Paediatrica Indonesiana

VOLUME 54 September • 2014 NUMBER 5

Original Article

Left ventricular mass in male adolescent athletes and non-athletes

Erling David Kaunang, Jane G. C. Metusala, Audrey M. I. Wahani

Abstract

Background Systematic exercise leads to increased left ventricular mass, which may be misleading in a differential diagnosis of heart disease in athletes (physiologic hypertrophy versus pathologic hypertrophy). The cause of left ventricular hypertrophy is an important risk factor in the morbidity and mortality of cardiovascular diseases.

Objective To compare left ventricular mass and left ventricular hypertrophy in male adolescent athletes and non-athletes.

Methods We conducted a cross-sectional, analytic study, from September to December 2012 in male adolescents aged 15-18 years. The case group included athletes from the Bina Taruna Football Club Manado, while the control group included non-athlete adolescents. All subjects underwent history-taking, physical examinations and further supporting examinations. Left ventricular mass was measured by cardiovascular echocardiography (*Esaote Mylab 4.0*) and calculated based on a formula. Left ventricular hypertrophy was defined as left ventricular mass of > 134 g/m^2 body surface area.

Results Subjects' mean left ventricular masses were 359.69 (SD 188.4; 95%CI 283.58 to 435.81) grams in the athlete group and 173.04 (SD 50.69; 95%CI 152.56 to 103.51) grams in the non-athlete group, a statistically significant difference (P=0.0001). Ventricular hypertrophy was found 76.9% compared to 11.5% in the non-athlete group (P=0.0001).

Conclusion Left ventricular mass in athletes is bigger than in non-athletes. In addition, left ventricular hypertrophy is more common in male adolescent athletes than in non-athletes.

[Paediatr Indones. 2014;54:305-8.]

Keywords: *adolescent, athlete, non-athlete, left ventricular mass, left ventricular hypertrophy*

Extensive exercises can cause changes in the heart, known as "athlete heart syndrome", a condition that involves structural adaptation, as well as electrophysiologic and functional changes in the myocardium in response to increased activity or exercise.[1-4] A study found increased left ventricular mass in athlete adolescents aged 14-18 years.[5] This enlargement of the athlete's heart is influenced by several factors, such as type of exercise, body composition, gender, ethnicity, and genetics.[6-8]

Left ventricular hypertrophy is indicated by an increase in left ventricular mass, which is a physiologic process in athletes, as the heart adapts to long-term exercise. However, physiologic hypertrophy of the heart should be detected immediately in order to prevent heart injury.[9] The causes of ventricular hypertrophy and the relative thickening of the ventricular wall are important risk factors in cardiovascular morbidity and mortality. Sudden deaths in school-aged athletes in America occur in 1 out of 100,000 athletes per year.[10,11] Athletes should undergo medical evaluations before competition in order to detect the existence of

From the Department of Child Health, Sam Ratulangi University Medical School, Manado, Indonesia

Reprint requests to: Erling David Kaunang, Department of Child Health, Sam Ratulangi University Medical School, Jalan Raya Tanawangko no.56, Malalayang, Manado, Indonesia. Tel +62-431-821562, Fax +61-431-859091, E-mail: drdavidkaunang@yahoo.com.

asymptomatic heart disease and to prevent sudden death.[12] We aimed to compare left ventricular mass and ventricular hypertrophy in adolescent male athletes to that of non-athletes.

Methods

We conducted a cross-sectional, analytic study from September to December 2012. Subjects were male adolescents aged 15 to 18 years. Athletes adolescent were from the Bina Taruna Football Club Manado, who exercised regularly for 4 years at a frequency of three times per week for 1½ hours each time. Non-athletes adolescent were highschool students from SMU Negeri 3 Manado who had never regularly attended any sports training neither participated in any sport competition. All subjects underwent history-taking, physical examinations, and laboratory tests to rule out basic diseases that might affect the results of this study. Subjects' parents agreed to participation and to fill the research form. Adolescents with heart diseases, kidney diseases, hypertension, or anemia, were excluded from this study.

Left ventricular mass was measured by cardiovascular echocardiography (*E Saote Mylab 4.0*) and calculated based on the following formula:[13]

- Left ventricular mass= {0.8 [1.04(DDVKi + DPVKi + DSV)^3 –(DDVKi)^3]} + 0.6 grams
- DDVKi: internal diastolic dimension of the left ventricle
- DPVKi : posterior diameter of the left ventricle
- DSV : diameter between ventricle septum

Left ventricular hypertrophy was based on the Deveroux criteria defined as left ventricular mass >134 g/m^2 body surface area in males.[13] Data was analyzed with *Statistical Software and Services Solutions* (*SPSS*) for Windows version 20.0 by independent T-test for differences in left ventricular mass between groups and Chi-square test to assess for left ventricular hypertrophy in adolescent athletes. A P value of <0.05 was considered to be statistically significant.

Results

A total of 52 adolescents, 26 for each group, were included in this study. Thirty adolescents fulfilled the inclusion criteria for the athlete group, but 4 did not appear for further examination. Therefore, only 26 subjects were examined in the athlete group. **Table 1** shows the characteristics of the subjects.

Table 2 shows the difference in left ventricular mass between the two groups. Independent T-test revealed the mean left ventricular mass was significantly bigger in the athlete group than in the non-athlete group (P=0.0001).

Table 3 shows proportion of left ventricular hypertrophy in the two groups. The Chi-square test revealed that X^2 was 22.531, indicating significantly more subjects with ventricular hypertrophy in the athlete group than in the non-athlete group (P=0.0001).

Table 1. Subjects' characteristics

Characteristics	Athletes group (n=26)	Non-athletes group (n=26)
Mean age (SD), years	16.42 (1.14)	16.85 (0.83)
Mean body weight (SD), kg	55.11(9.54)	54.19 (8.29)
Mean body height (SD), m	1.61 (0.08)	1.62 (0.06)
Mean total body surface area (SD), m^2	1.57 (0.16)	1.55 (0.14)

Table 2. The difference in left ventricular mass between athletes and non-athletes

	Left ventricular mass		
	Mean (SD), grams	95%CI	P value
Athletes group	359.69 (188.44)	283.58 to 435.81	<0.0001
Non-athletes group	173.04 (50.69)	152.56 – 193.51	

Table 3. The proportion of left ventricular hypertrophy in athletes and non-athletes groups

Variables	Athletes group	Non-athletes group	X^2	P value
Left ventricular hypertrophy, n	20	3	22.53	0.0001
Without left ventricular hypertrophy, n	6	23		

Discussion

Left ventricular hypertrophy is defined as an increase in the left ventricle as a result of the heart adapting to extensive training or to pathologic conditions, such as chronic overload, e.g., systemic hypertension, aortic stenosis, increased volume as in aortic regurgitation, or myocardial disease such as hypertrophic cardiomyopathy.[14] The incidence of left ventricular hypertrophy and the relative thickening of the ventricle wall is one of the risk factors for cardiovascular disease morbidity and mortality.[9] Heart injury due to physiologic hypertrophy in athletes for a long period of time until now is still not surely known. Sudden death of the heart in young athletes is a very tragic incidence and brings a huge concern.[15]

We limited our sample population to male adolescents aged 15-18 years, in their middle to late adolescence. For exercise, children should be grouped by the maturity level of their neuromuscular and cardiovascular system physiology. In addition, their cardiopulmonary capacity and reuptake of oxygen are important and increase by age.[16] Sharma *et al.* reported a low incidence of increased ventricular wall mass, which were found in athletes who regularly engaged in high intensity exercise and had a large body surface area.[5]

Gender also affects exercise-related morphological changes in the heart. We included only male adolescents because, in general, male athletes have a greater increase in left ventricular wall thickness, dimension and mass.[6,17] Pellica *et al.* reported that female athletes had smaller left ventricular dimensions compared to male athletes of similar age, ethnicity, and exercise type.[18] Furthermore, Whyte *et al.* reported that only 5.8% of male athletes had increased left ventricular diastole.[19] In contrast, Douglas *et al.* found that of 235 athletes, 43% of female athletes had larger than normal left ventricle size, but only 17% of male athletes had left ventricle size that exceeded normal values.[20]

In our study, there were no significant differences in body weight, height, and total surface area between the athlete and non-athlete groups. However, the athlete group had significantly higher ventricular mass than that of the non-athlete group. Furthermore, significantly more athletes had left ventricular hypertrophy than non-athletes. Similarly, a study also reported that athletes had higher mean left ventricular mass than non-athletes ($P<0.05$).[1]

In a meta-analysis of 59 studies, Pluim *et al.* reported a significant difference between the heart mass of athletes compared to non-athletes ($P<0.001$), 249 grams vs. 174 grams, respectively.[21] In addition, Fagard[4] reported that left ventricular mass in athletes was higher compared to that of the control group ($P<0.001$), and the thickness of the wall was relative: the ratio of the ventricular wall to the internal diameter was significantly increased in athletes compared to the control group ($P<0.05$).

Limongelli *et al.* found a significant difference in left ventricular mass and left ventricular index between professional football players and the control group ($P=0.05$).[22] Butz *et al.* also reported increased left ventricle and left ventricular index in athletes compared to the control group ($P<0.001$).[23] In addition, PioCaso *et al.* found significant differences between athlete and control groups in left ventricular index ($P<0.0001$) and the thickness of the posterior wall and septum ($P<0.001$) using M-mode echocardiography.[24]

Exercise induces changes in heart structure. Chronic changes are associated with blood volume and blood pressure burden. The blood pressure burden during exercise causes septal hypertrophy along with increased left posterior ventricular wall muscle volume. A blood volume burden can result in proportional increases in the septum and the thickening of the wall.[8]

A limitation of this study was that subjects were male adolescent football players aged 15-18 years who engaged in the same exercise intensity. Therefore,

our study does not represent all adolescent athletes. Also, since the study had a cross-sectional design, increases in left ventricular mass and left ventricular hypertrophy were not followed from the beginning.

In conclusion, left ventricular mass of athletes is higher than that of non-athletes, and there is a greater proportion of left ventricular hypertrophy in athletes compared to non-athletes.

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