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Relationship between BMI and Percent Body Fat among the adult Tai Ahoms of Lakhimpur district, Assam

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ABSTRACT

Background: *Body Mass Index (BMI) is simple measure of the weight of a person scaled according to their height. On the other hand Body Fat Percentage (PBF) is the weight of a person's fat divided by the person's weight. BMI is widely used method for estimating body fat mass. It is an accurate reflection of Body Fat Percentage (PBF) in the majority of the adult population.*

Methods*: The aim of this study was to investigate the relationship between Body Mass Index & Body Fat Percentage among the adults Tai Ahom Population of North Lakhimpur district of Assam. A cross-sectional study was conducted among 850 adult populations, out of which 411 males and 429 females from the age group 20 years to 60 & above years were participated.*

Results*: Pearson's correlation coefficient (r) was calculated to see the relationship between BMI- BF % in the different age groups. A significant positive correlation was observed between BMI-BF% in males ($r=0.75$, $p<0.01$) and in females ($r=0.68$, $p<0.01$).*

Conclusion*: The study shows strongly correlated BMI with BF% estimated by bioelectrical impedance, in this Tai Ahom group of population. This relationship was significantly influenced by age and BMI. The present study supports the importance of taking age and BMI in to consideration to predict body fat percentage in a population.*

Key words*: Body Mass index, Body Fat, Bioelectrical impedance, Ahoms, Adults.*

INTRODUCTION

The World Health Organisation (WHO) has defined obesity as a condition with excessive fat accumulation in the body to the extent that health and well being are adversely affected (WHO, 1998). Obesity is recognised as a global health problem because it affects a large proportion of individuals in developed and developing countries (Kelly *et.al.*, 2008 and Marie et.al., 2014). In the US, 32 % of adult men and 35% of adult women are obese (i.e. BMI$\geq$30kg/m$^{2)}$ (Flegal et. *al*., 2009). In Asia, approximately 17 % of population is considered obese by the World Health Organisation Expert Consultation (WHO Expert Consultation, 2004).

Overweight and obesity are rapidly increasing in countries like India. In India it has reached epidemic proportions in the 21st century with morbid obesity affecting 5% of the country's population (The Hindu, 2007). According to the WHO, obesity is one of the most neglected public health problems in both developed and developing countries (WHO, 2000). Again according to the WHO Statistic Report 2012, globally one in six adults is obese and nearly 2.8 million individuals due to overweight and obesity (WHO, 2012). India with 1.2 billion people is the second most populous country in the world and is currently experiencing rapid epidemiological transition.

World Health Organisation also recommends BMI as the most useful population level measure of overweight and obesity, and is used as the same for both sexes and in all ages of adults (WHO, 2012). The ratio of weight over height squared or body mass index (BMI), also referred to as Quatelet Index, is a common and useful indicator for defining obesity in adult individuals (WHO,2000). However, it is increasingly recognized that fat mass, rather than BMI, is a better indicator of true fat mass and hence obesity. Weight is primarily made up of fat mass and muscle mass. BMI, with weight in the numerator, can not distinguish between the two components. Thus, an individual with high muscle mass can be classified as obese, even though the individual does not carry excess body fat.

By the clinical definition, a better measure of obesity should be based on an individual's percent body fat (PBF), which can now be measured by a variety of instruments, including bioelectrical impedance analysis, magnetic resonance imaging, computed tomography, and dual energy X-ray absorptiometry (DXA).While the WHO recommended BMI thresholds for defining obesity and overweight are well established, it is not clear what is the appropriate threshold of PBF for classifying an individual as obese (Pham *et.al*., 2015) .It is widely claimed that a PBF greater than 25% for men and 35% for women are the criteria for diagnosing obesity (Ko *et.al*., 2001, Chang et.al.,2003, Deurenberg 2001,Deurenberg *et.al*.,2002, He *et.al*.,2001, Romero *et.al*.,2008). It has been assumed that for a given BMI, Asian have greater PBF than Caucasians (Wang *et.al.,* 1994 and Pham *et.al.,* 2010)

Deurenberg *et.al.,* (2000) showed that the relationship between BMI and BF% is different between Singaporean and Caucasians and also among three ethnic groups in Singapore. Ranasinghe *et.al.,* (2013) found a strong positive relationship between BMI and BF% among the Sri Lankan adults. Pham *et.al.,* (2015), also supported that there is a positive correlation between percent body fat (BF%) and BMI among the Vietnamese. Again, Mukadas *et.al.,* (2016) address an accurate measure of body adiposity, bearing in mind several short coming of body mass index (BMI), should be used. This study determined the relationship between BMI and body fat percent (BF%) among adult Nigerian of different ethnic groups residing in an urban setting. There was a strong and positive statistical relationship between BF% and BMI when both were paired without controlling for gender and age. From the review of literature it is very much clear that there is correlation between BF% and BMI. However, the study on the relationship between BMI and BF% not been done before.

Therefore the present study is an attempt to assess the relationship between BMI and BF% among the adult Tai Ahoms of Lakhimpur district, Assam. Tai Ahoms are an Assamese speaking community in Lakhimpur district. Other Assamese speakers are Chutiya, Koch, Mishing and Deuri tribe which dominates the district. In this district Assamese and Bengali speaking Muslims also has sizeable population. Tea tribe community also called Adivasi forms nearly one-tenth of the district's population. Bodo, Hajong and Khamtis are also forms a section of the population in the distrcit.

MATERIAL AND METHODS

The present study was carried out among 429 females and 411 males Tai Ahoms of North Lakhimpur , Assam. Their ages ranged from 20 years and above to study the changes young adults to old adults. The subjects of each gender were grouped into nine different age groups with five years interval each, to study the trend of Height, Weight, BMI and Body Fat percent (BF%). A correlation between BMI and BF% at five years age interval is also being studied.

Tai Ahoms which are known as the biggest Tai community in the state of Assam. They belong to a major population group of Assam and ruled Assam for nearly six hundred years. This is one of the major ethnic groups of Assam and is o Mongoloid in origin, which belong to Other Backward Class under Indian Constitution. The total Tai Ahom population of Assam is approx 40, 00,000 which is mainly concentrated in Upper Assam district like Golaghat, Sibsagar, Dibrugarh, Dhemaji, Jorhat, Tinsukia and Lakhimpur (Gogoi, 2000). The Ahom's assimilation with the existing culture of the local people is visible in many aspects. The Tai language, the Ahom religion, rituals, dress, food habits and socio-cultural institutions gradually passed into oblivion. The Hindu religion, culture, lifestyle and Assamese language were imbibed replacing the ones of original Tai. Ahom people worship their ancestors. There is a section that follows Vaishnavism of Sankardeva and another section who are the follower of *Phura-lung* cult. The ancestors and deities are worshipped offering obligation. Traditionally, prior to the assimilation process with the Hindus the Tai Ahoms followed a religious system known as '*Phuralong*'. The system was based on Taoism which consists of the concepts relating to deities and spirits. A very prominent marker among the women folk is the use of vermilion (sindur) which signifies the Hindu assimilation. Traditionally, the Tai Ahom women did not vermilion as the sign of marriage.

Data has been collected from Balijan, Gohaingaon , Lahongaon from Lakhimpur circle under North Lakhimpur circle under North Lakhimpur subdivision of the district.Anthropometric measurements like height and weight were taken by using standardized equipments. Heights of all participants were measured using Martin's Anthropometer in standing position without footwear to the nearest 0.1cm. Body weight was measured with minimum clothes using weighing machine. BMI was calculated by weight (kg) divided by height (m) squared (kg/m^2) Total body fat percentage (BF %) was estimated by using a commercially available Omron Fat Analyzer system, which works on the principles of Bioelectrical Impedance to measure a person's actual body fat content. By utilizing BIA (bioelectrical impedance analysis) principles, a relatively accurate picture can be obtained of the body's fat content. The method Bioelectrical Impedance is considered to be one of the standard techniques as stated in many literatures (Kushner, *et.al*., 1990 and Chumela *et.al*.,1998)

Statistical analyses of the data collected were carried out using SPSS 16.0 version. Besides descriptive statistics, to test the difference between the age groups, one way ANOVA was done. Pearsons' correlation coefficients (r) were calculated to assess the linked and the degree of relation between BMI and BF%, in relation to gender and age variables. This was performed in males and females separately. The value of BMI was calculated and summarized age wise, and in order to assess BMI-based nutritional status, recommended cut off for Asians (Barba *et.al*.,2004) was used. Distribution and linearity of age-BMI and age-BF% relationships were separately assessed.

RESULTS

The basic data of height, weight, and BMI and BF% of Tai Ahom males in nine different categories are described in Table 1. The mean body height could be seen as maximum in the age category 25 to 29 years (168.5 cm). Then afterwards there is a decline. Height shows a decreasing trend after 50 years of age. Same is the case in body weight, where maximum body weight is seen in the age category of 30-34 years. Mean BMI was found to be lowest among 20-24 years age category (21.8 kg/m^2) after that it has increased up to 40-45 years of age category (24.2kg/m^2). This is the maximum value for mean BMI found among Tai Ahom males. The mean value has again declined in the older age category (60& above) which is 21.9 kg/m^2. The lowest mean BF% (19.7%) was found among 20-24 years age categories. Again the mean BF% increases with age till age group 45-49 years of age groups i.e. 25.5%, after that it starts declining in the older age category.

Table 2 shows the basic data of height, weight, and BMI and BF% of Tai Ahom females. The mean body height is almost similar till the age of 34 years. There is a slight decline in the age category of 35-39 years. Height also shows decreasing trend after 45 years. Maximum bodyweight has been seen in the age category of 55-59 years. The highest mean BMI could also be found between 55-59 years (26.4 kg/m^2). The highest mean value of BF% was 32.6% found among the 50-54 years of age categories. The BMI and BF% of the male between the age category of 25-29 years and 30-34 years is significantly different at the level of 0.05. Among the females the BMI is statistically significant after 55 years. And BF% is significantly different between 30-34.9 and 35-39.9 years of age. The difference is also significant between the age categories 40-44years, 45-49 years, 50-54 and 55-59 of years.

Table 3 and 4 depict the prevalence of obesity in both male and female groups. The females have higher prevalence of obesity than males. It is 24.01% as obese-I and 5.59 % as obese-II.

Table 5 indicates that there is a significant positive correlation between BMI and BF%. This was observed in both males and females separately and in each age group (males r=0.749and females r=0.679; p< 0.001).

Visual inspection of the scatter plots (Figure 1 and Figure 2) also showed the positive relationships between the BF% and BMI. It revealed that the relationship appears to be linear in nature.

Multiple regression analysis conducted showing a significant of age and BMI on BF% of males and females, where the effect of BMI (Beta β) =0.641 p<0.000; Beta β) =0.756

p<0.000, females and males respectively) is more than age (Beta β)=0.172 p<0.000; Beta β)=0.241 p<0.000, females and males respectively) shown in Table 6.

DISCUSSION

Individual reach maturity through growth and development at certain age, but the age of maturity of all the components is not similar between individuals or population. It is evitable that after middle age the changes in physical characteristics are marked and shows a declining trend. Present study shows that with the increasing age in both the sexes, the values of height, body weight, BMI and BF% rises but with the subsequent fall. Das *et al.,* (2012) have reported that with the increasing age, the values of height, body weight, BMI and BF% rise significantly but with a subsequent fall, among older rural Bauri women of West Bengal. Das *et.a.l*, (2010) studied the Bishnupriya Manipuris of Cachar and reported that there are also significant age changes in some anthropometric characteristic and body composition. Decreasing change has also been found among the adult Muslims of Kamrup district in Assam (Begum, 1998).

BMI values of women are slightly higher than men (after age 18 years). Among the middle aged adults, overweight women tend to have higher Body Mass Index values than overweight men. Because BMI uses a person's total body weight and doesn't distinguish lean mass from fatty tissues, two people with the same BMI can have very different body composition. On the other hand mean BF% is higher among the women than men in all the age categories. Flegal *et.al.*, 2009 also reported that females have higher percentages of body fat compared to males of all ages and ethnic groups and for an equivalent. Kirchengast *et.al.*, 2010 also reported that there is a typical human sexual dimorphism in body composition which is characterised by a substantially higher amount of lean body mass among women. In the present study also a similar trend has been noticed in all the age categories except at 25-29, 30-34, 40-44 age groups.

In the present study also shows the prevalence of obesity among women is found to be increasing with increasing age. Males have a higher percentage of normal BMI (51.82%) where as the females have 44.52% of normal BMI. Prevalence of obesity is more among females than males in the upper age categories. The total percentage of occurrence of overweight and obesity among the females is 48.01%. Almost half of the adult female population is overweight,whereas among the males it is 40.63%. Overweight and obesity is the fifth leading risk of deaths, resulting in around 2.8 million deaths of adults globally every year. The most obvious factors leading to overweight or obesity are excessive intake of energy-dense food, sedentary lifestyle and lack of physical activity (Sinha and Kapoor, 2010). The fraction of overweight and obesity has been found to be increasing with age, education and parity of the women (Agarwal and Mishra, 2004; Kain etal., 2003). Women with higher parity were found to be overweight and obese in India. This generally implies that women's higher age with declining physical activity helps accumulate more weight. Agarwal and Mishra (2004) have concluded that women media exposure is about two times more at risk of being overweight or obese.

Our study confirmed the significant positive relationship between BMI and BF% which was demonstrated in most of the former studies. This was observed in both males and females separately. A study by Deurenberg et.al.,(1989) done among the Caucasians, this interaction was also found to be significant. Asian Indians adults also confirmed the significant positive relationship in BMI-BF%. Rush et.al., (2009) who studied European, Maori, Pacific Islanders and Asian Indian adults also confirmed the significant positive relationship in BMI-BF% in all these groups of population. Ranasinghe *et.al*., (2013) also demonstrated that BMI strongly correlates with BF% in a group of South Asian adults of Sri Lanka. Again, the study of Meeuwsen (2010) on UK adults has shown that the association is not especially good. This is particularly so when BMI is less than 25 kg/m^2, particularly in men. BMI values of most of our participants were between 20-30 kg/m^2 , whereas the BMI range varied among other studies.

Conclusion

With the increasing age in both the sexes, the values of height, bodyweight, BMI and BF% rises but with a subsequent fall. The females have higher prevalence of obesity than their male counterparts. Males have higher percentage of BMI (51.82%) whereas the females have 44.52 % of normal BMI. The mean BF% is more in females than males in all the age categories. Our result also demonstrate that Body Mass Index (BMI) strongly correlates with body fat percentage (BF%) among the Tai Ahom population of Assam. BF% was significantly influenced by BMI and age of the individual where BMI affected most. Therfore our findings support the importance of taking age and BMI to predict body fat percentage /obesity, in a population.

Conflict of Interest: None

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Table 1: Age wise distribution of basic data and BMI among the Tai Ahom males of Lakhimpur district, Assam

Age Group (Years)	N	Height (cm) X̄±SD	"t" value	Weight (cm) X̄± SD	"t" value	BMI(kg/m^2) X̄ ± SD	"t" value	BF % X̄ ± SD	"t" value
20-24	40	163.7±6.23		58.5±10.37		21.8 ±3.38		19.7±6.23	
25-29	51	168.5±4.97	1.49	62.0±8.01	2.13	22.1±2.33	0.48	20.5±5.72	1.27
30-34	40	167.0±4.36	1.53	65.8±10.39	1.50	23.6±3.61	2.27*	24.0±7.16	2.52*
35-39	55	166.1±7.02	0.77	64.2±13.48	0.66	23.2±4.38	0.49	23.5±7.56	0.32
40-44	45	165.7±6.55	0.29	63.1±9.90	0.47	24.2±9.21	0.67	23.5±5.82	0.00
45-49	45	166.1±4.70	0.06	61.8±7.15	0.71	22.4±2.64	1.27	25.5±5.91	1.61
50-54	45	166.7±4.16	0.09	63.2±7.30	0.92	22.7±2.29	0.58	23.8±4.37	1.56
55-59	45	165.9±4.92	0.84	60.9±7.92	1.43	22.1±2.54	1.18	25.1±5.52	1.54
60 and above	45	164.9±6.87	1.52	59.2±9.80	0.90	21.9±2.78	0.35	23.8±5.09	1.17

*Significant at the level of 0.05

Table 2: Age wise distribution of basic data and BMI among the Tai Ahom females of Lakhimpur district, Assam

Age Group (Years)	N	Height (cm) X̄±SD	"t" value	Weight (cm) X̄± SD	"t" value	BMI(kg/m^2) X̄ ± SD	"t" value	BF % X̄ ± SD	"t" value
20-24	53	156.4±5.96		54.2±7.61		22.1±2.71		25.0±5.56	
25-29	45	156.6±5.74	0.17	53.7±7.57	0.13	21.9±3.23	0.26	23.8±7.00	1.34
30-34	58	156.2±6.16	0.34	53.8±9.28	0.06	22.0±3.82	0.20	25.6±7.18	1.29
35-39	47	155.0±7.34	0.90	57.6±11.00	1.89	23.9±3.81	2.53*	28.4±6.41	2.12*
40-44	41	160.6±6.73	1.07	60.3±10.81	1.16	23.3±3.66	0.75	29.0±7.40	0.56
45-49	45	158.5±7.40	1.40	59.3±11.76	0.42	23.5±4.20	0.24	31.8±6.11	2.64*
50-54	39	158.1±6.40	0.26	61.7±7.40	1.04	24.6±3.20	1.36	32.6±5.65	0.65
55-59	46	157.8±4.28	0.52	65.5±7.54	2.45	26.4±3.39	2.54*	29.9±6.02	2.76*
60 and above	55	154.6±6.26	2.60*	54.0±9.54	6.76	22.6±3.51	5.51*	28.9±5.60	1.09

*Significant at the level of 0.05

Table 3: Distribution of grades of nutritional status as per BMI among the adult Tai Ahommales of Lakhimpur district, Assam

Age grp	**N**	**Underweight <18.5**	**Normal 18.5-22.9**	**Overweight 23.0-24.9**	**Obese-I**	**Obese II**
20-24	40	5(12.50%)	21(52.50%)	5(12.50%)	9(22.50%)	-
25-29	51	2(3.92%)	33(64.71%)	12(21.53%)	4(7.84%)	-
30-34	40	4(10.00%)	11(27.50%)	13(32.50%)	10(25.00%)	2(5.00%)
35-39	55	7(12.73%)	18(32.73%)	13(23.64%)	13(23.64%)	4(7.27%)
40-44	45	3(6.67%)	22(48.89%)	6(13.33%)	14(31.11%)	-
45-49	45	2(4.44%)	29(64.44%)	7 (15.56%)	6(13.33%)	1(2.22%)
50-54	45	1(2.22%)	24(53.33%)	13(28.89%)	7(15.56%)	-
55-59	45	3(6.67%)	30(66.67%)	7(15.56%)	5(11.11%)	-
60 and above	45	4(8.89%)	25(55.56%)	11(24.44%)	5(11.11%)	-
Total	411	31(7.54%)	213(51.82%)	91(22.14%)	69(16.79%)	7(1.70%)

*Asia Pacific cut off (WHO, 2000)

Table 4: Distribution of grades of nutritional status as per BMI among the adult Tai females of Lakhimpur district, Assam

Age grp	**N**	**Underweight <18.5**	**Normal 18.5-22.9**	**Overweight 23.0-24.9**	**Obese-I**	**Obese II**
20-24	53	5 (9.43%)	32 (60.38%)	12(22.64%)	3(5.67%)	1(1.89%)
25-29	45	3(6.67%)	31(68.89%)	7(15.56%)	3(6.67%)	1(2.22%)
30-34	58	6(10.34%)	34(58.62%)	8(13.79%)	7(12.07%)	3(5.17%)
35-39	47	4(8.51%)	16(34.04%)	9(19.15%)	14(29.79%)	4(8.51%)
40-44	41	2(4.88%)	17(41.46%)	13(31.70%)	8(19.51%)	1(2.44%)
45-49	45	5(11.11%)	17(37.78%)	7(15.56%)	12(26.67%)	4(8.89%)
50-54	39	2(5.13%)	10(25.64%)	9(23.08%)	17(43.59%)	2(5.13%)
55-59	46	-	8(17.39%)	6(13.04%)	25(54.35%)	7(15.22%)
60 and above	55	5(9.09%)	27(49.09%)	8(14.55%)	14(25.45%)	1(1.81%)
Total	429	32(7.50%)	192(44.76%)	79(18.41%)	103(24.01%)	23(5.36%)

*Asia Pacific cut off (WHO, 2000)

Table 5: Pearson Correlation matrix between BMI and PBF the adult Tai Ahom males and females

Pearson Correlation between BMI and BF%	
FEMALE	**0.679 (p<0.000)**
MALE	**0.749 (p<0.000)**

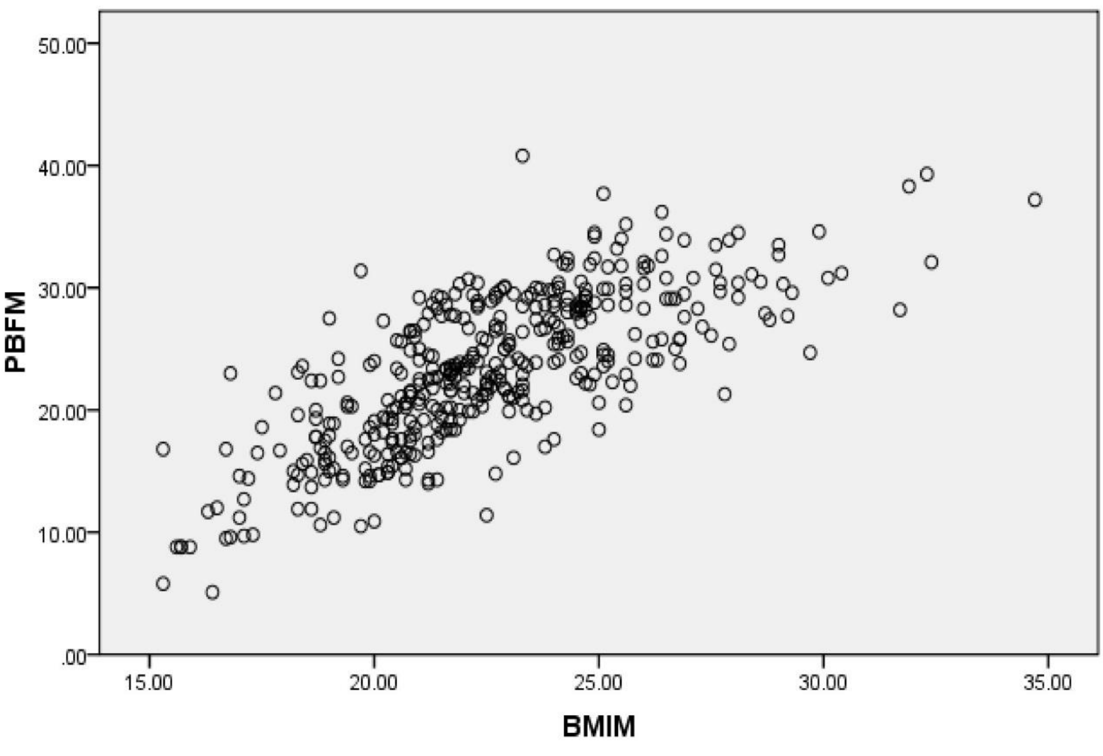

Fig 1 Scatter plot showing the correlation between BFP and BMI among the Tai Ahom Males

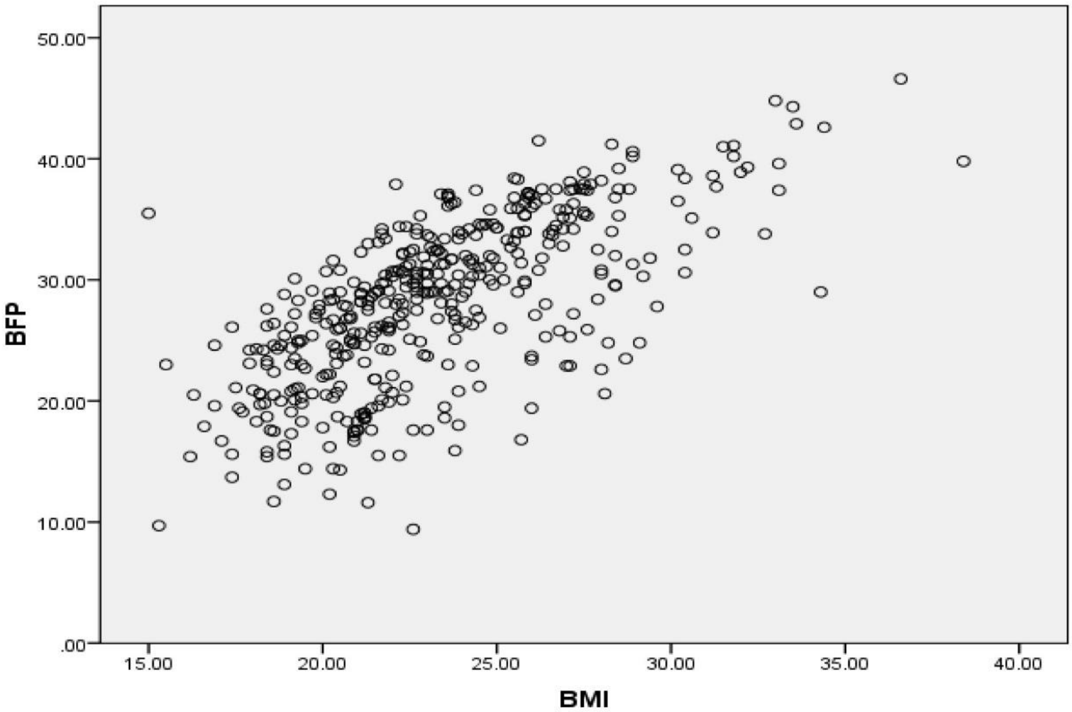

Table 6 Multiple regression analysis for change in BF% with BMI, age for males and females (Model 1)

Female				Male			
Regression coefficient/ R^2		**SE**	**Beta**	**Regression coefficient/ R2**		**SE**	**Beta**
BMI	0.448	0.092	0.641(p<0.000)	**BMI**	1.505	0.061	0.756(p<0.000)
Age	1.76	0.065	0.172(p<0.000)	**Age**	0.589	0.075	0.241(p<241)
R^2	0.490			**R^2**	0.620		