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Generalized Sex and Age Specific Body Composition Prediction Equations for Indian Subjects

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ABSTRACT:

Body composition analysis (BCA) is necessary to yield data about normal growth, maturity, and longer life. By measuring body composition, a person's health status can be more accurately assessed. Bioelectrical impedance analysis (BIA) is a commonly used method for estimating body composition which actually determines the electrical impedance, or opposition to the flow of an electric current through body tissues which can then be used to calculate an estimate of body composition. The method is popular owing to its ease of use, portability of the equipment and it's relatively low cost compared to some other methods of body composition analysis. To the best of our knowledge there were no prediction equations that were validated on Indian subjects. The objective of the study was to develop prediction equations for Fat free mass (FFM) and Total body water (TBW) for Indian subjects based on Bio electrical measurement of weight, age, sex, height and Impedance Index. To predict the same; a form of statistics known as multiple regression Analysis have been used which allows an immeasurable component such as Total Body Water, Fat Free Mass etc. to be predicted from one or more measured variables. The multiple regression analysis of the data is carried out with the help of statistical software R version (2.9.2) which is useful for multiple regression analysis and easy handling of the data. In the current paper; based on the correlation between Total Body water, Fat free Mass, Impedance Index at different frequencies and weight, age, sex and height;8 sets of prediction equations were developed.

KEYWORDS: *Bio Electrical Impedance Analysis, Prediction Equation, Multiple Regression*

I. INTRODUCTION:

It is a well-known fact that India; next only to China, is the second largest country in terms of population in the world. But the health status of the majority of the people is far from satisfactory as compared to China and other developed countries (16). When it comes to health status of the country, there is a large disparity between rural and urban elite class. Even though there is an imminent urbanization phenomenon in the country an important sector of the population still lives in the rural areas and there is large disparity in the lifestyles of people; especially regarding the physical activity of the people living there. This can be reflected in the general body composition of the people. The people in rural areas are particularly active then there counterpart; i.e. the people living in the urban areas. As the country is becoming richer, many people are becoming obese and, like Westerners, they are seeking medical help. According to a survey by the All-India Institute of Medical Sciences; seventy-six per cent of women in the capital, New Delhi, are suffering from abdominal obesity and it is a serious problem for country; because with obesity comes health related problems, from diabetes to heart failure. An estimated 25 million Indians have diabetes, and this is forecast to grow to 57 million by 2025.The rural section of the country is facing the different challenge of under nutrition. It is found mostly in rural areas and is concentrated in a relatively small number of districts and villages; with 10 percent of villages and districts accounting for 27-28 percent of all underweight children. So; all in all, we can say that India is facing the dual challenge of obesity and undernourishment. Individuals who are overweight or obese are at the risk of developing cardiovascular, pulmonary, metabolic disease, osteoarthritis and certain types of cancer. On the other hand underweight individuals are malnourished and have a high risk of fluid-electrolyte imbalances, renal and reproductive disorders. Body composition analysis (BCA) therefore; is necessary to yield data about normal growth, maturity, and longer life.

By measuring body composition, a person's health status can be more accurately assessed. In order to face these challenges there was a need in physiological and nutritional research to assess human body composition analysis.Laboratory method such as densitometry, computer tomography, electrical conductivity, body water by isotope dilution, whole body counting of potassium-40, neutron activation analysis for total body calcium and nitrogen are expensive and are not suited for field studies. Besides these; technique developed for epidemiological surveys, such as anthropometry, skin fold thickness, and infrared interactance are less reliable predictors of body composition. Thus, there was a need for a safe, noninvasive technique that is rapid and convenient and provides reliable and sufficiently accurate estimation of human body composition. Maltron-II Body Composition Analyzer is one such instrument for estimating the body composition of human body. Since the advent of the first commercially available devices in the mid-1980s the method has become popular owing to its ease of use, portability of the equipment and it's relatively low cost compared to some of the other methods of body composition analysis. It is familiar in the consumer market as a simple instrument for estimating body fat. BIA actually determines the electrical impedance, or opposition to the flow of an electric current through body tissues which can then be used to calculate an estimate of body composition. The electrical impedance through the body is measured by passing an excitation current of amplitude of 800µA through electrodes stuck at the right wrist and right ankle of the volunteer, at different frequencies of 5 KHz, 50 KHz, 100 KHz and 200 KHz. The voltage drop was detected by proximal electrodes. Some of the basic assumptions that were made to measure the impedance of the body were as follows; the human body was assumed to be perfect cylinder, at fixed signal frequency(e.g.,50 KHz). The volume of FFM or TBW of the body was assumed to be directly proportional to L^2 or $height^2$ and inversely related to Z, since the impedance(Z) to current flow through the body is directly related to the length of conductor(height) and inversely related to the cross sectional area(A): $Z=\rho(L/A)$.Multiplying and diving the right hand side by L we have $Z=\rho(L^2/V)$.Readjusting the equation we have, $V=\rho(L^2/Z)$. Thus; in order to predict volume of Fat Free Mass or Total Body Water of Human body we have to include the term Impedance Index ($height^2$/Impedance), while developing the generalised prediction equation for the estimation of TBW and FFM of Indian subjects at different frequencies.

II. MATERIALS AND METHODS:

2.1. Literature survey:

A lot of scientists have been contributing in the past, for the development of body composition prediction equations for cohorts of individual belonging to different ethnic groups, age groups, sex and according to their level of physical activity. Martin Wabitch et al. in 1996 developed an equation for the prediction of total body water (TBW) from bioelectrical impedance analysis (BIA) in obese children and adolescents before and after weight reduction using multiple-regression analysis. Shumei S Sun et al. developed sex-specific BIA equations to predict total body water (TBW) and fat-free mass (FFM) with the use of a multicomponent model for children and adults. Kim et al. in 1994 developed the BIA prediction equation for 84 Japanese boys in the age span of 9-14 years. Nayeli Macius et al. in 2007 developed and cross validated the BIA prediction for 155 Mexican subjects. Besides this several other scientists such as Deurenberg in 1991, Kushner in 1992 have already been contributing in developing the BIA prediction equation either for different ethnicities or for people of particular age group. And they have been using multiple regression technique to do so. ME Valencia et.al in 2003 determine the body composition of subjects from Cuba, Chile and Mexico. S. Going et.al in 2009 validated the use of bioelectrical impedance analysis (BIA) for estimation of body composition in Black, White and Hispanic adolescent girls. A lot of research has been undertaken by various scientists to develop prediction equation for cohorts of individual belonging to different ethnic groups, age groups, different sex and according to their level of physical activeness and the research in this field is still in progress. Some of the major researches in this field have been done in developing prediction equations for American Indians, Asians, and Srilankans, Chinese and Singaporean subjects. To the best of our knowledge there were no published height weight prediction equations validated on Indian subjects. The purpose of the study was therefore to develop sex combined prediction equation for TBW and FFM at different frequencies of 5 KHz, 50 KHz, 100 KHz and 200 KHz for Indian subjects through careful analysis of data.

2.2 Subjects and Procedure:

Human Body Composition data of 100 subjects (49males and 51 females) within the age group of 23 yrs to 50 yrs were studied through Maltron-II Body Composition Impedance Analyzer method; where excitation current of 800µA at different frequencies of 5 KHz, 50 KHz, 100 KHz and 200 KHz were applied to the source or drive distal electrodes on the hand and foot; and the voltage drop due to impedance is detected by sensor electrodes on the wrist and ankle. These human Body composition data were then utilized to calculate the Impedance Index i.e. ($height^2$/impedance) at different frequencies of 5 KHz, 50 KHz, 100 KHz and 200 KHz. The calculated impedance index of each individual at different frequency is formulated in the form of Table (1). Finally multiple regression analysis of these data was carried out to develop and design a linear model with the help of R software (version 2.9.2), taking Impedance Index, weight, sex, height and age as independent variable and TBW and FFM as dependent variables. To predict TBW and FFM at different frequencies, an algorithm was developed and statistical analysis of the data was done; the flow chart showing the actual process carried out to generate the linear model and Descriptive statistics is shown below in fig. (1) and Table (1) respectively.

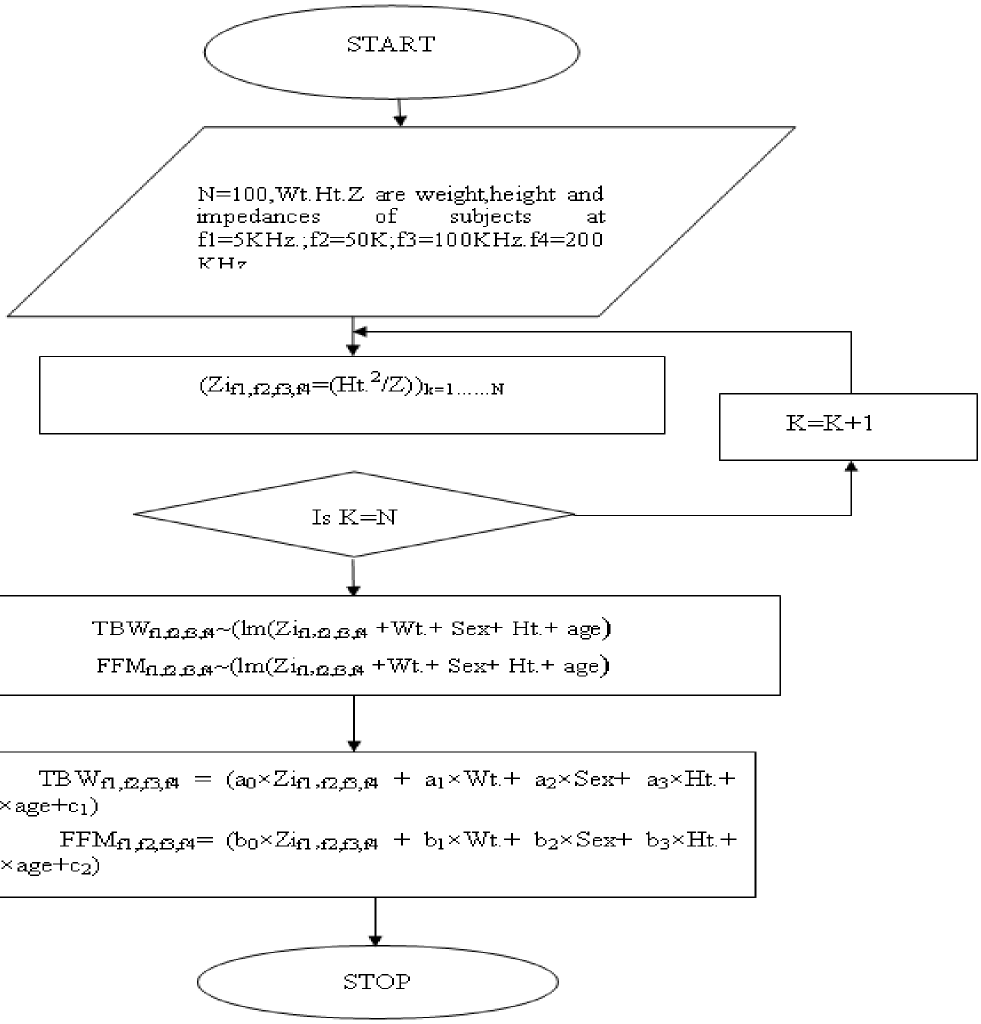


Fig1: Flowchart showing the general process to develop linear model of TBW and FFM at the frequencies of 5 KHz, 50 KHz, 100 KHz and 200KHz

Table1: Descriptive statistics of Indian Subjects (n=100)

Variables	Mean ± S.D.
TBW	30.19130 ± 6.1147635
FFM	44.81100 ± 8.4755007
Weight	56.31560 ± 10.9202889
Sex	49 males and 51 females
Height	163.72000 ± 8.1365617
Age	20.76000 ± 4.7399442
Zi at 5 KHz	34.04617 ± 7.1236521
Zi at 50 KHz	38.36969 ± 8.8680447
Zi at 100 KHz	40.74625 ± 9.5384717
Zi at 200 KHz	41.86337 ± 10.4356058

TBW = Total Body Water, FFM = Fat Free Mass, Zi at 5 KHz, Zi at 50 KHz, Zi at 100 KHz and Zi at 200 KHz are Impedance Index i.e.(height^2/Impedance) at 5KHz, 50 KHz, 100KHz and 200 KHz respectively.

2.3 Prediction Equation developed:

The obtained equations are of the form:

$$TBW\ (f_1, f_2, f_3, f_4) = a_0 \times Zi\ (f_1, f_2, f_3, f_4) + a_1 \times Wt. + a_2 \times sex + a_3 \times ht. + a_4 \times age + c_{1(f1,f2,f3,f4)} \quad ….(1)$$

$$FFM\ (f_1, f_2, f_3, f_4) = b_0 \times Zi\ (f_1, f_2, f_3, f_4) + b_1 \times Wt. + b_2 \times sex + b_3 \times ht. + b_4 \times age + c_{2(f1,f2,f3,f4)} \quad ….(2)$$

where $TBW_{(f1,f2,f3,f4)}$ and $FFM_{(f1,f2,f3,f4)}$ is Total Body Water and Fat Free Mass at frequencies f_1=5KHz.,f_2=50KHz.,f_3=100KHz.,f_4=200KHz. and $Z_{I(f1,f2,f3,f4)}$ is the calculated Impedance index i.e. (height^2/impedance) of the subjects at these frequencies, $c_{1(f1,f2,f3,f4)}$ and $c_{2(f1,f2,f3,f4)}$ are intercepts of equation (1) and (2) respectively, a_0, b_0 are coefficients multiplied by Impedance index(Z_I)variable; a_1, b_1 are coefficients multiplied by variable dry weight (Wt.) of the subjects measured in Kg, a_2, b_2 are coefficients multiplied by variable sex of the subjects whose value is taken as 1 for female subjects and 0 for male subjects, a_3, b_3 are coefficients multiplied by variable height (ht.) of the subjects measured in cm, a_4, b_4 are coefficients multiplied by variable age of the subjects in years.

III. RESULTS AND DISCUSSION

The study was able to develop BIA prediction equation for Indian subjects. Data used in commercial software provided 8 BIA equations; 4 for TBW and 4 for FFM at frequencies of 5 KHz, 50 KHz, 100 KHz and 200 KHz. The prediction equations developed for Total Body Water at 5 KHz, 50 KHz, 100 KHz and 200 KHz are as shown below:

$$TBW(5KHz) = 0.2784713 \times Zi_{5kHz} + 0.2228589 \times Wt. + 5.258763 \times sex - 0.12625 \times Ht. + 0.0007028 \times age + 26.3271409 ………(1)$$

$$TBW(50KHz) = 0.300527 \times Zi_{50\ kHz} + 0.217007 \times Wt. + 3.443507 \times sex - 0.01367 \times Ht. + 0.002274 \times age + 7.374513 ……..(2)$$

$$TBW(100\ KHz) = 0.260753 \times Zi_{100\ kHz} + 0.186436 \times Wt. + 3.90009 \times sex - 0.023725 \times Ht. + 0.004265 \times age + 11.341107 ….(3)$$

$$TBW(200\ KHz) = 0.251182 \times Zi_{200\ kHz} + 0.216456 \times Wt. + 3.13538 \times sex - 0.01367 \times Ht. + 0.009393 \times age + 4.709239 ….(4)$$

In a similar pattern the prediction equation for FFM were developed at different frequencies. The predicted equations for FFM at different frequencies are as shown below:

$$FFM\ (5KHz) = 0.34197 \times Zi_{5kHz} + 0.19228 \times Wt. + 5.4558 \times sex + 0.13915 \times Ht. - 0.10942 \times age - 0.2449 ….(5)$$

$$FFM\ (50\ KHz) = 0.32512 \times Zi_{50\ kHz} + 0.19236 \times Wt. + 3.72059 \times sex + 0.26099 \times Ht. - 0.10984 \times age - 19.83645 ….(6)$$

$$FFM\ (100\ KHz) = 0.26775 \times Zi_{100\ kHz} + 0.1637 \times Wt. + 4.37531 \times sex + 0.24449 \times Ht. - 0.10869 \times age - 14.37819 ….(7)$$

$$FFM\ (200\ KHz) = 0.24582 \times Zi_{200\ kHz} + 0.19695 \times Wt. + 3.7678 \times sex + 0.27351 \times Ht. - 0.12292 \times age - 19.84588 ….(8)$$

where TBW(5 KHz), TBW(50 KHz), TBW(100 KHz) and TBW(200 KHz) is Total Body water of body in litres at5 KHz,50 KHz,100 KHz and 200 KHz frequency respectively, FFM(5 KHz), FFM(50 KHz), FFM(100 KHz) and FFM(200 KHz) is Fat Free mass of body in Kg at5 KHz,50 KHz,100 KHz and 200 KHz frequency respectively $ZI_{5\ kHz}$, $Zi_{50\ kHz}$,$Zi_{100\ kHz}$ $Zi_{200\ kHz}$ is Impedance index of body at 5KHz , KHz,50 KHz,100 KHz and 200 KHz frequency respectively in (cm^2/Ω). Value of sex of the subject is taken as 1 for female and 0 for male subject.Wt.is the weight of the body in Kg. and age is the age of subjects in years. Besides, development of BIA equations; statistical analysis of the data of data was also done the results of which were tabulated in table (3).In addition to this graphical analysis of the data is shown in Fig (2), Fig (3), Fig (4), Fig (5), Fig (6), Fig (7), Fig (8), Fig (9), Fig (10) and Fig (11). These figures showed different graphical plots such as scatter matrix plot for Total Body Water(TBW) and Fat free Mass (FFM) at different frequencies, normal distribution of standardized residuals, Scale location plot, Residual verses leverage plot and standardized residual verses cook's distance plot. These plots for linear model objects give the diagnostic information about the linear model. Besides this, a comparative study of their measured and predicted Total Body Water (TBW) and Fat Free Mass (FFM) at the frequencies of 5 KHz, 50KHz, 100KHz and 200 KHz is tabulated in Table (4) and from the results it is observed that the predicted value of TBW and FFM at these frequencies are very much closer to the measured.

Table 2: Descriptive statistics of Indian subjects (n=100) together with BIA equations developed.

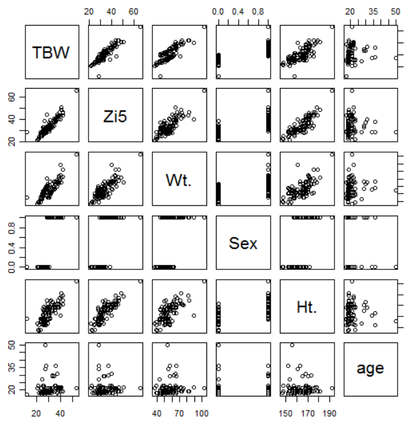
S.No..	Prediction equation developed.	Frequency used	Standard Error	Residual Error	Multiple R^2	Adjusted R^2
1.	TBW=0.314608×Zi+ 0.212291×Wt.+ 4.257354×sex- 0.009882×Ht.+ 0.039560×age+ 6.235368	5KHz	Intercept = 5.963570 Zi=0.065911 Wt.=0.030001 sex = 0.522615 Ht.=0.043147 age=0.039780	1.814 on 94 df	0.9165	0.912
2.	TBW = 0.290745×Zi + 0.2005097×Wt.+ 3.5597989×sex- 0.0006424×Ht.+ 0.0428386×age+ 5.0120239	50 KHz	Intercept = 5.857987 Zi=0.0529511 Wt.=0.0292819 sex = 0.5587226 Ht.=0.0397139 Age=0.0386036	1.759 on 94 df	0.9214	0.9172
3.	TBW = 0.2842034×Zi + 0.1922181×Wt.+ 3.3742453×sex- 0.0007968×Ht.+ 0.0524735×age+ 4.9240305	100 KHz	Intercept = 5.4772394 Zi=0.0490874 Wt.=0.0293544 sex=0.5627913 Ht.=0.0388512 age=0.0382678	1.736 on 94 df	0.9235	0.9194
4.	TBW = 0.18465×Zi + 0.22838×Wt.+ 3.82975×sex- 0.03285×Ht.+ 0.02245×age+ 1.8813	200 KHz	Intercept = 5.86617 Zi= 0.04563 Wt.=0.03014 sex=0.60795 Ht.=0.04101 age=0.04075	1.866 on 94 df	0.9116	0.9069
5.	FFM=0.45323×Zi+0.31139×Wt. + 2.27034×sex+0.16446×Ht.- 0.06293×age- 14.88628	5KHz	Intercept = 7.31313 Zi=0.08083 Wt.=0.036979 sex= 0.64088 Ht.=0.05291 age=0.04878	2.224 on 94 df	0.9346	0.9311
6.	FFM=0.40732×Zi+0.30335×Wt. + 1.15068×sex+0.18640×Ht.- 0.05924×age- 17.75259	50 KHz	Intercept = 6.7125 Zi=0.6252 Wt.=0.03469 sex =0.6878	2.133 on 94 df	0.9399	0.9367

			Ht.=0.04769 age=0.04679	2.104 on 94 df		
7.	FFM=0.40581×Zi+0.28364×Wt. + 1.07507×sex+0.17998×Ht.- 0.05651×age- 16.51783	100 KHz	Intercept = 6.6650 Zi=0.05975 Wt.=0.0357 sex= 0.67785 Ht.=0.04722 age=0.04619	2.375 on 94 df	0.9415	0.9384
8.	FFM=0.23182×Zi+0.34806×Wt. + 1.91612×sex+0.23878×Ht.- 0.08744×age -22.71149	200 KHz	Intercept = 7.46481 Zi= 0.05799 Wt.= 0.03831 sex=0.77485 Ht.=0.05219 age=0.05188		0.9254	0.9215

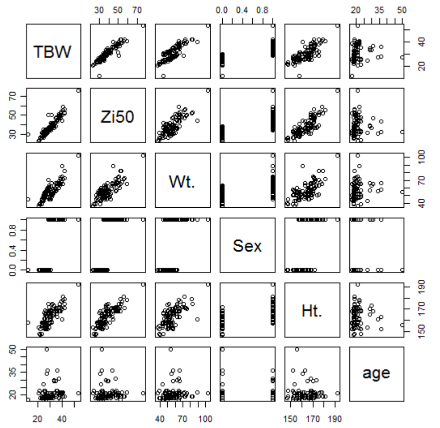
Table 3: Comparative study of measured and predicted value of TBW and FFM at different frequencies of participants for N= 10 out of 100 data

S.No.	**TBW predicted at 5KHz.**	**TBW predicted at 50KHz**	**TBW predicted at 100 KHz**	**TBW predicted at 200 KHz**	**TBW measured**	**FFM predicted at 5KHz**	**FFM predicted at 50 KHz**	**FFM predicted at 100 KHz**	**FFM predicted at 200 KHz**	**FFM measured**
1.	30.377	27.427	27.69	22.253	26.95	37.652	38.128	38.176	37.547	36.57
2.	36.565	36.433	36.556	25.602	36.9	51.626	51.656	51.858	51.620	51.97
3.	36.159	35.843	35.898	25.223	35.81	49.555	49.319	49.364	49.226	49.47
4.	32.568	32.726	32.904	22.392	33.16	45.527	45.960	46.289	46.491	47.34
5.	35.058	33.214	33.081	22.669	33.33	50.457	48.156	47.913	49.331	50
6.	26.821	26.605	26.801	16.412	26.99	39.787	39.842	39.922	40.084	39.26
7.	27.492	27.539	27.774	17.765	27.92	38.918	39.283	39.439	39.166	37.52
8.	34.694	34.184	34.221	19.845	34.46	49.533	49.141	48.481	50.053	50.52
9.	25.251	25.206	25.881	18.561	25.43	38.089	37.562	38.403	37.666	38.73
10.	32.660	23.990	23.375	17.604	24.54	35.082	35.456	34.571	34.875	36.41

Fig.2: Scatter Plot Matrix distribution of body composition of Indian subjects; showing the relationship between Total Body Water(TBW) in liters, Impedance Index ($Height^2$/Impedance) of body at frequencies of 5KHz,50KHz,100KHz and 200KHz in (cm^2/Ω) and Weight of body in Kg, sex, height of the body in cm and age of the individual in years.



(a)



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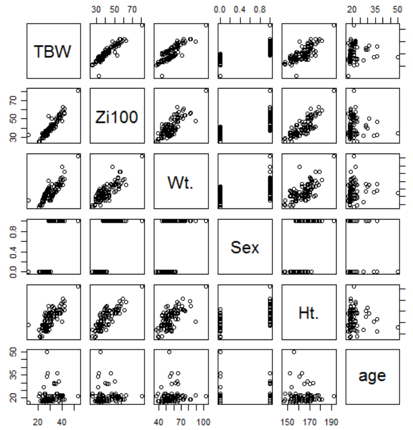

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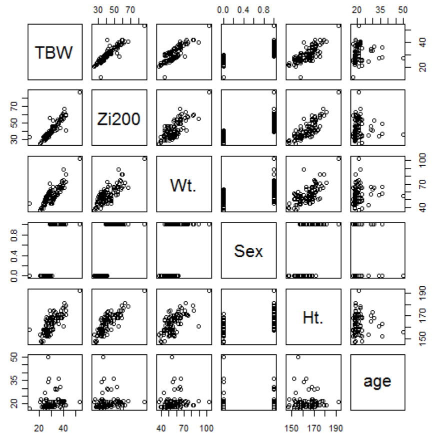
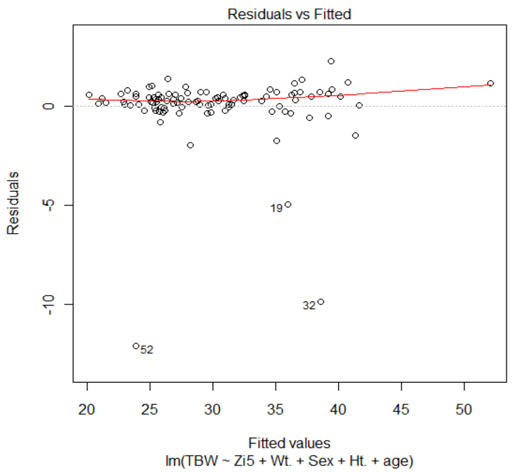
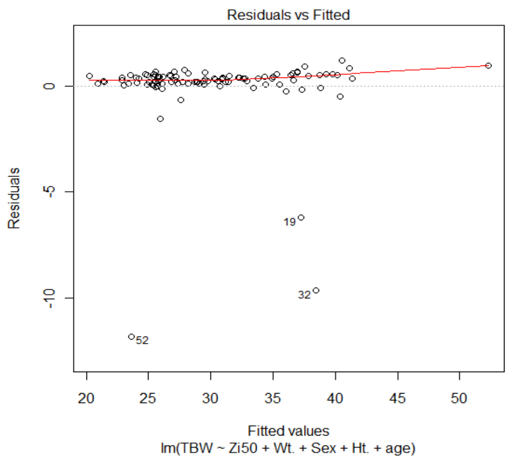


(d)

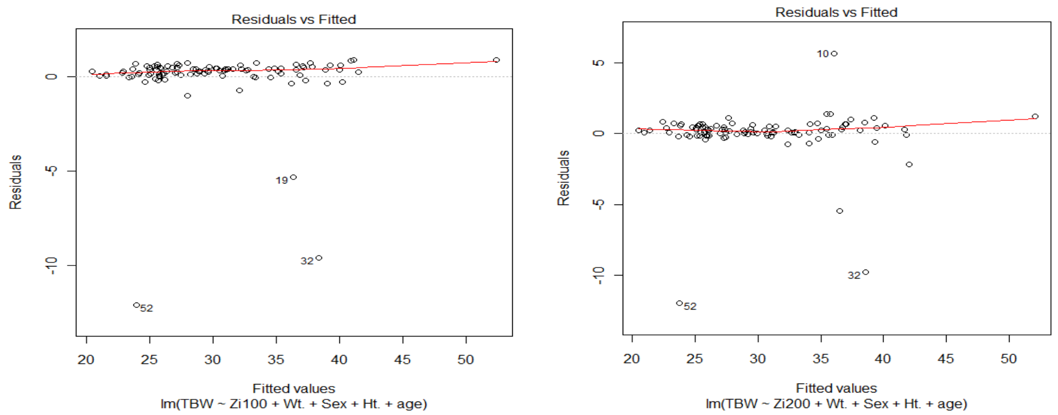
Fig3: Random scatter distribution of residual versus fitted values of Indian subjects showing the relationship between Total Body Water (TBW) in liters, Impedance Index (Height^2/Impedance) of body at 5KHz, 50KHz,100KHz and 200KHz frequency in (cm^2/Ω) and Weight of body in Kg, sex, height of the body in cm and age of the individual in years.



(a)

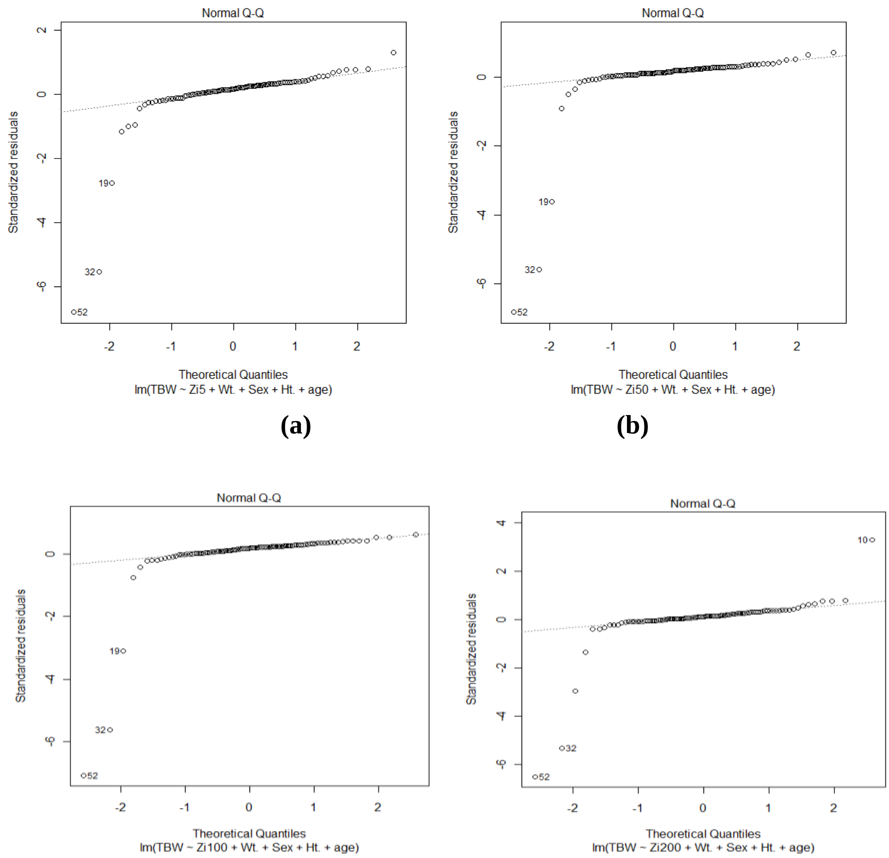


(b)



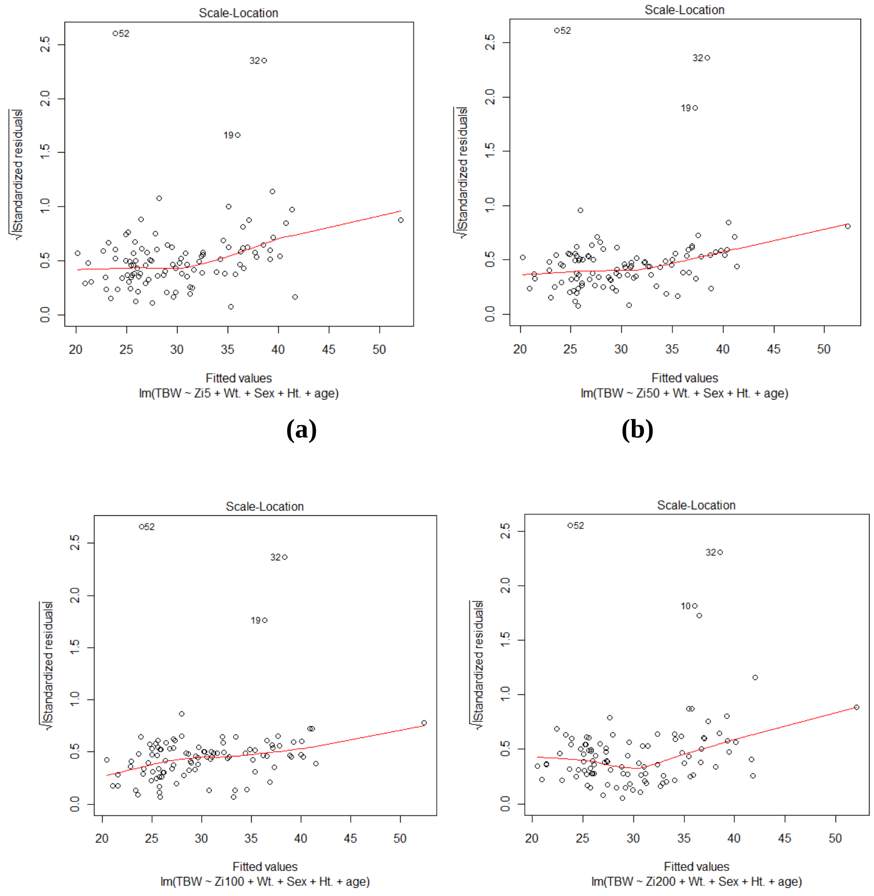
(c) (d)

Fig.4: Normal distribution versus Standardized residuals of Indian subjects showing the relationship between Total Body Water (TBW) in liters, Impedance Index (Height^2/Impedance) of body at frequencies of 5KHz,50KHz,100KHz and 200KHz.in (cm^2/Ω) and Weight of body(Kg), sex, height of the body in cm and age of the individual in years.



(c) (d)

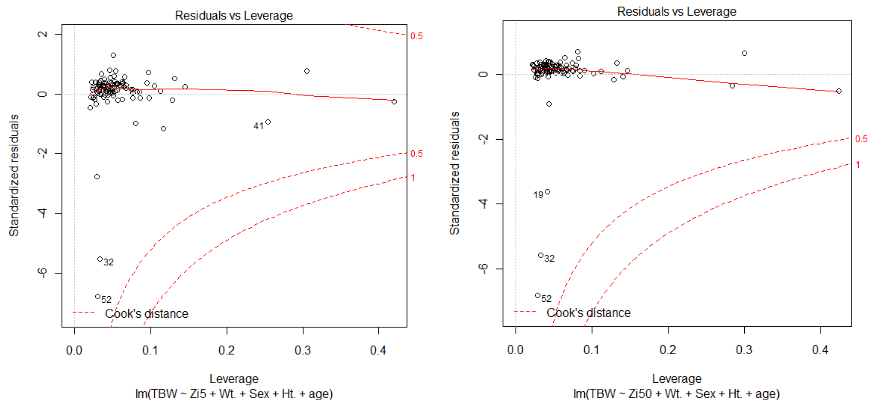
Fig5: Scale location plot between the square root of standardized residuals versus fitted values of Indian subjects showing the relationship between Total Body Water (TBW) in liters, Impedance Index (Height^2/Impedance) of body at frequencies of 5KHz, 50KHz, 100KHz and 200KHz.in (cm^2/Ω) and Weight of body(Kg), sex, height of the body in cm and age of the individual in years.



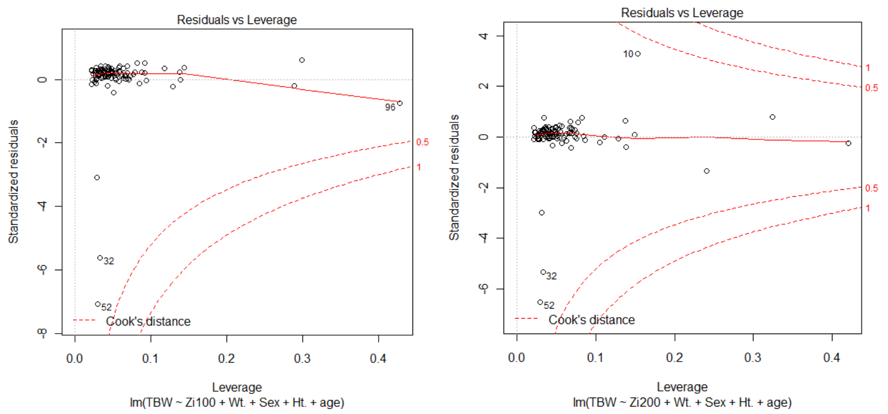
(a) **(b)**

(c) **(d)**

Fig6: Residual versus leverage plot and standardized residuals verses cook's distance plot of Indian subjects showing the relationship between Total Body Water (TBW) in liters, Impedance Index (Height^2/Impedance) of body at frequencies of 5KHz, 50KHz, 100KHz and 200KHz.in (cm^2/Ω) and Weight of body(Kg), sex, height of the body in cm and age of the individual in years.

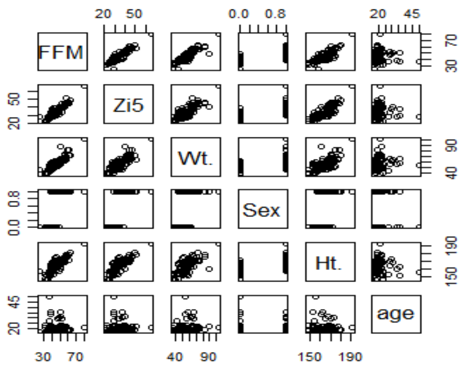


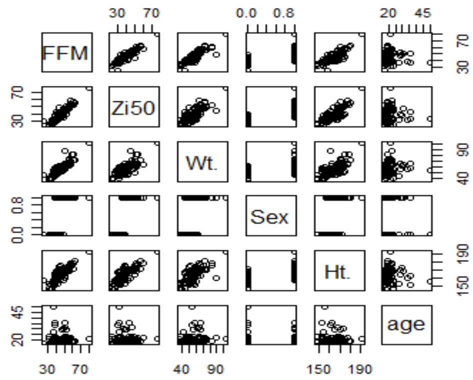
(a) **(b)**



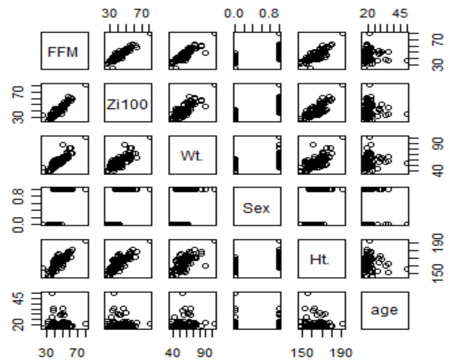
(c) **(d)**

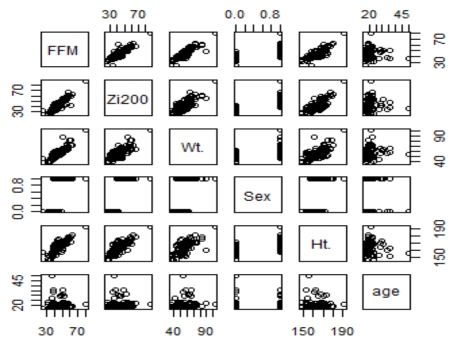
Fig.7: Scatter Plot Matrix distribution of body composition of Indian subjects; showing the relationship between Fat Free Mass (FFM) in (Kg), Impedance Index (Height^2/Impedance) of body at frequencies of 5KHz,50KHz,100KHz and 200KHz in (cm^2/Ω) and Weight of body in Kg, sex, height of the body in cm and age of the individual in years.





(a) **(b)**





(c) **(d)**

Fig8: Random scatter distribution of residual versus fitted values of Indian subjects showing the relationship between Fat Free Mass (FFM) in Kg, Impedance Index (Height^2/Impedance) of body at 5KHz, 50KHz,100KHz and 200KHz frequency in (cm^2/Ω) and Weight of body in Kg, sex, height of the body in cm and age of the individual in years.

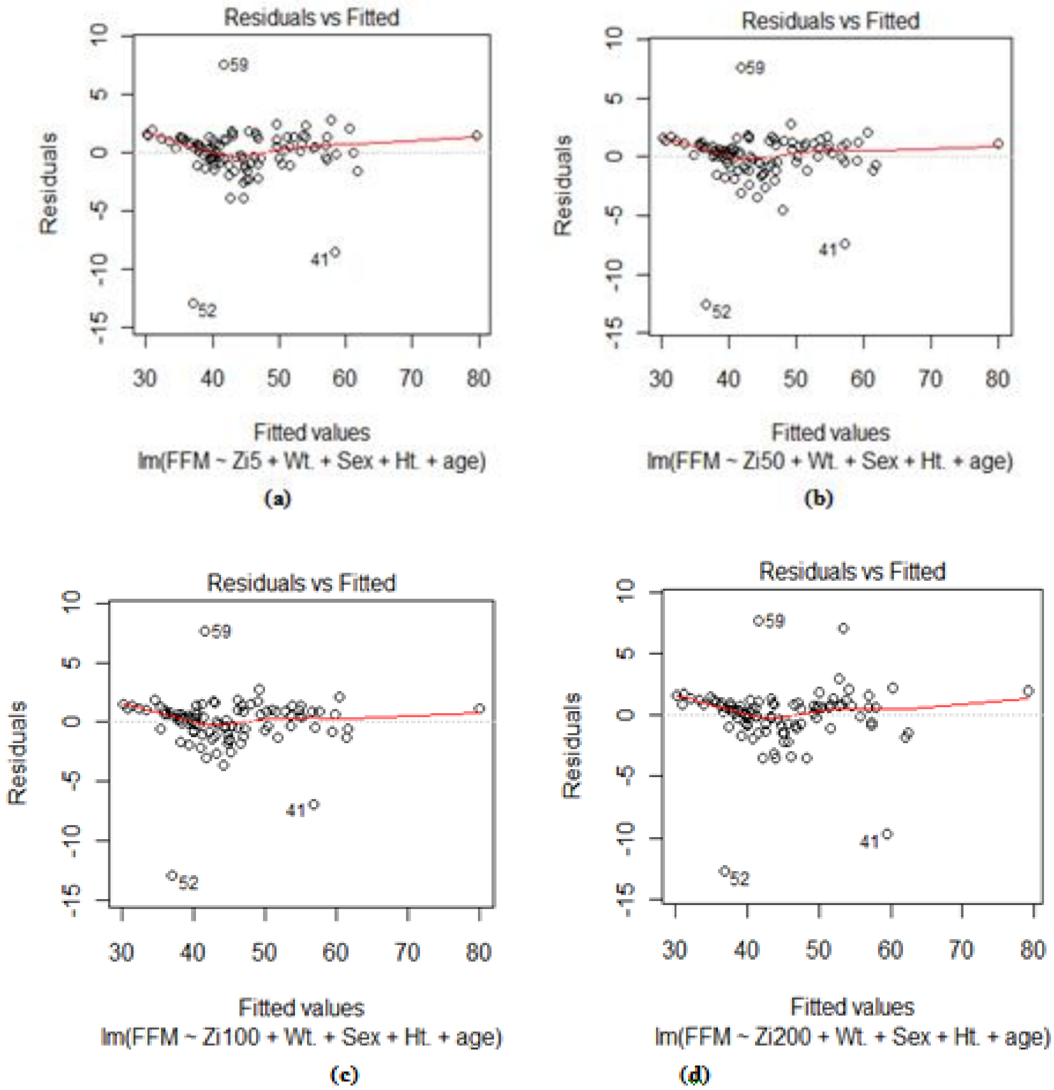
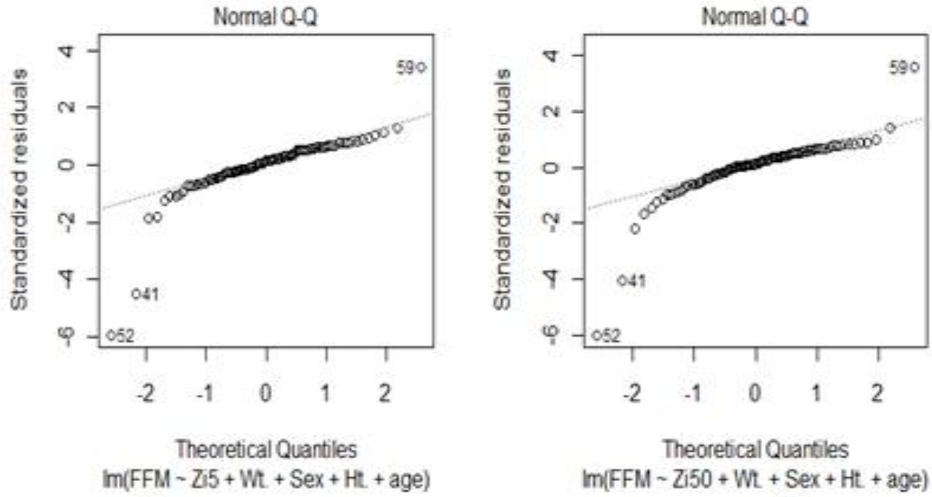
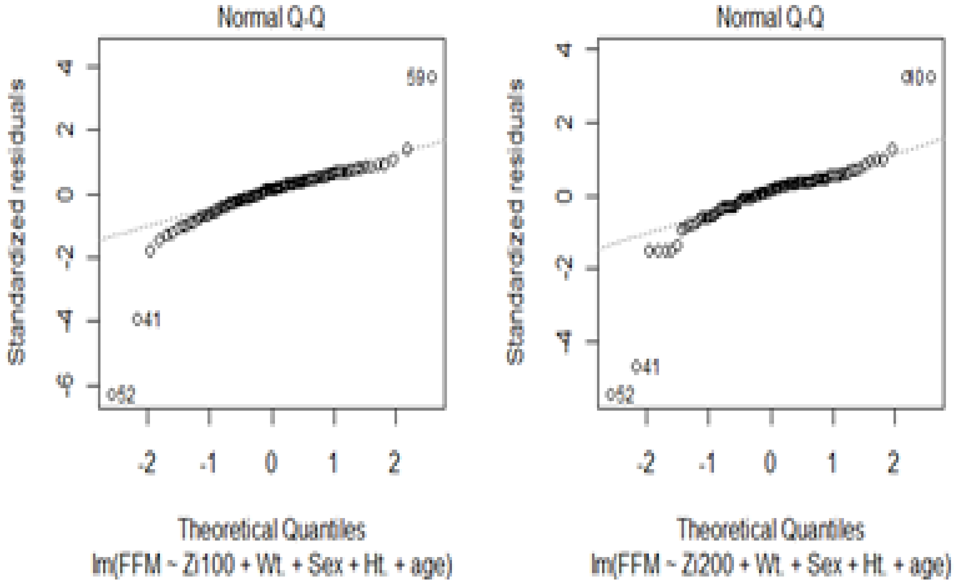


Fig.9: Normal distribution versus Standardized residuals of Indian subjects showing the relationship between Fat Free Mass (FFM) in Kg, Impedance Index (Height^2/Impedance) of body at frequencies of 5KHz,50KHz,100KHz and 200KHz.in (cm^2/Ω) and Weight of body in Kg, sex, height of the body in cm and age of the individual in years.

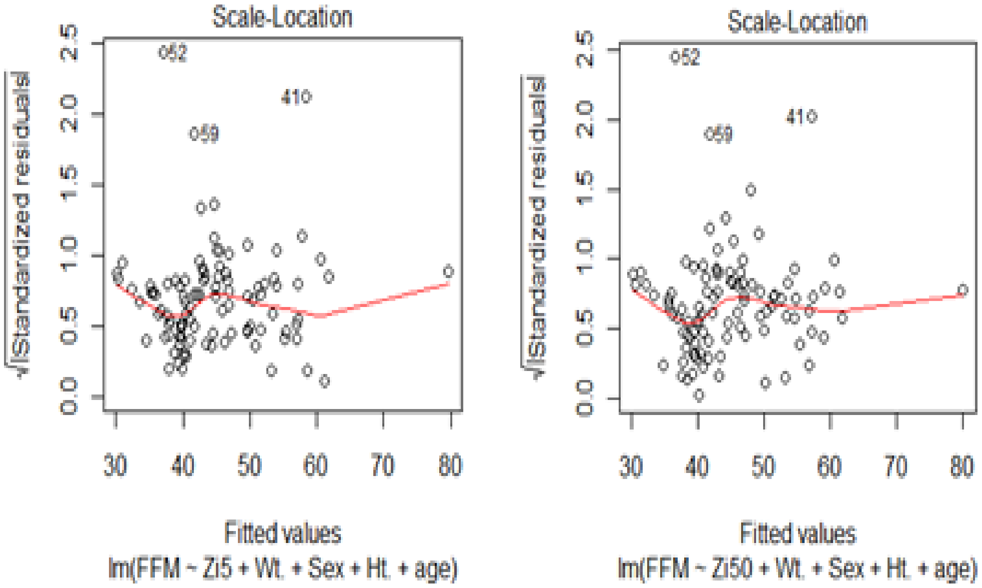


(a) (b)



(c) (d)

Fig10: Scale location plot between the square root of standardized residuals versus fitted values of Indian subjects showing the relationship between Fat Free Mass (FFM) in Kg, Impedance Index (Height^2/Impedance) of body at frequencies of 5KHz, 50KHz, 100KHz and 200KHz.in (cm^2/Ω) and Weight of body(Kg), sex, height of the body in cm and age of the individual in years.



(a) (b)

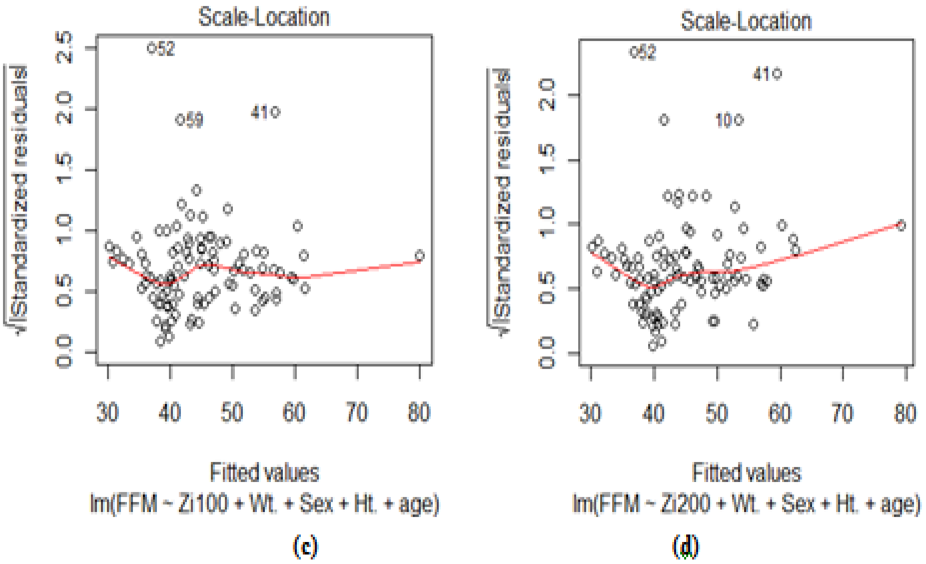
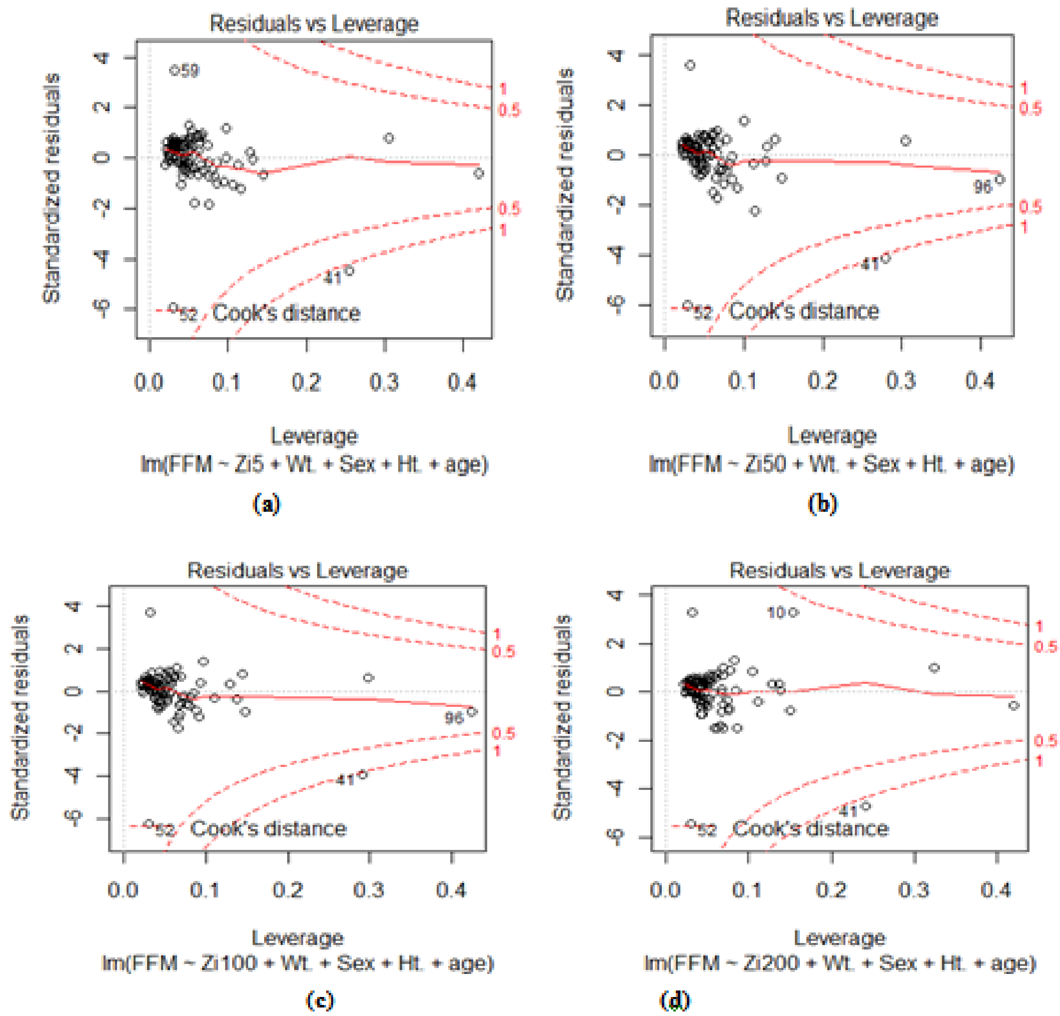


Fig11: Residual versus leverage plot and standardized residuals verses cook's distance plot of Indian subjects showing the relationship between Fat Free Mass (FFM) in Kg, Impedance Index (Height^2/Impedance) of body at frequencies of 5KHz, 50KHz, 100KHz and 200KHz.in (cm^2/Ω) and Weight of body(Kg), sex, height of the body in cm and age of the individual in years.



IV CONCLUSION:

The body composition parameters of the samples (100 subjects) measured through instrument Maltron-II Body Composition Impedance Analyzer at frequencies of 5 KHz, 50 KHz, 100 KHz and 200 KHz were utilized to obtain BIA equations. To do the same; multiple regression analysis was carried out on clinical data through R (2.9.2) software. The instrument has many advantages over the analysis of body composition through other methods and is safe, rapid, portable, easy to perform and require minimum operator training. The BIA prediction equation for Total Body water and Fat Free mass was developed at different frequencies. These prediction equation developed in the present paper is the first BIA prediction equation for TBW and FFM for Indian subjects. The predicted TBW and FFM of each individual are very close to the one measured through instrument. The results shows that the predicted values of TBW and FFM are very much closer to the one measured through the instrument. However, it is observed that at higher frequencies the results are much closer to the measured value. This is due to the fact that at low frequencies, the current cannot bridge the cellular membrane and will pass predominantly through the extracellular space, whereas at higher frequencies penetration of the cell membrane occurs and the current is conducted by both the extra-cellular water (ECW) and intra-cellular water (ICW). Based on these BIA equations, a general idea about the dietary habits of Indian subjects can be predicted which can be utilized for variety of clinical and research applications; as information about lean tissue mass, fat tissue mass, and fractional contribution of fat makes them excellent for monitoring pharmaceutical therapy, nutritional or exercise intervention, sports training &/or other body composition altering programs. Besides this, the information regarding the dietary habits of Indian subjects will give the pharmaceutical companies a chance to explore the change in body composition of Indian subjects before and after drug therapy. It will also provide coaches and researchers, the initial information regarding the general trends in the health status of Indian subjects so that they can formulate individualized training program and provide them with information about the suitable energy needs of the body so that they can achieve desirable body weight and composition.

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