Original Research

Association of body surface area and body composition with heart structural characteristics of female swimmers

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ABSTRACT

Int J Exerc Sci 3(3): 97-104, 2010. In healthy nonathletic populations, some left ventricle (LV) parameters such as LV mass (LVM) and LV end diastolic dimension (LVEDD) can be predicted by some of body size parameters such as body surface area (BSA), fat-free mass (FFM), and height (H). These body size parameters use to remove covariate influence of body size from cardiac dimension variables and allow comparisons to be made between individuals and groups of different body size. Endurance exercise has been associated with changes in LV size and body composition of athletes. The aim of this study was to evaluate in 30 trained female swimmers (12-17 y) possible correlations between BSA, FFM, fat mass (FM) determined by bioelectrical impedance analyzer(BIA); and a range of cardiac dimensions derived by echocardiography. Univariate correlations were studied between left ventricular and body size variables. Stepwise multiple linear regression was performed to determine the best determinants of LV variables. LVM and LVEDD had a significant relation with FFM ($P<0.001$) and BSA ($p<0.05$). Left ventricle posterior wall thickness (PWT) had a significant relation with BSA ($p<0.001$) and FFM ($p<0.005$). No relation was found between heart's structural variable (LVM, LVEDD, LVESD and PWT) and FM. Using a multivariate regression analysis, FFM was the only independent predictor of both LVM ($R^2=0.541$, $P<0.001$) and LVEDD ($R^2=0.189$, $P<0.05$). These results suggest that Correction of LVM and LVEDD by FFM in athletes may be more appropriate than other measures of body size for indexing absolute amounts of LV dimension. Yet further researches in other athletes are required to confirm these findings.

KEY WORDS: Indexation, LVM, LVEDD, fat-free mass, athlete

INTRODUCTION

Left ventricle (LV) size and mass (LVM) are related to body size and body composition (6, 26, 38, 44). It is vital to determine the best parameter for indexing absolute amounts of LV dimensions. This normalization will help to establish normal reference standards and correct inter-and intra-group comparisons (2, 4). It can also use for detecting the presence of pathologic left ventricular hypertrophy (LVH) (21, 23). For this purpose, in some populations LV size and LVM are often divided by body surface area (BSA) (21, 23). However, this over estimates LVH in lean subjects while underestimates LVH in obese individuals (42).

Height and height raised to various powers are recommended in place of BSA (8, 9). However, recent studies have demonstrated a close relationship between LVM and fat-free mass (FFM) in nonathletic populations (26, 44). The possibility of such a relation in athletic population because of differences in their body size and composition, and LV structure in comparison with nonathletic healthy individuals is under investigation. Whalley et al (36) have shown that FFM is the best predictor of LVM and left ventricular end-diastolic dimension (LVEDD) in both young and old male endurance athletes (42). George et al (2001) have found significant relationship between body surface area (BSA) and LVM in different athletes (20). May be this relation differs among different sport groups.

Swimming has special characteristics in comparison with other sports. Body condition and its motions are distinct in water and out of water. Such distinctions might have special effects on LV structure and body composition. With respect to these distinctions and their correlations, there is little information especially on female athletes. Also the majority of studies have focused on the LVM, with less attention paid to LV internal dimensions such as EDD, EDV and PWT. Therefore we have investigated the relationship of LV structure and body composition in exercised female swimmers.

METHODS

Subjects

Female swimmers (n=30, 12-17 y) who had competed in national competitions for at least 4 y participated to this investigation. All athletes and their parents signed informed consent form documents where study procedures were explained, agreeing to volunteer to the study and the use of data for scientific publication. All subjects completed a medical history questionnaire and were healthy. Measurements were made before the national competition in hopes that the swimmers were at their best physiological conditions.

Body Composition Measurement

Body composition was determined with a Bioelectrical Impedance Analyzer (BIA). It has been shown to yield precise measurements of FFM and FM (21, 25, 27, 30, 31, 39). Measurements were made in the morning or evening. Subjects were asked to drink plenty of water, avoid alcohol consumption, and avoid exercise training prior to being measured. Body surface area (BSA) was estimated through applying height and weight using the equation of Dubois and Dubois (17).

Heart structural measurement

Subjects rested in a supine position for 5-min before the echocardiographic evaluation. A heart specialist performed all examinations using a Vingmed echocardiograph equipped with monitor and transducer. Parasternal long and short axis views of the left ventricle (LV) were imaged with the subject lying on left side. All measurements were recorded as the average value derived from a minimum of three successive cardiac cycles in accordance with ASE recommendations. LVM was estimated applying LVED structural measures using the previously validated formula of Devereux (13, 14).

Statistical Analysis

All statistical analyses were performed using SPSS 11 software (Chicago, IL). Prior to formal statistical testing frequency distributions were tested for normality using the Kolmogrof-Smirnov test. Univariate correlation coefficient (Pearson) was used to examine the relationship between LV structure and body composition. Multiple linear regression analysis was used to determine the independent predictors of LV structure. $P<0.05$ was considered statistically significant.

RESULTS

Subjects' characteristics, body size variables, and echocardiography measurements are represented in Table 1.

Table 1: Subjects' Characteristics and Echocardiograph Measurements (n=30)

Variable	Mean ± SD
Age (y)	14.5 ± 1.7
Height (m)	1.62 ± 0.04
Weight (kg)	58.24 ± 6.10
Body surface area (m2)	1.61 ± 0.09
Fat mass (kg)	13.68 ± 3.59
Fat-Free mass (kg)	44.50 ± 3.97
Left Ventricle End – diastolic Dimension (mm)	42.1 ± 2.7
Left Ventricle End – systolic Dimension (mm)	29.23 ± 1.96
Left Ventricle Mass (g)	157.12 ± 18.79
Posterior Wall Thickness (mm)	11.1 ± 0.94

Values represent mean ± SD

LVM had a significant relation with BSA and FFM (r= 0.69, r= 0.74, $P<0.001$ respectively). LVEDD had also a significant relation with BSA and FFM (r=0.40, r=0.44, $P<0.05$ respectively). Using multivariate regression analysis, the only independent predictor of LVM and LVEDD was FFM ($R^2=0.547$, $P<0.001$, $R^2=0.189$, $P<0.05$ respectively). For PWT the variable predictor was BSA ($R^2=0.301$, $P<0.001$). Other relations are shown in Table 2.

Table 2: Univariate correlation of body size and composition with left ventricular structure

Variable	Left Vermicular End-diastolic Dimension	Left Vermicular End-systolic Dimension	Left Ventricular Mass	Posterior Wall Thickness
Body surface area (m^2)	$R^2=0.40$* P=0.027	0.34 0.004	0.69* <0.001	0.60* <0.001
Fat mass (kg)	0.10 0.603	0.052 0.785	0.25 0.191	0.247 0.188
Fat- free mass (kg)	0.44* 0.016	0.337 0.068	0.74* <0.001	0.54* 0.002

Values represent R^2 and P
* Statistically Significant.

DISCUSSION

LVM, LVEDD, and PWT were significantly related to body surface area. This finding is consistent with other published research (15, 23, 38, 40, 42). Therefore in clinical studies, body surface area is used to estimate change in the left ventricle (21, 23); however, others argue that body surface area under estimates changes in heart structure (3, 26, 44). In athletic populations, body composition varies greatly depending on the primary exercise mode.

In this investigation, a significant relation between specific left ventricle dimensions (LVM, LVEDD, and PWT) and fat-free mass was identified. Using multivariate regression analysis fat-free mass was identified as the strongest predictor of LVM and LVEDD. This finding is consistent with what others have reported regarding the relationship between fat-free mass LV dimensions (1, 4, 6, 15, 23, 36, 45). There are two likely scientific explanations for the relationship between fat-free mass and LV dimensions. One, genetic factors and hormones which effect fat-free mass, also effect the heart. Two, fat-free mass is responsible for all metabolic activity in the body, thus, as it demands more blood flow during exercise, the heart is forced to adapt accordingly (7, 10, 11, 12, 21, 28, 29).

In the present study, no significant relationship was found between LV dimensions and fat mass. The published literature in this area is inconsistent, with some investigators reporting a relationship (3, 26, 44), while others do not (6, 21, 22). Differences in obesity status, distribution of body fat, and technique for the measuring body fat and the most likely explanations underlying the inconsistent findings. For example, use of BMI to estimate fat mass does not provide a reliable index (32, 34, 35). Also, LV dimensions and fat mass in obese individuals seem to have a stronger relationship because obesity places excess stress on the heart. Since the present study involved lean individuals, this may explain why we did not find a significant relationship between fat mass and LV dimensions.

In conclusion, we the key findings of the present study demonstrate that the quantity of fat-free mass provides the best index of LVM, LVEDD and PWT in athletes. More research is needed confirm these findings.

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