Original Article

Body Fat and Plasma Lipid Profile in Different Levels of Physical Fitness in Male Students

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ARTICLE INFORMATION

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ABSTRACT

Background: Adiposity is correlated with metabolic complications, such as insulin resistance, glucose intolerance, hypertension etc. that finally can lead to coronary heart disease (CHD). Physical activity plays an important role in prevention of these diseases. We aimed to study body fat and plasma lipids and lipoproteins in different levels of physical fitness; also to examine any relationship between body fat and level of physical fitness.

Methods: In this cross-sectional study carried out in Hamadan University of Medical Sciences (Hamadan, Iran) during 2010-2011, 80 healthy volunteer male students (19-27 yr old) were enrolled. The subjects were divided to three groups i.e. good, average and weak according to their physical fitness scores. Their lipid profile was determined using an auto-analyzer and commercial enzymatic spectorophptometric kits. Besides, body fat was determined using skinfold technique. The fitness tests were carried out for all participants, including: speed, stamina, aerobic endurance, muscular strength etc.

Results: The mean of body fat (%) in the subjects with good, medium and weak levels of physical activity was 8.25, 11.98, and 22.65 percent respectively. There were no significant differences in lipid parameters between the subjects with different level of physical fitness. A negative significant correlation was observed between physical fitness and body fat (r=-0.27, *P*=0.034). The body fat increased with increases in serum triglyceride.

Conclusions: The presence of difference in mean of body fat percent in different physical fitness confirms that aerobic activity improves the plasma lipid and lipoprotein profile, and can diminish the body fat.

Introduction

Obesity is an independent risk factor for several disorders such as stroke and type 2 diabetes[1]. Moreover, obesity resulting from any abnormal growth of adipose tissue is also directly associated with hypertension, type 2 diabetes, and heart as well as liver diseases[2]. Weight loss generally is associated with improvement in blood lipid and lipoprotein index[3].

Physical activity leads to increased capacity for exercise and physical fitness, and is highly beneficial to health. Physical activity and maintaining a good level of physical fitness not only prevents increase in body fat percentage (FP), but also is a risk reduction issue and improve lipids and lipoproteins levels[4]. Incidence rate of chronic diseases including Coronary artery disease (CAD) is lower in physically active people[5]. A study on elderly people aged 70 years and older also showed that physical activity level is dependent on people's social and physical factors[6]. In a study conducted on 7 to 10-yr-old children, association of reduced physical fitness with high BMI or waist circumference was shown[7]. Another study on elementary school children showed low probability of obesity and excess weight in people who exercised 30 min daily[8]. Sedentary lifestyle, together with high calorie diet has led to increased incidence of obesity and excess weight in Western societies. Leyk et al. on a study on the young population showed reduced physical fitness is associated with weight gain[9]. They also indicated that physical fitness had a positive relationship with education and a negative relationship with BMI[9]. Considering importance of physical activity and physical fitness, it is recommended and emphasized that care providers should advise patients about exercise and fitness[5].

Physical fitness is assessed using different practical tests. Peak oxygen uptake test (VO$_2$max) is an important component of physical fitness. Direct association between VO$_2$max and HDL-C are reported. Duration and intensity of physical activity are important in lowering blood cholesterol and triglyceride. Physical activity with intensity above 7 kcal/min is associated with higher HDL-C[10]. VO$_2$max is directly associated with HDL-C and inversely associated with log (triglyceride), and atherogenic index[10].

Muscle strength and muscle endurance are other health related components of physical fitness tests; they are measured by sit-up and lift-up tests. Speed, agility, and strength

are other components that are skill-related. However there are a lot of studies showing that physical fitness is an important health factor and beneficial for lipid metabolism, still some details about the threshold and type of exercise that can improve lipid metabolism is not fully elucidated.

Nevertheless the lowest level and type of physical activity that can cause desirable physical fitness and its effects on the lipid metabolism are still largely unknown.

This study was aimed to survey the serum lipid indices in different physical fitness levels and also to determine any possible relationship between the physical fitness, body fat percentage and serum lipid indices. To approach this fact we studied lipid profile, BF% and various components of physical fitness in a group of young students with different physical fitness.

Methods

This cross-sectional descriptive study was conducted on male students who had chosen physical education as their general subject in Hamadan University of Medical Sciences, Hamadan, Iran during 2010-2011. Sample size was calculated according to the results of similar studies and using sample size formula in this type of studies[11]. Accordingly, a total of 80 subjects were randomly selected from the male students.

All subjects were in healthy physical and physiological conditions and had no history of diseases. The subjects after filling a questionnaire about the health and activity were examined by a physician and those who had the inclusion criteria were referred to a laboratory for taking a blood sample. Those with primary hyperlipidemia and also those considered obese, given their BMI and in accordance with international standard definition and classification of obesity and overweight (National Institutes of Health, National Heart, Lung, and Blood Institute...) were excluded from the study[12]. Therefore, people with BMI in excess of 30 were considered obese. Furthermore, none of the subjects were smokers.

Subjects' fasting blood samples (12-14 hours) were taken for serum lipid profile assay. Lipid profile (total cholesterol, triglyceride, HDL-Cholesterol) was determined using an auto-analyzer and the commercial available kits (Pars Azmoon, Tehran, Iran). LDL- C was calculated according to the Friedewald equation. Besides, body percentage fat was calculated using skinfold technique[12]. In this technique triceps (A) and subscapular (B) skinfolds were measured in millimeter and percent of body fat was calculated according to the formula: 0.43A+0.58B+1.47. Subsequently, subjects were assessed in terms of physical fitness using AHPHERD test containing cardiovascular, respiratory fitness, hand grip strength, jumping, agility, speed, and endurance tests and also VO_2 max assay (Queen's test). Subjects were divided into 3 groups of good, moderate and poor physical fitness according to the Z scores in physical fitness standard criteria[13]. One-way variance analysis was used to determine differences in variables at different levels of physical fitness, and Pearson correlation coefficient was used to assess the relationships between variables. Results with $P<0.05$ were considered statistically significant.

Results

Subjects' characteristics are presented in Table 1. As the BMI of subjects show none of them were overweight or obese and they were in a narrow range of age. Table 2 shows the results of measured parameters in subjects' fitness tests. As this table shows, the components of physical fitness tests in the studied subjects were in normal standard range.

Table 1: Demographics characteristics of studied subjects

Characteristic	Range		Mean	SD
	Min	Max		
Age (yr)	19	27	22.2	2.1
Height (cm)	165	186	176.6	5.4
Weight (kg)	51	96	68.1	8.9
Lean body mass (kg)	47	74	59.6	5.2
Fat weight (kg)	1.4	26.5	8.6	5.2
Percentage fat (%)	2.4	27.8	12.2	5.9
BMI (kg/m^2)	17.0	31.8	21.7	2.9

Table 2: Results of physical fitness tests in studied male students

Test	Range		Mean	SD
	Min	Max		
$VO_{2\,max}$ (ml/kg min)	34.1	60.9	44.9	7.2
30 m run (sec)	3.7	5.1	4.3	0.3
545 m run (sec)	83.0	210.0	130.7	23.1
Sit-ups (number/min)	25.0	75.0	50.2	10.9
4×9 m run (sec)	8.0	10.6	9.1	0.6
Paired long-jump	1.6	2.9	2.3	0.2
Lift-up (number)	0.0	20.0	7.7	5.8
Hand Grip Strength (kg)	6.8	75.0	51.6	10.5

There were no significant differences in lipid parameters between the subjects with different level of physical fitness.

Test results of physical fitness components and also body fat percentage related to the 3 categories of physical fitness are presented in Table 3. These results indicate significant differences ($P=0.001$) in all parameters among the 3 categories of physical fitness. Analysis of results showed a significant positive relationship ($r=0.395$, $P=0.001$) between PF and concentration of plasma triglyceride (Table 4). However, the relationship between PF and concentration of serum total cholesterol and LDL-C was not significant. There was a significant and inverse relationship between FP and concentration of HDL-C ($r=-0.24$).

Table 3: Comparison of the of physical fitness components scores (mean±SD) in 3 different fitness categories

Components	Fitness category						*P* value
	Good		Moderate		Poor		
	Mean	SD	Mean	SD	Mean	SD	
VO_{2max} (ml/kg/min)	53.1	5.9	44.7	6.8	37.1	3.9	0.001
30 m run (sec)	3.8	0.2	4.3	0.7	4.7	0.5	0.001
545 m run (sec)	100.7	10.2	131.9	22.1	155.5	6.6	0.001
Sit-ups (number/min)	61.7	3.6	50.2	10.3	33.3	4.3	0.001
4×9 m run (sec)	8.2	0.2	9.2	0.6	9.9	0.3	0.001
Paired long-jump	2.5	0.2	2.3	0.2	2.0	0.3	0.001
Lift-up (number)	11.7	4.0	7.7	5.8	5.0	0.6	0.001
Strength (kg)	59.3	10.4	51.4	10.3	44.3	9.0	0.050
Body fat (%)	8.3	4.1	12.0	5.4	22.7	5.9	0.001

Table 4: The Serum lipid indices and their relationship with fat percentage and serum lipid indices

Serum lipid index (mg/dl)	Mean	SD	Correlation coefficient	*P* value
Triglyceride	115.8	56.1	0.395	0.001
Cholesterol	178.9	31.9	0.130	0.249
Low density lipoprotein-cholesterol	106.7	27.6	0.055	0.626
High density lipoprotein-cholesterol	48.4	6.8	-0.240	0.032

There was a significant and inverse relationship between FP and fitness level (P=0.034, r=-0.27), meaning that physical fitness increases with decreasing body FP.

Discussion

The studied subjects in this survey had different levels of physical fitness; comparison of all components of physical fitness tests in different group of physical fitness levels i.e. good, moderate and poor showed statistically significant differences.

Studies have clearly shown the role of increased level of plasma lipids and lipoproteins in the risk of coronary heart diseases (CHD), and in their inverse relationship with physical activity[14]. Although only a few studies have investigated all physical fitness factors' relationship with plasma lipid patterns, if we accept that there is a relationship between each of the fitness factors and plasma lipid patterns, then it can be concluded that coronary-vascular-respiratory fitness, based on VO_2max assay is one of the most effective parts of physical fitness in prediction of CHD prevention.

As far as the relationship between body FP and plasma lipid patterns is concerned, the obtained results indicated a significant and positive relationship between PF and triglyceride (r=0.395, P=0.001) level and a negative relationship with HDL-C concentration (r=-0.0240, P=0.032). This study is in line with the study by Kraus et al. in 2002[1], in which in a 10-year investigation, triglyceride level and HDL-C concentration were directly related to body FP. High level of HDL-C is probably related to low level of triglyceride. An inverse relationship between TG and HDL-C concentrations has been reported, which seems to be due to lipoprotein lipase activity with increase in HDL- concentration and a decrease in TG as a result of response to increased physical activity and consequently, reduction in FP[15]. In healthy person and even in patients with ischemic heart disease, diabetes and renal failure, moderate-intensity activities usually produce favorable alteration in lipoproteins[16]. Furthermore Williams et al. studying on 48 healthy, sedentary men who performed supervised running and 33 sedentary controls indicated that " plasma concentrations of HDL-C and LDL-C generally did not begin to change until a threshold exercise level (ten miles run per week) was maintained for at least nine months; fitness increased and percent body fat decreased sooner and at lower exercise levels than required for HDL-C and LDL-C concentration changes" [17]. Long and mild activities (a few miles of daily walk) did not cause a significant increase in HDL-C concentration[18], which is a similar fact with our findings. Compared to less active people, men and women that are generally more active during their leisure time or at work tend to be physically fitter, and on average have higher levels of HDL-C[19]. A possible reason for high HDL-C in physically fit people is its formation from apo-A1 and cell lipids[20-25].

The other noticeable finding of our study was significant and inverse relationship between FP and fitness level (P=0.034, r=-0.27), that indicates lowering FP can improve physical fitness.

On the other hand since it has been shown that high strength training can improve serum lipid profile and PF, it can be recommended to achieve a better physical fitness. Our obtained data on body fat percent in different level of physical activity which is presented in Table 3 strongly support this aspect. Also higher strength in subjects with good fitness is another evidence for this conclusion.

Obesity, impaired glucose tolerance test, hyperlipidemia, hypertension, and insulin resistance are parts of metabolic syndrome associated with increased cardiovascular morbidity. Results of studies in this area confirm association of aerobic activity with metabolic parameters and fat distribution, and it has been suggested that improvement and increase in this activity may improve predicting indices of CAD[20].

A study by Taralov et al. on adolescent boys and girls confirms that physically active people at this age have lower levels of cholesterol, and their plasma triglyceride level is not related to type of exercise, and also long exercise cannot lower serum HDL (in either sexes)[21].

A positive correlation was found in our study between TG and FP%. In terms of triglyceride level, most studies report reduced level of triglyceride due to increased fitness, while other studies report physical exercise less affected triglyceride as compared with weight loss[22-24].

Moreover, there are some studies in childhood and youth that indicate adiposity level can be a determinant of physical activity behavior and an intervention is required to promote physical activity in overweight children[26, 27]. Given the significant relationship between FP and plasma lipid patterns, when weight loss is induced by physical activity, it can be beneficial in improving lipids and lipoprotein states.

Since participants in this study were male young students (19-27 years old), it can be mentioned as a limitation of our study and the results can not be extrapolate to other sex or aged groups. To further study in this field a clinical trial study can be designed and performed on the effect of combination of supervised physical exercise and hypo-caloric diet on FP and physical fitness. Also to obtain more details about lipid profile changes, study of apoproteins and enzymes which are involved in lipid metabolism can be recommended.

Conclusions

The presence of difference in mean of body fat percent in different physical fitness confirms that aerobic activity improves the plasma lipid and lipoprotein profile, and can diminish the body fat. Supervised physical exercise can be recommended to improve body composition and lipid profile. Given the therapeutic objectives of physical activity to maintain physical fitness (especially in sedentary occupations) and its desirable effects on lowering CHD risk factors, low intensity long physical activities are recommended.

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Conflict of interest statement

The authors have no conflict of interest to declare.

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