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THE EFFECT OF SELECTED AEROBIC AND ANAEROBIC SPORTS ON STRUCTURAL CHANGES IN HEART WALLS AND CAVITIES

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SUMMARY

The use of echocardiography has created a possibility for cardiologists to assess the athletic heart. Findings indicate that sport causes cardiac hypertrophy, but changes in the heart have different aspects. Now it is clear that elite endurance champions display larger cavity dimensions during diastole, and increased left ventricle mass. Theory describes heart dimension changes as a result of the type and intensity of physical activity. Extensive studies in the area indicate that regular exercise effects heart size increase. Forty elite male athletes, from wrestling, karate, kanopolo, rowing, and ten healthy males as controls, all aged between 26-30 years of age, were the subjects of the study. The athletes were being trained in training camps. A questionnaire about sport experience information, daily exercise duration and possible drug usage was answered. Echocardiography revealed significant ($p<0.05$) differences among athletes and controls in terms of interventricular septum (IVS) and posterior wall thicknesses (PWT), end diastolic (EDD) and end systolic dimensions (ESD) in the left ventricle (LV).

Key words: Aerobic, anaerobic, cardiac hypertrophy, athletes' heart, IVS, PWT, EDD, ESD

ÖZET

SEÇİLMİŞ AEROBİK VE ANAEROBİK SPORLARIN KALP DUVARLARI VE BOŞLUKLARINDAKİ DEĞİŞİKLİKLERE ETKİLERİ

Ekokardiyografi kullanımı kardiyologlar için sporcu kalbini daha iyi değerlendirme imkanı sağlamıştır. Bulgular sporun kardiyak hipertrofiye neden olduğunu, ancak kalpteki değişikliklerin spora özgü olduğunu göstermektedir. Elit dayanıklılık sporcularının diastolde daha büyük sol ventriküle ve daha geniş kavitelere sahip oldukları ortaya konmuştur.

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Kalp boyutu değişikliklerinin fiziksel egzersizin tip ve şiddetine göre değiştiği bilinmektedir. Çalışmalar düzenli egzersizin kalp boyutlarını arttırdığını göstermektedir. Yaşları 26 - 30 arasında bulunan; güreş, karate, kano polo ve kürek branşlarından onar denek olarak 40 sporcu ve sağlıklı 10 kontrol bireyi araştırmaya katıldılar. Sporcular kamp dönemindeydiler. Spor deneyimi, günlük antrenman süresi ve olası ilaç kullanımı konularında anketi yanıtladılar. Ekokardiyografi sonucunda interventriküler septum (IVS), sol ventrikülde (LV) diyastol sonu boyut (EDD), sistol sonu boyut (ESD) ve arka duvar kalınlığı (PWT) parametrelerinde sporcu grupları arasında ve kontrollere göre anlamlı ($p<0.05$) farklılıklar gözlendi.

Anahtar sözcükler: *Aerobik, anaerobik, kardiyak hipertrofi, sporcu kalbi, IVS, PWT, EDD, ESD*

INTRODUCTION

The heart contracts powerfully similar to skeleton muscles in trained people. Heart muscle cells' cooperation increases, so more blood is expelled to the organs. Aerobic sports cause cardiac hypertrophy (3), and resting heart rates decrease. In isotonic exercises, significant increase in cardiac output and oxygen consumption, and increase in elasticity of systemic blood vessels results. Continued activity in such exercises increases blood volume that causes an increase in left ventricle diastole volume, leading to increased heart stroke volume (8).

In isometric exercises systemic blood pressure increases considerably, cardiac output and oxygen consumption are slightly affected. Because of the increasing pressure that is exerted to the ventricle, ventricular septum thickness increases but ventricular cavity size remains normal. In these athletes, in spite of the fact that the heart's size gets larger, heart stroke ability does not differ a lot from non-athletes (1).

Extensive research done on cyclists has shown that left ventricle's mass increases, and that these athletes have larger diastolic and systolic dimensions, and thicker posterior walls and interventricular septum compared with non-athletes (4). Experimental research has also confirmed heart hypertrophy and an increase in coronary arteries of the heart bottom in active animals (2). The matter of sudden death of athletes (11) was also discussed among supporters of physical activities and their opponents. While the latter related physical activity based cardiac hypertrophy to athletes' death, the former revealed hidden heart diseases of these athletes by echocardiography (4,6,14).

In isometric exercise, because of peripheral arteriosclerosis increase, and the resulting increase in arterial pressure, ventricular septum thickness increases. The ventricular cavity volume of these athletes is unchanged. One can say that the changes in ventricular cavity volume and septum thickness in aerobic and anaerobic exercises have opposite functions. In both groups of athletes the whole size of the heart increases, but the ability of their stroke volume differs (10).

Rowers train more than 20 km per day, with aerobic metabolic requirements of over 60%. The activity they are involved in is over 3 min, which categorizes this sport among aerobic sports. Kanopolo athletes train many kilometers each day, but as exercise duration is less than 3 min, this sport can be categorized as anaerobic. The characteristic of wrestling being 70% anaerobic, it is categorized as an anaerobic resistance sport. Finally, karate which has 60% anaerobic characteristics is categorized among anaerobic sports (7).

The question that has many times been asked about the effects of sport activity type on cardiac structure and physiological function did not receive exclusive and clear responses yet, despite extensive research done in the field. The present study was planned to provide some explanations concerning some cardiac parameters in different sports.

MATERIALS AND METHODS

Subjects were 40 professional male athletes competing in wrestling, karate (kojorio), kanopolo, and rowing. They were all members of the national team for at least four years, having obtained first to fourth place in Asian and World Championship. They were regularly participating in trainings (6-10 sessions per week, 2-4 hours per session). They were attending training camps during the study. Their age range, body weight and height were respectively 26-30 yrs, 68-93 kg and 165-195 cm. The athletes had never experienced any cardiovascular disease. They were free of smoking and/or medicine usage known to have some effects on the heart. A total of 10 healthy untrained people were also randomly chosen as a control group. The variables which were measured by two-dimensional, M-mode Doppler echocardiography included:

1) Interventricular septum thickness (IVST)
2) Left ventricular (LV) posterior wall thickness (PWT)

3) Left ventricular (LV) end diastolic dimension (EDD)
4) Left ventricular (LV) end systolic dimension (ESD)

The statistical method used for studying natural distribution of variables was the Kolmogrov-Smirnov test. Co-variance was used for equilibrating variables. Moreover, by use of omega squared (w^2) figures, the relation strength between dependent and independent variables were calculated. To compare the group averages, ANOVA and the Scheffs test was used. The significance level was set at $p<0.05$.

RESULTS

Physical characteristics of the subjects and their measured cardiac variables are given in Table 1 and Table 2 respectively, as means ± standard deviations. The multiple comparisons of the parameters related to the Scheffs post hoc tests are given in Table 3. Significantly higher scores were observed for the four parameters in the sport groups when comparing with the control group, with the exception of IVST for karate and kanopolo groups.

Rowers had significantly lower EDD figures, when compared with other sport groups. No significant differences were observed in terms of ESD between sport groups. Wrestlers had significantly higher IVST scores than the kanopolo and karate groups. The kanopolo group revealed significantly lower PWT's compared with the wrestler and karate groups.

Table 1. Physical characteristics of the subjects (as means ± SD)

Variable / Groups	N	Age, yr	Body weight, kg	Height, cm
Control	10	27.6 ± 1.3	76.4 ± 8.0	176.6 ± 8.3
Wrestling	10	27.5 ± 1.7	77.9 ± 4.6	174.5 ± 9.0
Karate	10	27.3 ± 1.4	76.7 ± 7.0	174.1 ± 7.3
Rowing	10	27.7 ± 1.2	75.4 ± 6.7	175.4 ± 6.6
Kanopolo	10	27.7 ± 1.7	75.1 ± 5.2	177.3 ± 7.4
Total	50	27.6 ± 1.9	76.3 ± 8.7	175.6 ± 6.6

Table 2. Measured cardiac variables (in mm, as means ± SD)

Variable/ Groups	N	EDD	ESD	PWT	IVST
Control	10	46.5 ± 0.5	22.7 ± 0.7	6.10 ± 0.32	7.94 ± 0.10
Rowing	10	51.2 ± 0.8	30.6 ± 0.8	8.05 ± 0.16	9.50 ± 0.53
Wrestling	10	53.7 ± 2.1	31.2 ± 3.5	8.50 ± 0.71	10.1 ± 1.09
Karate	10	54.0 ± 2.5	32.5 ± 1.4	8.20 ± 0.42	8.80 ± 1.23
Kanopolo	10	55.0 ± 1.4	31.5 ± 1.2	7.40 ± 0.52	8.70 ± 0.67
Total	50	52.1 ± 3.5	29.7 ± 4.0	7.65 ± 0.97	9.02 ± 1.10

Table 3. Multiple comparisons related to the Scheffs post hoc tests

Group 1	Group 2	EDD	ESD	PWT	IVST
Control	Rowing	*	*	*	*
Control	Wrestling	*	*	*	*
Control	Karate	*	*	*	-
Control	Kanopolo	*	*	*	-
Rowing	Wrestling	*	-	-	-
Rowing	Karate	*	-	-	-
Rowing	Kanopolo	*	-	-	-
Wrestling	Karate	-	-	-	*
Wrestling	Kanopolo	-	-	*	*
Karate	Kanopolo	-	-	*	-

*: <0.05

DISCUSSION

The significant differences between athletes and non-athletes for EDD and ESD measurements confirm the theory on left ventricle behavior. These findings are similar to those of Shapiro (12) who explains that training is effective on enhancing left ventricle measures. Heavier athletes may have larger hearts, depending on the nature of the physical activity done. Although ESD and PWT were found to be correlated to body weight and height to some extent, co-variance analysis to determine the effects of age, body weight and height variables on structural changes in the heart, did not yield any biologically significant correlations for the measured parameters.

The lower EDD measurements in the rowing group compared with the karate, wrestling and kanapolo groups does not confirm research theory based on significant increase in this parameter among rowers in comparison with other sport groups. Lower involvement in strength and

endurance trainings by rowers may be a possible explanation. In athletes participating in aerobic sports with an eccentric hypertrophy pattern, changes occur concerning the size of diastole. Research reveals both kinds of structural changes in rowers (7), which in contrast with the results of the present study.

On the other hand, the higher EDD scores in the kanopolo athletes might have possibly resulted due to their training styles, where the main part of these athletes' activities is allocated to aerobic exercises. In this context, the present research rather confirms the findings of Urhausen (13) based on the existence of heart hypertrophy of rowers.

The measure of ESD in all the sport groups displayed significant differences in comparison with the control group, but no such differences were observed among the sport groups. These findings confirm research that yielded significant increases in the measure of ESD in athletes in comparison with control groups.

Significant increases determined in the PWT of the left ventricle in sport groups compared with non-athletes confirm the observations of Shapiro (12), about the increase in PWT of the left ventricle in rowers and cyclists. Moreover the present research also confirms the research by Morganroth (9) and Shapiro (12) on the existence of significant increase in PWT measures of left ventricle in athletes.

In general, because of the overload pressure mechanism (5), powerful aerobic exercises lead to increases in PWT and IVST. In wrestlers, considering the many years of experience and regular trainings, an increase in PWT may have appeared in response to the overload pressure during training. IVST increases in wrestlers were also significant, which confirms research theory. Both increases in PWT and IVST show that the left ventricle mass of wrestlers has increased. Moreover, the possibility of left ventricle concentric hypertrophy may also be questioned.

Karate athletes also displayed significant increases in cardiac size in comparison with the control group, which is again confirmed by theory. Karate is an activity which includes a combination of isometric and isotonic activities at 70 to 80% maximal heart rate. This is effective in increasing physiological cardiovascular capacities and morphological size of the left ventricle in the normal range, reflecting itself in increased

cardiorespiratory capacity. The findings of the present research support research concluding that aerobic endurance (3) and anaerobic resistance sport activities lead to the physiological hypertrophy of the left ventricle, both in the cavity, wall and septum structures. Additionally, because of adaptive activities, these athletes encounter no cardiac diseases.

REFERENCES

1. Cox ML, Bennett JB, Dudley GA: Exercise training-induced alterations of cardiac morphology. *J Appl Physiol* **61:** 926-31, 1986.
2. Constable PD, Hinchcliff KW, Farris J, Schmidt KE: Athletic heart syndrome in dogs competing in a long-distance sled race. *J Appl Physiol* **76:** 433-8, 1994.
3. Dickhuth HH, Nause A, Staiger J, Bonzel T, Keul J: Two-dimensional echocardiography measurements of left ventricular volume and stroke volume of endurance-trained athletes and untrained subjects. *Int J Sports Med* **4:** 21-6, 1983.
4. Ehsani AA, Hagberg JM, Hickson RC: Rapid changes in left ventricular dimensions and mass in response to physical conditioning and deconditioning. *Am J Cardiol* **42:** 52-6, 1978.
5. Hofmann P, Pokan R, Schmid P: Load dependent myocardial function and heart rate performance in healthy young male gender subjects. In: *Abstracts of the 34th German Congress of Sports Medicine*, Saarbrucken, Germany. October 19-22, 1995. *Int J Sports Med* **17 S1:** 13, 1996.
6. Hojjat S: *Comparison of Echocardiography in Elite Women Athletes.* MS thesis. Islamic Azad University, Iran, 1999.
7. Maron BJ: Structural features of the athlete heart as defined by echocardiography. *Am J Cardiol* **7:** 190-203, 1986.
8. Martin WH, Spina RJ, Korte E, Ogawa T: Effects of chronic and acute exercise on cardiovascular beta-adrenergic responses. *J Appl Physiol* **71:** 1523-8, 1991.
9. Morganroth J, Maron BJ: The athletes' heart syndrome: a new perspective. *Ann N Y Acad Sci* **301:** 931-41, 1977.
10. Paulson W, Boughner DR, Ko P, Cunningham DA, Persaud JA: Left ventricular function in marathon runners: echocardiographic assessment. *J Appl Physiol* **51:** 881-6, 1981.
11. Rich BS: Sudden death screening. *Med Clin North Am* **78:** 267-88, 1994.
12. Shapiro LM: Physiological left ventricular hypertrophy. *Br Heart J* **52:** 130-5, 1984.
13. Urhausen A: Echocardiographic findings in strength- and endurance-trained athletes. *Sports Med* **13:** 270-84, 1992.
14. Wight JN, Salem D: Sudden cardiac death and the 'athlete's heart'. *Arch Intern Med* **155:** 1473-80, 1995.

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