Body Composition Analysis of Staff members of College Using Bioelectrical Impedance Analysis Method

Swaroopa Rani N. Gupta

Abstract—**Aims: In this analysis of body composition such as body weight, BMI, body fat percentage, segmental subcutaneous fat & skeletal muscle percentage (whole body, trunk, legs and arms), resting metabolism, visceral fat level and body age is done by bioelectrical impedance technique and results are interpreted and corresponding instructions for better health improvement is given.**

Methods: Body composition analysis of teaching and non-teaching staff members of Brijlal Biyani Science College Amravati Maharashtra India using bioelectrical impedance analysis method is done. For ideal weight management and for a more accurate and precise body composition analysis full body sensing technology karada scan body composition monitor – HBF-375 is used. The general principle behind bioelectrical impedance analysis is that two or more conductors are attached to a person's body and a small electric current is sent through the body. The resistance between the conductors provides a measure of body fat between a pair of electrodes, since the resistance to electricity varies between adipose, muscular and skeletal tissue.

Result: Interpretation of body composition analysis report of Teaching Staff members (Senior College) shows that overweight person is 70.6 %; that of Junior College is 73.3 %; that of non-teaching staff members (laboratory) is 52.4 % while; that of office is 76.9 %; and that of library is 100 %.

Index Terms—**Body age, body fat, BMI, RM, skeletal muscle, subcutaneous fat, visceral fat.**

I. INTRODUCTION

Bioelectrical impedance analysis (BIA) is a commonly used method for estimating body composition, and in particular body fat. 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 total body water (TBW). TBW can be used to estimate fat-free body mass and, by difference with body weight, body fat [1].

Many of the early research studies showed that BIA was quite variable and it was not regarded by many as providing an accurate measure of body composition. In recent years technological improvements have made BIA a more reliable and therefore more acceptable way of measuring body composition. Nevertheless it is not a "gold standard" or reference method. Like all assessment tools, the result is only as good as the test done. Although the instruments are straightforward to use, careful attention to the method of use (as described by the manufacturer) should be given.

Simple devices to estimate body fat, often using BIA, are available to consumers as body fat meters. These instruments are generally regarded as being less accurate than those used clinically or in nutritional and medical practice. They tend to under-read body fat percentage [2].

Dehydration is a recognized factor affecting BIA measurements as it causes an increase in the body's electrical resistance, so has been measured to cause a 5 kg underestimation of fat-free mass i.e. an overestimation of body fat [3].

Body fat measurements are lower when measurements are taken shortly after consumption of a meal, causing a variation between highest and lowest readings of body fat percentage taken throughout the day of up to 9.9% [4].

Moderate exercise before BIA measurements lead to an overestimation of fat-free mass and an underestimation of body fat percentage due to reduced impedance [5]. For example moderate intensity exercise for 90–120 minutes before BIA measurements causes nearly a 12 kg overestimation of fat-free mass, i.e. body fat is significantly underestimated [6]. Therefore it's recommended not to perform BIA for several hours after moderate or high intensity exercise [7].

BIA is considered reasonably accurate for measuring groups, or for tracking body composition in an individual over a period of time, but is not considered sufficiently accurate for recording of single measurements of individuals [8].

The accuracy of consumer grade devices for measuring BIA has not been found to be sufficiently accurate for single measurement use and is better suited for use to measure changes in body composition over time for individuals [9].

Bioelectrical impedance analysis (BIA) is widely used in clinics and research to measure body composition. However, the results of BIA validation with reference methods are contradictory, and few data are available on the influence of adiposity on the measurement of body composition by BIA. BIA is a good alternative for estimating %BF when subjects are within a normal body fat range. BIA tends to overestimate %BF in lean subjects and underestimate %BF in obese subjects [10].

Bioelectrical impedance analysis (BIA) is a promising tool in the evaluation of body composition in large population studies because it is fast, is inexpensive, and does not require extensive operator training or cross-validation. The empiric nature of the relation between

Manscript received November 15, 2013; revised January 19, 2014.

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DOI: 10.7763/IJCEA.2014.V5.390

resistance and reactance measured by BIA and body composition has led to the development of equations that translate the raw data into liters of body water or kilograms of fat-free mass (FFM) or fat mass. These equations may not be easily transferred from one population to another if the populations differ significantly in important determinants of body composition such as age, obesity, and illness. Review of two recent studies from the Framingham Heart Study in which BIA was first compared with dual-energy X-ray absorptiometry (DXA) as a validation technique, and then compared with the body mass index (BMI, in kg/m2) as an alternative estimate of body fat. BIA was a good predictor of DXA-derived FFM (r = 0.85-0.88, P < 0.001) and was superior to BMI as an estimator of body fat [11].

Over the past decade, considerable attention has been paid to accurately measuring body composition in diverse populations. Recently, the use of air-displacement plethysmography (AP) was proposed as an accurate, comfortable, and accessible method of body-composition analysis. AP is an accurate method for assessing body composition in healthy adults. Future studies should assess further the cause of the individual variations with this new method [12].

Obesity continues increasing at epidemic levels worldwide, as does the number of genetic studies that focus on obesity. Body mass index (BMI) is often used to characterize weight phenotypes and obesity status due to its simplicity. Refined measurements of body composition may be needed to understand variations in gene expression. This study explores gene expression when individuals are characterized as overweight based on BMI versus body fat percent. Individuals were recruited to a natural history protocol at the National Institutes of Health. Twelve Caucasian participants with the highest and lowest BMI were included. Whole-body air displacement plethysmography was performed to calculate body fat percent, and BMI was calculated. Fasting whole blood was collected and RNA extracted. Quantitative real time PCR array was used to determine expression of 96 obesity related genes. The PCR array from participants with high BMI compared to low BMI showed dysregulation of four genes: peroxisome proliferator-activated receptor gamma coactivator 1-alpha (*PPARGC1A*), pro-opiomelanocortin (*POMC*), growth hormone secretagogue receptor (*GHSR*), and leptin (*LEP*), whereas participants with high body fat compared to low body fat showed dysregulation of one gene: *PPARGC1A*. This research showed differential gene expression and clinical indices depending on method of weight Classification [13].

The study aims to improve accuracy of Bioelectrical Impedance Analysis (BIA) prediction equations for estimating fat free mass (FFM) of the elderly by using non-linear Back Propagation Artificial Neural Network (BP-ANN) model and to compare the predictive accuracy with the linear regression model by using energy dual X-ray absorptiometry (DXA) as reference method. When compared the performance of developed prediction equations for estimating reference FFM_{DXA}, the linear model has lower r^2 with a larger SD in predictive results than that of BP-ANN model, which indicated ANN model is more suitable for estimating FFM [14].

Although international interest in classifying subject health status according to adiposity is increasing, no accepted published ranges of percentage body fat currently exist. Empirically identified limits, population percentiles, and scores have all been suggested as means of setting percentage body fat guidelines, although each has major limitations. A convenient sample of 1626 adults with BMIs ≤35 was evaluated. Independent percentage body fat predictor variables in multiple regression models included 1/BMI, sex, age, and ethnic group (R values from 0.74 to 0.92 and SEEs from 2.8 to 5.4% fat). The prediction formulas were then used to prepare provisional healthy percentage body fat ranges based on published BMI limits for underweight (<18.5), overweight (≥25), and obesity (≥30). This proposed approach and initial findings provide the groundwork and stimulus for establishing international healthy body fat ranges [15].

Several studies have raised the suspicion that the body mass index (BMI) cut-off for overweight as defined by the WHO may not adequately reflect the actual overweight status. The present study looked at the relationship between BMI and body fat per cent (BF %) / health risks (hypertension and type 2 diabetes) in male residents of Lucknow city, north India to evaluate the validity of BMI cut-off points for overweight. The study subjects showed higher body fat percentage and risk factors like hypertension and type 2 diabetes at normal BMI range proposed by the WHO. The cut-off for BMI was proposed to be 24.5 kg/m^2 for our study population. If overweight is regarded as an excess of body fat and not as an excess of weight (increased BMI), the cut-off points for overweight based on BMI would need to be lowered. However, the confidence of estimate of the BMI cut-off in the present study may be considered with the limitations of BI analysis studies [16].

Body composition assessment in patients with chronic renal failure is of paramount importance since studies have demonstrated the association of protein-energy malnutrition with an increased morbidity and mortality in this population. However, practical and sensible indicators of body compartments are still needed for clinical purposes. Thus, we aimed to evaluate the simple methods of skinfold thicknesses (SKF) and bioelectrical impedance analysis (BIA), using dual-energy X-ray absorptiometry (DEXA) as a reference method, for the assessment of body fat in patients on long-term haemodialysis therapy [17].

In this analysis of body composition such as Body Weight, BMI, Body Fat Percentage, Segmental Subcutaneous Fat & Skeletal Muscle Percentage (Whole Body, Trunk, Legs and Arms), Resting Metabolism, Visceral Fat Level and Body Age is done by Bioelectrical impedance technique and results are interpreted and corresponding instructions for better health improvement is given.

II. Materials and Methods

Body Composition Analysis of Teaching and Non Teaching Staff members of Brijlal Biyani Science College Amravati Maharashtra India Using Bioelectrical Impedance Analysis method is done. For ideal weight management and for a more accurate and precise body composition analysis full Body Sensing Technology Karada Scan Body Composition Monitor – HBF-375 as shown in figure 1 is used which measures body composition- weight, body fat percentage, visceral fat level, subcutaneous fat and skeletal muscle percentage, RM, BMI and Body age. The general principle behind bioelectrical impedance analysis is that two or more conductors are attached to a person's body and a small electric current is sent through the body. The resistance between the conductors will provide a measure of body fat between a pair of electrodes, since the resistance to electricity varies between adipose, muscular and skeletal tissue. Fat-free mass (muscle) is a good conductor as it contains a large amount of water (approximately 73%) and electrolytes, while fat is anhydrous and a poor conductor of electric current. Each (bare) foot may be placed on an electrode, with the current sent up one leg, across the abdomen and down the other leg. There is little scope for technician error as such, but factors such as eating, drinking and exercising must be controlled since hydration level is an important source of error in determining the flow of the electric current to estimate body fat. The instructions for use of instruments typically recommended not making measurements soon after drinking or eating or exercising, or when dehydrated. Instruments require details such as sex and age to be entered, and use formulae taking these into account; for example, men and women store fat differently around the abdomen and thigh region.

BMI: Body mass index is defined as the individual's body mass divided by the square of his or her height. The formulae universally used in medicine produce a unit of measure of kg/m^2.

$$BMI = Weight\ (Kg) / [height\ (m)]^2$$

Body fat percentage:

Body fat percentage = [Body fat Mass (Kg) / Body weight (Kg)] × 100

Visceral Fat: Adipose tissue is one of the main types of connective tissue. In biology, adipose tissue or body fat or fat depot or just fat is loose connective tissue composed of adipocytes.

BMR (RMR): Basal metabolic rate (BMR), and the closely related resting metabolic rate (RMR), is the amount of energy expended daily by humans and other animals at rest. Rest is defined as existing in a neutrally temperate environment while in the post-absorptive state.

Skeletal muscle: Skeletal muscle is a form of striated muscle tissue existing throughout the human body, and which is under control of the somatic nervous system; that is to say, it is voluntarily controlled. It is one of three major muscle types, the others being cardiac and smooth muscle. As their name suggests, most skeletal muscles are attached to bones by bundles of collagen fibers known as tendons.

Biological (Real) Age: Biological age is how time and lifestyle have affected organs and cells compared to other people of chronological age. Factors of biological aging include changes in the physical structure of the body as well as changes in the performance of motor skills and sensory awareness. Chronological age is current age in years, calculated from birth date. Interpretation of Bioelectrical Impedance Analysis report is shown in Table I.

Body composition analysis of Teaching Staff members (Senior College & Junior College) & Non Teaching Staff members (Laboratory, Office & Library) is shown in Table II

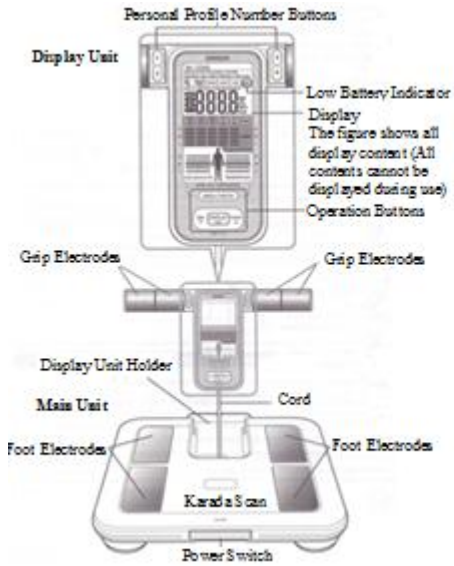

Fig 1. Omron Body Composition Scale Karada Scan HBF-375.

TABLE I: INTERPRETATION OF BIOELECTRICAL IMPEDANCE ANALYSIS

Interpretation of Body Composition Report						
Body Fat %	**Gender**		**Low**	**Normal**	**High**	**Very High**
	Female		Up to 19.9	20-29.9	30-34.9	35 & more
	Male		Up to 9.9	10-19.9	20-24.9	25 & more
Trunk Fat %				**Normal**	**High**	**Very high**
				<15	16-18	18+
Visceral Fat %				**0 (Normal)**	**+ (High)**	**++ (Very High)**
				0.5-9.5	10.0-14.5	15.0-30.0
Skeletal Muscle %	**Gender**	**Age**	**-(Low)**	**0 (Normal)**	**+ (High)**	**++ (Very High)**
	Female	18-39	< 24.3	24.3-30.3	30.4-35.3	≥ 35.4
		40-59	< 24.1	24.1-30.1	30.2-35.1	≥ 35.2
		60-80	< 23.9	23.9-29.9	30.0-34.9	≥ 35.0
	Male	18-39	< 33.3	33.3-39.3	39.4-44.0	≥ 44.1
		40-59	< 33.1	33.1-39.1	39.2-43.8	≥ 43.9
		60-80	< 32.9	32.9-38.9	39.0-43.6	≥ 43.7
BMI			**Under wt**	**Normal**	**Over wt**	**Obese**
			Up to18.4	18.5-24.9	25-29.9	30 & more

TABLE II: BODY COMPOSITION ANALYSIS OF TEACHING STAFF & NON-TEACHING STAFF MEMBERS

Case No	Male / Female	Age	Height cm	Weight Kg	Fat %	Subcutaneous Fat				Visceral Fat %	Skeletal Muscle %				RM Kcal	BMI	Body Age
						Whole Body	Trunk	Arms	Legs		Whole body	Trunk	Arms	Legs			
Teaching Staff members (Senior College)																	
1	Male	24	185	61	14.9	9.9	8.2	16.5	15.5	1.5	37.6	31.8	42.5	54.7	1506	17.8	18
2	Female	25	152	44.2	25.4	20.9	17.0	37.0	32.2	2.0	26.7	22.4	32.0	37.6	1040	19.1	21
3	Female	27	154.5	43.3	26.1	20.5	17.1	37.7	31.9	15	26.6	22.5	32.1	37.1	1024	18.1	20
4	Male	28	168.6	79.6	30.1	21.0	19.2	30.5	30.7	12.5	29.5	21.3	35.9	46.9	1719	28.0	47
5	Female	30	154	67.5	37.6	33.8	29.9	51.8	48.7	9.5	22.5	16.9	22.0	35.8	1349	28.5	49
6	Male	33	173	54.3	23.3	15.2	12.9	22.5	22.3	2.5	33.5	26.3	40.2	50.7	1354	18.1	23
7	Female	36	163.5	74.7	37.8	33.5	29.7	51.6	47.8	9.0	23.0	16.9	21.0	36.1	1459	27.9	54
8	Male	40	169	72.7	29.9	20.5	18.4	29.2	29.5	11.0	29.1	21.0	35.7	46.5	1608	25.5	49
9	Male	43	173.5	89.2	31.9	22.4	20.6	30.7	31.3	16.5	28.3	19.9	34.5	45.7	1855	29.6	59
10	Male	45	171	70.5	26.8	18.4	16.4	25.5	25.6	9.5	30.0	22.6	36.4	47.4	1588	24.1	48
11	Female	48	148	38.7	31.6	22.9	20.6	42.2	32.4	2.0	22.8	18.5	28.7	32.4	931	17.7	36
12	Male	48	173	74.8	31.2	21.2	19.1	29.9	30.4	11.5	28.5	20.2	35.2	45.9	1633	25.0	54
13	Male	48	155	61.3	34.8	23.5	21.1	33.2	34.0	12.5	25.6	17.0	34.3	43.2	1398	25.5	53
14	Male	49	176	87.1	36.9	33.1	29.2	48.7	43.9	10	24.5	16.8	20.2	38.0	1659	28.1	63
15	Male	52	159	73.0	33.5	23.3	21.3	32.1	32.8	17.5	25.8	17.5	33.7	43.3	1582	28.9	62
16	Male	59	172.5	77.4	29.1	20.1	18.1	26.3	26.7	13.5	28.5	20.8	34.7	45.9	1681	26.0	60
17	Male	60	162.5	70.3	33.0	22.6	20.5	30.6	31.3	15.0	25.8	17.7	33.4	43.4	1542	26.6	63
Teaching Staff members (Junior College)																	
1	Female	25	151	35.2	19	15.0	10.9	29.8	25.3	0.5	28.4	24.8	36.0	38.2	913	15.4	18
2	Male	27	169	64.5	24.9	23.1	18.3	35.2	31.9	3.5	29.7	23.3	31.2	42.9	1377	22.6	31
3	Female	31	144.5	56.5	37.7	32.8	29.3	51.9	47.9	8.5	21.5	16.6	23.2	33.7	1180	27.1	45
4	Male	36	165	66.2	32.0	28.0	24.1	43.9	39.2	6.0	25.5	19.5	25.9	38.0	1362	24.3	45
5	Female	37	154	65.8	35.9	32.4	28.3	48.6	44.8	9.5	23.2	17.4	23.2	36.5	1332	27.7	52
6	Female	39	159	72.6	41.3	35.8	32.5	56.8	53.0	10.5	21.1	15.4	19.3	33.8	1406	28.7	58
7	Female	39	156	53.2	33.3	26.9	23.8	45.7	39.1	4.0	23.8	18.8	26.7	36.2	1151	21.9	43
8	Female	39	152	54.5	34.7	28.8	25.6	47.4	41.3	5.5	23.0	18.0	25.4	35.5	1164	23.6	46
9	Female	39	158	43.7	26.5	20.3	17.0	37.5	30.5	1.5	26.2	21.8	31.5	36.3	1028	17.5	28
10	Male	40	172.5	82.8	33.3	31.1	26.6	43.6	39.4	8.5	26.9	18.9	23.9	40.9	1623	27.8	53
11	Male	44	159	60.0	24.4	16.8	14.9	23.2	23.2	9.5	29.6	23.0	36.2	47.0	1424	23.7	44
12	Female	44	145	48.6	37.1	29.6	27.0	49.7	42.2	6.0	21.2	16.5	24.6	33.0	1064	23.1	49
13	Female	45	166.5	66.1	34.3	28.8	25.4	46.6	40.7	5.5	24.3	18.3	24.4	36.9	1347	23.8	52
14	Male	51	160.5	73.6	31.5	21.9	20.1	29.7	30.3	17.0	26.8	18.9	33.8	44.3	1603	28.6	60
15	Male	56	175	64.6	30.0	19.9	17.4	27.5	28.0	7.0	28.9	20.8	36.1	46.3	1479	21.1	48
Non Teaching Staff members (Laboratory)																	
1	Male	25	168	62.4	23.9	16.2	14.2	24.4	24.1	6.0	32.6	25.4	39.0	49.9	1480	22.1	30
2	Male	25	158	55.1	29.2	19.5	17.2	29.0	29.2	6.0	30.5	22.3	38.0	47.8	1339	22.1	30
3	Male	27	177	56.9	17.6	11.7	9.7	18.4	17.7	2.0	35.9	29.7	41.7	53.0	1421	18.2	18
4	Male	29	167	58.4	22.6	15.2	13.2	22.8	22.5	5.0	32.8	25.9	39.3	50.1	1419	20.9	28
5	Male	29	174	65.5	22.8	15.5	13.5	23.0	22.7	5.5	33.1	26.1	39.5	50.4	1536	21.6	32
6	Male	30	171	57.6	18.7	12.6	10.8	19.2	18.6	3.5	34.4	28.3	40.5	51.7	1432	19.7	24
7	Male	33	163	51.8	19.5	13.0	11.1	19.5	19.0	4.0	33.1	27.0	39.8	50.4	1318	19.5	25
8	Male	33	157.5	68.6	29.8	20.8	18.9	29.9	30.2	13.0	28.3	20.5	35.3	45.8	1539	27.7	47
9	Male	34	155.5	64.3	26.1	18.3	16.6	25.9	25.9	12.0	29.3	22.3	36.4	46.7	1487	26.6	44
10	Male	35	169	91.7	30.6	22.0	20.5	29.2	29.6	18.5	29.0	20.8	34.4	46.4	1904	32.1	56
11	Male	37	166	68.7	27.8	19.1	17.1	27.2	27.4	10.0	29.7	22.1	36.6	47.1	1555	24.9	45
12	Male	39	158.5	45.9	20.1	13.0	10.8	18.7	18.4	1.5	32.1	26.1	39.4	49.4	1167	17.1	19
13	Male	41	171.5	72.0	26.0	17.9	16.0	24.9	25.0	10.0	30.6	23.3	36.4	48.0	1618	24.5	46
14	Male	43	168	63.0	24.5	16.6	14.6	23.4	23.4	7.5	30.8	23.9	37.0	48.2	1478	22.3	41
15	Male	43	162.5	78.7	25.4	18.4	17.0	22.7	22.9	16.5	30.5	23.4	35.7	47.8	1726	29.8	54
16	Male	44	162	49.7	26.7	17.4	15.0	24.2	24.5	40	29.9	22.6	37.8	47.3	1256	18.9	32
17	Male	48	165.8	65.8	24.6	17.0	15.1	23.0	23.0	10.0	30.1	23.3	36.0	47.5	1519	23.9	47
18	Male	51	169	103	38.6	27.6	26.0	38.5	39.4	28.0	24.7	15.2	31.1	42.3	2008	36.0	73
19	Male	53	172	71.4	27.7	18.9	16.9	25.6	25.9	10.5	29.3	21.8	35.6	46.7	1595	24.1	53
20	Male	56	167.5	72.2	30.1	20.6	18.6	27.8	28.3	13.5	27.7	20.0	34.4	45.2	1591	25.7	58
21	Male	57	171	66.3	26.8	18.1	16.0	24.4	24.7	9.0	29.2	22.0	35.9	46.6	1516	22.7	51
Non Teaching Staff members (Office)																	
1	Female	32	153.5	62.9	40.4	33.9	30.9	55.9	51.3	8.0	21.3	16.3	21.6	33.8	1267	26.7	49
2	Male	32	172.5	62.0	23.2	15.6	13.5	23.1	22.8	5.0	32.8	25.7	39.0	50.1	1476	20.8	31
3	Male	32	170	64.2	23.8	16.2	14.2	23.7	23.5	6.5	32.2	25.1	38.3	49.5	1507	22.2	35
4	Male	35	162.5	59.3	30.3	20.3	17.9	29.4	29.8	7.5	29.4	21.2	36.7	46.8	1398	22.5	39
5	Male	38	166	78.5	28.9	20.4	18.7	28.0	28.2	14.5	29.1	21.3	35.5	46.5	1703	28.5	52
6	Male	39	162	55.0	31.4	20.7	18.1	29.4	30.0	6.0	29.0	20.5	37.0	46.4	1326	21.0	37
7	Male	39	157.5	65.8	28.0	19.4	17.6	27.3	27.5	12.5	28.5	21.2	35.4	46.0	1501	26.5	47
8	Male	40	164	66.8	29.7	20.3	18.2	28.9	29.2	10.5	28.7	20.8	35.9	46.2	1514	24.8	47
9	Male	42	170	68.8	26.7	18.2	16.2	25.6	25.7	9.0	30.2	22.8	36.6	47.6	1562	23.8	45
10	Male	43	159	62.8	29.8	20.3	18.2	28.7	29.1	11.0	27.9	20.2	35.4	45.4	1446	24.8	48
11	Male	43	169.2	82.9	30.8	21.6	19.8	29.5	30.0	16.0	28.4	20.3	34.7	45.9	1761	29.0	57
12	Male	54	169.5	75.7	31.7	21.7	19.7	29.8	30.4	13.5	27.5	19.3	34.7	45.0	1640	26.3	59

Non Teaching Staff members (Library)																	
1	Male	36	168.5	70.3	26.9	18.5	16.6	26.4	26.5	9.5	30.4	22.9	37.3	47.7	1587	24.8	44
2	Male	40	161	63.3	25.8	17.8	15.9	24.9	25.0	10.0	29.7	22.7	36.6	47.1	1474	24.4	44
3	Male	44	163.5	68.6	30.3	28.1	23.5	40.1	35.6	7.0	27.3	20.3	27.5	41.1	1414	25.7	50
4	Male	50	167	74.4	27.8	19.4	17.6	25.7	26.0	13.5	29.0	21.5	35.4	46.4	1640	26.7	55

III. Result and Discussion

The ideal BMI is 22. Maintaining an ideal weight can help prevent obesity or weight loss and other diseases, and lead a longer life. The ideal weight for BMI of 22 is calculated as follows.

$$\text{Ideal Weight (Kg)} = 22 \times [\text{height (m)}]^2$$

However this method of ideal weight calculation may not be applicable for professional athletes and body builders, who have higher muscles ratio in their bodies.

Correct Weight Reduction: If we lose weight by going on a diet instead of doing exercise and neglecting nutrition balance, even if our weight is reduced, resting metabolism will decrease as muscle (Skeletal muscle) decreases and we are more likely to become fatter. We should build up non-fat physique by increasing skeletal muscle and improving resting metabolism.

Interpretation of body composition analysis report of teaching Staff members (Senior College & Junior College) & Non Teaching Staff members (Laboratory, Office & Library) is shown in Table III.

TABLE III: Interpretation of Body Composition Analysis Report of Teaching & Non-Teaching Staff Members

Case No	Ideal wt (Kg) = 22 × [ht (m)]^2	Over wt / Under wt Kg	Period required for wt Loss / Gain at the rate of 1.5 kg per month	Period required for wt maintain	Fat %	Subcutaneous Fat % (Trunk)	Visceral Fat %	Skeletal Muscle % (Whole	RM Kcal	BMI	Body Age
Teaching Staff members (Senior College)											
1	75.3	↑ 14.3 Kg Under wt	9.5 Month	9.5 Month	Normal	Normal	Normal	Normal	↑	↑ Under wt	↑
2	50.8	↑ 6.6 Kg Under wt	4 Month	4 Month	Normal	↓ High	Normal	Normal	↑	Normal	↑
3	52.5	↑ 9.2 Kg Under wt	6 Month	6 Month	Normal	↓ High	↓ Very High	Normal	↑	↑ Under wt	↑
4	62.5	↓ 17.1 Kg Over wt	11.5 Month	11.5 Month	↓ Very High	↓ Very high	↓ High	↑ Low	↑	↓ Over wt	↓
5	52.2	↓15.3 Kg Over wt	10 Month	10 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	↓ Over wt	↓
6	65.8	↑ 11.5 Kg Under wt	8 Month	8 Month	↓ High	Normal	Normal	Normal	↑	↑ Under wt	↑
7	58.8	↓ 15.9 Kg Over wt	11 Month	11 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	↓ Over wt	↓
8	62.8	↓ 9.9 Kg Over wt	6.5 Month	6.5 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
9	66.2	↓ 23 Kg Over wt	15 Month	15 Month	↓ Very High	↓ Very High	↓Very High	↑ Low	↑	↓ Over wt	↓
10	64.3	↓ 6.2 Kg Over wt	4 Month	4 Month	↓ Very High	↓ High	Normal	↑ Low	↑	Normal	↓
11	48.2	↑ 9.5 Kg Under wt	7 Month	7 Month	↓ Very High	Normal	Normal	Normal	↑	↑ Under wt	↑
12	65.8	↓ 9 Kg Over wt	6 Month	6 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
13	52.9	↓ 8.4 Kg Over wt	6 Month	6 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
14	68.1	↓ 19 Kg Over wt	13 Month	13 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
15	55.6	↓ 17.4 Kg Over wt	12 Month	12 Month	↓ Very High	↓ Very High	↓ Very High	↑ Low	↑	↓ Over wt	↓
16	65.5	↓ 11.9 Kg Over wt	8 Month	8 Month	Normal	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
17	58.1	↓ 12.2 Kg Over wt	8 Month	8 Month	↓ Very High	↓ Very High	↓ Very High	↑ Low	↑	↓ Over wt	↓
Teaching Staff members (Junior College)											
1	50.2	↑ 15 Kg Under wt	10 Month	10 Month	↑ Low	Normal	Normal	Normal	↑	↑ Under wt	↑
2	66.8	↓ 1.7 Kg Over wt	1 Month	1 Month	↓ High	↓ Very High	Normal	↑ Low	↑	Normal	↓
3	45.9	↓ 10.6 Kg Over wt	7 Month	7 Month	↓ Very High	↓ Very high	Normal	↑ Low	↑	↓ Over wt	↓
4	59.9	↓ 6.3 Kg Over wt	4 Month	4 Month	↓ Very High	↓ Very high	Normal	↑ Low	↑	Normal	↓
5	52.2	↓13.6 Kg Over wt	9 Month	9 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	↓ Over wt	↓
6	55.6	↓ 17 Kg Over wt	11 Month	11 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
7	53.5	↑ 0.3 Kg Under wt	8 Days	8 Days	↓ High	↓ Very high	Normal	↑ Low	↑	Normal	↓
8	50.8	↓ 3.7 Kg Over wt	2.5 Month	2.5 Month	↓ High	↓ Very High	Normal	↑ Low	↑	Normal	↓
9	54.9	↑ 11.2 Kg Under wt	7.5 Month	7.5 Month	Normal	↓ High	Normal	Normal	↑	↑ Under wt	↑
10	65.5	↓ 17.3 Kg Over wt	11.5 Month	11.5 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	↓ Over wt	↓
11	55.6	↓4.4 Kg Over wt	3 Month	3 Month	↓ High	Normal	Normal	↑ Low	↑	Normal	-
12	46.3	↓ 2.3 Kg Over wt	1.5 Month	1.5 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	Normal	↓
13	61.0	↓ 5.1 Kg Over wt	3.5 Month	3.5 Month	↓ High	↓ Very High	Normal	Normal	↑	Normal	↓
14	56.7	↓ 16.9 Kg Over wt	11 Month	11 Month	↓ Very High	↓ Very High	↓ Very High	↑ Low	↑	↓ Over wt	↓
15	67.4	↑ 2.8 Kg Under wt	2 Month	2 Month	↓ Very High	↓ High	Normal	↑ Low	↑	Normal	↑
Non Teaching Staff members (Laboratory)											
1	62.1	↓ 0.3 Kg Over wt	7 days	7 days	↓ High	Normal	Normal	↑ Low	↑	Normal	↓
2	54.9	↓ 0.2 Kg Over wt	7 days	7 days	↓ Very High	↓ High	Normal	↑ Low	↑	Normal	↓
3	68.9	↑ 12 Kg Under wt	8 Month	8 Month	Normal	Normal	Normal	Normal	↑	↑ Under wt	↑
4	61.4	↑ 3 Kg Under wt	2 Month	2 Month	↓ High	Normal	Normal	↑ Low	↑	Normal	↑
5	66.6	↑ 1.1 Kg Under wt	1 Month	1 Month	↓ High	Normal	Normal	↑ Low	↑	Normal	↓
6	64.3	↑ 6.7 Kg Under wt	4.5 Month	4.5 Month	↑ Low	Normal	Normal	Normal	↑	Normal	↑
7	58.5	↑ 6.7 Kg Under wt	4.5 Month	4.5 Month	Normal	Normal	Normal	↑ Low	↑	Normal	↑
8	54.6	↓ 14 Kg Over wt	9 Month	9 Month	Normal	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
9	53.2	↓ 11.1 Kg Over wt	7.5 Month	7.5 Month	Normal	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
10	62.8	↓ 28.8 Kg Over wt	19 Month	19 Month	↓ Very High	↓ Very High	↓ Very High	↑ Low	↑	↓ Obese	↓

11	60.6	↓ 8.1 Kg Over wt	5.5 Month	5.5 Month	↓ Very High	↓ High	↓ High	↑ Low	↑	Normal	↓
12	55.3	↑ 12.4 Kg Under wt	8 Month	8 Month	Normal	Normal	Normal	↑ Low	↑	↑ Under wt	↑
13	64.7	↓ 7.3 Kg Over wt	5 Month	5 Month	↓ Very High	↓ High	↓ High	↑ Low	↑	Normal	↓
14	62.1	↓ 0.9 Kg Over wt	15 Days	15 Days	↓ Very High	Normal	Normal	↑ Low	↑	Normal	↑
15	58.1	↓ 20.6 Kg Over wt	14 Month	14 Month	↓ Very High	↓ High	↓ Very High	↑ Low	↑	↓ Over wt	↓
16	57.7	↑ 8 Kg Under wt	5 Month	5 Month	↓ Very High	Normal	↓ Very High	↑ Low	↑	Normal	↑
17	60.5	↓ 5.3 Kg Over wt	3.5 Month	3.5 Month	↓ High	Normal	↓ High	↑ Low	↑	Normal	↑
18	62.8	↓ 40 Kg Over wt	27 Month	27 Month	↓ Very High	↓ Very High	↓ Very High	↑ Low	↑	↓ Obese	↓
19	65.1	↓ 6.3 Kg Over wt	4 Month	4 Month	↓ Very High	↓ High	↓ High	↑ Low	↑	Normal	-
20	61.7	↓ 10.5 Kg Over wt	7 Month	7 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
21	64.3	↓ 2 Kg Over wt	1 Month	1 Month	↓ Very High	↓ High	Normal	↑ Low	↑	Normal	↑
Non Teaching Staff members (Office)											
1	51.8	↓ 11.1 Kg Over wt	7.5 Month	7.5 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	↓ Over wt	↓
2	65.5	↑ 3.5 Kg Under wt	2 Month	2 Month	↓ High	Normal	Normal	↑ Low	↑	Normal	↑
3	63.6	↓ 0.6 Kg Over wt	15 Days	15 Days	↓ High	Normal	Normal	↑ Low	↑	Normal	↓
4	58.1	↓ 1.2 Kg Over wt	1 Month	1 Month	↓ Very High	↓ High	Normal	↑ Low	↑	Normal	↓
5	60.6	↓ 17.9 Kg Over wt	12 Month	12 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
6	57.7	↑ 2.7 Kg Under wt	2 Month	2 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	Normal	↑
7	54.6	↓ 11.2 Kg Over wt	7.5 Month	7.5 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
8	59.2	↓ 7.6 Kg Over wt	5 Month	5 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	Normal	↓
9	63.6	↓ 5.2 Kg Over wt	3.5 Month	3.5 Month	↓ Very High	↓ High	Normal	↑ Low	↑	Normal	↓
10	55.6	↓ 7.2 Kg Over wt	5 Month	5 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	Normal	↓
11	63.0	↓ 19.9 Kg Over wt	13 Month	13 Month	↓ High	↓ Very High	↓ Very High	↑ Low	↑	↓ Over wt	↓
12	63.2	↓ 12.5 Kg Over wt	8 Month	8 Month	↓ Very High	↓ Very High	↓ High	↑ Low	↑	↓ Over wt	↓
Non Teaching Staff members (Library)											
1	62.5	↓ 7.8 Kg Over wt	5 Month	5 Month	↓ Very High	↓ High	Normal	Normal	↑	Normal	↓
2	57.0	↓ 6.3 Kg Over wt	4 Month	4 Month	↓ Very High	Normal	↓ High	↑ Low	↑	Normal	↓
3	58.8	↓ 9.8 Kg Over wt	6.5 Month	6.5 Month	↓ Very High	↓ Very High	Normal	↑ Low	↑	↓ Over wt	↓
4	61.4	↓ 13 Kg Over wt	9 Month	9 Month	↓ Very High	↓ High	↓ High	↑ Low	↑	↓ Over wt	↓

In Table III sign ↑ indicates corresponding value should increase and sign ↓ indicates corresponding value should decrease during weight loss or weight gain programme.

Interpretation of body composition analysis report of Teaching Staff members (Senior College) shows that overweight person is 70.6 % while that of underweight person is 29.4 % and normal person is 0 %.

Interpretation of body composition analysis report of Teaching Staff members (Junior College) shows that overweight person is 73.3 % while that of underweight person is 20.0 % and normal person is 6.7 %.

Interpretation of body composition analysis report of Non Teaching Staff members (Laboratory) shows that overweight person is 52.4 % while that of underweight person is 42.9 % and normal person is 4.8 %.

Interpretation of body composition analysis report of Non Teaching Staff members (Office) shows that overweight person is 76.9 % while that of underweight person is 16.7 % and normal person is 0 %.

Interpretation of body composition analysis report of Non Teaching Staff members (Library) shows that overweight person is 100 % while that of underweight person is 0 % and normal person is 0 %.

IV. Conclusion

In Teaching Staff members (Senior College) case number 1 - RM has to be increased so that BMI and body age can be increased and has to undergo 9.5 month weight gain (at the rate of 1.5 kg per month) programme to increase 14.3 kg weight. And has to undergo 9.5 month weight maintain programme.

In case number 2 - Subcutaneous trunk Fat % has to be decreased and RM has to be increased so that body age can be increased. And has to undergo 4 month weight gain programme to increase 6.6 Kg weight. And has to undergo 4 month weight maintain programme.

In case number 3 - Subcutaneous trunk Fat % and visceral fat % has to be decreased and RM has to be increased so that BMI and body age can be increased. And has to undergo 6 month weight gain programme to increase 9.2 Kg weight. And has to undergo 6 month weight maintain programme.

In case number 4 – Fat %, subcutaneous trunk Fat % and visceral fat % has to be decreased and whole body skeletal muscle % and RM has to be increased so that BMI and body age can be decreased. And has to undergo 11.5 month weight loss programme to decrease 17.1 Kg weight. And has to undergo 11.5 month weight maintain programme.

In case number 5 – Fat % and Subcutaneous trunk Fat % has to be decreased and whole body skeletal muscle % and RM has to be increased so that BMI and body age can be decreased. And has to undergo 10 month weight loss programme to decrease 15.3 Kg weight. And has to undergo 10 month weight maintain programme.

Likewise conclusion from other cases can be drawn.

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