

# GRADED ASSOCIATION BETWEEN CARDIORESPIRATORY FITNESS AND SKIN FOLDS THICKNESS IN ADOLESCENTS.

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AO Akinpelu\*, OO Oyewole \*\* and KS Oritogun\*\*\*

\*Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan.

\*\*Department of Physiotherapy, Olabisi Onabanjo University Teaching Hospital, Sagamu, Ogun State.

\*\*\*Department of Medical Microbiology and Parasitology (Biostatistics Unit), Olabisi Onabanjo University

Correspondence to:

OO Oyewole

oyewoleye@yahoo.co.uk

P.O. Box 343, Sagamu, Ogun state.

## SUMMARY

**Background:** Body fatness and cardiorespiratory fitness (CRF) are both related to health, and their interrelation to each other has been documented but with little information on Nigeria population.

**Objective:** The purpose of this study was to evaluate relationship between cardiorespiratory fitness and skin folds, and if this relation is linear or curvilinear.

**Methods:** A cross-sectional survey of secondary school students in Sagamu local government area of Ogun state, Nigeria during 2006 school year was carried out. Representative samples of 1638 apparently healthy students were selected from 11 schools with age ranged between 12 and 18 years. Their CRF, triceps and abdominal skin folds were measured.

**Results:** The results showed a significant negative correlation between the variables but not significant for males' triceps and sum of skin folds. There were significant graded relation between cardiorespiratory fitness and skin folds; the relations were curvilinear in the whole population. Coefficients of determination ( $R^2$ ) for cardiorespiratory fitness were 6.02%, 5.33% and 6.2% for triceps, abdominal and sum of skin folds respectively.

**Conclusion:** It is therefore, imperative to encourage participation in physical activities to improve fitness and thereby reduces the measure of adiposity.

**Key word:** Cardiorespiratory fitness, skin folds, body fatness, adolescents

## INTRODUCTION

Both abdominal fat and low cardiorespiratory fitness (CRF) are significant predictors of health risk, but the

independent contribution of these two factors is not firmly established. It is well established that aerobic exercise is cardioprotective (Eckel, 1997; Thompson et al, 2003) and that being overweight increases the risk of cardiovascular disease (CVD) (Calle et al, 1999; Wilson et al, 2002). However, because low physical activity and increased adiposity often occur in combination, masking their independent effects, it is unclear whether lower aerobic fitness or higher body fatness exerts a greater influence on CVD risk factors (Christou et al, 2005). Regular physical activity has been reported to be an effective means of improving CRF and reducing waist circumference, visceral fat, and subcutaneous fat independent of a corresponding change in body mass index (BMI) (Ross et al, 2000; Ross et al, 2004).

Skin fold thickness was related to a high risk profile regarding coronary heart disease (CHD), hence can be used to predict CHD (Twisk et al, 1998). In general, skin fold measurement contribute only marginally to improved prediction of risk of ischaemic heart disease (IHD) as measured by BMI, but central obesity, as measured by the subscapular skin fold, is predictive of IHD independently of BMI (Yarnell et al, 2001). Triceps skin fold predicted total fat content well in male children and adolescents (Sarria et al, 2001). The reports from the Aerobics Center Longitudinal Study present convincing evidence that fitness is a more potent risk factor for mortality than is fatness and that fitness attenuates the effect of obesity on mortality (Stevens et al, 2002).

The relationship of cardiorespiratory fitness and indices of adiposity has been reported in the literature. Previous study has shown that individuals with moderate CRF had lower levels of total fat mass and abdominal subcutaneous and visceral fat than individuals with low CRF for a given BMI (Janssen et al, 2004). It has been observed that for both men and women the mean body

weight, BMI, triceps skin fold thickness, sum of four skin fold measurements, predicted percentage of body fat and waist-hip ratio were significantly lower with increasing fitness (Jette et al, 1992). It was reported that sum of skin folds, subscapular and truncal skin fold thickness, BMI and percent body fat were lower in overweight and obese youths with high CRF in comparison with youths at the same BMI category with low CRF (Nassis et al, 2005). However, studies analyzing the graded relation between cardiorespiratory fitness and skin folds in this population are scarce. Therefore, the purpose of this study was to evaluate relationship between cardiorespiratory fitness and skin folds, and if this relation is linear or curvilinear.

## MATERIALS AND METHODS

During 2006 school year, a cross-sectional survey of secondary school students in Sagamu local government area of Ogun state, Nigeria was carried out. Thirty one secondary schools were in the area, 16 public and 15 private schools. The sample of 11 schools (8public and 3private) was drawn by stratifying the school into public and private schools. Participants were drawn from the selected schools by probability proportional to size from various arms of the classes. Total of 1638 (790 male and 848 female) apparently healthy students were selected. Their age ranged between 12 and 18 ( $14.96 \pm 1.84$ ) years. The protocol for this research was approved by Institutional Review Committee of University of Ibadan and University College Hospital, Ibadan. Informed consent was sought from the participants and their parents; permission was sought from local education authority and the principals of the selected schools. The nature, purpose and procedure of the study were explained to the participants in detail. The biodata of each participant was taken: this included age (as at last birth day) and sex. Each of the participants was medically screened for any disability and pathology.

### Measurements

**Cardiorespiratory fitness:** Cardiorespiratory fitness index was calculated using 3-minute step test. The participant was dressed in suitable clothes and the procedure was explained and demonstrated. The protocol is described in the previous study (Akinpelu et al, 2007). The Cardiorespiratory fitness index (CRFI) was computed with the following formula:  $CRFI =$

$$\frac{\text{Duration of exercise in second} \times 100}{2 \times \text{X sum of pulse counts in recovery}}$$

(Amusa and Udoh, 1982)

**Skin folds:** The American College of Sports Medicine guidelines for skin fold measurement was followed to measure triceps and abdominal skin fold thickness using Skin fold caliper (FAT-O-METER, Novel products Inc., Pat. No.4.233.743). The triceps skin fold was taken at the level of mid-point between the acromion and olecranon

processes and 5cm adjacent to the umbilicus to the right side for abdominal skin fold thickness as described by ISAK (2001). Two readings were taken on each site and the average was used in the computation.

### Data Analysis

Data analysis was done with computer software package (SPSS version 15.0). Descriptive statistics (mean  $\pm$  SD) were used to examine the data as appropriate. Pearson correlation was used to find the strength of the relationship between cardiorespiratory fitness and skin folds. Regression analysis was carried out to see relationship between the variables. The graded relations between CRF and skin folds were carried out using Microsoft excel. P-value  $< 0.05$  was taken as significant.

## RESULTS

Table 1 shows descriptive variables of the study population. Males were significantly older than the females. Boys were significantly fit than the girls while the girls were higher significantly in fatness than the boys. Table 2 presents correlation matrix between cardiorespiratory fitness and skin folds. There were significant negative correlation between the variables but not significant for males' triceps and sum of skin folds.

Figures 1-3 show the relation between cardiorespiratory fitness and triceps, abdominal and sum of skin folds respectively for the whole population. Triceps skin fold showed a significant curvilinear (3<sup>rd</sup> degree polynomial) relation with cardiorespiratory fitness. The regression equation was [Triceps skin fold ( $y_1$ ) =  $4E-06x^3 + 0.0043x^2 - 0.7258x + 37.893$ ]. Cardiorespiratory fitness explained 6.02% of total variance. Abdominal skin fold also showed a significant curvilinear (3<sup>rd</sup> degree polynomial) relation with cardiorespiratory fitness. The regression equation was [Abdominal skin fold ( $y_2$ ) =  $3E-05x^3 - 0.0028x^2 - 0.1235x + 21.131$ ]. The percentage contribution to the total variance from cardiorespiratory fitness was 5.33%. Sum of skin folds as well demonstrated a significant curvilinear (3<sup>rd</sup> degree polynomial) relation with cardiorespiratory fitness. The regression equation was [Sum of skin folds ( $y_3$ ) =  $3E-05x^3 + 0.0015x^2 - 0.8492x + 59.021$ ]. Cardiorespiratory fitness explained 6.2% of total variance.

**Table 1: Descriptive Statistics by Gender**

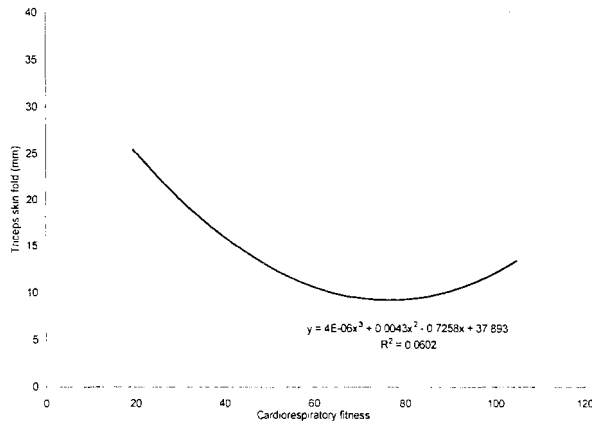
Variables	Male (n=790) Mean(SD)	Female (n=848) Mean(SD)	p
Age(years)	15.1(1.9)	14.8(1.8)	.001
CRF	67.8(9.3)	63.7(11.7)	.000
TSF (mm)	6.4 (3.0)	14.1 (5.3)	.000
ASF(mm)	6.9 (2.6)	12.7 (4.3)	.000
SSF(mm)	13.3 (5.1)	26.9 (8.9)	.000

Key: CRF=Cardiorespiratory Fitness, TSF= Triceps skin fold  
ASF=Abdominal skin fold, SSF=Sum of skin fold

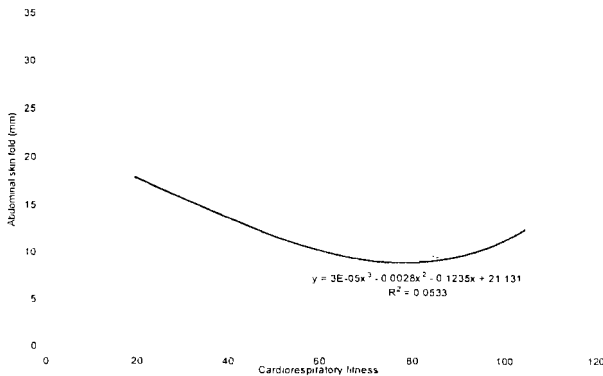
**Table 2: Correlation Matrix between Cardiorespiratory Fitness and Skin folds**

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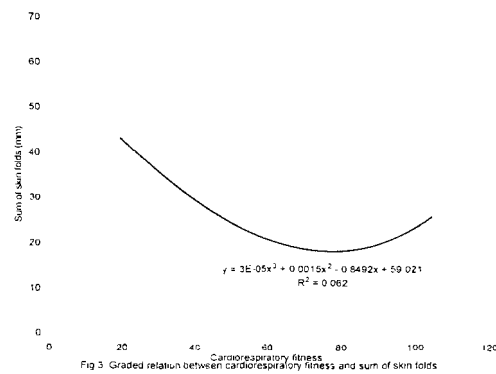
SSF= sum of skin fold, CRF=Cardiorespiratory Fitness  
 \*\*Correlation is significant at the .01 level (2-tailed)



**Fig 1: Graded relation between cardiorespiratory fitness and triceps skin fold**



**Fig 2: Graded relation between cardiorespiratory fitness and abdominal skin fold**



**Fig 3: Graded relation between cardiorespiratory fitness and sum of skin folds**

**DISCUSSION**

The present study evaluated the graded associations between cardiorespiratory fitness and skin folds in a representative sample of secondary school student’s adolescents. A graded relation between cardiorespiratory fitness and skin folds (triceps, abdominal and sum of skin folds) was demonstrated. The relation was curvilinear in the whole population. The third degree term of the fitness variable, which could indicate a more complex association than a second order polynomial, was significant for triceps, abdominal and sum of skin folds and only explained 6.02%, 5.33% and 6.2% of the total variation in triceps, abdominal and sum of skin folds respectively.

The results in the present study show a significant negative correlation between anthropometric variables and cardiorespiratory fitness in the whole population, which has also been reported earlier in children and adolescents (Boreham et al, 2001; Ekelund et al, 2001). When the data was adjusted for sex, a gender differences was seen in the relationship between cardiorespiratory fitness and anthropometric variables. The male students do not show a significant correlation with exception of abdominal skin fold. This observation was in contrast to the study of Mota et al, (2006). In that study, it was shown that cardiorespiratory fitness expressed indirectly was inversely and significantly associated with fatness, in both sexes. None of the previous studies analysed whether the association between cardiorespiratory fitness and skin fold was curvilinear in Nigeria population which the present study explored. It was observed that the relationship was curvilinear in Nigeria adolescents. The same observation was reported in European children and adolescents (Klasson-Heggebo et al, 2006).

Literature showed that there is an interest in the relationship between cardiorespiratory fitness and other indicators of health status, including obesity. Low levels of activity and fitness are a major public health problem in many countries (Mota et al, 2002). Although the mechanism by which high cardiorespiratory fitness reduces the risk of obesity is not clear, relationships of aerobic fitness and fatness to some risk factors were found even in childhood (Maffeis et al, 2003). Therefore, a measure to increase childhood cardiorespiratory fitness should be taken in order to reduce the risk of obesity. Results from the Muscatine study have pointed out that children who improve their cardiorespiratory fitness during childhood have less overall adiposity and less abdominal adiposity than their counterparts during adolescence (Janz et al, 2002). Participation in vigorous physical activities has been shown to relate inversely to fat deposition in male adolescents (Dionne et al, 2000). It is therefore, imperative to encourage participation in physical activities to improve fitness and thereby reduces the measure of adiposity.

## CONCLUSION

In this sample of Nigerian adolescents, a curvilinear relation was found between cardiorespiratory fitness and skin folds. It is therefore, imperative to encourage participation in physical activities to improve fitness and thereby reduces the measure of adiposity. It is therefore important to direct action towards those adolescents who have low cardiorespiratory fitness.

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