, and TG were measured through ADVIA 1650 chemical system (Bayer, Tarrytown, NY) (Kim et al., 2007). LDL was also measured by using the Friedenwald formula (Friedewald, Levy & Fredrickson, 1972). Fasting insulin levels were measured using an insulin kit (Pars Azmoon Co., Iran).

Statistical Analysis

In the beginning, the normality of data was confirmed by Kolmogorov-Smirnov test. Afterward, paired sample t-test was used to determine the difference between pre-test and post-test, and student's t-test for independent samples was used to determine the difference between the groups. Similarly, Pearson correlation test was used to determine the correlation between variables. The statistical analysis was performed using SPSS 21st version. The significance level was set at $\alpha = 0.05$. All values are expressed as mean ± standard deviation.

RESULTS

The subjects' demographic characteristics are shown in Table 2. The relationship between BMI and the studied variables is shown in Table 3. The results showed that BMI is positively related to IL-6 and leptin ($P=0.01$, $P<0.001$, respectively), whereas there was a negative and significant relationship between BMI and adiponectin ($p<0.001$).

The results of the present study showed that 8 weeks of sprint interval training significantly decreased the weight and BMI of the overweight children ($P<0.001$) (Table 4). In addition to weight and BMI reduction, levels of TNF-α, IL-6, leptin, insulin, cholesterol, triglyceride, and LDL significantly fell following eight weeks of the sprint interval training ($P< 0.001$ for all), while adiponectin and HDL levels rose ($P<0.001$, $P<0.01$, respectively).

Table 2: Subject's demographic characteristics

Variables	**Groups**	
	Control	**Exercise**
Age	9.85±0.18	10.02±0.20
Height (cm)	143.52±0.84	142.58±0.84
Weight (kg)	57.1±0.94	56.36±70
BMI (kg/cm^2)	27.69±0.22	27.76 ±0.22

Table 3: Correlation between BMI and IL-6, TNF-α, leptin, adiponectin, and insulin

Variables	BMI (kg/cm^2)
IL-6 (pg/mL)	0.620[a]
TNF-α (pg/mL)	0.381
Leptin (ng/ml)	0.777[b]
Adiponectin (µg/mL)	-0.798[b]
Insulin (µU/mL)	0.367

a $P < 0.01$
b $P < 0.001$

Table 4: The values of body composition, Insulin resistance, lipid profile, and adipokines before and after training a

Variables	Control		Exercise	
	Before	After	Before	After
Height (cm)	143.52±0.84	143.52±0.84	142.58±0.84	142.58±0.84
Weight (kg)	57.1±0.94	57.82±1.00	56.36±70	54.98±0.72[c,d]
BMI (kg/cm^2)	27.69±0.22	27.81±0.26	27.76 ±0.22	26.80±0.25[c,d]
IL-6 (pg/mL)	3.85±0.19	4.06±0.18	3.57±0.11	2.92±0.07[c,d]
TNF-α (pg/mL)	1.84±0.04	1.95±0.06	1.91±0.05	1.52±0.06[c,d]
Leptin (ng/ml)	11.61±0.58	12.29±0.58	12.24±0.58	8.58±0.44[c,d]
Adiponectin (µg/mL)	12.77±0.64	13.04±0.64	13.39±0.69	15.20±0.68[c,d]
Insulin (µU/mL)	13.13±0.65	13.28±0.60	12.51±0.65	7.98±0.50[c,d]
Chol (mg/dL)	175.49±3.23	173.41±2.75	169.81±3.05	152.66±2.96[c]
TG (mg/dL)	96.11±3.86	96.87±3.72	104.68±5.53	100.07±4.80[c]
LDL (mg/dL)	102.25±3.85	102.45±3.94	97.69±3.33	95.53±3.07[c]
HDL (mg/dL)	52.02±1.22	51.48±1.28	49.25±1.07	50.30±1.16[b]

a Each value is the mean ± SD of the seven rats in each group.
b $P < 0.01$, compared with pre-training levels in Exercise group.
c $P < 0.001$, compared with pre-training levels in Exercise group.
d $P < 0.01$, compared with post-training levels in control group.

DISCUSSION

The present research was conducted with an aim to simultaneously investigate the three sides involved in childhood obesity (increase in BMI, adipokines secretion, insulin resistance and lipid profile changes), as well as the effects of sprint interval training on them. Many studies demonstrated the close association between these factors in obesity (Cooke & Oka, 2002; Kraemer, Chu & Castracane, 2002; Lawlor, Smith, Kelly, Sattar & Ebrahim, 2007; Fuentes et al., 2010; Henderson et al., 2012). Thus, we initially explored the factors and BMI in the baseline state. The results of the study indicated that there is a positive and significant relationship between BMI and IL-6 and leptin, while BMI was negatively and significantly related to adiponectin. However, no significant relationship was observed between BMI and TNF-α and insulin. One study shows that adiponectin concentration is inversely correlated with anthropometric parameters of obesity and HOMA-IR and it is directly correlated with HDL-cholesterol in children aged 12, 4 (Arnaiz et al., 2010). A direct and significant relationship is also reported between BMI and IL-6 and leptin (Kraemer, Chu & Castracane, 2002; Kim et al., 2007). Although we doesn't show any significant relation between BMI and TNF-α, previous studies reported the relation between the two factors (Kim et al., 2007). A positive and weak relation is observed between BMI and Insulin, which is not statistically significant; however, previous studies demonstrated the relationship (Kim et al., 2007); it is possible to show the relationship with samples consisting of more subjects. In general, the results of the present study with previous studies, indicated the relationship between overweight and most factors contributing to children's obesity.

The dramatic rise in childhood obesity has been well demonstrated in recent decades (Ogden, Carroll, Curtin, Lamb & Flegal, 2010). Obesity is associated with a series of new risk factors such as pro-inflammatory factors (TNF-α, IL-6) and some adipocytokines (leptin and adiponectin) (Sypniewska, 2015). However, some studies reported an association between obesity and the increase in levels of inflammatory markers such as TNF-α, IL-6 and the increased risk of cardiovascular diseases (Sypniewska, 2015; Beavers et al. 2010; Kadoglou et al., 2007; Kohut et al., 2006; Peeri, Assarzadeh, Azarbayjani & Agaalinejad, 2011; Nicklas et al., 2008). Additionally, increased obesity, particularly in visceral area, ultimately end up with an imbalance in adipocyte metabolism, which contributes to the release of pro-inflammatory mediators and leads to low-grade inflammatory process, putting individuals at risk for cardiovascular diseases (Berg & Scherer, 2005). Therefore, any activity that modify the abnormal levels of the factors in the body may reduce the risk of cardiovascular disease.

Physical activity has a significant effect on obesity treatment. However, there is controversial information about the effects of physical activity on leptin, adiponectin, and inflammatory markers (TNF-α, IL-6). A number of studies have shown that the plasma concentration of leptin and adiponectin is necessarily affected by physical activity in healthy people (Bouassida et al., 2010; Nicklas et al., 2008; Bouassida et al., 2010; Kraemer & Castracane, 2007; Numao, Katayama, Hayashi, Matsuo & Tanaka, 2011; Numao et al., 2008; Olive & Miller, 2001). Our results shows that eight weeks of sprint interval training significantly increases the serum concentration of adiponectin. Adiponectin has been suggested as a marker of metabolic syndrome and cardiovascular risk (Sypniewska, 2015). The synthesis of this hormone is subdued by TNF-α and IL-6. Similarly, it seems that its production is regulated by insulin and inhibited under insulin resistance, which is common in obesity. Adiponectin levels and its anti-inflammatory actions are quelled in obesity, resulting in overexpression of pro-inflammatory molecules (Monteiro, 2010). Therefore, we have to use an intervention that reduce factors suppressing adiponectin, while directly increasing it, in order to get rid of negative effects of obesity on the levels of adiponectin.

In this research, we used sprint interval training, which significantly reduces the serum levels of TNF-α and IL-6. However, the high concentration of the two cytokines has been reported in obese youth (Balagopal et al., 2011). Furthermore, the increased release of TNF-α and IL-6 through adipose tissue is associated with cardiovascular disease in obesity situation (Sypniewska, 2015). Therefore, this form of training has been able to finely reduce negative factors in children's obesity (TNF-α, and IL-6), as it increases positive factors (adiponectin). The bilateral effects of sprint interval training have resulted in some kind of synergy in reversing the adverse effects of overweight and obesity in children. Alternatively, many studies that have reported increased adiponectin levels after exercise have also found significant weight loss

(Neligan & Fleisher, 2006; Kondo, Kobayashi & Murakami, 2006; Blüher, et al. 2006; Oberbach et al., 2006; Esposito et al., 2003). In our study, 8 weeks of sprint interval training significantly reduced weight and BMI in obese children. However, some studies showed that adiponectin increase without any change in the weight happens only by a decrease in body fat mass (Balagopal, George, Yarandi, Funanage & Bayne, 2005).

The results also shows that 8 weeks of sprint interval training significantly reduce leptin in overweight children. Leptin is a hormone that is exactly linked to adipose tissue, as its levels are affected by fat mass and adipocyte size (Margetic, Gazzola, Pegg & Hill, 2002). Some researchers considered leptin as an alarming mechanism for regulating body fat levels (Bouassida et al., 2010). Through its central actions, leptin controls food intake and indirectly maintains energy balance (Anubhuti & Arora, 2008). Additionally, it has pro-inflammatory properties, stimulating secretion of other cytokines including TNF-α and IL-6; all of the functions are important to the pathophysiological mechanisms of obesity (Pires et al., 2014). Since sprint interval training has shown to decrease weight and BMI, it is likely that the decrease in leptin was because of weight loss in the form of fat. This decrease eventually led to TNF-α and IL-6 reduction and this link was enhanced in both ways.

Obesity-related insulin resistance is very common in children, contributing to the increase in the risk of type-II diabetes and cardiovascular disease throughout life. The interplay between glucose and insulin was observed through body weight and physical activity (Henderson et al., 2012). In the present research, it was found that 8 weeks of sprint interval training significantly reduced insulin in overweight children. This reduction in insulin level may be attributable to increased adiponectin levels. Adiponectin has an important role in crushing insulin resistance created by specific diets. Studies conducted on rodents shows that adiponectin lowers blood sugar levels, preventing adipose tissue from accumulating in skeletal muscle (Bouassida et al., 2010, Bruun, Helge, Richelsen & Stallknecht, 2006; Liu et al., 2008). In addition, adiponectin levels in human blood are inversely correlated with insulin resistance level (Fuentes et al., 2010; Yamauchi et al., 2002; Yamauchi et al., 2001; Punthakee et al., 2006).

Furthermore, the development of obesity in children and adults has detrimental effects on the levels of cardiovascular risk factors. Obesity in children between the age of 9 and 12 is associated with increased cardiovascular risk factors at the age of 15 to 16. Thus, this risk can be mitigated in children who gain normal weight (Lawlor, 2010). The result of the study indicated that 8 weeks of sprint interval training significantly improved lipid profile (decreased TG, LDL and cholesterol as increased HDL) in obese children. Therefore, this practice was able to improve the status of lipid profile as one of the cardiovascular risk factors. It seems that this practice directs calorie balance toward energy consumption by lifting energy demand over short and repetitive intervals. Thus, the level of fat metabolism increases and lipid profile approaches the decrease in harmful fat (Duclos, Corcuff, Ruffie, Roger & Manier, 1999). Interestingly, this change in lipid profile is linked with the decrease in leptin level (Duclos, Corcuff, Ruffie, Roger & Manier, 1999; Elias et al., 2000). In the same vein, leptin shows significant decrease simultaneously in this research.

CONCLUSIONS

In general, the present study showed that sprint interval training, a new way of physical activity, managed to make a positive effect on most of components contributing to children's obesity. In other words, this practice, despite its short time and fatigueless feature, can reverse the process of weight gain and its deleterious effects such as increased inflammatory factors, resistance to insulin and adverse increase in lipid profile in obese children. Therefore, the use of the exercises can to some extent prevent overweight children from becoming obese adolescents and adults.

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