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The Effect of a Progressive Run Training Program on Lipid and Lipoprotein Profiles in High School Girls

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Abstract: The purpose of this study was to investigate the effect of a progressive run training program on lipid and lipoprotein profiles in high school girls. 37 healthy untrained female students were randomly selected as the participants from among the high school girls in Bandar Gaz city. The subjects were randomly assigned into two groups; an experimental group (n=18) with age 15.22±0.22 yr, height 159.81±1.5 cm, weight 58.13±2.86 kg; and a control group (n=19) with age 14.94±0.19 yr, height 159.17±1.4 cm, and weight 53.02±2.06 kg. Rockport walking test was used to calculate every participant's maximal oxygen consumption both before and after the training program. The training intensity was determined via monitoring maximum heart rate. The experimental group participated in the training (progressive run) for 4 weeks, 4 days a week, 31 minutes per session during the first week, 35 minutes per session during the second and third weeks, and 50 minutes per session during the fourth week at the intensity of 40, 50, 60, 70 and 80 percent maximum heart rate. Fasting Blood samples were taken from every participant before and after training to examine the concentration of lipid and plasma lipoproteins. The results showed that the training program has significantly increased VO2Max and high-density lipoprotein-cholesterol (HDL-C) ($P<0.05$) and significantly decreased the concentration of triglyceride (TG) and very low-density lipoprotein-cholesterol (VLDL-C) in the participants. The increase in total cholesterol (TC) and low-density lipoprotein-cholesterol (LDL-C) were insignificant in either group. Despite the control group, LDL/HDL and TC/HDL ratios decreased in the experimental group though the decrease was not significant at the level of $\alpha=0.05$. Therefore, it may be concluded that the progressive run training program for 4 weeks positively affected the lipid and lipoprotein profiles and increased cardiovascular fitness in the participants.

Key words: lipid, lipoprotein, progressive run training.

INTRODUCTION

Nowadays, developments in industry, technology, facilities and inactive (computer) games have directed the society toward indolence and inactivity (Aellen,1993). Lack of physical activity has in turn led to the development of hypokinetic diseases such as obesity, hypertension, hyperlipidemia, coronary artery diseases and muscular skeletal diseases (Aguilo, 2003). On the contrary, exercise and physical activities play a crucial role in the maintenance of health and life quality via preventing many of the abovementioned diseases. Women form 50% of human population. With regard to their increasing responsibilities in the modern world,

Women are exposed to health conditions induced by inactivity. Research has shown that, like men, women are vulnerable to cardiovascular diseases because androgen variations both before and after menopause may change blood lipid concentration and increase the risk of coronary heart diseases (Dowling, 2001; Anyanwu, 2011). Despite the evidence that emphasize the importance of physical activity, optimal levels of physical activities have not yet been identified for different age groups. In this regard, the researchers posed the following question: What intensity and amount of exercise is enough to produce favorable changes in lipid and lipoprotein profiles?

Many studies have investigated this question so far (Anyanwu, 2009; Harvey, 2003; Health, 1983). However, the results have been contradictory due to differences in training protocols and participants' anthropometric characteristics (e.g. gender, age, athlete vs. non-athlete, etc) (Anyanwu, 2011; Gordon, 1998; Gordon, 1977; Grandgean, 1096; Erfan Zaki, 2011; Hollman,1993). To investigate the question, a unique type of training protocol has been employed in the present study. The advantage of the present study over the previous ones is the consistency of exercise intensity. In other words, the present study draws on a type of aerobic training in the form progressive run whereby the exercise intensity increases every 2 minutes (at 40, 50, 60, 70, and 80 percent maximum heart rate). Besides, as a field study using the method of constant intensity, the findings of the research may be presented to coaches to use in real contexts. Therefore, the present study aims at investigating the effects of a progressive run training program on lipid and lipoprotein profiles in 14-17 year-old girls.

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Methodology:

The population of the study consisted of all 14-17 year-old female students in Bandar Gaz city of Golestan province. From among the girl high schools, 4 high schools were selected based on two-stage cluster random sampling. Subsequently, 37 healthy non-athlete female students from these 4 high schools were selected as the participants using table of random numbers. The subjects were randomly assigned into an experimental (n=18) and a control (n=19) group. Table 1 illustrates the participants' general characteristics.

Table 1: Descriptive characteristics of the subjects.

Variables	Mean±SE	Mean±SE
	Experimental group	Control group
Age	15.22±0.22 yr	14.94±0.19 yr
Height	159.81±1.5 cm	159.17±1.4 cm
Weight	58.13±2.86 kg	53.02±2.06 kg

Instrument And Procedure:

The participants' weight, body mass index (BMI), maximal oxygen consumption (VO2max), resting heart rate and maximal heart rate were measured both before and after the training program. BMI was calculated using the formula: weight/height2 (kg/m2) (3). The subjects' VO2max was calculated indirectly using Rockport walking test. To this end, the subjects were to walk one mile (1609) at their maximum walking speed. Their walking time and heart rate were recorded after the test. Then the following formula was run to calculate VO2max indirectly:

VO2max= 132.853- (0.0769×weight) – (0.3877×age) + (6.315×gender)- (3.2649×test completion time)- (0.156× final heart rate).

In this formula, VO2max is calculated based on ml/kg per minute. Also, the weight is measured in pounds, test completion time in minutes and decimals, and age in years. Zero was replaced for gender in the above formula. To calculate the resting heart rate in the sitting position, the individuals' pulses were taken for 6 seconds and the counted numbers were then multiplied by 10. Maximal heart rate was monitored in three stages (before training, after 8 sessions of training, and at the end of the training program) to determine the exercise intensity. To this end, the subjects were to run for 90 seconds at their maximum speed and then their heart rates were counted (table 2).

Table 2: Physical characteristics of the subjects.

Variables	experimental group		control group	
	Pre-training	Post-training	Pre-training	Post-training
VO_{2Max} (ml/kg/min)	42.01±1.31	45.00±1.12*	43.18±1.61	42.86±34.1
BMI(kg/m^2)	22.67±0.86	22.82±0.81	21.19±0.92	21.09±0.95
HR_{Max}(beats/min)	205.00±3.35	186.6±5.94*	181.25±9.53	180.00±10.00
HR_{Rest} (beats/min)	93.88±3.24	87.22±2.77	97.89±3.71	96.84±2.65

* significant at $p \leq 0.05$

Training Protocol:

The training program consisted of an aerobic progressive run exercise. The program was distinct in that the training intensity was consistent. The participants performed the exercise at 40, 50, 60, 70 and 80 percent maximum heart rates. In other words, the training intensity increased every 2 minutes.

The experimental group participated in the training program for 4 weeks, 4 days a week, 31 minutes per session during the first week, 35 minutes per session during the second and third weeks, and 50 minutes per session during the fourth week. Before the beginning of the main program, they did pilot exercises for 3 days during which they were taught how to count heart rate, running pace and other necessary points. In the main training sessions, the subjects were to do warm-up for 10 minutes first. Then they did the exercise after which they were to make recovery exercises for 15 minutes (Table 3). As to the exercise intensity, 30 seconds before reaching every intensity point, the heart rate was increased and kept for 2 minutes if it proved appropriate. In order to adjust the intensity and load of exercise, the participants did the 90-second test (running at their maximum speed) three times to determine their maximal heart rates. In this regard, they did the test before the training program for the first time, after 8 sessions of training for the second and at the end of the program for the third time. Subsequently, based on the results of the 90-second test, the subjects did the training at 40, 50, 60, 70 and 80 percent maximum heart rates.

Blood Sampling And Analysis:

Blood samples were taken from every participant twice (24 hours before and 24 hours after the training) in the sitting position while they had no food for 12 hours before the samplings. The blood was taken from the left and right arm veins.

HDL was measured using CHOD-PAP enzymatic method. TG and TC were measured using special kits and METROLAB 1600 DR. LDL and VLDL were measured using Friedewald equation.
LDL (mg/dl) = (HDL-C – TG/5)
VLDL (mg/dl) = TG/5

Paired- samples T Test was used to examine the difference between the means in the pre and post-training and independent-samples T Test was run to examine the differences between groups.

Table 3: Training protocol.

Number of repeat	80-85%	70-75%	60-65%	50-55%	40-45%	Intensity Week
1			*	*	*	First
1	*	*	*	*	*	Second
1	*	*	*	*	*	Third
2	*	*	*	*	*	Fourth

Results:

Table 4 illustrates the variations in lipid and lipoproteins both before and after the training program. TC increased in either group after the progressive run training program though the increase was not significant at the level of α=0.05. After 4 weeks of training, TG concentration decreased significantly in the experimental group ($P<0.05$) but insignificantly.

in the control group. HDL-C significantly increased in the experimental group ($P<0.05$); however, it significantly decreased in the control group. Despite the control group, VLDL-C significantly decreased in the experimental group ($P<0.05$). LDL-C insignificantly increased in either group. LDL/HDL and TC/HDL ratios insignificantly decreased in the experimental but increased in the control group. After 4 weeks of progressive run training, VO2max significantly increased in the experimental group ($P<0.05$).

Table 4: Lipid and lipoprotein concentrations before and after progressive run training program.

Variables	Mean±SE		Mean±SE	
	experimental group		control group	
	Pre-training	Post-training	Pre-training	Post-training
TC(mg/dl)	160.72±5.51	167.55±8.32	153.31±4.93	157.36±6.78
TG(mg/dl)	111.55±4.09	96.05±4.10*	112.89±7.94	104.57±4.13
HDL(mg/dl)	42.55±1.59	47.50±1.39*	46.47±2.28	42.42±1.96
VLDL (mg/dl)	22.31±0.81	19.21±0.82*	22.57±1.58	20.91±0.82
LDL (mg/dl)	95.77±5.04	100.88±8.25	84.21±5.11	94.00±41.7
LDL/HDL(Ratio)	2.28±0.12	2.11±0.18	1.93±0.18	2.31±0.25
TC/HDL (Ratio)	3.82±0.12	3.53±0.18	3.44±0.21	3.82±0.26

* significant at $p\leq0.05$

Discussion And Conclusion:

TC and TG:

The present study were to investigate the effect of progressive run on lipid and lipoprotein profiles in high school girls. After 4 weeks of training, TC increased in either group but the increase was not significant. In addition to exercise, TC increase may also be attributed to some factors like the subjects' diet. This is inconsistent with the findings of Grandgean (1996), Gill (2001), Kab park (2003), and Skoumas (2003) who reported a decrease in TC. However, it is consistent with the findings of Siconolfi *et al* (1982) and Naruhiko *et al* (1988) who reported an increase in TC. On the other hand, TG decreased in either group, yet it was significant only in the experimental group. This finding about TG corresponds to the findings of Kab Park (2003) and Goodyear (1990), who reported a decrease in TG. However, it is inconsistent with the findings of Gill *et al* (2002) who reported an increase in TG. Variations in TG concentration may be attributed to lipoprotein lipase (LPL) responses to the exercise training. LPL is an enzyme that regulates lipoproteins and hydrolyses TG present in lipoproteins. Research has shown that regular aerobic exercises reduce and control hepatic lipase. Consequently, the production of TG presents in VLDL and LDL decreases (Madsen, 2004; Pronk, 1995). It is notable to say that inconsistency in the findings of different studies may be attributed to such factors as the type, intensity, duration, or amount of exercises as well as the training period and subjects' gender. One of the long-term effects of exercise on lipid profile is the constant and significant decrease in TG concentration; however, the exercise-induced variations in lipid have scarcely been investigated in women even in recreational exercises. Nevertheless, some studies have tended to pay heed to gender effects in this regard (Tran, 1989; Wells, 2000). Failure to attain favorable results may be due to such factors as loss of participants during the research process and the amount or hours of training sessions. TG decrease and TC increase in this study may relate to the follicular phase of menstrual cycle because research has shown that the early follicular phase entails the least variations in lipid and lipoprotein concentrations (Gordon, 1977).

HDL:

Most of the studies that have investigated an aerobic or endurance exercise have reported either significant or insignificant increase in HDL-C concentration as a factor supporting the heart against coronary diseases. The present results are consistent with the findings of Kab Park (2003) who reported an increase in HDL concentration (Kantor, 1987; Lucia, 2001). The inconsistency of the present findings with some previous findings may relate to the methods, duration and intensity of aerobic exercises as well as the number of training sessions and baseline lipoprotein levels (Aguilo, 2003; Gordon, 1977; Siconolfi, 1982). Lack of any significant variation in lipid or plasma lipoprotein concentration may relate to baseline lipid and lipoproteins concentration in the participants. Tran *et al* (1989) emphasized the importance of baseline lipid concentration in identifying the magnitude and direction of variation in lipid concentration in exercise training studies. Davis *et al* (1992) reported that one session of maximal training (less than 90 minutes), independent of training intensity, does not produce favorable responses in lipid and lipoprotein profiles in active men with high baseline HDL concentration. The training-induced increase in HDL-C bears a complex mechanism. Such enzymes as LPL, hepatic triglyceride lipase (HL) and Cholesteryl ester transfer protein (CETP) play the major role in the variations of HDL-C concentration. LPL is the most important factor affecting the variations in HDL-C concentration via hydrolyzing plasma TG. Still, high LPL activity does not account for HDL-C increase immediately after the training. Increases in HDL-C concentration immediately after training may relate to the decrease in CETP concentration or activity. The results showed that the concentration of CETP, which transfers the lipids in HDL-C molecule and other lipoproteins, decreases after the training, Decreases in CETP decelerate HDL-C catabolism (increase in half life), which eventually increases HDL-C concentration (Warren,2000). In turn, HDL increase reduces the risk of coronary heart diseases. Therefore, the therapeutic effects of training and physical activity have been emphasized as a useful strategy to reduce the risk of heart diseases (Sohal, 1988; Superko, 1991).

VLDL and LDL:

VLDL, which is the most important carrier of TG in plasma, significantly decreased in the experimental group. Since TG is consumed during endurance exercises, enzymes tend to break down VLDL at a higher rate to supply the needed energy during exercise. On the other hand, LDL-C concentration insignificantly increased in either group (Gill, 2002; Goodyear, 1990). In most of the long-term aerobic exercises, LDL concentration decreases in the exercisers. It is notable to mention that the total LDL concentration was monitored in this study. However, the LDL increase in this study was not detrimental, rather it is the increase in low density LDL particles which is harmful (Eisenmann, 2001; Fergosen, 2003; Felg,1995).

LDL/HDL and TC/HDL Ratios:

HDL-C concentration should not be regarded as the only proactive factor against Arteriosclerosis, rather the TC/HDL ratio ought to be considered as the anti-arteriosclerosis indicator. Lower TC/HDL-C ratio bears the lower risk of arteriosclerosis (Skoumas, 2003). Therefore, the risk ratio can be calculated via dividing the TC by HDL-C or dividing the LDL-C by HDL-C. It has been proved that these ratios are more precise in predicting cardiovascular diseases comparing to measuring cholesterol concentration. The ratio of 3/5 or smaller is ideal while the ratio of 4/5 is close to the mean danger and the ratio of 5 or higher is essentially dangerous (Tikkanen, 1999). In the present study, both LDL/HDL and TC/HDL ratios decreased in the experimental group as much as 0.17 and 1.29, respectively. Yet, these decreases were not statistically significant. The present findings regarding the decrease in LDL/HDL ratio is consistent with the findings of Hollman (1993) and Tikkanen (1999). The present findings regarding the decrease in TC/HDL ratio after training correspond to the findings of Naruhiko (1988), Lokey (1989), Hollman (1992), Tikkanen (1999), and Kab Park (2003). Despite the lack of significant decrease in TC/HDL and LDL/HDL ratios in the present study, research has shown that long-term aerobic exercises taken either regularly or temporally may lead to the improvement of cardiovascular health factors, particularly in view of lipolysis (Wells, 2004; Williford, 1988).

VO2max:

VO2max increased in either group, yet the increase was significant only in the experimental group after the training program. This is consistent with the findings of Williford (1988) and Tikkanen (1999). The improvement in cardiopulmonary function in this study may be attributed to the increase in VO2max. This indicates that the type of aerobic training used in this study can increase VO2max in 14-17 year-old girls. In other words, the training stimulus has been adequate enough to create cardiovascular adaptations in the participants.

The results revealed that training at regular intensities in terms of repeats, duration and intensity of exercise may be a good stimulus to improve the lipid and lipoproteins profiles in 14-17 year-old girls. Therefore, the selective aerobic training may be recommended to school coaches and teachers because it increases VO2max and creates favorable variations in lipids in the students of this age range, which may prevent the development of cardiovascular diseases in adulthood.

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