CHAPTER 4

RESULTS AND DISCUSSION

In this chapter, the results of the study entitled **"Metabolic syndrome in relation to body composition and lifestyle adaptation among selected adults residing in Bengaluru"** are presented and discussed in different phases below:

PHASE I:

4.1 Validation and testing the reliability of InBody 770 equipment, and Knowledge Attitude and Practice (KAP) questionnaire

4.1.1 Validation and testing the InBody 770 with DEXA for performing Body Composition analysis

4.1.2 Validation of the KAP questionnaire used in the study

PHASE II:

4.2 Socio-economic profile of the research subjects

4.2.1 Age-wise distribution of the research subjects

4.2.2 Socioeconomic profile of the research subjects

PHASE III:

4.3 Metabolic Syndrome among the research subjects

4.3.1 Anthropometric measurements of the research subjects

4.3.2 Biochemical parameters of the research subjects

4.3.3 Lifestyle habits of diet preference, physical activity level, exercise, smoking, and alcohol habits of the research subjects

4.3.4 Prevalence of Metabolic Syndrome criteria among the research subjects

PHASE IV:

4.4 Assessment of metabolic syndrome subjects, assessment of Body Composition and Imparting intervention to the sub sampled metabolic syndrome subjects

4.4.1 Assessment of sub sampled metabolic syndrome subjects

4.4.1.1 Background information of the research subjects

4.4.1.2 Sex and Age-wise distribution of the research subjects

4.4.1.3 Anthropometric measures of the research subjects

4.4.1.4 Biochemical parameters of the research subjects

4.4.1.5 Dietary preference, smoking and alcohol habits of the research subjects

4.4.1.6 Exercise and Physical Activity Level of the research subjects

4.4.2 Metabolic syndrome parameters of sub sampled metabolic syndrome subjects

4.4.3 Body composition analysis of sub sampled metabolic syndrome subjects

4.4.4 Knowledge, Attitude, and Practice (KAP) of of sub sampled metabolic syndrome subjects

4.4.5 Validation of the developed lifestyle education modules

Phase V:

4.5 Impact of intervention of lifestyle education counseling among the metabolic syndrome research subjects

4.5.1 Impact of intervention on anthropometric measures and BCA parameters in research subjects

4.5.2 Impact of intervention on calorie intake, physical activity level, exercise, smoking and alcohol habits in research subjects

4.5.3 Impact of intervention on Metabolic syndrome criteria in research subjects

4.5.4 Impact of lifestyle education counselling on KAP in the research subjects

PHASE I:

4.1 Validation and testing the reliability of InBody 770 equipment, and Knowledge Attitude and Practice (KAP) questionnaire

4.1.1 Validation and testing the reliability of InBody 770 with DEXA for performing Body Composition analysis

There are various direct and indirect methods to perform Body Composition Analysis (BCA). Dual x-ray absorptiometry (DEXA) scan is the gold standard to

measure an individual's body composition. But Dexa scan involves radiation exposure and is costlier than the Bio Impedance Analysis (BIA) method. Prior *et al*., (1997) showed DEXA is the recommended method for BCA. Kulkarni (2014) compared the body composition methods of DEXA with other BIA methods in Indian adults. In the current study, the BIA method was intended to be used to analyze the Body Composition of an individual with the help of InBody 770 (BioSpace Co., South Korea) equipment. So, the validation and reliability of the InBody 770 usage was necessary.

Randomly 20 subjects, 10 each males and females were selected and Body Composition Analysis was performed using InBody 770 and DEXA. The results obtained in both tests were analyzed using Cronbach‘s alpha, a measure of scale reliability (Bujang *et al.,* 2018; Bonett and Wright 2015; Leontitsis and Pagge 2007), which measure the close relation between the groups. It is possible to express Cronbach's alpha as a function of both the average inter-correlation and the quantity of test items.

The formula for the Cronbach‘s alpha is as follows:

$$\alpha = \frac{N\overline{c}}{\overline{v} + (N-1)\overline{c}}$$

Here N is equal to the number of items

$\overline{c}$ is the average inter-item covariance among the items

$\overline{v}$ equals the average variance.

Five items namely total body mass, fat mass, lean mass, bone mineral content, and Body Mass Index (BMI) were considered in the reports. The arithmetic mean of the subjects who underwent Body Composition Analysis are mentioned in Table 4.1.

Table: 4.1 Representation of subjects undergoing BCA in InBody 770 and DEXA

Parameter (Units)	InBody 770	DEXA
	n ± S.D	
Age (y)	34.45 ± 9.34	
Height (cm)	163.11 ± 8.5	
Total Mass (kg)	69.48	69.85
Fat Mass (kg)	25.65	25.95
Lean Mass (kg)	41.48	41.35
Bone Mineral Content (kg)	2.37	2.55
Body Mass Index (kg/m2)	26.06	26.1

No items were deleted or excluded while subjecting to Cronbach‘s alpha as mentioned. Five components of total mass, fat mass, lean mass, bone mineral content and body mass index were compared as shown in Table 4.1. The estimated values of DEXA were higher than InBody 770.

4.1.1.1 DEXA Body Composition Analysis

The number of items measured were five and the Cronbach‘s Alpha obtained was 0.821 while doing reliability statistics for DEXA Body Composition. The five parameters obtained by doing DEXA body composition were statistically analysed and is tabulated in Table 4.2.

Table: 4.2

DEXA body composition parameters

Parameter	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Total Mass	95.57	423.69	0.99	0.70
Fat Mass	139.39	860.13	0.75	0.75
Lean Mass	123.57	848.90	0.73	0.75
Bone Mineral Content	162.68	1325.85	0.69	0.87
Body Mass Index	138.98	1048.62	0.88	0.78

4.1.1.2 InBody 770 Body Composition Analysis

The number of items measured were five (Table 4.3) and the Cronbach‘s Alpha obtained was 0.821 while doing reliability statistics for InBody 770 Body Composition.

Table: 4.3

InBody 770 body composition parameters

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Total Mass	95.955	424.05	0.99	0.69
Fat Mass	139.85	824.47	0.76	0.74
Lean Mass	124.45	893.27	0.67	0.76
Bone Mineral Content	163.25	1318.85	0.71	0.86
Body Mass Index	139.70	1044.38	0.88	0.77

The Cronbach‘s alpha obtained for DEXA and InBody 770 body composition analysis were 0.821 and 0.818 respectively. This states that the InBody 770 BCA analyser is validated for performing body composition analysis in comparison with DEXA scan body composition analysis.

4.1.2 Validation of the Knowledge, Attitude, and Practice (KAP) questionnaire used in the study

KAP surveys play a crucial role in materializing the health care programs. It contains three aspects knowledge, attitude and practice which are measured. It contains both qualitative and qualitative data. KAP surveys are easy to conduct, measure and interpret. They can be used to approve or disapprove the hypothesis of the research study. Yvette (2014), Food and Agriculture Organization (FAO) of the United Nations (UN), Guidelines for assessing KAP was used as reference while preparing the current studies KAP questionnaire. KAP survey was used to validate the education materials intended for interventional study are effective or not.

The KAP questionnaire was validated by conducting a pilot study. Around 60 (30 males and 30 females) were enrolled for conducting the pilot study. 30 subjects who had nutrition and exercise background and were in healthcare and 30 subjects who had no nutrition or exercise and were nonhealthcare were selected into the pilot study. This will give us scope to test whether the KAP questionnaire developed is clear, concise and simple but still good enough to serve capture the study objective. The KAP questionnaire was administered with two month interval between pre and post lifestyle education modules intervention. KAP Pre and Post scores of the pilot study subjects are as in Table 4.4.

Table: 4.4 KAP Pre and Post scores of the pilot study subjects

Scoring for		Healthcare subjects (N=30) Mean±SD		Non- Healthcare subjects (N=30) Mean±SD		p Value
		Pre	Post	Pre	Post	
Knowledge	1	10.43 ± 0.94	11.3 ± 0.31	5.63 ± 1.94	7.12 ± 1.81	<0.001*
	2	3.43 ± 0.97	4.56 ± 0.22	2 ± 0.74	3 ± 1.2	<0.001*
	3	2.03 ± 0.72	3.3 ± 0.45	1.87 ± 0.82	2.88 ± 0.11	<0.001*
	4	4.03 ± 1.16	5.02 ± 0.34	2.17 ± 0.99	2.92 ± 0.12	<0.001*
Attitude		3.03 ± 0.56	3.45 ± 0.28	2.03 ± 0.72	2.78 ± 0.21	<0.001*
Practice		3.13 ± 0.68	3.6 ± 1.2	2.17 ± 0.70	3.15 ± 0.31	<0.001*

- Pre vs post between non-healthcare vs healthcare is observed.

*Significant at 95% confidence interval

As mentioned in Table 4.4, the KAP scores of 30 healthcare subjects and 30 non-healthcare subjects pre and post with an interval of two months gap shows that KAP questionnaire developed had a significant correlation with a p value <0 .001 in knowledge, attitude and practice of both healthcare and non- healthcare pilot study subjects. This states that the KAP questionnaire developed is effective and can be used in the research study. As depicted in data the non-healthcare subjects had less knowledge, attitude and practice average scores than the healthcare subjects. But the healthcare subjects were also not having good knowledge about Body composition Analysis. Though the knowledge and attitude of healthcare subjects were relatively good enough, putting the knowledge into practice had to be emphasized.

To establish validity and reliability of the developed KAP questionnaire the data was subjected to statistical analysis. By using Cronbachs alpha the validity and reliability was observed. The obtained results are tabulated in Validity of KAP questionnaire Table 4.5.

Table: 4.5 Validity of KAP questionnaire

Pre & Post Scoring for		Cronbachs α (CA)	
		Healthcare subjects	Non- Healthcare subjects
Knowledge	**1**	0.65	0.85
	2	0.67	0.82
	3	0.8	0.83
	4	0.75	0.86
Attitude		0.69	0.82
Practice		0.82	0.85

The KAP questionnaire was validated by conducting a pilot study. The Cronbach's alpha obtained for healthcare subjects and non- healthcare subjects for KAP questionnaire were 0.81 and 0.83 respectively. KAP questionnaire developed had a significant correlation with a p value <0 .001 in KAP of both healthcare and non-healthcare pilot study subjects. This states that the KAP questionnaire developed is effective and can be used in the research study.

PHASE II:

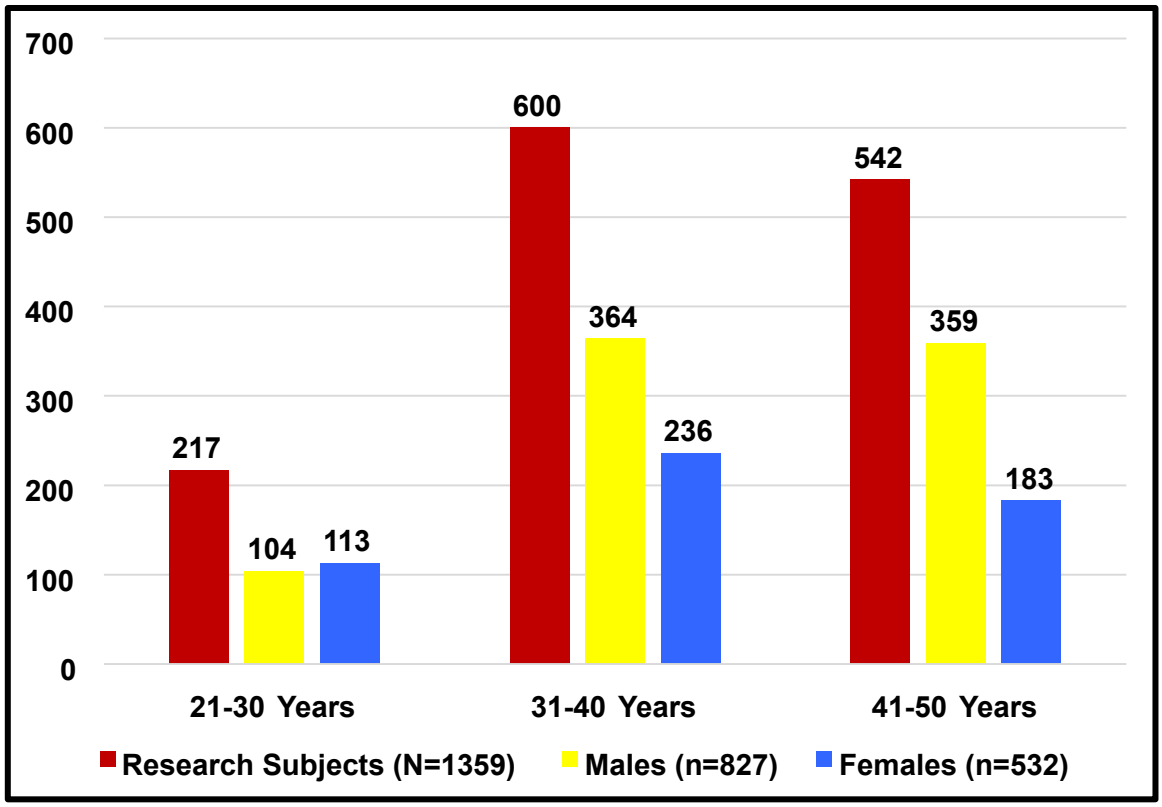
4.2 Socio-economic profile of the research subjects

A total of 2250 potential subjects were screened and 1359 subjects were enrolled in the study belonging to South-Asian Ethnicity and residing in Bengaluru. Males were 827 (60.9%) and females were 532 (39.1%). The socio-economic information of the research subjects is detailed below:

4.2.1 Age-wise distribution of the research subjects

Erik Erikson, an eminent 20th-century American-German psychologist proposes eight particular life stages. Adulthood is of three stages- Young adulthood (18- 40 year), Middle adulthood (40- 65 year), Late adulthood (65

years and above). As per WHO adults are of 19 to < 60-year age. The current study had research subjects of age 21- 50 years old as mentioned in Graph 4.1.



Graph 4.1: Representation of subjects according to age and sex

The subjects were categorized based on age and sex and presented. Age of 20- 50 years, that is 1359 were included in the study comprised of 60.9% male and 39.1% female subjects. In the age group of 21-30 years, there were 15.9% in total among which 12.6% were males and 21.2% were females. In the age group of 31- 40 years there were 44.2% in total among which 44% were males and 44.4% were females. In the age-group of 41- 50 years, there were 39.9% in total among which 43.4% were males and 34.4% were females.

4.2.2 Socio- economic profile of the research subjects

The socio-economic profile of individuals plays a crucial role in research studies. Understanding socio-economic profiles enriches research by providing context, addressing biases, and informing policies. It ensures that studies are relevant, inclusive, and impactful. The socio economic profile/ status is studied to frame interventions that can target the selected group of subjects and improve their overall well-being (Harrison, 2023)

4.2.2.1 Age:

The mean age of enrolled subjects (N=1359) was 38 ± 6.9 years.

The mean age in years of males (n=827) was 38.6 ± 6.6 years and females (n=532) was 37 ± 7.3 years.

The socio-economic and economic profile of the subjects is presented in Table 4.6. The socio-economic profile emphasized on the literacy level, occupation, socio-economic class, marital status, consumption of alcohol, smoking habit, exercise pattern, physical activity level, and diet pattern.

Table: 4.6 Socio-economic profile information of the research subjects

Parameter		Research subjects	Males	Females
		(N 1359)	(n 827)	(n 532)
Age (year)	Mean ± S.D	38±6.9	38.6±6.6	37±7.3
		Number (%)		
Literacy level	Illiterate	3 (0.2)	1 (0.1)	2 (0.4)
	Primary schooling	6 (0.1)	1 (0.1)	5 (0.9)
	Secondary schooling	108 (8)	58 (7)	50 (9.4)
	Technical/ diploma/ certificate courses	353 (26)	242 (29.3)	111 (20.9)
	Graduate	733 (53.9)	421 (50.9)	312 (58.6)
	Professional or Honours	156 (11.5)	104 (12.6)	52 (9.8)
Occupation	Semi-routine and routine occupations	119 (8.8)	0(0)	119(22.4)
	Lower supervisory and technical occupations	117(8.6)	28(3.4)	89(16.7)
	Small employers and own account workers	370(27.2)	312(37.7)	58(10.9)
	Intermediate occupations	743(54.7)	480(58)	263(49.4)
	Higher managerial, administrative and professional occupations	10(0.7)	7(0.8)	3(0.6)
Socioeconomic Class	Upper Lower	53(3.9)	38(4.6)	15(2.8)
	Lower- middle	1197(88.1)	700(84.6)	497(93.4)
	Upper- middle	109(8)	89(10.8)	20(3.8)
	Upper	0(0)	0(0)	0(0.0)
Family structure	Single member	146(10.7)	129(15.6)	17(3.2)
	Nuclear family	1147(84.4)	660(79.8)	487(91.5)
	Joint family	50(3.7)	29(3.5)	21(3.9)
	Extended family	16(1.2)	9(1.1)	7(1.3)
Marital status	Unmarried	414(30.5)	234(28.3)	180(33.8)
	Married	918(67.5)	585(70.7)	333(62.6)
	Divorcee	20(1.5)	7(0.8)	13(2.4)
	Widowed	7(0.5)	1(0.1)	6(1.1)

4.2.2.2 Education:

Education plays a significant role and gives the skills and competency that are prime for human development and enhanced quality of life. As released by the government of India, (MHRD, 2018) in their Educational Statistics at a Glance, 2018

stated that those who did not have any education were ‘no education/ illiterate’, primary schooling (I-V); upper primary (VI- VIII), secondary schooling (IX- X), senior secondary (XI- XII), technical/ diploma/ certificate courses (for skill development), graduate (bachelor degree) and professional courses (postgraduate i.e., master degree & post- doctoral degrees). In the current research study, the literacy of subjects is as given in Table 4.6. In the current study majority had graduation (53.9%). The technical/ diploma/ certificate courses was done by 26 % of subjects.

4.2.2.3 Occupation:

As per National Classification of Occupations (2015), the occupations are classified based on the education and skill set of an individual. In the current study unemployed subjects were not present; 54.7% of subjects did intermediate occupations and small employers and own account workers were of 27.2% of subjects.

4.2.2.4 Socio- economic scale:

The socio- economic scale of a family plays a crucial role in their availability and affordability to food and beverage. In present study we have used 29 point scale as mentioned in Sood and Bindra Modified Kuppuswamy Socio-economic scale: 2022 update of India (Mishra *et al., 2003)*. In the present study, majority belonged to lower middle socio- economic class (88.1%). In the current study there were no lower socio-economic state

4.2.2.5 Family Structure:

Based on the family structure the foods consumed varied and the availability of a variety of dishes for consumption were different too. The classification that is used to define family structure is as per Singh (2003); Saggurti *et. al.,* (2005). In the current study, single, nuclear, joint, and extended family structures. The majority belonged to nuclear families 79.8% subjects.

4.2.2.6 Marital Status: In this study 67.5% married and 30.5% unmarried subjects were present.

PHASE III:

4.3 Metabolic Syndrome among the research subjects

Kumar (2013) in his study found that general outpatients coming for regular health issues had metabolic syndrome and addressing it on priority is better to avoid the future health complications. In the current study metabolic syndrome among the research subjects was assessed through:

4.3.1 Anthropometric measurements of the research subjects

The height (cm), weight (kg), waist circumference (cm) and hip circumference (cm) were the anthropometric measurements (Table 4.7) taken for all the enrolled subjects. Body mass index and waist-hip ratio were calculated later.

Table: 4.7 Anthropometric measurements of the research subjects

Measured Parameter	Research subjects	Males	Females
Number of subjects	**N= 1359 (100%)**	**n= 827 (60.9%)**	**n= 532 (39.1%)**
	Mean ± S.D		
Mean Height (cm)	166.4 ± 9	171 ± 6.9	159.1 ± 6.6
Mean Weight (kg)	73.7 ± 14.3	77.7 ± 13.3	67.6 ± 13.6
Body Mass Index (kg/m^2)	26.6 ± 4.6	26.6 ± 4.2	26.7 ± 5.2
Waist Circumference (cm)	91 ± 9.2	92.5 ± 8.1	88.7 ± 10.3
Hip Circumference (cm)	106.8 ± 13.6	108.1 ± 12.3	104.9 ± 15.2
Waist Hip Ratio	0.86 ± 0.1	0.86 ± 0.1	0.85 0.1

The mean height of the enrolled subjects was 166.4 ± 9 cm. The males had a mean height of 171 ± 6.9 cm and the females had 159.1 ± 6.6 cm. The mean weight of the subjects was 73.7 ± 14.3 kg. The males' mean weight was 77.1 ± 13.3 kg and the females had a mean weight of 67.6 ± 13.6 cm. The reference age of adult Indians is revised to 19-39 years, height (171 cm male and 152 cm female) and adult reference weight (65 kg males and 55 kg females) [ICMR NIN Recommended Dietary Allowances (RDA) and Estimated Average Requirements (EAR), 2020]. The study

subjects average height was as per reference range but the average weight was above the reference range.

The mean BMI of the entire subjects was 26.6 ± 4.6 kg/m^2; the mean BMI of males was 26.6 ± 4.2 kg/m^2 and among females mean BMI was 26.7 ± 5.2 kg/m^2. Majority of the subjects were overweight/ obese as per Asian adult body mass index classification (2000).

Mahajan and Batra (2018) study emphasized to use of the revised Asian Indian cut off values for classifying overweight or obesity. Luhar *et al.,* (2020) have shown that overweight and obesity are increasing in the Indian population. In the current study also overweight and obesity were high. Verity *et al*., (2008) study highlighted that viewing television for a longer duration was a contributing cause of obesity in young adults. This can be stated in other works that if an individual is sedentary for a longer period for work purposes or entertainment purposes; the obesity will set it. Ko et al., (2000) in his study showed that BMI cut-off values have to be reduced while defining obesity or if correlated with another measure will be better.

The waist circumference (cm) was measured for all the subjects to measure the central obesity. The mean waist circumference among the subjects was found to be 91 ± 9.2 cm; the waist circumference of males was 92.5 ± 8.1cm and females had a waist circumference of 88.7 ± 10.3 cm. Most of the enrolled subjects were having abdominal obesity (>90 cm males and >80cm females is considered as abdominal obesity as per IDF, 2021). As suggested by Misra *et* al., (2006) the current study waist circumference values highlights the need for action plan has to be taken to bring them down. Chaudhary *et al.,* (2023) have shown in their study that abdominal obesity measured using waist circumference was higher than the previous years and it was more prevalent in females, as observed in the current study.

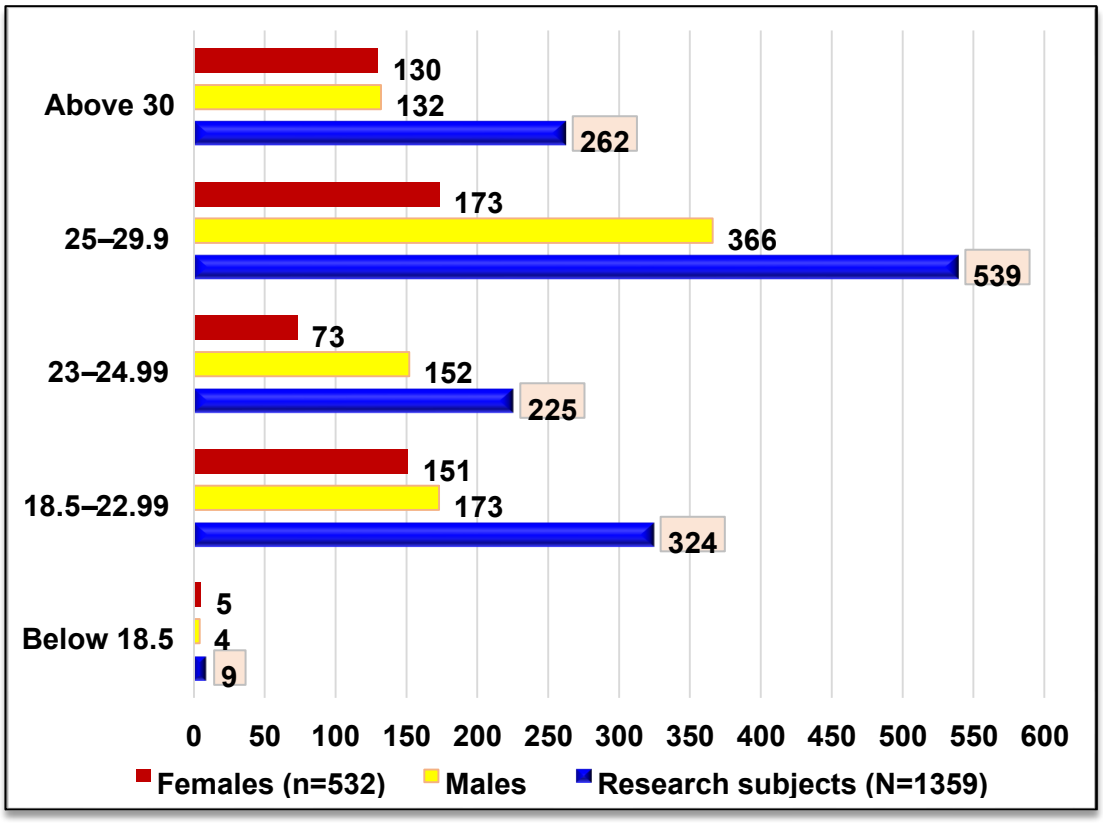
The hip circumference was measured for the research subjects and the mean value was 106.8 ± 13.6 cm. The mean hip circumference of males was 108.1 ± 12.3 cm and of females 104.9 ± 15.2 cm.

Waist- hip ratio was calculated by dividing waist circumference with hip circumference. The mean waist-hip ratio among the subjects was 0.86 ± 0.1. The waist-hip ratio among males was 0.86 ± 0.1 and for females, 0.85 ± 0 .1. The

subjects' mean values indicated the waist-hip ratio was normal to high, as, the normal waist-hip ratio (WHO, 2008) is ≥ 0.9 for males and females ≥ 0.85.

Dilip and Anand (2017) have stated that waist to hip ratio is better index to measure central adiposity and the same is observed in the current study. Sivanatha *et al.,* (2022) in their study observed that abdominal obesity is twice prevalent than men in women. Zhang *et al*., (2008) mentioned abdominal obesity as a risk of all causes.

Nutritional status based on Body Mass Index World Health Organisation, International Association for the Study of Obesity, and International Obesity Task Force (2000) classification was considered to mark the nutritional status of the enrolled 1359 subjects. Graph 4.2 shows the BMI and the nutritional status of the subjects.



Graph 4.2: Body Mass Index of the Research Subjects

In total research subjects 0.7 % were underweight (0.5 % males and 0.9 % females). Normal BMI was observed in 23.8 % of total research subjects (20.9 % males and 28.4 % females). Overweight BMI of 23- 24.99 was observed in 16.6 % of the research subjects (18.4 % males and 13.7 % females). Obesity class I BMI of 25-29.9 was observed in 39.7 % of total research subjects (44.3 % males and 32.5% females) and Obesity class II BMI >30 was observed in 19.3 % of total research subjects (16 % males and 24.4 % females).

4.3.2 Biochemical Parameters of the research subjects

The biochemical parameters measured for the enrolled are presented in the Table 4.8.

Table: 4.8 Biochemical parameters of the research subjects

Measured Parameter	Research subjects (N 1359)	Males (n 827)	Females (n 532)
Haemoglobin (g/dl)	14 ± 2.5	14.9 ± 1.3	12.7 ± 3.3
Fasting blood sugar (mg/dl)	103.3 ± 34.3	105.6 ± 37.5	99.7 ± 28.2
Post prandial blood sugar (mg/dl)	131.8 ± 52.6	131.6 ± 52.3	132.1 ± 53
Glycosylated Hemoglobin (HbA1C)	5.3 ± 1.4	5.3 ± 1.5	5.2 ± 1.3
Thyroid Stimulating Hormone (TSH)	3.4 ± 3.4	3.4 ± 3.6	3.4 ± 3
Total cholesterol (mg/dl)	193.3 ± 41.5	192.3 ± 40	194.7 ± 43.7
Triglycerides (mg/dl)	141 ± 93.7	154.9 ± 104.5	119.3 ± 68.6
High Density Lipoproteins (mg/dl)	42.5 ± 9.4	41.5 ± 9.1	44.2 ± 9.7
Low Density Lipoproteins (mg/dl)	111.5 ± 36.1	110.7 ± 35.7	112.7 ± 36.6

Research subjects had a mean haemoglobin of 14 ± 2.5 g/dL. Haemoglobin of males and females was found to be 14.9 ± 1.3 g/dL and 12.7 ± 3 .3 g/dL, normal to the reference standard ranges. The mean of fasting blood sugar (FBS) in the entire subjects was found to be 103.3 ± 34.3 mg/dL. Males had fasting blood sugar of 105.6 ± 37.5 mg/dL and females had 99.7 ± 28.2 mg/dL. The post-prandial blood sugars (PPBS) mean values were found to be 131.8 ± 52.6 mg/dL among the entire group. 131.6 ± 52.3 mg/dL and 132.1 ± 53 mg/dL among males and females respectively. The glycosylated haemoglobin (HbA1C) was 5.3 ± 1.4 % in the research subjects and males had 5.3 ± 1.5 % and females had 5.2 ± 1.3 % HbA1C values. As per NCEP ATP III (2002 revised in 2005) criteria, the mean FBS values were higher in both males and females. But, the mean PPBS and HbA1C values were normal. In Anjana *et al*., [ICMR INDIAB (2023)] study the state of diabetes is increasing in the population drastically. Similar findings were observed in the current study. The Thyroid Stimulating Hormone (TSH) values were 3.4 ± 3 .4 µIU/ml, 3.4 ± 3.6 µIU/ml, and 3.4 ± 3 µIU/ml among the entire subjects, males and females respectively. The TSH values were normal when compared to reference range standards.

The total cholesterol among the research subjects was 193.3 ± 41.5 mg/dL. The males had 192.3 ± 40 mg/dL and the females had 194.7 ± 43.7 mg/dL and their mean total cholesterol values were normal. The mean triglycerides were 141 ± 93.7 mg/dL in the entire research subjects. The triglycerides among males were higher with a mean of 154.9 ± 104.5 mg/dL, than, 119.3 ± 68.6 mg/dl in females. The high density lipoproteins (HDL) among the research subjects were 42.5 ± 9.4 mg/dL among males the HDL cholesterol was 41.5 ± 9.1 mg/dL and 44.2 ± 9.7 mg/dL in females. The mean low-density lipoproteins (LDL) of research subjects were 111.5 ± 36.7 mg/dL. The mean LDL of males was 110.7 ± 35.7 mg/dl and for females was 112.7 ± 36.6 mg/dl.

As per NCEP ATP III (2002 revised in 2005); the males had higher triglyceride mean values and higher mean values of LDL cholesterol. The mean HDL values were normal. In females the triglycerides were normal, but the mean LDL values were higher and mean HDL values were lower than normal. The dyslipedemic state observed in current study is similar to the study outcome of Gupta *et al*., (2017).

4.3.3 Lifestyle habits of dietary preference, physical activity level, exercise, smoking, and alcohol habits of the research subjects

4.3.3.1 Dietary preference of the research subjects:

The definition of dietary choice is the ratios, amounts, types, or mixes of various foods, drinks, and nutrients in diets, as well as how often they are typically consumed. There is a wide range of dietary preferences in India. Dietary Diversity plays an important role in ensuring overall nutrition of an individual and their well being. As stated by Mahendra and Pandey (2022) India is facing, a triple burden of malnutrition, undernutrition, micronutrient deficiency and overnutrition.

The ICMR and NIN (Nutrient Requirements for Indians, RDA 2020) recommend a daily plate for Indians which should consist of 45% cereals, 17% pulses, egg and meat, 12% fats and oils, 10% milk and its products, 8% nuts and seeds, 8% fruits and vegetables. Green *et al*., (2016) and Weerasekara (2020) in their studies stated that food diversity is not as desired to provide nourishment.

Based on food frequency relative nutritional importance and dietary diversity the food composition score is made. The food groups consumed in a week are

calculated for their frequency of consumption this course are mentioned as pore borderline or acceptable food consumption. The food composition score shows a week long consumption. The food security is measured through the dietary diversity. 24- hour recall and the Individual Dietary Diversity Scores in Table 4.9 of the subjects were obtained using a Diet Recall method.

Table: 4.9

Dietary Diversity score of the research subjects (N=1359)

Sex	Low Dietary Diversity	Medium Dietary Diversity	High Dietary Diversity
	<=4 food groups	5-8 food groups	>=9 food groups
Males (n=827)	91 (11%)	456(55.2%)	280 (33.8%)
Females (n=532)	112 (21.1%)	245 (46.1%)	175 (32.9%)
Total (N=1359)	203 (14.9%)	701(51.6%)	455 (33.5%)

Dietary Diversity of more than or equal to nine food groups among 455 subjects (33.5%). Medium dietary diversity of five to eight food groups was observed in most of the subjects (701). Low dietary diversity was observed in 203 subjects due to non-availability or low- affordability. Food Groups consumed by the research subjects daily basing on 24- hour Diet recall are in Table 4.10.

Table: 4.10
Food groups consumed by the research subjects 24- hour diet recall

Food Item	Total Subjects (N=1359)	Males (n=827)	Females (n=532)
	n (%)		
Wheat/ Wheat Based products	869 (63.9)	467 (56.5)	402 (75.6)
Millets/ Millet Based products	717 (52.8)	351 (42.4)	366 (68.8)
Rice/ Rice Based products	856 (63)	541 (65.4)	315 (59.2)
Pulses	1075 (79.1)	725 (87.7)	350 (65.8)
Legumes	192 (14.1)	112 (13.5)	80 (15)
Sprouts (cooked/ raw)	70 (5.2)	25 (3)	45 (8.5)
Milk & its Products	1050 (77.3)	650 (78.6)	400 (75.2)
Vegetables (cooked / raw)	1144 (84.2)	694 (83.9)	450 (84.6)
Green Leafy Vegetables	202 (14.9)	127 (15.4)	75 (14.1)
Fruits (Fresh)	708 (52.1)	489 (59.1)	219 (41.2)
Sugar	1027 (75.6)	600 (72.6)	427 (80.3)
Jaggery	852 (62.7)	505 (61.1)	347 (65.2)
Honey	615 (45.3)	326 (39.4)	289 (54.3)
Nuts	821 (60.4)	512 (61.9)	309 (58.1)
Oily seeds	444 (32.7)	258 (31.2)	186 (35)
Dry Fruits	719 (52.9)	435 (52.6)	284 (53.4)
Saturated Fats	550 (40.5)	350 (42.3)	200 (37.6)
Unsaturated Fats	947 (69.7)	600 (72.6)	347 (65.2)
Eggs	865 (63.6)	592 (71.6)	273 (51.3)
Chicken	898 (66.1)	603 (72.9)	295 (55.5)
Fish	550 (40.5)	400 (48.4)	150 (28.2)
Red Meat	530 (39)	350 (42.3)	180 (33.8)

When the food frequency questionnaire was used to observe the consumption pattern, it was observed that Rice (63%) and wheat (63.9%) and its products were the staple food of the subjects. They have included millet-based products (52.8%) after the Covid -19 pandemic. But the fruit (52.1%) and green leafy vegetable (14.9%) was found to be low as in study conducted by Sivanatha *et al.,* (2022).

Sweetened options were consumed by most of the subjects in the form of sugar (75.6%), jaggery (62.7%) or honey (45.3%) base products. Saturated fat, ghee was included by most of the research subjects (40.5%). Nuts (60.4%), oily seeds (32.7%) and dry fruits (52.9%) were included by the subjects to increase their immunity levels. The sprouts consumption was sparingly found (5.2%). Non- vegetarian consumption of eggs (63.6%), chicken (66.1%), fish (40.5%) and red meat (39%) was consumed daily among the subjects.

Millets and whole grain products are recommended as a dietary intervention among these subjects as it is found in the study of Hollaender *et al*., (2015) which mentioned, whole grain diets can reduce the total cholesterol and LDL cholesterol values. High fiber content foods are recommended (Rossner, 1992) as a part of diet modification as satiety reduces the quantity of food consumption and indirectly restricts in consumption of extra calories as mentioned in a study done by Holt *et al*., (1995) where the suggestion on treatment and prevention of overweight and obesity can be done by consuming satiating foods. WHO: obesity prevention (2000) and Wynne *et* al., (2005) included high-fiber food for weight management and appetite control. Keats (2014) study insists on using the locally grown produce of agriculture, reducing fat and salt intake along with initiation of physical activity to decrease the incidence of overweight or obesity. Sunkara and Verghese (2014) mentioned dietary modifications are important to manage weight and also specified the need of developing certain low-density foods; that can induce thermogenesis and also alter nutrient absorption in the body; that aid in weight loss, ruling out the use of obesity drugs.

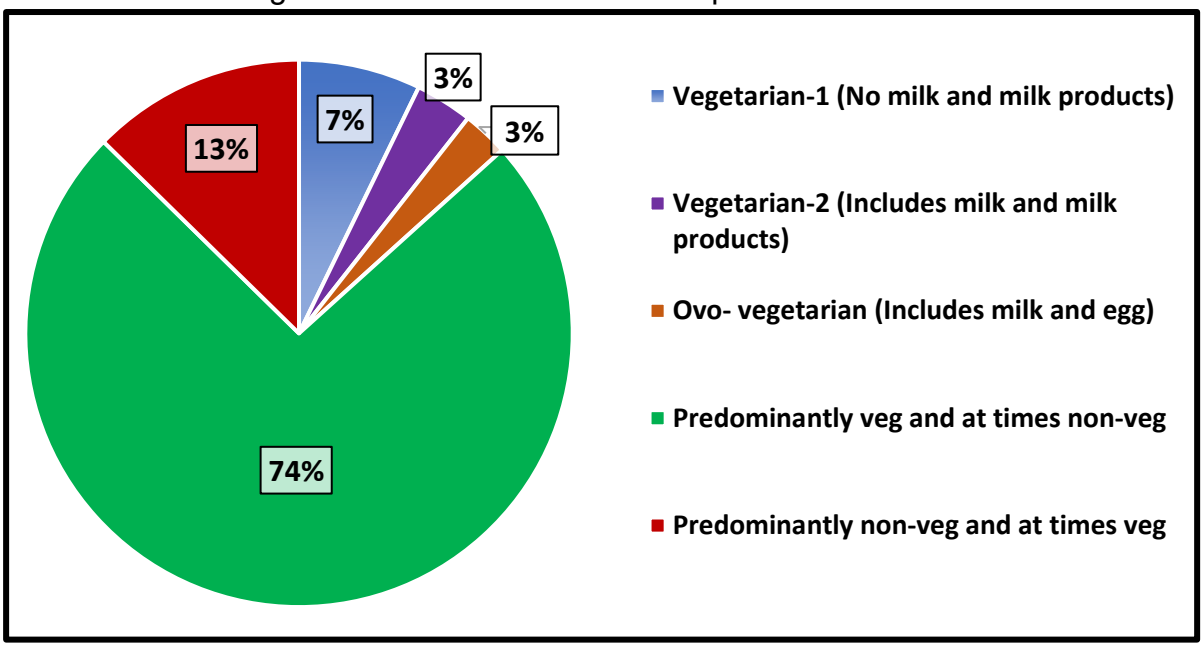
The Diet preference of the research subject is presented in Table 4.11.

Table: 4.11 Diet preference of the research subjects

Diet preference	Research subjects (N 1359)	Males (n 827)	Females (n 532)
Vegetarian-1 (No milk and milk products)	98	26	72
Vegetarian-2 (Includes milk and milk products, no other non-veg)	46	21	25
Ovo- vegetarian (Includes milk and egg)	37	10	27
Predominantly veg and at times non-veg	1006	669	337
Predominantly non-veg and at times veg	172	101	71

The research subjects diet preferences towards vegetarian or non- vegetarian are collected to understand the relation between those habits and metabolic syndrome and body composition parameters. There were five types- Vegetarian-1 (No milk and milk products), Vegetarian-2 (Includes milk and milk products, no other non veg), Ovo-vegetarian (Includes milk and egg), predominantly veg and at times non-veg, predominantly non-veg-and at times veg. majority of males and females and overall research subjects belonged to predominantly veg and at times non-veg.

The results are as given in the Table 4.11 and Graph 4.3.



Graph 4.3: Diet habit of the research subjects

The calories consumed, basal metabolic rate and total energy expenditure of the research subjects was calculated from the data collected and tabulated in 4.12. Despite being vegetarian or non- vegetarian; in general, the calories consumed by an individual, basal metabolic rate, and total energy expenditure play a key role in keeping up the person's healthy weight. The calories consumed are calculated by using the ICMR, NIN Food composition Tables (Longvah *et al.,* 2017). Basal metabolic rate is calculated by using Harris-Benedict equation (Harris and Benedict 1918). The total energy expenditure is calculated by multiplying the Basal metabolic rate with the physical activity level (Jette *et al*., 1990) of an individual. Mirmiran (2002) in his study mentioned the familial intake has an influence on the consumption pattern of the individuals and while giving lifestyle counselling on dietary modifications it was taken care, so that adherence to the modifications can be better.

Table: 4.12 Calories consumed, BMR and TEE of the research subjects

Measured Parameter	**Research subjects**	**Males**	**Females**
Total number of subjects	N= 1359 (100)	N=827 (60.9)	N=532 (39.1)
	Mean ± S.D		
Calories consumed per day	2176 ± 280.1	2244 ± 260.9	2070 ± 276.2
Basal Metabolic Rate	1610 ± 235	1730 ± 205.2	1423 ± 134.9
Total Energy Expenditure	2039 ± 365.5	2200 ± 41.7	1787 ± 236.2

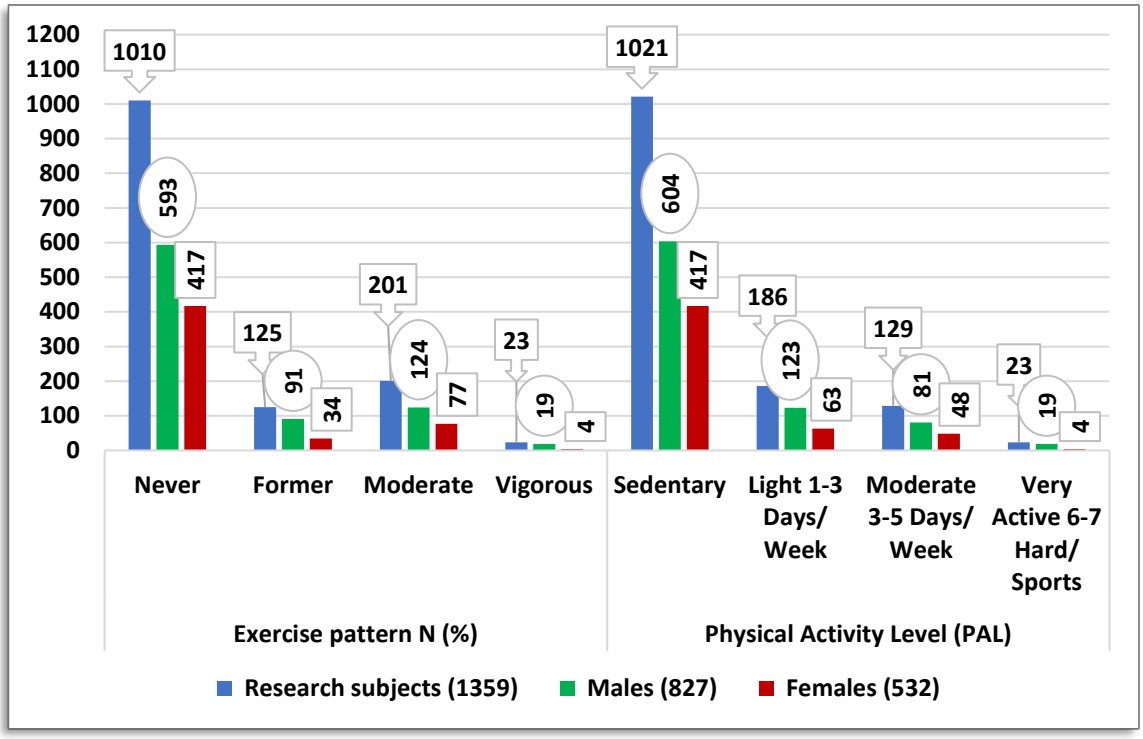
The average calories consumed per day by males was normal and the females had higher calorie consumption and values were 2244 ± 260.9 kcal and 2070 ± 276.2 kcal respectively. As per ICMR, NIN (2020) For sedentary and moderate activity men and women, the recommended dietary allowances of energy were 2110-2710 kcal and 1660-2130 kcal per day respectively. The Basal Metabolic Rate (BMR) of the subjects were 1730 ± 5.2 kcal and 1423 ± 134 .9 kcal in males and females respectively. The PAL of males had a slight to moderate physical activity level compared to Sedentary to Light PAL of females (Graph 4.4). As the physical activity level of males was higher than that in females, the total energy expenditure in males was 2200 ± 341.7 and in females 1787 ± 236.2 kcal.

4.3.3.2 Exercise and Physical Activity Level of the research subjects:

The exercise and Physical activity level of the research subjects as in Graph 4.4. The exercise is categorised into four different groups: Never- people who never attempted an exercise routine in day-to-day life. Former those who stopped the exercise routine for more than three months. Duration of activity and frequency of activity were obtained and classified under moderate activity (2) (3-6 metabolic equivalents- 3.5 to 7 kcal/min) and vigorous activity (3) (greater than 6 metabolic equivalents- more than 7 kcal/min).

The daily level of activity is measured by a number called your Physical Activity Level (PAL). A person's daily physical activity can be expressed as a multiple of their basal metabolic rate (BMR) using the PAL method. PAL encompasses all activities, including moving, exercising, sleeping, and resting. Initially, PAL values were coefficients that were used in dietary studies to calculate a person's total daily energy expenditure (TDEE) in relation to their degree of physical activity.

. BMR is the total number of calories burned by our bodies to sustain basic physiological processes such as breathing, heart rate, and brain activity while we are completely at rest. Total Daily Calorie Expenditure, or TDEE, is estimated by multiplying the BMR by the PAL value. It excludes, however, the energy required for metabolism, digestion, absorption, and the storage of surplus nutrients—the Thermic Effect of Food (TEF). To determine the total daily caloric expenditure, TEF needs to be added individually. As stated in Human energy requirements: report of a joint FAO/WHO/UNU Expert Consultation (2005), the PAL values were determined through a collaborative effort among these organizations.



Graph 4.4: Exercise and Physical Activity Level of the Research Subjects

As shown in Graph 4.4, research subjects 1010 (593 males and 417 females) never attempted any exercise. The exercise was stopped for more than three months among 9.2 % of subjects (11 % males and 6.4 % females). Moderate exercise pattern was observed in 14.8% of subjects (15 % males and 14.5% females). A vigorous exercise pattern was observed in 1.7 % of subjects (2.3 % males and 0.8 % females). Sedentary physical activity was observed in 75.1 % of subjects (73 % males and 78.4 % females), and Light physical activity level was observed in 13.7 % of subjects (14.9 % males and 11.8 % females). Moderate physical activity level was observed in 9.5 % subjects (9.8 % males and 9 % females). Very active physical activity level was observed in 1.7 % subjects (2.3 % males and 0.8 % females). The exercise habit and physical activity levels were lower than the standards recommended [NIN (ICMR) Dietary guidelines for Indians, A Manual, 2011]. As mentioned by Centers for Disease Control and Prevention, 2022 and Sivanatha *et al.,* (2022), the physical inactivity is very high in the population. Koh *et al.,* (2005) in his study has shown importance for primary prevention of the metabolic syndrome risk factors through lifestyle modification.

4.3.3.4 Consumption of alcohol and smoking habit:

Alcohol and Smoking habits among research subjects are in Table 4.13.

Table: 4.13 Alcohol and Smoking habits among research subjects

Parameter		Research subjects (1359)	Males (827)	Females (532)
		N (%)	n (%)	n (%)
Consumption of alcohol	**Never**	1132 (83.3)	665 (80.4)	467 (87.8)
	Former	2 (0.1)	2 (0.2)	0 (0.0)
	Current	225 (16.6)	160 (19.3)	65 (12.2)
Smoking habit	**Never**	1287 (94.7)	764 (92.4)	523 (98.3)
	Former	10 (0.7)	9 (1.1)	1 (0.2)
	Current	62 (4.6)	54 (6.5)	8 (1.5)

In the current study, 1132 subjects (83.3%) never consumed alcohol. Around 665 male subjects (80.4%) and 467 female subjects (87.8%) never consumed alcohol. The people who stopped alcohol or smoking, one year before, were considered former alcoholics/ smokers. Only two subjects (0.1%) stopped consuming alcohol in the present research. Research subjects 225 (16.6%) were consuming alcohol among the enrolled subjects out of which 160 subjects (19.3%) were males and 65 subjects (12.2%) were females. Sivanatha *et al.,* (2022) in their study mentioned that quitting of tobacco and alcohol has to be promoted as public health intervention, as carried in the current study.

In the current study, 1287 subjects (94.7%) did not have a smoking habit, out of which 764 subjects (92.4%) were males and 523 subjects (98.3%) were females. About 10 subjects (0.7%) stopped smoking out of which 9 subjects (1.1%) were males and one subject (0.2%) was female. Around 62 subjects (4.6%) had a smoking habit out of which 54 subjects (6.5%) were males and 8 subjects (1.5%) were females. In the current metabolic syndrome subjects the habit of smoking and alcohol consumption was less prevalent.

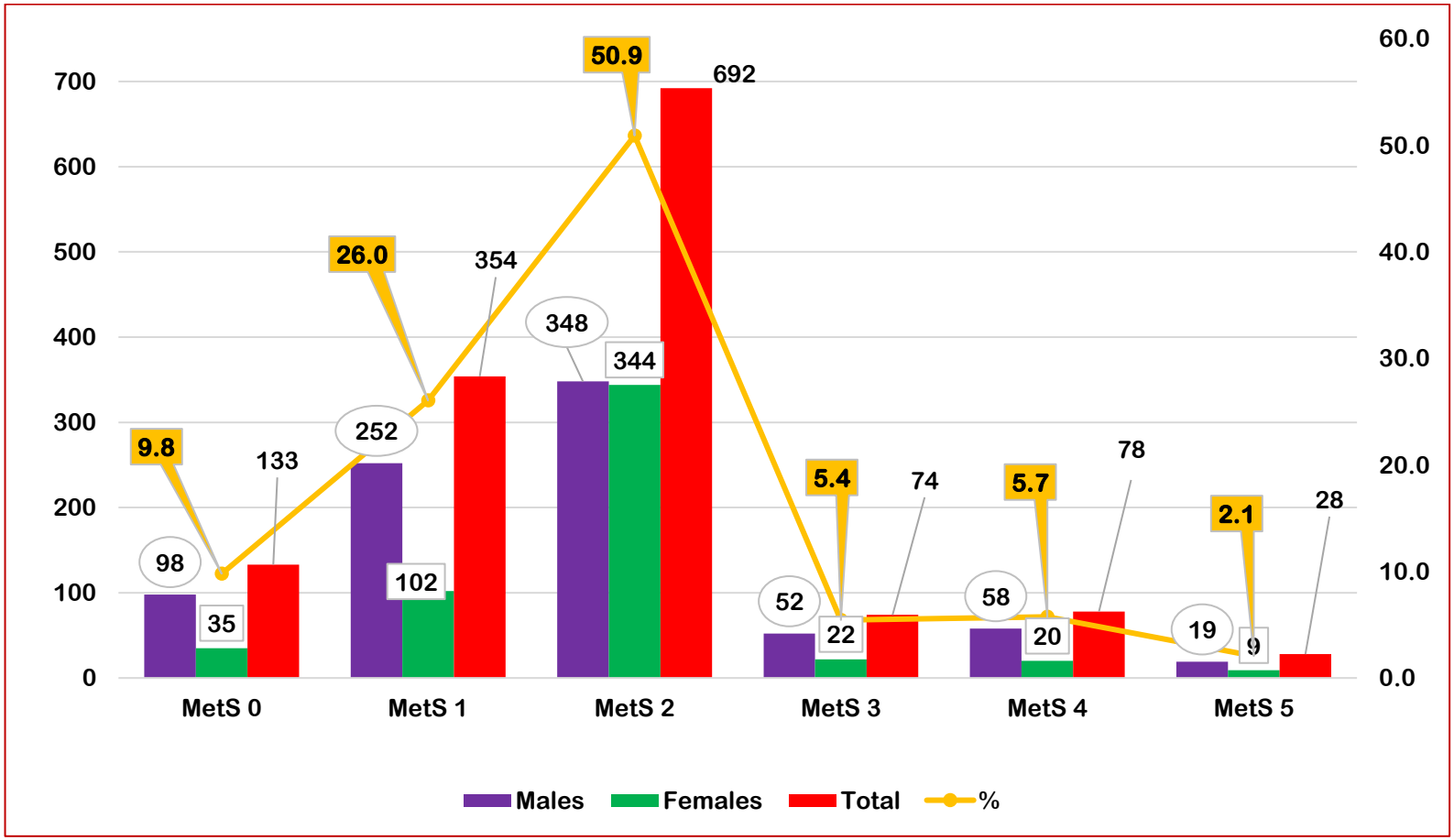
4.3.4 Prevalence of Metabolic Syndrome criteria among the subjects

As per NCEP ATP III (2005 revision) criteria Metabolic syndrome is defined if subjects have three or more parameters among Waist Circumference >90 cm Male; >80 cm Female, FBS >= 100 mg/dl or on medicines, TG >= 150 mg/dl or on medicines, HDL <40 mg/dL Male or <50 mg/dL Female or on medicines and Blood pressure >130 mmHg Systolic Or >85 mmHg Diastolic or on medicines. Rus *et al*., (2016) in their study have stated that, males had higher metabolic syndrome than women, but as age progressed the women also had an equal risk of metabolic syndrome. Studies by Meher *et al.,*(2020), Pathania *et al.,*(2014) and Mangat *et al.,*(2010) stated that metabolic syndrome is more prevalent in women than men. Haffner's (2003) study stated metabolic syndrome might be a new risk factor of coronary heart disease. Ho *et al*., (2001) in a study stated BMI and waist circumference for men and waist circumference and waist hip ratio for women were good markers for identifying the CVD risk. The Table 4.14 and Graph 4.5 shows the data of subjects of metabolic syndrome parameters.

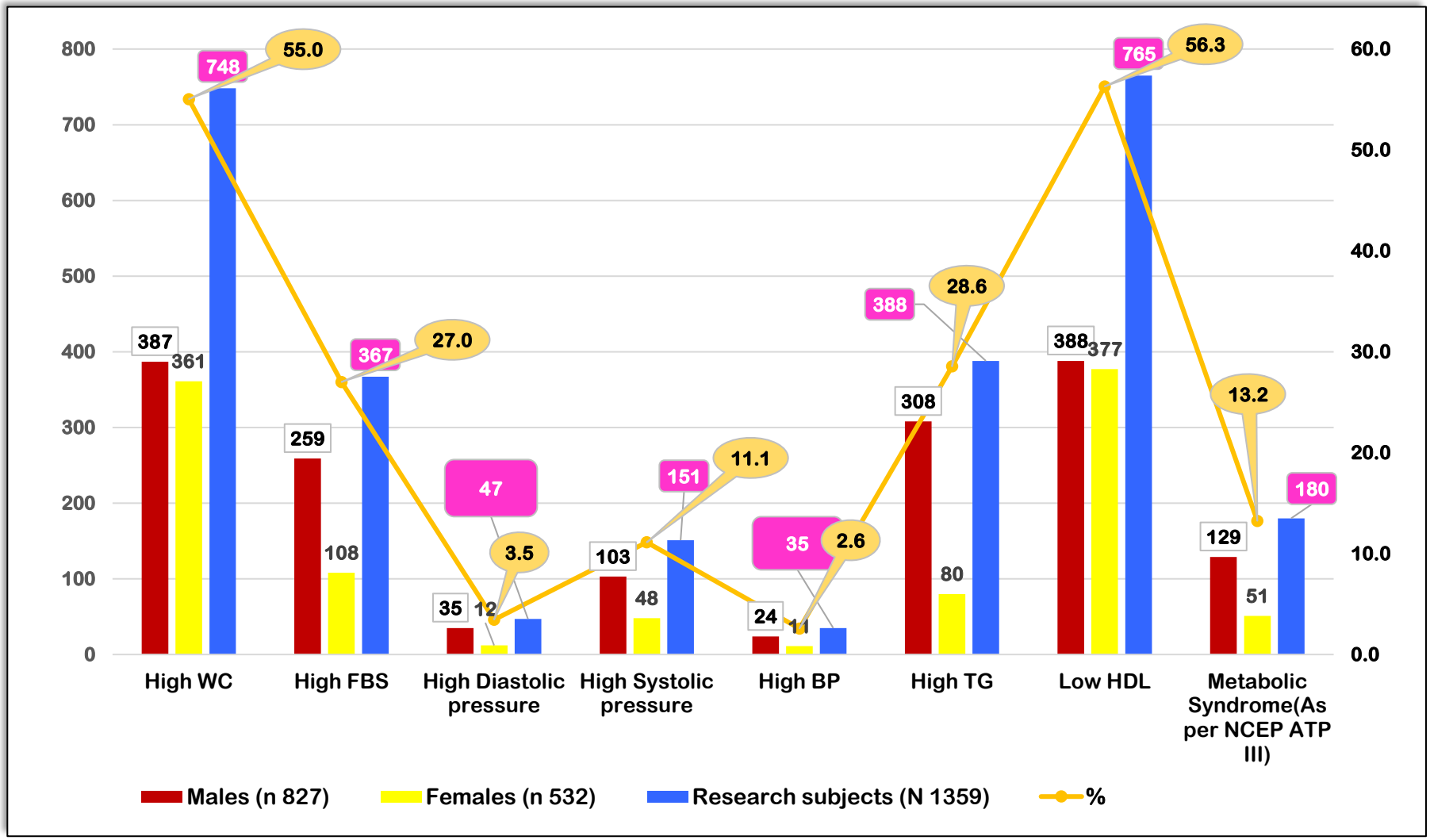
Table: 4.14 Metabolic syndrome parameters in research subjects

Measured Parameter	Research subjects (N=1359)	Males (n=827)	Females (n=532)
	N (%)	n (%)	n (%)
High waist circumference	748 (55)	387 (46.8)	361 (67.9)
High fasting blood sugar	367 (27)	259 (31.3)	108 (20.3)
High diastolic pressure	47 (3.5)	35 (4.2)	12 (2.3)
High systolic pressure	151 (11.1)	103 (12.5)	48 (9)
High blood pressure	35 (2.6)	24 (2.9)	11 (2.1)
High triglycerides	388 (28.6)	308 (37.2)	80 (15)
Low high density lipo protein cholesterol	765 (56.3)	388 (46.9)	377 (70.9)
Metabolic syndrome n(%)	180 (13.2)	129 (15.6)	51 9.6)

The prevalence of metabolic syndrome in the currently enrolled subjects was 13.2%. The metabolic syndrome prevalence was 15.6% and 9.6% among males and females respectively. The waist circumference was higher in females (67.9%) than in males (46.8%). The higher waist circumference depicts abdominal obesity (Ahmad *et al.,* 2016*)* and increases the risk of diseases (Stevens *et al*., 2010). High triglyceride values were observed in males (37.2%) compared to females (15%). Low-density lipoproteins were higher in females (70.9%) than in males (56.3%) (NCEP ATP III, 2002, revised in 2005). Gupta *et al.,* (2004) in urban Indian population there was high prevalence of metabolic syndrome. Deepa *et al.,* (2006) study in India showed abdominal obesity was higher in urban population than the rural population and attributed to their lifestyle. Deepa *et al.,* (2009) in Asian Indians, women and men had abdominal obesity and generalised obesity. Waist circumference was found to be a better criterion for metabolic risk. Thus, the higher waist circumference is an indicator for the higher metabolic risk in current study. Misra and Shrivastava (2013) in their study have shown a similar correlation, between obesity and dyslipedemia, as observed in the current research study.



Graph 4.5: Metabolic Syndrome as per NCEP ATP III (2005) among the Research Subjects



Graph 4.6: Individual Metabolic Syndrome criteria in the research subjects

As per NCEP ATP III criteria (2005) the metabolic syndrome is present if any of the three criteria are present. As given in Graph 4.5, in the current study, as per NCEP ATP III (2002, revised in 2005); 5.4% (74 subjects, 52 males and 22 females) had three metabolic syndrome criteria. Four metabolic syndrome criteria were present in 5.7% (78 subjects, 58 males and 20 females). All five metabolic syndrome criteria were observed in 2.1% (28 subjects, 19 males and 9 females). The next major concern was two criteria were observed in 50.9% of subjects, 692 total, 348 males and 344 females. If a healthy lifestyle is not followed by these 692 subjects there is more chance of developing metabolic syndrome. About 26% (354) of subjects had one of the metabolic syndrome criteria. Only 133 subjects did not have any of the metabolic syndrome criteria.

In Graph 4.6 the Individual Metabolic Syndrome Criteria observed in the Research Subjects is represented. As described by NCEP ATP III 2002, revised in 2005), low levels of high-density lipoproteins were observed in 765 (56.3%) subjects high waist circumference was observed in 748 (55%), high triglycerides were observed in 388 subjects (28.6%). High fasting blood sugar values were seen in 367 (27%) subjects. Systolic blood pressure was high in 151 subjects (11.1%) and high diastolic blood pressure in 47 subjects (3.5%) subjects. Overall, 180 subjects had metabolic syndrome of which 129 were males and 51 were females.

As stated and explained above Developing and framing questionnaires to determine the Metabolic Syndrome's prevalence and KAP of the subjects was possible. This leads to the rejection of H_0 1.

The socioeconomic profile of research subjects with metabolic syndrome and those without metabolic syndrome was compared; as given in Table 4.15.

Table: 4.15 Socio- Economic Profile of Research Subjects with Metabolic Syndrome and without Metabolic Syndrome

	Parameters	Overall (N=1,359)	Metabolic Syndrome		P-value
			Present (N=180)	Absent (N=1,179)	
Age	21-30 years	217 (16.0%)	10 (5.6%)	207 (17.6%)	<0.001
	31-40 years	600 (44.2%)	84 (46.7%)	516 (43.8%)	
	41-50 years	542 (39.9%)	86 (47.8%)	456 (38.7%)	
Gender	Male	827 (60.9%)	129 (71.7%)	698 (59.2%)	0.001
	Female	532 (39.1%)	51 (28.3%)	481 (40.8%)	
Level of education	Up to secondary schooling	101 (7.4%)	21 (11.7%)	80 (6.8%)	<0.001
	Technical/ diploma/ certificate courses	348 (25.6%)	61 (33.9%)	287 (24.3%)	
	Graduate	910 (67.0%)	98 (54.4%)	812 (68.9%)	
Occupation	Semi-routine and routine occupations	119 (8.8%)	16 (8.9%)	103 (8.7%)	<0.001
	Lower supervisory and technical	117 (8.6%)	21 (11.7%)	96 (8.1%)	
	Small employers and own shop workers	370 (27.2%)	84 (46.7%)	286 (24.25%)	
	Intermediate/high managerial	753 (55.4%)	59 (32.8%)	694 (58.9%)	
Socio-Economic Class	Upper lower	53 (3.9%)	32 (17.8%)	21 (1.8%)	<0.001
	Lower- middle	1,197 (88.1%)	116 (64.4%)	1,081 (91.7%)	
	Upper- middle	109 (8.0%)	32 (17.8%)	77 (6.5%)	
Family structure	Single-member	146 (10.7%)	26 (14.4%)	120 (10.2%)	<0.001
	Nuclear family	1,147 (84.4%)	120 (66.7%)	1,027 (87.1%)	
	Joint family	50 (3.7%)	25 (13.9%)	25 (2.1%)	
	Extended family	16 (1.2%)	9 (5.0%)	7 (0.6%)	
Marital status	Unmarried	414 (30.5%)	34 (18.9%)	380 (32.2%)	<0.001
	Married	918 (67.5%)	139 (77.2%)	779 (66.1%)	
	Widowed/divorcee	27 (2.0%)	7 (3.9%)	20 (1.7%)	

The socioeconomic profile of age, sex, level of education, occupation, socio-economic class, family structure and marital status of the person were statistically significant at <0.001 among the research subjects with metabolic syndrome and those without metabolic syndrome. When age grouping is done as 21-30 years; 31-40 years and 41-50 years among metabolic syndrome present and metabolic syndrome absent groups it was statistically significant at <0.001, showing with age, the risk of Metabolic syndrome is increasing too. Similar findings were shown in studies of Rus *et al*.,(2023), Bhalwar *et al*.,(2020). Meher *et al*.,(2020) in their study showed similar findings compared to the current study that marital status and higher socio-economic class leading to a sedentary lifestyle had a higher prevalence of metabolic syndrome (Ravikiran *et* al., 2010 and Prasad *et al*., 2012).

Table 4.16 depicts the habits of exercise, PAL, smoking and alcohol habits of the overall research subjects with metabolic syndrome and those without metabolic syndrome.

Table: 4.16 Exercise, Physical Activity Level, Smoking and Alcohol Habits of Research Subjects with Metabolic Syndrome and without Metabolic Syndrome

Parameter		Overall (n=1,359)	Metabolic syndrome		p value
			Present (n=180)	Absent (n=1,179)	
Exercise	Never	1,010 (74.3%)	51 (28.3%)	959 (81.3%)	**<0.001**
	Former	125 (9.2%)	122 (67.8%)	3 (0.3%)	
	Moderate	201 (14.8%)	4 (2.2%)	197 (16.7%)	
	Vigorous	23 (1.7%)	3 (1.7%)	20 (1.7%)	
Physical activity level	Sedentary	1,021 (75.1%)	51 (28.3%)	970 (82.3%)	**<0.001**
	Light 1-3 days/ week	186 (13.7%)	122 (67.8%)	64 (5.4%)	
	Moderate 3-5 days/ week	129 (9.5%)	4 (2.2%)	125 (10.6%)	
	Very active 6-7 hard/ sports	23 (1.7%)	3 (1.7%)	20 (1.7%)	
Smoking/ tobacco chewing	Never	1,287 (94.7%)	145 (80.6%)	1,142 (96.9%)	**<0.001**
	Former	10 (0.7%)	10 (5.6%)	0 (0.0%)	
	Current	62 (4.6%)	25 (13.9%)	37 (3.1%)	
Alcohol	Never	1,132 (83.3%)	102 (56.7%)	1,030 (87.4%)	**<0.001**
	Former	2 (0.1%)	2 (1.1%)	0 (0.0%)	
	Current	225 (16.6%)	76 (42.2%)	149 (12.6%)	

When metabolic syndrome and non-metabolic syndrome subjects were compared for the exercise, physical activity level, smoking, alcohol habit, calories consumed, basal metabolic rate and total energy expenditure; they were statistically significant at <0.001. So in the current study, the physical inactivity, smoking, alcohol habit, high calories consumption and low BMR were found to be the risk factors for metabolic syndrome. Physical activity is key for health [Gustat *et al.,* (2002)] as observed in the current study also. Klein (2004) study shows the importance of weight loss through physical activity as initial therapy by which the complications or health issue can be reduced. Sivanatha *et al.,* (2022) in their study stated that through public health intervention we have to promote healthy lifestyle to reduced the NCD‘s burden. Slagter *et al*., 2014 in their study have shown cessation of smoking and moderation of alcohol has a beneficial effect on reducing the prevalence of metabolic syndrome.

Anthropometric measures of research subjects with Metabolic Syndrome and without Metabolic Syndrome is tabulated in Table 4.17.

Table: 4.17 Anthropometric Measures of Research Subjects with Metabolic Syndrome and Non- Metabolic Syndrome

Parameters	**Overall (N=1,359)**	**Metabolic Syndrome**		**p value**
		Present (N=180)	**Absent (N=1,179)**	
Weight (kg)	73.7 ± 14.3	79.9 ± 14.8	72.8 ± 14.0	<0.001
BMI (kg/m2)	26.6 ± 4.6	28.7 ± 4.7	26.3 ± 4.5	<0.001
Waist circumference (cm)	91 ± 9.2	92.5 ± 8.1	88.7 ± 10.3	<0.001
Hip circumference (cm)	106.8 ± 13.6	105.1 ± 9.7	107.1 ± 14.0	0.074
Waist to hip ratio	0.9 ± 0.1	1.0 ± 0.1	0.8 ± 0.1	<0.001

The study participants with and without metabolic syndrome showed statistically significant differences in waist circumference, weight, body mass index, and waist-hip ratio ($p < 0.001$). Compared to individuals without metabolic syndrome, those with metabolic syndrome had greater waist circumferences, weights, BMIs

and waist-hip ratios. However, there was no statistically significant difference in hip circumference between individuals with metabolic syndrome and those without it. According to Kopelman (2000), obesity is a medical condition for which prevention should come first.

When the biochemical parameters of research subjects with metabolic syndrome and non-metabolic syndrome were compared. The mean haemoglobin levels were statistically significant <0.001 among metabolic syndrome subjects and non- metabolic syndrome subjects. The postprandial blood sugars, glycosylated haemoglobin, thyroid stimulating hormone, total cholesterol and LDL cholesterol were not statistically significant among metabolic syndrome subjects and non- metabolic syndrome subjects.

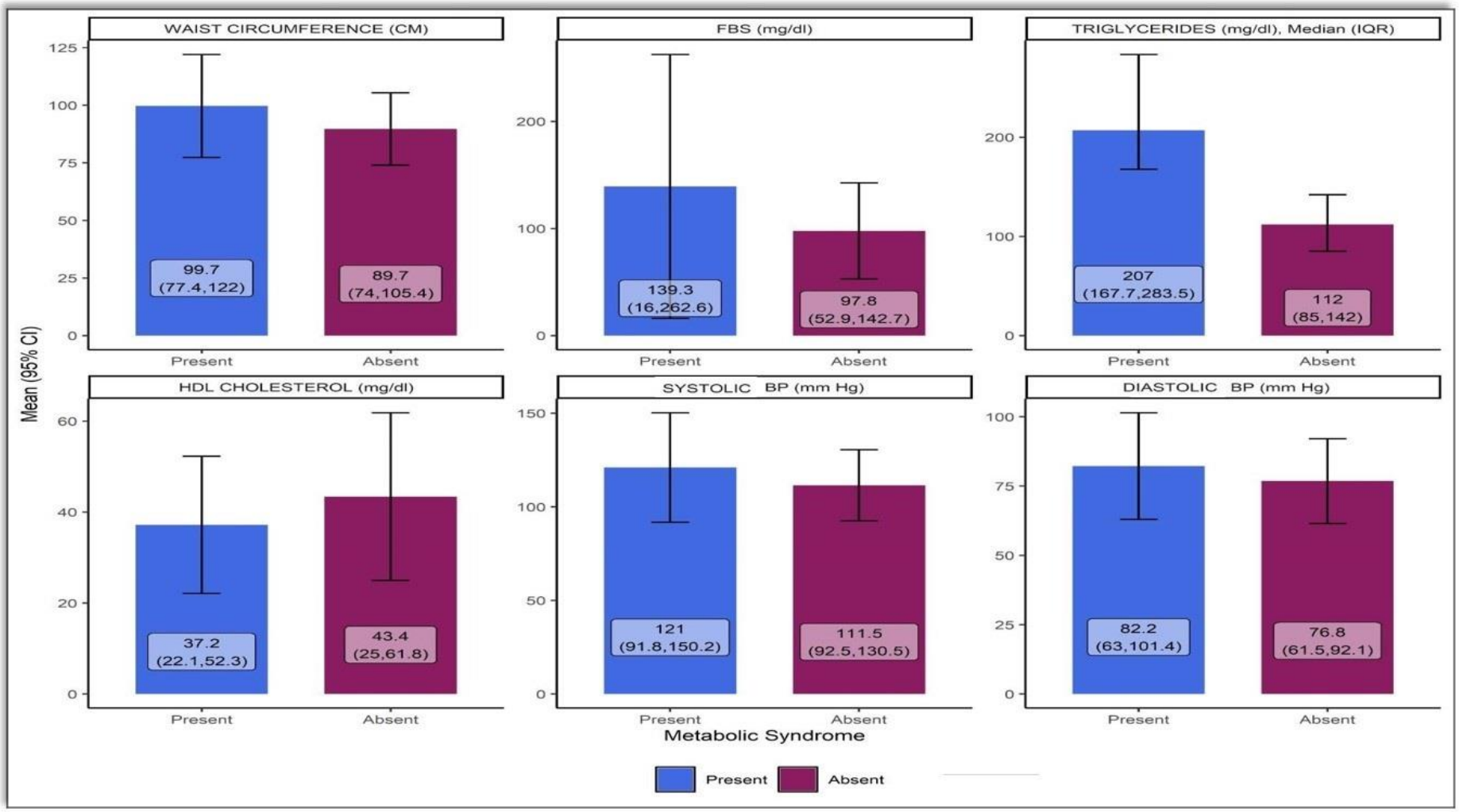
As per NCEP- ATP III (2002, revised in 2005) the metabolic syndrome criteria were examined in the research subjects; as given in Table 4.18, Graph 4.7.

Table: 4.18 Metabolic Syndrome criteria among Metabolic Syndrome and Non- Metabolic Syndrome research subjects

Parameters	Overall (N=1,359)	Metabolic syndrome		p value
		Present (N=180)	Absent (N=1,179)	
Waist circumference (cm)	91.0±9.2	99.7±11.4	89.7±8.0	<0.001
FBS (mg/dl)	103.3±34.3	139.3±62.9	97.8±22.9	<0.001
Triglycerides (mg/dl) *	121.0 (87.6-158.5)	207.0 (167.7-283.5)	112.0 (85.0-142.0)	<0.001
HDL cholesterol (mg/dl)	42.6±9.4	37.2±7.7	43.4±9.4	<0.001
Systolic BP (mmHg)	112.7±11.0	121.0±14.9	111.5±9.7	<0.001
Diastolic BP (mmHg)	77.5±8.3	82.2±9.8	76.8±7.8	<0.001

***Median [Inter Quartile Range (IQR)]**

The study participants with and without metabolic syndrome met the NCEP ATP III (2002 revised in 2005) metabolic syndrome criteria. The results showed that the subjects' metabolic risk was increasing due to the above measured values, which included waist circumference, fasting blood sugars, triglycerides, HDL cholesterol, diastolic blood pressure, and systolic blood pressure. All of these variables were statistically significant at <0.001.



Graph 4.7

Metabolic Syndrome Criteria among Metabolic Syndrome and Non- Metabolic Syndrome research subjects

PHASE IV:

4.4 Assessment of metabolic syndrome subjects, assessment of Body Composition and Imparting intervention to the sub sampled metabolic syndrome subjects

Among 1359 research subjects 180 subjects had Metabolic syndrome. A total of 150 subjects gave their consent to further continue in the study. Early lifestyle intervention is suggested by Jonas *et al*., (2022) and Joung *et al*., (2012) in their a studies in which it is stated the diet pattern of adolescence keep changing and this could affect the risk of developing metabolic syndrome at their adult age.

4.4.1 Assessment of sub sampled metabolic syndrome subjects

4.4.1.1 Background information of the research subjects

The background information of the research subjects are as given in the Table 4.19.

Table: 4.19

Background information of the subsampled metabolic syndrome subjects

Measured Parameter		Metabolic syndrome Subjects (N 150)	Males (n 116)	Females (n 34)
Age (y), Mean ±SD		**40.0 ± 5.9**	**39.7 ± 5.4**	**41 ± 7.2**
Height (cm), Mean ± SD		**167.3 ± 9.3**	**168.3 ± 8.7**	**163.8 ± 10.5**
Weight (kg), Mean ± SD		80.9 ± 15.1	81.5 ± 15.6	79 ± 13.3
				n (%)
Level of education	Illiterate	0 (0)	0 (0)	0 (0)
	Primary schooling	3 (2)	0 (0)	3 (8.8)
	Secondary schooling	17 (11.3)	8 (6.9)	9 (26.5)
	Technical/ diploma/ certificate courses	55 (36.7)	47 (40.5)	8 (23.5)
	Graduate	75 (50)	61 (52.6)	14 (41.2)
	Professional or Honours	0 (0)	0 (0)	0 (0)
Occupation	Unemployed	0 (0)	0 (0)	0 (0)
	Semi-routine and routine occupations	12 (8)	0 (0)	12 (35.3)
	Lower supervisory and technical occupations	17 (11.3)	13 (11.2)	4 (11.8)
	Small employers and own account workers	80 (53.4)	79 (68.1)	1 (2.9)
	Intermediate occupations	39 (26)	22 (19)	17 (50)
	Higher managerial, administrative and professional occupations	2 (1.3)	2 (1.7)	0 (0)
Socioeconomic Class	Lower	0 (0)	0 (0)	0 (0)
	Upper Lower	32 (21.3)	25 (21.6)	7 (20.6)
	Lower- middle	92 (61.4)	68 (58.6)	24 (70.6)
	Upper- middle	26 (17.3)	23 (19.8)	3 (8.8)
	Upper	0 (0)	0 (0)	0 (0)
Family Structure	Single Member	26 (17.3)	18 (15.5)	8 (23.5)
	Nuclear Family	93 (62)	75 (64.7)	18 (52.9)
	Joint Family	22 (14.7)	14 (12.1)	8 (23.5)
	Extended Family	9 (6)	9 (7.8)	0 (0)
Marital Status	Unmarried	30 (20)	21 (18.1)	9 (26.5)
	Married	114 (76)	92 (79.3)	22 (64.7)
	Divorcee	3 (2)	2 (1.7)	1 (2.9)
	Widowed	3 (2)	1 (0.9)	1 (5.9)

Among the 1359 research subjects enrolled into the study initially, 180 subjects had metabolic syndrome. A total of 150 subjects gave their consent to further continue in the study. Metabolic syndrome subjects had the mean age, height and weight were 40 ± 5.9 years, 167.3 ±9.3 cm and 80.9 ± 15.1 kg respectively. There were 3 (2%) of primary schooling, secondary schooling was done by 17 (11.3%), 55 (36.7%) did technical or diploma or certificate courses and 75 (50%) subjects were graduates. Around 80 (53.3%) subjects were small employers and own account workers, 39 (26%) of them had intermediate occupations 12 (8%) subjects had semi-routine and routine occupations, 17 (11.3%) subjects had lower supervisory and technical occupations 2 (1.3%) of them were in high managerial administrator and professional occupations. Around 92 (61.3%) belonged to lowermiddle socioeconomic class, 32 (21.3%) belonged to upper- lower socio-economic class and 26 (17.3%) were of upper middle socio-economic class. Ana *et al.,* (2010) in their research concluded people with less education and older age group had higher metabolic syndrome rate and central obesity was the strongest criteria observed. Subjects belonged to nuclear family, 26 (17.3%) subjects were single members 22 (14.7%) subjects were in a joint family and 9 (6%) belonged to extended family. Married subjects were 114 (76%), unmarried were 30 (20%) subjects and 3 (2%) divorced and another 3 (2%) widowed. Meher *et al.,* (2020) in their study showed a high correlation between metabolic syndrome and currently married, widowed, divorced or separated women.

Table 4.20 represents the Medical History and Family History (Mother/ Father) information of the research subjects.

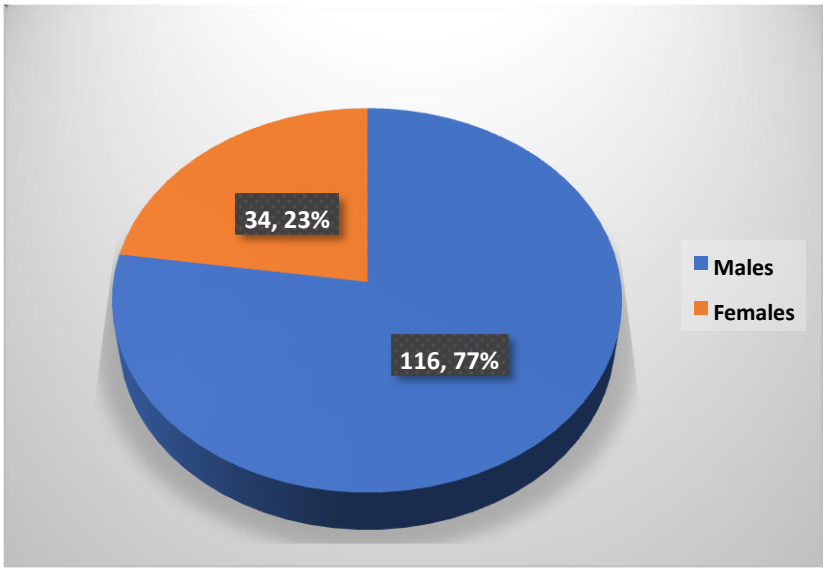
Table: 4.20 Medical History and Family History (Mother/ Father) information of the metabolic syndrome subjects

Measured Parameter (N=150)		Frequency n(%)
Medical history	Diabetes Mellitus	3 (2.0%)
	Diabetes Mellitus and Hypertension	2 (1.3%)
	Diabetes Mellitus, Hypertension and Dyslipedemia	1 (0.7%)
	Dyslipedemia	3 (2.0%)
	Preventive Health Check up	141 (94.0%)
Mother	Diabetes Mellitus	30 (20.0%)
	Diabetes Mellitus, Obesity and Dyslipedemia	16 (10.7%)
	Diabetes Mellitus and Hypertension	11 (7.3%)
	Diabetes Mellitus, Hypertension and Dyslipedemia	13 (8.7%)
	Dyslipedemia	6 (4.0%)
	Hypertension	11 (7.3%)
	Hypertension and Dyslipedemia	2 (1.3%)
	Nothing Significant	59 (39.3%)
	Pre- Diabetes Mellitus, Hypertension	1 (0.7%)
	Prediabetes Dyslipedemia	1 (0.7%)
Father	Diabetes Mellitus	27 (18.0%)
	Diabetes Mellitus, obesity and Hypertension	16 (10.7%)
	Hypertension	14 (9.3%)
	Nothing Significant	93 62.0%)

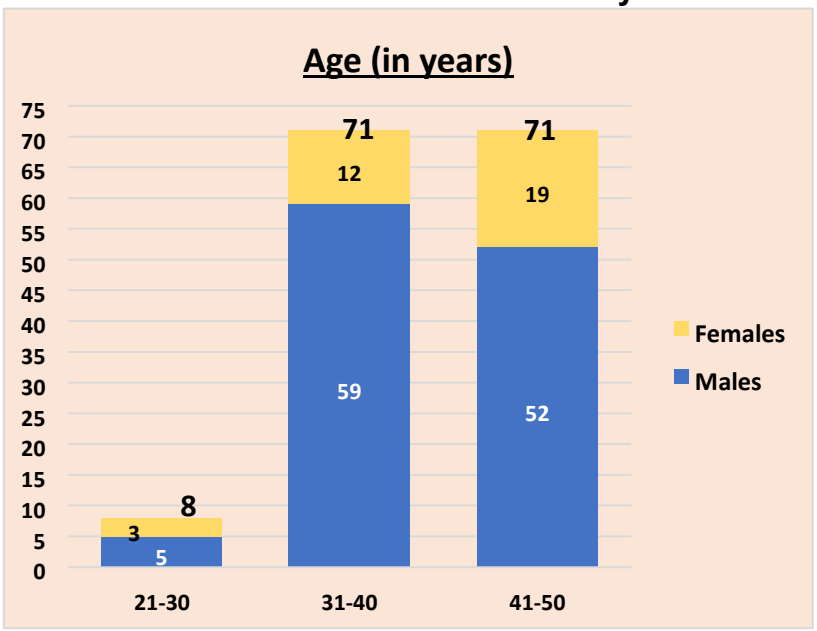
A majority of 94% (141) subjects had come for Preventive Health Checkup without any prior medical history. Mothers of 59 subjects (39.3%) had no previous family history of obesity, Type II diabetes mellitus, high blood pressure, dyslipidemia was not present in subjects‘ mothers 59 (39.3%) and fathers 93 (62%). Family history had no statistical correlation with the disease condition of the subjects in the current study. The findings were different, than Das *et al.,* (2012), Bener *et al*., (2014) and Paul *et al*., (2017) studies, concluded that type 2 diabetes family history had an effect on metabolic syndrome of the people than those who had no family history of type 2 diabetes and the researcher mentioned that this can be used as a predictive tool for diagnosing and preventing Asian Indians from metabolic syndrome. Paul *et al* (2017) in their study mentioned that family history could be one of the major cause of metabolic syndrome in next generations.

4.4.1.2 Sex and age-wise distribution of the metabolic syndrome subjects

A total of 150 subjects were included for further study. Among them there were 116 (77%) males and 34 (23%) females as shown in Graph 4.8.



Graph 4.8: Sex distribution of the metabolic syndrome subjects



Graph 4.9: Distribution of the metabolic syndrome subjects based on age

The age grouping was done for easy understanding of the sub-sample subjects. This includes 8 (5 males, 3 females 3) of 21- 30 years, 71 (59 males, 12 females) were 31-40 years and 71 (52 males, 19 Females) were 41-50 years. We had 71 subjects each in the age group of 31-40 and 41- 50 years. The subjects in 21-30 years were only 8 as shown in Graph 4.9.

4.4.1.3 Anthropometric measures of the metabolic syndrome subjects

The anthropometric measurements of the metabolic syndrome subjects are as given in Table 4.21.

Table: 4.21

Anthropometric measures of the metabolic syndrome subjects

Measured Parameter	21-30 (N=8)		31-40 (N=71)		41-50 (N=71)	
	Males (5)	Females (3)	Males (59)	Females (12)	Males (52)	Females (19)
Age (Y)	27.8 ± 2	24.7 ± 4.7	36.4 ± 2.6	36.9 ± 1	44.7 ± 2.7	44.8 ± 1.5
Height (cm)	169.2 ± 9.1	153.0 ± 13.9	167.2 ± 9.4	164.9 ± 9.5	169.5 ± 7.9	171.4 ± 2.2
Weight (kg)	82.4 ± 15.2	67.1 ± 7.6	78.8 ± 16.0	80.6 ± 16.9	84.4 ± 14.9	88.1 ± 7.5
BMI (kg/m2)	28.8 ± 5	29.0 ± 5.6	28.1 ± 4.8	29.4 ± 4.4	29.4 ± 4.6	30.0 ± 2.5
Waist Circumference (cm)	97.3 ± 9.9	104.4 ± 11.7	103.6 ± 12.9	97.5 ± 14.8	98.5 ± 10	106.7 ± 13.6
Hip Circumference (cm)	101.2 ± 5	105.0 ± 2.3	104.3 ± 8.2	102.9 ± 9	101.3 ± 5.9	111.8 ± 12.5
Waist-Hip Ratio	1 ± 0.1	1.0 ± 0.1	1.0 ± 0.1	0.9 ± 0.1	1.0 ± 0.1	1.0 ± 0.0

The males were taller than the females in the current study. The males and females had the reference height (ICMR NIN RDA EAR, 2020). But the weight of females was comparatively higher than the males and higher than the reference weight (ICMR NIN RDA EAR, 2020). All the subjects were overweight and obese. The waist and hip circumference of females was higher than the males the waist- hip ratio of both male and females were found to be high showing abdominal obesity is more prevalent among the subjects. Stevens (2010) in their research found that in both, men and women, waist and waist-to-hip ratio increase with age. In the current study we can observe that to identify overweight orobesity, BMI, waist circumference and waist hip ration were significant as mentioned by Gill *et al.,* (2003) in their study that to identify overweight or obesity, BMI, waist circumference and waist hip ratio have a role.

4.4.1.4 Bio chemical parameters of the metabolic syndrome subjects

The mean and standard deviation values of biochemical parameters of the subsample subjects are as given in Table 4.22.

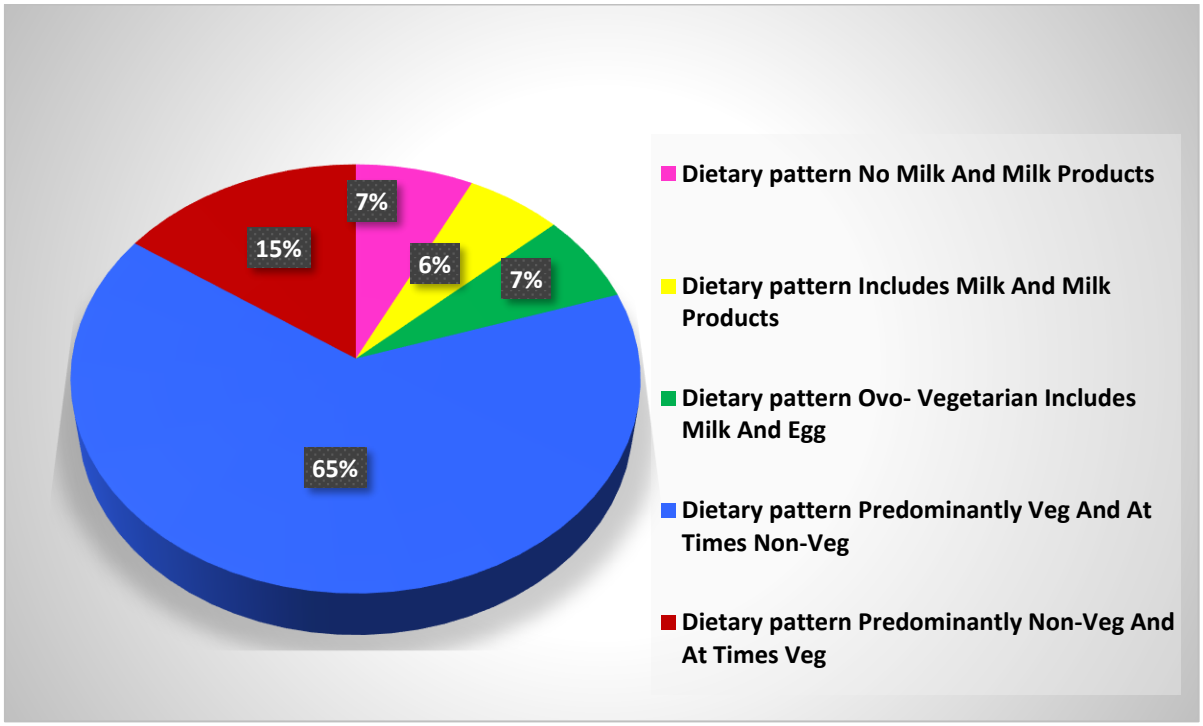
Table: 4.22 Bio-chemical parameters based on age- grouping classification of the metabolic syndrome subjects

Measured Parameter	21-30 (N=8)		31-40 (N=71)		41-50 (N=71)	
	Males (5)	Females (3)	Males (59)	Females (12)	Males (52)	Females (19)
Hemoglobin (g)	14.3 ± 1.4	14.1 ± 2.6	14.5 ± 1.7	20.1 ± 20.2	14.9 ± 1.5	15.1 ± 1.0
Fasting blood sugar (mg/dl)	134.7 ± 68.2	97.7 ± 5.9	142.9 ± 72.0	136.7 ± 55.4	151.2 ± 62.0	146.4 ± 71.9
Post prandial blood sugar (mg/dl)	271.4 ± 230.1	107.0 ± 12.2	163.8 ± 82.8	146.4 ± 66.1	124.5 ± 38.6	111.4 ± 14.7
Glycosylated haemoglobin (%)	7.4 ± 3.2	5.6 ± 2.3	5.6 ± 1.9	5.4 ± 1.8	5.1 ± 1.3	4.7 ± 0.4
Thyroid stimulating hormone (μIU/mL)	3.9 ± 1.4	2.6 ± 1.0	3.2 ± 1.3	3.6 ± 1.1	3.1 ± 0.8	2.7 ± 0.7
Total cholesterol (mg/dl)	187.2 ± 54.5	190.3 ± 52.7	198.1 ± 36.8	191.8 ± 29.1	194.8 ± 31.9	203.0 ± 39.9
High density lipo proteins (mg/dl)	34.5 ± 4.2	31.2 ± 4.3	37.2 ± 8.8	37.7 ± 6.5	37.3 ± 8.4	43.9 ± 6.0
Low density lipo proteins (mg/dl)	122.7 ±56.9	122.0 ± 41.8	119.8 ± 35.3	110.3 ± 46.7	114.0 ± 36.8	111.0 ± 55.3

The mean haemoglobin of the subjects was 15 ± 5.9 g/dL. The fasting blood sugar values and HDL cholesterol values increased with age in both males and females. The postprandial blood sugars ranged between 109 to 139 mg/dL interquartile range the glycosylated haemoglobin was found to be 5.4± 1.7 %. TSH values were 3.2±1.1 μIU/mL. The total cholesterols ranged 197.3 ± 35 .4 mg/dL. LDL cholesterol was found to be 116.3 ± 38 .2 mg/dL. These biochemical parameters are as given in the Table 4.23 based on grouping of age. The age group of 21 to 30 years males had higher PPBS, HbA1C and LDL cholesterol values. The total cholesterol values were higher among 41 to 50 year age group.

4.4.1.5 Dietary preference, smoking and alcohol habits of the research subjects

The Dietary preference of the research subjects is as mentioned in the Table 4.24 and Graph 4.10.

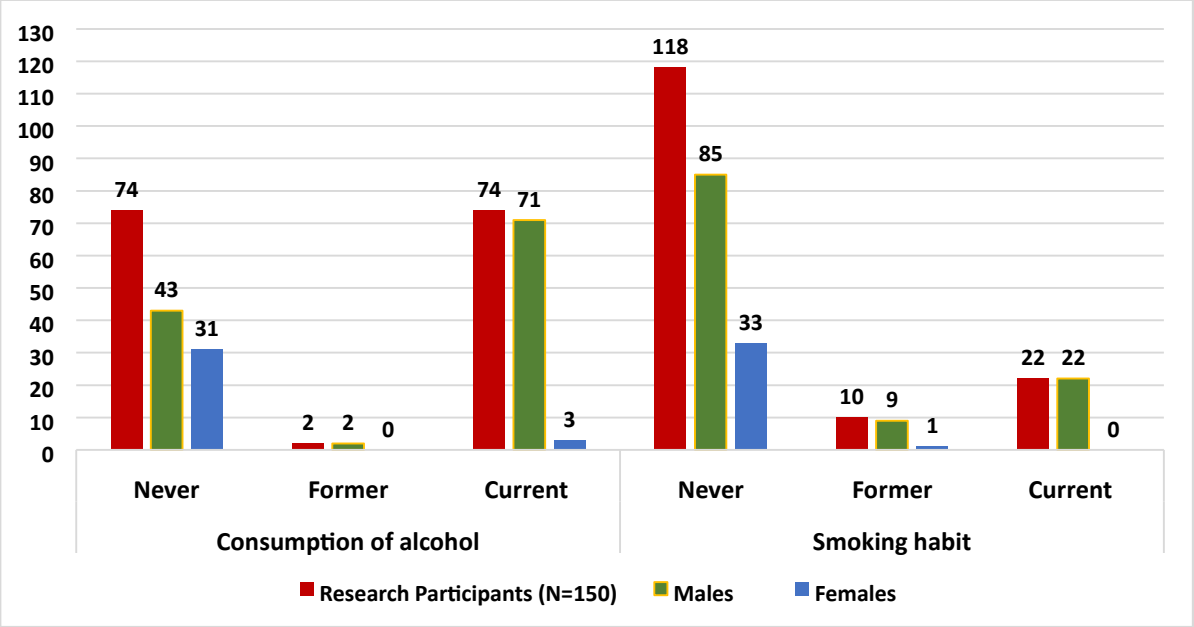


Graph 4.10: Dietary preference of metabolic syndrome subjects (n=150)

Most of the subjects (97, 64.7%) had predominantly vegetarian diet and at times were consuming non-vegetarian food. Around 23 (15.3%) subjects were consuming predominantly non-vegetarian food and at times vegetarian food. Ovo vegetarian subjects were 10 (6.7%), lacto-vegetarians were 9 (6%) and complete vegetarians were 11 (7.3%) of them. Anderson *et al*., (2004) and Larsen (2010) through their study mentioned that dietary proteins intake can help in regulating the food intake and maintain healthy weight. In the current study also the calories were cut down by 1/3rd from the carbohydrates and distributed into the protein calories to bring in the necessary changes in the composition. For vegans or vegetarians plant based protein were of a great option (Tuso *et al*., 2013)

Table: 4.23 Dietary preferences, smoking and alcohol habits of the metabolic syndrome subjects

Measured Parameter		Metabolic syndrome subjects N 150 (%)	Males n 116(%)	Females n 34(%)
Dietary preference	Vegetarian-1 (No Milk And Milk Products)	11 (7.3)	9 (7.8)	2 (5.9)
	Vegetarian-2 (Includes Milk And Milk Products)	9 (6)	5 (4.3)	4 (11.8)
	Ovo- Vegetarian (Includes Milk And Egg)	10 (6.7)	8 (6.9)	2 (5.9)
	Predominantly Veg And At Times Non-Veg	97 (64.7)	75 (64.7)	22 (64.7)
	Predominantly Non-Veg and at times veg	23 (15.3)	19 (16.4)	4 (11.8)
Consumption of alcohol	Never	74 (49.3)	43 (37.1)	31 (91.2)
	Former	2 (1.4)	2 (1.7)	0 (0)
	Current	74 (49.3)	71 (61.2)	3 (8.8)
Smoking habit	Never	118 (78.7)	85 (73.3)	33 (97.1)
	Former	10 (6.6)	9 (7.8)	1 (2.9)
	Current	22 (14.7)	22 (19)	0 (0)



Graph 4.11: Alcohol and smoking habit of the metabolic syndrome subjects

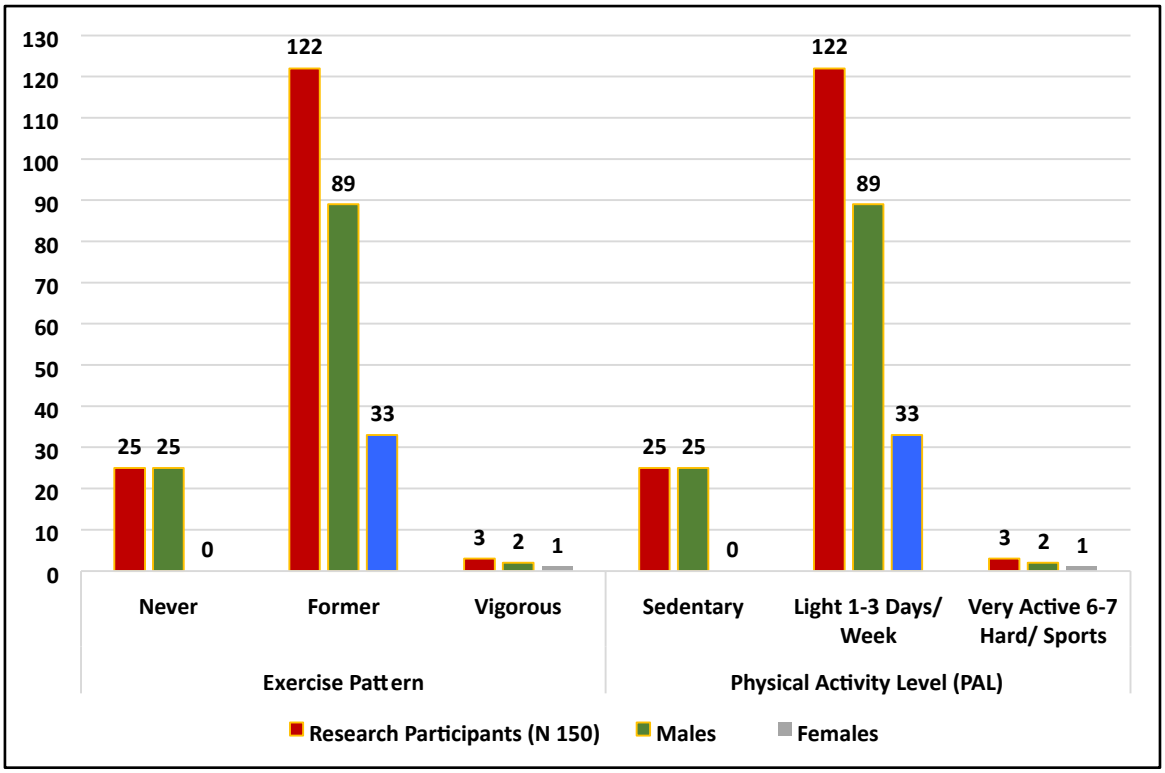
Increased BMI, smoking, and a history of hypertension are three individual risk factors that, when taken separately, are linked to an increased risk of metabolic syndrome by Manjunath *et al.,* (2014). Smoking habit was never done by 118 (78.7%) of the subjects 10 (6.7%) subjects stopped smoking for more than one year. Alcohol habit was stopped by 2 (1.3%) of the subjects. Around 74 (49.3%) subjects had never consumed alcohol and 74 (49.3%) of them were currently consuming alcohol. The smoking and alcohol habits were observed more in males than in females. The smoking habit was not that prevalent in the metabolic syndrome subjects in the current study. Table 4.23 and Graph 4.11 depicts the alcohol and smoking habit of the research subjects. Vancampfort *et al.,* (2016) showed a positive association between alcohol habit and metabolic syndrome contraindicating Vidot *et al.,* (2016) study which showed a negative association between metabolic syndrome and alcohol habit.

4.4.1.6 Exercise and Physical Activity Level (PAL) of the research subjects

The exercise and Physical Activity level of the research subjects is as shown in Table 4.24 and Graph 4.12.

Table: 4.24 Exercise and physical activity level of the metabolic syndrome subjects

Measured Parameter		**Research Subjects (N 150)**	**Males (n 116)**	**Females (n 34)**
Exercise Pattern	Never	25 (16.7)	25 (21.6)	0 (0)
	Former	122 (81.3)	89 (76.7)	33 (97.1)
	Moderate	0 (0)	0 (0)	0 (0)
	Vigorous	3 (2)	2 (1.7)	1 (2.9)
Physical Activity Level (PAL)	Sedentary	25 (16.7)	25 (21.6)	0 (0)
	Light	122 (81.3)	89 (76.7)	33 (97.1)
	Moderate	0 (0)	0 (0)	0 (0)
	Very Active	3 (2)	2 (1.7)	1 (2.9)
	Vigorous/ Very Hard Physical Job	0 (0)	0 (0)	0 (0)



Graph 4.12: Exercise and physical activity level of the metabolic syndrome subjects

Genovefa *et al.,* (2007) in their study showed sedentary lifestyle and diet pattern are the reasons for metabolic syndrome. In the current study similar finding was observed, the exercise was not done by 25 (21.6%) male subjects. Around 89 (76.7%) male and 33 (97.1%) female subjects stopped exercising for more than three months. Two males and one female were doing vigorous exercise. Sedentary activity was observed among 25 (21.6%) male subjects. Light 1-3 days/ week physical activity was observed in 89 (76.7%) males and 33 (97.1%) females.

Moderate 3-5 days/ week and Vigorous/ Very hard physical job weren‘t observed among the research subjects (n=150). The low exercise habit and sedentary activity was observed in the research subjects when compared with the Guideline 9: Exercise regularly and be physically active to maintain ideal body weight. [NIN (ICMR) Dietary guidelines for Indians: A manual 2011]. The pandemic period had both effects on stopping and initiating exercise among the subjects.

4.4.2 Metabolic syndrome parameters of the subsampled metabolic syndrome subjects

According to Rosenbloom et al. (1999), type 2 diabetes is one of the metabolic syndrome risk factors that is increasingly common in young people and

needs to be treated with dietary and exercise modifications. According to Manjunath et al. (2014), metabolic syndrome is more prevalent among young adults living in metropolitan areas of India, and it is correlated with higher blood pressure, smoking habits, and body mass index (BMI). Seyed *et al.,* (2017) in their study observed a triple burden, in developing economy, physical inactivity, obesity and under nutrition. Aljohani *et al.,* (2014) stated that though metabolic syndrome raised as epidemic, still MetS is evident. Need for public awareness to control is necessary. Jingya *et al*., (2013) in a study showed BMI increases with age for male students but decreases with age for female students. Based on NCEP ATP III (2005) criteria when assessed; the mean and standard deviation values of waist circumference, fasting blood sugars, triglycerides, HDL cholesterol and blood pressure are as in Table 4.25

Table: 4.25 Metabolic syndrome parameters in research subjects

Measured Parameter	Research Subjects (N 150)	Males (n 116)	Females (n 34)
	(Mean ± SD)		
Waist Circumference (cm)	100.8 ± 11.8	101 ± 11.8	100 ±11.9
Fasting Blood Sugar (mg/dl)	145.7 ± 65.5	146.3 ± 67.1	143.8 ± 60.6
Triglycerides (mg/dl)	209.5 ± 173.1	258.8 ± 181.8	256 ± 141.9
HDL Cholesterol (mg/dl)	37.5 ± 8.0	37.1 ± 8.4	38.4 ± 6.1
Systolic BP (mm Hg)	121.6 ± 15.3	122.1 ± 16.1	119.8 ± 11.9
Diastolic BP (mm Hg)	82.7 ± 10.1	83.1 ± 10.1	81.6 ± 10.4

Mean values of waist circumference 101 ± 11.8 cm (males), 100 ± 11.9 cm (females), fasting blood sugar 146.3 ± 67.1 mg/dL (males), 143 .8 ± 60 .6 mg/dL (females), triglycerides 258.8 ± 181.8 mg/dL (males), 256 ± 141.9 mg/dL (females), HDL cholesterol 37.1 ± 8.4 mg/dL (males) 38.4 ± 6.1 mg/dL (females). The systolic blood pressure 122.1 ± 16.1 mmHg (males), 119.8 ± 11.9 mmHg (females) and diastolic blood pressure 83.1 ± 10.1 mmHg (males), 81.6 ± 10.4 mmHg (females).

Table 4.26 represents this data stating both males and females have the metabolic syndrome criteria elevated. In a study conducted by Bhalwar (2020) the prevalence of metabolic syndrome was 20 to 25% and women had higher metabolic syndrome criteria than men and consistently with age metabolic syndrome had a raise. Ramakrishna *et al*.,(2019) have shown in their study that both systolic and diastolic blood pressures were higher in men than women, similar to the current study.

Table: 4.26 Metabolic syndrome parameters in Age grouping wise in enrolled research subjects

Measured Parameter	21-30 (n=8)		31-40 (n=71)		41-50 (n=71)	
	MALES (5)	FEMALES (3)	MALES (59)	FEMALES (12)	MALES (52)	FEMALES (19)
Waist Circumference (cm)	97.3 ± 9.9	104.4 ± 11.7	103.6 ± 12.9	97.5 ± 14.8	98.5 ± 10.0	106.7 ± 13.6
Fasting Blood Sugar (mg/dl)	134.7 ± 68.2	97.7 ± 5.9	142.9 ± 72.0	136.7 ± 55.4	151.2 ± 62.0	146.4 ± 71.9
Triglycerides (mg/dl)	306.2 ± 199.1	282.4 ± 47.2	282.3 ± 229.1	277.0 ± 156.4	227.7 ± 99.3	190.8 ± 82.3
HDL Cholesterol (mg/dl)	34.5 ± 4.2	31.2 ± 4.3	37.2 ± 8.8	37.7 ± 6.5	37.3 ± 8.4	43.9 ± 6.0
Systolic BP (mm Hg)	118 ± 16.4	118.7 ± 8.1	119.8 ± 15.7	114.1 ± 12.3	125.2 ± 16.3	123.6 ± 9.7
Diastolic BP (mm Hg)	80.4 ±14.2	78.3 ± 7.6	82.4 ± 11.1	77.8 ± 11.0	84.1 ± 8.5	80.4 ± 0.9

When NCEP ATP III (2002 revised in 2005) criteria are considered to define the metabolic syndrome, the metabolic syndrome criteria observed in the current study were, central obesity in 11.9%, high blood pressure among 15.4%, high triglycerides in 26.0%, low HDL-cholesterol among 31.9% and high fasting glucose in 3.7% of the metabolic syndrome subjects. This indicated that if early preventive measures to promote a healthy lifestyle aren‘t taken, the metabolic syndrome will become a serious public health issue. Ramesh *et al*., (2022) study showed a prevalence of metabolic syndrome at 5.2% in the adolescent age group. In the current study, subjects were selected above 20 age, which is the succession age mentioned by Ramesh *et al*., (2022).

When the metabolic syndrome parameter mean values were observed after grouping the age, it is found that waist circumference was highest among females 41 -50 years (106.7 ± 13.6 cm) and 21-30 year females (104.4 ± 11.7 cm). Among males the waist circumference was highest in 31-40 year age group (103.6 ± 12.9 cm) compared to the other age groups. Haidar *et al.,* (2011) in their study have stated obesity affects all age groups and socioeconomic classes. The fasting blood sugar values were higher in males 41-50 years (151.2 ± 62 mg/dl) and females 41-50 years (146.4 ± 71.9 mg/dl). The males in 21-30 years and 31-40 years had higher FBS than females of the same age group. The triglycerides are very high among 21 to 30 years males (306.2 ± 199.1 mg/dL) and 31-40 years males (282.3 ± 229.1 mg/dL) which is significantly corelating with refined carbohydrate and high calorie consumption. The HDL cholesterol was low in 21-30 years males (34.5 ± 4.2 mg/dl) and females (31.2 ± 4 .3 mg/dL). Mackenzie R. (2011) recommended lifestyle modifications as the initial treatment strategy for reduction of high blood pressure. The systolic and diastolic blood pressures were high in 41-50 years males and females compared to other age groups as mentioned in Table 4.27. As observed by Seyed *et* al., (2017) in their study group >20 year old adults the prevalence of obesity, metabolic syndrome, hypertension and type 2 diabetes. In the current study, the younger adults between the age of 21 to 40 had higher risk factors for metabolic syndrome. Ramakrishna *et al*.,(2019) have shown in their study that the mean systolic blood pressure and diastolic pressure blood pressure increased with increasing age in both the sex, but in current study Systolic blood pressure increased; but diastolic blood pressure did not increase significantly. Roy *et al*.,(2017) stated that the prevalence of high blood pressure increased remarkable over two decades but with no improvement in the management.

4.4.3 Body composition analysis of the sub sampled metabolic syndrome subjects

Frankenfield *et al.,* (2001) emphasised that measuring body fat percentage and body fat divided by height in meter square are most appropriate method than BMI for assessing obesity and if BIA or DEXA can be used for analyzing body fat percentage is possible; then that'll be the best method of assessing the body fat percentage. In another study, Kamimura *et al*., (2003) showed skin fold thickness is the preferable mode of measuring body composition among hemodialysis patients and if BIA can be done, that is the best method. Erselcan *et al.,* (2000) found that the

skinfold thickness or body impedance analysis would be preferred to measure body composition in non-obese subjects and DEXA might be the better method for analyzing body composition. Ozhan *et al*., (2012) in his study stated that BIA can be used as a diagnostic tool for identifying metabolic syndrome risk. Kuriyan (2018) has stated various methods in which body composition can be analysed. But, as the Inbody 770 was validated against DEXA; the body composition of the research subjects was analyzed using Inbody 770 the parameters used in the current research study were total body water, protein, minerals, body fat mass, weight, skeletal muscle mass, body fat percentage, extracellular water ratio, Inbody score, visceral fat area, target weight, weight to control, fat to control, muscle to control, basal metabolic rate, Obesity degree and whole body phase angle. The mean and standard deviation of the body composition parameters Assessed are tabulated in Table 4.27.

Table: 4.27

Body composition parameters for the enrolled research subjects

Parameters	**Research Subjects**	**Males**	**Females**
	(N =150)	**(n=116)**	**(n=34)**
Total Body Water (kg)	36.8 ± 6.8	39.1 ± 5.6	28.9 ± 4.3
Protein (kg)	9.9 ± 1.9	10.5 ± 1.6	7.7 ± 1.1
Minerals (kg)	3.5 ± 0.7	3.7 ±0.6	2.7 ± 0.4
Body Fat Mass (kg)	30.8 ± 10.3	28.7 ±9.4	37.7 ± 10.6
Weight (kg)	80.9 ± 15.1	81.5 ±15.6	79 ± 13.3
Skeletal Muscle Mass (kg)	27.9 ± 5.6	29.8 ± 4.6	21.3 ± 3.4
Body fat %	37.6 ± 8.2	34.4 ±6	48.3 ± 4.5
Extracellular water Ratio (ECW)	0.4 ± 0.0	0.4 ±0	0.4 ±0
Inbody Score	58.9 ± 7.9	60 ± 7.9	55 ± 6.7
Visceral Fat Area (cm2)	148.1 ± 51.4	135.6 ± 47.9	190.8 ± 39
Target Weight (kg)	63.2 ± 8.6	66.2 ± 6.5	52.7 ± 6.1
*** Weight To Control(kg)**	-17.7 ± 11.2	-15.8 ± 10.5	-24.3 ± 10.8
*** Fat To Control(kg)**	-20.2 ± 9.5	-18.7 ± 8.9	-25.6 ± 9.6
***Muscle To Control, Median (IQR)**	1.1 (0.0, 4.6)	2.9 ± 3.2	1.3 ± 1.9
Basal Metabolic Rate (BMR)	1451.3 ± 201.6	1519.2 ± 166.4	1219.8 ± 124.7
Obesity Degree	106.2 ± 57.8	100.3 ± 55	126.5 ± 63.3
Whole Body Phase Angle (WBPA)	5.8 ± 0.6	5.9 ± 0.6	5.2 ± 0.5

*Weight, Fat and Muscle To Control were based on the age wise reference values.

Once Inbody 770 was validated against DEXA, the BCA was done for the subsampled metabolic syndrome subjects, the mean values of, total body water in males was 39.1 ± 5.6 kg in females 28.9 ± 4.3 kg the protein was higher in males (10.5 ± 1.6 kg) compared to females (7.7 ± 1.1 kg). The mineral content was higher in males (3.7 ± 0.6 kg) compared to females (2.7 ± 0.4 kg). The body fat mass was higher in females (37.7 ± 10.6 kg) compared to males (28.7 ± 9.4 kg). The weights of both sexes were not different statistically. The skeletal muscle mass of males (29.8 ± 4.6 kg) was higher than females (21.3 ± 3.4 kg). The body fat percent of females (48.3 ± 4.4 %) was higher than that of males (34.4 ± 6 %). As the protein, skeletal muscle mass, and mineral content were high in males they had higher InBody scores than females. The visceral fat area of females (190.8 ± 39 cm^2) was higher compared to males (135.6 ± 47.9 cm^2). The obesity degree was higher in females (126.5 ± 63.3 %) than in males (100.3 ± 55 %). The whole-body phase angle was good in males (5.9 ± 0.6) compared to females (5.2 ± 0.5). Raji *et al*., (2013) in their study showed body fat distribution and insulin resistance had a correlation in healthy Asian Indians and Caucasians.

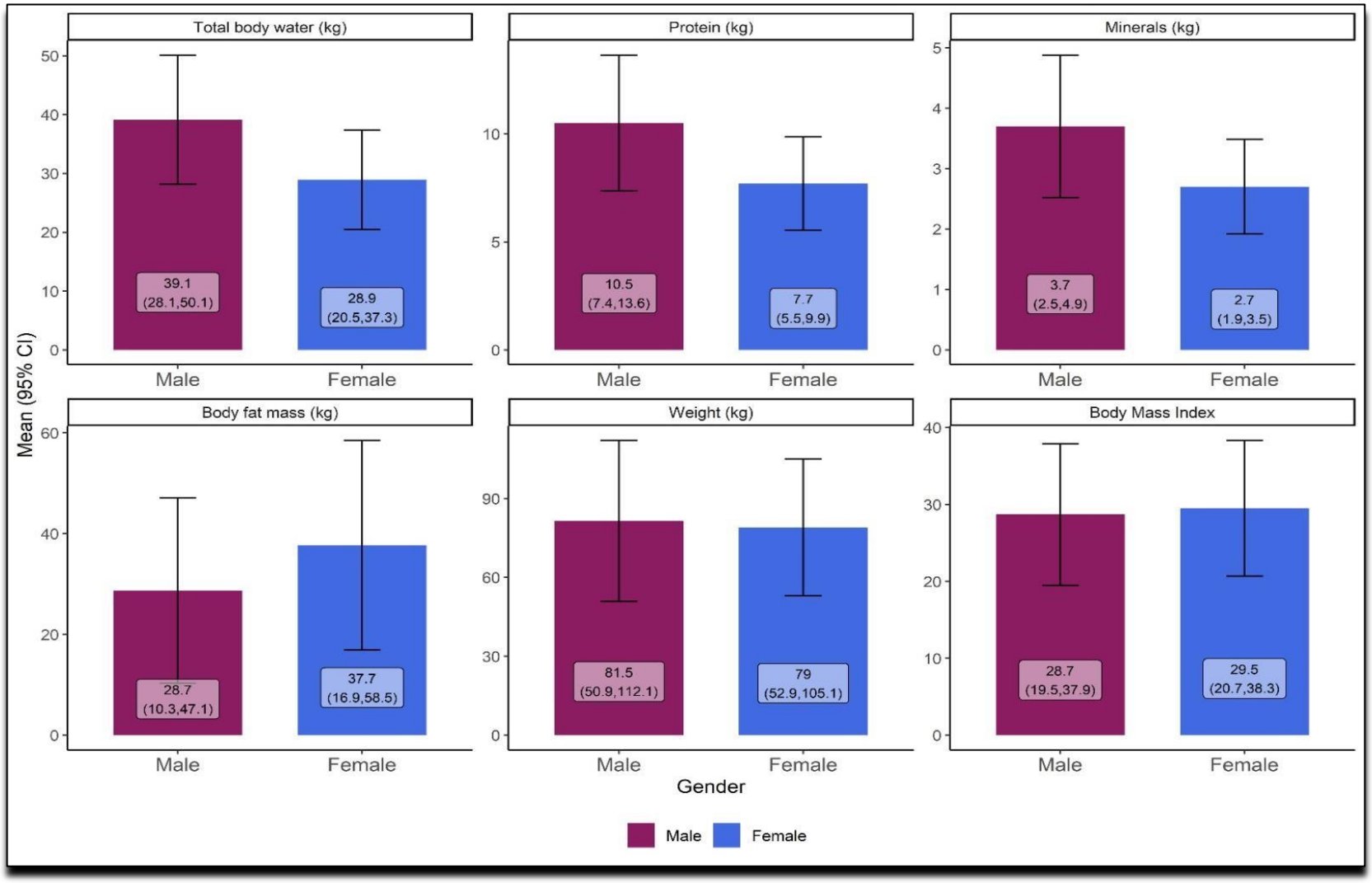
As given in Table 4.28 and Graph 4.13, Graph 4.14 the body composition analysis parameters were statistically analyzed between the sex males and females.

Table: 4.28 Body composition parameters comparison sex wise for the enrolled research subjects

Parameter	Sex		p value
	Male (N = 116)	Female (N=34)	
Total body water (kg)	39.1 ± 5.6	28.9 ± 4.3	<0.001
Protein (kg)	10.5 ± 1.6	7.7 ± 1.1	<0.001
Minerals (kg)	3.7 ± 0.6	2.7 ± 0.4	<0.001
Body fat mass (kg)	28.7 ± 9.4	37.7 ± 10.6	<0.001
Weight (kg)	81.5 ± 15.6	79.0 ± 13.3	0.40
Body Mass Index	28.7 ± 4.7	29.5 ± 4.5	0.40
Waist Hip Ratio	1.0 ± 0.1	0.9 ± 0.1	0.007
Skeletal muscle mass (kg)	29.8 ± 4.6	21.3 ± 3.4	<0.001
Body fat (%)	34.4 ± 6.0	48.3 ± 4.5	<0.001
Visceral fat Area (cm^2)	135.6 ± 47.9	190.8 ± 39.0	<0.001
Basal Metabolic Rate	1519.2 ± 166.4	1219.8 ± 124.7	<0.001
Whole Body Phase Angle	5.9 ± 0.6	5.2 ± 0.5	<0.001

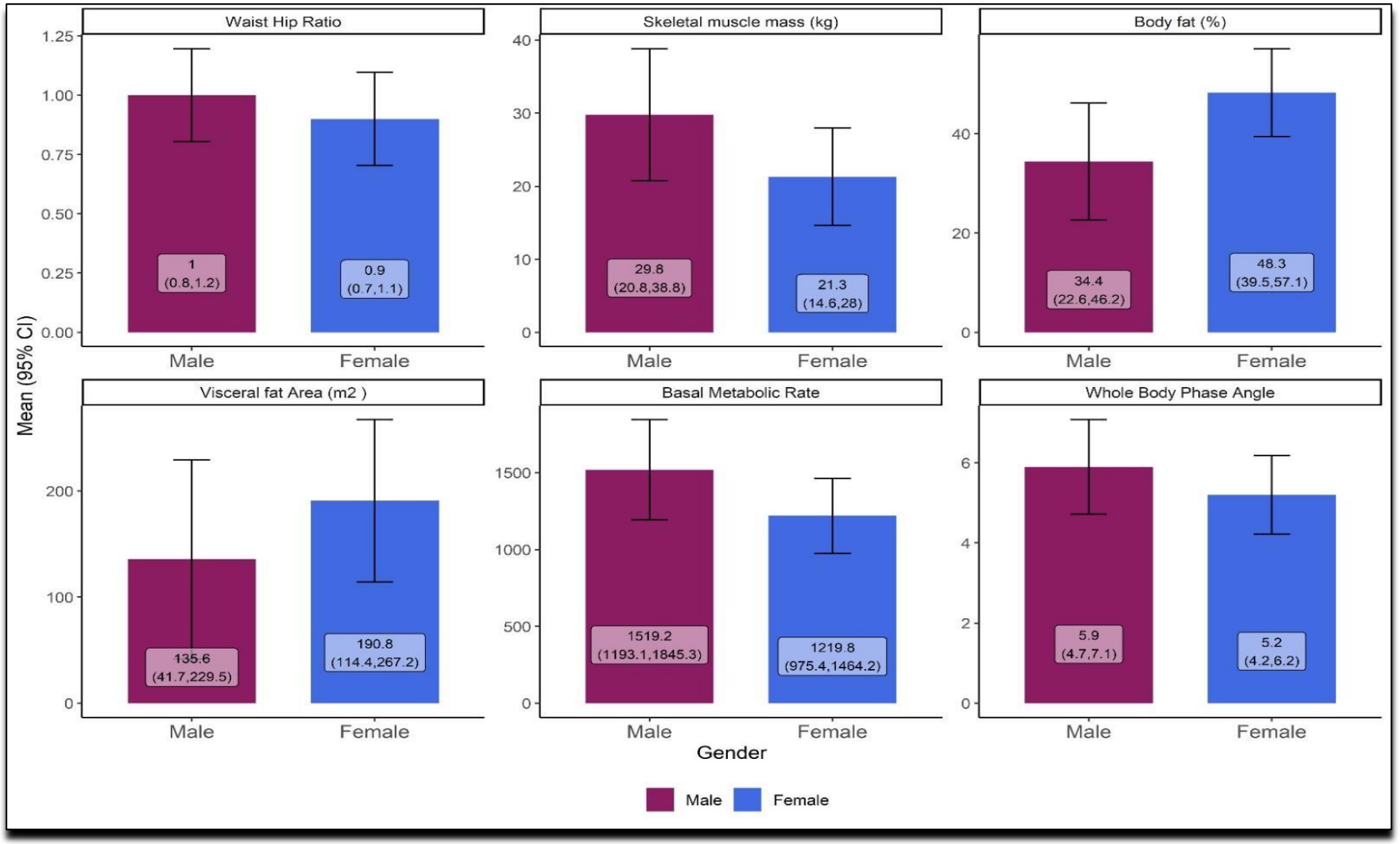
The total body water, protein, minerals, skeletal muscle mass, body fat percentage, visceral fat area, basal metabolic rate, and whole-body phase angle were statistically significant at $p<0.001$ when the mean BCA values were compared between the sexes. Upon comparing the BCA parameters between the two genders, it became apparent that the males exhibited significantly higher levels of total body water protein, minerals, skeletal muscle mass, basal metabolic rate, and whole body phase angle than the females. Whole body phase angle is an indication of the resilience and integrity of the cellular membrane. Higher whole body phase angle readings are typically observed in healthy individuals with robust cell membranes, as well as elevated assessments of Lean Body Mass and Body Cell Mass. Females exhibited statistically significant increases in body fat mass, body fat percentage, and visceral fat area. When comparing males and females, the BCA parameters of weight, body mass index, and waist-hip ratio did not show statistical significance.

As stated and explained above associating Metabolic Syndrome and Body composition parameters of the subjects was possible. This leads to rejection of H_0 2.



Graph 4.13

Body Composition Analysis measurements (1-6) Sex wise of the Research subjects



Graph 4.14: Body Composition Analysis measurements (7-12) Sex wise of the research subjects

Except weight and body mass index, all other body composition parameters were significantly different between Males and Female. Fat mass, % Fat and Visceral fat area were significantly higher in Females compared to males whereas total body water, Protein, Minerals, Waist Hip Ratio, skeletal muscle mass, Basal Metabolic Rate and Whole Body Phase Angle were significantly higher in males.

Table: 4.29 Age group wise Body composition parameters for the enrolled research subjects

MEASURED PARAMETER	21-30 (n=8)		31-40 (n=71)		41-50 (n=71)	
	MALES (5)	FEMALES (3)	MALES (59)	FEMALES (12)	MALES (52)	FEMALES (19)
Total Body Water (kg)	40.2 ± 3.7	31.4 ± 4.5	40.1 ± 5.8	28.4 ± 4.7	37.8 ± 5.3	32.0 ± 5.9
Protein (kg)	10.9 ± 1.1	8.5 ± 1.3	10.8 ± 1.6	7.6 ± 1.3	10.2 ± 1.5	8.5 ± 1.5
Minerals (kg)	3.7 ± 0.3	3.0 ± 0.4	3.8 ± 0.6	2.7 ± 0.4	3.5 ± 0.6	3.0 ± 0.6
Body Fat Mass (kg)	24.2 ± 6.8	38.0 ± 3.4	30.7 ± 10.7	35.3 ± 10.7	27.0 ± 7.4	46.9 ± 16.0
Weight (kg)	82.4 ± 15.2	67.1 ± 7.6	78.8 ± 16.0	80.6 ± 16.9	84.4 ± 14.9	88.1 ± 7.5
BMI (kg/m2)	28.8 ± 5	29.0 ± 5.6	28.1 ± 4.8	29.4 ± 4.4	29.4 ± 4.6	30.0 ± 2.5
Waist Circumference (cm)	97.3 ± 9.9	104.4 ± 11.7	103.6 ± 12.9	97.5 ± 14.8	98.5 ± 10.0	106.7 ± 13.6
Hip Circumference (cm)	101.2 ± 5	105.0 ± 2.3	104.3 ± 8.2	102.9 ± 9.0	101.3 ± 5.9	111.8 ± 12.5
Waist -Hip Ratio	1 ± 0.1	1.0 ± 0.1	1.0 ± 0.1	0.9 ± 0.1	1.0 ± 0.1	1.0 ± 0.0
Skeletal Muscle Mass (kg)	30.9 ± 3.1	23.5 ± 3.9	30.6 ± 4.8	20.8 ± 3.8	28.8 ± 4.3	23.6 ± 4.5
Body Fat %	30.2 ± 5.5	47.2 ± 3.6	35.1 ± 6.7	47.0 ± 4.3	34.0 ± 5.0	51.0 ± 4.3
Visceral Fat Area (cm^2)	108.6 ± 38	198.3 ± 20.8	144.3 ± 52.9	182.8 ± 45	128.2 ± 40.8	214.5 ± 43.9
Basal Metabolic Rate	1553.8± 142.5	1295.7 ± 134.5	1549.0 ± 171.5	1204.2 ± 136.7	1482.1 ± 159.8	1308.6 ± 173.1

As given in Table 4.29 body composition parameters for the enrolled research subjects were analyzed age group-wise, the total body water was similar among all age groups of males and females. The protein content was higher among females (8.5 ± 1.5 kg) in the age group of 41-50 years. Males in age group 41-50 year had

lower protein (10.2 ± 1.5 kg) compared to other age groups males. The body fat mass (46.9 ± 16 kg) was highest in females in the age group of 41-50 year. Males had high body fat mass (30.7 ± 10.7 kg) at the age of 31-40 years. The females in the age group of 41-50 year were obese (BMI 30 ± 2.5) compared to all the age groups males and females who were overweight (28.1 to 29.4). The waist circumference was highest among 41-50 years females (106.7 ± 13.6 cm) compared to other age groups males and females. In a study by Gregory *et al.,* (2009) younger adults; due to hormonal differences; had high measures of adiposity compared to last 5 years and it lead to high lipid and blood pressure values; in the current study females had higher adiposity than males at 21-30 year age. Tells *et al*., (2012) in their study have shown that economic status and gender had no significant correlation with obesity as both the gender developed obesity and both lower and upper income group had the equal risk of being obese as observed in the current study.

The hip circumference of males remained similar in all age groups. The hip circumference of 41-50 years females (111.8 ± 12.5 cm) was the highest among all the other age groups. Skeletal muscle mass (SMM) was highest for males (30.9 ± 3.1 kg) at the age of 21-30 years. Females at age 41-50 years had high SMM (23.6 ± 4.5 kg) compared to other age groups. The body fat percentage was highest among females (51 ± 4.3 %) at the age of 41-50. The visceral fat area (214.5 ± 43.9 cm^2) was highest among females aged 41-50. Males at 21-30 years old had lesser visceral fat area (108.6 ± 380 cm^2) compared to other age group males. At 31-40 years males had the highest visceral fat area (144.3 ± 52.9 cm^2) compared to other age groups.

The Basal Metabolic Rate (BMR) of 21-30-year-old males (1553.8 ± 142.5 kcal) was highest; among females 41-50 years old had a high BMR of 1308.6 ± 173.1 kcal. Mifflin (1990) and Mifflin *et* al., (1990) in their study mentioned that Harris Benedict Equation (developed based on European population) overestimated the resting energy expenditure, which is also observed in the current study. The BMR is on an average 227 calories higher while calculating using Harris Benedict Equation than that analyzed in InBody 770. Table 4.30 shows the Energy Balance of the research subjects pre and post intervention.

Table: 4.30 Energy Balance of subjects obtained with BMR calculated from Harris Benedict Equation and BMR of Inbody 770

Energy Balance with BMR	Inter vention	Energy Balance											
		Research Subjects				Males				Females			
		Positive		Negative		Positive		Negative		Positive		Negative	
		%	Average Calories	%	Average Calories	%	Average Calories	%	Average Calories	%	Average Calories	%	Average Calories
Calculated using Harris Benedict Equation	Pre	55	141	45	-268	50	137	50	-281	71	150	29	-193
	Post	21	269	79	-644	18	215	82	-697	29	382	71	-436
Obtained in InBody 770 BCA analysis	Pre	81	417	19	-208	77	393	23	-214	97	483	2.9	-50
	Post	43	365	57	-502	36	344	64	-542	65	403	35	-253

Energy balance constantly higher over a continuous period of time can lead to weight gain. As tabulated in Table 4.13 post-intervention we can see a percentage of increase in the individuals having negative energy balance. The reason is the physical activity level of individuals increased and consumption of calories were adequate. The positive energy balance in females was found to be higher compared to males. This can be a contributory reason for higher weight/ body fat in females than that in males.

Body composition analysis measurement occupation wise of the research subjects is as tabulated in Table:4.31.

Table: 4.31

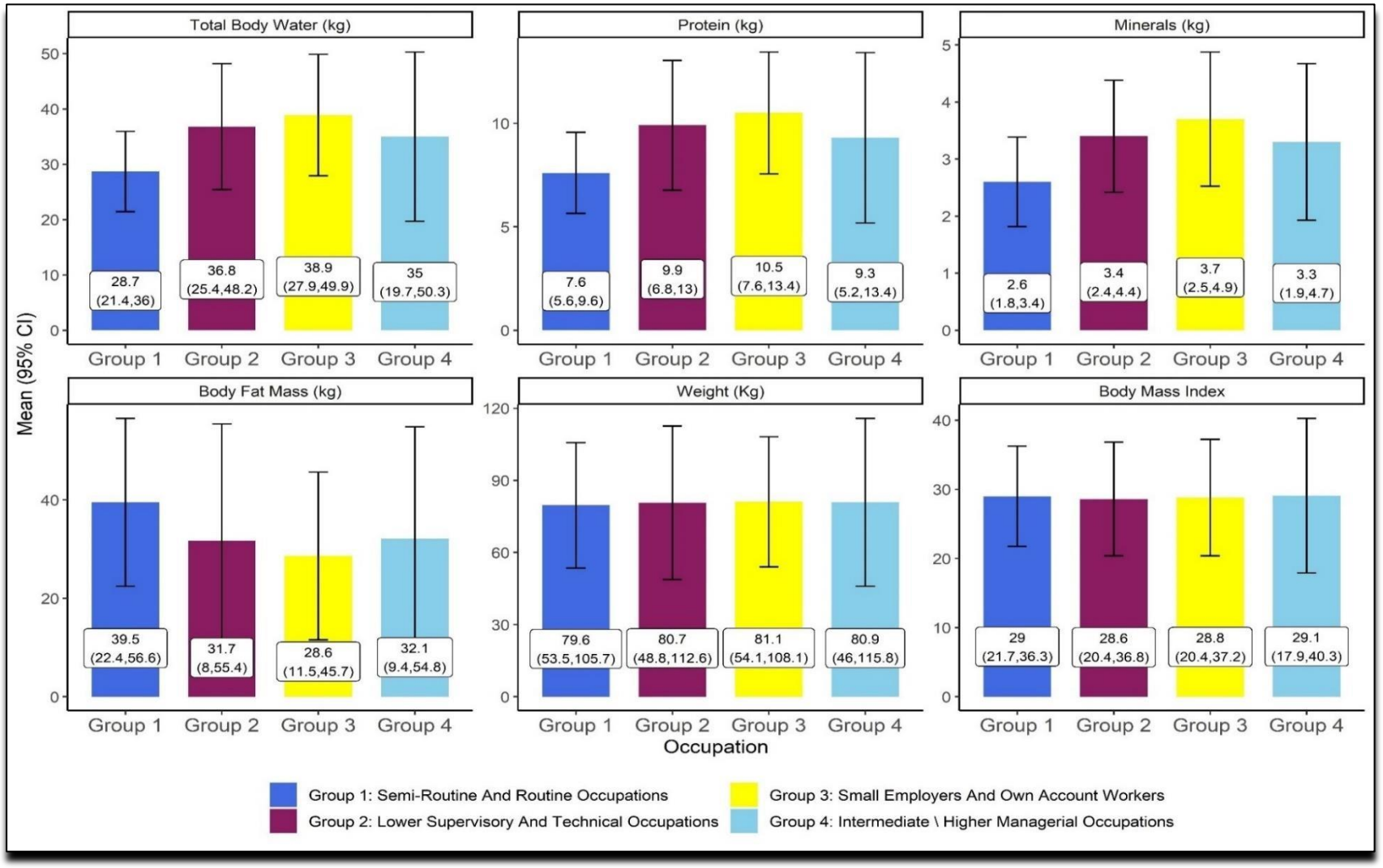
Body composition analysis measurements occupation wise of the research subjects

Parameter	Occupation				p value
	Semi-routine and routine	Lower supervisory and technical	Small employers and own account workers	Intermediate / higher managerial	
N	12	17	80	41	
Total body water (kg)	28.7 ± 3.7	36.8 ± 5.8	38.9 ± 5.6	35.0 ± 7.8	<0.001**
Protein (kg)	7.6 ± 1.0	9.9 ± 1.6	10.5 ± 1.5	9.3 ± 2.1	<0.001**
Minerals (kg)	2.6 ± 0.4	3.4 ± 0.5	3.7 ± 0.6	3.3 ± 0.7	<0.001**
Body fat mass (kg)	39.5 ± 8.7	31.7 ± 12.1	28.6 ± 8.7	32.1 ± 11.6	0.004*
Weight (kg)	79.6 ± 13.3	80.7 ± 16.3	81.1 ± 13.8	80.9 ± 17.8	0.99
Body mass index (kg/m^2)	29.0 ± 3.7	28.6 ± 4.2	28.8 ± 4.3	29.1 ± 5.7	0.97
Waist hip ratio	0.9 ± 0.0	1.0 ± 0.1	1.0 ± 0.1	1.0 ± 0.1	0.17
Skeletal muscle mass (kg)	21.0 ± 2.9	27.9 ± 4.9	29.6 ± 4.6	26.4 ± 6.4	<0.001**
Body fat (%)	50.1 ± 2.5	37.9 ± 7.5	34.5 ± 5.9	39.8 ± 9.1	<0.001**
Visceral fat area (cm^2)	198.3 ± 21.1	149.9 ± 57.0	134.7 ± 46.1	158.7 ± 54.8	<0.001**
Basal metabolic rate (kcal)	1210.2 ± 106.6	1453.5 ± 172.4	1514.9 ± 165.8	1397.0 ± 231.2	<0.001**
Whole body phase angle (degree)	5.2 ± 0.6	5.9 ± 0.6	5.9 ± 0.6	5.6 ± 0.6	<0.001**

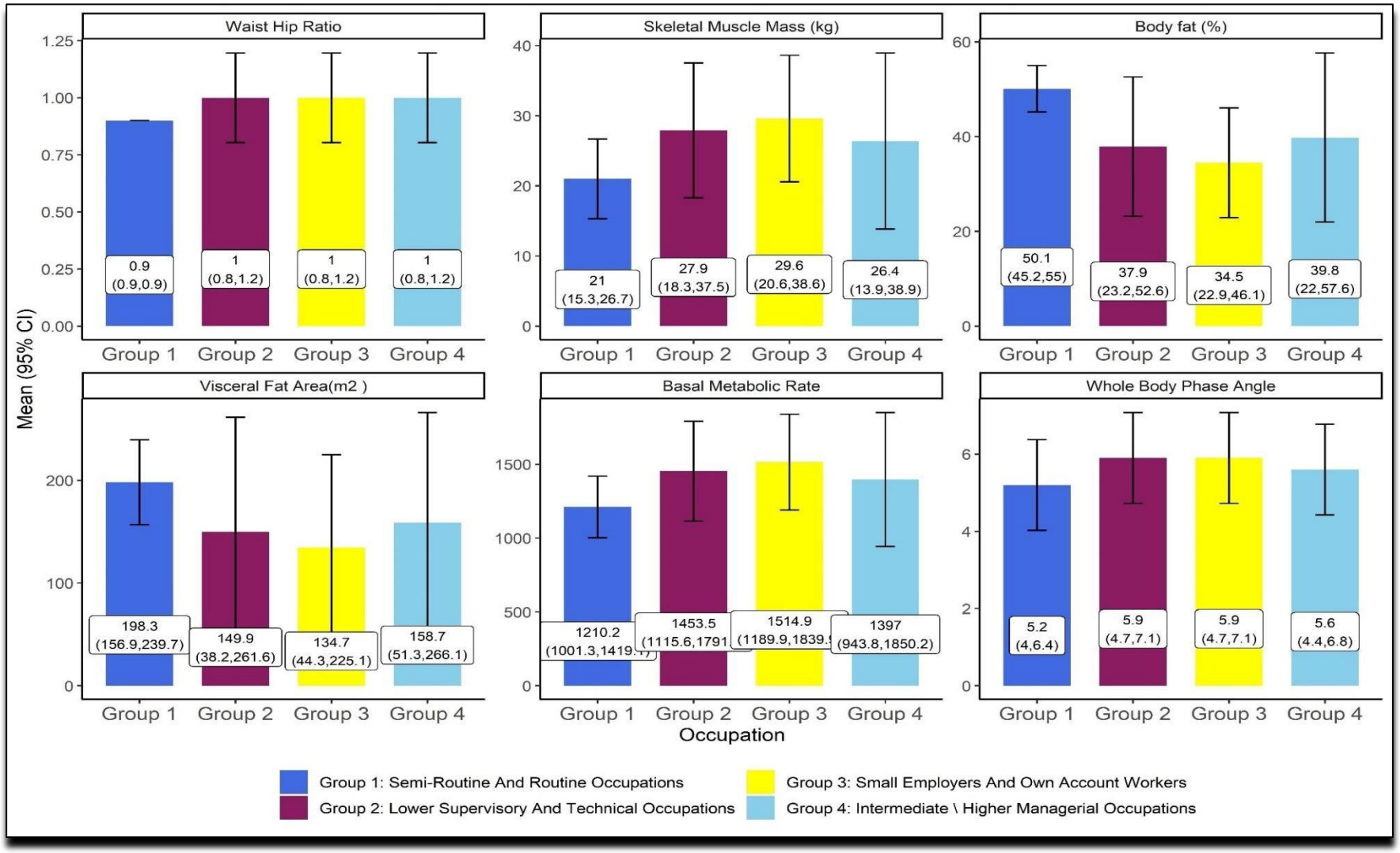
Statistical significance – ** Highly Significant p<0001; * Significant p<0.005

The occupations of the research subjects (N=150) ranged from semi-routine and routine jobs (n=12), lower supervisory and technical jobs (n=17), small employers and own account workers (n=80), and intermediate or higher managerial occupations (n=41), as shown in Table 4.31, Graph 4.15, and Graph 4.16. The results showed that total body water, protein, minerals, skeletal muscle mass, body fat percentage, visceral fat area, basal metabolic rate, and whole-body phase angle had p<0.001 and was highly statistically significant when mean body composition analysis measurements were statistically compared with the research subjects' occupations. The respondents' occupations had an impact on their overall body composition. The participants with routine and semi-routine employment had notably high body fat.

Connelly *et al.,* (2016) mentioned that age, gender and occupation-based socioeconomic status of the people had an impact on their health and lifestyle. Hence modifications should be suggested to them considering these factors. As revealed by Gopalakrishnan *et al.,* (2012) in their study that the importance of healthy lifestyle, diet and physical activity is a better approach to reduce the obesity is observed in the current study.



Graph 4.15: Body composition analysis measurements (1-6) Occupation wise of the research subjects



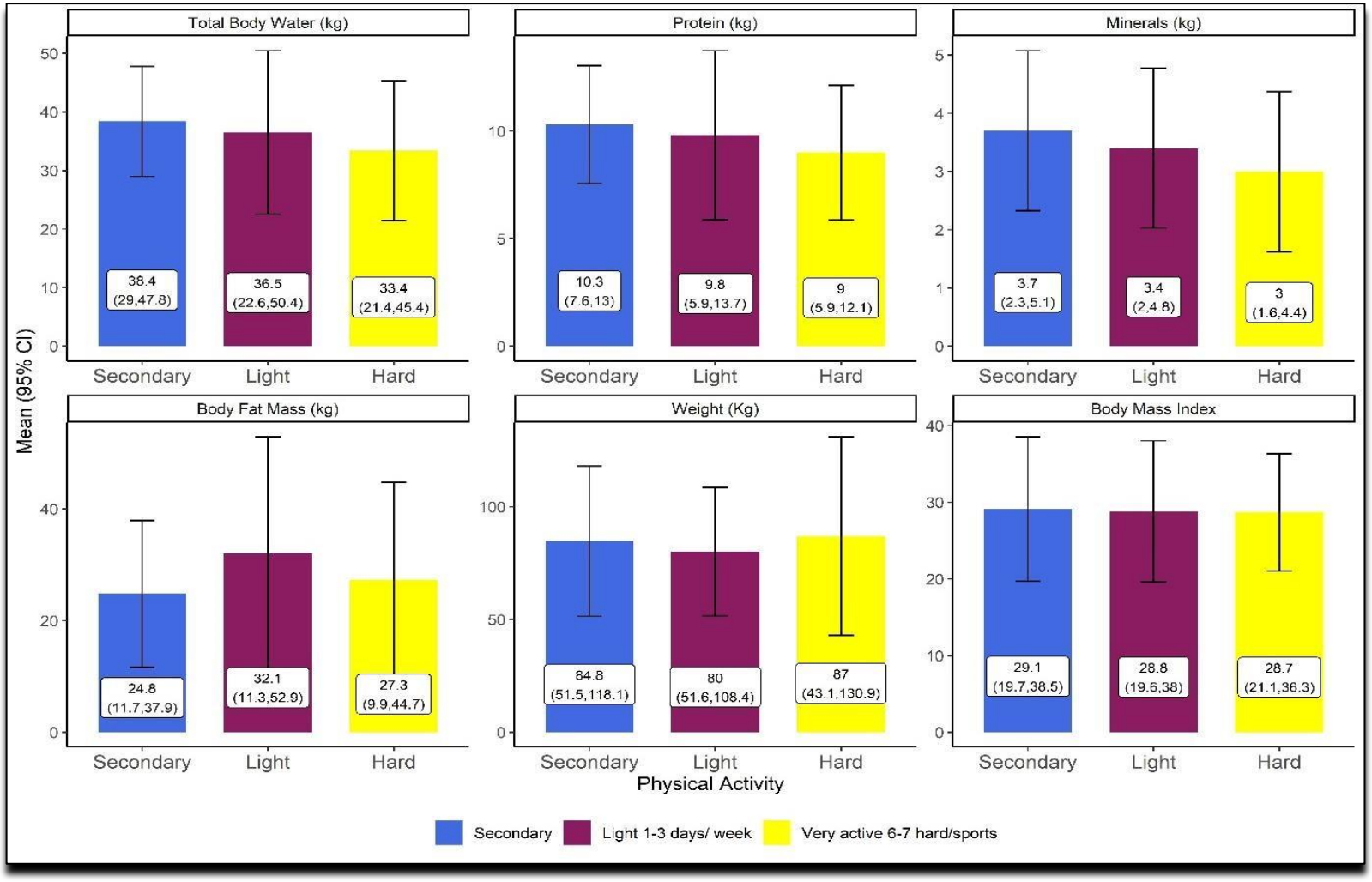
Graph 4.16: Body composition analysis measurements (7-12) occupation wise of the research subjects

Several studies [Pandey *et al*., (2013), Gustat *et al*., (2002), Lakka *et al.,* (2003) and Rennie *et al.,* (2003)] have shown a strong association between obesity and physical inactivity. They have shown an inverse relationship between physical activity, body mass index, hip-waist ratio, and waist circumference. Table 4.32 shows the BCA measurements and PAL of the research subjects.

Table: 4.32 Body Composition Analysis measurements and Physical Activity Level of the research subjects

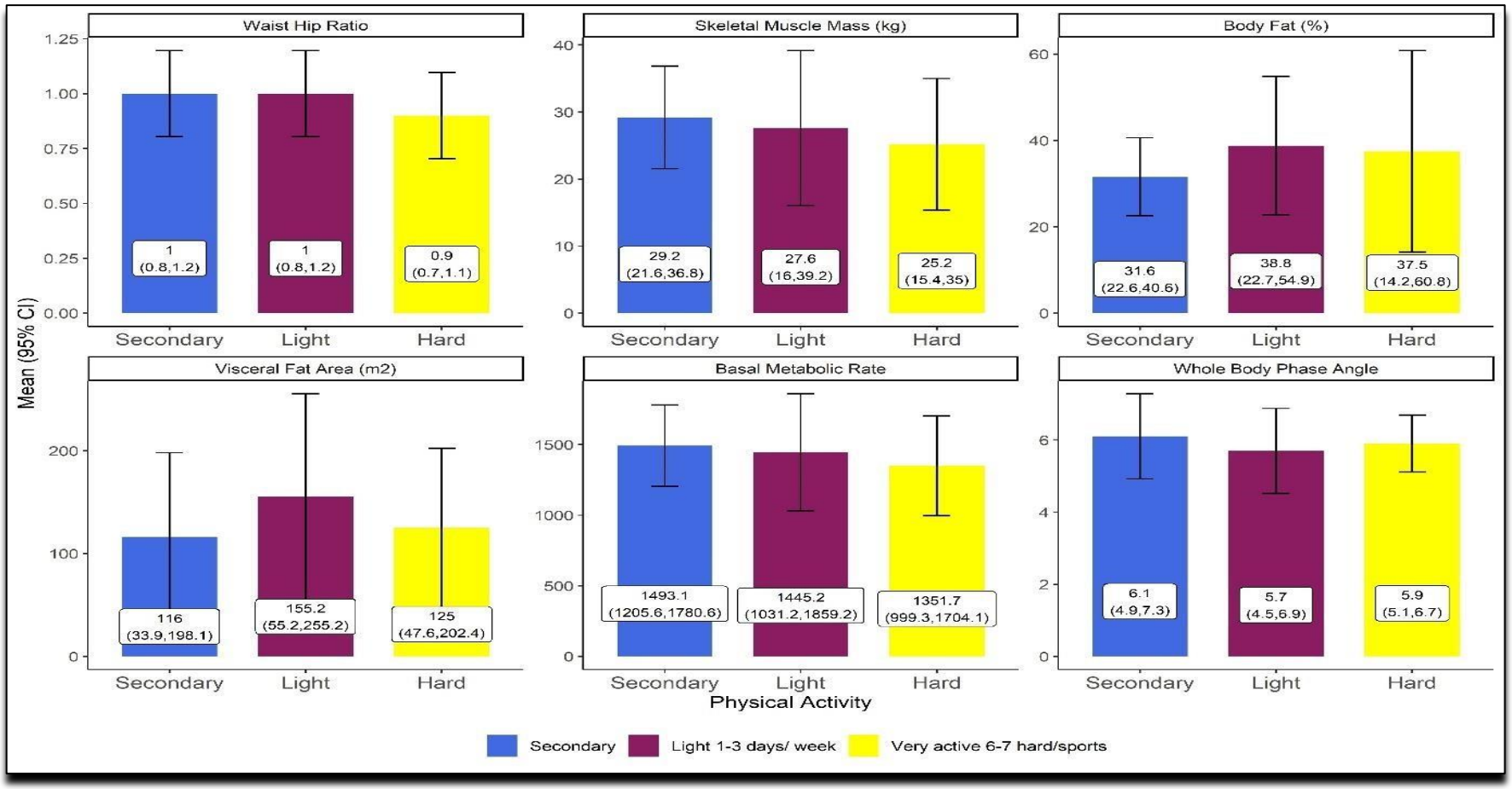
Parameter	Physical activity			p value
	Sedentary	Light	Very active	
N	**25**	**122**	**3**	
Total body water (kg)	38.4 ± 4.8	36.5 ± 7.1	33.4 ± 6.1	0.32
Protein (kg)	10.3 ± 1.4	9.8 ± 2.0	9.0 ± 1.6	0.40
Minerals (kg)	3.7 ± 0.7	3.4 ± 0.7	3.0 ± 0.7	0.11
Body fat mass (kg)	24.8 ± 6.7	32.1 ± 10.6	27.3 ± 8.9	0.004
Weight (kg)	84.8 ± 17.0	80.0 ± 14.5	87.0 ± 22.4	0.27
Body mass index	29.1 ± 4.8	28.8 ± 4.7	28.7 ± 3.9	0.95
Waist hip ratio	1.0 ± 0.1	1.0 ± 0.1	0.9 ± 0.1	0.068
Skeletal muscle mass (kg)	29.2 ± 3.9	27.6 ± 5.9	25.2 ± 5.0	0.30
Body fat (%)	31.6 ± 4.6	38.8 ± 8.2	37.5 ± 11.9	<0.001
Visceral fat area (cm^2)	116.0 ± 41.9	155.2 ± 51.0	125.0 ± 39.5	0.001
Basal metabolic rate	1493.1 ± 146.7	1445.2 ± 211.2	1351.7 ± 179.8	0.39
Whole body phase angle	6.1 ± 0.6	5.7 ± 0.6	5.9 ± 0.4	0.004

As given in Table 4.32 and Graph 4.17 and Graph 4.18; the physical activity of the research subjects was sedentary (20). Light 1-3 days of activity per week (122) and very active 6- 7 days of hard work/ sports in a week (n=3). When the physical activity level and body composition analysis measurements were statistically compared among the research subjects. The body fat percentage was statistically significant with $p<0.001$. The visceral fat area also had p- value 0.001 which was statistically significant. The body fat mass and whole-body phase angle had p value 0.004 which was also statistically significant. The body fat percent, visceral fat area and body fat mass was high in sedentary physical activity levels than in the subjects who had light or very active physical activity level. The whole body phase angle was higher in research subjects those who were active than the sedentary subjects.



Graph 4.17:

Body composition analysis measurements (1-6) and Physical Activity Level of the Research subjects



Graph 4.18:

Body composition analysis measurements (7-12) and Physical Activity Level of the Research subjects

4.4.4 Knowledge, Attitude and Practice (KAP) of the subsampled metabolic syndrome subjects before intervention

Table: 4.33

Knowledge, attitude, and practice of the research subjects before intervention

FREQUENCY DISTRIBUTION OF KNOWLEDGE ABOUT LIFESTYLE MODIFICATION, DIET AND GLOBAL KNOWLEDGE SCORE		
Variable	Number	Percentage
Score on knowledge about healthy diet/ general nutrition		
0–5 (Poor knowledge)	24	16
6–9 (Average knowledge)	16	10.7
10–12 (Good knowledge)	110	73.3
Score on knowledge about benefits of exercise and weight loss		
0-2 (Poor knowledge)	12	8
3-4 (Average knowledge)	44	29.3
5–6 (Good knowledge)	94	62.7
Knowledge Regarding Body composition		
0-2 (Poor knowledge)	89	59.3
3-4 (Average knowledge)	22	14.7
5–6 (Good knowledge)	39	26
Score on Knowledge Regarding Metabolic syndrome and lifestyle to be followed		
0-2 (Poor knowledge)	42	28
3-4 (Average knowledge)	32	21.3
5–6 (Good knowledge)	76	50.7
FREQUENCY DISTRIBUTION OF SUBJECTS ACCORDING TO ATTITUDE SCORE FOR LIFESTYLE MODIFICATIONS		
Attitude score	Number of respondents	Percentage
0 (Strongly negative)	3	2
1 (Negative)	18	12
2 (Neutral)	45	30
3 (Positive)	69	46
4 (Strongly positive)	15	10
Total	150	100
FREQUENCY DISTRIBUTION OF SUBJECTS ACCORDING TO LIFESTYLE MODIFICATION PRACTICE SCORE		
Practice score	Number of respondents	Percentage
0 (Very poor practice)	25	16.7
1 (Poor practice)	35	23.3
2 (Neutral)	30	20
3 (Good practice)	52	34.7
4 (Very good practice)	8	5.3
Total	150	100

The knowledge, attitude and practice scores pre-intervention is as shown in Table 4.33. The Knowledge, Attitude and Practice (KAP) scores pre-intervention was recorded. Regarding healthy diet for general nutrition was good in 73.3% (110 subjects), knowledge regarding exercise and weight loss was good in 62.6% (94 subjects), knowledge regarding body composition was good in 26% (39 subjects), knowledge regarding metabolic syndrome and lifestyle to be followed was good in 50.7% (76 subjects), positive attitude for lifestyle modification was observed in 56% (84 subjects) and good practice of lifestyle was observed in 40% (60 subjects). The scores of knowledge recorded, for various tested aspects, needed a significant increase, and indicated the need of intervention through lifestyle awareness modules. The lifestyle intervention counselling becomes important in two aspects if the knowledge is poor or if the though knowledge is present, the attitude and practice is poor. As stated in Herath *et al*., (2017) study on knowledge, attitude and practice related to diabetes mellitus among general public in which it was observed that though knowledge on diabetes was present the attitude and practice towards preventive measures for diabetes mellitus was poor. Lifestyle intervention (Lazo *et al.*, 2010) and meal replacement (Madan and Manyal 2010) have been great preventive mode for preserving health.

4.4.5 Validation of the developed lifestyle education modules

Lifestyle education modules are generally used in reaserch studies to increase the knowledge, put the knowledge into practice with positive attitude. That means the KAP of the individual will be the key. Thus, it becomes important to validate and check the reliability of the lifestyle education modules. To do that performing KAP survey was the best way. In the current study to validate the lifestyle education modules a pilot study was conducted enrolling 60 subjects (30 males and 30 females). 30 subjects who had nutrition and exercise background and were in healthcare and 30 subjects who had no nutrition or exercise and were nonhealthcare were selected. KAP questionnaire was administered with two months interval between pre and post education modules intervention. The Validity and reliability of lifestyle education modules is given in Table 4.34.

Table: 4.34 Validity and reliability of lifestyle education modules

SNo.	Education Module	Cronbachs α (CA)	
		Healthcare subjects	Non- Healthcare subject
1	Basics of Nutrition	0.78	0.83*
2	Nutrition for Healthy living	0.79	0.85*
3	BMI_BCA_Nutritional Status	0.81*	0.82*
4	Lifestyle to be followed_ Metabolic syndrome	0.80	0.84*
5	Exercise as a part of Healthy Lifestyle	0.77	0.86*
6	Stress relief tips for relaxing to lead a Healthy life	0.75	0.82*
7	Mighty Millets	0.82*	0.85*
8	Break the fast without skipping the main meal of the day	0.80	0.81*
9	Fresh Fruits in our day to day consumption	0.75	0.83*
10	Antioxidants	0.79	0.82*

*Statistically significant

Ten lifestyle education modules were developed for the interventional study. The validity and reliability of these modules were tested and found to be valid and reliable with Cronbach's alpha test 0.81 and 0.85 for health care and non-healthcare subjects. The Validity and reliability of these modules are given in Table 4.34.

Phase V:

4.5 Impact of intervention of lifestyle counseling among the metabolic syndrome research subjects

In 2014 study of Ogden *et* al., (2014) it was observed that childhood obesity is a major cause of developing metabolic syndrome in the later years. As mentioned by Farrag *et al.,* (2014) in their study they showed 2.3 to 12% obesity and 28.8% overweight in young adults. Kelishadi (2007) also mentioned that in childhood and adolescence age itself, overweight and obesity are to be addressed with lifestyle intervention to avoid the future risk of metabolic syndrome. Unnikrishnan *et al*., (2012) have mentioned that the prevention of obesity can happen if a cumulative effort is taken by the government, non-government organizations, society, and individual/ family. Wang *et al*., (2017) and Victoria *et al*., (2017) research showed the importance of lifestyle modification.

The need for obesity prevention or management through intervention should be identified and addressed at optimal age is considered in the current study and lifestyle intervention was given to prevent or cure the elevated risk factors.

After the consent is obtained from the research subjects with Metabolic Syndrome; they were continued in the study. These research subjects were given lifestyle counseling as an intervention. On the enrollment day; the counselling is given in person. Every 15th day; on call consultation was done and the information regarding life style was re-iterated to the subjects; if they had any doubts it was clarified too. After 3 months of the lifestyle education intervention; in the 4th month, the research subjects were asked to visit the hospital to reassess the study parameters as intimated during the sub-sample enrollment and the consent obtained time.

4.5.1 Impact of intervention on anthropometric measures and BCA parameters in research subjects

The pre and post mean values of anthropometric measurements were statistically analyzed. Table 4.35 shows Anthropometric measures of the research subjects Pre & Post Intervention.

Table: 4.35 Anthropometric measures of the research subjects Pre & Post Intervention

Parameters (N=150)	Preintervention (Mean ± SD)	Postintervention (Mean ± SD)	Mean Difference (95% C.I)	p value
Weight (kg)	80.9 ± 15.1	78.4 ± 15.0	2.5(-0.9,5.9)	0.148
BMI (kg/m2)	28.9 ± 4.7	28.0 ± 4.6	0.9(-0.1,2)	0.09
Waist Circumference (cm)	100.8 ± 11.8	98.1 ± 11.8	2.8(1.9,3.6)	<0.001
Hip Circumference (cm)	103.4 ± 7.7	102.7 ± 8.4	0.7(0,1.4)	0.052
Waist-Hip Ratio	1.0 ± 0.1	1.0 ± 0.1	0.0(0.0,0.0)	<0.001

The pre and post-interventional data of waist circumference and waist-hip ratio had a highly significant correlation at <0.001, indicating waist circumference and waist-hip ratio decreased post-intervention. The anthropometric measurements of weight, body mass index and hip circumference did not correlate with each other statistically. Popkin *et al*., (2012) stated obesity as pandemic and the numbers are still increasing. Sadaf *et al*., (2014) has done a study with and without meal intervention for weight reduction and concluded type of food, cooking methodology and calories consumed are to be monitored than being without a meal.

In Table 4.36 Body Composition analysis measures of the research subjects Pre & Post Intervention are shown.

Table: 4.36 Body Composition analysis measures of the research subjects Pre & Post Intervention

Parameters (N=150)	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Difference (95% C.I)	p value
Total Body Water (kg)	36.8 ± 6.8	36.6 ± 6.8	0.2(-0.3,0.6)	0.476
Protein (kg)	9.9 ± 1.9	9.8 ± 1.9	0.0(-0.1,0.2)	0.529
Minerals (kg)	3.5 ± 0.7	3.5 ± 0.7	0.0(-0.1,0.0)	0.478
Body Fat Mass (kg)	30.8 ± 10.3	28.5 ± 10.6	2.3(1.5,3.1)	<0.001
Weight (kg)	80.9 ± 15.1	78.4 ± 15.0	2.5(-0.9,5.9)	0.148
Skeletal Muscle Mass (kg)	27.9 ± 5.6	27.7 ± 5.6	0.2(-0.2,0.6)	0.383
Body Fat %	37.6 ± 8.2	35.6 ± 9.1	1.9(1.0,2.8)	<0.001
Extra cellular water Ratio	0.4 ± 0.0	0.4 ± 0.0	0.0(0.0,0.0)	0.387
Inbody Score	58.9 ± 7.9	61.8 ± 8.1	-2.9(-4.1,-1.8)	<0.001
Visceral Fat Area (cm2)	148.1 ± 51.4	136.4 ± 51.0	11.6(7.2,16.1)	<0.001
Target Weight (kg)	63.2 ± 8.6	63.0 ± 8.5	0.2(-0.5,0.9)	0.565
Weight To Control (kg)	-17.7 ± 11.2	-14.8 ± 12.3	-2.9(-4.1,-1.7)	<0.001
Fat To Control (kg)	-20.2 ± 9.5	-17.1 ± 10.7	-3.1(-4.2,-2.0)	<0.001
Muscle To Control, Median (IQR)	1.1 (0.0, 4.6)	0.6 (0.0, 3.6)	-	0.190
Basal Metabolic Rate	1451.3 ± 201.6	1447.5 ± 201.5	3.86(-9.59,17.31)	0.572
Obesity Degree	106.2 ± 57.8	122.9 ± 37.1	-16.73(-25.03,-8.43)	<0.001
Whole Body Phase Angle	5.8 ± 0.6	5.7 ± 0.6	0.07(-0.03,0.16)	0.182

*Weight, Fat and Muscle To Control were based on the age wise reference values.

The pre and post-mean values of body composition analysis values were statistically analyzed. Among various measures of body composition analysis the body fat mass, body fat percentage, in-body score, visceral fat area, weight to control, fat to control and obesity degree were statistically significant at <0.001. After the intervention; as intended; the body fat mass, body fat percentage, visceral fat area, weight to control and fat to control decreased and there was an increase in Inbody score and obesity degree, which were statistically significant too. Obesity degree increased on average due to outliers present in Post intervention group. Though the

mean weight reduced slightly (2.5kg) it was not statistically significant and this was the proposed way by Bhardwaj *et al.,* (2011) in his study. The study showed that both generalised and abdominal obesity was observed in urban Asian North Indians and called for urgent public intervention to stay healthy. Chuang *et al.,* (2012) in their research study has shown both men and women the body fat percentage had high correlation with BMI and waist circumference and similar findings are observed in the current study also. The pre and post values of protein, skeletal muscle mass, weight and basal metabolic rate were not statistically significant. Though, the values had a intended change (increase/ decrease in comparison with reference values); they were not statistically significant. Landman and Cruickshank (2001) In his study mentioned physical activity and dietary modification can improve overall health of an individual. Albert *et al.,* (2018) in their study also showed that multidisciplinary approach with modified diet and exercise brings change in body composition in metabolic syndrome patients.

4.5.2 Impact of intervention on calorie intake, Physical activity level, exercise, smoking and alcohol habits in research subjects

Table 4.37 has the values obtained regarding the Physical activity level, Total energy intake, Basal metabolic rate and total energy expenditure of the metabolic syndrome subjects.

Table: 4.37 PAL, TEI and TEE of the research subjects Pre & Post Intervention

Parameter (n=150)	Pre (Mean ± SD)	Post (Mean ± SD)	Mean difference (95% C.I)	p value
Physical activity level (PAL)	1.4 ± 0.1	1.4 ± 0.2	-0.1(-0.1,-0.1)	<0.001
TEI (Total energy Intake) Average calories consumed	2261.7 ± 268.9	1960.7 ± 226.6	301.1(250.8,351.3)	<0.001
Basal Metabolic Rate (Harris-Benedict equation)	1706.3 ± 240.6	1674.8 ± 230.6	31.5(-12.1,75.1)	0.155
TEE (Total Energy Expenditure)	2306.0 ± 344.6	2416.4 ± 478.6	-110.3(-189.5,-31.1)	0.007

As mentioned in the Table 4.37; the Dietary preference was majorly modified for daily calorie consumption. The macronutrient source from which the calories were obtained as counselled to be from protein, cereals and sparingly from fats. The

average calories consumed pre and post-intervention were statistically significant at p<0.001. The average calorie consumption of the subjects decreased and they were in par with the set weight loss goals. Barnett *et al*., (2006) have stated that insulin resistance is because of obesity and sedentary lifestyle leading to Type 2 diabetes and CVD‘s and recommended weight management as key to reducing the risk. In the current study weight management was considered to reduce the other risk factors. In a study conducted by Davidson *et al.,* (2004) showed high caloric intake, as sweets, in rats lead to weight gain and overeating too. Thus, fat intake and simple sugar intakes which are contributing factors for weight gain were restricted for the subjects to bring in healthy weight goals. In Diabetes, Obesity and Metabolism (Deurenberg *et al., 2000 and* Haffner and Cassells 2003) stated that by focusing on regulating food intake, eating patterns and energy homeostasis, weight/ obesity can be reduced. Garcia and Manuel (2019) in their study mentioned that if a diet is optimal with macro nutrient distribution of calories in par with total daily energy expenditure it will be the key to maintain weight and health. This distribution of calories from proteins, carbohydrates and fat was done in individual meal plans of the subjects based on their weight loss goals. The calories were coming from proteins (30-40%) and complex carbohydrates (60-50%) and 10% calories were planned from visible unsaturated fats. Keller (2011) also stressed on including proteins in the diet to regulate the body weight, composition, thermogenesis and energy efficiency.

Lakka (2003) study mentions that sedentary PAL, compromised cardio-respiratory fitness had a correlation with metabolic syndrome and emphasized for regular physical activity to improve health. Volp *et al*., (2011) study stated that indirect calorimetry and doubly labelled water are best methods to evaluate energy expenditure, but as they are expensive other methods available can be conveniently used. Through metabolic equivalent; the physical activity level of the subjects pre and post intervention was calculated; it was statistically significant at <0.001. Through Harris Benedict Equation the Basal metabolic rate was calculated and by multiplying the physical activity level the total energy expenditure of the subjects were obtained. But the Basal metabolic rate and total energy expenditure were not statistically significant.

Table: 4.38

Physical Activity Level of the research subjects Pre & Post Intervention

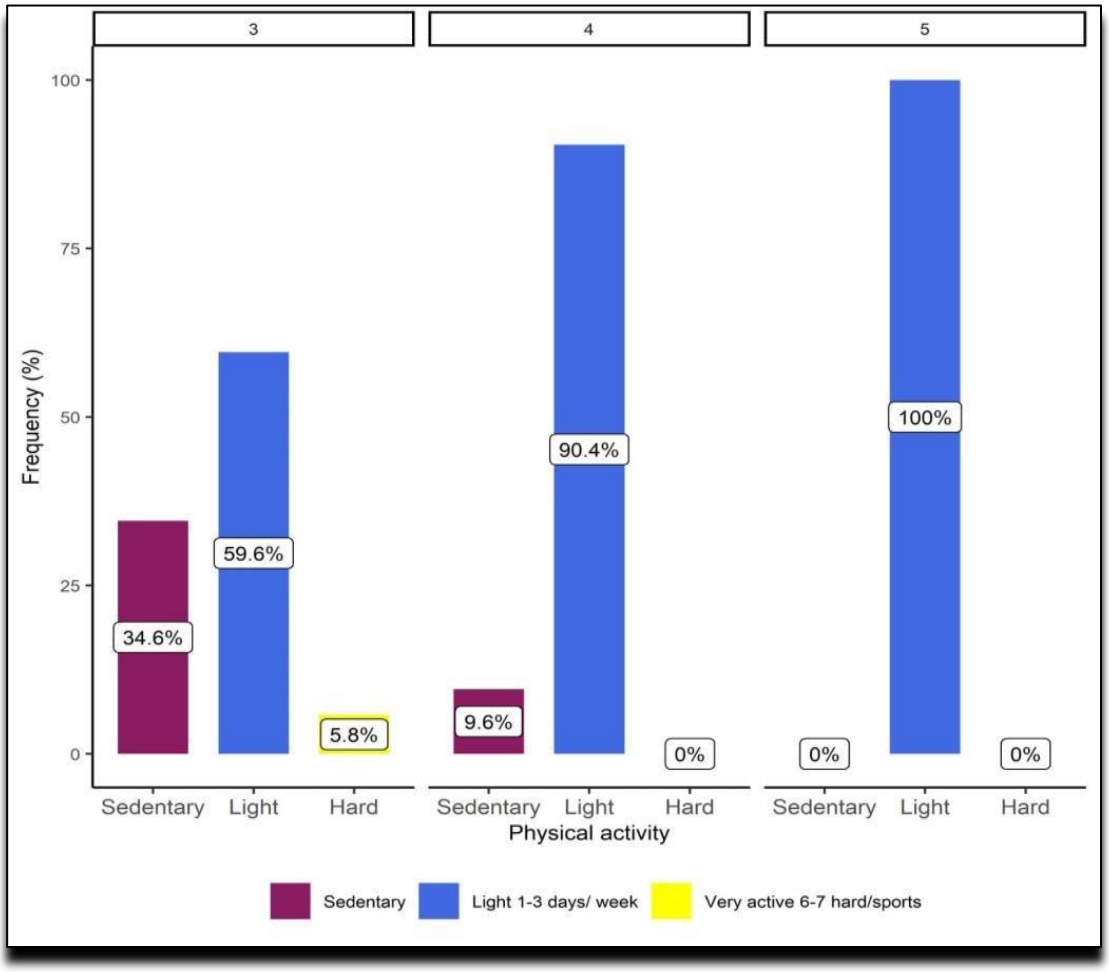
Physical Activity Level (N=150)	Pre- Intervention N (%)	Post - Intervention N (%)	p value
Sedentary	25 (16.7 %)	54 (36 %)	<0.001
Light	122 (81.3 %)	8 (5.3 %)	
Moderate	0	72 (48 %)	
Very Active/ Hard/ Sports	3 (2 %)	7 (4.7 %)	
Vigorous/ Very Hard Physical job	0	9 (6 %)	

The physical activity level of the subjects was calculated using metabolic equivalents. As mentioned in Table 4.38, the physical activity level of the subjects when observed pre and post intervention. Pre-intervention the subjects had physical activity levels in three categories: sedentary, light one to three days per week, very active six to seven hardcore sports physical activity levels. Post-intervention nine subjects did a vigorous or very hard physical job, 72 subjects increased their physical activity level from light one to three days per week to moderate three to five days per week. It is observed that 29 subjects have become sedentary in their physical activity level. The physical activity level pre and post-intervention was found to be statistically significant at <0.001. The subjects included exercise as a part of their daily routine and they also increased their physical activity level after the lifestyle counselling intervention.

Table: 4.39 Exercise routine of the research subjects Pre & Post Intervention

Exercise routine (N=150)	Pre- Intervention N (%)	Post- Intervention N (%)	p value
Never	25 (16.7 %)	54 (36 %)	**<0.001**
Former	122 (81.3%)	80 (53.3 %)	
Moderate	3 (2 %)	16 (10.7 %)	

Physical Activity Level of the Metabolic syndrome subjects who had 3, 4 and 5 criteria was studied and is as shown in Graph 4.19.



Graph 4.19: Physical Activity Level of Metabolic Syndrome Subjects

Research subjects who had five metabolic syndrome criteria were having light one to three days of physical activity. People with metabolic syndrome four criteria had light physical activity and 9.6% subjects were having sedentary activity. People

with metabolic syndrome four criteria 5.8% subjects had hard physical activity and 59.6% subjects were having light physical activity. 34.6% of the subjects from metabolic syndrome three criteria were sedentary. Jonas *et al*., (2022) conducted a study in elderly population aged 65 to 74 years and found high prevalence of metabolic syndrome. This emphasizes prevention of metabolic syndrome risk factors should be addressed at an early age than curing after its onset in elderly age. Kelley *et al*., (2018) in his study observed that maximal oxygen uptake is compromised as a secondary effect of metabolic syndrome which might result in adverse health conditions of cardiac or respiratory disorders.

4.5.3 Impact of intervention on Metabolic syndrome criteria in research subjects

Table: 4.40 Metabolic Syndrome Criteria of the research subjects Pre & Post Intervention

PARAMETERS (N=150)	Pre intervention (Mean ± SD)	Post intervention (Mean ± SD)	Mean difference (95% C.I)	p value
Waist Circumference(cm)	100.8 ± 11.8	98.1 ± 11.8	2.8(1.9,3.6)	<0.001
Fasting Blood Sugar (mg/dl)	145.7 ± 65.5	122.6 ± 44.5	23.1(17,29.2)	<0.001
Triglycerides (mg/dl), Median (IQR)	209.5 (170.9, 279.0)	168.0 (145.0, 245.0)	---	<0.001
HDL Cholesterol (mg/dl)	37.5 ± 8.0	37.8 ± 6.7	-0.3(-0.9,0.3)	0.339
Systolic BP (mm Hg)	121.6 ± 15.3	120.0 ± 8.0	1.6(0.1,3.2)	0.041
Diastolic BP (mm Hg)	82.7 ± 10.1	80.5 ± 6.4	2.2(1,3.5)	0.001

According to Table 4.40 Following the intervention, there was a noteworthy decrease in the metabolic syndrome criteria, including triglycerides, waist circumference, fasting blood sugars, and systolic blood pressure, all of which were statistically significant with p<0.001. There was no significant difference in the diastolic blood pressure or high-density lipoprotein levels. Similar results were reported in a research by Ross et al. (2020), which hypothesized that high waist circumference may be reduced with diet and exercise changes. According to Chambers et al. (2019), diet and exercise play a major role in lowering the risk of

metabolic syndrome. According to Dalton et al. (2003), there was an association between CVDs and BMI, waist circumference, and waist hip ratio. The current study's risk variables were lowered through intervention. According to a study by Esposito et al. (2015), there was a drop in fasting blood sugar levels following the intervention, indicating that Mediterranean and low-fat diets were more associated with glycemic control and the management of type 2 diabetes. According to Franklin (2006), who discovered that a low-calorie diet and lifestyle can lower the risk of metabolic syndrome in hypertensive people, the metabolic risk variables were also shown to be significantly lower in the current study (Manjunath et al., (2014). Mohan *et al*., (2006) showed the high prevalence of metabolic syndrome and the major risk factor was identified to be obesity [Must (1999), Misra (2009) and Misra (2010)]

.

Table: 4.41 Metabolic Syndrome state of the research subjects Pre & Post Intervention (N=150)

Metabolic Syndrome Criteria	Pre- intervention N (%)	Post- intervention N (%)	p value
0	0	2 (1.3%)	<0.001
1	0	7 (4.7%)	
2	0	26 (17.3%)	
3	52 (34.6 %)	57 (38%)	
4	73 (48.7%)	48 (32%)	
5	25 (16.7 %)	10 (6.7%)	

As shown in the Table 4.41 the metabolic syndrome criteria were as per NCEP ATP III 2005. If a subject had three or more criteria defined under NCEP ATP III 2005 they were called as metabolic syndrome subjects. Consent was obtained from one fifty research subjects and enrolled as research subjects.

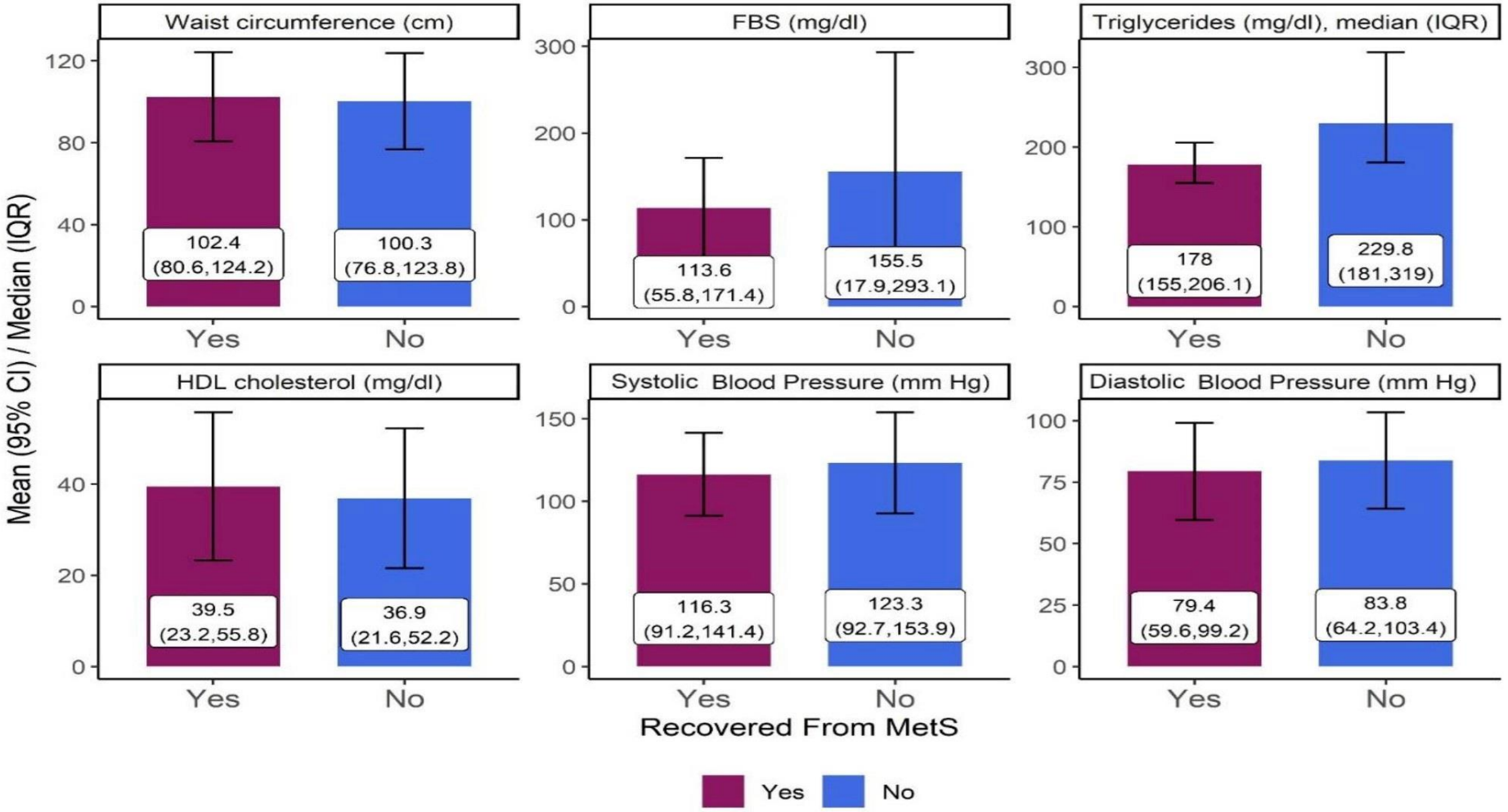
Among 150 metabolic syndrome subjects 52 of them had three Metabolic syndrome criteria, 73 subjects of them had four metabolic syndrome criteria and 25 subjects of them had five metabolic syndrome criteria. From 150 subjects, 35 subjects of them could come out of the metabolic syndrome state and become non- metabolic. From 25 subjects who had five metabolic syndrome criteria. 15 subjects

could reduce the risk factors from five to lower number of criteria. Around 73 subjects had four metabolic syndrome criteria pre-intervention, post-intervention only 48 subjects had four metabolic syndrome criteria. The pre and post-metabolic syndrome criteria were having a highly significant correlation of <0 .001. The lifestyle counselling intervention helped the subjects to reduce the number of metabolic syndrome risk factors and even got them to a non- metabolic syndrome state. As concluded by Gracia *et al.,* (2022) in their study the need for managing and preventing the metabolic syndrome should be the priority.

Table: 4.42 Metabolic syndrome criteria– post intervention recovered from metabolic syndrome

Metabolic syndrome Criteria	Recovered from Metabolic syndrome		p value
	Yes (N=35)	No (N=115)	
Waist circumference (cm)	102.4 ± 11.1	100.3 ± 12.0	0.36
FBS (mg/dl)	113.6 ± 29.5	155.5 ± 70.2	<0.001
Triglycerides (mg/dl), median (IQR)	178.0 (155.0, 206.1)	229.8 (181.0, 319.0)	<0.001
HDL cholesterol (mg/dl)	39.5 ± 8.3	36.9 ± 7.8	0.091
Systolic Blood Pressure (mmHg)	116.3 ± 12.8	123.3 ± 15.6	0.017
Diastolic Blood Pressure (mmHg)	79.4 ± 10.1	83.8 ± 10.0	0.026

The Table 4.42 and Graph 4.20 shows the Metabolic syndrome criteria mean values post intervention. Research subjects 35 (23.3%) recovered from metabolic syndrome. These 35 subjects had significantly lesser fasting blood sugar, triglycerides diastolic blood pressure and systolic blood pressure compared to those who still had metabolic syndrome post intervention. This states that with early intervention during the new onset of metabolic syndrome itself if the lifestyle education intervention is given can bring in statistically significant reduction in the metabolic syndrome risk factors. Obesity was found prevalent in the current study similar to the findings of Garg *et al.,* (2010) where National family health survey data was compared and found obesity increased in Indian women over the years due to lack of physical activity and calorie dense food consumption and the need for creating awareness was found to be important.



Graph: 4.20 Metabolic Syndrome Criteria- Pre and Post Intervention

4.5.4 Impact of lifestyle counseling on KAP in the research subjects

According to Gautam and Gupta (2022), spending money on patient counseling to raise their KAP score will greatly lessen the impact of this illness. Effective health education, according to Chawla et al. (2019), led to greater knowledge, a better attitude, and the adoption of beneficial practices, all of which improved glycemic control in patients with type 2 diabetes, helping to slow the disease's course and avoid consequences. Prasad *et al*., (2011) stated abdominal obesity can be one of the risk factor for CVD's. Amarasekara *et al.,* (2016) assessed KAP of adults pertaining to Metabolic syndrome as indicator for CVD risk. In their study they demonstrated that people with high knowledge scores had lesser waist circumference and lower FBS. But those who had moderate knowledge and practice score had higher risk of CVD though their attitude score was good. As observed in the current study and study conducted by Melanson *et al.,* (2009), there is a clear relationship between dietary fat, fatty acid intake, blood sugar levels and metabolic syndrome and with lifestyle intervention the risk factors were found to decrease as their KAP increased.

The impact of lifestyle counselling on knowledge regarding healthy diet/ general nutrition, knowledge regarding benefits of exercise and weight loss, knowledge regarding body composition and knowledge regarding metabolic syndrome and the lifestyle to be followed had a high statistical significance at <0 .001. The tables and figures give detailed information regarding the knowledge pre and post-intervention among the subjects.

Table: 4.43 Knowledge regarding healthy diet/ general nutrition Pre & Post-intervention in research subjects

Parameter (N=150)	Pre Intervention N (%)	Post Intervention N (%)	p value
Poor	24 (16%)	2 (1.3 %)	<0.001
Average	16 (10.7%)	3 (2 %)	
Good	110 (73.3%)	145 (96.7 %)	

Table 4.43 shows, the knowledge regarding healthy diet or general nutrition pre and post-intervention in the metabolic syndrome. The knowledge regarding healthy diet or general nutrition post-intervention in the metabolic syndrome subjects increased and was statistically significant with p-value

<0.001. Pre-intervention there were 24 (16%) subjects who had poor knowledge, 16 (10.7%) subjects had average knowledge 110 (73.3%) subjects had good knowledge. Post-intervention only 2 (1.3%) subjects had poor knowledge, average knowledge was observed in 3 subjects (2%) and 145 subjects (96.7%) subjects had good knowledge regarding healthy diet or general nutrition. Sunkara and Verghese (2014) in their study highlighted that lifestyle modifications of diet and physical activity are important to manage obesity.

Table: 4.44 Knowledge regarding the benefits of exercise and weight loss Pre & Post intervention in research subjects

Parameter (N=150)	Pre Intervention N (%)	Post Intervention N (%)	p value
Poor	12 (8%)	2 (1.3 %)	<0.001
Average	44 (29.3%)	10 (6.7 %)	
Good	94 (62.7%)	138 (92 %)	

Table 4.44 depicts the knowledge regarding the benefits of exercise and weight loss pre and post-intervention in research subjects. The knowledge regarding the benefits of exercise and weight loss post-intervention in metabolic syndrome subjects increased and was statistically significant with p-value <0.001. Preintervention poor knowledge was observed in 12 subjects (8%) subjects, average knowledge was noted in 44 subjects (29.3%) subjects, and good knowledge was observed in 94 subjects (62.7%) subjects. Post-intervention poor knowledge was observed in 2 subjects (1.3%) subjects, average knowledge was observed in 10 subjects (6.7%) subjects and 138 subjects (92%) subjects had good knowledge regarding the benefits of exercise and weight loss.

Table: 4.45 Knowledge regarding the Body Composition Analysis Pre & Post-intervention in research subjects

Parameter (N=150)	Pre Intervention N (%)	Post Intervention N (%)	p value
Poor	89 (59.3%)	12 (8 %)	<0.001
Average	22 (14.7%)	14 (9.3 %)	
Good	39 (26%)	124 (82.7 %)	

The knowledge regarding the body composition analysis was interviewed in the subjects. As shown on Table 4.45, the knowledge regarding the body composition analysis post-intervention in metabolic syndrome subjects increased and was statistically significant with p-value <0.001. Poor knowledge was observed in 59.3% subjects (89) subjects, 14.7% subjects (22) had average knowledge 26% subjects (39) had good knowledge. Post-intervention poor knowledge was observed in 8% subjects (12) average knowledge was observed in 9.3% subjects (14) and good knowledge was observed in 82.7% subjects (124) subjects regarding the body composition analysis.

Table: 4.46 Knowledge regarding Metabolic Syndrome and the lifestyle to be followed Pre and post-intervention in research subjects

Parameter (N=150)	Pre Intervention N (%)	Post Intervention N (%)	p value
Poor	42 (28%)	3 (2 %)	<0.001
Average	32 (21.3%)	6 (4 %)	
Good	76 (50.7%)	141 (94 %)	

The knowledge regarding metabolic syndrome and the lifestyle to be followed was recorded as given in Table 4.46. The knowledge regarding metabolic syndrome and the lifestyle to be followed post-intervention in metabolic syndrome subjects increased and was statistically significant with p-value <0.001. Poor knowledge was observed in 42 subjects‘ average knowledge in 32 subjects and 76 subjects had good knowledge post intervention three subjects had poor knowledge six subjects had average knowledge and 141 subjects had good knowledge regarding metabolic syndrome and the lifestyle to be followed.

According to Verma et al. (2019), MS patients did not adopt healthy lifestyle habits to avoid CVD even when they had a positive mindset. According to the study's findings, these patients need to get rigorous educational interventions in order to avoid difficulties. The KAP of the research individuals was evaluated both before and after the intervention in the current investigation. In contrast to knowledge and practice, attitude improvement in our study was likewise a little below average. The current metabolic syndrome research subjects had an impression that; currently they don't have any serious health issues, and the knowledge is gained during the intervention period. They can practice if necessary at a later stage. Yahya et al. (2020) did a study on diabetics' attitudes toward the ailment and discovered that patients who knew more about it than the average had a positive attitude and good practice patterns, which allowed them to present with the sickness earlier.

In the current study as stated above, The impact of lifestyle counselling on four knowledge aspects: knowledge regarding healthy diet/ general nutrition, knowledge regarding benefits of exercise and weight loss, knowledge regarding body composition and knowledge regarding metabolic syndrome and the lifestyle to be followed had a high statistical significance at <0.001 proving that the intervention improved the overall knowledge of the metabolic syndrome subjects.

Table: 4.47

Attitude Score for the Life style Modification among Pre and post-intervention in research subjects

Parameter (N=150)	Pre Intervention N (%)	Post Intervention N (%)	P value
Strongly negative	3 (2%)	2 (1.3 %)	**<0.001**
Negative	18 (12%)	12 (8 %)	
Neutral	45 (30%)	28 (18.7 %)	
Positive	69 (46%)	90 (60 %)	
Strongly positive	15 (10%)	18 (12 %)	

The attitude score for lifestyle modification among the subjects was rated in five scale: strongly negative, negative, neutral, positive and strongly positive. Postintervention in metabolic syndrome subjects the attitude score increased and was

statistically significant with p-value <0.001. Pre intervention, strongly negative 3 subjects (2%) and post 2 subjects (1.3%), Pre intervention, negative attitude was in 18 subjects (12%) were having and post-intervention 12 subjects (8%). Neutral attitude was observed in 45 subjects (30%) and pre-intervention 28 subjects (18.7%) were neutral in attitude. Positive attitude was observed in 69 subjects (46%) preintervention and 90 subjects (60%) post-intervention were of positive attitude. Strongly positive attitude was observed in 15 subjects (10%) of people preintervention and post intervention 18 subjects (12%) were strongly positive. There was a clear shift from being neutral on the attitude to being positive and strongly positive post-intervention.

Table: 4.48 Practice Score for the Lifestyle Modification among Pre and post-intervention in research subjects

Parameter (N=150)	Pre Intervention N (%)	Post Intervention N (%)	p value
Very poor	25 (16.7%)	3 (2 %)	**<0.001**
Poor	35 (23.3%)	11 (7.3 %)	
Neutral	30 (20%)	20 (13.3 %)	
Good	52 (34.7%)	97 (64.7 %)	
Very good	8 (5.3%)	19 (12.7 %)	

Post-intervention in metabolic syndrome subjects the practice score increased and was statistically significant with p-value <0.001. To assess the practice score five scale rating very poor, poor, neutral, good and very good was used based on the questions. 25 subjects (16.7%) had very poor practice pre-intervention, post intervention 3 subjects (2%) had very poor practice. Poor practice in 35 subjects (23.3%) was observed pre-intervention and 11 subjects (7.3%) had poor practice 30 subjects (20%) were neutral on the practice pre intervention; post intervention 20 subjects (13.3%) were neutral. Good practice was observed in 52 subjects (34.7%) pre intervention and post intervention 97 subjects (64.7%) were good in practice. Very good practice was observed in 8 subjects (5.3%) pre intervention and post intervention 19 subjects (12.7%) had very good practice.

The Knowledge, Attitude and practice of the sub sampled subjects was observed later on statistical analysis was done to study if socio economic profile of age, level of education, occupation, socioeconomic status, family structure, marital status and diet habit had any significance on the knowledge about healthy diet or general nutrition knowledge about benefits of exercise and weight loss knowledge regarding body composition and knowledge regarding metabolic syndrome and lifestyle to be followed.

Table: 4.49 Socio- economic profile influence on Knowledge about healthy diet/ general nutrition

Parameter		Knowledge about healthy diet/ general nutrition			p value
		Poor (n=24)	Average (n=16)	Good (n=110)	
Age	**<=35 years**	3 (12.5%)	3 (18.8%)	20 (18.2%)	**0.51**
	36-40 years	5 (20.8%)	7 (43.8%)	41 (37.3%)	
	41-45 years	9 (37.5%)	4 (25.0%)	32 (29.1%)	
	>45 years	7 (29.2%)	2 (12.5%)	17 (15.5%)	
Level of education	**Primary/secondary schooling**	10 (41.7%)	2 (12.5%)	8 (7.3%)	**<0.001**
	Technical/ diploma/ certificate courses	7 (29.2%)	6 (37.5%)	42 (38.2%)	
	Graduate	7 (29.2%)	8 (50%)	60 (54.5%)	
Occupation	**Semi-routine and routine occupations**	5 (20.8%)	1 (6.3%)	6 (5.5%)	**0.068**
	Lower supervisory and technical occupations	5 (20.8%)	2 (12.5%)	10 (9.1%)	
	Small employers and own account workers	8 (33.3%)	7 (43.8%)	65 (59.1%)	
	Intermediate/high managerial	6 (25.0%)	6 (37.5%)	29 (26.4%)	
Socio Economic Class	**Upper lower**	7 (29.2%)	5 (31.3%)	20 (18.2%)	**0.54**
	Lower- middle	12 (50.0%)	9 (56.3%)	71 (64.5%)	
	Upper- middle	5 (20.8%)	2 (12.5%)	19 (17.3%)	
Family structure	**Single member**	2 (8.3%)	3 (18.8%)	21 (19.1%)	**0.88**
	Nuclear family	16 (66.7%)	10 (62.5%)	67 (60.9%)	
	Joint family	5 (20.8%)	2 (12.5%)	15 (13.6%)	
	Extended family	1 (4.2%)	1 (6.3%)	7 (6.4%)	
Marital status	**Unmarried**	2 (8.3%)	3 (18.8%)	25 (22.7%)	**0.59**
	Married	21 (87.5%)	12 (75.0%)	81 (73.6%)	
	Widowed/divorcee	1 (4.2%)	1 (6.3%)	4 (3.6%)	

As given in Table 4.49, the socio- economic profile except level of education (p <0.001) the rest other parameters like age, occupation, socioeconomic class, family structure and marital status had no statistical significance on the influence of knowledge about healthy diet/ general nutrition. This helps us to state, the level of education or the awareness brought in through counselling intervention can help the subjects to gain knowledge on healthy diet/ general nutrition.

Table 4.50 shows Socio- economic profile influence on Knowledge about benefits of exercise and weight loss had no statistical significance.

Table: 4.50 Socio- economic profile influence on Knowledge about benefits of exercise and weight loss

Parameter		Knowledge about benefits of exercise and weight loss			p value
		Poor (n=12)	Average (n=44)	Good (n=94)	
Age	<=35 years	0 (0%)	10 (22.7%)	16 (17%)	0.67
	36-40 years	5 (41.7%)	13 (29.5%)	35 (37.2%)	
	41-45 years	4 (33.3%)	14 (31.8%)	27 (28.7%)	
	>45 years	3 (25%)	7 (15.9%)	16 (17%)	
Level of education	Primary/secondary schooling	0 (0%)	7 (15.9%)	13 (13.8%)	0.21
	Technical/ diploma/ certificate courses	8 (66.7%)	14 (31.8%)	33 (35.1%)	
	Graduate	4 (33.3%)	23 (52.3%)	48 (51.1%)	
Occupation	Semi-routine and routine occupations	0 (0%)	3 (6.8%)	9 (9.6%)	0.65
	Lower supervisory and technical occupations	2 (16.7%)	4 (9.1%)	11 (11.7%)	
	Small employers and own account workers	6 (50%)	28 (63.6%)	46 (48.9%)	
	Intermediate/high managerial	4 (33.3%)	9 (20.5%)	28 (29.8%)	
Socio Economic Class	Upper lower	1 (8.3%)	9 (20.5%)	22 (23.4%)	0.48
	Lower- middle	7 (58.3%)	29 (65.9%)	56 (59.6%)	
	Upper- middle	4 (33.3%)	6 (13.6%)	16 (17%)	
Family structure	Single member	0 (0%)	9 (20.5%)	17 (18.1%)	0.42
	Nuclear family	11 (91.7%)	24 (54.5%)	58 (61.7%)	
	Joint family	1 (8.3%)	8 (18.2%)	13 (13.8%)	
	Extended family	0 (0%)	3 (6.8%)	6 (6.4%)	
Marital status	Unmarried	0 (0%)	9 (20.5%)	21 (22.3%)	0.095
	Married	12 (100%)	31 (70.5%)	71 (75.5%)	
	Widowed/divorcee	0 (0%)	4 (9.1%)	2 (2.1%)	

Table: 4.51 Socio- economic profile influence on the knowledge regarding body composition

Parameter		Knowledge Regarding Body composition			p value
		Poor (n=89)	Average (n=22)	Good (n=39)	
Age	<=35 years	11 (12.4%)	7 (31.8%)	8 (20.5%)	<0.001
	36-40 years	23 (25.8%)	7 (31.8%)	23 (59%)	
	41-45 years	29 (32.6%)	8 (36.4%)	8 (20.5%)	
	>45 years	26 (29.2%)	0 (0%)	0 (0%)	
Level of education	Primary/secondary schooling	20 (22.5%)	0 (0%)	0 (0%)	<0.001
	Technical/ diploma/ certificate courses	40 (44.9%)	2 (9.1%)	13 (33.3%)	
	Graduate	29 (32.6%)	20 (90.9%)	26 (66.7%)	
Occupation	Semi-routine and routine occupations	12 (13.5%)	0 (0%)	0 (0%)	0.04
	Lower supervisory and technical occupations	12 (13.5%)	2 (9.1%)	3 (7.7%)	
	Small employers and own account workers	42 (47.2%)	16 (72.7%)	22 (56.4%)	
	Intermediate/high managerial	23 (25.8%)	4 (18.2%)	14 (35.9%)	
Socio Economic Class	Upper lower	21 (23.6%)	4 (18.2%)	7 (17.9%)	0.92
	Lower- middle	52 (58.4%)	14 (63.6%)	26 (66.7%)	
	Upper- middle	16 (18%)	4 (18.2%)	6 (15.4%)	
Family structure	Single member	7 (7.9%)	7 (31.8%)	12 (30.8%)	<0.001
	Nuclear family	52 (58.4%)	14 (63.6%)	27 (69.2%)	
	Joint family	21 (23.6%)	1 (4.5%)	0 (0%)	
	Extended family	9 (10.1%)	0 (0%)	0 (0%)	
Marital status	Unmarried	9 (10.1%)	9 (40.9%)	12 (30.8%)	0.004
	Married	75 (84.3%)	13 (59.1%)	26 (66.7%)	
	Widowed/divorcee	5 (5.6%)	0 (0%)	1 (2.6%)	

Table: 4.52 Socio- economic profile influence on the knowledge regarding metabolic syndrome and diet to be followed

Parameter		Knowledge Regarding Metabolic syndrome and diet to be followed			p value
		Poor (n=42)	Average (n=32)	Good (n=76)	
Age	<=35 years	6 (14.3%)	6 (18.8%)	14 (18.4%)	0.9
	36-40 years	13 (31%)	10 (31.3%)	30 (39.5%)	
	41-45 years	14 (33.3%)	10 (31.3%)	21 (27.6%)	
	>45 years	9 (21.4%)	6 (18.8%)	11 (14.5%)	
Level of education	Primary/secondary schooling	6 (14.3%)	3 (9.4%)	11 (14.5%)	0.41
	Technical/ diploma/ certificate courses	17 (40.5%)	8 (25%)	30 (39.5%)	
	Graduate	19 (45.2%)	21 (65.6%)	35 (46.1%)	
Occupation	Semi-routine and routine occupations	3 (7.1%)	1 (3.1%)	8 (10.5%)	0.2
	Lower supervisory and technical occupations	5 (11.9%)	5 (15.6%)	7 (9.2%)	
	Small employers and own account workers	28 (66.7%)	14 (43.8%)	38 (50%)	
	Intermediate/high managerial	6 (14.3%)	12 (37.5%)	23 (30.3%)	
Socio Economic Class	Upper lower	8 (19%)	7 (21.9%)	17 (22.4%)	0.93
	Lower- middle	27 (64.3%)	18 (56.3%)	47 (61.8%)	
	Upper- middle	7 (16.7%)	7 (21.9%)	12 (15.8%)	
Family structure	Single member	5 (11.9%)	6 (18.8%)	15 (19.7%)	0.15
	Nuclear family	25 (59.5%)	25 (78.1%)	43 (56.6%)	
	Joint family	9 (21.4%)	1 (3.1%)	12 (15.8%)	
	Extended family	3 (7.1%)	0 (0%)	6 (7.9%)	
Marital status	Unmarried	5 (11.9%)	8 (25%)	17 (22.4%)	0.14
	Married	33 (78.6%)	24 (75%)	57 (75%)	
	Widowed/divorcee	4 (9.5%)	0 (0%)	2 (2.6%)	

Table: 4.53

Socio- economic profile on the attitude of lifestyle modifications

Parameter		Attitude towards lifestyle modifications					p value
		Strongly negative (N=3)	Negative (N=18)	Neutral (N=45)	Positive (N=69)	Strongly positive (N=15)	
Age	<=35 years	1 (33.3%)	3 (16.7%)	6 (13.3%)	15 (21.7%)	1 (6.7%)	**0.85**
	36-40 years	1 (33.3%)	7 (38.9%)	13 (28.9%)	25 (36.2%)	7 (46.7%)	
	41-45 years	0 (0%)	5 (27.8%)	16 (35.6%)	20 (29%)	4 (26.7%)	
	>45 years	1 (33.3%)	3 (16.7%)	10 (22.2%)	9 (13%)	3 (20%)	
Level of education	Primary/secondary schooling	0 (0%)	1 (5.6%)	5 (11.1%)	11 (15.9%)	3 (20%)	**0.54**
	Technical/ diploma/ certificate courses	0 (0%)	8 (44.4%)	14 (31.1%)	28 (40.6%)	5 (33.3%)	
	Graduate	3 (100%)	9 (50%)	26 (57.8%)	30 (43.5%)	7 (46.7%)	
Occupation	Semi-routine and routine occupations	0 (0%)	0 (0%)	3 (6.7%)	7 (10.1%)	2 (13.3%)	**0.25**
	Lower supervisory and technical occupations	0 (0%)	4 (22.2%)	5 (11.1%)	8 (11.6%)	0 (0%)	
	Small employers and own account workers	2 (66.7%)	7 (38.9%)	30 (66.7%)	35 (50.7%)	6 (40%)	
	Intermediate/high managerial	1 (33.3%)	7 (38.9%)	7 (15.6%)	19 (27.5%)	7 (46.7%)	
Socio Economic Class	Upper lower	0 (0%)	4 (22.2%)	9 (20%)	17 (24.6%)	2 (13.3%)	**0.92**
	Lower- middle	2 (66.7%)	10 (55.6%)	30 (66.7%)	40 (58%)	10 (66.7%)	
	Upper- middle	1 (33.3%)	4 (22.2%)	6 (13.3%)	12 (17.4%)	3 (20%)	
Family structure	Single member	0 (0%)	5 (27.8%)	5 (11.1%)	15 (21.7%)	1 (6.7%)	**0.73**
	Nuclear family	3 (100%)	11 (61.1%)	28 (62.2%)	40 (58%)	11 (73.3%)	
	Joint family	0 (0%)	2 (11.1%)	9 (20%)	9 (13%)	2 (13.3%)	
	Extended family	0 (0%)	0 (0%)	3 (6.7%)	5 (7.2%)	1 (6.7%)	
Marital status	Unmarried	0 (0%)	5 (27.8%)	7 (15.6%)	16 (23.2%)	2 (13.3%)	**0.52**
	Married	3 (100%)	13 (72.2%)	34 (75.6%)	51 (73.9%)	13 (86.7%)	
	Widowed/divorcee	0 (0%)	0 (0%)	4 (8.9%)	2 (2.9%)	0 (0%)	

Table: 4.54 Socio- economic information influence on the practice of lifestyle modifications

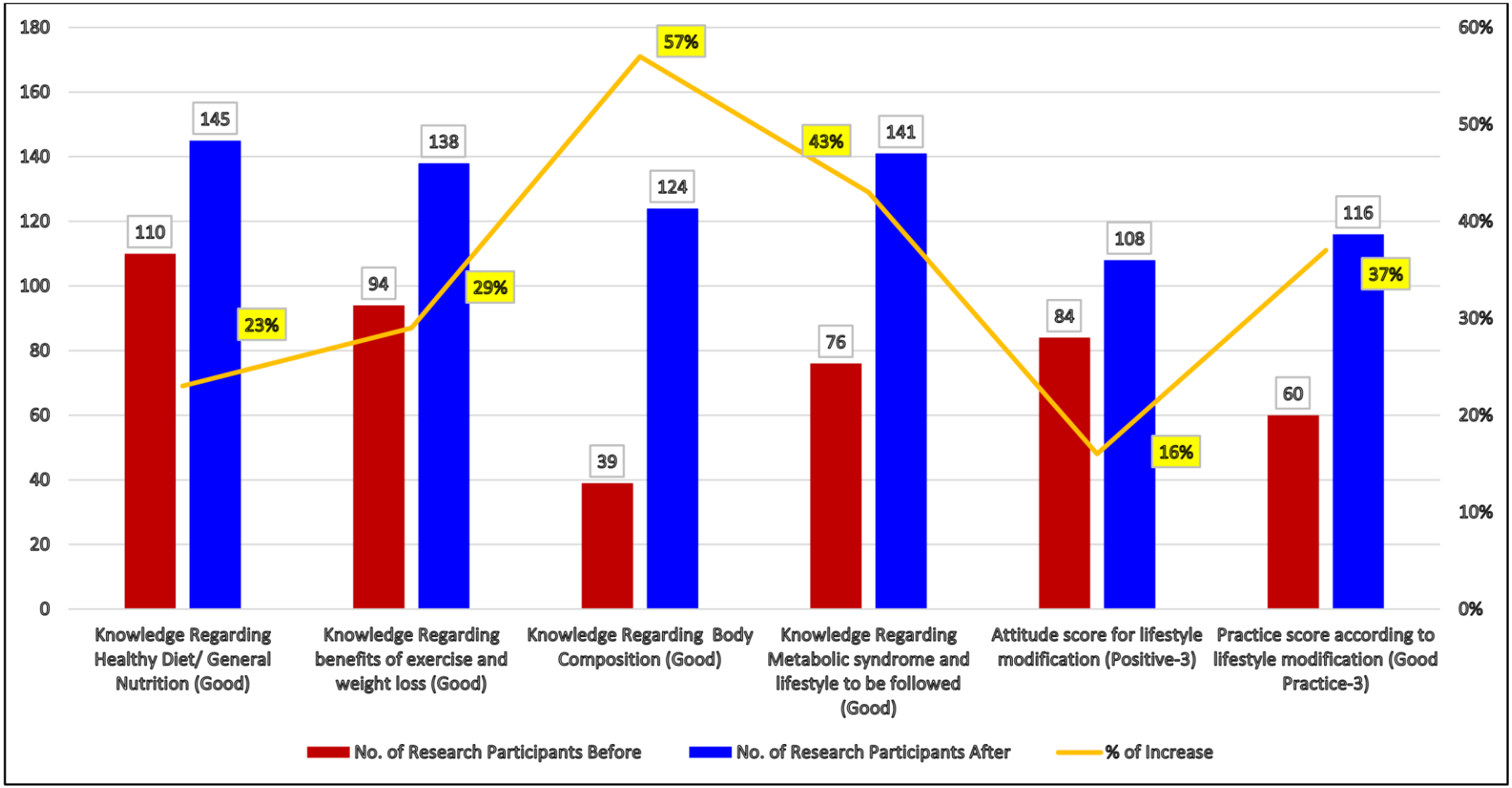
Parameter		Practice of lifestyle modifications					p value
		Very poor (N=25)	Poor (N=35)	Neutral (N=30)	Good (N=52)	Very good (N=8)	
Age	<=35 years	3 (12%)	7 (20%)	6 (20%)	10 (19.2%)	0 (0%)	0.52
	36-40 years	6 (24%)	12 (34.3%)	11 (36.7%)	21 (40.4%)	3 (37.5%)	
	41-45 years	7 (28%)	11 (31.4%)	8 (26.7%)	15 (28.8%)	4 (50%)	
	>45 years	9 (36%)	5 (14.3%)	5 (16.7%)	6 (11.5%)	1 (12.5%)	
Level of education	Primary/secondary schooling	5 (20%)	7 (20%)	1 (3.3%)	6 (11.5%)	1 (12.5%)	0.45
	Technical/ diploma/ certificate courses	10 (40%)	12 (34.3%)	9 (30%)	20 (38.5%)	4 (50%)	
	Graduate	10 (40%)	16 (45.7%)	20 (66.7%)	26 (50%)	3 (37.5%)	
Occupation	Semi-routine and routine occupations	3 (12%)	3 (8.6%)	1 (3.3%)	5 (9.6%)	0 (0%)	0.13
	Lower supervisory and technical occupations	4 (16%)	3 (8.6%)	6 (20%)	4 (7.7%)	0 (0%)	
	Small employers and own account workers	10 (40%)	25 (71.4%)	13 (43.3%)	25 (48.1%)	7 (87.5%)	
	Intermediate/high managerial	8 (32%)	4 (11.4%)	10 (33.3%)	18 (34.6%)	1 (12.5%)	
Socio Economic Class	Upper lower	4 (16%)	8 (22.9%)	7 (23.3%)	13 (25%)	0 (0%)	0.25
	Lower- middle	15 (60%)	21 (60%)	18 (60%)	34 (65.4%)	4 (50%)	
	Upper- middle	6 (24%)	6 (17.1%)	5 (16.7%)	5 (9.6%)	4 (50%)	
Family structure	Single member	2 (8%)	4 (11.4%)	8 (26.7%)	11 (21.2%)	1 (12.5%)	0.29
	Nuclear family	18 (72%)	21 (60%)	20 (66.7%)	30 (57.7%)	4 (50%)	
	Joint family	4 (16%)	7 (20%)	2 (6.7%)	8 (15.4%)	1 (12.5%)	
	Extended family	1 (4%)	3 (8.6%)	0 (0%)	3 (5.8%)	2 (25%)	
Marital status	Unmarried	2 (8%)	4 (11.4%)	10 (33.3%)	11 (21.2%)	3 (37.5%)	0.051
	Married	23 (92%)	27 (77.1%)	19 (63.3%)	40 (76.9%)	5 (62.5%)	
	Widowed/divorcee	0 (0%)	4 (11.4%)	1 (3.3%)	1 (1.9%)	0 (0%)	

Table 4.51 has the data showing socio-economic profile influence on the Knowledge regarding body composition. With increasing age, and education level; the knowledge regarding body composition was observed to be high and nuclear family subjects had good knowledge than others on BCA in the present study and had high statistical significance with p-value <0.001. The small employers and own account owners and intermediate/ higher managerial occupation subjects and subjects who were married had statistical significance at <0.05. It is observed that their exposure towards the health awareness was a reason for this finding. The parameters like socioeconomic status and diet habit had no statistical significance with knowledge about benefits of exercise and weight loss. Durai *et al.,* (2015) did a knowledge and practice survey among hypertensive males and found diet modification practices were low. Drewnowski *et al.,* (2009) stated that low level of education and income had high prevalence of obesity and type 2 diabetes.

Table 4.52 given shows socio-Economic information influence on the Knowledge Regarding Metabolic syndrome and life style diet to be followed.

As shown in Table 4.53, the Socio-economic profile influence on the attitude of lifestyle modifications. The attitude towards lifestyle modifications had no statistical significance with socio- economic profile.

As shown in Table 4.54 Socio-economic profile influence on the practice of lifestyle modifications when analysed; except those who were married (significant correlation with p<0.05); no other parameter of socio- economic profile showed statistical correlation with practice of lifestyle modifications.



Graph 4.21: Knowledge, Attitude and Practice of Research subjects Pre and Post Intervention

Ranasinghe *et al*., (2017) in their study mentioned that primary prevention of metabolic syndrome is important to reduce the morbidity and mortality rate, thus, life style intervention to increase KAP towards metabolic syndrome is very important. The knowledge attitude and practice of sub sample subjects pre and post intervention was recorded and tabulated in Graph 4.21.

The knowledge was assessed on four parameters like knowledge regarding healthy diet general nutrition knowledge regarding benefits of exercise and weight loss knowledge regarding body composition and knowledge regarding metabolic syndrome and diet and lifestyle to be followed. Also attitude and practice score for lifestyle modification were recorded. Post intervention the good knowledge regarding healthy diet/ general nutrition increased by 23%. Good knowledge on benefits of exercise and weight loss knowledge was increased by 29%. Good knowledge regarding body composition increased by 57%. Good knowledge regarding metabolic syndrome and lifestyle to be followed increased by 43% attitude and practice score for lifestyle modification increased by 16 and 37% respectively. Okonta *et al*., (2014) in their study stated that KAP survey with lifestyle intervention can reduce the risk factors of metabolic syndrome. Nikhil *et al*., (2014) mentioned that lifestyle intervention is the best strategy for reducing metabolic syndrome risk factors. Santos *et al*., (2022) have shown that the educational intervention reduces the risk of metabolic syndrome as KAP increases. As explained above there was a relation between Metabolic syndrome and body composition parameters with lifestyle habits like diet, exercise, physical activity level and social habits of smoking and alcohol of an individual. This leads to rejection of H_0 3. A relation between metabolic syndrome and body composition parameters with lifestyle habits like diet, exercise, physical activity level and social habits- smoking and alcohol of an individual existed and was statistically significant. The lifestyle counselling given to the metabolic syndrome subjects increased their knowledge regarding healthy diet/ lifestyle, exercise, healthy weight, body composition and metabolic syndrome. The lifestyle intervention also helped subjects to develop a positive attitude and intention to practice the healthy lifestyle too.

From the foregoing results, it is evident that it was possible to validate body composition measurements of Inbody 770 against DEXA using Cronbach‘s alpha and found valid and reliable. The prevalence of metabolic syndrome among a total of

1359 subjects visiting for Preventive Health Checkup, Sakra World Hospital, Bengaluru was found to be 13.2%, by following the NCEP ATP III (2005) metabolic syndrome criteria, The data obtained in the research study was statistically analysed using ‗R' software . The impact of health style modification was assessed by comparing pre and post data using the Paired Sample T-test, Mann-Whitney U tests, Chi-Square test, univariate and multivariate logistic regression analysis and StuartMaxwell marginal homogeneity test. P-values were considered significant at a 5% level or lower for all comparisons.

The impact of lifestyle counseling intervention was statistically analyzed with pre and post-data. The findings revealed that, statistical significance was obtained with lifestyle counselling intervention. The waist circumference and waist-hip ratio reduced, the average calories consumed by the subjects reduced as per weight loss goals, the exercise habit increased and the physical activity level improved, the body composition analysis measures of body fat mass, body fat percentage, visceral fat area, weight to control, fat to control and obesity degree reduced, the whole body phase angle increased.

The metabolic syndrome criteria showed a significant reduction. The knowledge regarding healthy diet/ general nutrition, knowledge regarding benefits of exercise and weight loss, knowledge regarding body composition and knowledge regarding metabolic syndrome and the lifestyle to be followed, practice and attitude scores of the subjects increased.