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Results and Discussion

The results of the present study entitled **"Evaluation of a Functional Food Supplement on Body Composition of Obese Young Adults and Influence of a selected PPAR Gamma Gene Polymorphism on its Outcome"** are discussed in the following phases

A Phase I : Age Wise Distribution of Subjects Based on Anthropometric Measurements

B Phase II : Development, Standardization and Evaluation of the FunctionalFood Supplement

C Phase III : Assessment of Socio Economic, Nutritional Status,Body Composition Measures and Computation of Total Energy expenditure

D Phase IV : Impact of Intervention and influence of Pro 12 Ala Polymorphism

A. PHASE I

AGE WISE DISTRIBUTION OF SUBJECTS BASED ON ANTHROPOMETRIC MEASUREMENTS

1. Age wise distribution of subjects based on age and gender

The subjects were categorized based on age as well as gender and presented in table 3, which gives the age wise distribution of the subjects. A total of 1873 subjects comprising of 990 male and 883 female subjects were enrolled for the purpose of screening obese and overweight subjects among young adults in the age group of 19-24 years.

Table - 3

Age wise distribution of the subjects

N = 1873

Age (years)	Male(990)		Female(883)	
	No	**%**	**No**	**%**
19	185	18.69	160	18.12
20	159	16.06	140	15.86
21	177	17.88	186	21.06
22	205	20.71	186	21.06
23	118	11.92	102	11.55
24	146	14.74	109	12.35
Total	**990**	**100**	**883**	**100**

. The subjects selected for the study were distributed based on their age and gender in order to ascertain the age as well as gender related differences that existed among the subjects. The data revealed that among 19 years old, 18.69 and 18.12 percent were males and females respectively; while among those aged 20 years, 16.06 and 15.86 percent were males and females respectively. Around 17.88 and 21.06 per cent of the selected males and females

subject were 21 years old while about 20.71 and 21.06 percent of selected males and females respectively were 22 years old. Almost equal number of 11.92 and 11.55 per cent of males and females respectively were 23 years of age and remaining 14.74 and 12.35 per cent of male and female respectively were 24 years old. National Family Health Survey 3 data (2005-06) states that the Youth in India constitutes one-fifth of total population whose health and wellbeing is asset for the development of a nation.

2. Distribution of subjects based on Body Mass Index (BMI) and gender

The mean Body Mass Index (BMI) and prevalence of obesity, overweight and underweight among the subjects are given in figure 12 based on their gender

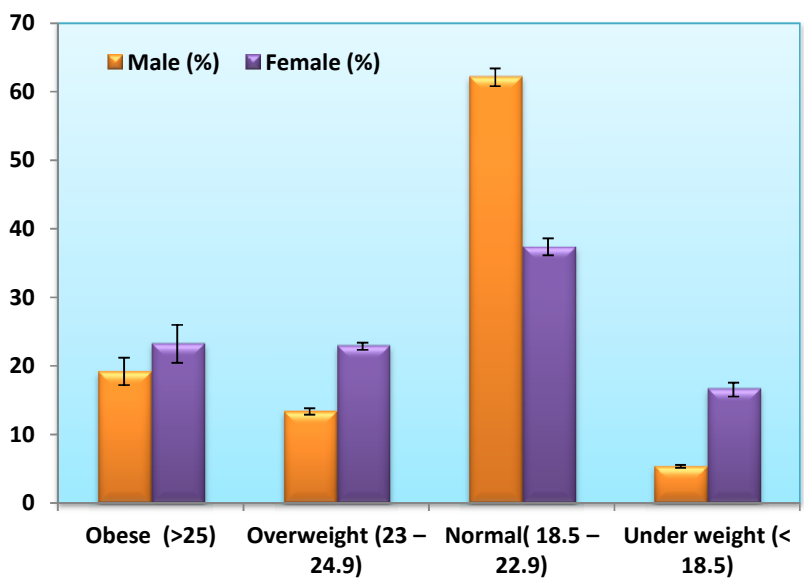


Figure 12

Distribution of the subjects based on BMI and gender

Rapid rise in obesity in India emphasizes the importance to predict the "weight of the nation." Due to the long-term consequences, the cost burden of obesity on the health care system is enormous. A better understanding of the numbers and causes can help to overcome barriers for primary prevention of obesity among children as well as adults (Ramachandran and Snehalatha, 2010).

The Body Mass Index (BMI) is widely used for the determination of nutritional status for individuals and groups. Guidelines for obesity and overweight based on Body Mass Index (BMI) for Asian Indians were revised based on consensus developed through discussions by a Prevention and Management of Obesity and Metabolic Syndrome group (Mirsa *et al.*, 2009). Body Mass Index of 18.50 to 22.9 are categorized as normal, 23.0 – 24.9 as overweight and ≥25 as obesity according to the revised guidelines in the place of the ethnic specific BMI previously advocated for Asian Indians.

The distribution of subjects based on Body Mass Index and gender revealed that prevalence of obesity was 19.91 and 23.21 per cent among the male and female subjects respectively. Similar results were reported by ICMR study, Phase I - INDIAB (2015) which indicated the overall prevalence of generalized obesity as 24.6 per cent among residents of Tamil Nadu (Pradeepa*et al.,* 2015). The mean Body Mass Index of obese male was found to be 26.80 ±2.00 while it was found to be 27.68 ±2.76 among the females. Obviously, females outnumbered males in the prevalence of obesity and had a higher Body Mass Index when compared to the male counterparts. The result of the present study fall in line with the NFHS – 4 (2015-16) data that reports prevalence of obesity among females (36.2%) which was higher than the males (30.6%) in Tamil Nadu..

Prevalence of overweight among the selected subjects were found to be higher among females (22.87%) than males (13.33%). The mean Body Mass Index of overweight males and females were found to be 24.28 ±0.46 and 23.97 ±0.53 respectively. Among the selected subjects, 62.12 per cent of the male subjects had a normal Body Mass Index while only 37.37 percent of the females had a normal Body Mass Index. However the mean Body Mass Index of normal male (20.78 ±1.30) and female (20.68 ±1.24) subjects were found to be more or less similar. The prevalence of underweight was higher among the female (16.53%) than among male subjects (5.35%). The mean Body Mass Index of underweight male and female subjects were found to be 18.25 ±0.21 and 17.13 ±1.00 respectively. Higher prevalence of underweight and lower mean Body

Mass Index among female subjects may be attributed to the fact that males concentrate on muscle building while females are figure conscious during their transformation from late adolescence to early adulthood.

3. Mean anthropometric measurements of the subjects

The anthropometric measurement of subjects in terms of height, weight, Body Mass Index (BMI), Waist Circumference (WC), Hip Circumference (HC), Waist Hip Ratio (WHR), Waist Height Ratio (WHtR), Conicity Index (CI) and Body Adiposity Index (BAI) are depicted in the Table 4

Table 4

Mean anthropometric measurements of the subjects

N = 1873

Anthropometric Measurements	Male (N=990)	Female (N= 883)
Height(Cm)	165.01 ±9.17	158.08 ±7.81
Weight(Kg)	60.50 ±8.38	56.44 ±12.28
Body Mass Index BMI	22.26 ±2.93	22.47 ±3.91
Waist Circumference(Cm)	79.42 ±9.91	73.09 ±10.30
Hip Circumference(Cm)	91.33 ±10.09	91.91 ±10.76
Waist –Hip Ratio (WHR)	0.88 ±0.12	0.79 ±0.05
Waist – Height Ratio (WHtR)	0.48 ±0.07	0.46 ±0.06
Conicity index (CI)	0.80 ±0.11	0.78 ±0.06
Body Adiposity Index (BAI)	25.36 ±6.20	28.27 ±4.89

The mean height of the selected male subjects (165.01±9.17) was found to be greater than the female subjects (158.08 ± 7.81). The mean heights of the subjects in both the groups were found to be less than the reference standard with respect to their gender. The mean weight of the selected male subjects

(60.50 ± 8.38) was found to be more than the female subjects (56.44 ±12.28). The mean weight of both the groups was found to be less than the reference standard weight for their respective gender. The mean Body Mass Index of the selected male (22.26 ±2.93) and female (22.47 ±3.91) subjects were found to be similar. The mean waist circumferences of the selected male subjects (79.42 ±9.91) were found to be greater than the selected female subjects (73.09 ±10.30). The mean hip circumference of the selected male (91.33 ±10.09) and female (91.91 ±10.76) subjects were found to be similar. The mean Waist Hip Ratio, Waist Height Ratio, Conicity Indices of the male subjects was found to be higher than the female subjects. The mean Body Adiposity Indices of the selected females (28.27 ±4.89) was found to be higher than selected male (25.36 ±6.20).

3. Age wise distribution of the subjects based on height and phenotype

The age wise distribution of the subjects based on height with respect to age and phenotype are given in Table 5

Table 5

Agewise distribution of the subjects based on height and phenotype

N = 1873

Age (years)	Underweight (199)		Normal (945)		Overweight (334)		Obese (395)	
	Male (53)	Female (146)	Male (615)	Female (330)	Male (132)	Female (202)	Male (190)	Female (205)
19+	168.80 ±7.55	156.97 ±3.74	167.45 ±7.79	157.00 ±5.64	162.73 ±9.35	158.18 ±8.12	160.25 ±10.61	162.36 ±8.82
20+	167.11 ±5.47	157.59 ±5.74	167.10 ±8.68	157.41 ±5.33	160.29 ±7.68	158.61 ±11.03	160.4 ±9.00	162.06 ±9.73
21+	167.63 ±7.91	156.83 ±4.46	163.99 ±9.38	157.15 ±5.85	160.24 ±8.35	157.33 ±10.39	160.50 ±8.29	160.72 ±8.90
22+	168.41 ±7.02	156.69 ±5.30	167.93 ±8.88	157.02 ±5.90	160.64 ±8.08	158.18 ±10.53	164.6 ±10.5	160.73 ±9.74
23+	174.88 ±4.94	155.88 ±3.83	166.48 ±9.71	158.39 ±7.16	161.22 ±9.88	155.20 ±6.28	159.1 ±6.5	160.64 ±10.14
24+	167.91 ±7.69	153.58 ±4.72	167.30 ±7.73	157.40 ±6.59	161.41 ±8.51	159.20 ±8.81	161.5 ±10.1	157.79 ±10.33

The age wise distribution of the subjects based on height and phenotype revealed that the mean height of the male subjects were higher than the mean height of the female subjects among all the groups except the obese subjects who belonged to the 19 and 20 years group.

Stratification of mean height based on body mass index and age revealed that the mean height of the males were 174.88 ± 4.94 in the 23 years age group and the females were 157.59± 5.74 in the 20 years age group which was found to be the highest among underweight subjects.

Among the normal subjects, the mean height based on the Body Mass index was the highest 167.93 ± 8.88 for the males in the 22 years age group and the females 158.39± 7.16 in the 23 years age group. In the overweight individuals studied, the mean height based on the Body Mass Index showed the maximum in the males 162.73±9.35 belonging to the 19 years age group whereas it was the 24 years in the females(159.20±8.81).The mean height was found to be the highest in the males(164.6±10.5) who were 22 years of age and the females(162.36±8.82) who were 19 years of age among the obese subjects.

5. Age wise distribution of the subjects based on weight and phenotype

The mean weight of the subjects corresponding to their age and phenotype are presented in Table 6

Table 6

Agewise distribution of the subjects based on weight and phenotype

N = 1873

Age (Years)	Underweight (199)		Normal (945)		Overweight (334)		Obese (395)	
	Male (55)	Female (146)	Male (615)	Female (330)	Male (132)	Female (202)	Male (190)	Female (205)
19+	52.07 ±4.26	41.38 ±4.05	57.98 ±5.97	51.58 ±5.37	64.45 ±8.02	60.18 ±6.21	68.20 ±8.28	71.97 ±11.21
20+	51.01 ±3.28	43.24 ±3.99	57.69 ±6.38	51.60 ±4.84	62.62 ±6.02	60.19 ±8.17	70.0 ±8.2	70.75 ±8.53
21+	51.03 ±4.72	41.90 ±3.72	56.30 ±6.85	50.38 ±4.77	62.64 ±6.73	59.49 ±8.00	68.67 ±7.64	72.52 ±11.81
22+	51.78 ±4.46	46.66 ±4.00	58.50 ±6.41	50.96 ±4.41	62.83 ±6.90	60.23 ±8.05	72.60 ±8.6	71.94 ±10.68
23+	56.33 ±3.09	41.19 ±3.67	57.45 ±6.29	51.95 ±5.26	63.51 ±8.87	58.13 ±5.18	68.30 ±5.5	70.56 ±10.31
24+	51.17 ±4.79	40.60 ±4.64	58.96 ±6.09	51.71 ±5.32	63.22 ±6.69	61.09 ±6.98	69.6 ±7.90	71.55 ±11.04

The age wise distribution of the subjects based on weight and phenotype revealed that the male subjects of all the age groups weighed more than the females excepting the obese female group invariable of the phenotype and age the mean weight of the male and female subjects were found to be highest among the obese group.

In the underweight group, the male subjects recorded a maximum of 56.33±3.09 who were 23 years of age whereas the females recorded a 46.66±4.00 who were 22 years of age. The maximum weight was 58.96±6.09 in the male subjects who were 24 years old and 51.95±5.26 in the female subjects who were 23 years old, both belonging to the normal category.

Among the overweight subjects studied, the males belonging to the 19 year age group recorded a maximum weight of 64.45±8.02 and in the females, the maximum weights recorded was 61.09±6.98 who belonged to the 24 years age group. The males who were 22 years of age were found to have the maximum weight of 72.60±8.6 and the females who were 21 years of age showed the maximum weight of 72.52±11.81 in the obese group.

6. Age wise distribution of the subjects based onBody Mass Index (BMI)

Age wise distribution of the subjects based on body mass index are depicted in figure 13

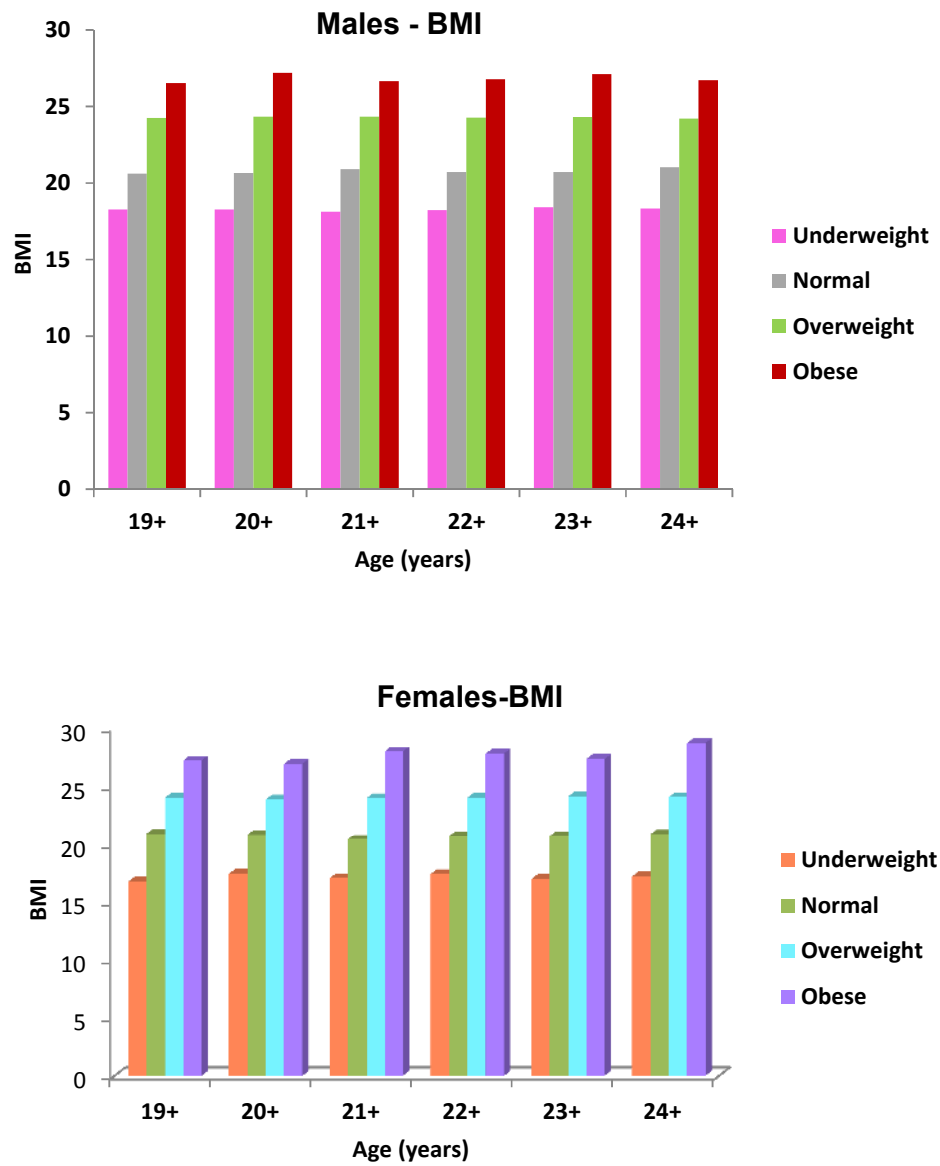


Figure 13

Agewise distribution of subjects based on Body Mass Index (BMI)

Body Mass Index (BMI) is a simple measure of weight-for-height and is age-independent, same for both sexes and corresponds to same degree of fatness.

The BMI recorded for the subjects who belonged to the underweight category revealed that the males who were 21 years of ageshoweda minimum of 18.13 ± 0.25 and a maximum of 18.41±0.08 in those who were 23 years of age whereas in the females, the minimum BMI was 16.71±1.22 and a maximum of 17.38±0.78 in the 19 and 20 years respectively.

The normal male group had a maximum BMI of 21.04±1.28 (24 years) and a minimum BMI of 20.60±1.35 (19 years). In the normal female group, the maximum BMI was 20.88±1.21 (19 years) and the minimum BMI was 20.37±1.20 (21 years).

Among the overweight subjects, the maximum (24.33±0.38) BMI was recorded in the males who were 21 years of age and the minimum (24.20±0.41) was recorded in the males who were 24 years of age. A maximum of (24.09±0.61) BMI was recorded in the females who were 23 years of age and the minimum (23.84±0.53) was recorded in the females who were 20 years of age

The BMI recorded for the obese males was found to be maximum 27.20 ±2.10 in those who were 20 years of age and it was found to be minimum 26.53±1.85 in those who were 19 years of age. Similarly, in the obese females, the maximum BMI was 28.68±3.07 in the 24 year age group and the minimum BMI was found to be 26.89±1.73 in the 20 year age group.

7. Age wise distribution of the subjects based on waist circumference and phenotype

The subjects were distributed based on their waist circumference with reference to gender as well as age and presented in Table 7.

Waist Circumference is an important measure of abdominal obesity compared to WHR, which can be low in some obese people because of high hip circumference (Ahmad et, 2016)waist circumference alone could replace WHR

and BMI as a single risk factor for all causes of mortality (Chatarved and Singh 2016).

Table 7

Agewise distribution of the subjects based on waist circumference (wc) and phenotype

N = 1873

Age (years)	Underweight (199)		Normal (945)		Overweight (334)		Obese (395)	
	Male (53)	Female (146)	Male (615)	Female (330)	Male (132)	Female (202)	Male (190)	Female (205)
19+	64.40 ±3.78	62.23 ±5.16	76.23 ±8.99	68.65 ±4.76	82.0 ±6.75	75.80 ±8.11	90.58 ±6.09	82.49 ±10.18
20+	64.70 ±2.71	61.59 ±3.08	76.40 ±8.12	68.75 ±4.77	84.04 ±6.57	76.68 ±8.35	89.2 ±5.5	83.74 ±6.44
21+	63.67 ±2.24	61.30 ±3.71	78.38 ±8.72	68.72 ±6.39	82.12 ±7.71	76.56 ±8.86	91.17 ±5.40	84.65 ±7.61
22+	66.18 ±4.09	61.19 ±3.97	77.43 ±8.67	69.63 ±5.21	79.69 ±9.09	76.87 ±7.11	89.4 ±6.0	84.50 ±7.54
23+	69.75 ±11.03	62.38 ±4.36	75.62 ±8.31	68.82 ±5.89	79.17 ±5.51	74.87 ±3.93	89.6 ±4.8	85.18 ±10.06
24+	65.44 ±2.83	60.92 ±3.37	77.33 ±9.17	69.21 ±5.69	79.38 ±5.97	77.33 ±9.08	90.2 ±6.1	86.62 ±9.80

Waist circumference provides an independent prediction of risk over and above that of BMI. Waist circumference measurement is particularly useful in subjects who are categorized as normal or overweight on the BMI scale. At a BMI of 35, waist circumference has little added predictive power of disease risk beyond that of BMI. It is therefore not necessary to measure waist circumference in individuals with BMI above 35. It is evident from the above table, that the waist circumference of the underweight males was the highest (69.7±11.03) in those who were 23 years of age and lowest(63.67±2.24)in those who were 21 years of age. The waist circumference of the underweight females was the highest (62.38±4.36) in those who were 23 years of age and lowest (60.92±3.37)in those who were 24 years of age.

The waist circumference of the normal male subjects was maximum (78.38 ±8.72) in the 21 years age group and minimum (75.62± 8.31) in the 23 years age group. The waist circumference of the normal female subjects was

maximum (69.63±5.21) in the 22 years age group and minimum (68.65±4.76) in the 19 years age group.

The recorded waist circumference of the overweight male subjects was found to be greater (84.04±6.57) in those who were 20 years old and lesser (79.17±5.51) in those who were 23 years old. The recorded waist circumference of the overweight female subjects was found to be greater (77.33±9.08) in those who were 24 years old and lesser (74.87±3.93)in those who were 23 years old.

In the obese category, the waist circumference of the males recorded a maximum (91.17±5.40) and a minimum (89.2±5.5) in the 21 years and 20 years age group respectively. The waist circumference of the females recorded a maximum (86.62±9.80) and a minimum (82.49±10.18) in the 24 years and 19 years age group respectively.

8. Age wise distribution of the subjects based on hip circumference and phenotype

The subjects were classified based on their hip circumference with reference to gender and age and given in Table 8.

Table 8

Agewise distribution of the subjects based on hip circumference (hc) and phenotype

Age (years)	Underweight (199)		Normal (945)		Overweight (334)		Obese (395)	
	Male (53)	Female (146)	Male (615)	Female (330)	Male (132)	Female (202)	Male (190)	Female (205)
19+	86.80 ±4.69	80.32 ±5.36	89.51 ±9.21	87.44 ±5.92	90.32 ±9.16	94.29 ±9.05	92.09 ±10.44	103.34 ±10.86
20+	87.10 ±3.00	80.32 ±3.57	91.48 ±9.63	87.89 ±5.50	91.75 ±13.89	94.29 ±8.96	91.8 ±11.0	102.90 ±6.55
21+	85.56 ±2.92	80.04 ±4.36	91.91 ±10.36	86.96 ±7.20	90.00 ±10.09	94.87 ±8.13	93.31 ±9.92	103.42 ±9.29
22+	88.36 ±4.32	80.81 ±4.07	91.56 ±9.86	87.39 ±5.31	91.09 ±10.99	95.69 ±8.79	95.8 ±11.9	104.18 ±8.48
23+	90.25 ±4.72	79.54 ±3.60	90.82 ±9.88	89.06 ±5.59	88.0 ±7.47	94.87 ±6.25	92.2 ±9.70	101.91 ±9.19
24+	87.22 ±3.15	79.83 ±3.86	92.40 ±10.26	88.85 ±6.40	92.31 ±10.67	97.07 ±8.56	93.50 ±13.19	107.09 ±8.23

It has recently been demonstrated that, in middle-aged women, a wide hip circumference is a protective factor for a number of health endpoints in later years.

In the underweight males, the 23 years recorded a maximum Hip Circumference of 90.25±4.72 and the 21 years recorded a minimum Hip Circumference of 85.56±2.92. In the females, the 22 years recorded a maximum Hip Circumference of 80.81±4.07 and the 23 years recorded a minimum Hip Circumference of 79.54±3.60.

The Hip Circumference of the normal male subjects was recorded and it was found to be maximum (92.40±10.26) in those who were 24 years of age and minimum (89.51±9.21) in those who were 19 years of age. The Hip Circumference of the normal female subjects was recorded and it was found to be maximum (89.06±5.59) in those who were 23 years of age and minimum (86.96±7.20) in those who were 21 years of age. In the overweight category, the maximum (92.31±10.67) Hip Circumference of the males was found in those who were 24 years old and the minimum (88.0±7.47) was found in those who were 23 years old. In the females, the maximum (97.07±8.56) Hip Circumference was found in those who were 24 years old and the minimum (94.29±8.96) was found in those who were 19 and 20 years old.

The mean hip circumference of the male obese subjects was the highest (95.8±11.9) in those who were 22 years of age and the lowest (91.8±11.0) in those who were 20 years of age. In the female obese subjects, the mean Hip Circumference was the highest (107.09 ±8.23) in those who were 24 years of age and the lowest (101.91±9.19) in those who were 23 years of age.

8. Age wise distribution of the subjects based on waist hip ratio and Phenotype

The Figure 14 shows the mean Waist Hip Ratio of the subjects based on their gender and age.

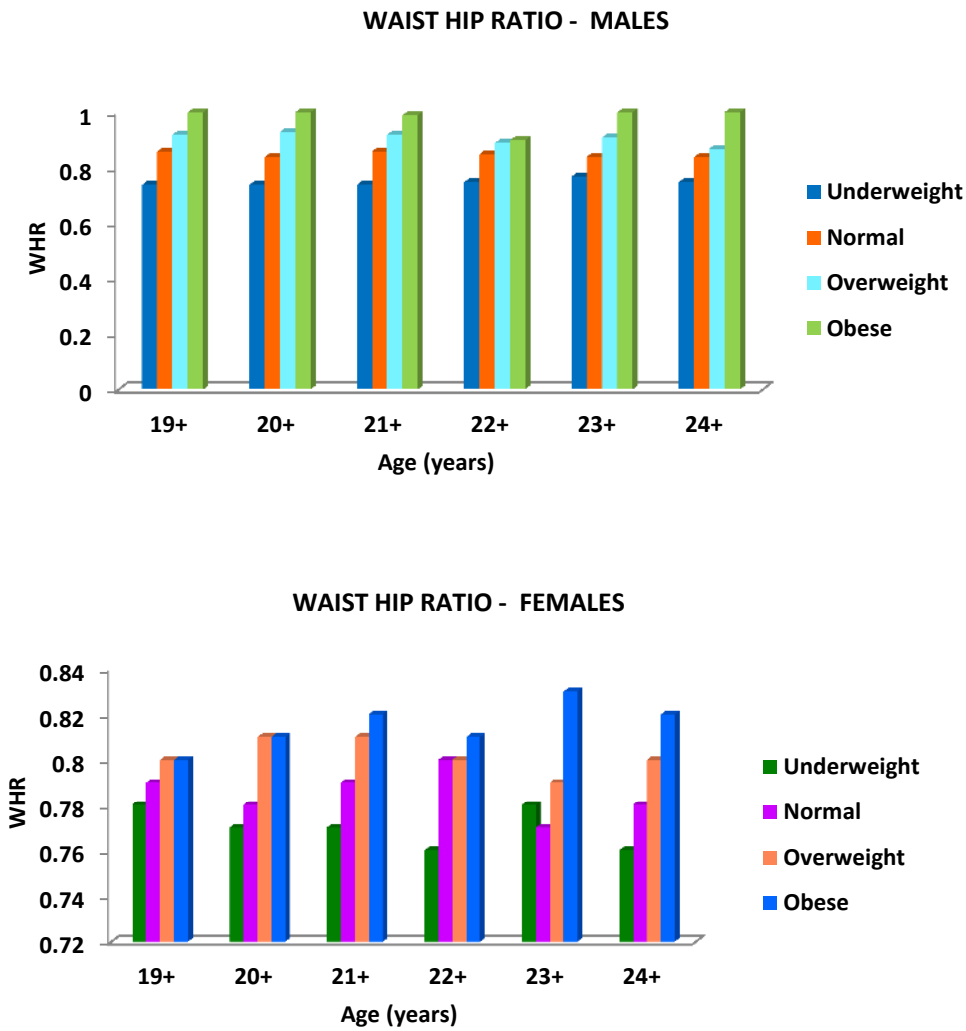


Figure 14

Agewise distribution of the subjects based on Waist Hip Ratio (WHR) and phenotype

Waist circumference and waist-hip ratio are strongly predictive in young and middle aged adults compared to older people and those with low BMI (Chaturved and Singh, 2016).The mean Waist hip Ratio of the underweight male subjects was maximum (0.77 ±0.08)in those who were 23 years of age and

minimum (0.74±0.03)in those who were 19, 20 and 21 years of age. The mean Waist hip Ratio of the underweight female subjects was maximum (0.78 ±0.06) in those who were 23 and 19 years of age and minimum (0.76±0.04)in those who were 22 years of age.

In the normal male subjects the Waist Hip ratio was found to be greater (0.86±0.11) in those who were 21 and 19 years old and minimum (0.84±0.09) in those who were 20, 23 and 24 years old. In the normal female subjects the Waist Hip ratio was found to be greater (0.80±0.05) in those who were 22 years old and minimum (0.77±0.05) in those who were 23 years old.

The Waist Hip ratio recorded for the overweight male subjects was found to be greater (0.93±0.14) in the 20 years age group and the least (0.87±0.12) in the 24 years age group. The Waist Hip ratio recorded for the female subjects was found to be greater (0.81±0.04) in the 20 years age group and the least (0.79±0.03) in the 23 years age group.

In the obese category, the males belonging to the age groups of 19, 20, 23 and 24 years had a maximum waist Hip Ratio of 1.00 ±0.14 which was over that of the standard and in the females, the maximum(0.83±0.04)was found in the 23 years and the least(0.80±0.06) in the 19 years group.

9. Age wise distribution of the subjects based on waist to height ratio and phenotype

The mean waist to height ratio of the subjects are presented in table 9- based on their gender and age

Table 9

Agewise distribution of the subjects based on waist to height ratio (whtr) and phenotype

N = 1873

Age (years)	Underweight (199)		Normal (945)		Overweight (334)		Obese (395)	
	Male (53)	Female (146)	Male (615)	Female (330)	Male (132)	Female (202)	Male (190)	Female (205)
19+	0.38 ±0.03	0.40 ±0.03	0.46 ±0.06	0.44 ±0.03	0.50 ±0.04	0.48 ±0.04	0.57 ±0.05	0.51 ±0.06
20+	0.39 ±0.02	0.39 ±0.02	0.46 ±0.06	0.44 ±0.03	0.52 ±0.04	0.48 ±0.04	0.6 ±0.04	0.52 ±0.03
21+	0.38 ±0.02	0.39 ±0.02	0.46 ±0.06	0.44 ±0.04	0.51 ±0.06	0.49 ±0.04	0.57 ±0.05	0.53 ±0.04
22+	0.39 ±0.03	0.39 ±0.03	0.46 ±0.06	0.44 ±0.03	0.50 ±0.07	0.49 ±0.03	0.5 ±0.04	0.53 ±0.05
23+	0.40 ±0.06	0.40 ±0.03	0.46 ±0.06	0.43 ±0.04	0.49 ±0.04	0.48 ±0.02	0.6 ±0.04	0.53 ±0.07
24+	0.39 ±0.02	0.40 ±0.02	0.46 ±0.06	0.44 ±0.04	0.49 ±0.04	0.49 ±0.05	0.6 ±0.1	0.56 ±0.07

On analyzing the Waist to Height Ratio of the subjects studied, the underweight males recorded a maximum (0.40±0.06) in the 23 year age group and a minimum (0.38±0.02) in the 21 year age group. The underweight females recorded a maximum (0.40±0.03) in the 23 and 19 year age group and a minimum (0.39±0.02) in the 20 and 21 year age group.

The mean Waist Hip Ratio of the male and female normal subjects belonging to all the age categories showed a similar pattern, which was 0.46±0.06 in the males and 0.44±0.03 in the females.

Among the overweight male subjects, the mean Waist to Height Ratio was the highest (0.52±0.04) in those who were 20 years old and the lowest (0.49±0.04) in those who were 23 and 24 years old. Among the overweight female subjects, the mean Waist to Height Ratio was the highest (0.49±0.05) in those who were 24 years old and the lowest (0.48±0.02) in those who were 23 years old.

In the obese category, the male subjects recorded a maximum (0.60±0.04) mean Waist to Height Ratio in the 23 years age group and a minimum (0.50±0.04) in the 22 years age group. The female subjects recorded a maximum (0.56±0.07) mean Waist to Height Ratio in the 24 years age group and a minimum (0.51±0.06) in the 19 years age group.

10. Age wise distribution of the subjects based on conicity index and phenotype

Table 10 reveals the mean Conicity Index of the subjects with reference to gender and age

Table 10

Agewise distribution of the subjects based on Conicity Index (CI) and phenotype

Age (years)	Underweight (199)		Normal (945)		Overweight (334)		Obese (395)	
	Male (53)	Female (146)	Male (615)	Female (330)	Male (132)	Female (202)	Male (190)	Female (205)
19+	0.69 ±0.07	0.77 ±0.07	0.78 ±0.10	0.76 ±0.04	0.81 ±0.018	0.78 ±0.06	0.87 ±0.10	0.77 ±0.08
20+	0.70 ±0.05	0.75 ±0.05	0.78 ±0.10	0.76 ±0.05	0.84 ±0.017	0.79 ±0.07	0.80 ±0.10	0.78 ±0.05
21+	0.69 ±0.05	0.76 ±0.05	0.82 ±0.12	0.77 ±0.06	0.82 ±0.10	0.79 ±0.06	0.87 ±0.019	0.79 ±0.05
22+	0.71 ±0.06	0.75 ±0.05	0.79 ±0.11	0.78 ±0.05	0.80 ±0.12	0.79 ±0.04	0.80 ±0.10	0.79 ±0.06
23+	0.70 ±0.10	0.78 ±0.06	0.78 ±0.10	0.76 ±0.06	0.79 ±0.018	0.79 ±0.04	0.9 ±0.1	0.80 ±0.09
24+	0.71 ±0.05	0.74 ±0.04	0.78 ±0.10	0.77 ±0.07	0.79 ±0.018	0.79 ±0.08	0.9 ±0.1	0.83 ±0.09

The mean Conicity Index of the underweight male subjects was higher (0.71± 0.06) in the 22 years age group and lower (0.69± 0.05) in the 21 years age group. The mean Conicity Index of the underweight female subjects was higher (0.78± 0.06) in the 23 years age group and lower (0.74± 0.04) in the 24 years age group.

In the normal male subjects, the maximum mean Conicity Index (0.82±0.12) was found in those aging 21 years and the minimum (0.78±0.10) was found in those aging 19, 20, 23 and 24 years. In the normal female subjects, the maximum mean Conicity Index (0.78±0.05) was found in those aging 22 years and the minimum (0.76±0.04) was found in those aging 19 years.

In the overweight category, the mean Conicity Index of the males was found to be the maximum (0.84±0.02) in those aging 20 years and minimum (0.79±0.02) those ageing 23 and 24 years. The mean Conicity Index of the females was found to be the maximum (0.79±0.08) in those aging 24 years and minimum (0.78±0.06) those ageing 19years

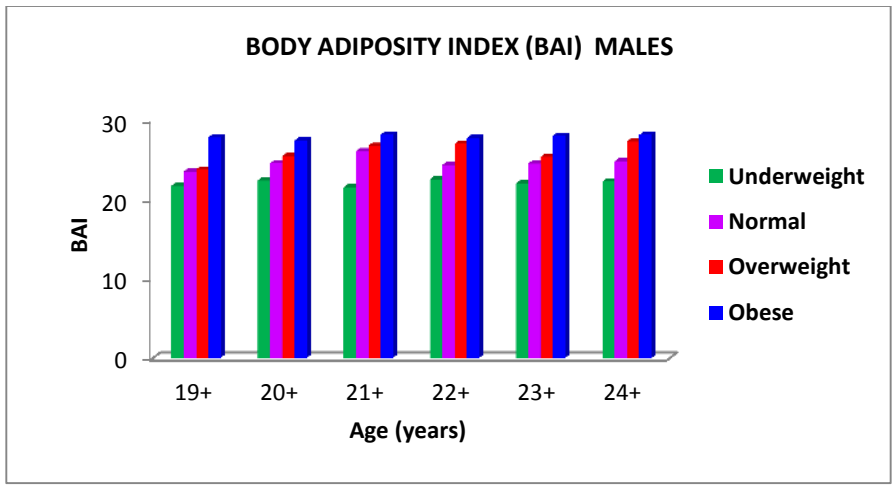
The mean Conicity Index observed in the obese male subjects was higher (0.90±0.10) in those who were 23 and 24 years of age and lower (0.80±0.10) in those who were 20 and 22 years of age. The mean Conicity Index observed in the obese female subjects was higher (0.83±0.09) in those who were 24 years of age and lower (0.77±0.08) in those who were 19 years of age.

11. Age wise distribution of the subjects based on adiposity index and phenotype

The mean Adiposity Index of subjects of the subjects are shown in figure 15 corresponding to their gender and age

The mean Body Adiposity Index studied among the underweight male subjects was found to be maximum (22.51±2.62) in those who were 22 years old and minimum (21.03±1.65) in those who were 23 years old. The underweight female subjects recorded a maximum of (23.95±1.48) in those who were 24 years old and minimum (22.65±2.01) in those who were 20 years old

In the normal male subjects, the mean Body Adiposity Index was the highest (26.08±6.67) in the 21 year age group and the lowest (23.52±5.57) in the 19 year age group. In the female subjects, it was the highest (27.06±3.42) in the 24 year age group and the lowest (26.17±3.41) in the 21 year age group.



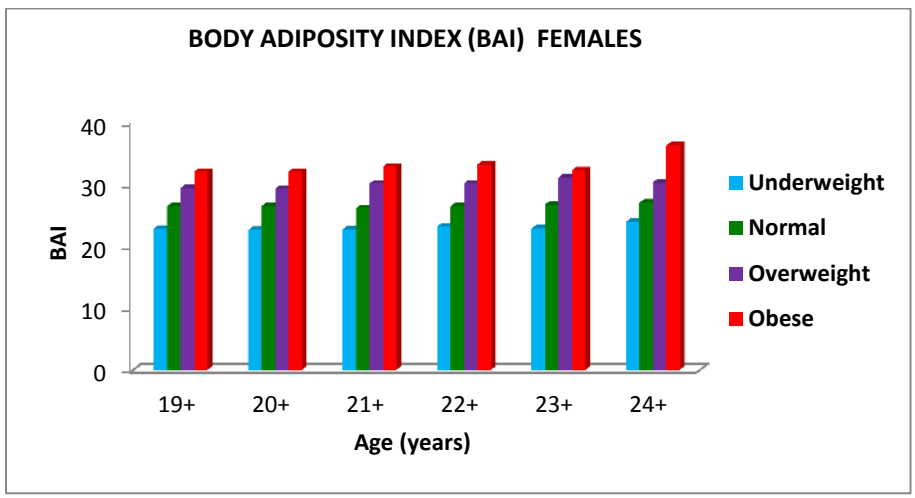


Figure 15

Agewise distribution of the subjects based on Body Adiposity Index (BAI) and phenotype

Among the overweight male subjects, the Body Adiposity Index was found to be the most (27.28 ±6.60) among those aged 24 years and the least (23.74±5.64) in those aged 19 years. In the female subjects, the Body Adiposity Index was found to be the most (31.10±2.64) among those aged 23 years and the least (29.28±3.39) in those aged 20 years.

The Body Adiposity Index recorded in the obese male subjects was found to be maximum (28.14±6.14) in those aged 21 years and minimum (27.4±6.50) in those aged 20 years. In the obese female subjects, the BAI was found to be a maximum (36.29±5.41) in those aged 24 years and minimum (32.02±3.43) in those aged 20 years

12. Coefficient of corelation between anthropometric parameters and BMI

The extent and type of association (correlation) between the various anthropometric parameters and BMI among the subjects were evaluated and presented below table 11

Table 11

Coefficient of corelation between anthropometric parameters and BMI

	Age	Height	Weight	BMI	WHtR	WC	HC	WHR	CI	BAI	DIETARY
Age	1	.001	.003	.005	.014	.012	.050*	-.032	.015	.043	-.025
Height		1	.552**	-.111**	-.221**	.194**	.168**	.076**	-.451**	-.298**	.023
Weight			1	.762**	.436**	.670**	.527**	.291**	-.100**	.005**	.084**
BMI				1	.697**	.652**	.502**	.290**	.231**	.242**	.080**
WHTR					1	.912**	.512**	.578**	.835**	.293**	.056*
WC						1	.586**	.614**	.651**	.170**	.066**
HC							1	-.275**	.266**	.489**	.039
WHR								1	.502**	-.282**	.042
CI									1	.285**	.011
BAI										1	-.0.01
Dietary											1

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

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

From the table, it was seen that height showed a strong positive correlation ($p<0.01$) with weight, waist circumference, hip circumference and waist hip ratio. It was noted that height showed a high negative correlation with BMI, weight height ratio, conicity index and body adiposity index. With Weight, a strong positive correlation ($p<0.01$) was seen among BMI, waist height ratio,

waist circumference, hip circumference, waist hip ratio, body adiposity index and dietary pattern of the subjects. BMI showed a strong positive correlation ($p<0.01$) with waist height ratio, waist circumference, hip circumference, waist hip ratio, conicity index, body adiposity index and dietary pattern of the subjects.

Waist height ratio exhibited a strong positive correlation ($p<0.01$) with waist circumference, hip circumference, waist hip ratio, conicity index and body adiposity index. Waist height ratio showed a positive correlation ($p<0.05$) with dietary pattern of the subjects. Waist circumference had a one per cent significant association with ($p<0.01$) hip circumference, waist hip ratio, conicity index, body adiposity index and dietary pattern of the subjects. Hip circumference exhibited strong negative correlation with weight height ratio but a strong association ($p<0.01$) were seen with conicity index and body adiposity index. Weight height ratio showed a strong positive correlation ($p<0.01$) with conicity index and negative correlation with body adiposity index. Conicity index was seen to have a strong positive correlation ($p<0.01$) with body adiposity index. Conicity index exhibited negative association with body adiposity index.

B. PHASE II

DEVELOPMENT, STANDARDIZATION AND EVALUATION OF THE FUNCTIONAL FOOD SUPPLEMENT

In this phase the results of the standardization, development and evaluation of functional food supplement is discussed

1. Organoleptic evaluation of the functional food supplement

Table 12 gives the organoleptic evaluation of the functional food supplement in terms of appearance, flavor, taste, texture, taste and overall acceptability of all the variations viz Variation I,II and III.

Table 12

Organoleptic evaluation of functional food supplement

Criteria	Variation I	Variation II	Variation III
Appearance	8.14±0.92	7.66±1.04	7.73±1.08
Flavour	7.79±0.89	7.78±1.00	6.85±1.08
Colour	7.55±0.57	7.36±0.78	7.40±0.64
Texture	8.56±0.31	7.30±0.46	8.32±0.25
Taste	8.40±0.34	7.20±0.29	8.26±0.42
Overall Acceptability	8.41±0.60	7.38±0.77	7.31±0.85
F value	**0.17492****		

**- 1% significant level

The results revealed that the variation I scored maximum in all the criterias than variation II and III which might be attributed to the percentage of flax seed added which contributes to the change in taste. Table depicted that variation I gained significantly high score ($p < 0.01$) than the variation II and III prepared using functional food supplement.

2. Nutrient content of functional food supplement

Table 13 gives the Nutrient content of functional food supplement

Table 13

Nutrient content of functional food supplement

NUTRIENTS	AMOUNT/100gm
Energy(Kcal)	336.37±1.67
Protein(g)	17.47±0.86
Fat(g)	6.81±0.07
Carbohydrate (g)	42±0.72
Crude Fiber(g)	14.02±0.26
Moisture (%)	5.02±0.0
Nitrogen (%)	2.51±0.13
Iron(mg)	451.56±0.43
Vitamin – C(mg)	999.80±0.38
Vitamin – A(IU)	0.78±0.09
Total Aminoacid (mg)	251.67±0.56
Phosphorous	2.13±0.71

Values are expressed as mean±SD (n=3)

The developed functional food mix was found to be rich in macro and micronutrients. The energy content was found to be 336.37 Kcal. While, its protein content was found to be 17.47g and fat content was found to be 6.81g. The carbohydrate content was found to be 42.02g. The crude fiber content was estimated as 14.02g .It was also rich in iron, vitamin C, Vitamin A and phosphorous. The prepared functional food was found to be nutritionally superior to the snacks that were consumed by the target population.

3. Phytochemical screening of selected food ingredients snd supplement

Table 14 gives qualitative analysis of phytochemcials present in food ingredients are presented below

Table 14

Phytochemical screening of selected food ingredients snd supplement

Phytochemicals	Flaxseed		Defatted soy flour		Finger Millet		Wheat Bran		Oats		Horse Gram Dhal		Supplement	
	E	A	E	A	E	A	E	A	E	A	E	A	E	A
Alkaloids	-	+	+	+	+	+	+	+	+	+	+	+	+	+
Terpenoids	+	-	+	+	+	-	+	+	+	-	+	+	+	-
phenol/tannin	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Reducing sugar	+	-	+	-	+	-	+	+	+	-	+	+	+	+
Saponin	-	+	+	-	+	-	+	-	+	-	-	-	+	-
Flavonoids	+	+	+	+	+	+	+	-	+	-	+	+	+	+
Quinone	+	+	+	-	-	-	+	+	+	+	+	-	+	-
Protein	-	+	+	+	+	-	+	-	+	-	+	-	+	-
Steroid	-	+	+	-	+	-	+	-	+	-	+	-	+	-

E – Ethanoicextract , A – Aqueous extract

The results of phytochemical screening showed the presence of maximum secondary metabolites (alkaloids, tannin and phenolic compounds, flavonoids and protein) in all the ingredients and food supplementof ethanol extract than aqueous extract. Therefore, all the analysis with respect to the quantitative constituents of phytochemicals and *in vitro* radical scavenging assays were carried out in ethanol and aqueous extracts. Natural products provide a vast pool of pancreatic lipaseinhibitors (Mohammad *et al*., 2014).A wide variety of plant products such as saponins, polyphenols, flavonoids, and caffeine possess

lipaseinhibitory effects (Birari and Bhutani, 2007). According to Varadarajan *et al*(2008), the secondary metabolites and other phytochemical constituents account for their medicinal value.

4. Quantitative analysis of phytochemicals in aqueous and ethanolic extracts of food supplement

Table 15 gives the total phenols, flavonoids and tannin content in food supplement

Table 15

Quantitative analysis of phytochemicals

Parameters (mg/100g)	Food Supplement	
	Aqueous Extract	Ethanol Extract
Total flavonoids	12.238±0.33	151.96±1.98 mg
Total phenols	5.2595±0.12	7.554±0.89
Tannin	6.125±0.66	38.805±0.32
Saponin	0.21±0.41	7.34±0.66
Alkaloid	2.25±0.23	5.34±0.12

Values are expressed as mean±SD (n=3)

Antioxidant activity has been directly linked to the presence of phenolic moieties present in the molecular structure of natural antioxidants. Many phytochemicals having phenolic moieties have been shown to exhibit antioxidant activity. Dietary phytochemicals might be employed as anti-obesity agents because they may suppress the growth of the adipose tissue, inhibit differentiation of preadipocytes, stimulate lipolysis, and induce apoptosis of existing adipocytes, thereby reducing adipose tissue mass (Mohammad *et al*., 2014).

Results revealed that the ethanolic extract of the supplement exhibited 151.96±1.98 mg/100g of gallic acid equivalents of flavonoid followed by the aqueous extract of supplement 12.238±0.33 mg/100g. With regard to the phenolic content, the ethanolic extract of sample established higher content of

phenol (7.554±0.89mg/100g) than the aqueous extract of the supplement (5.2595±0.12mg/ 100g). It was also seen that the supplement exhibited very low tannin content in aqueous extract (6.125±0.66 mg/100g) than ethanolic extract of the supplement (38.805±0.32 mg/100g). The food supplement of ethanolic extract exhibited higher content of saponin (7.34±0.66 mg/100g) followed by the aqueous extract of the supplement. Similar results were found in the alkaloid content of the ethanolic extract of the food supplement (5.34±0.12 mg/100g). Phenols inhibit enzymes related to fat metabolism including pancreatic lipase, lipoprotein lipase, and glycerophosphate dehydrogenase.

Polyphenol extracts are able to decrease the blood levels of glucose, triglycerides and LDL cholesterol, increase energy expenditure and fat oxidation, and reduce body weight and adiposity. In fact, many polyphenols, including flavones, flavonols, tannins and chalcones, have shown an inhibitory activity of pancreatic lipase (Yoshikawa *et al*., 2002, Terra *et al*., 2009, Gracia*et al*., 2009). Saponins are found to inhibit pancreatic lipase and, thus, may represent potentially effective treatments for obesity and related disorders (Birari and Bhutani, 2004).

5. Enzymatic and Non- Enzymatic Antioxidants

Oxidative stress results from the metabolic reactions that use oxygen and represents a disturbance in the equilibrium status of prooxidant/ antioxidant reactions in living organisms (Bagchi, 2006). Enzymatic and Non-enzymatic antioxidant levels in functional food supplementare presentedin Table 16

Table 16

Enzymatic antioxidants in functional food supplement

Parameters	Food Supplement
Superoxide dismutase	26.64±0.39
Catalase	36.37±0.33
Glutathione peroxidase	311.86±1.22
Ascorbate oxidase	40.59±0.21
Total GSH	70.34±0.21

Values are expressed as Mean ± SD (n=3) GSH - Glutathione

Units: Superoxide dismutase: Units/mg protein; **Catalase :**µmole of H_2O_2 consumed/min/mg protein; **Glutathione peroxidase:** µg of glutathione oxidized/min/mg protein; **Ascorbate oxidase** – Unit/g plant tissue; Total reduced glutathione - µg/mg protein

The results revealed that food supplement exhibited 26.64±0.39 of SOD and 36.37±0.33 of catalase activity. Superoxide dismutase and catalase are the two major scavenging enzymes that remove toxic radicals. Superoxide dismutase is an important antioxidant enzyme having an antitoxic effect against superoxide anion. The over expression of superoxide dismutase might be an adaptive response and it results in increased dismutation of superoxide to hydrogen peroxide.

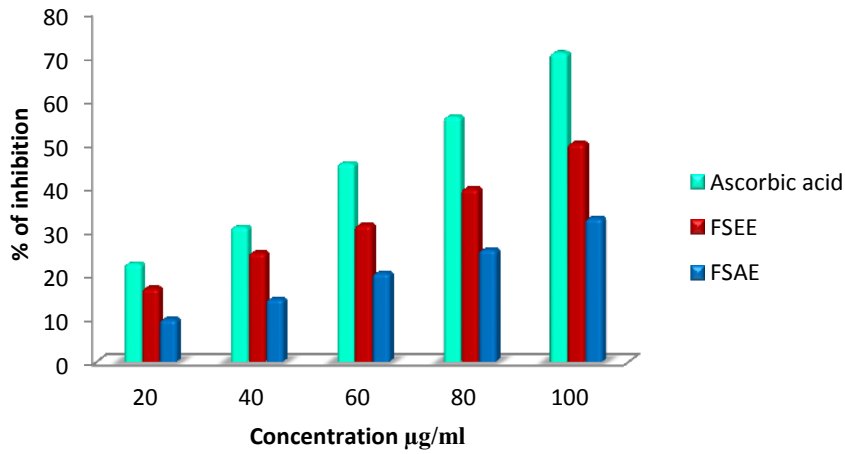
Glutathione peroxidase plays a significant role in peroxyl scavenging mechanism and maintaining functional integration of the cell (Chandra *et al.,* 2000). Ascorbic acid oxidase is widespread in plant tissues. The role of this enzyme is to regulate the levels of oxidised and reduced glutathione and NADPH. Phenol oxidases are copper proteins which catalyse the aerobic oxidation of certain phenolic compounds to quinones. The polyphenol oxidase comprises catechol oxidase and lactase. The activities these enzymes are important with regard to the defence mechanism against diseases (Benzie, 1999).

The result showed that non enzymatic antioxidant like total reduced glutathione (70.34±0.21) was found to be in high concentration in functional food supplement. Glutathione antioxidant systems play a fundamental role in cellular defence against free radical and their oxidant species. It functions by reaction with superoxide radical, peroxy radical and singlet oxygen followed by the formation of oxidised glutathione and other disulphides (Pastore *et al*., 2003).

6. In vitro free radical scavenging activity

i. DPPH radical scavenging activity

DPPH radical scavenging is considered as a good *in vitro* model widely used toassess antioxidant efficacy within a very short time. The DPPH free radical scavengingof antioxidants is due to their hydrogen donating ability, the plants with higherhydrogen donating capacity have shown higher DPPH free radical scavenging activity. Percent DPPH radical scavenging activities of all the extractswere dose dependent. The dose dependent DPPH radical scavenging activities of sample are shown in figure 16



FS- Food Supplement, EE- Ethanol Extract, AE- Aqueous extract

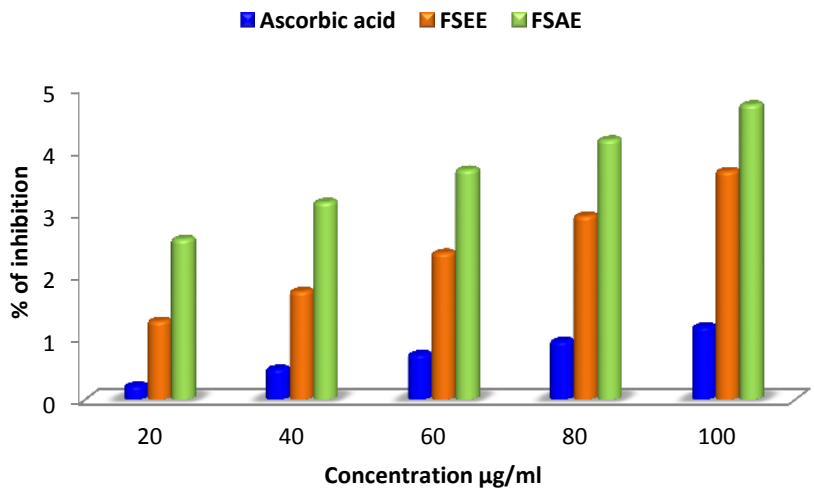
Figure 16

DPPH radical scavenging activity of food supplement

The value of the 50 per cent inhibition concentration (IC_{50}) of food supplement ethanolic extract was 39.17µg/ml respectively. A significant difference was observed among IC_{50} values of the ethanolic and aqueous extract of food supplement. This antiradical scavenging activity of raw and cooked rice samples would be related to the nature of phenolics, thus contributing to their electron transfer / hydrogen donating ability. In the present study, the maximum DPPH activity in food supplement of ethanolic extract were due to the high polyphenolic content of the food supplement exhibited in the quantification of phytochemical constituents which were discussed earlier.

ii. **Ferric Reducing Antioxidant Power (FRAP)**

In ferric reducing antioxidant power, non enzymatic antioxidants react withprooxidants and inactivate them. In this redox reaction, antioxidants act as reductant. Inthis context assay an easily reducible oxidant Fe (III) – TPTZ complex by antioxidant toformed Fe (II) – TPTZ. Table gives the ferric reducing antioxidant power of food supplement.



FS- Food Supplement, EE- Ethanol Extract, AE- Aqueous extract

Figure 17

Ferric reducing antioxidant power of food supplement

Graph shows that ethanolic extract of food supplement had high ferricreducing antioxidant power than aqueous extract of food supplement compared with standard ascorbic acid at the concentration of 2.5 mg/ml. In this study, the ethanolic extract possees the better hydrogen donation capacity than aqueous extract which suppreses the free radicals. The study results are similar to the report of Loganayaki *et al* .(2010) with regard to the antioxidant potential. According to Oktay *et al.*, (2003), a highly positive relationship between total phenols and antioxidant activity appears to be the trend in many plant species. Recently, Li *et al.,* (2008) reported that the presences of total phenolics in several plants significantly correlated with high FRAP values. Since, the extracts had ability to scavenge free radicals, thereby preventing lipid oxidation via a chain breaking reaction; they could serve as potential nutraceuticals when ingested along with nutrients. Extensive investigations on the anti-radical and antioxidant activities of small phenolics including flavonoids and phenolic acids have been reported (Heim *et al.,* 2002).

iii. Reducing Power Assay

Figure 18 gives the reducing power activity of functional food supplement.

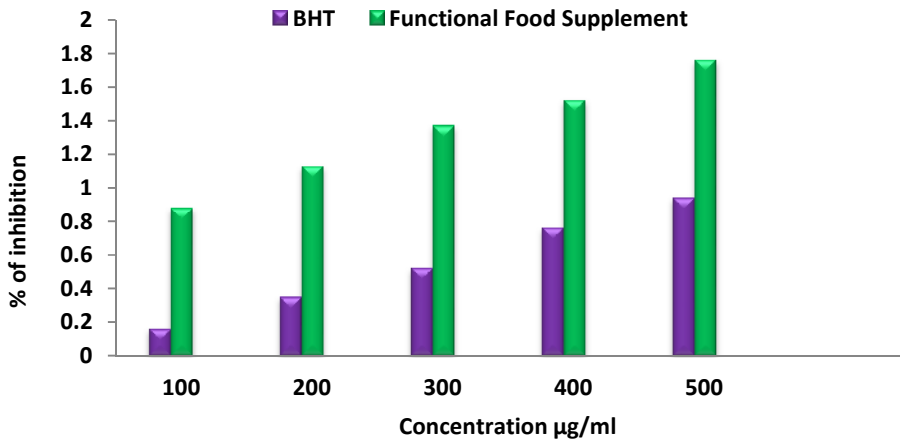


Figure 18

Reducing power activity of functional food supplement

BHT – ButylatedHydroxy Toluene

Results showed that food supplement reduced the most Fe^{3+} ions, with a concentrated dependent manner. Reducing power is compared with BHT.It is evident that functional food supplement showed a higher ferric reducing ability.The reducing ability of a compound generally depends on the presence of reductants which have been exhibited antioxidative potential by breaking the free radical chain, donating a hydrogen atom (Arulmozhi*et al*., 2008). In the reducing power assay the presence of antioxidants in the sample would result in the reduction of Fe^{3+} to Fe^{2+} by donating an electron. Amount of Fe^{2+} complex can be monitored by measuring the formation of perl'sprussion blue at 700 nm (Ebrahimzadeh*et al.,* 2008). Fe (III) reduction is often used as an indicator of electron donating activity, which is an important mechanism of phenolic antioxidant action (Nabavi*et al.,* 2009). The reducingpower capacity of compound may serve as a significant indicator of its potential antioxidant activity.

iv. Nitric oxide Radical Scavenging activity

Nitric oxide is an important chemical mediator generated by endothelial cells, macrophages, neurons etc and is involved in the regulation of various physiological processes (Lata and Ahuja, 2003). Figure 19 gives the nitric oxide radical scavenging activity of functional food supplement.

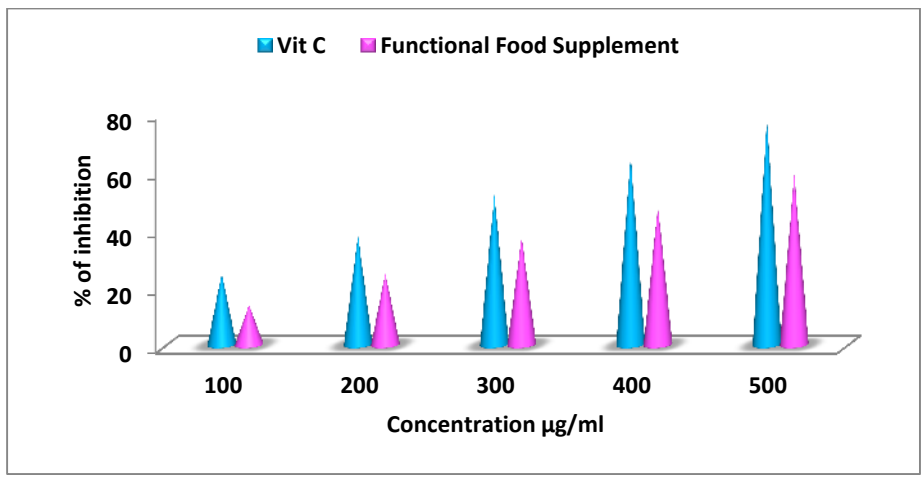


Figure 19

Nitric oxide radical scavenging activity of functional food supplement

Figure revealed that highest scavenging activity on nitric oxide radical is 58.6 per cent for extract at the concentration of 500 µg /ml. The extract is compared to that ofvit C as standard (77.4%). Scavenging of nitric oxide radical is based on the generation of nitric oxide from sodium nitroprusside on buffered saline which reacts with oxygen to produce nitrite molecules that can be measured by using Griess reagent (Marcocci *et al.,* 1994).

7. *In vitro* assay of pancreatic lipase inhibition activity

The ability of the compounds to inhibit porcine pancreatic lipase was evaluated and tabulated.

Table 17

Pancreatic lipase inhibiting activity of food supplement

Concentration (µg/ml)	Food Supplement
10	3.58
30	12.78
50	23.56
100	34.82

Pancreatic lipase is a principal lipolytic enzyme secreted by the pancreas and plays a vital role in the digestion of fats. In view of search for a better and comparatively safer drug target for pancreatic lipase inhibition, large number of synthetic or natural molecule extracts has been investigated for the pancreatic lipase inhibiting activity than to use the synthetic drug of orlistat. Many studies reported that the drug orlistat displays severe side effects with various complications for a long term. From the table, results revealed that food supplement exhibited 34.82% of inhibition activity at 100 µg/ml. When compared with the other research, food supplement exhibited above 70% of pancreatic lipase inhibition at certain concentration. Food supplement exhibited pancreatic lipase inhibition which will be more beneficial for the health in long term use to avoid the major risk complications when consume the artificial drugs.

8. Shelf Life Evaluation of Functional Food Mix

Table 18 shows the shelf life evaluation of functional food mix.

Table 18

Shelf life evaluation of functional food mix

Criteria	No. of Days			
	0	**7**	**15**	**30**
Peroxide value (mEq/kg)	-	0.79	1.03	2.05
Total bacterial count (cfu/g)	BDL	29×10^2	74×10^2	1.62×10^2
Total fungi count (cfu/g)	BDL	16×10^2	39×10^2	95×10^2

BDL- Below detectable level

The developed functional food mix was subjected to the shelf life evaluation. The functional food mix was stored in an air tight container for a period of 30 days at a room temperature. The functional food mix were analysed for shelf life study including peroxide value, total bacterial count and total fungal count at the intervals of 0, 7, 15 and 30 days. At the 0^{th} day, total bacterial count and total fungal count were found to be below detectable level. The peroxide values were found to be 0.79, 1.03 and 2.05 at 7^{th}, 15^{th} and 30^{th} day respectively. Total bacterial count was found to be 29×10^2, 74×10^2 and 1.62×10^2at 7^{th}, 15^{th} and 30^{th} day respectively. Total fungal count was found to be 16×10^2, 39×10^2 and 95×10^2at 7^{th}, 15^{th} and 30^{th} day respectively. The keeping quality of functional food mix was found to be best within one week of preparation.

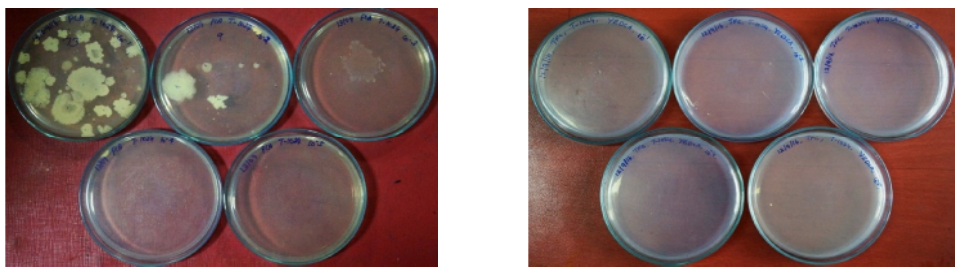


Plate 8

Total Bacterial Count and Total Fungal Count

PHASE III

C. ASSESSMENT OF NUTRITIONAL STATUS, BODY COMPOSITION MEASURES AND ENERGY EXPENDITURE OF THE SELECTED SUBJECTS

Among the selected 1873 subjects (990 male and 883 female subjects) a total of 150 subjects with different phenotype and gender were selected for further investigation.Based on the latest Body Mass Index cutoff, they were grouped asNormal (N=50), Overweight (N=50) and Obese (N=50) and further subdivided equally based on gender which included 25 males and femalesrespectively in each of the three groups of the phenotype which totaled to 150 subjects. However, in the course of the study, there were a total of 20 dropouts from different groups. Therefore, the results are presented for 130 subjects (65 males and 65 females).

1. Socio-Economic Profile

Socio economic factors such as religion, type of family, education and occupation of head of the family and the total family income are given in the Table 19

Table 19

Socio economic profile of the selected subjects

N=130

Socio economic factors	Categories	Male (N = 65)		Female (N = 65)	
Religion		N	%	N	%
	Hindus	53	82	57	88
	Muslim	10	15	7	11
	Christian	2	3	1	1
	Total	**65**	**100**	**65**	**100**
Caste of the respondents	BC	15	22	22	34
	MBC	43	66	37	57
	SC/ST	7	11	6	9
	Total	**65**	**100**	**65**	**100**
Type of family	Nuclear	54	83	59	91
	Joint	11	17	6	9
	Total	**65**	**100**	**65**	**100**
Education of the Head of the Family	Illiterate	2	3	0	0
	Primary	4	6	11	17
	Secondary	3	5	7	11
	Higher Secondary	14	21	10	15
	Under Graduate	35	54	32	49
	Post graduate	7	11	5	8
	Total	**65**	**100**	**65**	**100**
Occupation of the Head of the Family	Coolie	3	4	7	11
	Agricultural labour	14	21	6	9
	Professionals	3	5	8	12
	Businessmen	5	8	9	14
	Private sector employee	33	51	22	34
	Government jobs employee	7	11	13	20
	Total	**65**	**100**	**65**	**100**
Total monthly income of the family*	<Rs 3300	2	3	3	5
	Rs 3301- 7300	12	19	8	12
	Rs 7301-14500	28	43	36	55
	>14500	23	35	18	28
	Total	**65**	**100**	**65**	**100**

*11 th five year plan (2007-2011)

Socio-cultural factors have been found to influence the development of obesity apart from the genetic and environmental factors. Among the selected subjects 88 per cent of the females and 82 per cent of the males were Hindus while15 per cent of the male and 11 per cent of the female subjects were Muslims and the remaining three per cent of the males and one per cent of the femalesbelonged to Christianity

Thirty four per cent of the females and 22 per cent of the males belonged to backward class, while 66 per cent of the male subjects and 57 per cent of female subjects belonged to the most backward class, while 11 per cent of the male subjects and 9 per cent of the female subjects belonged to the SC/ST communities.Family size and type of family influences the food security and nutritional status of the individual. Almost 91 per cent of the females and 83 per cent of the males belonged to the nuclear family while remaining 17 per cent male and 9 per cent female lived in joint families.

The education status of head of the family revealed that an appreciable percentage of the males (54%) and females (49 %) had qualified under graduation followed by 11 per cent of the males and 8 per cent of the females who had completed post graduation. It was also found that 21 per cent of the males and 15 per cent of the females had completed higher secondary schooling followed by 11 per cent of the females and 5 per cent of the maleswith secondary school education. Seventeen per cent of the females and six per cent of the males had completed primary education. However 3 per cent of the males were found to be illiterate but none of the females were illiterate.

On analyzing the occupation of the head of the family, majority of the males (51%) and females (34 %) were employed in private enterprises while 20 per cent of the females and 11 per cent of the males were employed in government sector. Fourteen per cent of the females and 8 per cent of the males were engaged in business. About 12 per cent of the females and five per cent of the males were professionals, while 21 per cent of the males and 9 per cent of

females were agricultural labourers. A very few per cent of the males (4%) and the females(11%) were daily coolies.

The total family income classification as per 11th Five year plan (2007-2011) was used to stratify the families which revealed that almost 55 of the females and 43 per cent of the males lived in the families who earned between Rs 7301 to 14500.Around 35 per cent of the males and 28 per cent of females belonged to the families whose monthly income was more than Rs.14500. Nineteen per cent of the males and 12 per cent of the females belonged to families with an average income of Rs.3301 to 7300 followed by three per cent of the males and five per cent of the femalesearning less than Rs.3300 per month. Families that reported an income of less than Rs.3300 did not have a regular employment and most of them were single parent.

2. Dietary pattern of the subjects

Data on the dietary the pattern of the subjects such as dietary habits, nature of appetite, number of meals consumed and skipping of meals are presented in Table 20.

Table 20

Dietary pattern of the subjects

N=130

Dietary Pattern	Category	Male (N = 65)		Female (N = 65)	
Dietary habits		No	%	No	%
	Vegetarian	41	63	9	14
	Non-vegetarian	22	34	49	75
	Ova-vegetarian	2	3	7	11
	Total	**65**	**100**	**65**	**100**
Nature of appetite	Heavy	39	60	14	22
	Moderate	22	34	43	66
	Poor	4	6	8	12
	Total	**65**	**100**	**65**	**100**
No. of meal consumption /day	Two	6	9	15	23
	Three	57	88	50	77
	Four	2	3	0	0
	Total	**65**	**100**	**65**	**100**
Skipping of meals	Present	7	11	28	43
	Absent	58	89	37	57
	Total	**65**	**100**	**65**	**100**

Our society tends to use food as a reward, as a means to control others, and as part of socializing. Wrong choice of food can encourage the development of unhealthy relationships with food, thereby increasing the risk of developing obesity(Sahoo*et al.*, 2015). Results of the study revealed that 63 per cent of the males and 14 per cent of the females were vegetarians whereas 75 per cent of the females and 34 per cent of the maleswere non-vegetarians allowing them to consume animal foods which contains highly bioavailable proteins, minerals and vitamins for a better nutritional and health status. It was found that 11 per cent of the females and 3 per cent of the males were ova-vegetarians.

Appetite of an individual determines his/her food intake, sixty per cent of the males and 22 per cent of the females described their appetite to be heavy which was followed by 34 per cent males and 66 per cent females describingtheir appetite to be moderate. Twelve per cent of the females and 6 per cent of the males had a very poor appetite which would interfere with the consumption of a sumptuous meal.

The meal pattern of the individual depends upon the family and the community to which they belong, 88 per cent the male subjects and 77 per cent of the female subjects reported to consume three meals a day while 23 per cent of the females and nine per cent of males consumed two meals a day owing to lack of time or dislike of certain dishes. Only 3 per cent of the male subjects consumed four meals a day whereas none of the female subjects consumed four meals a day putting them at risk of low food intake and thereby lower nutritional status.

The young adults have a very bad food repertoire which poses a risk of developing a poor nutritional status putting them at risk of bad health which was evident from this study which showed their habit of skipping the meals. Forty three per cent of the males and 11 per cent of females skipped their meals frequently while 89 per cent of the males and 57 per cent of the females consumed their food regularly. On further investigation, it was found that the

female subjects skipped their breakfast due to lack of time and the male subjects skipped their lunch because they considered that carrying a packed lunch was not fashionable or due to the dislike of the food provided in their hostel/home.

3. Details of the Duration the Routine Daily Activities

The time spent for the various daily activities such as studying in college, physical exercise, watching television and using mobile phones were studied among the selected subjects and the data is presented in Table 21.

Table 21

Details of the time spent on routine daily activities

N=130

Activities in hours	Categories	Male (N = 65)		Female (N = 65)	
College		No	%	No	%
	Less than 6 hours	23	35	4	6
	6 – 9 hour	37	57	56	86
	>9 hour	5	8	5	8
	Total	**65**	**100**	**65**	**100**
Physical exercise	Less than 30 min	36	55	33	51
	30min – I hour	12	18	22	34
	1-2 hour	14	22	8	12
	More than 2 hour	3	5	2	3
	Total	**65**	**100**	**65**	**100**
Watching Television	Nil	7	11	3	5
	30 min – 1 hour	53	81	12	18
	I hour – 2 hour	4	6	43	66
	>2 hour	1	2	7	11
	Total	**65**	**100**	**65**	**100**
Using mobile	less than 30 min	4	6	3	5
	30 min – 1 hour	5	8	5	8
	>1 hour	56	86	57	87
	Total	**65**	**100**	**65**	**100**

Sedentary life style compounded with the change in the nutritional pattern in South Asians makes them more vulnerable to NCDs. The changes in occupations, advent of newer technologies, and rapid pace of urban life have

increasingly resulted in more sedentary work and less energy expenditure (Misra and Shrivastava, 2013).

Eighty six per cent of the females and 57 percent of the males spent nearly 6-9 hours in the college comprising of academic and co-curricular activities which constituted the major duration of their daily activities. Thirty five per cent of the male subjects and 6 per cent of the female subjects spent less than 6 hours in the college which indicated only their involvement in academic activities. About eight percent of both the male and female subjects spent more than 9 hours in the college premises since they resided in the hostel.

"Physical activity" refers to any body movement that burns calories, whether it is for work or play, daily chores, or the daily commute. "Exercise," a subcategory of physical activity, refers to planned, structured, and repetitive activities aimed at improving physical fitness and health. In this perspective, the physical exercising pattern was studied and the findings revealed that a majority of 55 per cent of the males and 51 per cent of the females spent less than 30 minutes for exercise followed by 34 per cent of the female subjects and 18 per cent of the male subjects doing physical exercise for about 30 minutes to one hour showing that they were aware of the benefits of physical exercise.

Television viewing is one activity that has been used as a marker of sedentary behaviour, and has been found to be associated with body fat (Inoue *et al*, 2012).TV viewing was significantly correlated with waist circumference in both men and women. Television viewing by the subjects revealed thatmajority of the males (81 %) and 18 per cent of the females watched television from 30 minutes to 1hour/day. Nearly 66 per cent of the females and 6 per cent of the maleswatched television for about 1-2 hours /day. It was also found that 11 percent of the females and 2 per cent of the males watched TV for more than 2 hours who pose a high risk of a sedentary life style. However, 5 per cent of the females and 11 per cent of the males did not watch television owing to lack of this facility in their hostel or home. A study conducted by Verity *etal* (2008) among young adults revealed that TV viewing significantly correlated with waist circumference in both men and women

In this era of information technology, the exposure to social media is very high especially among the youngsters which are enabled through the various apps in their mobile phones. The data on the time spent for the usage of mobile phones showed that a majority of the males (89%) and the females (87%) were using their mobile phones for more than one hour. About 8 per cent each of the males and females used their mobiles for 30 minutes to one hour and 6 per cent of the males and 5 per cent of the females used their mobile phone for less than 30 minutes. The social media network such as face book, twitter, whats app, chat etc had a major influence on the time spent by the young adults

4. Anthropometric Measurements

Anthropometric measurements are one of the most effective and widely used methods for the assessment of nutritional status. Data pertaining to height, weight, Body Mass Index (BMI) and Waist Hip Ratio (WHR) are presented in Table 22.

Table 22
Mean anthropometric measurements of the subjects

N=130

Anthropometric Measurements	OBESE N= 43		OVERWEIGHT N= 44		NORMAL N= 43	
	Male (N= 23)	Female (N= 20)	Male (N= 22)	Female (N= 22)	Male (N= 20)	Female (N= 23)
Height(cm)	171.65 ±7.37	154.30 ±6.96	171.82 ±7.69	156.36 ±6.47	166.30 ±5.70	156.17 ±4.73
Weight(kg)	84.43 ±11.52	67.49 ±10.63	71.43 ±6.49	59.28 ±4.64	58.57 ±5.83	51.35 ±4.78
Body Mass Index (BMI)	28.65 ±2.92	28.35 ±2.87	24.21 ±0.50	24.19 ±0.32	21.17 ±1.59	21.05 ±1.24
Waist –Hip Ratio	0.92 ±0.04	0.86 ±0.04	0.87 ±0.02	0.83 ±0.02	0.83 ±0.02	0.80 ±0.04

The height, weight and Body Mass Index(BMI) of a reference man are 173cm, 60kg and 20.3 respectively while that of women are 161 cm, 55kg and 21.2 respectively (ICMR, 2010).Weight is usually related to increased morbidity and mortality whereas height is referred as linear growth and is often associated with good health.

The mean height of the obese male subjects was 171.65±7.33 cm and that of the females were 154.30±6.96 cm. Among the overweight males the mean height was recorded as 171.82±7.69 cm while in the females, it was 156.36±6.47 cm. In the normal male subjects, the mean height was found to be 166.30±5.70 cm and in the females it was 156.17±4.73 cm. Among all the three groups, the males subjects were taller than the female subjects.

The mean weight of the obese male subjects was recorded as 84.43±11.52 kg whereas in the females, it was found to be 67.49±10.63 kg. Among the overweight males the mean weight was found to be 71.43±6.49kg and in the female subjects, it was 59.28±4.64 kg. The mean weight of the normal male subjects was 58.57±5.83 kg and the female subjects were 51.35±4.78 kg. Among all the three groups studied, the male subjects were found to have a higher mean body weight when compared with the female counter parts.

The mean Body Mass Index of the obese male subjects was found to be 28.65±2.92 and that of the female subjects was found to be 28.35±2.87. In the overweight male subjects, the Body Mass Index recorded was found to be 24.19±0.50 and in the same group the female subjects recorded a BMI of 24.19±0.32. Among the male subjects who were normal, the BMI was found to be 21.17±1.59 and in the same category, the females had a BMI of 21.05±1.24. The male subjects of all the groups recorded a higher BMI than their female counterparts.

Waist Hip ratio is an indicator of central obesity with a high proportion of intra-abdominal fat. The cutoff points recommended by WHO (2011) was used for comparing the above data. Abdominal obesity is defined as Waist Hip Ratio (WHR) above 0.90 for males and above 0.80 for females.

The obese male subjects recorded a WHR of 0.92±0.04 and in the females, it was 0.86±0.04. In the overweight category, the male subjects showed a WHR of 0.87±0.02 and the females showed a WHR of 0.83±0.02. Among the normal male subjects, the WHR was found to be 0.83±0.02 whereas in the females, it was 0.80±0.04. Among all the three groups, the male subjects

recorded a higher measure when compared with the female subjects. The results clearly indicate that there is an urgent need to undertake lifestyle modification to prevent and treat obesity and their problems amongst the youngsters.

5. Biochemical Profile

The biochemical profile parameters of the subjects such as haemoglobin, fasting blood glucose level, triglycerides, total cholesterol, High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL) and Very Low Density Lipoprotein (VLDL) and was measured and their means calculated. The ratios such as LDL to HDL, Total Cholesterol to HDL, Triglycerides to HDL was computed and the data are presented in the following table 23

Table 23
Biochemical profile of the subjects

N=130

PARAMETERS	REF. VALUE		OBESE N= 43		OVERWEIGHT N= 44		NORMAL N= 43	
			Male (N= 23)	Female (N= 20)	Male (N= 22)	Female (N= 22)	Male (N= 20)	Female (N= 23)
Haemoglobin	M	F	14.71 ±1.25	13.0 ±1.0	15.00 ±1.12	13.2 ±0.8	15.00 ±1.32	12.5 ±0.5
	12-15	13-17						
FBG (mg/dl)	70-100		90.13 ±8.57	86.7 ±13.0	91.86 ±7.80	88.5 ±9.0	86.35 ±4.50	83.6 ±6.3
TC (mg/dl)	< 200		155.17 ±21.03	166.9 ±27.9	160.80 ±20.68	166.1 ±38.4	128.35 ±28.06	149.0 ±25.4
TGL (mg/dl)	< 150		115.61 ±50.20	90.6 ±36.7	124.68 ±46.03	97.9 ±34.7	86.00 ±40.23	70.0 ±22.9
HDL (mg/dl)	M	F	41.17 ±8.50	43.2 ±7.1	44.91 ±8.11	43.5 ±8.7	42.45 ±18.49	50.9 ±9.4
	>40	>50						
LDL (mg/dl)	< 100		90.88 ±19.86	105.6 ±24.6	91.02 ±19.27	103.0 ±13.0	68.70 ±18.49	84.1 ±19.70
VLDL (mg/dl)	< 40		23.12 ±10.04	18.1 ±7.3	24.94 ±9.21	19.6 ±6.9	17.20 ±8.05	14.9 ±5.2
LDL/HDL Ratio	0.5-3.00		2.20 ±0.71	2.44 ±0.8	2.02 ±0.59	2.36 ±0.6	1.61 ±0.52	1.65 ±0.5
TC/HDL Ratio	<5.0		3.76 ±0.96	3.86 ±1.0	3.58 ±0.96	3.81 ±0.6	3.02 ±0.68	2.92 ±0.6
TGL/HDL Ratio	<2.0		2.80 ±1.90	2.09 ±0.3	2.77 ±1.45	2.25 ±0.4	2.02 ±1.04	1.37 ±0.4

FBG- Fasting Blood Glucose; TC- Total cholesterol; TGL- Triglycerides; HDL- High Density Lipoprotein; LDL- Low Density Lipoprotein; VLDL-Very Low Density Lipoprotein

Biochemical profile is considered as one of the important biomarker of health. In the present study, biochemical parameters including such as Haemoglobin, Fasting Blood Glucose, Total Cholesterol, Triglycerides, High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), Very Low Density Lipoprotein (VLDL), were analyzed and their mean computed. The ratios such as Low Density Lipoprotein to High Density Lipoprotein (LDL/HDL), Total Cholesterol to High Density Lipoprotein (TC/HDL), Triglycerides to High Density Lipoprotein (TGL/HDL) were also calculated.

The mean Haemoglobin of the obese male subjects was 14.71±1.25 which was higher than the females (13.0±1.0) belonging to the same group. The mean haemoglobin content of the overweight male subjects was found to be 15.00±1.12 while in the female subjects of the same group, it was 13.2±0.8. Among the normal male subjects, the mean haemoglobin was 15.00±1.32 whilst in the females it was 12.5±0.5. The haemoglobin content was higher in the males of all the three groups when compared to the females which necessitate proper nutrition education and dietary intervention.

The mean fasting blood glucose level of the obese male subjects was found to be 90.13±8.57 while in the females, it was 86.7±13.0. Among the overweight male subjects, the fasting blood glucose was estimated to be 91.86±7.80 and in the females belonging to the same category, it was 88.5±9.0. In the normal male subjects, the fasting blood glucose level was about 86.35±4.50 and in the normal female subjects, it was 83.6±6.3. In all the three groups, the male subjects had a higher fasting blood glucose level which was however within the normal range.

The total cholesterol level estimated for the obese male subjects was found to be 155.17±21.03 and in the same group, the females showed a higher TC level of 166.9±27.9. Among the overweight male subjects, the TC level was

found to be 160.80±20.68 whereas in the female subjects of the same group, the TC level was slightly was slightly higher (166.1±38.4). The normal male subjects had a TC level of 128.35±28.06 and in the normal female subjects, it was 149.0±25.4. In all the three groups, the females showed a higher TC level when compared with the male counterparts, which was however within the normal range.

The mean triglyceride content of the obese male subjects was 115.61±50.20 while in the females, it was much lesser amounting to 90.6±36.7. In the overweight male subjects, the TGL level was estimated to be 124.68±46.03 and the females belonging to the same group recorded a lower level of 97.9±34.7. Among the normal male subjects, the mean TGL was 86.00±40.23 and in the female subjects, it was 70.0±22.9, both of which were lesser than the other two groups predicting that the obese and overweight subjects had a risk of developing health problems in future.

The mean HDL level of the obese male subjects was found to be 41.17±8.50 which was within the normal reference range. In the females of the same group the HDL level was found to be 43.2±7.1. which was lesser than the reference level. Among the overweight male subjects, the HDL level was found to be 44.91±8.11 while in the females, it was 43.5±8.7. The HDL was within the normal range for males and it was much lesser in the females. In the normal male subjects HDL level of 42.45±18.49 while in the female, it was found to be 50.9±9.4. The HDL values recorded for both the males and females in the normal category were in line with the reference value.

Among the obese male subjects, the LDL content of the blood was found to be 90.88±19.86 and in the females it was 105.6±24.6. The females had a higher LDL level when compared with the reference value. The mean LDL of the overweight male subjects was found to be 91.02±19.27 and in the females it was 103.0±13.0. Similar to the obese group, the females recorded a higher LDL value. In the normal male subjects, the LDL content was estimated to be 68.70

±18.49 while in the females, it was 84.1±19.70 both of which were lesser than the reference value which was ideal for health.

The mean VLDL level of the obese male subjects was determined to be 23.12±10.04 and in the females it was 18.1±7.3 both of which were in the normal range. The overweight male subjects recorded a VLDL level of 24.94±9.21 while in the females, it was 19.6±6.9. The VLDL levels of the overweight group were also within the normal range. The mean VLDL levels recorded for the normal males and females was found to be 17.20±8.05 and 14.9±5.2 respectively which was the least among all the three groups.

The LDL to HDL ratio computed for the obese male subjects was 2.20±0.71 and in the females, it was 2.44±0.8 which was within the normal recommended range. In the overweight male and female subjects, the LDL to HDL ratio was found to be 2.02±0.59 and 2.36±0.6 respectively which was also within the prescribed normal range. Among the normal male subjects, the LDL to HDL ratio was found to be 1.61±0.52 and in the females, it was 1.65±0.5 both of which was found to be much lesser that the overweight and the obese group.

The total cholesterolto HDL ratio calculated for the obese male and female subjects were found to be 3.76±0.96 and 3.86±1.0 respectively which was within the normal range. Among the overweight male subjects, the TC to HDL ratio was found to be 3.58±0.96 and in the females, it was 3.81±0.6 and fell in the normal range. In the normal male subjects, the TC to HDL ratio computed showed that it was 3.02±0.68 while in the females, it was 2.92±0.6. The ratio recorded for all the three groups was found to be lesser than the standard normal range

The TGL to HDL ratio computed for the obese male subjects was 2.80±1.90 and in the females, it was 2.09±0.3 which was within the normal recommended range. In the overweight male and female subjects, the TGL to HDL ratio was found to be 2.77±1.45 and 2.25±0.4 respectively which was also within the prescribed normal range. Among the normal male subjects, the TGL to

HDL ratio was found to be 2.02±1.04 and in the females, it was 1.37±0.4 both of which was found to be much lesser that the overweight and the obese group.

Healthy choice of foods and inclusion of foods that are rich in fibre and low in fat which comprises of Poly Unsaturated Fatty Acids (PUFA) along with limited intake of saturated fatty acids would help to improve the lipid profile. Increased physical activity would enable them to maintain the HDL level. Maintenance of normal lipid profile right from the young age is of primary importance in preventing the consequences associated with hyperlipidemia.

6. Body Composition Measures

Body composition measures including protein, mineral, Body Fat Mass. Total Body Water, Soft lean Mass, Fat Free mass, visceral fat area, Skeletal Muscle Mass, per cent body fat, obesity degree, basal metabolic rate and fitness score are presented in the table 24

Table 24

Mean body composition measures of the subjects

N=130

PARAMETERS	OBESE N= 43		OVERWEIGHT N= 44		NORMAL N= 43	
	Male (N= 23)	Female (N= 20)	Male (N= 22)	Female (N= 22)	Male (N= 20)	Female (N= 23)
Protein(kg)	11.08 ±1.33	7.41 ±1.17	10.60 ±1.11	7.20 ±0.75	5.56 ±1.11	6.74 ±0.48
Mineral(kg)	3.98 ±0.52	2.62 ±0.61	3.75 ±0.47	2.68 ±0.30	3.35 ±0.33	2.49 ±0.24
BFM(kg)	28.23 ±9.08	29.89 ±6.16	17.89 ±3.59	22.49 ±2.13	10.57 ±4.98	16.24 ±4.05
TBW(l)	41.15 ±4.91	27.59 ±4.35	38.87 ±4.51	26.89 ±2.78	35.14 ±3.76	25.13 ±1.80
SLM(kg)	52.89 ±6.32	35.44 ±5.58	50.45 ±5.47	34.53 ±3.55	45.25 ±4.91	32.29 ±2.28
FFM(kg)	56.19 ±6.74	37.61 ±6.04	53.54 ±5.86	36.81 ±3.80	48.03 ±5.13	35.10 ±4.00
VFA(cm^2)	108.81 ±28.31	86.48 ±27.35	73.39 ±10.17	67.44 ±8.93	46.71 ±18.84	48.32 ±17.06
SMM(kg)	31.39 ±4.03	19.56 ±5.51	29.96 ±3.56	19.73 ±2.24	26.66 ±3.21	18.32 ±1.45
PBF%	33.07 ±7.41	44.18 ±4.30	24.65 ±4.35	37.92 ±3.04	17.72 ±7.81	31.48 ±6.20
Obesity Degree	130.78 ±14.18	133.70 ±13.73	110.86 ±4.00	114.45 ±1.84	95.35 ±1.95	98.39 ±6.10
BMR	1578.04 ±142.37	1181.85 ±130.37	1517.68 ±127.78	1163.86 ±82.22	1408.35 ±112.59	1127.65 ±86.55
Fitness score	62.83 ±10.74	60.80 ±5.95	69.64 ±5.64	66.50 ±3.33	73.50 ±4.56	70.83 ±5.46

BFM- body Fat Mass; TBW- Total Body Water; SLM- Soft Lean Mass; FFM- Fat Free Mass; VFA- Visceral Fat Area; SMM- Skeletal Muscle Mass; PBF- Percent Body Fat; BMR- Basal Metabolic Rate

Estimation of body composition is a vital element of nutritional assessment as fat and fat-free compartments of body mass which has different health implications. (Kulkarni et al, 2014). A number of techniques are available for the assessment of body composition, and the choice of technique usually depends on precision, accuracy, ease of application as well as the cost. Bioelectrical Impedance analysis (BIA) is one of the easy and precise techniques to measure body composition of individual and community at large. It is a fast

and non-invasive method that estimates body composition including distribution of body fluids of intra and extracellular space (Volp.P*et al.,* 2011). Fat mass (FM) is closely linked with metabolic complications of obesity because the adipose tissuefunctions as an endocrine organ that releases bioactive substances having pro-inflammatory properties (Ouchi*et al*, 2011).

Obesity is generally defined by using the body mass index (BMI; weight/height^2), which does not distinguish between lean and fat components of body weight (Prentice and Jebb, 2001) Body composition measure will be a better predictor of obesity.

The mean body protein content of obese male and female subjects was found to be 11.08±1.33 and 7.41±1.17 respectively. In the overweight male subjects, the protein content was found to be 10.60±1.11 kg while in the females it was 7.20±0.75 kg. Among the normal males, the body protein content was found to be 5.56±1.11kg and in the females, it was 6.74±0.48kg. It was found that the protein content of the males were higher in the obese and overweight group and lower in the normal group.

The body mineral content of the obese male subjects were found to be 3.98±0.52 and it was 2.62±0.61 in the female obese subjects. The total mineral content recorded for the overweight group consisting of the males and the females showed that it was 3.75±0.47 and 2.68±0.30 respectively. Among the normal male subjects, the total mineral content was found to be 3.35±0.33 in the males and 2.49±0.24 in the females. In all the three groups, the mineral content was lesser in the females when compared with the males

The Body fat mass obtained for the male and female obese subjects was found to be 28.23±9.08 and 29.89±6.16 respectively. In the overweight male subjects the estimated BFM was found to be 17.89±3.59 while in the females, it was 22.49±2.13. In the normal group, the BFM for the males and females was found to be 10.57±4.98 and 16.24±4.05 respectively. The body fat mass was greater among the females of all the three groups when compared to the males

The mean total body water content of obese male and female subjects were found to be 41.15±4.91 and 27.59±4.35 respectively. In the overweight male subjects, the total body water content was found to be 38.87±4.51 while in the females it was 26.89±2.78. Among the normal males, the total body water content was found to be 35.14±3.76 and in the females, it was 25.13±1.80. It was found that the total body water content of the males were higher than the females in all the three groups

The Soft lean mass obtained for the male and female obese subjects were found to be 52.89±6.32 and 35.44±5.58 respectively. In the overweight male subjects the estimated SLM was found to be 50.45±5.47 while in the females, it was 34.53±3.55. In the normal group, the SLM for the males and females were found to be 45.25±4.91 and 32.29±2.28 respectively. The soft lean mass was greater among the males of all the three groups when compared to the females

The mean fat free mass of obese male and female subjects was found to be 56.19±6.74 kg and 37.61±6.04 kg respectively. In the overweight male subjects, the FFM was found to be 53.54±5.86kg while in the females it was 36.81±3.80 kg. Among the normal males, FFM was found to be 48.03±5.13kg and in the females, it was 35.10±4.00 kg. It was found that the FFM of the males were higher than the females in all the three groups

The visceral fat area determined for the obese male subjects was 108.81±28.31cm^2 whereas in the females, it was found to be 86.48±27.35cm^2. In the overweight group, the VFA recorded for the males revealed that it was 73.39±10.17$cm^2$and in the females, it was found to be 67.44±8.93cm^2.VFA of the normal male and female subjects was found to be 46.71±18.84$cm^2$and 48.32±17.06cm^2 respectively

The skeletal muscle mass assessment through the INBODY 720 body composition analyser showed that among the obese male and female subjects, it was around 31.39±4.03 and 19.56±5.51 respectively. In the overweight category, the SMM of the male subjects was around 29.96±3.56 and in the females, it was

19.73±2.24. The SMM recorded for the normal male and female subjects revealed that it was 26.66±3.21 and 18.32±1.45 respectively.

The mean Percent Body Fat of obese male and female subjects were found to be 33.07±7.41 and 44.18±4.30 respectively. In the overweight male subjects, the PBF was found to be 24.65±4.35 while in the females it was 37.92±3.04. Among the normal males, PBF was found to be 17.72±7.81 and in the females, it was 31.48±6.20. It was found that the PBF of the females were higher than that of the males in all the three groups

The obesity degree determined for the obese male subjects was 130.78±14.18 whereas in the females, it was found to be 133.70±13.73. In the overweight group, the obesity degree recorded for the males revealed that it was 110.86±4.00and in the females, it was found to be 114.45±1.84.Obesity degrees of the normal male and female subjects were found to be 95.35±1.95and 98.39±6.10 respectively. The obesity degrees of the female subjects in all the three groups were greater than the male subjects.

The Basal Metabolic Rate (BMR) assessment through the INBODY 720 body composition analyser showed that among the obese male and female subjects, it was around 1578.04±142.37 and 1181.85±130.37 respectively. In the overweight category, the BMR of the male subjects were around 1517.68±127.78 and in the females, it was 1163.86±82.22. The BMR recorded for the normal male and female subjects revealed that it was 1408.35±112.59 and 1127.65± 86.55 respectively.

The fitness score determined for the obese male subjects was 62.83±10.74 whereas in the females, it was found to be 60.80±5.95. In the overweight group, the fitness score recorded for the males revealed that it was 69.64±5.64.and in the females, it was found to be 66.50±3.33. Fitness score of the normal male and female subjects were found to be 73.50±4.56and 70.83±5.46 respectively. The fitness score of the male subjects in all the three groups were greater than the female subjects.

The females tend to store more fat than the males owing to physiological demand. Moreover, hormonal influence affects the total body fat to a greater extent which is evident from the above findings in the female category. Increased physical activity, intake of a balanced diet as well as lifestyle modification would help to lower the body weight and the fat mass of the subjects

7. Mean Food Intake

The mean food intake of the selected sub sample of the normal, overweight and obese subjectsare presented in Table 25

Table 25

Mean food intake of the selected male subjects

N=65

Food Groups	RDA (ICMR 2010)	Mean Food Intake					
		Normal N=20	% Deficit / Excess	Overweight N=22	% Deficit / Excess	Obese N=23	% Deficit / Excess
Cereals(g)	375	320 ± 152.6	-14.66	327 ±172.8	-12.8	421 ±73.7	+12.26
Pulses(g)	75	72.8 ± 27.8	-2.93	64 ±18.5	-14.6	75.6 ±20.16	+0.8
Milk and Milk products(ml)	300	475 ±150.7	+58.3	421.63 ±128.6	+40.54	506.87 ±154.3	+68.95
Roots & Tubers(g)	200	130.83 ±25.12	-34.58	208.16 ±60.85	+4.08	176.98 ±48.82	-11.51
Green leafy vegetables(g)	100	52.1 ±15.62	-47.9	43.52 ±22.10	-56.48	58.43 ±20.86	-41.57
Other vegetables(g)	200	150.32 ±46.8	-24.84	132.09 ±29.1	-33.95	95.73 ±23.24	-52.13
Fruits(g)	100	62.86 ±13.75	-37.14	84.65 ±25.87	-15.35	77.54 ±32.85	-2.46
Sugarand Jaggery(g)	20	40.45 ±15.96	+102.2	55.10 ±23.50	+175.5	49.53 ±27.92	+147.65
Fats & Oils(g)	25	52.5 ±20.1	+110.0	65.7 ±14.82	+162.8	69.4 ±22.4	+177.6

The mean food intake of the subjects was compared with the recommended dietary allowances suggested by ICMR (2010). Data on daily intake of different food groups showed that the mean intake of green leafy

vegetables, other vegetables, roots and tubers, fruits, milk and milk products, sugar and jaggery, fats and oils, showed their adequacy and their deficit which was reflected in their nutritional profiles.

The mean food intake of the normal subject showed that the intake of foods such as cereals pulses, green leafy vegetables, other vegetables, roots and tubers and fruits, were found to be in deficit. While the intake of milk and milk products, sugar and fats showed higher intake when compared to the RDA. The intake of cereal were 320 g, and the mean intake of pulses were 72.8 g, followed by green leafy vegetables 52.1g, other vegetables 150.32 g, roots and tubers 130.83g, while the mean intake of fruits were 62.86g which were lesser when compared to the RDA allowances. The intake ofmilk and milk products were 475, fats and oils 52.5 g, sugar and jaggerywere 40.45g which were found to be greaterwhen compared to their RDA allowances.

When the mean food intake of the overweight male subjectswere analysed, it showed that the intake of cerealswere 327 g, and the mean intake of pulses 64 g, followed by green leafy vegetables 43.52g, other vegetables 132.09 g, while the mean intake of fruits were 84.65 g, all of which were found to be deficit when compared to the RDA allowances. The intake ofmilk and milk products were 421.63 ml, roots and tubers were 208.16g, fats and oils 65.7g, sugar and jaggerywere 55.10g which were in excesswhen compared to their RDA allowances.

The mean food intake of the obese subjects revealed that the intake of cereals were 421g followed bythe mean intake of pulses 75.6g, whereas the intake ofmilk and milk products were found to be 506.87 followed by roots and tubers 176.98g, fats and oils 69.4g, sugar and jaggerywere 49.53g which were found to be higher than the RDA allowances. The mean intake of green leafy vegetables were 58.43 g, followed by other vegetables 95.73 g, while the mean intake of fruits were 77.54 g, which were found to be lower than the RDA allowances.

In comparison with the suggested allowances (ICMR 2010), the intake of cereals showed a percentage deficit of 14.66, 12.8 and an excess of 12.26 per

cent among the selected male subjects in normal, over weight and obese categories respectively.

Whereas the intake of milk and milk products showed an excess of 58.3 per cent, 40.54, 68.9 per cent among the normal, over weight and obese groups respectively. With regard to pulses, deficits of 2.93per cent, 14.6 per cent and an excess of 0.8 per cent was foundamong the males of normal, overweight and obese groups respectively

Intake of green leafy vegetables among the males of the normal, overweight and obese showed deficits of 47.9, 56.48 and 41.57 per cent respectively followed by 24.84, 33.95 and 52.13 per cent deficits in the intake of other vegetables. The intake of roots and tubers among males belonging to the normal and obese groups showed deficits of 34.58, 11.51 per centand an excess intake of 4.08 per cent were found to be recorded among overweight category.

The mean intake of fruits showed a deficit of 37.14 per cent, 15.35 and 22.46 per cent among the normal, overweight and obese respectively. Whereas an excess intake of sugar and jaggery 102.2, 175.5 and 147.65 per cent and intake of fats and oils with 110.0 per cent and 162.8 per cent and 177.6 per cent were recordedfor the normal, overweight and obese males respectively.

There is great controversy aboutthe role of diet composition in the development and managementof obesity. It is likely that some functionalfoods aimed at reducing obesity will attempt to alter the dietcomposition. Determining the diet composition accuratelymay be even more difficult than determining the total energyintake. Perhaps changes in protein intake are more easilyassessed than changes in the other macronutrient. Functional foods rich in protein that modify energy expenditure could be useful in weight management.

8. Mean food intake of the selected female subjects

Table 26 represents the mean food intake of selected female subjects

Table 26

Mean food intake of the selected female subjects

N=65

Food groups	RDA (ICMR 2010)	Mean Food Intake					
		Normal N=23	% Deficit / Excess	Overweight N=22	% Deficit / Excess	Obese N=20	% Deficit / Excess
Cereals(g)	270	279.80 ±109.25	+3.62	295.77 ±125.17	+9.54	313.32 ±122.08	+16.04
Pulses(g)	75	64.16 ±38.86	-14.45	49.30 ±22.90	-34.2	53.64 ±31.77	-28.48
Milk and Milk products(ml)	300	241.08 ±97.45	-19.64	245.73 ±96.75	-18.09	222.61 ±97.07	-25.79.
Roots & Tubers(g)	200	133.72 ±28.83	-33.14	138.86 ±48.20	-30.57	138.47 ±39.57	-30.76
Green leafy vegetables(g)	100	36.27 ±22.13	-63.73	42.96 ±15.82	-57.04	33.54 ±19.57	-66.46
Other vegetables(g)	200	98.87 ±19.01	-50.5	119.58 ±22.58	-40.21	108.82 ±19.82	-45.59
Fruits(g)	100	52.12 ±12.7	-47.88	67.81 ±9.1	-32.19	59.25 ±15.12	-40.75
Sugarand Jaggery(g)	20	42.15 ±12.16	+110.75	38.62 ±15.2	+93.1	45.42 ±18.16	+127.1
Fats & Oils(g)	25	57.18 ±14.2	+128.72	43.12 ±9.62	+72.48	52.62 ±11.10	+110.48

The mean food intake of the normal female subjects showed that the intake of foods such as pulses, milk and milk products green leafy vegetables, other vegetables, roots and tubers and fruits, were found to be in deficit. While the intake of cereals, sugars and fats showed higher intake when compared to the RDA. The intake of pulses were 64.16g, followed by green leafy vegetables 36.27g, other vegetables 98.87 g, roots and tubers 133.72g, and milk and milk products 241.08ml while the mean intake of fruits were 52.12g which were lesser when compared to the RDA allowances in the normal female subjects. The intake ofcereals were 279.80, fats and oils 57.18 g, sugar and jaggerywere 42.15g which were found to be greaterwhen compared to their RDA allowances.

When the mean food intake of the overweight female subjectswere analysed, it showed that the intake of pulses 49.30g, followed by green leafy vegetables 42.96g, other vegetables 119.58 g, roots and tubers 138.86g while the mean intake of fruits were 67.81 g and that of milk and milk products were 245.73ml, all of which were found to be deficit when compared to the RDA allowances. The intake ofcereals was 295.77g, fats and oils 43.12g, sugar and jaggerywere 38.62g which were in excesswhen compared to their RDA allowances.

The mean food intake of the obese subjects revealed that the intake of cereals were 313.32 g, sugar and jaggerywere 45.42g, fats and oils 52.62g, which were found to be higher than the RDA allowances. The mean intake of the pulses was found to be 53.64g, milk and milk products 222.61ml, green leafy vegetables were 33.54 g, followed by other vegetables 108.82 g, roots and tubers 138.47g while the mean intake of fruits were 59.25 g, which were found to be lower than the RDA allowances.

In comparison with the suggested allowances (ICMR 2010), the intake of cereals showed a percentage excess of 3.62, 9.54 and 16.04 per cent among the selected female subjects in normal, over weight and obese categories respectively.

Whereas the intake of milk and milk products showed a deficit of 19.64, 18.09 and 25.79 per cent among the normal, over weight and obese groups respectively. With regard to pulses, deficits of 14.45, 34.2 and 28.48 per cent was foundamong the females of normal, overweight and obese groups respectively

Intake of green leafy vegetables among the females of the normal, overweight and obese showed a deficit of 63.73, 57.04 and 66.46 per cent respectively followed by 50.5,40.21 and 45.59 per cent deficits in the intake of other vegetables. The intake of roots and tubers among the females belonging to the normal, overweight and obese groups showed deficits of 33.14, 30.57 and 30.76 per centrespectively.

The mean intake of fruits showed a deficit of 47.88, 32.19 and 40.75 per cent among the normal, overweight and obese females respectively. Whereas an excess intake of sugar and jaggery 110.75, 93.1 and 127.1 per cent and intake of fats and oils with 128.72, 72.48 and 110.48 per cent were recordedfor the normal, overweight and obese females respectively.

9. Mean nutrient intake

Mean nutrient intake calculated based on food intake of the selected normal, overweight and obese subjects are presented in Table 27

Table 27

Mean nutrient intake of the selected male subjects

Nutrient Intake	RDA (ICMR 2010)	Mean Nutrient Intake					
		Normal N=20	% Deficit / Excess	Overweight N=22	% Deficit / Excess	Obese N=23	% Deficit / Excess
Energy (Kcal)	**2320**	2842 ±223	+22.5	2522 ±357	+8.70	2974 ±438	+28.18
Protein (g)	**60**	80.53 ±8.05	+34.21	62.34 ±9.21	+3.9	67.46 ±15.63	+12.43
Fat (g)	**25**	49.98 ±6.21	+99.92	62.65 ±10.94	+150.6	59.75 ±17.84	+139.0
Fibre(g)	**25-35**	19.90 ±3.93	-43.14	19.73 ±4.63	-43.62	18.65 ±4.71	-46.7
Calcium (mg)	**600**	717.04 ±221.91	+19.5	1116.68 ±584.67	+86.11	920.06 ±461.76	+53.34
Iron (mg)	**17**	18.70 ±5.16	+10.0	11.57 ±3.84	-31.94	12.40 ±4.62	-27.0
B-carotene(mg)	**4800**	5947 ±996.1	+23.9	4968 ±682.4	- 3.5	6672 ±448.1	+39.0
Thiamine (mg)	**1.2**	2.04 ±0.50	+70.0	1.24 ±0.41	+3.33	1.36 ±0.56	+13.33
Riboflavin (mg)	**1.4**	1.26 ±0.22	-10.0	1.30 ±0.21	-7.14	1.37 ±0.69	-2.14
Niacin (mg)	**16**	20.84 ±4.57	+30.25	14.62 ±5.87	-86.25	16.64 ±6.69	+4.0
Vitamin C(mg)	**40**	41.13 ±13.33	+2.82	36.01 ±20.19	-9.97	38.84 ±19.52	-2.9
Zinc(mg)	**12**	9.21 ±2.54	-23.25.	5.73 ±2.13	-52.25	7.33 ±3.45	-38.9

The mean nutrient intake was calculated from the mean food intake using the food composition table of ICMR (2010).

The mean nutrient of the normal, overweight and obese subjects corresponding to intake of energy were found to be 2842, 2522, 2974 Kcal, protein,80.53, 62.34,and 67.46g, fat intake were found to be 49.98, 62.65, and 59.75g, followed by, fibre intake of 19.90, 19.73, and 18.65grespectively for the normal, overweight and obese subjects Whereas the intake of calcium were 717.04 mg, 1116.68, and 920.06mg respectively. While the intakes of beta-carotene were5947, 4968 and 6672 mg followed by iron intake of 18.70 mg in the normal subjects 11.57 mg in the overweight group and 12.40 mg in the obese subjects.

The computed mean intake of thiamine were 2.04, 1.24 and1.36followed by riboflavin with 1.26, 1.30 and 1.37 mg in the normal, overweight and obese male subjects respectively. The niacin intake were 20.84,14.62 and 16.64 mg followed by the vitamin C intake 41.13, 36.01 and 38.84 mg, and the mean intake of zinc being 9.21, 5.73, and 7.33 respectively for the selected normal, overweight and obese male.

Deficits offiber intake were 43.14 per cent, 43.62 and 46.7 per cent followed by riboflavin intake of 10.0 per cent, 7.14 and 2.14 per cent and that of zinc intake showed a deficit of 23.25, 52.25 and 38.9 per cent among thenormal, over weight and obese male subjects. Excess intake of energy was found to be 22.5, 8.70 and 28.18per cent and that of protein was34.21, 3.9and 12.43 per cent while fat showed a maximum high of 99.92, 150.6 and 139 per cent in normal, overweight and obese male subjects respectively.

The calcium was found to be excess amounting to19.5 , 86.11 and 53.34 per cent among the normal, overweight and obese male subjects respectively and in the case of iron, excess of 10.0 per cent was found in the normal subjects and a deficit of 31.94 and 27.0 per cent in theoverweight and obese subjects.

The beta carotene intake of the normal, overweight and obese male subjects were higher than the RDA (23.9, 3.5, 39%). The thiamine intake was found to be excess in all the three groups amounting to 70, 3.33 and 13.33 in the normal, overweight and obese subjects respectively. The niacin intake recorded

for the subjects showed that it was greater in the normal and obese subjects (30.25 and 4) while it was lesser in the overweight subjects (8.62).The vitamin C. intake of the normal male subjects showed an excess of 2.82 per cent and among the overweight and obese subjects, a deficit was found to be 9.97 and 2.9 respectively. The zinc intake was found to be deficient in all the three groups amounting to 23.25, 52.25 and 38.9 per cent in the normal, overweight and obese individuals respectively.

10. The mean nutrient intake of the selected female subjects

Table 28 depicts the mean nutrient intake of the selected female subjects

Table 28

Mean nutrient intake of the selected female subjects

N=65

Nutrients	RDA (ICMR 2010)	Mean Intake					
		Normal N=20	% Deficit / Excess	Overweight N=22	% Deficit / Excess	Obese N=23	% Deficit / Excess
Energy (Kcal)	**1900**	2276 ±204	+19.78	2143 ±204	+12.7	2278 ±330	+19.8
Protein (g)	**55**	54.01 ±10.93	-1.8	55.96 ±11.67	+1.74	59.39 ±13.79	+7.98
Fat (g)	**20**	56.94 ±4.73	+184.7	45.86 ±13.68	+129.3	52.64 ±10.75	+163.2
Fibre(g)	**25-35**	22.79 ±2.39	-34.8	22.01 ±5.45	-37.1	22.50 ±4.13	-35.7
Calcium (mg)	**600**	769.42 ±310.24	+28.23	596.08 ±113.62	0.653	709.77 ±256.37	+18.29
Iron (mg)	**21**	10.12 ±3.92	-51.8	10.12 ±3.02	-51.8	17.96 ±18.02	-14.47
B-carotene (mg)	**4800**	4142 ±890.24	-13.7	4905 ±734.71	+2.2	3830 ±827.11	-20.2
Thiamine (mg)	**1.2**	1.05 ±0.27	-12.5	1.27 ±0.40	+5.83	1.35 ±0.53	+12.5
Riboflavin (mg)	**1.4**	0.98 ±0.39	-30.0	0.88 ±0.11	-37.14	1.01 ±0.26	-27.8
Niacin (mg)	**16**	11.91 ±2.02	-25.5	14.17 ±5.46	-11.43	14.37 ±4.89	-10.18
Vitamin C(mg)	**40**	32.62 ±460.19	-18.45	37.99 ±54.83	-5.02	26.74 ±29.10	-33.15
Zinc(mg)	**10**	6.21 ±3.22	-37.9	6.38 ±2.97	-36.2	5.21 ±1.08	-47.9

The energy intake of the female subjects belonging to the normal, overweight and the obese category recorded an excess of 19.78, 12.7 and 19.8 per cent respectively. Among the normal female subjects, the protein intake was less(1.8) than the RDA while in the overweight and obese subjects it was slightly higher(1.74 and 7.98%).The fat consumption was abnormally greater in all the three groups studied amounting to 184.7 in the normal, 129.3 in the overweight and 163.2 per cent in the obese subjects. The poor choice of foods was evident in the fibre intake of the normal, overweight and obese subjects which was found to be deficient that ranged from 34.8 in the normal to 37.1 in the overweight subjects.

The calcium intake of the normal and obese female subjects were more (28.23, 18.29%) than the RDA. The iron consumption showed a great deficit in the normal and overweight female subjects which amounted to 51.8 per cent in both the groups while it was 14.47 per cent in the obese group. Iron deficiency especially among the females increases the risk of anaemia and its consequences. The mean beta-carotene consumption pattern revealed that it was deficient (13.7 and 20.2%) in the normal and obese group respectively while, the overweight group recorded a slight excess of 2.2 per cent.

The average intake of thiamine was deficient by 12.5 per cent in the normal female subjects and it was excess by 5.83 and 12.5 per cent in the overweight and obese category. The mean intake of riboflavin was deficient in all the three groups which ranged from 27.8 to 37.14 per cent. Niacin intake was also found to be deficient in the normal, overweight and obese groups which recorded a deficiency of 25.5, 11.43 and 10.18 per cent respectively. Vitamin C intake computed for the female subjects revealed that it was lower in all the three groups amounting to 18.45 per cent in the normal, 5.02 per cent in the overweight and 33.15 per cent in the obese individuals. Zinc intake of the selected female subjects showed that there was a deficiency of 37.9 per cent in the normal subjects, 36.2 per cent in the overweight subjects and 47.9 per cent in the obese subjects.

11. Prevalence of Metabolic syndrome

Prevalence of metabolic syndrome was assessed of all the subjects based on the revised ATP III criteria and prevalence were assessed based on the occurrence of 3 out of 5 factors and the results are presented based on phenotypes

Table 29 represents the prevalence of metabolic syndrome a per ATP III criteria

Table 29
Prevalence of metabolic syndrome based on phenotype

N=130

CRITERIA	OBESE (N= 43)				OVERWEIGHT (N=44)				NORMAL (N=43)			
	Male (N=23)		Female (N=20)		Male (N=22)		Female (N=22)		Male (N=20)		Female (N=23)	
	No	%	No	%	No	%	No	%	No	%	No	%
Presence of MS	8	35	10	50	6	28	9	41	1	5	4	17
Absence of MS	15	65	10	50	16	72	13	59	19	95	19	83
	23	100	20	100	22	100	22	100	20	100	23	100

Thirty five per cent of obese male subjects and 50 per cent of the obese female subjects presented with metabolic syndrome. Among the overweight male and female subjects, the metabolic syndrome was present in 28 per cent of the males and 41 per cent of the females respectively. Among the normal males, metabolic syndrome was present in 5 per cent and that of the females, it was 17 per cent

Metabolic syndrome was absent in 65 per cent of the obese male subjects and 50 per cent of the obese female subjects. In the overweight category, 72 per cent of the males and 59 per cent of the females did not show any evidence of the metabolic syndrome. Among the normal subjects, metabolic syndrome was absent in 95 per cent of the males and 83 per cent of the females. The prevalence of metabolic syndrome based on phenotype revealed that the obese and overeight subjects tend to develop metabolic syndrome earlier than the

normal subjects. It was also noted that the normal subjects also presented with metabolic syndrome.

Metabolic syndrome (MetS) is a complex web of metabolic factors that are associated with a 2-fold risk of cardiovascular diseases (CVD) and a 5-fold risk of diabetes. MetS is a constellation of multiple cardio metabolic abnormalities including truncal (central) obesity, borderline and high blood pressure (BP), high fasting glucose, high triglycerides (TGs), and low high-density lipoprotein cholesterol (HDL-C).(Ghaffar et al, 2004)

12. Mean Resting Energy Expenditure

The mean restingenergy expenditure of the selected subjects calculated based on various prediction information such as Mifflin, Harris Benedict, Owen's, WHO -1(using weight alone), WHO -2, Schofield and Liu's. The mean resting energy expenditure was also computed

Table 30

Mean resting energy expenditure of the selected subjects

Prediction Equation	OBESE N= 43		OVERWEIGHT N= 44		NORMAL N= 43	
	Male (N= 23)	Female (N= 20)	Male (N= 22)	Female (N= 22)	Male (N= 20)	Female (N= 23)
Mifflin	1817.67 ±148.97	1374.41 ±141.84	1687 ±110.18	1304.21 ±88.91	1531.7 ±91.53	1223.32 ±72.75
Harris Benedict	1921.55 ±179.07	1458.29 ±115.24	1748.43 ±120.75	1387.88 ±64.89	1556.81 ±104.34	1313.61 ±55.83
Owen's	1736.19 ±117.51	1279.54 ±76.36	1612.36 ±61.75	1220.57 ±34.16	1759.85 ±91.71	1163.41 ±34.30
Schofield	1963.46 ±173.46	1486.59 ±157.58	1767.75 ±97.67	1365.04 ±68.81	1577.05 ±91.711	1247.47 ±69.23
WHO - 1	1963.47 ±173.47	1486.59 ±157.58	1780.67 ±91.16	1364.88 ±70.50	1577.05 ±91.71	1247.47 ±70.80
WHO – 2	1970.88 ±176.13	1447.91 ±160.91	1770.68 ±97.68	1345.70 ±83.15	1576.98 ±92.70	1239.55 ±76.57
LIU's	1812.45 ±181.12	1390.38 ±170.52	1632.74 ±119.82	1284.35 ±92.62	1437.45 ±103.59	1173.19 ±82.01
Overall Mean	1883.67 ±93.94	1417.67 ±75.01	1714.23 ±69.99	1324.66 ±58.55	1573.84 ±96.00	1229.72 ±50.66

Resting energy expenditure (REE) is the largest component of total daily energy expenditure, accounting for 60% to 75% of total expenditure (Melzer K et al., 2007) .The mean REE of the obese male subjects computed using Mifflin's equation was found to 1817.67±148.97 and it was 1374.41±141.84 for female obese subjects. In the overweight individuals the same was found to be 1687±110.18 for males and 1304.21±88.91 for females. The REE computed for the normal male and female subjects were found to be 1531.7±91.53 and 1223.32±72.75 respectively.

Harris Benedict's equation has always been popularly used for predicting the REE of the individuals. The REE of the obese male and female subjects calculated shows that it was 1921.55±179.07 and 1458.29±115.24 respectively. Among the overweight male subjects, the REE was found to be 1748.43±120.75 and in the female subjects, it was 1387.88±64.89. In normal males, the values were 1556.81±104.34 and in the females, it was 1313.61±55.83.

The REE calculated using Owen's equation revealed that in the obese male subjects, it was 1736.19±117.51 and in the females, it was 1279.54±76.36. The REE predicted by the Owen's equation for the overweight male and female subjects were 1612.36±61.75 and 1220.57±34.16 respectively. In the normal male subjects, the REE was found to be 1759.85±91.71 and in the females, it was found to be 1163.41±34.30.

The REE computed based on Schofield equation showed that it was 1963.46±173.46 in the obese male subjects and 1486.59±157.58 in the female obese subjects. Among the overweight male subjects, the REE was found to be 1767.75±97.67 where as in the females, it was 1365.04±68.81. Among the normal male and female subjects, the REE obtained through Schofield's equation revealed that they were 1577.05±91.71 and 1247.47±69.23 respectively.

The mean REE obtained through computation based on WHO1 equation showed that the obese male subjects had a REE of 1963.47±173.47 while among the females, it was 1486.59±157.58. In the overweight male and female subjects, the REE was calculated using WHO1 equation and the results obtained

revealed that they were 1780.67±91.16 and 1364.88±70.50 respectively. Among the normal male subjects, the REE was found to be 1577.05±91.71 and among the female subjects, it was 1247.47±70.80. The mean energy expenditure was also calculated employing WHO-2 equation. In the obese male subjects, the REE was found to be 1970.88±176.13 while in the obese females, it was 1447.91±160.91. Among the overweight male and female subjects, the mean REE was found to be 1770.68±97.68 and 1345.70±83.15 respectively. REE was also calculated for the normal subjects. The REE computed for the males was found to be 1576.98±92.70 and in the females, it was 1239.55±76.57.

The Liu's equation was employed to determine the mean REE of the selected subjects. Among the obese male subjects, the REE was found to the 1812.45±181.12 and in the females, it was found to be 1390.38±170.52. The overweight male and female subjects recorded a mean REE of 1632.74±119.82 and 1284.35±92.62 respectively. The REE computed for the normal male subjects were found to be 1437.45±103.59 and 1173.19±82.01 for the female subjects.

The overall mean REE based on all the equations were also computed and the results revealed that in the obese male and female subjects, they were1883.67±93.94 and 1417.67±75.01. It is observed that the REE of the male subjects were greater than that of their female counterparts. In the overweight category, the overall mean REE of the male subjects were found to be 1714.23±69.99 and in the female subjects, it was found to be 1324.66±58.55. Among the normal male subjects, the overall mean REE was found to be 1573.84±96 and in the female subjects, it was found to be 1229.72±50.66. all the females had a lower REE when compared with the males subjects.

13. Mean Total Energy Expenditure

The mean total energy expenditure of the selected subjects were calculated based on various prediction equation such as Mifflin, Harris Benedict, Owen's, WHO -1(using weight alone), WHO -2, Schofield and Liu's. The mean

resting energy expenditure was multiplied by the physical activity factor and the mean total energy expenditure was computed

Table 31

Mean total energy expenditure of selected male subjects

Prediction Equation	OBESE N= 43		OVERWEIGHT N= 44		NORMAL N= 43	
	Male (N= 23)	Female (N= 20)	Male (N= 22)	Female (N= 22)	Male (N= 20)	Female (N= 23)
Mifflin	2180.01 ±178.76	1649.30 ±170.21	2025 ±132.22	1565.05 ±106.69	1838 ±109.83	1467.98 ±87.301
Harris Benedict	2305.86 ±214.88	1749.94 ±138.29	2098.12 ±144.90	1655.45 ±77.85	1868.17 ±125.21	1576.33 ±67.00
Owen's	1736.19 ±117.51	1535.45 ±91.63	1612.36 ±61.75	1464.68 ±40.99	1759.85 ±91.17	1396.41 ±41.16
Schofield	2552.51 ±225.50	1932.57 ±204.86	2298.07 ±126.97	1774.55 ±89.45	2050.16 ±119.22	1621.71 ±90.011
WHO - 1	3043.38 ±268.87	2319.08 ±245.83	2760.04 ±141.30	2129.22 ±109.98	2444.43 ±142.15	1946.06 ±110.44
WHO – 2	3053.87 ±273.00	2258.74 ±249.89	2744.56 ±151.73	2099.30 ±129.71	2444.31 ±143.68	1933.69 ±119.45
LIU's	2174.94 ±217.34	1668.45 ±204.62	1959.29 ±143.78	1541.22 ±111.15	1724.94 ±124.31	1407.83 ±98.41
Overall Mean	**2435.3 ±483.84**	**1873.36 ±308.84**	**2213.9 ±420.86**	**1747.07 ±269.10**	**2018.60 ±308.76**	**1621.43 ±232.64**

The mean TEE of the obese male subjects computed using Mifflin's equation was found to 2180.01±178.76 and it was 1649.30±170.21 for female obese subjects. In the overweight individuals the same was found to be 2025±132.22 for males and 1565.05±106.69 for females. The TEE computed for the normal male and female subjects were found to be 1838±109.83 and 1576.33±67.0 respectively.

Harris Benedict's equation has always been popularly used for predicting the TEE of the individuals. The TEE of the obese male and female subjects calculated shows that it was 2305±214.88 and 1749.94±138.29 respectively.

Among the overweight male subjects, the TEE was found to be 2098.12±144.90 and in the female subjects, it was found to be 1655.45±77.85. In the normal males, the values were 1868.17±125.21 and in the females, it was 1576.33±67.0.

The TEE calculated using Owen's equation revealed that in the obese male subjects, it was 1736.19±117.51 and in the females, it was 1535.45±91.63. The TEE predicted by the Owen's equation for the overweight male and female subjects were 1612.36±61.75 and 1464.68±40.99 respectively. In the normal male subjects, the TEE was found to be 1759.85±91.17 and in the females, it was found to be 1396.41±41.16

The TEE computed based on Schofield equation showed that it was 2552.51±225.50 in the obese male subjects and 1932.57±204.86 in the female obese subjects. Among the overweight male subjects, the TEE was found to be 2298.07±126.97 where as in the females, it was 1774.55±89.45. Among the normal male and female subjects, the TEE obtained through Schofield's equation revealed that they were 2050.16±119.22 and 1621.71±90.011 respectively.

The mean TEE obtained through computation based on WHO1 equation showed that the obese male subjects had a TEE of 3043.38±268.87 while among the females, it was 2319.08±245.83. In the overweight male and female subjects, the TEE was calculated using wHO1 equation and the results obtained revealed that they were 2760.04±141.30 and 2129.22±109.98 respectively. Among the normal male subjects, the TEE was found to be 2444.43±142.15 and among the female subjects, it was 1946.06.

The mean total energy expenditure was also calculated employing WHO2 equation. In the obese male subjects, the TEE was found to be 3053.87±273.00 while in the obese females, it was 2258.74±249.89. Among the overweight male and female subjects, the mean TEE was found to be2744.56±151.73 and 2099.30±129.71 respectively. TEE was also calculated for the normal subjects. The TEE computed for the males was found to be 2444.31±143.68 and in the females, it was 1933.69.

The Liu's equation was employed to determine the mean TEE of the selected subjects. Among the obese male subjects, the TEE was found to the 2174.94±217.34 and in the females, it was found to be 1668.45±204.62. The overweight male and female subjects recorded a mean TEE of 1959.29±143.78 and 1541.22±111.15 respectively. The TEE computed for the normal male subjects were found to be 1724.94±124.31 and 1407.83±98.41 for the female subjects.

The overall mean TEE based on all the equations were also computed and the results revealed that in the obese male and female subjects, they were2435.3±483.84 and 1873.36±308.84. It is observed that the TEE of the male subjects was greater than that of their female counterparts. In the overweight category, the overall mean TEE of the male subjects was found to be 2213.9±420.86 and in the female subjects, it was found to be 1747.07±269.10. Among the normal male subjects, the overall mean TEE was found to be 2018.60±308.76 and in the female subjects, it was found to be 1621.43±232.64. All the females had a lower TEE when compared with the male subjects.

D. PHASE IV

IMPACT OF INTERVENTION AND INFLENCE OF POLYMORPHISM

Impact of intervention on selected subjects based on genotype, phenotype and gender are discussed. The genotypes of the subjects are classified based on presence of polymorphism (pro 12 ala) and absence of polymorphism (pro 12 pro). However, for the case of understanding, the results are discussed based on genotype, phenotype and gender.

The results of impact of intervention and influence of polymorphism are discussed under following heads:

1. **Prevalence of polymorphism**

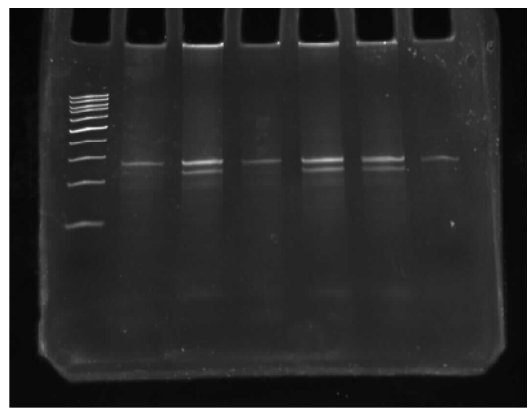
The prevalence of polymorphism based on phenotype and gender are presented .The presence of polymorphism as pro 12 ala and absence of polymorphism as Pro 12 Pro.

Table 32 gives the prevalence of polymorphism based on phenotype and gender

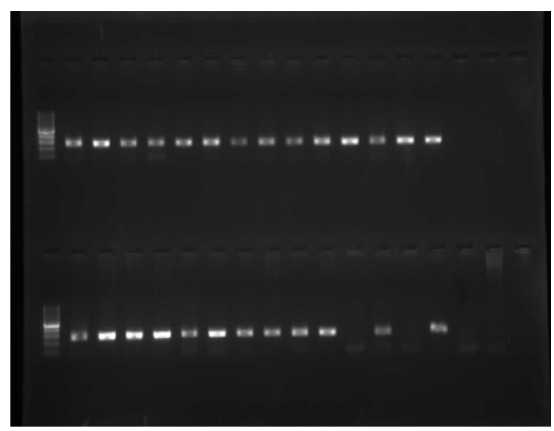
Table 32

Prevalence of polymorphism based on phenotype and gender

Phenotype	obese (N=43)				Overweight (N=44)				Normal (N=43)			
Gender	Male (N=23)		Female (N=20)		Male (N=22)		Female (N=22)		Male (N=20)		Female (N=23)	
	N	%	N	%	N	%	N	%	N	%	N	%
Pro 12 Pro	18	78.3	15	75	17	77.27	17	77.27	19	95	21	91.3
Pro 12 ala	5	21.7	5	25	5	22.73	5	22.73	1	5	2	8.7



Lane 1 indicate 1000 bpmarker,Lane 2, 5, 7 indicates pro 12 pro polymorphism; Lane 3,5,6 indicates pro 12 ala Polymorphism



Lane 1 indicates 1000bp marker, All the lane indicates pro 12 pro polymorphism

Plate 9
Confirmation of genotype in gel electrophoresis

PPAR-γ plays a key role in adipocyte differentiation and body fat mass is a strong determinant of insulin sensitivity and the influence of the Pro12Ala polymorphism on susceptibility for obesity has been of major interest.

In the present study, the genotype frequency of Pro 12 Pro was found to be 78.3 and 75 percent among male and female obese subjects. An equal per cent of male and female subjects (77.27%) exhibited pro 12 pro polymorphism among the selected overweight subjects while around 95 and 91 per cent of the normal male and female subjects were identifies to possess pro 12 pro polymorphism. The prevalence of pro12 pro polymorphism was higher among the selected subjects invariable of the phenotype.Bhatt et al, 2012 reports the genotype frequency of pro 12 pro as 82.6% and *Pro 12* ala14.7%.

The genotype frequency of Pro 12 ala was foundto be five per cent among the selected males and females of obese and overweight genotypes while among the normal subjects, one and two percent of the males and females were found to possess pro 21 ala polymorphism. The prevalence of pro 12 ala polymorphism was more prevalent among the obese and overweight subjects when compared with the normal subjects. The genotype frequencies were in Hardy-Weinberg equilibrium in each subgroup.Ala 12 ala genotype was absent in the study population. Results suggested by Yao et al., 2014 demonstrated that PPAR-γ Pro12Ala polymorphism might be a risk factor for obesity susceptibility.

2. Mean changes in anthropometry

The mean changes in the anthropometric measurements of subjects in terms of height, weight, Body Mass Index (BMI) and Waist Hip Ratio (WHR) are presented in the following tables

The mean changes in the anthropometric measurements of the selected obese subjects are presented in the Table 33

Table 33

Mean changes in the anthropometric measurements of the selected obese subjects

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N= 5)			FEMALE(N= 5)			MALE(N= 18)			FEMALE(N=17)			MALE(N= 23)			FEMALE(N=20)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Height(kg)	175 ±8.75	175 ±8.75	-	156.8 ±6.06	156.8 ±6.06	-	170.7 ±6.94	170.7 ±6.94	-	153.4 ±7.23	153.4 ±7.23	-	171.6 ±7.37	171.6 ±7.37	-	154.30 ±6.96	154.30 ±6.96	-
Weight(cm)	97.28 ±11.52	92.46 ±12.15	-4.79 ±1.28	74.82 ±4.65	71.30 ±4.75	-3.52 ±1.13	80.86 ±8.86	77.56 ±9.09	-3.30 ±1.27	65.04 ±11.03	64.00 ±11.08	-1.04 ±0.63	84.43 ±11.52	80.80 ±11.41	-3.63 ±1.39	67.49 ±10.63	65.83 ±10.28	-1.66 ±1.33
BMI	31.76 ±0.92	30.19 ±1.34	-1.57 ±0.49	30.43 ±2.85	29.08 ±2.67	-1.35 ±0.52	27.74 ±2.71	26.61 ±2.74	-1.13 ±0.47	27.58 ±2.51	27.10 ±2.54	-0.48 ±0.27	28.65 ±2.92	27.42 ±2.87	-1.24 ±0.50	28.34 ±2.87	27.65 ±2.66	-0.69 ±0.56
WHR	0.95 ±0.03	0.93 ±0.03	-0.02 ±0.01	0.89 ±0.04	0.85 ±0.03	-0.04 ±0.03	0.91 ±0.03	0.89 ±0.04	-0.02 ±0.01	0.85 ±0.03	0.83 ±0.16	-0.02 ±0.11	0.92 ±0.04	0.90 ±0.04	-0.02 ±0.01	0.86 ±0.04	0.83 ±0.09	-0.03 ±0.09

Polymorphism in the *PPAR-γ2* gene (Pro12Ala) has been shown to be associated with insulin resistance and obesity.(Benet al.,2009).It has been suggested that the Pro12Alapolymorphism has an effect on body mass index (BMI) in individuals with marked obesity and that this effect is not apparent in lean individuals. (Beamer et al.,1998). In the present study, there were no differences in the height of male and female obese subjects with polymorphism after intervention. The differences in weight for the male and female obese subjects after intervention were found to be -4.79±1.28 and -3.52±1.13 which shows the efficacy of the functional food supplementation and the exercise regimen that were followed by the subjects. There was a notable change in the BMI of the male and female obese subjects which were -1.57±0.49 and -1.35±0.52 respectively. A reduction in BMI is a positive outcome of the dietary and activity intervention of the selected subjects. There was a marginal difference in the Waist Hip Ratio of the male and female subjects with polymorphism and it was found to be -0.02±0.01 and -0.04±0.03 which proves that obesity in the individuals could be modified through appropriate intervention mechanisms.

Similar to the group with polymorphism, the non-polymorphism group also did not record any difference in their heights because height is a linear measure and differences are evident only on a longer term and moreover, the height changes among the adults are not remarkable. The differences in the weight of the male and female obese subjects without polymorphism also recorded weight reductions which were 3.30±1.27 and 1.04±0.63 respectively. The differences in the BMI recorded pre and post intervention for the subjects without polymorphism revealed that they were -1.13±0.47 in the males and -0.48±0.27 in the females.Among the subjects without polymorphism, the differences in the waist Hip Ratioof the males and the females were found to be -0.02±0.01.

When the genotypes with and without polymorphism were compared the differences in the mean anthropometric measurements post intervention were found to be greater among the obese subjects with polymorphism highlighting the effectiveness of the intervention programmes.

The mean anthropometric changes of the phenotypical obese subjects were studied and the results revealed that there were no changes in the heights of both the male and female subjects. Weight reduction was noted among the male and female phenotypes which were -3.63 ±1.39 in the males and -1.66± 1.33 in the females. The BMI measurements pre and post intervention of the male and female phenotypes showed that there was a reduction in the BMI which were - 1.24±0.50 and -0.69±0.56 respectively. The differences in the Wait Hip ratio of the male and female phenotypes after dietary intervention and activity modification were found to be -0.02±0.01 and -0.03±0.09 respectively. Subjects with pro 12 ala polymorphism had higher body weight and BMI at baseline when compared with subjects with pro 12 pro genotype. Among the variants, weight reduction was more pronounced among the males when compared with females. From the result, male subjects with pro 12 ala polymorphism in BMI showed a five per cent significant level. Similarly in female, waist hip ratio of pro 12 ala obese subjects exhibited high significant level of one per cent. In pro 12 pro female subjects, waist hip ratio exerted at five per cent significant level.

The mean changes in the anthropometric measurements of the selected overweight subjects are presented in the Table 34

Table 34

Mean changes in the anthropometric measurements of the selected overweight subjects

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=5)			FEMALE(N=5)			MALE(N=17)			FEMALE(N=17)			MALE(N=22)			FEMALE(N=22)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Height(kg)	174.2 ±10.28	174.2 ±10.28	-	161.4 ±6.07	161.4 ±6.07	-	171.1 ±6.99	171.1 ±6.99	-	154.8 ±5.96	154.8 ±5.96	-	171.8 ±7.69	171.8 ±7.69	-	156.36 ±6.47	156.36 ±6.47	-
Weight(cm)	73.34 ±7.86	68.58 ±7.91	-4.76 ±1.58	62.70 ±4.52	58.40 ±4.44	-4.30 ±1.00	70.87 ±6.19	68.32 ±5.82	-2.55 ±2.34	58.28 ±4.30	56.44 ±4.21	-1.84 ±1.19	71.43 ±6.49	68.38 ±6.14	-3.05 ±2.35	59.28 ±4.64	56.88 ±4.24	-2.40 ±1.54
BMI	24.16 ±0.53	22.59 ±0.58	-1.57 ±0.54	24.07 ±0.29	22.41 ±0.46	-1.67 ±0.39	24.20 ±0.50	23.33 ±0.78	-0.87 ±0.79	24.32 ±0.32	23.55 ±0.62	-0.77 ±0.59	24.21 ±0.50	23.16 ±0.79	-1.05 ±0.79	24.24 ±0.32	23.26 ±0.74	-0.98 ±0.65
WHR	0.87 ±0.03	0.85 ±0.03	-0.02 ±0.02	0.82 ±0.01	0.83 ±0.01	0.01 ±0.01	0.87 ±0.02	0.86 ±0.02	-0.01 ±0.01	0.83 ±0.02	0.80 ±0.02	-0.03 ±0.12	0.87 ±0.02	0.86 ±0.02	-0.01 ±0.01	0.83 ±0.02	0.81 ±0.11	-0.02 ±0.10

Among the overweight subjects with polymorphism, the heights of both the males and females did not show any difference after intervention. The differences in weight of the male overweight subjects were found to be -4.76±1.58 and that of the females were found to be -4.30±1.00. The differences found in the males were slightly higher than the females post intervention. Differences were also observed in the BMI of the male and female overweight subjects with polymorphism and were found to be -1.57±0.54 for the males and -1.67±0.39 for the females. The differences in the BMI for the overweight male and female subjects without polymorphism were recorded to be -0.87 and -0.77 respectively which were lesser than the genotypes with polymorphism. The BMI variation of the male phenotpyes was found to be -1.05 and in that of the female phenotypes, it was found to be -0.98

The differences in the Waist Hip Ratios recorded for the overweight male genotypes were found to be – 0.02±0.02 whereas in the females there was no reduction in the WHR but an increase of 0.01±0.01.In the overweight genotypical males, the differences in the WHR was found to be -0.01±0.01 and in the genotypical females without polymorphism, the difference in the WHR was observed to be -0.03±0.12. The differences in the Waist Hip Ratios for the male and female phenotypes were found to be -0.01 and -0.02 respectively. It evident from the present result that subjects with pro12 ala had higher BMI and weight at baseline. However, pro 12 ala subjects showed a higher reduction in body weight

The differences observed among the overweight genotypes with polymorphism was higher than those without polymorphism which shows that appropriate intervention strategies could modify the anthropometric measurement among those genotypes with polymorphism. From the result, male subjects with pro 12 ala polymorphism in waist hip ratio showed a five per cent significant level ($p<0.05$). Similarly in female, waist hip ratio of pro 12 pro overweight subjects exhibited high significant level of one per cent ($p<0.01$). In phenotype female subjects, BMI exerted at one per cent significant level difference ($p<0.01$).

The mean changes in the anthropometric measurements of the selected normal subjects are presented in the Table 35.

Table 35

MEAN CHANGES IN ANTHROPOMETRIC MEASUREMENT OF SELECTED NORMAL SUBJECTS

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=1)			FEMALE(N=2)			MALE(N=19)			FEMALE(N=21)			MALE(N=20)			FEMALE(N=23)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Height(kg)	170	170	-	155.0 ±7.07	155.0 ±7.07	-	166.1 ±5.79	166.1 ±5.79	-	156.2 ±4.68	156.29 ±4.68	-	166.30 ±5.70	166.3 ±5.70	-	156.17 ±4.73	156.17 ±4.73	-
Weight(cm)	62.3	59.2	-3.1	47.60 ±5.23	47.25 ±6.15	-0.35 ±0.02	58.37 ±5.92	59.45 ±6.02	1.08 ±1.50	51.70 ±4.71	53.50 ±4.35	1.79 ±1.07	58.57 ±5.83	59.44 ±5.89	0.88 ±1.74	51.35 ±4.78	52.95 ±4.63	1.60 ±1.21
BMI	21.55	20.48	-1.07	19.81 ±0.37	19.66 ±0.77	-0.15 ±0.40	21.15 ±1.63	21.54 ±1.56	0.39 ±0.66	21.18 ±1.23	21.92 ±1.16	0.74 ±0.48	21.17 ±1.59	21.49 ±1.54	0.32 ±0.66	21.05 ±1.24	21.71 ±1.30	0.66 ±0.53
WHR	0.84	0.83	-0.01	0.79 ±0.01	0.78 ±0.01	-0.01 ±0.01	0.83 ±0.02	0.83 ±0.02	-	0.80 ±0.04	0.81 ±0.02	0.01 ±0.04	0.83 ±0.02	0.83 ±0.02	-	0.80 ±0.04	0.81 ±0.02	0.01 ±0.04

Among the normal male and female genotypes with polymorphism, there were no differences in the height measurements. The weight measurements done for the same individuals revealed that the males, the differences were -3.1 and among the females the differences were -0.35±0.02. The BMI measurements done for the normal male and female genotypes with polymorphism showed that they were – 1.07 and -0.15±0.40 respectively. The differences in the waist hip ratios of the male and female genotypes with polymorphism were found to be – 0.01.

Among the normal genotypes without polymorphism, there were no differences in the heights of the subjects. The weight measurements done for these genotypes showed that the differences were +1.08±1.50 and +1.79±1.07 for the males and females respectively. The BMI measurements done pre and post interventions revealed that there was an increase of 0.39±0.66 and 0.74±0.48 in the male and female genotypes without polymorphism. The differences in the Waist Hip Ratios for the male and female overweight genotypes without polymorphism showed that there were no changes in the males whereas there was a slight increase of 0.01±0.04 in the females

The height measurements done before and after intervention for the normal male and female phenotypes showed no difference. The differences in weight recorded for the normal male and female genotypes with polymorphism showed that they were -3.1 and -0.35±0.02 respectively. The differences in weight measurements recorded for the normal genotypes without polymorphism showed an increment of 1.08±1.50 in the males and 1.79±1.07 in the females. Similarly, among the normal phenotypes, there was a slight increase in the weight post intervention and was found to be 0.88±1.74 in the males and 1.60 ±1.21 in the females.Even among subjects with normal BMI,the mean weight and BMI of the subjects with polymorphism were markedly greate than subjects without polymorphism at baseline and further the reduction in weight and BMI were found to be greate among the subjects with polymorphism. From the result, male subjects with pro 12 ala polymorphism in weight showed a one per cent significant level ($p<0.01$). Similarly in female, waist hip ratio of pro 12 ala normal

subjects exhibited high significant level of one per cent ($p<0.01$). In pro 12 pro female subjects, waist hip ratio exerted at five per cent significant level difference ($p<0.05$). BMI of female phenotype of normal subjects showed a significant difference at 5 per cent level ($p<0.05$).

The difference in the BMI for the normal male and female genotypes with polymorphism was about -1.07 and -0.15±0.40 respectively. The differences in the BMI after intervention in the normal genotypes without polymorphism indicated that it was 0.39±0.66 in the males and 0.74±0.48 in the females.The differences were found to be positive.The differences in the BMI observed in the normal male and female phenotypes were found to be 0.32±0.66 and 0.66±0.53 respectively which were found to be incremental. The differences in the waist hip ratios observed among the normal male and female genotypes with polymorphism showed that it was -0.01 in both the groups. The Waist Hip Ratios of normal genotypes without polymorphism among the males did not show any difference after intervention while in the female the difference was found to be 0.01±0.04. Among the normal male and female phenotype, there were no differences in the waist hip ratios of the males while the difference was 0.01±0.04 in the females.

3. Mean changes in Biochemical Profile

The mean changes in biochemical profile such as fasting blood glucose, Haemoglobin, Lipid profile – total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol and VLDL cholesterol were measured and the ratios such as LDL to HDL ratio, Total cholesterol to HDL ratio and triglycerides to HDL ratio were calculated and discussed

The mean changes in the biochemical profile of all the obese subjects pre and post intervention are presented in the Table 36

Table 36

Mean changes in the biochemical profile of the selected obese subjects

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N= 5)			FEMALE(N= 5)			MALE(N= 18)			FEMALE(N=17)			MALE(N= 23)			FEMALE(N=20)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Hb (g/dl)	14.50 ±0.14	15.02 ±0.07	0.52 ±0.07	13.5 ±0.7	13.7 ±0.6	0.2 ±0.3	14.77 ±0.99	15.27 ±078	0.50 ±0.21	12.9 ±1.0	13.2 ±1.1	0.4 ±0.4	14.71 ±1.25	15.21 ±1.25	0.50 ±0.50	13.0 ±1.0	13.3 ±1.0	0.3 ±0.4
FBG (mg/dl)	90.00 ±8.49	89.20 ±4.24	-0.80 ±4.24	79.2 ±4.6	81 ±6.5	1.8 ±3.4	90.17 ±14.85	89.06 ±0.71	-1.11 ±14.14	89.2 ±14.0	85.1 ±6.6	-4.1 ±8.9	90.13 ±8.57	89.09 ±6.73	-1.04 ±7.09	86.7 ±13.0	84.1 ±6.6	-2.7 ±8.3
TC (mg/dl)	151.2 ±34.65	142.0 ±42.43	-9.20 ±7.78	194.6 ±27.3	152.4 ±20.5	-42.2 ±12.1	156.28 ±34.65	143.1 ±46.6	-13.11 ±12.02	157.6 ±21.8	135.3 ±20.3	-22.3 ±12.9	155.17 ±21.03	142.91 ±25.36	-12.26 ±13.34	166.9 ±27.9	139.6 ±21.2	-27.3 ±15.2
TGL (mg/dl)	163.8 ±38.18	160.0 ±82.73	-3.80 ±44.55	141.6 ±14.9	107.4 ±10.7	-34.2 ±24.0	102.2 ±21.92	85.39 ±4.95	-16.83 ±16.97	73.6 ±23.0	68.1 ±17.1	-5.5 ±10.8	115.61 ±50.20	101.61 ±44.88	-14.00 ±27.34	90.6 ±36.7	77.9 ±23.4	-12.7 ±19.2
HDL (mg/dl)	32.00 ±4.95	32.20 ±2.83	0.20 ±2.12	41.0 ±5.5	42.4 ±5.6	1.4 ±0.5	43.72 ±1.41	44.72 ±0.00	1.00 ±1.41	43.9 ±7.7	44.1 ±7.8	0.2 ±1.5	41.17 ±8.50	42.00 ±8.70	0.83 ±3.24	43.2 ±7.2	43.7 ±7.2	0.5 ±1.4
LDL (mg/dl)	86.44 ±31.96	77.8 ±28.7	-8.64 ±3.25	125.3 ±24.5	88.5 ±19.9	-36.8 ±10.7	92.11 ±31.68	81.40 ±45.70	-10.71 ±14.00	99.0 ±21.5	77.7 ±19.6	-21.4 ±12.8	90.88 ±19.86	80.59 ±23.35	-10.29 ±13.85	105.6 ±24.6	80.4 ±17.7	-25.2 ±138
VLDL	32.76 ±7.64	32.00 ±16.55	-0.76 ±8.96	28.3 ±3.0	21.5 ±2.1	-6.8 ±4.8	20.44 ±4.38	17.08 ±0.99	-3.36 ±3.39	14.7 ±4.6	13.6 ±3.4	-1.1 ±2.2	23.16 ±10.04	20.32 ±8.98	-2.84 ±5.47	18.1 ±7.3	15.6 ±4.7	-2.5 ±3.8
LDL/HDL	2.70 ±1.63	2.41 ±1.24	-0.29 ±0.39	3.05 ±0.8	2.08 ±0.5	-0.97 ±0.4	2.10 ±0.75	1.82 ±0.91	-0.28 ±0.16	2.25 ±0.8	1.76 ±0.6	-0.49 ±0.4	2.20 ±0.71	1.91 ±0.73	-0.52 ±0.33	2.4 ±0.8	1.83 ±0.6	-0.57 ±0.4
TC/ HDL	4.72 ±2.10	4.40 ±1.90	-0.32 ±0.20	4.74 ±0.9	3.6 ±0.6	-1.14 ±0.4	3.57 ±0.86	3.20 ±0.93	-0.37 ±0.07	3.58 ±0.9	3.06 ±0.7	-0.52 ±0.4	3.76 ±0.96	3.40 ±0.98	-0.52 ±0.37	3.8 ±1.0	3.19 ±0.7	-0.61 ±0.5
TGL/HDL	5.11 ±2.35	4.96 ±3.30	-0.15 ±0.94	3.45 ±0.2	2.53 ±0.5	-0.92 ±0.6	2.33 ±0.55	1.90 ±0.10	-0.43 ±0.45	1.67 ±0.2	1.54 ±0.5	-0.13 ±0.5	2.80 ±1.90	2.41 ±1.78	-0.69 ±0.86	2.09 ±0.3	1.78 ±0.7	-0.31 ±0.5

The differences in the haemoglobin concentrations of the male and female obese genotypes with polymorphism were found to be 0.51±0.07and 0.2±0.3 g/dl respectively while in the genotypes without polymorphism; it was found to be 0.50±0.21 and 0.4±0.4 g/dl respectively. While in the male and female phenotypes, the increments in the haemoglobin concentrations were found to be 0.50±0.50 and 0.3±0.4 g/dl respectively. The differences in the fasting blood glucose level of the obese male genotypes with polymorphism showed a decline of -0.80±4.24 mg/dl and an increase of 1.8±3.4 mg/dl in the obese female genotypes. Among the male and female genotypes without polymorphism, the fasting blood glucose concentration reduced by -1.11±14.14 and -4.1±8.9 mg/dl respectively. Among the obese male and female phenotypes, the fasting blood glucose level reduced by -1.04±7.09 and -2.7±8.3 mg/dl respectively.

The total cholesterol determined of the obese male and female genotypes with polymorphism, there was an appreciable reduction in the total cholesterol content amounting to -9.20±7.78 and -42.2±12.1 mg/dl respectively. Among the obese male and female genotypes, without polymorphism, the total cholesterol content reduced in both the groups which were -13.11±12.02 and -22.3±12.9 mg/dl respectively. The total cholesterol content also showed a decline in the obese male and female phenotypes which were -12.26±13.34 and -27.3±15.2 mg/dl respectively

Total cholesterol, TGL, LDL levels were found to be markedly higher in the female subjects with pro 12 ala variant than in the subjects with pro 12 pro variant. The reduction in the lipid profile was appreciable among subjects with pro 12 ala when compared with the other variant. The present study lines with the study conducted by Bener et al., 2015 who reported that Pro 12 Ala had a higher fasting glucose, cholesterol, triglyceride than those with common allele. .

The triglycerides were estimated pre and post intervention and the differences in the obese male and female genotype were found to be -3.80±44.55 and 34.2±24.0 mg/dl respectively. Among the obese male and female genotypes without polymorphism, the differenced observed in the triglycerides level

amounted to -16.83± 16.97 in the males and -5.5±10.8 mg/dl in the females. Among the male and female phenotypes, the decline in the triglycerides levels was observed to be -14.00 ±27.34 and -12.7± 19.2 mg/dl respectively.

When the HDL concentration was estimated for the obese male and female genotypes, the differences showed an increase of 0.20± 2.12 in the males and an increase of 1.4 ±0.5 mg/dl in the females. Among the obese male genotypes without polymorphism, there was an increase of 1.00 ±1.41 in the males and an increase of 0.2±1.5 mg/dl in the female. The HDL content of the obese phenotypical males and the females showed an increase of0.83±3.24 and of 0.5±1.4 mg/dl respectively.

Among the obese male and female genotypes with polymorphism, the differences in the LDL concentrations were found to be -8.64±3.25 and -36.8±10.7 mg/dl respectively while in the genotypes without polymorphism, the differences were -10.71±14.00 and -21.4±12.8 mg/dl respectively while in the phenotypes, the differences were -10.29±13.85 and -25.2±1.38 mg/dl respectively.

The differences in the VLDL concentrations found among the male and female obese genotypes with polymorphism were foundto be – 0.76 ±8.96 and -6.8 ± 4.8 mg/dl respectively. Among the obese male and female genotypes without polymorphism, the reduction was found to be -3.36± 3.39 and -1.1± 2.2 respectively. A decline was also observed among the male and female phenotypes which were found to be -2.84±5.47 and -2.5 ±3.8 respectively.

The differences in the LDL to HDL ratios observed among the obese male and female genotypes with polymorphism were found to be – 0.29±0.39 and -0.97±0.4 respectively while in the genotypes without polymorphism, they were – 0.28 ±0.16 and -0.49±0.4 respectively. Among the male and female obese phenotypes, the LDL to HDL ratios was found to be – 0.52±0.33 and -0.57±0.4 respectively. The TC to HDL ratios computed for the obese male and female genotypes with polymorphism revealed that they were – 0.32±0.20 and -1.14 ±0.4 respectively. Among those without polymorphism the same was found to be -

0.37±0.07 and -0.52±0.4 respectively. A similar decline was also found among the phenotypical male and female obese subjects which were found to be -0.52±0.37 and -0.61±0.5 respectively.

The result showed that female subjects with pro 12 ala polymorphism in LDL showed one per cent significant difference ($p<0.01$) . Similarly in female subjects with pro 12 ala polymorphism in LDL/HDL, TC/HDL and TGL/HDL exhibited significant difference of five per cent ($p<0.05$) whereas TGL level exerted at one per cent ($p<0.01$) significant difference. In pro 12 pro female subjects, TC, LDL, VLDL, TC/HDL exerted at five per cent significant level difference ($p<0.05$) where as TGL/HDL showed BMI of female phenotype of normal subjects showed a significant difference at one per cent level ($p<0.01$).

The mean changes in the biochemical parameters such as TGL/HDL among the obese male and female genotype with polymorphism were found to be -0.15 ±0.94 in the males and 0.92±0.6 in the females. Among the obese male and female genotype without polymorphism the differences were found to be -0.43±0.45 in the males and -0.13± 0.5 in the females. In the obese male and female phenotypes, the differences in the TGL to HDL ratio were found to be -0.69±0.86 in the males and -0.31±0.5 in the females.

4. COEFFICIENT OF CORRELATION BETWEEN BMI AND BIOCHEMICAL PARAMETER OF PRO 12 PRO OBESE SUBJECTS

The coefficient of correlation between the BMI and Biochemical parameter of pro 12 pro obese subjects is given in table 37

Table 37

Coefficient of corelation between BMI and biochemical

	BMI	Haemoglobin	Blood Glucose	Total Cholesterol	TGL	HDL	LDL	VLDL
BMI	1	-.026	-0.163	0.056	-0.373	-0.335	0.229	-0.373
Haemoglobin		1	0.108	0.307	-0.087	0.094	0.315	-0.087
Blood Glucose			1	-0.099	-0.056	0.576*	-0.268	-0.056
Total Cholesterol				1	0.370	0.142	0.953**	0.370
TGL					1	-0.179	0.261	1.000**
HDL						1	-0.116	-0.179
LDL							1	0.261
VLDL								1

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

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

From the table, BMI of obese Pro 12 pro subjects showed a non significant positive association with total cholesterol and LDL and exhibited a non significant negative association with haemoglobin, blood glucose TGL, HDL and VLDL. A negative association was noticed in all bio-chemical parameters with haemoglobin. Blood glucose was seen to have a positive correlation ($p<0.05$) with HDL and negative association exerted in other bio-chemical parameters. Total cholesterol showed a highly positive correlation ($p<0.01$) with LDL and negative association with TGL, HDL and VLDL. TGL was positively high correlated ($p<0.01$) with VLDL and negative association with HDL and LDL. HDL showed a negative correlation with LDL and VLDL. LDL had a non significant positive association with VLDL among pro 12 pro obese subjects without polymorphism.

5. COEFFICIENT OF CORRELATION BETWEEN BMI AND BIOCHEMICAL PARAMETER OF PRO 12 ALA OBESE SUBJECTS

The coefficient of correlation between the BMI and Biochemical parameter of pro 12 ala obese subjects is given in Table 38

Table 38

Coefficient of corelation between BMI and biochemical

	BMI	Haemoglobin	Blood Glucose	Total Cholesterol	TGL	HDL	LDL	VLDL
BMI	1	-0.268	-0.131	-0.838	-0.332	-0.419	-0.727	-0.332
Haemoglobin		1	0.209	0.078	-0.724	0.397	0.409	-0.724
Blood Glucose			1	0.052	-0.358	0.524	0.131	-0.358
Total Cholesterol				1	0.590	-0.097	0.915*	0.590
TGL					1	-0.471	0.272	1.000**
HDL						1	-0.116	-0.471
LDL							1	0.272
VLDL								1

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

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

From the table, BMI of obese subjects with Pro 12 ala polymorphism exhibited a non significant negative association with biochemical parameters. Similarly, Haemoglobin indicated a non significant positive association with blood glucose, total cholesterol, HDL and LDL. With Blood glucose, a non significant positive association was seen in total cholesterol, HDL and LDL. Total cholesterol was seen to have an association ($p<0.05$) with LDL and negative association existed with other biochemical parameters. TGL showed a highly positive ($p<0.01$) association with VLDL. Fat free mass was seen to have a non significant negative association LDL and VLDL. LDL exhibited a non significant positive association with VLDL

The mean changes in the biochemical profile of all the overweight subjects pre and post intervention are presented in the Table 39

Table 39

Mean changes in biochemical profile of selected overweight subjects

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=5)			FEMALE(N=5)			MALE(N=17)			FEMALE(N=17)			MALE(N=22)			FEMALE(N=22)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Hb (g/dl)	15.32 ±0.27	15.00 ±0.94	-0.32 ±0.77	13.6 ±1.1	14.6 ±1.1	1.1 ±0.6	14.90 ±1.26	15.05 ±1.16	0.15 ±0.66	13.0 ±3.2	13.8 ±3.3	0.7 ±0.5	15.00 ±1.12	15.04 ±1.09	0.04 ±0.70	13.2 ±0.8	14.0 ±0.9	0.8 ±0.5
FBG (mg/dl)	88.60 ±4.39	89.40 ±3.71	0.80 ±4.38	86.4 ±10.9	82.0 ±3.1	-4.4 ±10.1	92.82 ±8.41	98.65 ±6.11	-4.18 ±7.49	89.2 ±22.6	85.4 ±20.6	-3.8 ±7.4	91.86 ±7.80	88.82 ±5.59	-3.05 ±7.13	88.5 ±9.0	84.6 ±4.5	-4.0 ±8.0
TC (mg/dl)	155.40 ±23.95	145.60 ±21.85	-9.80 ±8.26	228.2 ±18.1	181.4 ±16.6	-46.8 ±28.0	162.4 ±20.14	149.1 ±21.30	-13.35 ±11.0	147.8 ±38.6	118.3 ±32.4	-29.5 ±15.5	160.8 ±20.68	148.3 ±20.95	-12.55 ±10.42	161.1 ±38.4	132.2 ±31.7	-33.5 ±19.0
TGL (mg/dl)	183.20 ±57.51	144.60 ±34.06	-38.60 ±25.97	111.6 ±37.9	93.4 ±33.8	-18.2 ±5.2	107.4 ±23.85	92.65 ±20.88	-14.82 ±17.40	93.8 ±39.6	73.8 ±29.9	-20.0 ±15.4	124.6 ±46.03	104.4 ±32.40	-20.23 ±21.52	97.9 ±34.7	78.3 ±27.7	-19.6 ±13.4
HDL (mg/dl)	36.60 ±4.93	36.80 ±4.76	0.26 ±2.17	52.6 ±10.0	53.6 ±9.6	1.0 ±0.7	47.35 ±7.24	48.00 ±8.25	0.65 ±3.64	40.9 ±15.5	43.2 ±14.9	2.3 ±6.0	44.91 ±8.11	45.45 ±8.90	0.55 ±3.32	43.5 ±8.7	45.5 ±11.5	2.0 ±5.4
LDL (mg/dl)	82.16 ±19.97	79.9 ±16.5	-2.28 ±13.79	153.3 ±15.0	109.1 ±22.1	-44.2 ±26.8	93.62 ±18.87	82.60 ±19.70	-11.04 ±9.83	88.2 ±23.4	60.4 ±18.7	-27.8 ±15.4	91.02 ±19.27	81.97 ±18.70	-9.05 ±11.13	103.0 ±30.3	71.5 ±25.5	-31.5 ±18.5
VLDL	36.64 ±11.50	28.92 ±6.81	-7.72 ±5.19	22.3 ±7.6	18.7 ±6.8	-3.6 ±1.0	21.49 ±4.77	18.53 ±4.18	-2.96 ±3.48	18.8 ±7.9	14.8 ±6.0	-4.0 ±3.1	24.94 ±9.21	20.89 ±6.48	-4.05 ±4.30	19.6 ±6.9	15.7 ±5.5	-3.9 ±2.7
LDL/HDL	2.24 ±0.46	2.17 ±0.28	-0.07 ±0.52	2.91 ±0.7	2.03 ±0.6	-0.88 ±0.5	1.97 ±0.01	1.72 ±0.00	-0.07 ±0.04	2.15 ±0.6	1.39 ±0.6	-0.76 ±0.4	2.02 ±0.59	1.80 ±0.51	-0.22 ±0.47	2.36 ±0.6	1.57 ±0.6	-0.79 ±0.4
TC/ HDL	4.24 ±0.39	3.97 ±0.46	-0.27 ±0.45	4.33 ±0.8	3.38 ±0.6	-0.95 ±0.5	3.43 ±0.93	3.10 ±0.62	-0.37 ±0.59	3.61 ±1.0	2.73 ±0.9	-0.88 ±0.4	3.58 ±0.96	3.26 ±0.70	-0.32 ±0.56	3.70 ±0.6	2.90 ±0.6	-0.8 ±0.4
TGL/ HDL	5.00 ±1.63	3.92 ±1.33	-1.08 ±0.44	2.12 ±0.2	1.74 ±0.5	-0.38 ±0.4	2.26 ±0.57	1.93 ±0.43	-0.31 ±0.39	2.29 ±0.4	1.70 ±0.5	-0.59 ±0.3	2.77 ±1.45	2.29 ±1.13	-0.48 ±0.48	2.25 ±0.4	1.72 ±0.4	-0.53 ±0.3

The differences in the haemoglobin concentrations of the male and female overweight genotypes with polymorphism were found to be 0.32±0.77 and 1.1±0.6 g/dl respectively while in the genotypes with polymorphism; it was found to be 0.15±0.66 and 0.7±0.5 g/dl respectively. While in the male and female phenotypes, the increments in the haemoglobin concentrations were found to be 0.04±0.70 and 0.8±0.5 g/dl respectively. The differences in the fasting blood glucose level of the overweight male genotypes with polymorphism showed an increase of -0.80±4.38 mg/dl and a decline of 4.4±10.1 mg/dl in the overweight female genotypes. Among the male and female genotypes without polymorphism, the fasting blood glucose concentration reduced by -4.18±7.49 and 3.8±7.4 mg/dl respectively. Among the overweight male and female phenotypes, the fasting blood glucose level reduced by 3.05±7.13 and 4.0±8.0 mg/dl respectively.

The total cholesterol determined of the overweight male and female genotypes with polymorphism, there was an appreciable reduction in the total cholesterol content amounting to 9.80±8.26 and 46.8±28.0 mg/dl respectively. Among the overweight male and female genotypes, without polymorphism, the total cholesterol content reduced in both the groups which were 13.35±11.0 and 29.5±15.5 mg/dl respectively. The total cholesterol content also showed a decline in the overweight male and female phenotypes which were 12.55±10.42 and 33.5±19.0 mg/dl respectively. Cholesterol, LDL and Triglyceride were higher in *Pro/Ala* carriers (Bener at al., 2015)

The triglycerides were estimated pre and post intervention and the differences in the overweight male and female genotype were found to be 38.60±29.97 and 18.2±5.2 mg/dl respectively. Among the obese male and female genotypes without polymorphism, the difference observed in the triglycerides level amounted to -14.82 ±17.40 in the males and -20.0±15.4 mg/dl in the females. Among the male and female phenotypes, the decline in the triglycerides levels was observed to be -20.23±21.52 and -19.6± 13.4mg/dl respectively.

When the HDL concentration was estimated for the overweight male and female genotypes, the differences showed an increase of 0.26± 2.17 in the males and an increase of 1.0 ±0.7 mg/dl in the females. Among the overweight male genotypes without polymorphism, there was an increase of 0.65 ±3.64 in the males and an increase of 2.3±6.0mg/dl in the female. The HDL content of the overweightphenotypical males and the females showed an increase of 0.55±3.32 and of 2.0±5.4 mg/dl respectively.Among the overweight male and female genotypes with polymorphism, the differences in the LDL concentrations were found to be -2.28±13.79 and -44.2±26.8 mg/dl respectively while in the genotypes without polymorphism, the differences were -11.04±9.83 and -27.8±15.4 mg/dl respectively while in the phenotypes, the differences were -9.05±11.13 and -31.5±18.50 mg/dl respectively.

The differences in the VLDL concentrations found among the male and female overweight genotypes with polymorphism were found to be – 7.72±5.19 and -3.6 ± 1.0 mg/dl respectively. Among the obese male and female genotypes without polymorphism, the reduction was found to be -2.96± 3.48 and -4.0± 3.1 respectively. A decline was also observed among the male and female phenotypes which were found to be -4.05±4.30and -3.9 ±2.7respectively.

The mean TGL level were found to be higher among male subjects with pro 12 ala polymorphism while mean LDL and TC were found to be higher among female subjects with pro 12 ala polymorphism. The differences in the mean TC, LDL and TGL were found to br greater in sujects with pro 12 ala polymorphism.

The differences in the LDL to HDL ratios observed among the overweight male and female genotypes with polymorphism were found to be – 0.07±0.52 and -0.88±0.5 respectively while in the genotypes without polymorphism, they were – 0.07 ±0.04 and -0.76±0.4 respectively. Among the male and female overweight phenotypes, the LDL to HDL ratios was found to be – 0.22±0.47 and -0.79±0.4 respectively. The TC to HDL ratios computed for the overweight male and female genotypes with polymorphism revealed that they were – 0.27±0.45 and -0.95 ±0.5 respectively. Among those without polymorphism the same was found to be -

0.37±0.59 and -0.88±0.4 respectively. A similar decline was also found among the phenotypical male and female overweight subjects which were found to be -0.32±0.56 and -0.80±0.4 respectively.

The result showed that male subjects with pro 12 ala polymorphism in V LDL showed one per cent significant difference ($p<0.01$) . Similarly in female subjects with pro 12 ala polymorphism in LDL and TGL/HDL exhibited significant difference of five per cent ($p<0.05$) whereas VLDL level exerted at one per cent ($p<0.01$) significant difference. In pro 12 pro female subjects, TC/HDL exerted at five per cent significant level difference ($p<0.05$) where as TGL/HDL showed a significant difference at one per cent level ($p<0.01$). In phenotype male subjects, one per cent significant difference ($p<0.01$). at LDL whereas TGL/HDL and TC/HDL obtained five per cent significant difference($p<0.05$).

The mean changes in the biochemical parameters such as TGL/HDL among the overweight male and female genotype with polymorphism were found to be -1.08 ±0.44 in the males and 0.38±0.4 in the females. Among the overweight male and female genotype without polymorphism the differences were found to be -0.31±0.39 in the males and -0.59± 0.30 in the females. In the overweight male and female phenotypes, the differences in the TGL to HDL ratio were found to be -0.48±0.48 in the males and -0.53±0.3 in the females.

6. COEFFICIENT OF CORRELATION BETWEEN BMI AND BIOCHEMICAL OF PRO 12 PRO OVERWEIGHT SUBJECTS

The coefficient of correlation between the BMI and biochemical of pro 12 pro overweight subjects is given in table 40

Table 40

Coefficient of corelation between BMI and biochemical

	BMI	Haemoglobin	Blood Glucose	Total Cholesterol	TGL	HDL	LDL	VLDL
BMI	1	-0.204	-0.101	-0.191	0.293	0.013	-0.274	0.293
Haemoglobin		1	-0.013	0.420	0.165	-0.058	0.443	0.165
Blood Glucose			1	0.044	0.325	-0.254	0.085	0.325
Total Cholesterol				1	0.255	0.393	0.861**	0.255
TGL					1	0.487*	-0.141	1.000**
HDL						1	-0.097	0.487*
LDL							1	-0.141
VLDL								1

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

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

From the table, BMI of overweight Pro 12 pro subjects showed a non significant association with all biochemical parameters. Haemoglobin showed a non significant positive association with total cholesterol, TGL, LDL and VLDL. A non significant association was noticed in total cholesterol, TGL, HDL, LDL and VLDL with blood glucose. Total cholesterol was seen to have a high positive correlation ($p<0.01$) with LDL. TGL had a positive correlation with HDL at five per cent significant level and one per cent high positive correlation with VLDL. HDL showed a positive correlation ($p<0.05$) with VLDL. Fat free mass was positively high correlated ($p<0.01$) with skeletal muscle mass and five per cent correlation with per cent body fat. LDL had a negative non significant association with VLDL among pro 12 pro overweight subjects without polymorphism.

7. COEFFICIENT OF CORRELATION BETWEEN BMI AND BIOCHEMICAL OF PRO 12 ALA OVERWEIGHT SUBJECTS

Correlation among BMI and biochemical of pro 12 ala overweight subjects is given in table 41

Table 41

Coefficient of corelation between BMI and body composition

	BMI	Haemoglobin	Blood Glucose	Total Cholesterol	TGL	HDL	LDL	VLDL
BMI	1	-0.972**	0.503	0.344	0.920*	-0.263	-0.152	0.920*
Haemoglobin		1	-0.379	-0.364	-0.974**	0.312	-0.170	-0.974**
Blood Glucose			1	-0.330	0.409	-0.333	-0.511	0.409
Total Cholesterol				1	0.356	0.724	0.970**	0.356
TGL					1	-0.286	0.141	1.000**
HDL						1	0.790	-0.286
LDL							1	0.141
VLDL								1

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

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

From the table, BMI of overweight subjects with Pro 12 ala polymorphism exhibited a positive correlation ($p<0.05$) with TGL and VLDL. BMI showed a strong negative correlation with blood haemoglobin. Blood Haemoglobin indicated a strong negative correlation with TGL and VLDL. Blood glucose exerted a non significant correlation with all biochemical parameters. Total cholesterol was seen to have a strong association ($p<0.01$) with LDL and a non significant association existed with other biochemical parameters. TGL showed a highly positive ($p<0.01$) association with VLDL. HDL was seen to have a non significant association with LDL and VLDL. LDL indicated a non significant positive association with VLDL.

The mean changes in the biochemical profile of all the normal subjects pre and post intervention are presented in the Table 42

Table 42

Mean changes in biochemical profile of selected normal subjects

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=1)			FEMALE(N=2)			MALE(N=19)			FEMALE(N=21)			MALE(N=20)			FEMALE(N=23)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Hb (g/dl)	15.2	14.7	-0.5	12.9 ±0.7	13.4 ±0.8	0.5 ±0.1	15.0 ±0.57	14.5 ±1.77	-0.5 ±1.20	12.5 ±0.9	12.7 ±0.6	0.2 ±0.6	15.00 ±1.32	14.48 ±1.36	-0.52 ±0.65	12.5 ±0.9	12.7 ±0.7	0.3 ±0.6
FBG (mg/dl)	83	87	4	76.5 ±2.1	78.0 ±1.4	1.5 ±0.7	86.50 ±1.41	85.7 ±0.71	-0.8 ±0.71	84.3 ±6.1	86.1 ±6.2	2.6 ±3.9	86.35 ±4.50	85.75 ±5.32	-0.60 ±4.33	83.6 ±6.3	86.1 ±6.4	2.5 ±3.8
TC (mg/dl)	149	135	-14	206.5 ±19.1	145.5 ±4.9	-61.0 ±14.1	127.3 ±10.61	133.2 ±18.38	8.5 ±26.87	143.5 ±18.2	156.0 ±24.2	12.6 ±20.1	128.35 ±25.06	133.25 ±22.82	7.3 ±18.92	149.0 ±25.4	155.1 ±23.3	6.2 ±28.7
TGL (mg/dl)	93	115	22	117.0 ±4.2	97.2 ±5.7	-20.0 ±1.4	85.6 ±13.44	99.6 ±49.50	13.9 ±30.06	65.5 ±18.3	79.8 ±24.2	14.3 ±18.4	86.00 ±40.23	100.35 ±59.12	14.35 ±51.64	70.0 ±22.9	81.3 ±23.7	11.3 ±20.2
HDL (mg/dl)	35	33	-2	62.5 ±4.5	64.0 ±5.7	1.5 ±0.7	42.8 ±7.07	41.6 ±12.02	1.02 ±4.95	49.8 ±9.0	48.3 ±10.3	-1.5 ±2.3	42.45 ±7.35	41.20 ±5.75	-1.25 ±6.08	50.9 ±9.4	49.7 ±10.8	-1.3 ±2.4
LDL (mg/dl)	95.4	102	6.6	117.6 ±10.7	62.1 ±0.4	-55.5 ±10.3	67.3 ±6.22	71.6 ±16.3	4.3 ±10.04	81.10 ±17.3	91.8 ±23.3	10.8 ±20.0	68.70 ±18.49	73.13 ±18.44	4.43 ±10.93	84.1 ±19.7	89.2 ±23.8	5.1 ±27.1
VLDL	18.6	23	4.4	26.4 ±3.4	19.4 ±1.1	7.0 ±4.5	17.1 ±2.69	19.9 ±9.90	2.8 ±7.21	13.1 ±3.7	16.0 ±4.8	2.9 ±3.7	17.20 ±8.05	20.07 ±11.82	2.87 ±10.33	14.3 ±5.2	16.3 ±4.7	2.0 ±4.6
LDL/HDL	2.72	3.09	0.37	1.88 ±0.0	0.97 ±0.1	-0.91 ±0.1	1.57 ±0.21	1.72 ±0.13	0.15 ±0.08	1.62 ±0.5	1.90 ±0.8	0.28 ±0.5	1.61 ±0.52	1.77 ±0.56	0.16 ±0.30	1.65 ±0.5	1.79 ±0.8	0.14 ±0.6
TC/ HDL	4.25	4.09	-0.16	3.3 ±0.00	2.27 ±0.1	-1.03 ±0.2	2.97 ±0.38	3.20 ±0.55	0.23 ±0.17	2.88 ±0.6	3.2 ±0.8	0.32 ±0.5	3.02 ±0.68	3.23 ±0.70	0.21 ±0.39	2.92 ±0.6	3.12 ±0.8	0.2 ±0.6
TGL/ HDL	2.65	3.48	0.83	1.87 ±0.2	1.51 ±0.2	-0.36 ±0.0	2.0 ±0.86	2.39 ±2.10	0.39 ±1.24	1.31 ±0.4	1.65 ±0.6	0.34 ±0.4	2.02 ±1.04	2.43 ±1.64	0.41 ±1.19	1.37 ±0.4	1.63 ±0.6	0.26 ±0.5

The differences in the haemoglobin concentrations of the male and female normal genotypes with polymorphism were found to be -0.5and 0.5±0.1g/dl respectively while in the genotypes without polymorphism, it was found to be -0.5±1.20 and 0.2±0.6 g/dl respectively. While in the male and female phenotypes, the differences in the haemoglobin concentrations were found to be 0.52±0.65 and 0.3±0.6 g/dl respectively. The differences in the fasting blood glucose level of the normal male and female genotypes with polymorphism showed an increase of 4 mg/dl and 1.5±0.7 mg/dl respectively Among the male genotypes without polymorphism, the fasting blood glucose concentration reduced by -0.8±0.71 and an increment of 2.6±3.9 mg/dl in the females. Among the normal male and female phenotypes, the differences in fasting blood glucose level were found to be y -0.60±4.33 and 2.5±3.8 mg/dl respectively.

The total cholesterol determined of the normal male and female genotypes with polymorphism, there was an appreciable reduction in the total cholesterol content amounting to 14.0and -61.0±14.1 mg/dl respectively. Among the normal male and female genotypes, without polymorphism, the total cholesterol content showed an increment in both the groups which were 805±26.87 and 12.6±20.1mg/dl respectively. The total cholesterol content also showed an increment decline in the obese male and female phenotypes which were 7.3±18.92 and 6.2± 28.7mg/dl respectively

The triglycerides were estimated pre and post intervention and the differences in the normal male and female genotype were found to be 22 and 20.0±1.4 mg/dl respectively. Among the normal male and female genotypes without polymorphism, the difference observed in the triglycerides level amounted to 13.9±30.06 in the males and 14.3±18.4 mg/dl in the females. Among the male and female phenotypes, the increment in the triglycerides levels was observed to be 14.35 ±51.64and 11.3± 20.2 mg/dl respectively.

When the HDL concentration was estimated for the normal male and female genotypes, the differences found in the males showed a decline of -2.00 in the males and an increase of 1.5 ±0.7 mg/dl in the females. Among the normal male and female genotypes without polymorphism, there was a decline of 1.02

±4.95 and of -1.5±2.3 mg/dl respectively. The HDL content of the normalphenotypical males and the females showed a decline of -1.25±6.08 and of -1.3±2.4 mg/dl respectively.

Among the normal male and female genotypes with polymorphism, the differences in the LDL concentrations were found to be 606 and -55.5±10.3mg/dl respectively while in the genotypes without polymorphism, the differences were -4.3±10.04 and 10.8±20.0 mg/dl respectively while in the phenotypes, the differences were 4.43±10.93 and 5.1±27.1 mg/dl respectively. The differences in the VLDL concentrations found among the male and female normal genotypes with polymorphism were found to be -4.4 and 7.0 ± 4.5 mg/dl respectively. Among the normal male and female genotypes without polymorphism, the increase in HDL was found to be 2.8± 7.21 and 2.9± 3.7 respectively. An increase was also observed among the male and female phenotypes which were found to be -2.87±10.33 and 2.0±4.6 respectively.

The mean TC, TGL, LDL were found to be higher among the subjects with pro 12 ala polymorphism and a greater reduction after intervention were also noted in subjects with pro 12 ala polymorphism.

The differences in the LDL to HDL ratios observed among the normal male and female genotypes with polymorphism were found to be 0.37and -0.91±0.1 respectively while in the genotypes without polymorphism, they were0.15 ±0.08 and 0.28±0.5 respectively. Among the male and female normal phenotypes, the LDL to HDL ratios was found to be 0.16±0.30 and 0.14±0.6 respectively. The TC to HDL ratios computed for the normal male and female genotypes with polymorphism revealed that they were – -0.16 and -1.03 ±0.2 respectively. Among those without polymorphism the same was found to be 0.23±0.17 and 0.32±0.5 respectively. A similar increment was also found among the phenotypical male and female normal subjects which were found to be -0.21±0.39 and 0.2±0.6 respectively.

The result showed that male subjects with pro 12 ala polymorphism in HDL showed five per cent significant difference ($p<0.05$) . Similarly in female subjects with pro

12 ala polymorphism in VLDL and TC/HDL exhibited significant difference of five per cent ($p<0.05$) whereas TC level exerted at one per cent ($p<0.01$) significant difference. In pro 12 pro female subjects, LDL and TC exerted at five per cent significant level difference ($p<0.05$) where as TC/HDL showed a significant difference at one per cent level ($p<0.01$). In phenotype male subjects, one per cent significant difference ($p<0.01$) of VLDL, TC/HDL whereas HDL obtained five per cent significant difference ($p<0.05$). In phenotype female subjects, TC showed one per cent significant difference ($p<0.01$) whereas VLDL and TGL/HDL obtained five per cent significant difference($p<0.05$).

The mean changes in the biochemical parameters such as TGL/HDL among the normal male and female genotype with polymorphism were found to be 0.83 in the males and -0.36±0.0 in the females. Among the normal male and female genotype without polymorphism the differences were found to be 0.39±1.24 in the males and 0.34± 0.4 in the females. In the normal male and female phenotypes, the differences in the TGL to HDL ratio were found to be 0.41 ±1.19 in the males and 0.26±0.5 in the females.

8. COEFFICIENT OF CORRELATION BETWEEN BMI AND BIOCHEMICAL OF NORMAL SUBJECTS

The coefficient of correlation between the BMI and biochemical of normal subjects is given in table 43

Table 43

Coefficient of corelation between BMI and body composition

	BMI	Haemoglobin	Blood Glucose	Total Cholesterol	TGL	HDL	LDL	VLDL
BMI	1	0.350	-0.325	0.195	0.072	-0.358	0.326	0.068
Haemoglobin		1	-0.413	0.370	0.234	0.071	0.316	0.224
Blood Glucose			1	-0.381	-0.370	0.454	-0.414	-0.344
Total Cholesterol				1	0.692**	0.031	0.876**	0.647**
TGL					1	-0.304	0.300	1.000**
HDL						1	-0.063	-0.308
LDL							1	0.270
VLDL								1

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

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

From the table, subjects with normal BMI showed a non significant association with all biochemical parameters. A non significant association was noticed in all biochemical parameters with haemoglobin. Blood glucose was seen to have a non significant association with all biochemical parameters. Total cholesterol had a strong positive correlation with TGL, LDL and VLDL at one per cent significant level. TGL showed a highly positive correlation ($p<0.01$) with VLDL. HDL and LDL exhibited a non significant association with biochemical parameters among normal subjects.

9. Body Composition Measures

The mean changes in the body composition was analysed Obese subjects pre and post intervention and the results obtained are presented in the Table 44

Table 44

Mean changes in the body composition measures of the selected obese subjects

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N= 5)			FEMALE(N= 5)			MALE(N= 18)			FEMALE(N=17)			MALE(N= 23)			FEMALE(N=20)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Protein(kg)	11.58 ±1.03	11.42 ±1.64	-0.16 ±1.80	7.84 ±0.73	7.76 ±0.82	-0.08 ±0.26	10.94 ±1.39	10.92 ±1.50	-0.02 ±0.96	7.26 ±1.27	7.27 ±1.23	0.01 ±0.83	11.08 ±1.33	11.03 ±1.50	-0.05 ±1.14	7.41 ±1.17	7.40 ±1.14	-0.01 ±0.72
Mineral(kg)	4.25 ±0.60	4.21 ±0.68	-0.04 ±0.68	2.86 ±0.33	2.90 ±0.42	0.04 ±0.20	3.90 ±0.49	3.94 ±0.54	0.04 ±0.28	2.54 ±0.67	3.00 ±1.59	0.46 ±1.57	3.98 ±0.52	4.00 ±0.57	0.02 ±0.38	2.62 ±0.61	2.98 ±1.38	0.36 ±1.36
BFM (kg)	38.36 ±8.17	34.40 ±6.49	-3.96 ±7.76	34.94 ±5.39	31.58 ±4.69	-3.36 ±2.55	25.42 ±7.24	22.32 ±8.27	-3.10 ±4.49	28.21 ±5.58	25.79 ±9.43	-2.41 ±7.17	28.23 ±9.08	24.94 ±9.30	-3.29 ±5.16	29.89 ±6.16	27.24 ±8.76	-2.65 ±6.28
TBW(l)	43.10 ±4.07	42.44 ±6.14	-0.66 ±6.29	29.18 ±2.75	28.98 ±3.25	-0.20 ±1.29	40.61 ±5.08	40.38 ±5.39	-0.23 ±0.30	27.05 ±4.72	28.72 ±6.66	1.32 ±4.47	41.14 ±4.91	40.83 ±5.48	-0.31 ±3.96	27.59 ±4.35	28.53 ±5.92	0.94 ±3.94
SLM(kg)	55.36 ±5.18	54.56 ±7.87	-0.80 ±8.23	37.46 ±3.53	37.12 ±4.13	-0.34 ±1.57	52.21 ±6.56	51.96 ±6.97	-0.25 ±4.32	34.77 ±6.07	36.11 ±7.87	1.35 ±5.09	52.89 ±6.32	52.53 ±7.07	-0.36 ±5.17	35.44 ±5.58	36.37 ±7.03	0.93 ±4.49
FFM(kg)	58.90 ±5.74	58.10 ±8.42	-0.80 ±8.74	39.86 ±3.79	39.54 ±4.48	-0.32 ±1.73	55.43 ±6.95	55.24 ±7.40	-0.19 ±4.49	36.86 ±6.56	38.21 ±8.71	1.35 ±6.95	56.19 ±6.74	55.87 ±7.52	-0.32 ±5.44	37.61 ±6.04	38.55 ±7.78	0.94 ±6.06
VFA(cm^2)	143.52 ±23.21	126.92 ±18.84	-16.60 ±17.91	111.30 ±15.94	93.82 ±17.37	-17.48 ±16.02	99.17 ±21.39	88.12 ±23.92	-11.05 ±8.97	78.21 ±25.47	66.59 ±34.04	-11.61 ±43.03	108.81 ±28.31	96.55 ±27.83	-12.26 ±11.2	86.48 ±27.35	73.40 ±32.61	-13.08 ±37.75
SMM(kg)	32.88 ±3.16	32.44 ±4.91	-0.44 ±5.38	21.60 ±2.24	21.22 ±2.55	-0.38 ±0.82	30.97 ±4.22	30.93 ±4.54	-0.04 ±2.91	18.88 ±6.15	19.94 ±3.73	1.06 ±4.54	31.39 ±4.03	31.26 ±4.55	-0.13 ±3.44	19.56 ±5.51	20.26 ±3.46	0.70 ±3.97
PBF (%)	39.14 ±5.02	34.68 ±3.19	-4.46 ±6.30	46.78 ±5.30	44.48 ±5.63	-2.30 ±2.77	31.38 ±7.16	28.34 ±8.58	-3.04 ±5.89	43.31 ±3.73	40.02 ±11.38	-3.29 ±10.88	33.07 ±7.41	29.72 ±8.11	-3.35 ±5.87	44.18 ±4.30	41.14 ±10.30	-3.04 ±9.43
Obesity Degree	147.60 ±9.24	136.40 ±6.77	-11.20 ±8.93	114.60 ±13.69	135.80 ±17.94	-8.80 ±11.97	126.11 ±11.53	116.94 ±13.39	-9.17 ±7.36	130.07 ±12.07	128.60 ±16.38	-1.47 ±7.13	130.78 ±14.15	121.17 ±14.64	-9.61 ±7.55	113.70 ±13.73	130.40 ±16.61	-3.30 ±8.84
BMR (Kcal)	1631 ±119.18	1690 ±160.35	59 ±140.3	1230 ±81.91	1224 ±97.45	-6.40 ±38.55	1563 ±147.7	1566 ±161.8	3.00 ±97.4	1166 ±141.5	1195 ±187.9	29.27 ±149.7	1578 ±142.3	1593 ±166.2	15 ±107.1	1182 ±130.3	1202 ±167.8	20.35 ±130.6
Fitness Score	55.40 ±9.63	63.20 ±7.60	7.80 ±9.26	56.80 ±6.46	61.20 ±3.63	4.40 ±5.13	64.89 ±10.33	67.94 ±9.38	3.05 ±6.38	62.13 ±5.34	63.80 ±6.09	1.67 ±5.16	62.83 ±10.74	66.91 ±9.09	4.08 ±7.15	60.80 ±5.95	63.15 ±5.60	2.35 ±5.16

In the obese male and female genotypes with polymorphism, the differences in the protein content were found to be – 0.16 ±1.80 and -0.08± 0.26 respectively. Among the genotypes without polymorphism, the decline in the males was found to be -0.02±0.96 and in the females, it was 0.01±0.83.The differences in the body protein content of the male and female phenotypes showed a difference of – 0.05±1.14 and -0.01±0.72 respectively. The changes in the body mineral content were analysed in the obese male and female genotypes with polymorphism and it was found to be -0.04±0.68 among the males and 0.04±0.20 in the females. While among the genotypes without polymorphism, the differences observed were 0.04±0.28 and 0.46±1.57 respectively. Among the male and female phenotypes, the differences in the body mineral content were recorded as 0.02±0.38 and 0.36±1.36 respectively.

The differences in the body fat mass of the obese male and female genotypes with polymorphism showed a decline of -3.96±7.76 and -3.36±2.55 respectively while in the genotypes without polymorphism, the differences were -3.10 ±4.49 and -2.41±7.17 respectively. Among the obese male and female phenotypes, the differences recorded were – 3.29 ±5.16 and -2.65±6.28 respectively.

The differences in the total body water estimated in the obese male and female genotypes with polymorphism showed a decline of -0.66±6.29 and -0.20±1.29 respectively. In the obese subjects without polymorphism, the total body water content showed a decline in the males which were – 0.23±0.30 and an increase in the females which were 1.32±4.47. Among the male and female obsess phenotypes, the differences in the TBW content showed a decline in the males which were – 0.31±3.96 and an increase in the females which were 0.94±3.94. Among the obese male and female genotypes with polymorphism, the differences in the soft lean mass was found to be -0.80±8.23 and -0.34±1.57 respectively while in the genotypes without polymorphism, the difference were -0.25±4.32 in the males and 1.35±5.09 in the females. Among the obese male and female phenotypes, the differences in the soft lean mass were found to be -0.36±5.17 and 0.93±4.49 respectively.

The differences were also observed in the fat free mass of obese male and female genotypes with polymorphism which were found to -0.80±8.74 and -0.32±1.73 respectively. Similar differences were also observed among the obese

genotypes without polymorphism and were recorded as -0.19±4.49 and 1.35±6.95 respectively. Among the phenotypical male and female obese subjects, the differences in the fat free mass were found to be -0.32±5.44 and 0.94±6.06 respectively.

The Visceral fat area determined for the male and female obese genotypes with polymorphism, a decline was observed and were found to be –16.60±17.91 and -17.48±16.02 respectively. Among the obese male and female genotypes without polymorphism, the differences were found to be – 11.05±8.97 and -11.61±43.03 respectively. The VFA of the male and female phenotypes belonging to the same category showed a reduction which were recorded as -12.26±11.22 in the males and -13.08±37.75 in the females

The difference in the SMM of the obese male and female genotypes showed a decline of -0.44±5.38 and -0.38±0.82 respectively. While in the genotypes without polymorphism, they were -0.04± 2.91 and 1.06±4.54 respectively. Among the obese phenotypes the differences in the SMM were found to be -0.13±3.44 in the males and 0.70±3.97 in the females.

The percent body fat analysed for the subjects before and after intervention showed a decline in all the groups, among the male and female genotypes with polymorphism, the differences observed were -4.46±6.30 and -2.30±2.77 respectively. Whilst in the genotype without polymorphism, the differences recorded were -3.04±5.89 and -3.29±10.88 respectively. The difference observed in the male and female phenotypes were -3.35 ±5.87 and -3.04±9.43 respectively.

The obesity degree computed forthe selected subjects pre and post intervention also showed a decline, it was -11.20±8.93 and -8.80±11.97 in the obese male and female genotypes with polymorphism while in the genotypes without polymorphism, they were recorded as -9.17±7.36 and -1.47±7.13 respectively. Among the male and female phenotypes, the decline in the degree of obesity was recorded as -9.61 ±7.55 and -3.30 ±8.84 respectively.

Variations were also observed for the basal metabolic rate of the obese male and female genotypes with polymorphism and they were found to be 59±140.30 in

the males and -6.40 ±38.55 in the females. Among the genotypes, without polymorphism, the differences were 3±97.41 in the males and 29.27±149.70 in the females. The BMR differences among the male and female phenotypes were recorded as 15±107.11 in the males and 20.35±130.68 in the females.

The result showed that male subjects with pro 12 ala polymorphism in Visceral fat area showed five per cent significant difference ($p<0.05$). Similarly in female subjects with pro 12 ala polymorphism in obesity degree and skeletal muscle mass exhibited significant difference of five per cent ($p<0.05$).In pro 12 pro female subjects, obesity degree exerted at five per cent significant level difference ($p<0.05$) where as fitness score showed a significant difference at one per cent level ($p<0.01$). In phenotype male subjects, visceral fat area showed one per cent significant difference ($p<0.01$) , whereas fat free mass obtained five per cent significant difference ($p<0.05$).

There were improvement in the Fitness Scores of all the selected subjects due to the intervention strategies and the differences among the male and female obese genotypes with polymorphism were found to be 7.80±9.26 and 4.40±5.13 respectively. Among the genotypes without polymorphism, the differences in the fitness scores were found to be 3.05±6.38 and 1.67±5.16 respectively. The variations in the fitness scores of the male and female phenotypes were recorded 4.08±7.15 and 2.35±5.16 respectively.

10. COEFFICIENT OF CORRELATION BETWEEN BMI AND BODY COMPOSITION OF PRO 12 PRO OBESE SUBJECTS

The coefficient of correlation between the BMI and body composition of pro 12 pro obesesubjects is given in table 45.

Table 45

Coefficient of corelation between BMI and body composition

	BMI	Body Fat Mass	Total Body Water	Visceral Fat Area	Soft Lean Mass	Fat Free Mass	Skeletol Muscle Mass	% Body Fat	Obesity Degree
BMI	1	0.731**	0.116	0.863**	0.107	0.110	0.074	0.499*	0.847**
BFM		1	-0.330	0.875**	-0.341	-0.330	-0.375	0.925**	0.903**
TBW			1	-0.017	1.000**	1.000**	0.996**	-0.635**	-0.143
VFA				1	-0.027	-0.015	-0.060	0.703**	0.829**
SLM					1	1.000**	0.998**	-0.644**	-0.152
FFM						1	0.996**	-0.634**	-0.147
SMM							1	-0.672**	-0.176
PBF								1	0.745**
Obesity Degree									1

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

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

From the table, BMI of obese Pro 12 pro subjects showed a high positive correlation ($p<0.01$) with body fat mass, visceral fat, per cent body fat and obesity degree. With total body water, soft lean mass, fat free mass and skeletal muscle mass, a negative association existed. Body fat mass showed a highly positive association ($p<0.01$) with visceral fat area, per cent body fat and obesity degree. A negative association was noticed in total body water, soft lean mass, fat free mass and skeletal muscle mass with body fat mass. Total body water was seen to have a high positive correlation ($p<0.01$)with soft lean mass, fat free mass, skeletal muscle mass and per cent body fat. Soft lean mass showed a highly positive correlation ($p<0.01$) with fat free mass, skeletal muscle mass and per cent body fat. Fat free mass was positively high correlated ($p<0.01$) with skeletal muscle mass and highly negative association with per cent body fat. Skeletal muscle mass showed a highly negative correlation with per cent body fat. Per cent body fat had a highly significant

association with obesity degree among pro 12 pro obese subjects without polymorphism.

11. COEFFICIENT OF CORRELATION BETWEEN BMI AND BODY COMPOSITION OF PRO 12 ALA OBESE SUBJECTS

Correlation among BMI and body composition of pro 12 ala obese subjects is given in table 46

Table 46

Coefficient of corelation between BMI and body composition

	BMI	BFM	TBW	VFA	SLM	FFM	SMM	PBF	OD
BMI	1	0.448	0.875	0.870	0.868	0.875	0.854	0.634	0.724
BFM		1	0.321	0.826	0.304	0.315	0.262	0.353	0.914*
TBW			1	0.692	1.000**	1.000**	0.997**	0.321	0.669
VFA				1	0.679	0.689	0.647	0.603	0.938*
SLM					1	1.000**	0.998**	0.305	0.655
FFM						1	0.997**	0.320	0.664
SMM							1	0.265	0.618
PBF								1	0.470
Obesity Degree									1

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

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

From the table, BMI of obese subjects with Pro 12 ala polymorphism exhibited a non significant positive association with body composition parameters. Similarly, body fat mass indicated a positive correlation ($p<0.05$) with obesity degree and had a non significant positive association with other body composition parameters. With total body water, a strong positive correlation ($p<0.01$) was seen only for soft lean mass, fat free mass and skeletal muscle mass. Visceral fat area was seen to have an association ($p<0.05$) with obesity degree and negative association existed with other body composition parameters. Soft lean mass showed a highly positive association with fat free mass and skeletal muscle mass. Fat free mass was seen to have a strong positive association with skeletal muscle mass at 1 per cent level.

Skeletal muscle mass and per cent body fat exhibited a non significant positive association.

The mean changes in the body composition was analysed overweight subjects pre and post intervention and the results obtained are presented in the Table 47.

Table 47

Mean changes in the body composition measures of the selected overweight subjects

PARAMETERS	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=5)			FEMALE(N=5)			MALE(N=17)			FEMALE(N=17)			MALE(N=22)			FEMALE(N=22)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Protein(kg)	10.80 ±1.37	11.08 ±1.42	0.28 ±0.46	7.58 0.92	7.36 0.52	-0.32 0.54	10.55 ±1.14	10.47 ±1.14	-0.08 ±0.75	7.09 0.68	7.03 0.62	-0.06 0.36	10.60 1.17	10.61 1.20	0.01 0.70	7.20 0.75	7.08 0.59	-0.12 0.41
Mineral(kg)	3.83 ±0.58	3.82 ±0.46	-0.01 ±0.14	2.87 0.38	2.62 0.20	-0.24 0.25	3.73 ±0.45	3.65 ±0.39	0.08 ±0.27	2.62 0.26	2.59 0.25	-0.03 0.14	3.75 0.47	3.69 0.40	-0.06 0.25	2.68 0.30	2.60 0.24	-0.08 0.19
BFM (kg)	18.82 ±4.93	13.08 ±3.35	-5.74 ±2.94	23.66 1.67	21.38 2.50	-2.28 3.00	17.61 ±3.24	15.46 ±3.68	-2.15 ±3.76	22.15 2.17	20.69 2.07	-1.45 1.40	17.89 3.59	14.92 3.67	-2.97 3.85	32.49 2.13	20.85 2.13	-1.64 1.82
TBW(l)	39.90 ±5.00	40.62 ±4.67	0.72 ±1.31	28.54 3.35	27.14 1.83	-1.40 2.01	38.56 ±4.48	37.54 ±5.40	-1.02 ±5.49	26.40 2.50	26.14 2.32	-0.26 1.23	38.87 4.51	38.24 5.30	-0.63 4.88	26.89 2.78	26.37 2.22	-0.52 1.47
SLM(kg)	51.36 ±6.45	52.38 ±6.16	1.02 ±1.76	36.58 4.30	34.84 2.39	-1.74 2.59	50.18 ±5.34	49.79 ±5.19	-0.39 ±3.41	33.93 3.19	33.64 3.04	-0.29 1.71	50.45 5.47	50.38 5.38	-0.07 3.13	34.53 3.55	33.91 2.90	-0.62 1.98
FM(kg)	54.50 ±6.96	55.52 ±6.54	1.02 ±1.76	38.98 4.65	37.04 2.56	-0.70 0.00	53.25 ±5.71	52.84 ±5.57	-0.41 ±3.60	36.17 3.42	33.69 8.75	-0.70 0.00	53.54 5.86	53.45 5.75	-0.09 3.30	36.81 3.80	34.45 7.85	-0.70 0.00
VFA(cm^2)	79.18 ±10.46	59.94 ±12.54	-19.24 ±7.13	71.06 8.60	60.14 12.60	-10.92 5.32	71.94 ±9.78	63.01 ±7.18	-8.93 ±8.20	66.38 8.99	60.94 13.85	-5.44 9.24	73.59 10.17	62.31 8.42	-11.28 8.97	67.44 8.93	60.76 13.28	-6.68 8.71
SMM(kg)	30.56 ±4.08	31.40 ±4.33	0.84 ±1.39	20.98 2.77	19.90 1.55	-1.08 1.73	29.78 ±3.45	29.59 ±3.43	-0.19 ±2.24	19.36 2.00	19.39 2.31	-0.04 1.57	29.96 3.52	30.00 3.63	0.04 2.10	19.73 2.24	19.51 2.14	-0.22 1.64
PBF (%)	25.56 ±6.07	18.96 ±3.95	-6.60 ±3.80	37.90 3.48	36.58 2.33	-1.32 4.66	24.38 ±3.92	22.50 ±4.64	-1.88 ±5.10	37.93 3.02	34.76 9.13	-3.17 8.04	24.65 4.35	21.70 4.66	-2.95 5.17	37.92 3.04	35.18 8.07	-2.75 7.35
Obesity Degree	112.40 ±6.15	102.8 ±6.29	-9.60 ±3.05	113.8 1.48	112.2 4.15	-1.60 4.10	110.4 ±3.26	105.2 ±5.11	-5.17 ±3.80	114.65 1.93	112.12 2.23	-2.53 2.83	110.86 4.00	104.6 5.33	-6.18 4.04	114.4 1.84	112.14 2.66	-2.32 3.08
BMR(Kcal)	1547 ±150.0	1598 ±139.3	50 ±34.56	1212 100.0	1169 54.41	-42.20 60.72	1509 ±124.3	1522 ±118.9	13 ±76.9	1150 73.80	1141 69.13	-8.82 37.0	1518 127.78	1539 124.6	21.00 70.77	1164 82.82	1147 65.96	-16.45 45.24
Fitness Score	69.40 ±7.27	78.20 ±6.02	8.80 ±5.22	65.80 3.63	67.60 2.19	1.80 5.12	69.71 ±5.34	74.71 ±4.93	5.00 ±3.66	66.71 3.33	68.06 2.97	1.35 2.69	69.64 5.64	75.50 5.26	5.86 4.25	66.50 3.33	67.95 2.77	1.45 3.25

In the overweight male and female genotypes with polymorphism, the differences in the protein content were found to be 0.28 ±0.46 and -0.32 ±0.54 respectively. Among the genotypes without polymorphism, the decline in the males was found to be -0.08 ±0.75 and in the females, it was 0.06 ±0.36.The differences in the body protein content of the male and female phenotypes showed a difference of 0.01 ±0.70 and -0.12 ±0.41 respectively. The changes in the body mineral content were analysed in the overweight male and female genotypes with polymorphism and it was found to be -0.01 ±0.14 among the males and -0.24 ±0.25 in the females. While among the genotypes without polymorphism, the differences observed were 0.08 ±0.27 and 0.03 ±0.14 respectively. Among the male and female phenotypes, the differences in the body mineral content were recorded as -0.06 ±0.25 and -0.08 ±0.19 respectively.

The differences in the body fat mass of the overweight male and female genotypes with polymorphism showed a decline of -5.74 ±2.94 and -2.28 ±3.00 respectively while in the genotypes without polymorphism, the differences were -2.15 ±3.76 and -1.45 ±1.40 respectively. Among the overweight male and female phenotypes, the differences recorded were -2.97 ±3.85 and -1.64 ±1.82 respectively.

The differences in the total body water estimated in the overweight male and female genotypes with polymorphism were found to be 0.72 ±1.31 and -1.40 ±2.01 respectively. In the overweight subjects without polymorphism, the total body water content showed a decline in the males which were -1.02 ±5.49 and in the females it was -0.26 ±1.23. Among the male and female overweight phenotypes, the differencesin the TBW content showed a decline in the males which were -0.36 ±4.88 and in the females it was -0.52 ±1.47. Among the overweight male and female genotypes with polymorphism, the differences in the soft lean mass was found to be 1.02 ±1.76 and -1.74 ±2.59 respectivelywhile in the genotypes without polymorphism, the difference were -0.25±4.-0.39 ±3.41 in the males and -0.29 ±1.71 in the females. Among the overweight male and female phenotypes, the differences in the soft lean mass were found to be -0.07 ±3.13 and -0.62 ±1.98 respectively.

The differences were also observed in the fat free mass of overweight male and female genotypes with polymorphism which were found to be 1.02 ±1.76 and -0.70 ±0.00 respectively. Differences were also observed among the overweight genotypes without polymorphism and were recorded as -0.41 ±3.60 and -0.70 ±0.00respectively. Among the phenotypical male and female overweight subjects, the differences in the fat free mass were found to be -0.09 ±3.30 and -0.70 ±0.00 respectively.

The Visceral fat area determined for the male and female overweight genotypes with polymorphism, a decline was observed and were found to be -19.24 ±7.12 and -10.92 ±5.32 respectively. Among the overweight male and female genotypes without polymorphism, the differences were found to be -8.93 ±8.20 and -5.44 ±9.24 respectively. The VFA of the male and female phenotypes belonging to the same category showed a reduction which were recorded as -11.28 ±8.97 in the males and -6.68 ±8.71 in the females.

The difference in the SMM of the overweight male and female genotypes were found to be 0.84 ±1.39 and -1.08 ±1.73 respectively. While in the genotypes without polymorphism, they were -0.19 ±2.24 and 0.04 ±1.57 respectively. Among the overweight phenotypes the differences in the SMM were found to be 0.04 ±2.10 in the males and -0.22 ±1.64 in the females.

The percent body fat analysed for the subjects before and after intervention showed a decline in all the groups, among the male and female genotypes with polymorphism, the differences observed were -6.60 ±3.80 and -1.32 ±4.66 respectively. Whilst in the genotype without polymorphism, the differences recorded were -1.88 ±5.10 and -3.17 ±8.04 respectively. The difference observed in the male and female phenotypes were -2.95 ±5.17 and -2.75 ±7.35 respectively.

The obesity degree computed forthe selected subjects pre and post intervention also showed a decline, it was -9.60 ±3.05 and -1.60 ±4.10 in the overweight male and female genotypes with polymorphism while in the genotypes without polymorphism, they were recorded as -5.17 ±3.80 and -2.53

±2.83 respectively. Among the male and female phenotypes, the decline in the degree of obesity was recorded as -6.18 ±4.04 and -2.32 ±3.08 respectively.

Variations were also observed for the basal metabolic rate of the overweight male and female genotypes with polymorphism and they were found to be 50 ±34.56 in the males and -42.20 ±60.72 in the females. Among the genotypes, without polymorphism, the differences were 13 ±76.98 in the males and -8.82 ±37.08 in the females. TheBMR differences among the male and female phenotypes were recorded as 21 ±70.77 in the males and -16.45 ±45.24 in the females.

There were improvement in the Fitness Scores of all the selected subjects due to the intervention strategies and the differences among the male and female obese genotypes with polymorphism were found to be 8.80 ±5.22 and 1.80 ±5.12 respectively. Among the genotypes without polymorphism, the differences in the fitness scores were found to be 5.00 ±3.66 and 1.35 ±2.69 respectively. The variations in the fitness scores of the male and female phenotypes were recorded 5.86 ±4.25 and 1.45 ±3.25 respectively.

Bouwman(2008) considered who would use such personalised nutrition products and associated advice and what are the limitations of providing potential users with highly specific information on individual health risks and benefits of specific eating habits.

12. COEFFICIENT OF CORRELATION BETWEEN BMI AND BODY COMPOSITION OF PRO 12 PRO OVERWEIGHT SUBJECTS

The coefficient of correlation between the BMI and body composition of pro 12 pro overweight subjects is given in table 48

Table 48

Coefficient of corelation between BMI and body composition

	BMI	BFM	TBW	VFA	SLM	FFM	SMM	PBF	OD
BMI	1	0.287	-0.090	0.349	0.155	0.148	0.174	0.174	0.575*
BFM		1	-0.091	0.634	-0.261	-0.263	-0.268	0.939**	0.632**
TBW			1	0.180	0.494*	0.505*	0.477	-0.251	-0.093
VFA				1	0.107	0.118	0.131	0.509*	0.518*
SLM					1	0.999**	0.998**	-0.563*	0.225
FFM						1	0.998**	-0.564*	0.213
SMM							1	-0.567*	0.233
PBF								1	0.466
Obesity Degree									1

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

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

From the table, BMI of overweight Pro 12 pro subjects showed a negative association with body composition parameters. Body fat mass showed a highly positive association ($p<0.01$) with visceral fat area, per cent body fat and obesity degree. A negative association was noticed in total body water, soft lean mass, fat free mass and skeletal muscle mass with body fat mass. Total body water was seen to have a positive correlation ($p<0.05$) with soft lean mass and fat free mass. Visceral fat area had a positive correlation per cent body fat and obesity degree at five per cent significant level. Soft lean mass showed a highly positive correlation ($p<0.01$) with fat free mass and skeletal muscle mass and five per cent correlation was seen in per cent body fat. Fat free mass was positively high correlated ($p<0.01$) with skeletal muscle mass and five per cent correlation with per cent body fat. Skeletal muscle mass showed a correlation with per cent body fat at five per cent significant level. Per cent body fat had a negative association with obesity degree among pro 12 pro overweight subjects without polymorphism.

13. COEFFICIENT OF CORRELATION BETWEEN BMI AND BODY COMPOSITION OF PRO 12 ALA OVERWEIGHT SUBJECTS

Correlation among BMI and body composition of pro 12 ala overweight subjects is given in Table 49

Table 49

Coefficient of corelation between BMI and body composition

	BMI	BFM	TBW	VFA	SLM	FFM	SMM	PBF	OD
BMI	1	-0.134	-0.029	0.075	-0.026	-0.021	-0.013	-0.161	0.244
BFM		1	0.188	0.925*	0.190	0.196	0.174	0.919*	0.903*
TBW			1	0.457	1.000**	1.000**	0.998**	-0.209	0.291
VFA				1	0.460	0.465	0.454	0.738	0.971**
SLM					1	1.000**	0.999**	-0.206	0.296
FFM						1	0.998	-0.201	0.301
SMM							1	-0.220	0.293
PBF								1	0.777
Obesity Degree									1

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

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

From the table, BMI of overweight subjects with Pro 12 ala polymorphism exhibited a non significant association with body composition parameters. Similarly, body fat mass indicated a positive correlation ($p<0.05$) with visceral fat area, per cent body fat, obesity degree and had a non significant positive association with other body composition parameters. With total body water, a strong positive correlation ($p<0.01$) was seen only for soft lean mass, fat free mass and skeletal muscle mass. Visceral fat area was seen to have a strong association ($p<0.01$) with obesity degree and a non significant association existed with other body composition parameters. Soft lean mass showed a highly positive ($p<0.01$) association with fat free mass and skeletal muscle mass. Fat free mass

was seen to have a strong positive association with skeletal muscle mass at 1 per cent level. Skeletal muscle mass indicated a non significant positive association with obesity degree and negative association with per cent body fat. Per cent body fat exhibited a non significant positive association with obesity degree.

The mean changes in the body composition was analysed normal subjects pre and post intervention and the results obtained are presented in the Table 50.

Table 50

Mean changes in the body composition measures of the selected normal subjects

	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=1)			FEMALE(N=2)			MALE(N=19)			FEMALE(N=21)			MALE(N=20)			FEMALE(N=23)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Protein(kg)	10	9.4	-0.6	6.9 0.57	6.75 0.78	-0.15 0.21	9.54 ±1.14	9.44 ±1.03	-0.09 ±0.54	6.73 0.48	6.82 0.59	0.09 0.34	9.56 ±1.11	9.44 ±1.01	-0.12 ±0.54	6.74 0.48	6.81 0.59	0.07 0.34
Mineral(kg)	3.61	3.39	-0.22	2.60 0.29	2.54 0.40	-0.06 0.11	3.34 ±0.33	3.31 ±0.31	-0.02 ±0.14	2.48 0.24	2.60 0.24	0.11 0.23	3.35 ±0.33	3.31 ±0.30	-0.03 ±0.14	2.49 0.24	2.59 0.24	0.10 0.23
BFM (kg)	11.5	11.2	-0.3	12.25 1.91	12.55 2.05	0.3 0.14	10.52 ±5.12	11.68 ±5.82	1.16 ±2.22	16.62 4.01	18.56 2.58	1.94 3.13	10.57 ±4.98	11.66 ±5.64	1.09 ±2.19	16.24 4.05	18.04 3.04	1.80 3.02
TBW(l)	37.2	35.1	-2.1	25.9 2.40	25.45 3.04	-0.45 0.64	35.03 ±3.83	35.04 ±3.69	0.02 ±1.21	25.06 1.79	25.54 2.12	0.49 1.42	35.14 ±3.76	35.05 ±3.52	-0.09 ±1.27	25.13 1.80	25.53 2.12	0.40 1.38
SLM(kg)	47.9	45.2	-2.7	33.25 3.04	32.6 3.82	-0.65 0.78	45.11 ±5.00	45.05 ±4.70	-0.06 ±1.46	32.20 2.27	32.16 2.73	0.57 1.75	45.25 ±4.91	45.06 ±4.58	-0.19 ±1.54	32.29 2.28	32.75 2.23	0.46 1.71
FM(kg)	50.8	48.0	-2.8	35.4 3.25	34.75 4.17	-0.65 0.92	47.88 ±5.23	47.85 ±4.98	-0.03 ±1.56	35.07 4.13	34.94 2.93	-0.12 3.02	48.03 ±5.13	47.86 ±4.85	-0.17 ±1.64	35.10 4.00	34.93 2.93	-0.17 2.89
VFA(cm^2)	58.6	52.0	-6.6	30.8 2.97	29.9 0.85	-0.9 3.82	46.08 ±19.14	52.02 ±16.46	5.94 ±12.22	49.99 16.91	58.35 9.69	8.37 13.17	46.71 ±18.84	52.02 ±16.02	5.32 ±12.22	48.32 17.06	55.88 12.35	7.56 12.86
SMM(kg)	28.2	26.5	-1.7	18.8 1.84	18.4 2.26	-0.4 0.42	26.58 ±3.27	26.47 ±3.09	-0.11 ±0.99	18.27 1.46	18.57 1.77	0.30 1.03	26.66 ±3.21	26.47 ±3.01	-0.19 ±1.03	18.32 1.45	18.56 1.76	0.24 1.00
PBF (%)	18.4	18.9	0.5	25.6 1.27	26.45 0.78	0.85 0.49	17.68 ±8.02	19.18 ±8.75	1.49 ±3.16	32.04 6.20	34.64 3.35	2.60 5.56	17.72 ±7.81	19.17 ±8.52	1.45 ±3.09	31.48 6.20	33.93 3.97	2.45 5.33
Obesity Degree	97.0	93.0	-4.0	93.5 2.12	92.00 4.24	-1.5 2.12	95.26 ±10.22	97.42 ±9.61	2.16 ±8.25	99.95 6.08	102.62 4.01	2.67 4.63	95.35 ±9.95	97.20 ±9.40	1.85 ±8.15	99.39 6.10	101.70 4.98	2.30 4.60
BMR(Kcal)	1468	1406	-62	1134 70.71	1120 89.80	-14.5 19.09	1405 ±114.7	1400 ±104.6	-4.89 ±32.9	1127 89.36	1124 63.16	-2.81 65.58	1408 ±112.5	1401 ±101.8	-7.75 ±34.5	1128 86.55	1124 63.21	-3.83 62.75
Fitness Score	75.0	72.0	-3.0	76.00 1.41	75.00 0.00	-1.00 1.41	73.42 ±4.69	71.74 ±4.70	-1.68 ±4.24	70.33 5.45	68.43 3.74	-1.90 4.97	73.50 ±4.56	71.75 ±4.38	-1.75 ±4.14	70.83 5.46	69.00 4.03	-1.83 4.75

In the normal male and female genotypes with polymorphism, the differences in the protein content were found to be -0.6 and 0.15 ±0.21 respectively. Among the genotypes without polymorphism, the decline in the males was found to be -0.09 ±0.54 and in the females, it was 0.09 ±0.54.The differences in the body protein content of the male and female phenotypes showed a difference of -0.12 ±0.54 and 0.07 ±0.34 respectively. The changes in the body mineral content were analysed in the normal male and female genotypes with polymorphism and it was found to be -0.22 among the males and 0.06 ±0.11 in the females. While among the genotypes without polymorphism, the differences observed were -0.02 ±0.14 and 0.11 ±0.23 respectively. Among the male and female phenotypes, the differences in the body mineral content were recorded as -0.03 ±0.14 and 0.10 ±0.23 respectively.

The differences in the body fat mass of the normal male and female genotype with polymorphism showed a decline of -0.30 and in the increment of0.3 ±0.14 was noted. While in the genotypes without polymorphism, the differences were 1.16 ±2.22 and 1.94 ±3.13 respectively. Among the normal male and female phenotypes, the differences recorded were 1.09 ±2.19 and 1.80 ±3.02 respectively.

The differences in the total body water estimated in the normal male and female genotypes with polymorphism showed a decline of -2.1 and -0.45 ±0.64 respectively. In the normal subjects without polymorphism, the total body water content showed an increase in the male and female which were 0.02 ±1.21 and 0.49 ±1.42 respectively. Among the male and female normal phenotypes, the differences in the TBW content showed a decline in the males which were -0.09 ±1.27 and an increase in the females which were 0.40 ±1.38. Among the normal male and female genotypes with polymorphism, the differences in the soft lean mass was found to be-2.7 and 0.65 ±0.78 respectively while in the genotypes without polymorphism, the difference were -0.06 ±1.46 in the males and 0.57 ±1.75 in the females. Among the normal male and female phenotypes, the differences in the soft lean mass were found to be -0.19 ±1.54 and 0.46 ±1.71 respectively.

The differences were also observed in the fat free mass of normal male and female genotypes with polymorphism which were found to -2.8 and -0.65 ±0.92 respectively. Similar differences were also observed among the normal genotypes without polymorphism and were recorded as -0.03 ±1.56 and 0.12 ±3.02 respectively. Among the phenotypical male and female normal subjects, the differences in the fat free mass were found to be -0.17 ±1.64 and 0.17 ±2.89 respectively.

The Visceral fat area determined for the male and female normal genotypes with polymorphism, a decline was observed and were found to be -6.6 and -0.9 ±3.82 respectively. Among the normal male and female genotypes without polymorphism, the differences were found to be 5.94 ±12.22 and 8.37 ±13.17 respectively. The VFA of the male and female phenotypes belonging to the same category showed an increment which were recorded as 5.32 ±12.22 in the males and 7.56 ±12.86 in the females.

The difference in the SMM of the normal male and female genotypes showed a decline of -1.7 and -0.4 ±0.42 respectively. While in the genotypes without polymorphism, they were -0.11 ±0.99 and 0.30 ±1.03 respectively. Among the normal phenotypes the differences in the SMM were found to be -0.19 ±1.03 in the males and 0.24 ±1.00 in the females.

The percent body fat analysed for the subjects before and after intervention showed an increment in all the groups, among the male and female genotypes with polymorphism, the differences observed were 0.5 and 0.85 ±0.49 respectively. Whilst in the genotype without polymorphism, the differences recorded were 1.49 ±3.16 and 2.60 ±5.56 respectively. The difference observed in the male and female phenotypes were -1.45 ±3.09 and 2.45 ±5.33 respectively.

The obesity degree computed for the selected subjects pre and post intervention also showed a decline, it was -4.0 and -1.5 ±2.12 in the obese male and female genotypes with polymorphism, while in the genotypes without polymorphism they were recorded as 2.16 ±8.25 and 2.67 ±4.63 respectively. Among the male and female phenotypes, an increment in the degree of obesity was recorded as 1.85 ±8.15 and 2.30 ±4.60 respectively.

Variations were also observed for the basal metabolic rate of the normal male and female genotypes with polymorphism and they were found to be -62 in the males and -14.8 ±19.09 in the females. Among the genotypes, without polymorphism, the differences were -4.89 ±32.99 in the males and 2.81 ±65.58 in the females. The BMR differences among the male and female phenotypes were recorded as -7.75 ±34.5 in the males and -3.83 ±62.75 in the females.

Decrease in the mean Fitness Scores of all the selected subjects was observed. The differences among the male and female normal genotypes with polymorphism were found to be -3.0 and 1.00 ±1.41 respectively. Among the genotypes without polymorphism, the differences in the fitness scores were found to be -1.68 ±4.24 and -1.90 ±4.97 respectively. The variations in the fitness scores of the male and female phenotypes were recorded -1.75 ±4.14 and -1.83 ±4.75 respectively.

14. COEFFICIENT OF CORRELATION BETWEEN BMI AND BODY COMPOSITION OF NORMAL SUBJECTS

The coefficient of correlation between the BMI and body composition of normal subjects is given in table 51

Table 51

Coefficient of corelation between BMI and body composition

	BMI	BFM	TBW	VFA	SLM	FFM	SMM	PBF	OD
BMI	1	0.516*	0.194	0.541*	0.203	0.212	0.230	0.442	0.586**
BFM		1	-0.392	0.835**	-0.384	-0.372	-0.360	0.984**	0.717**
TBW			1	-0.153	1.000**	0.999**	0.995**	-0.532	-0.050
VFA				1	-0.141	-0.126	-0.107	0.792	0.906**
SLM					1	0.999**	0.997**	-0.525*	-0.038
FFM						1	0.995**	-0.513*	-0.026
SMM							1	-0.504*	0.000
PBF								1	0.671**
Obesity Degree									1

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

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

From the table, subjects with normal BMI showed a high positive correlation ($p<0.01$) with obesity degree and positive association ($p<0.05$) with body fat mass and visceral fat area. Body fat mass showed a highly positive association ($p<0.01$) with visceral fat area, per cent body fat and obesity degree. A negative association was noticed in total body water, soft lean mass, fat free mass and skeletal muscle mass with body fat mass. Total body water was seen to have a positive correlation ($p<0.05$) with soft lean mass, skeletal muscle mass and fat free mass. Visceral fat area had a strong positive correlation per cent body fat and obesity degree at one per cent significant level. Soft lean mass showed a highly positive correlation ($p<0.01$) with fat free mass and skeletal muscle mass and five per cent negative correlation was seen in per cent body fat. Fat free mass was positively high correlated ($p<0.01$) with skeletal muscle mass and five per cent correlation with per cent body fat. Skeletal muscle mass showed a correlation with per cent body fat at five per cent significant level. Per cent body fat had a strong positive association ($p<0.01$) with obesity degree among normal subjects.

15. Energy Balance

The mean changes in the energy balance of the selected obese, overweight and normal subjects are presented in the Tables 52,53 and 54 respectively

Table 52

Mean changes in the energy balance of the selected obese subjects

PARAMETERS (kcal)	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N= 5)			FEMALE(N= 5)			MALE(N= 18)			FEMALE(N=17)			MALE(N= 23)			FEMALE(N=20)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Energy Intake	3155 ±394	2698 ±379	-457 ±255	2198 ±363	1754 ±453	-444 ±303	2749 ±361	2151 ±445	-598 ±419	2380 ±215	1975 ±58	-405 ±256	2974 ±438	2444 ±491	-530 ±333	2278 ±330	1852 ±378	-426 ±287
Energy Expenditure	2344 ±207	2953 ±277	609 ±71	2135 ±72	2703 ±98	568 ±29	2118 ±139	2684 ±184	566 ±47	2002 ±181	2570 ±234	568 ±54	2169 ±179	2743 ±230	574 ±55	2035 ±169	2603 ±215	568 ±48
Energy Balance	811 ±173	-255 ±92	-1066 ±193	63 ±24	-949 ±120	-1012 ±141	631 ±211	-533 ±176	-1164 ±214	378 ±67	-595 ±118	-973 ±105	805 ±169	-299 ±111	-1104 ±311	243 ±71	-751 ±53	-994 ±100

The energy intake in the obese and female genotypes with polymorphism showed a difference of -457±255 in the males and a difference of -444±303 in the females. The obese genotypes without polymorphism, the energy intake difference in the males were found to be -598±419 and -405±256 in the females. The energy intake differences in the male and female phenotypes were found to be -530±333 and-426±287 respectively.

The energy expenditure differences in the obese male genotypes with polymorphism showed a difference of 609±71 in the males while it was 568±29 in the females. The energy expenditure differences in the male and female genotypes without polymorphism recoded a difference of 566±47 and 568±54 respectively. The differences in the energy expenditure recorded for the male and female phenotypes were found to be 576±55 and 568±48 respectively.

The differences in the energy balance of the obese genotypes with polymorphism showed a difference of -1066 in the males and -1012 in the females and in the genotypes without polymorphism, the differences were -1164 for the males and -973 for the females. Among the male and female phenotypes, the energy balance difference was observed to be -1104 and -994 respectively. The energy balance in all the groups were found to be negative that proves the efficacy of the inventions among selected subjects in the present study.

Table 53

Mean changes in the energy balance of the selected overweight subjects

PARAMETERS (kcal)	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=5)			FEMALE(N=5)			MALE(N=17)			FEMALE(N=17)			MALE(N=22)			FEMALE(N=22)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Energy Intake	2304 ±888	1692 ±767	-612 ±381	2187 ±124	1604 ±76	-583 ±167	2354 ±585	1797 ±505	-511 ±319	2099 ±300	1791 ±375	-308 ±180	2522 ±357	1924 ±409	-598 ±132	2143 ±218	1697 ±270	-446 ±218
Energy Expenditure	2050 ±175	2574 ±225	524 ±55	2028 ±102	2553 ±129	525 ±30	2002 ±122	2547 ±151	544 ±43	1929 ±99	2463 ±124	534 ±30	2013 ±132	2553 ±165	540 ±45	1952 ±106	2484 ±128	532 ±30
Energy Balance	254 ±123	-882 ±121	-1136 ±153	159 ±42	-949 ±108	-1108 ±123	352 ±111	-750 ±152	-1102 ±304	170 ±57	-672 ±141	-842 ±96	509 ±148	-629 ±132	-1138 ±201	191 ±42	-787 ±68	-978 ±121

The energy intake in theoverweight and female genotypes with polymorphism showed a difference of -612±381 in the males and a difference of -583±167 in the females. The normal genotypes without polymorphism, the energy intake difference in the males were found to be -557±319 and -308±180 in the females. The energy intake differences in the male and female phenotypes were found to be -598±132 and -448±218 respectively.

The energy expenditure differences in the overweight male genotypes with polymorphism showed a difference of 524±55 in the males while it was 525±30 in the females. The energy expenditure differences in the male and female genotypes without polymorphism recoded a difference of 545±43 and 534±30 respectively. The differences in the energy expenditure recorded for the male and female phenotypes were found to be 540±45 and 532±30 respectively. The differences in the energy balance of the overweight genotypes with polymorphism showed a difference of -1136 in the males and -1108 in the females and in the genotypes without polymorphism, the differences were -1102 for the males and -842 for the females. Among the male and female phenotypes, the energy balance difference was observed to be -1138 and -978 respectively.

The final energy intake was found to be lower when compared with the initial energy intake and the energy expenditure was found to be higher when compared with the final energy expenditure in almost all the groups. The aspect of reduced energy intake and increased energy expenditure were instrumental in creating a negative energy balance that would aid in weight loss. The efficacy of the inventions was well documented in all the groups.

“All size does not fit one”. This is specifically true with regard to nutrient and food intake recommendations. Indeed such inter-individual differences in response to dietary factors and interventions highlight the role of genetics and the potential of a nutrigenetics approach based on identification of nutrient sensitive or responsive genotypes, whereby nutrient intake is manipulated or optimized based on an individuals’ genetic profile to reduce disease risk or improve effectiveness of dietary recommendations.

Table 54

Mean changes in the energy balance of the selected normal subjects

PARAMETERS (kcal)	GENOTYPE												PHENOTYPE					
	PRO 12 ALA POLYMORPHISM						PRO 12 PRO POLYMORHISM											
	MALE(N=1)			FEMALE(N=2)			MALE(N=19)			FEMALE(N=21)			MALE(N=20)			FEMALE(N=23)		
	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D	I	F	D
Energy Intake	3119	2926	-193	2172 ±155	1467 ±32	-705 ±186	2749 ±153	1975 ±28	-774 ±145	2346 ±235	1616 ±361	-730 ±155	2842 ±223	2213 ±476	-629 ±314	2276 ±207	1556 ±269	-720 ±144
Energy Expenditure	1898	2132	234	1926 ±115	2202 ±145	276 ±29	1814 ±107	2093 ±125	279 ±26	1879 ±81	2178 ±90	299 ±16	1818 ±106	2095 ±122	277 ±27	1883 ±82	2180 ±91	297 ±17
Energy Balance	1221	794	-421	246 ±81	-735 ±137	-981 ±98	935 ±106	-118 ±35	-1053 ±214	467 ±114	-562 ±130	-1029 ±157	1024 ±254	118 ±25	-906 ±110	393 ±125	-624 ±145	-1017 ±241

The energy intake in the normal and female genotypes with polymorphism showed a difference of -193 in the males and a difference of -705±186 in the females. The normal genotypes without polymorphism, the energy intake difference in the males were found to be -774±145 and -730±155 in the females. The energy intake differences in the male and female phenotypes were found to be -629±314 and -720±144 respectively.

The energy expenditure differences in the normal male genotypes with polymorphism showed a difference of 234 in the males while it was 276±29 in the females. The energy expenditure differences in the male and female genotypes without polymorphism recoded a difference of 279±26 and 299±16 respectively. The differences in the energy expenditure recorded for the male and female phenotypes were found to be 277±27 and 297±17 respectively.

The differences in the energy balance of the normal genotypes with polymorphism showed a difference of -427 in the males and -981 in the females and in the genotypes without polymorphism, the differences were -1053 for the males and -1029 for the females. Among the male and female phenotypes, the energy balance difference was observed to be – 906 and -1017 respectively.

From the foregoing results, it is evident that the prevalence of obesity and overweight among the selected population were 19.97 and 23.21 per cent among females and males respectively. Prevalence of overweight was in the range of 22.87 among females and 13.33 per cent among males. Based on the study results, a smaller target group was selected and aimed at supplementation and education. Initially body fat (%), Waist Hip Ratio(WHR) and Visceral fat were higher and biochemical values were normal except triglycerides. Base don the SNP analysis, it was evident that, obese and overweight subjects showed pro 12 pro polymorphism where pro 12 ala was higher in obese and overweight compared to normal individuals. Functional food supplementation rch in nutraceuticals proved to be efficient in reducing the body weight, fat percent, visceral fat, total cholesterol, triglycerides and increased HDL cholesterol. In general, obesity degree decreased. Long term interventions are recommended.