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Research Article

Body Fat Distribution among College Students

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Abstract

Background: Present study involves the use of Bioelectrical Impedance Analysis (BIA) technique for estimating body composition including the muscle and fat percentage distribution in a body.

Objectives: The primary objective of this study was to evaluate the pattern of body composition among college students.

Methods: The body composition and weight were measured using bioelectrical impedance analysis of Omani and Non-Omani college student's studying in and around Muscat. The readings about body weight, BMI, body age, visceral fat, free fat mass, subcutaneous fat and skeletal muscle distribution were measured and recorded in a data sheet.

Results: Results are compiled as frequency and percentage followed by multiple linear regression analysis. The d = 1.769 value obtained in Durbin-Watson analysis shows that there is no first order linear auto-correlation in our multiple linear regression data. The linear regression analyzed by F-test is highly significant, thus it can be assumed that the model explains a significant variance in body fat composition. In our stepwise multiple linear regression analysis, we found significant skeletal muscle percentage in arms, which we can interpret as: for every 1-year increase in age per 21 years, we will see (5.372/20.351) 0.264 kg additional gain in skeletal muscle mass in arms.

Conclusion: Results indicates there is a significant correlation between age and arm skeletal muscles as the skeletal muscle in arms increase by 0.264 kg every year.

Keywords: *Body Fat; Obesity; Bioelectrical Impedance Analysis; Oman*

Introduction

Obesity is considered as a preventable modern lifestyle disease epidemic in all age groups across countries. It is known that the obesity has wide spectrum of consequences such as metabolic syndrome, diabetes mellitus, cardiovascular complications, osteoarthritis and hormonal disturbances [1-2]. The composition and distribution of fat and muscles is also known to have effect on perception mood, psychology and behavior [3]. One of the study carried out in Oman reported that the prevalence of overweight and obesity was 38.9% in selected study population [4]. It has been demonstrated that health complications could arise even in very low body mass, disorders in eating and dehydration indicating the importance of estimating body composition [5].

Incidence of obesity and overweight in children and adolescent is of great concern in many countries due to its continued presence throughout the life leading to cascading adverse effects on health [6]. Usual college age group of students includes those from 16 - 24 years old. This age group is more sensitive due to its vulnerability due to rapid change in body composition and higher rate of growth during this age [7]. Therefore, analysis of body composition results in this age group provides information on trend of nutritional status, need of clinical monitoring and addressing chronic malnutrition [8]. Higher rate of fat accumulation in this group is becoming epidemic due to sedentary lifestyle, dietary habits and easy availability of high calorie diet [9]. It has been proved that the composition of body during this age group is onward transmitted into adulthood [10].

Use of body mass index (BMI), waist circumference (WC) and waist hip ratio (WHR) are most widely accepted method of assessing distribution of body fat and categorization of obesity. However, WC and WHR are considered to be inaccurate method of estimating body fat in youth [11]. BMI also has limited acceptance due to the fact that it does not differentiate the mass of fat and muscles; high muscle content person might be categorized as obese; underestimates and overestimates the obesity-associated morbidity and mortality in shorter and taller people respectively [12]. Application of BMI in athletes, pregnant women, children and infants is also questionable [12]. Radiation based near infra-red radiation (NIA) and Dual-energy X-ray absorptiometry (DEXA) has limited use in estimating the body composition due to low-dose radiation and the cost [14]. Therefore, several methods recommended the use of non-invasive bio-electrical impedance analysis (BIA) method for estimating body composition [15].

Bioelectrical impedance analysis (BIA) is gaining its importance in clinical practice due to its sensitivity in assessment of body fat distribution, calculating incubation period for fat associated complications, reliable therapeutic outcome monitoring and assistance in individualizing therapeutic regimen [16]. It is important to mention that there are spectroscopic, single-frequency and multi-frequency BIA devices having the conducting systems arm to foot, arm to arm, and foot to foot. However, more reliable BIA devices are multi-frequency arm to foot devices due to reproducible results and estimation of fat distribution especially in trunk [17]. The aim of the present study was to assess body composition among college students in and around Muscat using BIA methods. It is expected that the study results will provide baseline data for the development of strategies in assessing, preventing, treatment andmonitoring therapeutic efficacy [18].

We hypothesize that there is a strong correlation between the body composition among college students and age. Therefore, we studied the correlation between the body fat, visceral fat, skeletal muscle, subcutaneous fat, BMI and random blood sugar among college students and age.

Methodology

Criteria for inclusion and exclusion

The inclusion criterion of this study includes those students age between (18 - 24 years) and registered for study in college. The study excludes those students who are not willing to provide measurements or data; who had food or not emptied bladder; and who just returned from indoor or outdoor activities.

Selection of participants

Present study was a cross over longitudinal prospective study to be carried out at colleges in Oman involving 252 randomly selected college students from Oman Medical College, Muscat; GU Technological University, Muscat; Sur College of Applied Science, Sur; Higher College of Technology, Musannah; and College of Finance and Banking, Muscat. Study was conducted by obtaining permission from National Centre for Statistics & Information, Muscat (NCSI/426/2018 dtd. 1/3/2018) and administrator from respective institutes.

Materials

The height scale and Omron bioelectrical impedance analytical instrument were used to measure body composition, calculate BMI and body weight of students.

Methods

Body fat distribution

The body composition was measured as directed by the manufacturer of Omron Body Composition analyser. This instrument is approved by FDA for research in adults. For the precise measurements the students were asked to stand bare feet arranged parallel and almost at an equal position on both sides of the instrument. They were allowed to stand straight without bending knees and hands hanging freely. Students were asked to extend their hand straight to the level of chest and grip the handles lightly. When the measurements were completed by noting the change in colour and numbers on display unit they were asked to step down from the unit.

Body composition analysis

The readings from BIA analyser were noted including body weight, visceral fat, subcutaneous fat, muscle mass, percent body fat, BMI and ideal body weight. A standard measurement scale was used to measure height, waist and waist-hip ratios.

Statistical Analysis

Each student was given a code number and then the information was entered directly into SPSS version 23 (SPSS Inc. Chicago, IL, USA) and analyzed. The continuous numerical data was analyzed for mean and standard deviation and for categorical data frequency and percentage were calculated. The relationship of age was investigated by the use of Pearson correlation coefficients. In order to estimate the true relationship between the patient's characteristics and body composition we used multiple logistic regression analysis. Backward stepwise logistic regression was used to adjust for confounding factors. A p-value of less than 0.05 was considered statistically significant to derive conclusion.

Results

Frequency of Factors distributed in Study Population

Most of the students involved in our study are from 18 - 24 years of age. Female students (55.6%) were comparatively more than male (44.4%). It is surprising to see that 46.4% of study population belongs to overweight and 32.9% of them belongs to obesity type I. It is difficult to correlate the body composition distribution to hereditary diabetic and obesity factors as 71% of the data is missing. Present study results shows that 30.2% of students were categorized into high total body fat and 48.0% of them were in very high total body fat. However, 84.9% of the study population were found to be in normal visceral fat category (Table 1).

	Frequency	Percent
Age		
< 18 years	5	2
18 - 20 years	94	37.3
21 - 22	67	26.6
22 - 24	47	18.7
> 24	37	15.4
Gender		
Male	112	44.4
Female	140	55.6
BMI Category		
Normal	30	11.9
Overweight	117	46.4
Obesity I	83	32.9
Obesity II	20	7.9
Students with Family history of Diabetes Mellitus		
No	49	19.4
Yes	24	9.5
Total	73	29.0
Missing	179	71.0
Students with Family history of Obesity		
No	59	23.4
Yes	14	5.6
Total	73	29.0
Missing	179	71.0
Relative having history of DM/ Obesity		
No	44	17.5
Yes	17	6.7
Father	7	2.8
Sister	4	1.6
Brother	1	0.4
Total	73	29.0
Missing	179	71.0
Total Body Fat Category		
Low	6	2.4
Normal	46	18.3
High	76	30.2
Very high	121	48.0
Total	249	98.8
Visceral Fat Category		
Normal	214	84.9
High	19	7.5
Very high	14	5.6
Total	247	98.0

Table 1: *Frequency of Factors distributed in Study Population.*

Descriptive Statistics of Body Composition

Descriptive analysis of data shows positive skewness in age, resting metabolic rate, visceral fat and random blood glucose. The average total body fat percentage is 29.7 ± 6.72 which comes under obesity category but having BMI 23.97 ± 4.25 kg/m^2 it is within normal range. The average RBR is 1375.94 ± 598.32 kcal/day showing that these students have sedentary lifestyle having little to no regular exercise. A rough estimate of the number of calories required per day is 1818 kcal/day to maintain ideal body weight [18]. The average visceral fat 6.06 ± 4.7 i.e. less than 10% indicating the normalcy in visceral fat distribution (Table 2).

	Mean ± Std. Deviation	Skewness
Age	23.18 ± 7.34	2.838
Body age	35.20 ± 12.23	0.366
Resting metabolic rate	1375.94 ± 598.32	12.193
Skeletal muscles (%) in legs	39.31 ± 5.66	0.612
Skeletal muscles (%) in arms	28.48 ± 6.29	0.785
Skeletal muscles (%) in trunk	20.64 ± 4.03	-0.284
Skeletal muscles (%) in whole body	26.35 ± 3.73	0.719
Subcutaneous fat (%) in legs	37.16 ± 9.69	-0.288
Subcutaneous fat (%) in arms	40.05 ± 10.72	-0.092
Subcutaneous fat (%) in trunk	21.83 ± 6.68	-0.068
Subcutaneous fat (%) in whole body	25.25 ± 6.93	-0.134
Visceral fat	6.06 ± 4.7	2.008
Total body fat (%)	29.7 ± 6.72	-0.414
Ideal body weight	56.5 ± 6.28	0.545
Body mass index	23.97 ± 4.25	-0.007
Height	160.62 ± 8.37	0.46
Weight	62.22 ± 13.82	0.057
Random blood glucose	102.75 ± 37.06	4.844

Table 2: *Descriptive Statistics of Body Composition.*

Pearson Cross-Correlation Analysis

This chart shows a significant correlation existing between body age and all other factors. Comparatively random blood glucose has limited correlation to other body composition factors (Table 3).

	Body age	Resting metabolic rate	Skeletal muscle of legs	Skeletal muscle of arms	Skeletal muscle of trunk	Skeletal muscle of whole body	Subcutaneous fat in legs	Subcutaneous fat in arms	Subcutaneous fat in trunk	Subcutaneous fat in whole body	Total visceral fat	Total body fat	Ideal body weight	Body mass index	Height	Weight	Age	Random blood glucose
Body age	1	0.196**	0.055	-0.347**	-0.438**	-0.273**	0.475**	0.367**	0.658**	0.599**	0.808**	0.704**	0.300**	0.911**	0.272**	0.849**	0.561**	0.341**
Resting metabolic rate	0.196**	1	0.158*	0.032	0.039	0.149*	-0.091	-0.128*	-0.029	-0.049	0.219**	-0.005	0.233**	0.187**	0.217**	0.265**	0.146*	0.351**
Skeletal muscle of legs	0.055	0.158*	1	0.735**	0.649**	0.822**	-0.603**	-0.647**	-0.495**	-0.532**	0.229**	-0.456**	0.564**	0.060	0.553**	0.317**	0.205**	0.171
Skeletal muscle of arms	-0.347**	0.032	0.735**	1	0.785**	0.878**	-0.851**	-0.826**	-0.815**	-0.843**	-0.069	-0.771**	0.392**	-0.364**	0.396**	-0.103	0.141*	0.046
Skeletal muscle of trunk	-0.438**	0.039	0.649**	0.785**	1	0.823**	-0.758**	-0.735**	-0.767**	-0.763**	-0.224**	-0.783**	0.333**	-0.449**	0.351**	-0.190**	-0.010	-0.040
Skeletal muscle of whole body	-0.273**	0.149*	0.822**	0.878**	0.823**	1	-0.828**	-0.831**	-0.787**	-0.798**	-0.039	-0.751**	0.533**	-0.286**	0.547**	0.034	0.129*	0.056
Subcutaneous fat in legs	0.475**	-0.091	-0.603**	-0.851**	-0.758**	-0.828**	1	0.909**	0.912**	0.951**	0.186**	0.884**	-0.381**	0.511**	-0.404**	0.184**	-0.146*	-0.072
Subcutaneous fat in arms	0.367**	-0.128*	-0.647**	-0.826**	-0.735**	-0.831**	0.909**	1	0.860**	0.901**	0.078	0.841**	-0.420**	0.374**	-0.444**	0.064	-0.163**	-0.112
Subcutaneous fat in trunk	0.658**	-0.029	-0.495**	-0.815**	-0.767**	-0.787**	0.912**	0.860**	1	0.954**	0.362**	0.943**	-0.235**	0.671**	-0.262**	0.382**	0.025	0.029
Subcutaneous fat in whole body	0.599**	-0.049	-0.532**	-0.843**	-0.763**	-0.798**	0.951**	0.901**	0.954**	1	0.291**	0.932**	-0.281**	0.622**	-0.309**	0.329**	-0.057	0.002
Total visceral fat	0.808**	0.219**	0.229**	-0.069	-0.224**	-0.039	0.186**	0.078	0.362**	0.291**	1	0.425**	0.297**	0.783**	0.269**	0.751**	0.555**	0.366**
Total body fat	0.704**	-0.005	-0.456**	-0.771**	-0.783**	-0.751**	0.884**	0.841**	0.943**	0.932**	0.425**	1	-0.159*	0.690**	-0.190**	0.431**	0.088	0.084
Ideal body weight	0.300**	0.233**	0.564**	0.392**	0.333**	0.533**	-0.381**	-0.420**	-0.235**	-0.281**	0.297**	-0.159*	1	0.180**	0.988**	0.617**	0.359**	0.228*
Body mass index	0.911**	0.187**	0.060	-0.364**	-0.449**	-0.286**	0.511**	0.374**	0.671**	0.622**	0.783**	0.690**	0.180**	1	0.149*	0.818**	0.326**	0.356**
Height	0.272**	0.217**	0.553**	0.396**	0.351**	0.547**	-0.404**	-0.444**	-0.262**	-0.309**	0.269**	-0.190**	0.988**	0.149*	1	0.592**	0.347**	0.230*
Weight	0.849**	0.265**	0.317**	-0.103	-0.190**	0.034	0.184**	0.064	0.382**	0.329**	0.751**	0.431**	0.617**	0.818**	0.592**	1	0.430**	0.365**
Age	0.561**	0.146*	0.205**	0.141*	-0.010	0.129*	-0.146*	-0.163**	0.025	-0.057	0.555**	0.088	0.359**	0.326**	0.347**	0.430**	1	0.263*
Random blood glucose	0.341**	0.351**	0.171	0.046	-0.040	0.056	-0.072	-0.112	0.029	0.002	0.366**	0.084	0.228*	0.356**	0.230*	0.365**	0.263*	1

Table 3: *Pearson Cross-Correlation Analysis.*

***: Correlation is significant at the 0.01 level (2-tailed).*

**: Correlation is significant at the 0.05 level (2-tailed).*

Linear Regression Analysis

Linear regression analysis shows a significant negative correlation between age and RMR, subcutaneous fat in arms and height in this study population. On the other hand there is a significant positive correlation is seen between age and body age and ideal body weight. The table 4 and 5 shows the multiple linear regression model summary and overall fit statistics. We find that the adjusted R^2 of our model is 0.188 with the $R^2 = 0.035$. The Durbin-Watson analysis shows that the d is 1.769 lying between 1.5 < d < 2.5. Thereby, indicating no first order linear auto-correlation in our multiple linear regression data.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	261.051	68.012			
Body age	1.141	0.097	2.097	11.785	0.000
Resting metabolic rate	-0.051	0.011	-2.235	-4.700	0.000
Skeletal muscle of legs	-0.130	0.165	-0.116	-0.783	0.437
Skeletal muscle of arms	-0.074	0.088	-0.069	-0.842	0.403
Skeletal muscle of trunk	-0.076	0.099	-0.048	-0.764	0.448
Skeletal muscle of whole body	-0.307	0.442	-0.168	-0.694	0.490
Subcutaneous fat of legs	-0.289	0.208	-0.382	-1.387	0.171
Subcutaneous fat of arms	-0.751	0.244	-1.135	-3.071	0.003
Subcutaneous fat of trunk	0.047	0.121	0.041	0.389	0.699
Subcutaneous fat of whole body	0.185	0.359	0.165	0.516	0.608
Visceral fat	0.023	0.070	0.020	0.331	0.742
Total body fat	0.144	0.132	0.122	1.096	0.278
Ideal body weight	4.060	1.183	3.802	3.431	0.001
Body mass index	-0.136	0.321	-0.087	-0.423	0.674
Height	-2.452	0.860	-3.169	-2.851	0.006
Weight	0.082	0.163	0.192	0.505	0.615
Random blood glucose	0.010	0.007	0.056	1.355	0.181

Table 4: *Linear Regression Analysis.*

a: Dependent Variable: Age

Model Summary					
Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Durbin - Watson
1	0.188[a]	0.035	0.029	1.946	1.769

Table 5: *Statistical evaluation of model of study.*

a: Predictors: (Constant), Skeletal Muscle of Arms

b: Dependent Variable: age

The linear regression's F-test (Figures 1-4) has shown highly significant value therefore the model explains a significant amount of variance in body fat composition (Table 5). This table 5 shows the multiple linear regression estimates including the intercept and the significance levels. The stepwise multiple linear regression analysis shown an insignificant intercept but significant skeletal muscle percentage in arms, which we can interpret as: for every 1-year increase in age per 21 years, we will see (5.372/20.351) 0.264 additional gain in skeletal muscle mass in arms. The data table checks for multicollinearity in multiple linear regression model. All variables have the tolerance > 0.1 (or VIF < 10). The graph plot shows that the residuals are normally distributed and the points follow the diagonal line without any strong deviations.

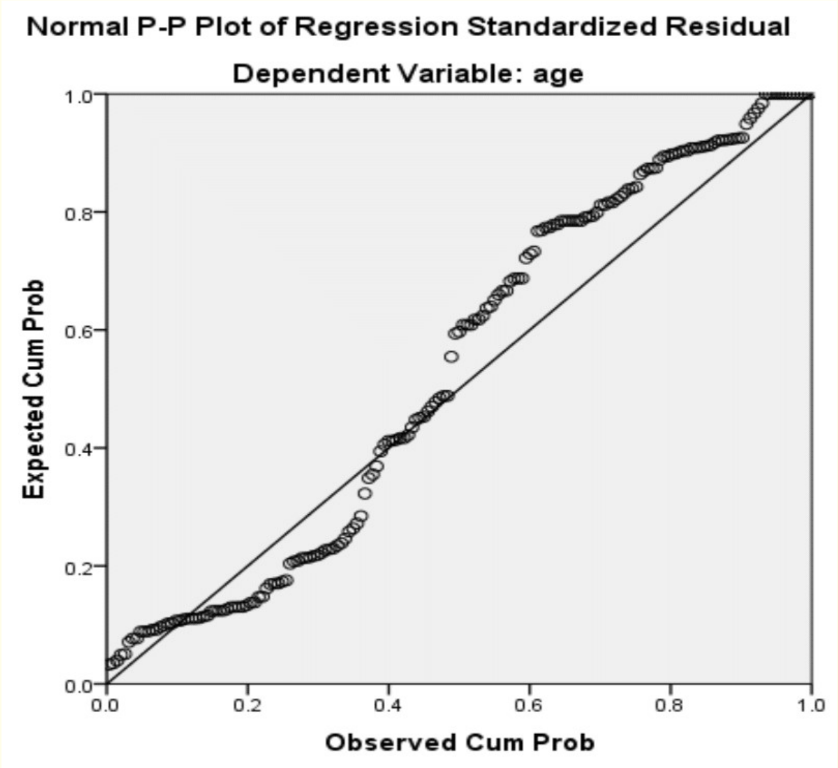

Figure 1

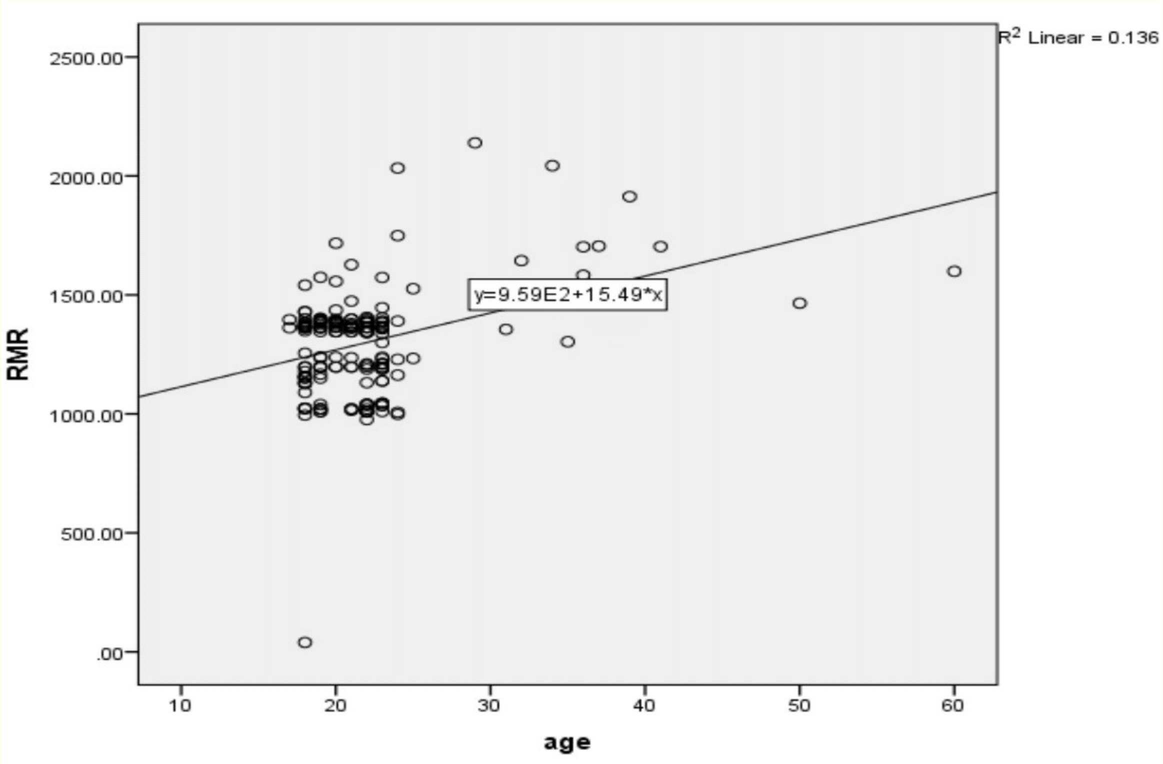

Figure 2

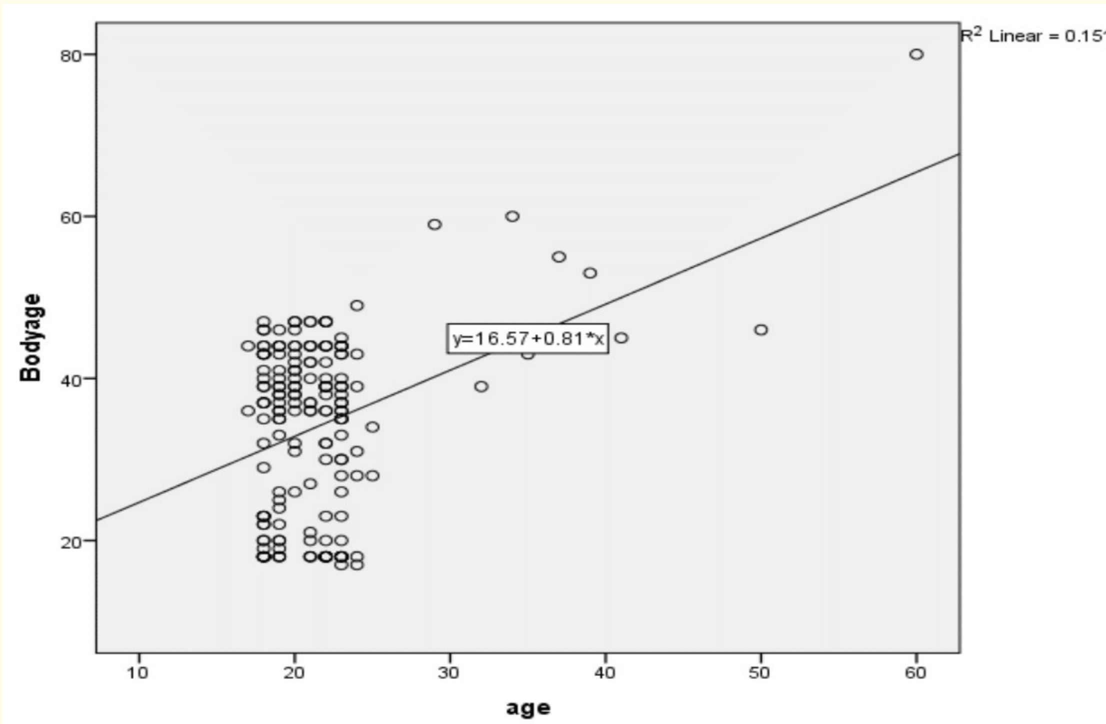

Figure 3

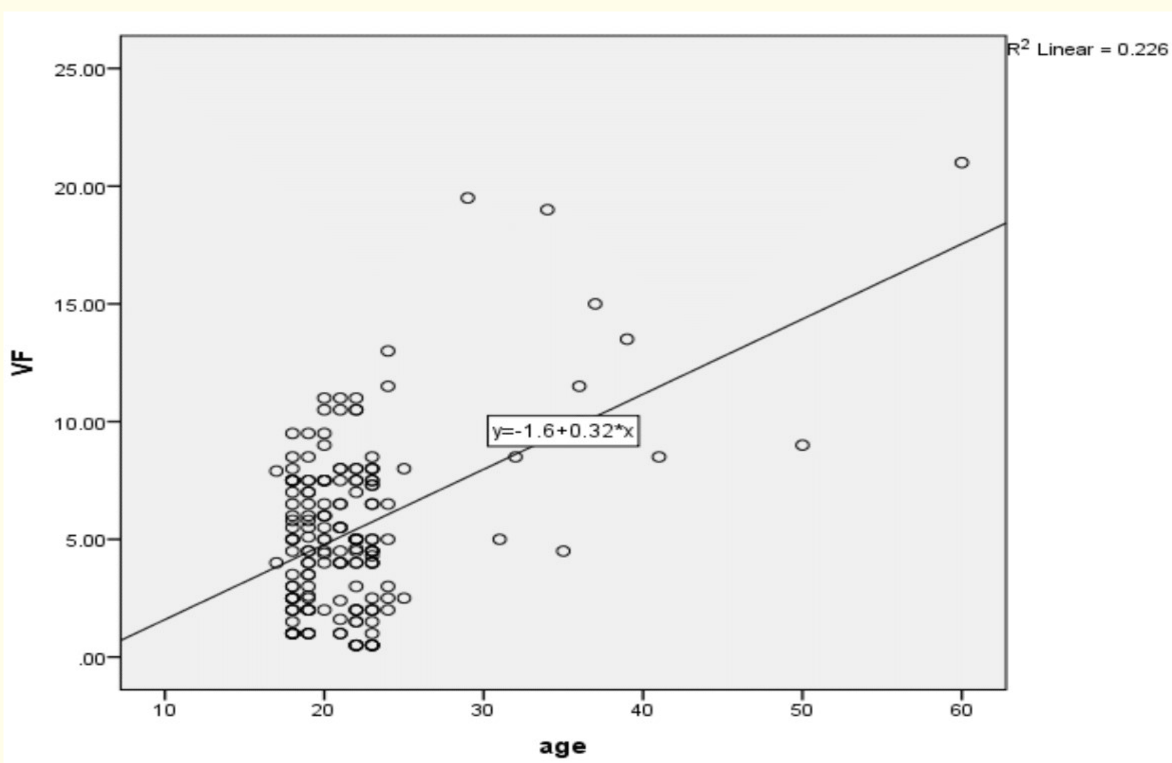

Figure 4

Discussion and Conclusion

A cross-sectional study carried out among 202 student's shows that 26.73% of sample were overweight and only 1.49% were obese [19]. Whereas in our study 46.4% of study population were overweight and 32.9% of them belongs to obesity type I. The variation in our study could be due to the fact that our study involves multiple colleges whereas previous study was carried out only in one university and the method of analysis we used was BIA different from previous study. In the same study they reported 26.73% of students categorized as high fat scores and 22.28% were very high body fat scores [19]. In our study 30.2% of students were having higher than normal and 48% were having very high total body fat. These results are again higher than reported in earlier study.

The average total body fat percentage is 29.7 ± 6.72 which comes under obesity category but having BMI 23.97 ± 4.25 kg/m^2 within normal range. The average visceral fat was less than 10% (6.06 ± 4.7) indicating the normalcy in visceral fat distribution. These results indicate that the visceral fat level in students is lower than 7-12 scores obtained in Saudi Arabia students [20]. Cross-sectional study carried out in 2012 shows mean hours of weekly exercising was 6.73 ± 1.20 and physical activity scores was 7.51 ± 1.67 [19]. Our results indicates an average RMR is 1375.94 ± 598.32 kcal/day showing that these students have sedentary lifestyle having little to no regular exercise. A rough estimate of the number of calories required per day is 1818 kcal/day to maintain ideal body weight [21]. Our results also supports previous study carried out among adolescents in Arab countries where they spend most time on watching TV, video gaming, computer, mobile and sleeping [22].

Results shows a significant correlation existing between body age and all other factors. Comparatively random blood glucose has limited correlation to other body composition factors. It has been shown that average body aging of population was 35.20 ± 12.23 years significantly higher than their age 23.18 ± 7.34 years. Indicates that the process of aging in college students is approximately 12 years more than normal aging. Linear regression analysis shows a significant negative correlation between age and RMR, subcutaneous fat in arms and height in this study population. On other side a significant positive correlation is seen between age and body age and ideal body weight. Hierarchical clustering analysis shows a central dogma and very close linkage existing between skeletal muscles of whole body and skeletal muscle trunk. In our stepwise multiple linear regression analysis, we find a non-significant intercept but significant skeletal muscle percentage in arms, which we can interpret as: for every 1-year increase in age per 21 years, we will see (5.372/20.351) 0.264 additional gain in skeletal muscle mass in arms.

Conclusion

We conclude from this study that the college students are burning 443 kcal/day energy less than normal due to sedentary lifestyle leading to 78% of them having higher than normal body fat leading to ageing of body 12 years faster than normal.

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