Original Article

Correlation of Triceps Skin fold with BMI in Age Matched Men: Anthropometric Analysis

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ABSTRACT

Objectives: To study the thickness of the triceps subcutaneous fat measured by the caliper anthropometry, in age matched individuals having different body mass indices; and to determine if there is any correlation between the thickness of subcutaneous fat with that of the body mass index (BMI).

Study Design: Cohort prospective.

Place and Duration of Study: This study was conducted at Anatomy Dept, Nishtar Medical College, Multan from August 2010 to December 2010.

Materials and Methods: Observations were made on 260 healthy men of 20-50 years of age. Regression analysis and Pearson's correlation coefficient were computed and are statistically significant ($p < 0.05$-0.01).

Results: The results reveal that the triceps skin fold fat was very strongly correlated (range = 0.88 to 0.96) in all age groups. While in case of BMI it good in Groups I & II. On the other hand Age and BMI show little correlation with that of triceps muscle area. The results are statistically significant p value being 0.05 to .01.

Conclusion: The study reflects some limitations of triceps anthropometry in estimating obesity but still has value in assessing nutritional status in special circumstances like refugee camps, schools, etc.

Key Words: Triceps Skin fold, BMI, Anthropometric Analysis.

INTRODUCTION

The human body composition assessment in research is well established. Most body composition assessment methods are based upon two models. The body may be divided into either two chemically distinct compartments, fat and fat free or four chemical compartments composed of water, proteins, lipids and bone minerals[1].

There are simpler and less expensive methods which assess the adipose tissue of the body to various degrees of accuracy, like, normal average weight and height charts. With the consideration of the skeletal frame, they are used widely to assess the overweight. Various body circumferences, particularly the ratio of waist to hip circumference, are used. Skin fold measurements also give good idea of the body fat and non-fat compartments.

Body Mass Index: The weight in relation to height is expressed as body mass index (BMI).

BMI = weight in Kg / height in m^2.

This simple measurement also known as Quetelet's Index correlates quite highly with other sophisticated technical methods of assessment of body fat[9]. The normal value for this index for men and women is 20-25 kg/m^2 (Ref.2) On the other hand a study published in 2010 that followed 11,000 subjects for up to eight years concluded that BMI is not a good measure for the risk of heart attack, stroke or death. A better measure was found to be the waist-to-height ratio[3]. The most accurate techniques, like denstiometry, computed tomography, magnetic resonance imaging, electrical conductivity; total body water determination by isotope dilution method, whole body counting of potassium 40, and neutron activation analysis is very expensive and not suited for clinical or epidemiological studies.

Obesity is established when more than 20% of body weight is due to fat in men and more than 25% in women. Obesity is on the increase with improved socio-economic conditions in Pakistan and other developing countries. It is decreasing in higher socio-economic classes of the Western world but exhibiting a rise in its middle class population[4]. Lean body mass decline accelerates after 60 years while fat keep increasing up till 75 years of age[4].

Anthropometric analysis of mid upper arm: The arm consists of a cylinder of muscles within a sheet of adipose tissue. From the external circumference of mid-arm and the width of adipose layer (equal to one half of the skin fold); mid-arm muscle area can be calculated (Figure-5). Mid-upper arm circumference (MUAC) measurement, if conducted by well-trained staff, can give a quick assessment of new arrivals at a refugee camp during a humanitarian crisis[5]. Normal average values for the adult American men are: mid upper arm muscle area is 50.1 cm^2 (Ref. 2). No difference was noted between measurements on either side of the body, nor is the thickness of the subcutaneous fat affected by the muscular activity. Therefore the skinfold thickness of a tennis player is no different at the upper arm sites in the active arm compared to the less active arm. Various callipers have been used previously but no significant difference was noted[6].

MATERIALS AND METHODS

The study was conducted on two hundred and sixty middle class healthy men. All the subjects were volunteers; usually accompanying the patients coming for ultrasound scan to the clinic. A Performa for every subject was filled. The subjects were weighed on the weighing machine, with minimal clothing. Their height was measured in centimetres. The weight and height of the subjects were recorded in multiples of 0.5 kilograms and 0.5 centimetres, respectively.

Triceps Skin Fold Thickness and Mid Upper Arm Circumference:
Skinfold thickness was measured on the left limb, to the nearest millimetre, and the mid-arm circumference up to nearest 0.5 centimetres. The recordings were made while subject was standing erect and relaxed. The instrument used for the measurement of skinfold thickness was Vernnier's calliper. The circumference of the upper arm was obtained using a flexible cloth tape. The principle of anthropometric analysis is illustrated in the Figure-5. Mid upper arm muscle circumference was calculated by the formula:

Muscle Circumference = C_1 – øS

C_1 = mid upper arm circumference in cm.

S = Triceps skin fold thickness.

Statistical Analysis: The statistical analysis was conducted for the whole data (n=260), for all the three age Groups (Group A, n=87, Group B, n=88 and Group C, n=84), and for all the three BMI Groups (Groups, I n=100, II n=97 and III n=63). Mean, median, mode and standard deviation for all the observed values were computed. The data proved to be quite consistent; hence it was decided to use the mean for all further computations, as required. The computer software, "Statistical Package for Social Sciences" were used for all computations and data handling.

Pearson's Correlation was computed for actual observations of the whole data. Correlations were considered statistically significant with confidence level 0.05 and highly significant with level 0.01.

Regression Analysis: Regression analysis was searched using simple Linear, Log linear and Multiple linear models. Simple linear model resulted in good regression coefficients, which were statistically significant too, but with multiple linear models, the regression coefficients improved and the statistical significance remained high. Multiple regression equations were computed. Age and BMI were regressed on triceps' subcutaneous fat in all Age and BMI Groups. Results were statistically tested by F-Statistics.

Curvefit Linear Regression lines were plotted to know the effect of the age and BMI on the triceps' subcutaneous fat for the three age Groups and the three BMI Groups. These lines were grouped for age and BMI and are presented together for comparison.

RESULTS

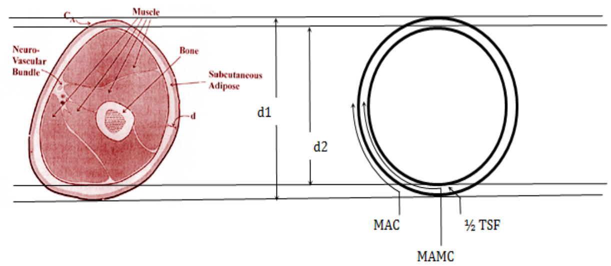
Correlation Analysis for Complete Data:
Pearson's Correlation Coefficients for the actual values of fat for complete data are shown in table-2. The results reveal that the triceps skin fold fat was very strongly correlated (range = 0.88 to 0.96) in all age groups. While in case of BMI it good in Groups I & II (Table 2)

Table No.1: Grouping of the Subjects

BMI Groups Age Groups	GROUP- A = < 25 Kg /m^2	GROUP - B > 25 - 35Kg/m^2	GROUP - C > 35 Kg / m^2	Total No of subjects in Age Groups
GROUP-I 21 - 30 years	n = 31	n = 34	n = 22	n = 87
Group-II 31 - 40 years	n = 35	n = 31	n = 23	n = 88
Group-III 41 - 50 years	n = 34	n = 32	n = 18	n = 84
Total No of subjects in BMI Groups	Grp-A n =100	Grp-B n = 97	Grp-C n = 63	Grand Total 260

Table No.2: Correlation Coefficient of Complete Data, Age and BMI Groups.

Measurements	**Split Data**					
	Age Groups (Cor. Coeff. for BMI)			**BMI Groups** (Cor. Coeff. for Age)		
	A	B	C	I	II	III
Triceps Skin Fold	0.9637**	0.9321**	0.9609**	0.8677*	0.8966**	0.6789**
Fat Area Triceps Skin Fold	0.8832**	0.9014**	0.9232**	0.8722*	0.7855*	0.8742*
Muscle Area Triceps Skin Fold	0.5421**	0.5368**	0.3918**	0.4542*	0.5245*	0.5211**
*p=0.05 **p=0.01 (2-Tailed)						



Calculation of mid-arm Muscle Circumference
C_1 = mid upper arm circumference in cm
S = triceps skin fold in cm
d_1 = arm diameter
d_2 = muscle diameter
Skinfold (S) = 2 x subcutaneous fat
= $d_1 - d_2$
Circumference (C_1) = $\pi\, d_1$
Muscle Circumference = $C_1 - \pi S$
Mid arm muscle area = $\frac{[C_1 - \pi S]^2}{4\pi}$
Mid arm fat area = $\frac{(S)(C_1)}{2} - \frac{\pi(S^2)}{4}$
MAC= Mid-arm Circumference
MAMC= Mid-arm Muscle Circumference
TSF= Triceps Skin Fold

Figure No.1: Illustration for principle of subcutaneous fat measurement by the triceps skin fold anthropometry and formula for mid arm muscle and fat circumferences by TSF.

On the other hand Age and BMI show little correlation with that of triceps muscle area. Though the elationship was poor, but notable observation was that muscles thicknesses are positively correlated to that of Age, (Table-2). The results are statistically significant p value being 0.05 to .01.

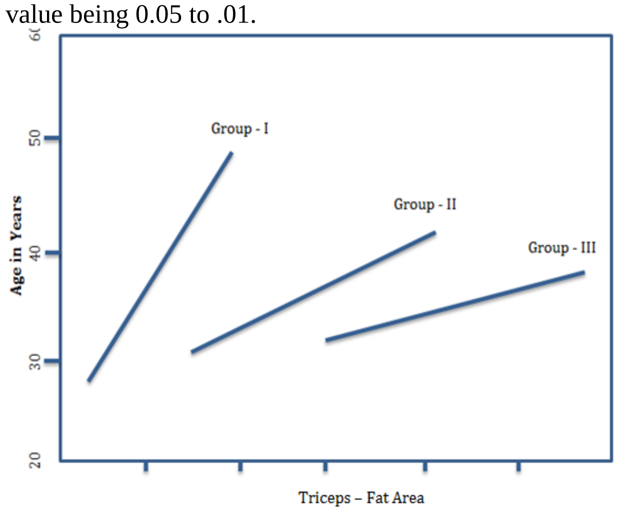


Figure No. 2: Curvefit linear regression lines of three BMI groups, dependent variable age, and independent variable – triceps skin fat area

Correlation Analysis for Split Data Age Groups: In all the Age Groups II III, and I fat was highly correlated to the BMI at the observed site. Good correlation (range = 0.88 to 0.97) was obtained for calculated values and for triceps skinfold thickness (Figure-2).

Correlation Analysis for Split Data BMI Groups: To estimate the influence of Age on the correlationship of Age, BMI and fat Pearson's Correlation Coefficients were computed. The Age (Table-2) shows poor correlation with that of fat, in all the three Groups. The relationship with that of BMI was better but not beyond 60%, except in group B, where it approaches 77%.

Regression Analysis: Relatively high coefficient of determination was obtained in Age Groups when BMI was regressed on fat (Figure-2). The relationship of fat and BMI was positive and there was consistent trend for Y-intercept (C), to become higher in Groups with increasing Age. The rate of change in the slope also increases especially in Age group III, demonstrating that more fat was present subcutaneously in this Age group (Figure-2).

When Age was regressed on fat in BMI Groups, the coefficient remained low. The relationship remained positive and linear. The y-intercept (C) increases with increase in BMI Groups, representing more fat deposition with increase in BMI (Table-2). The rate of change in BMI group A was very high, while it was reduced in BMI Groups B and C (Figure-2). This indicated that the relationship of Age on fat in Group-A subjects was more than in Group B and C subjects.

DISCUSSION

Skinfold Compressibility: Variation in the skin fold compressibility is another important factor to be accounted for in anthropometric analyses of skinfold thickness. Durnin and Womersley[6] have confessed that a possible reason for the shift of relationship between body density and skinfold thickness with age is that the skinfold compressibility may become greater with age. The literature review of the past presents evidence against this claim: skinfold-compressibility was found to be maximum in children and minimum in elderly, probably due to decrease in water content of the tissues[6, 7], hence, reducing the credibility of caliper anthropometry. Ohziki et al.,[8] , is of the view that assessment of subcutaneous fat using ultrasonography is not influenced by changes in cutaneous compressibility. Calliper anthropometry is still being quite widely used in clinical research and relied upon[9, 10, 11].

Triceps anthropometry and BMI: The correlation coefficient between the subcutaneous fat of triceps skin fold, measured by the callipers, and BMI is significantly high (Table-2). The correlation coefficient of triceps skin fold is least in the BMI Group-C, BMI >35 (Table-2). The low coefficient of determination by triceps anthropometry of subcutaneous fat especially in the BMI Groups is indicative of its limitations in estimating obesity, as is also apparent in correlation coefficient of triceps skin fold subcutaneous fat which is least in BMI groups (Table-2). BMI and triceps skin fold measurement is comparable and hence can be used efficiently in at least refugee population with much ease of single observation[5].

CONCLUSION

Hence, it is inferred that triceps skin fold, reveals increased deposition of subcutaneous fat with advancing age and this effect is more marked in normal weight individuals than of overweight or obese people. The study also reflects the limitations of triceps anthropometry in estimating obesity but still has value in assessing nutritional status of special circumstances.

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