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Original Article

The role of physical activity on cardiovascular risk factors in adolescents

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Abstract

Background Cardiovascular diseases remain the leading cause of death worldwide. Atherosclerotic process increases rapidly during adolescence. Physical activity is considered important in this period to modify cardiovascular risk factors, thus preventing disease in the future.

Objective To determine whether different physical activity status in adolescence can influence body mass index (BMI), waist-to-hip ratio, blood pressure (BP), and blood lipid profile.

Methods This was a cross-sectional descriptive study, conducted from December 2009 to January 2010. Adolescents who fulfilled the study criteria were classified into high and low physical activity category. Further examination including body mass index, waist-to-hip ratio, blood pressure, and blood lipid profile were performed.

Results Adolescents with high physical activity had higher, but statistically insignificant, BMI compared to adolescents in the P=0.493] and significantly lower waist-to-hip ratio [0.80 (range 0.73-0.9) vs.. 0.82 (range 0.7-0.9), P=0.019]. Difference in BP was not statistically significant between both groups [diastolic BP (70 (range 60-90) mmHg vs. 70 (range 60-90) mmHg, P=0.148; systolic BP 100 (range 90-130) mmHg vs. 100 (range 90-140) mmHg, P=0.228)]. Blood lipid examination in the high activity group showed significantly higher HDL cholesterol and lower triglyceride compared to the low activity group [HDL 59.8 (SD 11.8) mg/dL vs. 54.7 (SD 8.9) mg/dL; p=0.044; triglyceride: 60 (range 32-203) mmHg vs. 82 (range 37-198) mmHg, P=0.014]. Total and LDL cholesterol [total cholesterol 169.8 (SD 28.6) mmHg vs. 181.2 (SD 30.8) mmHg, P=0.107; LDL 103.6 (SD 26.8) mmHg vs. 114.1 (SD 27.3) mmHg, P=0.100] were lower in the high activity group but not statistically different in both groups.

Conclusions Adolescents with high physical activity show less cardiovascular risk factors compared to those in the low physical activity group. **[Paediatr Indones. 2010;50:220-5]**.

Keywords*: physical activity, cardiovascular risk factors, adolescent*

Cardiovascular diseases are the number one cause of death globally with an estimated 17.5 million people died from cardiovascular diseases in 2005, representing 30% of all global deaths. If not prevented, by 2015 almost 20 million people will die from this disease.[1]

Aterosclerotic process evolves in decades, begins in childhood and increases steadily during adolescence.[2] A postmortem study in the population collecting 1532 persons aged 15 through 34 years revealed that process concerning cardiovascular disease has started early in life. *The Pathobiological Determinants of Atherosclerosis in Youth Study* has found raised lesions in all of the aorta and about half of the right coronary arteries in the youngest age group (15 through 19).[3] The main causes of cardiovascular diseases are unhealthy life style such as low physical activity, high fat diet, smoking and excessive alcohol consumption.[4,5] Promoting high physical activity since chilldhood is considered as an effective methods in preventing cardiovascular diseases.[2,5] Studies in adult population has established strong association between physical activity and its effect in modifying risk factor of cardiovascular diseases, but data in children and

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adolescents are not as much as in adult population, and results are still controversial.[6]

Physical activity in adolescents is considered essential in modifying cardiovascular risk factors, thus preventing diseases in the future. In this study, we investigate whether difference in physical activity status in adolescent can influence body mass index (BMI), waist-to-hip ratio, blood pressure (BP) and lipid profile in this population.

Methods

A cross-sectional, diagnostic study was conducted from December 2009 to January 2010 at Al-Azhar Senior High School, Bumi Serpong Damai, Tangerang and Ragunan Athlete Senior High School, Jakarta. Consecutive sampling was done with minimum samples of 66. This study was approved by the Ethics Committee of the Medical School, University of Indonesia. Written informed consent was obtained from each subject and his / her parent or legal guardian prior to enrollment.

There were 73 adolescents aged 15-18 years with high and low physical activity based on the global physical activity questionnaire that fullfilled the inclusion criteria.[7] We excluded subjects who refused to participate, heavy/chronic smokers, those have congenital/acquired heart disease and chronic illness limiting daily activity.

We collected basic data including name, sex, age, and history of parents' disease. Each subject underwent several examinations including measurements of body weight using digital Camry weight scale, body height in standing position using stadiometer, waist and hip circumference using non-elastic band, and blood pressure using Nova mercury sphygmomanometer. Blood lipid profile was also examined by enzymatic methods using oxydase peroxidase in Prodia Laboratory with 12-hour fasting preparation before blood sample was taken from subjects. Mean and median values of each measurement were compared and calculated with SPSS.15 using unpaired t-test and Mann-Whitney test.

Results

During the study period, 73 children aged 15-18 years were included. The proportion of boys and girls, history of family with hypertension, coronary arterial disease and diabetes mellitus in both activity groups were comparable (**Table 1**).

Table 1. Subjects' characteristics

Characteristics	High activity n=35	Low activity n=38
Age [year; (median, range)]	16,3 (15-18)	15,4 (15-18)
Sex [n (%)]		
Male	11	11
Female	24	27
Disease history of first-degree relatives		
Hypertension		
Yes	10	15
No	25	23
Coronary arterial disease		
Yes	1	1
No	34	37
Diabetes mellitus		
Yes	3	4
No	32	34

In our study, adolescents with high physical activity had higher, but statistically insignificant, BMI compared to adolescents in the low activity group [21.6 (range 17-39) vs. 21.1 (range 17-36), P=0.493] and significantly lower waist-to-hip ratio [0.80 (range 0.73-0.9) vs. 0.82 (range 0.7-0.9), P=0.019]. Difference in BP was not statistically significant between both groups [diastolic BP 70 (range 60-90) mmHg vs. 70 (range 60-90) mmHg, P=0.148; systolic BP 100 (range 90-130) mmHg vs. 100 (range 90-140) mmHg, P=0.228)]. Blood lipid examination in the high activity group showed significantly higher HDL cholesterol and lower triglyceride compared to the low activity group [HDL 59.8 (SD 11.8) mg/dL vs. 54.7 (SD 8.9) mg/dL; P=0.044; triglyceride: 60(range 32-203) mmHg vs. 82(range 37-198) mmHg, P=0.014]. Total and LDL cholesterol [total cholesterol: (169.8(SD 28.6) mmHg vs. 181.2(SD 30.8) mmHg, P=0.107; LDL: 103.6 (SD 26.8) mmHg vs. 114.1(SD 27.3) mmHg, P=0.100] were lower in the high activity group but not statistically different in both groups (**Table 2**).

Discussion

Subjects' characteristics

Cardiovascular risk factor is greatly influenced by age,

Table 2. Physical activity and cardiovascular risk factors

Variable	High activity	Low activity	P
Body height mean (SD) cm	163.7 (84)	157.7 (8.5)	0.004*
Body weight median (range) kg	56.8 (439-109)	51.3 (39.3-93)	0.049+
Body mass index median (range)	21.6 (17-39)	21.1 (17-36)	0.493+
Waist circumference median (range) cm	72 (64-103)	72.5 (61-103)	0.786+
Hip circumference median (range) cm	89.5 (79-118)	86.7 (68-116)	0.126+
Waist-to-hip ratio median (range)	0.80 (0.73-0.90)	0.82 (0.70-0.90)	0.043+
Diastolic mean (range) mmHg	70 (60-90)	70 (60-90)	0.148+
Systolic mean (range) mmHg	100 (90-130)	100 (90-140)	0.228+
Total cholesterol mean (SD) mg/dL	169.8 (28.6)	181.2 (30.8)	0.107*
HDL cholesterol mean, (SD) mg/dL	59.8 (11.8)	54.7 (8.9)	0.044*
LDL cholesterol mean (SD) mg/dL	103.6 (26.8)	114.1 (27.3)	0.100*
Triglyceride median (range) mg/dL	60 (32-203)	82 (37-198)	0.014+

Note: *unpaired t-test + Mann-Whitney test

sex and genetic factors. In this study, subject's age, proportion of boys and girls and history of hypertension, diabetes mellitus and coronary artery disease in first degree relative in both groups were comparable, thus these confounding factors can be ignored.

Physical activity, body mass index, waist circumference and waist-to-hip ratio

Body mass index – measuring total body fat – has been widely used to evaluate obesity, but cardiovascular risk factors are more strongly correlated with visceral fat.[8,9] Visceral fat - measured by waist circumference or waist-to-hip ratio – is a risk factor more commonly related to hypertension, dyslipidemia and cardiovascular diseases than total body fat, measured by body mass index.[10] In our study, body mass index was higher in the high activity group but not statistically different [BMI: 21.6 (range 17-39) vs. 21.1 (range 17-36), P=0.493]. A cohort study by *the National Health and Nutrition Examination Survey* found that waist circumference was a stronger risk factor in predicting cardiovascular disease compared to body mass index,[11] and in this study, we found smaller waist circumference in the high activity group compared to those in the low activity group although not statistically significant [waist circumference: 72 (range 64-103) cm vs. 72.5 (range 61-103) cm, P=0.786]. This finding is different from study by Klein-Platat et al that found significant correlation between waist circumference and activity level,[12] this difference may be due to larger sample size in Klein-Platat et al study compared to ours (2714 vs. 73 subjects).

A prospective study by *The European Prospective Investigation into Cancer and Nutrition in Norfolk Cohort* found waist-to-hip ratio as a strong predictive factor for coronary artery disease compared to waist circumference alone. Risk of coronary artery disease is also increased with increased waist circumference, but estimate risk is 10-18% lower compared to waist-to-hip ratio.[13] In our study, waist-to-hip ratio was significantly lower in the high activity group compared to the low activity group. [waist-to-hip ratio: 0.8 (range 0.73-0.9) cm vs. 0.82 (range 0.7-0.9) cm, P=0.043]. We have not found any study that compares waist-to-hip ratio between activity groups in adolescents, but cohort study in adults found that this ratio is more related to cardiovascular disease and mortality compared to waist circumference and body mass index value.[13,9] Our data give an impression

that physical activity in adolescents can significantly modify waist-to-hip ratio, which is one of the risk factors of cardiovascular disease, although body mass index and waist circumference is not statistically different in our study group.

Physical activity and blood pressure

Increased blood pressure is one of the major cardiovascular risk factor that has been reported in children and adolescent.[14] Increased blood pressure may persist and become adult hypertension in the future.[15] Serial blood pressure measurement could predict hypertension and cardiovascular mortality in adult life.[16]

In our study, diastolic and systolic pressure were not statistically different between the two activity groups [systolic BP 100 (range 90-140) mmHg vs. 100 (range 90-130) mmHg, P=0.228; diastolic BP: 70 (range 60-90) vs. 70 (range 60-90) mmHg, P=0.148]. This finding is similar to a meta-analysis by Kelley et al that showed insignificant blood pressure change before and after physical activity intervention for ≥ 8 weeks.[17] Observational study by Klesges et al[18] and Brage et al[19] also did not find any correlation between physical activity and blood pressure in prepubertal children, but different with the findings of Leary et al[20] and Gidding et al[21] that found lower systolic blood pressure in children with more active lifestyle. This maybe due to difference in sample size of the two study compared to ours (5505 and 964 vs. 73, respectively).

Physical activity and blood lipid profile

Cholesterol and blood lipoprotein plays an important role in the atherosclerotic process. Epidemiologic study has found that dyslipidemia in children and adolescents, accompanied by other co-morbid factors, can predict cardiovascular disease in the future. Cholesterol level is commonly low in childhood, but increases rapidly during the second decade of life, thus an aggressive prevention is necessary during this period of life. [22,23]

In our study, blood lipid profile showed lower total and LDL cholesterol in the high activity group, but were not statistically different compared to the low activity group [total cholesterol 169.8 (SD 28.6) mg/dL vs. 181.2 (SD 30.8) mg/dL, P=0.107; LDL 103.6 (SD 26.8) mg/dL vs. 114.1 (SD 27.3) mg/dL, P=0.100]. These findings are similar to a meta-analysis study that found lower but not statistically different total and LDL cholesterol in the active group compared to control group.[24,25] Most cross-sectional studies also show nonsignificant difference of total and LDL cholesterol beween the active and control group.[24,25]

Kraus et al stated that HDL increment was the most effective, consistent and protective factor gained from physical activity.[26,27] because it played an important role in repairing the reverse cholesterol transport (RCT) pathway, a dynamic process that helped remove cholesterol outside the body.[28] In this study, HDL cholesterol was significantly higher in the high activity group – that consisted of teenage athletes - compared to the low activity group [HDL 59.8 (SD 11.8) mg/dL vs. 54.7 (SD 8.9) mg/dL, P=0.044]. This finding is similar to a study in athletes population that found higher HDL cholesterol compared to their sedentary control group.[29,30,31] While trygliceride was found significantly lower in our high activity group compared to the low activity group [trygliceride 60 (range 32-203) mg/dL vs. 82 (range 37-198) mg/dL, P=0.014], which had similar result to more than half cross-sectional studies in athletes and active individual.[24,25]

Our study was the first study on cardiovascular risk factors in youth athletes in Indonesia, but several limitations were found, including subjective measurement of physical activity using only questionnaire, no parent interview about history of family disease, and consecutive sampling instead of random sampling. Other limitations include no analysis of significant confounding factors – such as diet – and interrelation between risk factors studied.

In conclusion, adolescents with high physical activity show less cardiovascular risk factors compared to those in the low activity group.

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