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ORIGINAL RESEARCH

THE RELATION BETWEEN MAXIMAL AEROBIC CAPACITY AND LIPIDS PROFILE OF STUDENT AGED 12-15.

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Abstract
Elevated lipid levels and lack of exercise and physical activity in childhood, can predict cardiovascular disease later in life. The aim of this study was to investigate cardiovascular disease risk factors among young children and whether serum lipids were related to aerobic fitness determined by peak oxygen consumption. The number of students who participated in the study were 120 (59 boys and 61 girls), aged 12 to 15. They were examined for maximal aerobic capacity (VO_{2max}) and the lipidemic profile (triglycerides, cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol). Results revealed that student with better aerobic capacity had significantly lower levels of triglycerides $F_{(2,117)}$=17,55 p< ,000 and higher levels of HDL-C $F_{(2,117)}$=3,71 p< ,027. There were not found differences in lipids levels among boys and girls at these ages. In conclusion the risk of cardiovascular disease, because of elevated lipids levels may be reduced by improving aerobic capacity.
Key words: *blood, exercise, cholesterol, lipids,$VO_{2max.}$*

Introduction

The sedentary lifestyle, lack of exercise and physical activity are considered as risk factors for cardiovascular diseases (CVD). These habits are adopted as lifestyle, by a large number of young people and adolescents (1). The dyslipidemia is a disorder caused by the increased concentration of lipids or lipoproteins in the blood. High levels of total cholesterol (TC) (2), triglycerides (TG) (3), low density lipoprotein (LDL-C) (4) and low levels of high density cholesterol (HDL-C) (5), correlate with the progression of atherosclerosis and higher incidence of coronary heart disease (6). Clinical data show that high concentrations of total cholesterol, triglycerides and low density lipoprotein (LDL-C) are risk factors for cardiovascular disease. It has also been reported that increased levels of high density lipoprotein (HDL-C), have a positive effect in reducing cardiovascular risk (6).

It is well known that dyslipidemia is determined by genetic and demographic factors such as race, gender, income, employment or education level, however a person's lifestyle plays a significant role as well (7). Several studies were conducted to determine the relationship of lipids with lifestyle (8). The lipid levels in childhood and adolescence are crucial because, studies have shown that the first stage of atherosclerosis begins, often, in this age and it is associated with high levels of cholesterol and LDL-C and low levels of HDL-C (9). Significant risk factors for cardiovascular diseases, such as elevated LDL-C levels and low HDL-C, tend to be concentrated in young people, leading to an increased risk of CVD in later life (10).

The reduction of cholesterol levels in people can lead to significant reduction of coronary events and mortality due to heart disease in adulthood of an individual. However, since there are no long term studies on the relationship between levels of blood lipids measured in childhood and subsequent coronary heart disease in later life, this specific relationship results from indirect data (11).

Several pediatric studies that have explored the relationship between risk factors for cardiovascular disease and lipid profile, led to conflicting conclusions, due to the delimitations and limitations of each investigation or the particular designs that were applied to each of them (12). Also many of these studies included young people of different ages, so there were no comparable results, because the age and maturity of young people have a major impact on lipid profile in these age groups (13).

Regular exercise and physical fitness are considered key factors affecting the overall likelihood of cardiovascular disease and are considered effective for preventing coronary heart disease (14). According to a survey on physical activity only 55.4% of American youth exercised with moderate intensity and only 35.5% with vigorous physical activity for less than twice a week (15).

The exercise favorably affects a number of cardiovascular risk factors such as obesity, insulin resistance and blood pressure, while a beneficial effect on lipoprotein profile as well (16). In addition a reduction of concentration of triglycerides and LDL-C is attained due to the regular exercise, contributing in this way to the protection of an organism (16). However, the most distinct and consistent effect of exercise on lipoprotein profile is to increase the levels of high density lipoprotein (HDL-C) (16). As for the levels of triglycerides, there are conflicting studies, which indicate either an increase (22), or no change in their levels at all (17), resulting from exercise. Taken into consideration all the above and since there is no similar survey in Greece, the purpose of this study was to investigate, whether lipid levels in school age associated with good fitness and especially the aerobic capacity, expression of which is the maximum oxygen uptake.

Methods

Design and Participants

The study sample consisted of 120 students (59 boys and 61 girls) aged 12-15 years. Participants were informed about the purpose of the research. Students who exercised regularly in groups or clubs, exercised regularly in private gyms or follow any kind of training program, were excluded.

Biochemical tests

Parents were informed about the purpose of the research and signed an agreement before the blood donation. Test results were strictly personal. Received blood volume 10 ml. after at least 12 hours fasting. The blood samples were centrifuged after coagulation. Used Automatic Biochemical Analyzer OLYMPUS AU-560. The concentration of triglyceride was measured using the oxidase glycerol (GPO-PAP), the concentration of cholesterol was measured using the cholesterol oxidase (CHOD-PAP) and the concentration of HDL-C with anosoanastaltiki method. Finally, the LDL-C was calculated by applying the following equation: LDL-C = TC-(HDL-C + triglycerides / 5) (18). The levels of blood lipids, which were considered to be above the normal limit for cholesterol was 200 mg / dL, triglycerides of 150 mg / dL, the LDL-C 130 mg / dL, and HDL- C <40 mg / dL (2).

One mile run walk test (1609 m.)

The participants were lined up behind the starting line. Students were told to run properly, without changes in their running speed during the race. Walking was allowed but the students were encouraged to finish the race as quickly as possible. An electronic timer used and the score was the time at the moment of termination.

Calculation of maximum oxygen uptake

The methodology for the calculation of maximum oxygen uptake of the Fitnessgram test battery (19), was used for the assessment of aerobic capacity. The equation for prediction of VO_{2max} (ml × kg-1 × min-1) was based on the study of (20), which takes into account the performance on the one mile run walk test, age, sex and body mass index. The categorization of maximum oxygen uptake was in accordance with the norms of the Fitnessgram test battery. These categories were the "best zone", the "health fitness zone" and the "needs improvement zone". For example, at the age of 14 years in boys, values of VO_{2max} >52ml/kg/min were in the best zone, the health fitness zone of 42-52 ml/kg/min and the needs improvement zone <42 ml/kg/min. For girls of the same age the corresponding values were VO_{2max}>43ml/kg/min, $35 \le VO_{2max} \le 43$ml/kg/min and VO_{2max}< 35ml/kg/min. For all age groups the norms of the Fitnessgram test battery were used (19).

Statistical analysis

For the statistical analysis of data, Multivariate Analysis of Variance (MANOVA) with three dependent variables (VO_{2max} × age × sex) and post hoc evaluations by Scheffe´ test were used. For the statistical analysis of data, the statistical package SPSS 11 was used (SPSS inc., Chicago, Illinois, USA) and the significance level was set to p<0,05.

Results

The mean values of the concentration of triglycerides, cholesterol, LDL-C, the HDL-C, and maximum oxygen uptake per age and sex are presented in Table 1.

Table 1. Mean values and standard deviation of triglycerides, cholesterol, LDL-C and HDL-C per age and sex.

Age (years)	N	Triglycerides (mg/dl) (TA)	Cholesterol (mg/dl) (TA)	LDL-C (mg/dl) (TA)	HDL-C (mg/dl) (TA)	VO_2 max (ml/kg/min) (TA)
Boys						
12	**11**	59,27 (22,00)	165,45 (31,73)	96,09 (23,74)	57,45 (12,77)	51,37 (4,14)
13	**16**	61,81	170,88	105,31	53,19	47,45
14	**21**	60,43 (22,56)	168,57 (30,50)	103,86 (25,71)	52,71 (10,44)	47,84 (7,27)
15	**11**	67,82 (43,10)	159,00 (36,55)	98,36 (32,61)	47,09 (13,57)	45,22 (6,90)
Girls						
12	**17**	75,71 (46,99)	181,53 (27,95)	112,53 (19,58)	53,53 (15,77)	39,99 (3,98)
13	**15**	78,93 (29,23)	178,40 (23,84)	106,33 (25,40)	56,20 (11,26)	38,21 (4,57)
14	**17**	52,47 (17,92)	171,00 (34,65)	105,53 (29,79)	55,41 (10,90)	40,67 (4,67)
15	**12**	53,08 (11,20)	161,67 (25,71)	95,67 (23,81)	56,50 (10,61)	40,29 (3,65)

It was used Multivariate Analysis of Variance (Manova) 2x3. Dependent variables, triglycerides, cholesterol, LDL-C, HDL-C, compared with VO_{2max}, age and sex and interactions of VO_{2max}, age and sex. Examined if there were differences in levels of triglycerides, cholesterol, HDL-C and LDL-C, because of VO_{2max}, age and sex. The results based on Wilks' L=0,63 showed that there were statistically significant differences in the independent variable VO_{2max}, $F_{(8,190)}=6{,}06$ and $p<0{,}00$. The relationship between the combined dependent variables triglycerides, cholesterol, LDL-C and HDL-C with the independent VO_{2max}, was low ($n^2=0.20$). Statistically significant contribution to the prediction of differences in VO_{2max}, were the variables that measure the HDL-C, with $F_{(2,98)}=3{,}88$, $p<0{,}02$ and $n^2=0{,}07$, and triglycerides with $F_{(2,98)}=12{,}88$, $p<0{,}00$ and $n^2=0{,}20$. Regarding to age, sex, and the interactions of sex × age, sex × VO_{2max}, and sex × age × VO_{2max}, results did not reveal significant differences for any of the examined variables.

The mean values and standard deviations of the levels of triglycerides, cholesterol, the LDL-C and HDL-C, according to VO_{2max} (best zone, healthy fitness zone and needs improving zone) are shown in Table 2.

Table 2. Mean values and standard deviation of lipids levels according to the category of VO_{2max}

	Category VO_{2max}	N	Mean	Standard Deviation
Triglycerides (mg/dl)	best zone	28	59,46	21,09
	healthy fitness zone	66	54,74	19,25
	needs improving zone	26	91,46	43,84
Cholesterol (mg/dl)	best zone	28	174,21	32,50
	healthy fitness zone	66	170,32	31,62
	needs improving zone	26	166,65	22,45
LDL-C (mg/dl)	best zone	28	108,86	28,96
	healthy fitness zone	66	103,44	25,96
	needs improving zone	26	99,23	18,99
HDL-C (mg/dl)	best zone	28	54,04	8,67
	healthy fitness zone	66	56,24	11,82
	needs improving zone	26	48,31	13,75

After that, Post Hoc analysis using Scheffe´ method of the dependent variable triglycerides compared with the category of VO_{2max}, it was proved that there are significant differences between the participants who belong to the “best zone” and the “healthy fitness zone” and those at the “best zone” and “needs improvement zone”. Also, with Post Hoc analysis using Scheffe method of the dependent variable HDL-C, compared with VO2max, it was proved that there are significant differences between participants who belong to the “best zone” and the “healthy fitness zone”. The number and the percentage of participants in the categories belonged (desirable, borderline, high risk) for the examined factors are shown in Table 3.

Table 3. Percentage of participants according to the category belonged.

	Category					
	Desirable		Borderline		High Risk	
	Participants	(%)	Participants	(%)	Participants	(%)
Triglycerides	118	98,8	1	0,8	1	0,8
Cholesterol	103	85,8	14	11,7	3	2,5
HDL-C	35	29,2	75	62,5	10	8,3
LDL-C	103	85,8	12	10,0	5	4,2
$V0_{2max}$	31	25,8	63	52,5	26	21,7

Discussion

The study was contacted to determine the relationship between risk factors for cardiovascular diseases associated with lifestyles of individuals, such as lack of exercise and a sedentary lifestyle (low aerobic capacity) and other major risk factors (elevated LDL-C, triglycerides, cholesterol and decreased HDL-C) in young people.

The results, for aerobic capacity, showed that there was a difference in the concentration levels of triglycerides when comparing individuals with different levels of aerobic capacity. The better was the aerobic capacity of the test, as the lower was the concentration of triglycerides in the blood. These findings agree with the findings (21), pursuant to which aerobic exercise can reduce triglyceride levels. Results also come to an agreement with the research of Oscai, et al. (22) according to which those who exercised aerobically have reduced triglyceride levels independently of other factors.

According to our study, increased levels of HDL-C were found in participants who had better aerobic capacity. Similarly, results are reported in research of Durstine & Haskell (23), which showed that regular aerobic physical activity is associated with increased concentration of HDL-C. Other studies (24) (25) have reported the existence of transient changes that occur even with a simple exercise session and have as a result, the increase of HDL-C levels. Finally, in two studies (26), an increase in HDL-C was found, when improved aerobic capacity in participants in the experimental group with aerobic exercise training program in comparison with the control group.

Systematic aerobic exercise or even a single exercise session affects the metabolism of fats (27). During exercise the increased need for fatty acids as an energy substrate, met from increased lipolysis of triglycerides or lipoprotein rich in triglycerides. When mobilized muscle groups, increasing lipoprotein lipase and leads to increased catabolism of triglycerides (28). Also, regular aerobic exercise affects the lipid profile by modifying the activity of enzymes and proteins (23).

From the results, we note that there was no difference in the levels of LDL-C and cholesterol, in those who had better aerobic capacity, in contrast with previous surveys (23) that have shown that regular aerobic physical exercise is associated with a reduction in total cholesterol and LDL-C. Also there are conflicting findings in studies for the levels of total cholesterol, which have shown either an increase (24), or a decline (29), or remained unchanged (25).

There were no differences in the concentrations of cholesterol, triglycerides, HDL-C and LDL-C in the age group of our study. At this age, cholesterol levels are relatively stable, decrease during adolescence and increase later in adulthood (13). We also found that in the present study, the average values of lipids, compared with another recent study (CHASE), contacted in children (30), had similar results (170,4 mg/dl versus 174,4 mg/dl in total cholesterol, 103,7 mg/dl versus 101,3 mg/dl in LDL-C, 54,1 mg/dl versus 59,9 mg/dl in HDL-C and 63,8 mg/dl versus 71,74 mg/dl triglycerides).

There were no significant differences between boys and girls on average values of the lipids, in contrast to the findings of another study (31), indicating that girls have significantly higher rates of TC and LDL-C than boys. But it was found, a higher average (170,4 mg/dl), compared with a previous population-based study (NHANES III) for the years 1988-1994. Differences in lipid levels, in terms of gender, is a complex issue and the continuous monitoring of children and adolescents indicate that the period of growth strongly influences the values of cholesterol and that the development is different between boys and girls (32).

The results of this study indicate that about 15% of the young had levels of TC>200 mg/dl, a percentage that is higher by 5% compared with the study of Hickman et al. (33). Also the average values of the examined lipid levels, was increased and now tends to approach the maximum measurements of that period (33). This study has shown that today, the lipid profile of the participants has higher values than that of American young, in the study NHANES III (1988-1994). More specifically, higher levels were measured in LDL-C (+8,79 ml/dl), in total cholesterol (+5,43 ml/dl) and HDL-C at 5,16 ml/dl (31). The results are important and should be considered for the health of the students in the ensuing years, because, according to the data from the Bogalusa study, seventy percent of the students who had elevated cholesterol levels, maintained these elevated levels during their adulthood as well (34).

Conclusions

The findings may influence the prevention of CVD in young and adolescents. According to the results, the primary prevention should begin with interventions in lifestyle, which should focus on improving aerobic capacity, maintaining it, in acceptable levels according to age and gender. Further studies should focus on interventions that aim to change the lifestyles by increase exercise and physical activity both at schools and at the home environment.

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