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Research Article

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Evaluation of Physical Fitness, Body Composition and Insulin Resistance Index in Girl Adolescent Athletes and Non-Athletes in the Early and Late Puberty

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ABSTRACT

Puberty is an essential period of lifespan that body is along with structure and physiologic changes. The aim of this study was to investigate the physical fitness, body composition and insulin resistance indices in adolescent girl athlete and non-athletes in the early and late pubertal period. 36 healthy girl adolescent volunteers aged 10 to 15 years were divided into four groups: 1. Athletes in early puberty, 2. Non-athletes in early puberty, 3. Athletes in late puberty and 4. Non-athletes in late puberty. The exercise group had 2 years' experience of continuous exercise, three sessions in a week and non-exercise group did not have any experience of exercise training. Fasting blood samples were taken before physical fitness test. HOMA-IR method was used to calculate the indexes of insulin resistance, fasting blood glucose and insulin resistance. T test was used for analyzing the data. The results showed that levels of insulin were significantly lower at the late puberty. Consequently, the glucose in early and late puberty showed a significant decrease but there was no significant difference in the percentage of fat in all groups. Insulin resistance was decreased in late puberty which suggests that the physiological stress caused by activity in serum insulin and glucose regulation has a significant role.

Keywords: *Insulin Resistance Index, Insulin Sensitivity, Early and Late Puberty*

INTRODUCTION

The pubertal transition is a time during which rapid and dynamic changes occur in various metabolic systems, including hormonal regulations, changes in body fat and its distribution, and increased insulin resistance. According to Tanner, the most visible changes during puberty are growth in stature and development of secondary sexual characteristics [1]. Tanner Stage I is defined as prepubertal, Tanner Stages II and III are defined as early pubertal, Tanner Stage IV is defined as late pubertal, and Tanner Stage V is considered fully mature [1]. The factors such as hereditary, physiologic, nutrition, grow state are effective on Tanner stages [2].

Insulin sensitivity (SI) appears to be the highest before the onset of puberty (Tanner stage 1) and reaches it's the lowest point midway through maturation (Tanner stage 3), approaching near prepubertal levels at the end of maturation (Tanner stage 5) [3]. Specially, natural pubertal is determined by insulin resistance that is not associated with other actions of insulin include lipolysis and protein metabolism. It was reported that insulin resistance led to reduced carbohydrate utilization during moderate-intensity exercise (i.e., walking at 45% maximal O_2 uptake) and to a greater reliance on lipid as fuel [4]. Multiple factors play a role in the progression from insulin resistance to type 2 diabetes in youth. It is well known that insulin sensitivity decreases in puberty due to increases in growth hormone, testosterone, and estrogen secretion, and increases fat mass. Sedentary, high-calorie lifestyle has contributed to enhance in obesity overall rates, but the youth who develop insulin resistance or type 2 diabetes seem to store this excess lipid in different parts than obese youth who remain insulin sensitive [5]. Moran et al. [6] reported that insulin stimulation induced glucose uptake decreased about 20 to 45% during adolescence. Also, during pubertal, exercise training increased insulin sensitivity receptors thus entry of glucose into cell is needed in lower insulin. Studies that have implemented exercise programs in obese children have found significant improvements in a number of metabolic parameters, like as improved lipid profile and declined insulin resistance (IR) and inflammatory cytokines [7,8]. In puberty period, resistance to insulin is occurred [9] which may be related to changes in grow hormone, sexual hormone and fat increment [10].

Exercise training improves insulin sensitivity and reduces the body fat [11]. Puberty leads to sexual maturation and involves in physiological and behavioral changes. Gonadotropin-releasing hormone (GnRH) released from the Hypothalamus causes the secretion of estrogen and testosterone that result in development of secondary sexual characteristics and fat distribution [11]. Many studies showed that BMI have significant correlation with total body fat [10]. In this study, we evaluate physical fitness, body composition and insulin resistance index in girl adolescent athletes and non-athletes in early and late puberty.

MATERIALS AND METHODS

Subjects

Thirty six teenagers participated voluntary in this study. Half of them were athletes and had two years' experience of exercise training in Taekwondo and non-athletes did not have any history of doing exercise. Participants were free of drug and medication and had no history of endocrine disorders or diabetes, cardiovascular and respiratory diseases, hypertension, acute and chronic hormonal diseases, immune diseases, renal and hepatic diseases or other diseases. The Islamic Azad University, Rasht Branch, Ethics Committee initially approved the experimental procedures and study protocols, which were fully explained to all subjects and a written consent form was signed after having read and understood the details of the experiments. To control the possible effect of diet and physical activity, all the blood samples were collected after an overnight fast.

Anthropometric measurements

Before starting the protocol, the subjects referred to lab two times. The first day of familiarization session, 5ml of blood were taken from antecubital vein of subjects in the sitting position before exercise. Height was measured to the nearest 0.5 cm without shoes using a calibrated scale (Cranlea and Company, Bournville, Birmingham, UK) and body fat percent of triceps and shank were measured using caliper (Lafayette, model 1127, making U.S.A). Body mass index (BMI) was calculated as body weight in kilograms divided by height in meters squared (BMI=weight (kg)/height $(m)^2$). The second familiarization session was designed to familiar subjects with testing procedures (physical fitness test) and laboratory environment. Physical fitness test evaluated muscular strength, aerobic power, muscular endurance and flexibility.

Experimental design

Thirty six girl adolescent were divided into four groups athletes group in early puberty (n=9, age=10-11 year, TS2), non-athlete group in early puberty (N=9, age=10-11 year, TS2), athletes group in late puberty (N=9, age=14-15 year, TS4 and TS5) and non-athlete group in late puberty (N=9, age=14-15 year, TS4 and TS5). Training session was

preceded by general warm-ups (10 min), performance of physical fitness tests included hand strength, flexibility (seat and reach test), sit up, pull ups, 540 m running with 2-3 min rest between tests and cool down (10min).

Blood sampling and analysis

The blood samples were obtained from antecubital vein 24 h before trial session and at 7-8 AM. All the blood samples were collected after fasting overnight and each sample was about 5ml. Plasma was separated by centrifugation (3000g) and then was stored at -80 centigrade until biochemical analysis such as Insulin level, blood glucose, insulin sensitivity and insulin resistance.

Statistical analysis

All statistical analyses were performed using the software statistical package SPSS version 20.0. Data were expressed as mean ± standard deviation. All data were normalized by a Kolmogorov-Smirnov test. The mean changes were analyzed using T test. The significant level was $P<0.05$

RESULTS

Physiological characteristics of the subjects presented in table 1.

Table 1: The characteristics of the subjects

Group	Variable	Mean	Standard deviation	SE	Minimum	Maximum
Athlete in early puberty	Age (year)	10.55	0.52	0.17	10	11
	Height (cm)	142	6.66	2.22	140	160
	Weight (kg)	36.6	3.83	1.2	29.5	41.8
	BMI (kg/m^2)	18.42	1.6	0.53	15.9	20.9
Non athlete in early puberty	Age (year)	10.5	0.52	0.17	10	100
	Height (cm)	143.3	8.6	2.8	130	160
	Weight (kg)	38.45	5.39	1.7	29.8	45.2
	BMI (kg/m^2)	18.68	1.5	0.5	15.8	20.1
Athlete in late puberty	Age (year)	14.66	0.5	0.16	14	15
	Height (cm)	162.2	4.4	1.46	160	170
	Weight (kg)	54.5	5.58	1.86	44	60.8
	BMI (kg/m^2)	20.62	1.6	0.53	17.9	22.6
Non athlete in early puberty	Age (year)	14.66	0.5	0.16	14	15
	Height (cm)	163.3	7.07	2.35	150	170
	Weight (kg)	56.4	6.5	2.17	47.9	65
	BMI (kg/m^2)	20.9	1.69	0.56	22.08	30.01

The results showed that there was significant difference in physical fitness level in athletes and non-athlete groups in early ($P=0.005$, $t=3.5$) and late ($P=0.031$, $t=2.36$) puberty and between athletes and non-athlete groups in early and late puberty ($P=0.003$, $t=2.38$), standard score in athletes group significantly was more than non-athlete group.

The lean body mass had significant difference during early and late puberty in both athletes ($p=0.0001$, $t=9.39$) and non-athlete ($p=0.0001$, $t=7.77$) groups. Also, body fat mass showed significant decrease during early and late puberty in both athletes ($p=0.001$, $t=4.19$) and non-athlete ($p=0.001$, $t=3.87$) groups. Finally, the indices of resistance to insulin, blood glucose and serum insulin indicated significant difference during early and late puberty both athletes and non-athlete groups, respectively ($p=0.002$. $t=3.6$, $p=0.013$. $t=2.79$, $p=0004$, $t=3.4$, respectively). Other variables did not have any significant changes in groups.

DISCUSSION

Childhood and adolescence are essential course of life because during grow period, Dynamic changes occur in various metabolic systems including hormone regulation, alterations of body fat distribution and mental and insulin sensitivity. Several studies have demonstrated that insulin sensitivity decreases at the onset of puberty and rebounds toward the end of the maturation process, a normal physiological response that is thought to promote growth [12,13,14]. In longitudinal studies, they have also shown that the decline in insulin sensitivity that occurs in Caucasians recovers by the end of puberty but that African Americans do not show a recovery pattern [4]. Pubertal transition may be an additional risk factor for the development of pediatric type 2 diabetes. Eisenmann et al. [15,16] indicated that aerobic fitness attenuates the metabolic risk among fat children and adolescents. Components of physical fitness are cardiorespiratory fitness, muscle strength, flexibility, agility and muscle endurance. The studies reported cardiorespiratory fitness, strength and exercise training are related with SI. The association between exercise training and cardiorespiratory fitness in children and adolescents is moderate at best [17,18,19]. In present study, significant difference in physical fitness level in early and late puberty was due to natural grow and increase of muscle size and also, indicative of the lack of impact of puberty factor in drop of physical fitness level. There was no significant difference in resistance to insulin between athletes and non-athlete girls in late puberty and this marker was lower in adolescence athletes. This result suggested positive effect of continues physical activity on resistance to insulin. There are some documents that continue physical activity prevent from resistance to insulin or delay it and high intensity physical activity can increase the number of insulin receptors. Also, significant difference was seen in the blood glucose level between athletes and non-athlete groups in early and late puberty. Skeletal muscles are first place for consuming the glucose; therefore, improvement of glucose control can attribute to exercise training. As mentioned before, exercise training caused the glucose uptake improvement and insulin sensitivity specially in muscle cells [20]. Puberty is also a period that weight is increased; 50% of adult body weight is gained during adolescence. The rate of weight gain decelerates in a manner similar to height velocity during the later stages of pubertal development [21], there was significant difference in body fat mass and lean body mass between athletes and non-athlete girls in early and late puberty and in athletes group was lower. Exercise training via two ways induces gain in the energy consumption in body; increment in the metabolism levels during exercise and enhancement of energy consumption during rest time. During exercise training, saved fat in adipose tissue breakup, went to plasma and were utilized by muscle cells. It seems that part of these changes are because of natural grow process during puberty and rapid change of body.

CONCLUSION

Totally, exercise training especially aerobic training acts as an insulin hormone, induces improve the insulin sensitivity, increase the glucose uptake and physical fitness and decline the body fat mass during puberty.

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REFERENCES

1. Burt Solorzano, C.M., McCartney, C.R., Obesity and the Pubertal Transition in Girls' and Boys', *Reproduction*., 2010, 140(3), 399-410.
2. Kondo, T., Kobayashi, I., Murakami, M., Effect of Exercise on Circulating Adipokine Levels in Obese Young Women, *Endocrine Journal*., 2006, 53(2), 189–195.
3. Marshal, W.A., Tanner, J.M., Variations in Pattern of Pubertal Changes in Girls, *Archives of Disease in Childhood*., 1969, 44, 291.
4. Braun, B., Sharoff, C., Chipkin, S.R., Beaudoin, F., Effects of Insulin Resistance on Substrate Utilization during Exercise in Overweight Women, *Journal* of *Applied Physiology.*, 2004, 97, 991–997.
5. D'Adamo, E., Caprio, S., Type 2 Diabetes in Youth: Epidemiology and Pathophysiology, *Diabetes Care*., 2011, 34(2), S161–165.
6. Moran, A., Jacobs, D.R., Steinberger, J., Hong, C.P., Prineas, R., Luepker, R., Insulin Resistance during Puberty: Results from Clamp Studies in 357 Children, *Diabetes.*, 1999, 48, 2039–2044.

7. Brandou, F., Dumortier, M., Garandeau, P., Mercier, J., Brun, J.F., Effects of a Two-Month Rehabilitation Program on Substrate Utilization during Exercise in Obese Adolescents, *Diabetic Medicine.*, 2003, 29, 20–27.
8. Elloumi, M., Ben Ounis, O., Makni, E., Van Praagh, E., Tabka, Z., Lac, G., Effect of Individualized Weight-Loss Programmes on Adiponectin, Leptin and Resistin Levels in Obese Adolescent Boys, *Acta Paediatr*., 2009, 98, 1487–1493.
9. Hughes, I.A., Kumanan, M., A Wider Perspective on Puberty', *Molecular and Cellular Endocrinology*., 2006, 254, 1-7.
10. World Health Organization., Physical Status: The Use of and Interpretation of Anthropometry, *Report of a Who Expert Committee*., 2006, 189-195.
11. Plowman, S.A., Maturation and Exercise Training in Children, *Pediatric Exercise Science*., 1989, 1, 303-31 2.
12. Amiel, S.A., Sherwin, R.S., Simonson, D.C., Lauritano, A.A., Tamborlane, W.V., Impaired Insulin Action in Puberty: A Contributing Factor to Poor Glycemic Control in Adolescents with Diabetes, *The New England Journal of Medicine*., 1986, 315, 215–219.
13. Caprio, S., Plewe, G., Diamond, M.P., Simonson, D.C., Boulware, S.D., Sherwin, R.S., Tamborlane, W.V., Increased Insulin Secretion in Puberty: A Compensatory Response to Reductions in Insulin Sensitivity, *Journal of Pediatrics.*, 1989, 114, 963–967.
14. Goran, M.I., Gower, B.A., Longitudinal Study of Pubertal Insulin Resistance, *Diabetes*., 2001, 50, 2444–2450.
15. Eisenmann, J.C., Welk, G.J., Wickel, E.E., Blair, S.N., Combined Influence of Cardiorespiratory Fitness and Body Mass Index on Cardiovascular Disease Risk Factors among 8-18 Year Old Youth: The Aerobics Center Longitudinal Study, *International Journal of Pediatric Obesity*., 2007, 2, 66–72.
16. Eisenmann, J.C., Aerobic Fitness, Fatness and the Metabolic Syndrome in Children and Adolescents, *Acta Paediatrica*., 2007, 1723–1729.
17. Casazza, K., Gower, B.A., Willig, A.L., Hunter, G.R., Fernandez, J.R., Physical Fitness, Activity, and Insulin Dynamics in Early Pubertal Children, *Pediatric Exercise Science*., 2009, 21(1), 63–76.
18. Morrow, J.R., Freedson, P.S., Relationship Between-Habitual Physical Activity and Aerobic Fitness in Adolescents, *Pediatric Exercise Science*., 1994, 6, 315–315.
19. Strong, W.B., Malina, R.M., Blimkie, C.J., Daniels, S.R., Dishman, R.K., Gutin, B., Hergenroeder, A.C., Mus,t A., Nixon, P.A., Pivarnik, J.M., Rowland, T., Trost, S., Trudeau, F., Evidence based Physical
20. Dubé, J.J., Allison, K.F., Rousson, V., Goodpaster, B.H., Amati, F., Exercise Dose and Insulin Sensitivity: Relevance for Diabetes Prevention, *Medicine* & *Science* in *Sports* & *Exercise*., 2012, 44(5), 793–799.
21. Ball, G., Huang, T.T., Gower, B., Goran, M., Longitudinal Changes in Insulin Sensitivity, Insulin Secretion and Beta-Cell Function during Puberty in Caucasian and African American Youth, *Journal of Pediatrics.*, 2006, 148, 16–22.