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The Effect of Short-Term Training on the Cardiac Structure of Iranian Young Elite Weightlifters

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ABSTRACT

The aim of this study was to evaluate the effect of short-term training on the cardiac structure of Iranian young elite weightlifters. 10 elite male weightlifters from Iran (with an average age of 19.1±3.8 years, weight 104.1±23 kg, height 179.1±4.9 cm) participated in this study as one group. The subjects were tested by one and two-dimensional echocardiography so that their cardiac structure could be determined. From an echocardiographic view, the results showed that there were no significant differences between preparation and competition phases ($P>0.05$) in terms of the cardiac structure variables. However, athletes' performances showed significant differences in all variables ($p < 0.05$). It can be concluded that all elite weight lifters were being trained for a long-term- over the years, and all the changes in the echocardiography variables were already made due to the strength of their trainings and a short-term training (from preparation phase to competitive phase) didn't affect the cardiac structure of the weightlifters. It is suggested that in the future, the researchers may use long term training in order to observe changes in the cardiac structure of weightlifters.

1. Introduction

The ability of athletes in sports depends on efficiency and function of organs such as the cardiovascular system [1].Undoubtedly, if the training is of sufficient intensity and duration, the athletes' heart will differ from that of non-athletes' [2, 3]. The heart of an athlete is regarded as the source of change in the structure and function, including the increase in maximal cardiac output (CO), increase in stroke volume (SV), the decrease in the resting heart rate (HR) and structural alterations, as an increase in left ventricular wall thickness, cavity size and mass [4-6]. These adaptations may lead to a better performance of athletes in sports. However, to create such adaptations, the effect of intensity, type and duration of training is so important [3, 7-12].

There are controversial and various findings in the heart profiles of athletes. According to the studies of Alan et al, men had proportionally greater left ventricular mass' index compared to women, this included men's greater ventricular chamber size with a slightly greater wall thickness. However, wall thickness was nearly the same in both groups. Left ventricular mass index was greater in men than in women even after controlling the blood pressure [13]. Some investigations showed that hormonal factors may play the main role in the determination of ventricular dimensions. In animal subjects, gender differences in cardiac size are omitted by orchiectomy and restored by testosterone replacement, suggesting that endogenous androgens exert a direct trophic effect on the cardiac muscle [14]. Race–Ethnicity and sex differences can impact LV's size and structure. In this regard, Satrio et al. reported that while African American men have greater LV sizes, they indicate a lower LV systolic and diastolic function compared to African American women as well as white men/women [14]. The investigations comparing the cardiac size in athletes with matched control groups show increases of approximately 10% in left ventricular end-diastolic dimension, approximately 20% in wall thickness and approximately 45% in calculated left ventricular mass [5, 15, 16].

According to Morgan Roth et al., endurance athletes, such as marathon runners and endurance swimmers show interesting hypertrophy. Endurance training increases the left ventricular (LV) cavity's dimension, and thus; LV mass (LVM), as a consequence of prolonged repetitive volume may be overloaded. Tidal volume per beat is increased in this adaptation and the frequency of heart rate is decreased. However, the heart's ability to pump stronger and more effectively is improved. In contrast, strength training (sports as wrestling, weightlifting, or disk throwing) is supposedly associated with a concentric form of hypertrophy where increased ventricular wall's thickness (with no change in cavity size) underpins the elevated LVM as a consequence of the pressure produced during strenuous resistive exercise. This compatibility enables the heart to increase blood pressure to continue exercising, but it doesn't make any changes in stroke volume and heart rate [11, 17-21] Advanced studies in this area were carried out to confirm [4] or reject 'Morgan Roth hypothesis [22, 23].

In spite of the fact that the structure of athlete's heart and the effect of different training have been studied in many countries, there have been few data that examined the structural changes of the weightlifters' heart in performing short term resistance training. The small number of the previous studies have only examined the differences between the black and white races. Caucasian and Iranian weightlifters are always regarded as Olympic champions; therefore, it is necessary to collect data on their anthropometric characteristics and body composition. The need for doing studies on athletes of this area has doubled. There have been few data regarding the possible changes of the left ventricle echocardiographic profile in elite weightlifters during training phases (from the preparatory to competitive). Due to the fact that weightlifting is a sport relating to strength and power, the aim of this study was to assess effects of short term strength training on the echocardiographic and performance of the Iranian young elite weightlifters

2. Method

2.1. Participants

The present research is a semi-experimental research. To achieve the objectives of the study, ten (10) Iranian elite male weightlifters (with an average age of 19.1±3.8 years, weight 104.1±23 kg, height 179.1±4.9 cm) contributed in the research. This study was approved by the Research Ethic Boards of the University (Mohaghegh Ardabili) and conformed to the Declaration of Helsinki.

2.2. Experimental protocol and procedures

The subjects were examined by three examiners (Cardiology and Cardiology, Doctor of Physiology, PhD student of physiology) in the physiology laboratory of Mohaghegh Ardabili University and Cardiology Specialized

Clinic. Before testing, the aim and procedures of the study were explained to the participants. All participants provided a written consent and completed a medical history questionnaire. They were excluded if they had a known heart condition or hypertension. At first weightlifters were evaluated according to the anthropometric characteristics and body compositions (weight, height, body mass index, body surface area, body fat percentage and lean mass). Using a one and two-dimensional echocardiography, the heart variables were measured at the rest position, as in; total mass, end diastolic and systolic left ventricular diameter.

2.3. Anthropometric measurements

A total of 9 anthropometric variables (height, weight, BMI, arm circumference, hip circumference, waist to hip ratio, fat-free mass, fat mass, fat percentage) were recorded from each subjects' right side of the body by an expert in anthropometry. The following anthropometric instruments were used:

Seca 220R telescopic stadiometer (measuring range: 85-200cm; precision: 1mm), Seca 710R weighing scale (capacity: 200kg; precision: 50g), Anthropometric tape (precision: 1mm) and Sliding Caliper (precision: 1mm).

Lumen dual equation was used to measure the subjects' body fat: BF= (0.735* ∑ SF) +1

Amounts of fat and fat-free mass were calculated according to the obtained fat mass and weight of the subjects.

BF=BF*100/Wt FFM=Wt-BF

2.4. Cardiac structure measurements

The cardiac structural variables were measured using commercially available echocardiography system and setting the stage between the transducer- between 8/3 to 9/1(mHZ) . The images were recorded after 20 minutes of resting - between 5 to 9 pm. There was an interval of at least 24 hours between the last training session and imaging. A 2D and 1D color imaging of tissue took place in parasternal, cephalic and subcostal positions. Echocardiography was performed by two skilled sonographers. All data were recorded digitally; meanwhile, the basic data was analyzed by an expert echo cardiographer. Left ventricular mass was calculated using the longitudinal area method. Normalization definitions were based on the latest recommendations of the American Society of Echocardiography. To analyze the data, discretional and referential statistics were used as means, standard deviations and the independent T test statistics.

2.5. Statistical analyses

In the present study to analyze the data, descriptive statistics as well as the mean and standard deviation were used. A paired-sampled t-test was used to compare between groups. Significance was assigned at P<0.05 for all analyses. All statistical procedures were performed using SPSS version 21.

3. Results

All the subjects were healthy and none of them showed significant abnormalities. None of the 10 athletes showed clinical backgrounds of any kind, family diseases or sudden death, or any important personal clinical history.

3.1. Anthropometric

Table 1. Anthropometric data in both preparation and competitive phases.

Variables	Periods of test

	Preparation	Competition
Height (Cm)	179.1±4.9	179.1±4.9
Weight (Kg)	104.1±23	106±24.2
BMI (Kg/m^2)	32.5±6.7	33.1±6.9
Arm circumference (Cm)	37.3±4.6	39.1±4.8
Hip circumference (Cm)	66.9±8.6	66±9.7
Waist to hip ratio (Cm)	0.95±0.05	0.95±0.05
Fat-free mass (Kg)	28.6±7.7	28.7±5.44
Fat mass (Kg)	75.7±19	78.1±21.8
Fat percentage (percentage)	27.6±6.1	27.5±5.1

3.2. Echocardiography

From an echocardiographic stand point, the results showed that there were no significant differences between preparation and competition phases (P>0.05) in terms of cardiac structural variables; i.e. Left ventricular mass (TLVM), Left ventricular end-diastolic diameter (LVDD), Left ventricular end-systolic diameter (LVSD), End-diastolic inter ventricular septal size (DVS), End-systolic inter ventricular septal size (SVSS), Left ventricular posterior end-systolic wall size (LVPSWS) (Table 2).

Table 2. Preparation vs. competition phases values for ECG variables of weightlifters.

Variables		Periods of test		P value
		Preparation	Competition	
Left ventricular mass (TLVM) (g)		247±77	277±71	0.06
%Δ	+12.14			
Left ventricular end-diastolic diameter (LVDD) (mm)		50.3±3.5	50.6±3.9	0.14
%Δ	+0.59			
Left ventricular end-systolic diameter (LVSD) (mm)		35.3±3.8	34.4±6.2	0.62
%Δ	-2.54			
End-diastolic inter ventricular septal size (DVSS) (mm)		11.57±1.6	12.7±2.3	0.10
%Δ	+9.76			
End-systolic inter ventricular				

septal size (SVSS) (mm)		12.35±1.7	12.44±2.3	0.91
%Δ	+0.72			
Left ventricular posterior end-systolic wall size (LVPSWS) (mm)		13.2±2.1	12.5±2.2	0.60
%Δ	-5.30			

* Significantly greater than preparation phase value ($p < 0.05$).

3.3 Performance

While passing the preparation phase to competitive phase, performances of weightlifters showed significant differences in all of variables (Snatch, Jerk and clean, Squat, Strength Snatch, Strength jerk and clean) ($p < 0.05$) (Table 3).

Table 3. Preparation vs. competition phases values for performance variables of weightlifters

Variables		Periods of test		P value*
		Preparation	Competition	
Snatch (Kg)		123±27	129±29	0.005*
%Δ	+4.87			
Jerk and clean (Kg)		153±39	158±39	0.010*
%Δ	+3.26			
Squat (Kg)		184±51	197±49	0.001*
%Δ	+7.06			
Strength Snatch (Kg)		83±19	87±19	0.007*
%Δ	+4.81			
Strength jerk and clean (Kg)		102±21	105±21	0.011*
%Δ	+2.94			

* Significantly greater than preparation phase value ($p < 0.05$).

4. Discussion and Conclusion

Based on ‘Morgan Roth hypotheses, repeated sporting stimuli cause characteristic enlargement (hypertrophy) of the myocardium in athletes. The term used for such changes is left ventricular of the athlete (athlete’s heart). These structural changes in the left ventricular of the athletes may be different regarding the diverse training models [24]. According to the results of the previous studies, attending in aerobic or endurance sports result in eccentric LV hypertrophy whereas strength training result in concentric LV hypertrophy. These two adaptations are described as positive physiological adaptations of the heart being different from pathologic hypertrophy[11, 25]. For this reasons, a groups of young elite Iranian weight lifters were compared in two phases (preparation and competition phase). Therefore, this is the first study which examined short term effects of strength training on the echocardiographic and performance profile of Iranian young elite weightlifters.

4.1. Echocardiography

Some studies have showed that the absolute LV mass (g) of weightlifters may be ~13–30%larger than that of age-matched healthy and/or sedentary control subjects [26-29]. In this research, results about cardiac structural variables conducted by the echocardiography explained that none of the cardiac variables have significant differences in both preparation and competition phases. According to our search, there was no study that examines the left ventricular structural changes within their training season. Therefore, we examined similar studies that related to our research.

In regard of total left ventricular mass (TLVM), most researchers believe that hypertension affects the heart muscle which is the main driver of the increase in total mass of the left ventricle as a result of muscle contraction force [2, 4, 30]. However, some researchers have reported conflicting results in this regard .16 weeks of resistance training on the elderly, did not affect the total mass of the left ventricle [31, 32]. Others believe that a long period of resistance training is required to change the left ventricular structure of elderly [33]. Using the MRI, Scharhag 2002, showed that subjects who had continuously practiced relative to novice subjects had a larger left ventricle of the total mass [34].

The mean left ventricular end-diastolic size (LVDS) measurements obtained in this study was (5.06 – 5.05 cm). These values are almost identical to the study that examined 5500 average values for strength athletes (5.51-5.62 cm) through a three meta-analysis with echocardiography [3, 10, 35]. These results are consistent with the results obtained by other researchers [36, 37]. Most researchers in this field suggest that an increase in end-diastolic volume is due to the endurance training. However, some studies, have reported that implementation of strength training program is associated with the increased levels of end-diastolic volume. Perhaps the most important factor in creating inconsistencies is in the form of the implementation of training programs. Because studies carried out by Baggish and Tayyebi can be indicative of a power-endurance training [4, 38].

Very few studies have examined the left ventricular end-systolic as one of the indicators of left ventricle. In this regard, the results of Tayyebi 2010 are not much consistent with the results of other studies [38]. In addition, the findings of Baggish 2008 and Spence 2011 are similar to results of this study [4, 37]. The inconsistencies on this regard can be traced back to the nature of implementation of exercises and workout intensity.

Most of the previous researches focused on the septal thickness index only in diastole but we discuss the two variables (end-systolic and diastolic inter ventricle septal size) at the same time. Some previous studies- that considered ventricular changes of septal thickness after the implementation of strength training are inconsistent with the Morgan Roth hypothesis [23, 37]. These results are matched with the results of our study. But some other studies are consistent with the Morgan Roth theory [4, 39-42]. Perhaps we could search for the sources of inconsistency in factors such as volume, intensity, type of sport, the use of anabolic steroids and the type of research projects.

Considering the Left ventricular posterior end-systolic wall size (LVPSWS) (mm), most strength training exercises have taken place in relation to the impact of the fluctuation of morphological left ventricle; needless to say that only indicators of the left ventricle in end-diastolic wall were measured. Very few studies have also reported changes in end-systolic. Lalande and Baldys (2007) can be cited as an example of such researches [23]. There were no significant differences between the values of end-systolic wall thickness in the weightlifters and the control group; in addition, the results of previous studies are consistent with the results of the present study.

4.2. Performance

The results of this study regarding the effects of training on performance of participants show that all performance variables have significant differences from preparation phase to competitive phase. These results are consistent with the findings of some other researchers [43, 44].

4.3. Conclusion

Present findings suggest that all elite weight lifters were being trained for a long-term- over the years, and all the changes in the echocardiography variables were made due to the strength of their trainings. It was also concluded that the short-term trainings (from preparation phase to competitive phase) didn't affect the cardiac structure of the weightlifters. The researchers suggest that short term exercise should be avoided in order to change the cardiac structure in trained athletes.

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