4

Results and Discussion

The results of the study **"Association of Visceral Adiposity Index and Lipid Accumulation Product with Insulin Resistance among Selected Adult Women and the Impact of Intervention"** is discussed under the following headings:

4.1. Phase I: Socioeconomic Attributes

4.1.1. Distribution of Age of the Adult Women

4.1.2. Educational Status

4.1.3. Income Level

4.1.4. Marital Status

4.2. Phase II: Prevalence of Obesity among Adult Women

4.2.1. Results on Screening of Obesity

4.2.1.1. Details on Height and Weight

4.2.1.2. Body Mass Index (BMI)

4.2.1.3. Details on Waist and Hip Circumference

4.2.1.4. Waist and Hip Ratio (WHR)

4.2.1.5. Waist and Height Ratio (WHtR)

4.2.1.6. Prevalence of Obesity

4.2.2. Relationship of the Socio-economic Attributes with Obesity

4.2.2.1. Chi-square Analysis of Age with BMI, WHR and WHtR

4.2.2.2. Chi-square Analysis of Income with BMI, WHR and WHtR

4.2.2.3. Chi-square Analysis of Education with BMI, WHR and WHtR

4.2.2.4. Association of Anthropometric Variables among Experimental and Control Group

4.2.3. Biochemical Details of the Experimental and Control Groups

4.2.3.1. Details on Lipid Profile

4.2.3.2. Details on Fasting Blood Glucose and Insulin

4.2.3.3. Details on Blood Pressure

4.2.4. Details on Visceral Adiposity Indices

4.2.4.1. Details on VAI and LAP

4.2.4.2. Details on Insulin Resistance

4.2.5. Association of VAI and LAP with Insulin Resistance

4.2.5.1. Correlation Analysis

4.2.5.1.1. Correlation Analysis on VAI

4.2.5.1.2. Correlation Analysis on LAP

4.2.5.2. Regression Analysis

4.2.5.2.1. Regression Analysis on VAI

4.2.5.2.2. Regression Analysis on LAP

4.2.6. Deriving the cut-off Value for the Assessment of Visceral Adiposity Indices

4.2.6.1. Receiver Operating Characteristic (ROC) Curve for Deriving the Cut-off Value

4.2.6.2. Visceral Adiposity among Experimental and Control Adult Women using the Derived VAI and LAP Cut-off Value

4.2.6.2.1. Visceral Adiposity by Derived VAI Cut-off Value

4.2.6.2.2. Visceral Adiposity by Derived LAP Cut-off Value

4.3. Phase III: Dietary Pattern, Physical Activity and The Corresponding Anthropogens

4.3.1. Details on Dietary Pattern

4.3.1.1. Dietary Habits

4.3.1.2. Frequency of Meal Pattern

4.3.1.3. Nutrient Intake

4.3.1.4. Correlation Analysis

4.3.1.4.1. Correlation of VAI with Nutrient Intake

4.3.1.4.1. Correlation of LAP with Nutrient Intake

4.3.2. Details on Physical Activity Pattern

4.3.2.1. Frequency of Physical Activity

4.3.2.2. Type of Physical Activity and Duration

4.3.2.3. Physical Activity Level

4.3.2.4. Physical Activity Status

4.3.2.5. Correlation Analysis of VAI and LAP with Physical Activity

4.3.3. Anthropogens and Risk Assessment for Metabolic Dysfunction

4.4. Phase IV: Impact of Intervention on Adiposity Indices among Selected Experimental Group

4.4.1. Evaluation of Pre and Post Intervention on Visceral Adiposity Indices

4.4.1.1. Details on Pre and Post Diet Intervention

4.4.1.2. Details on Pre and Post Physical Activity Intervention

4.4.1.3. Details on Pre and Post Diet and Physical Activity Intervention

4.4.1.4. Details on Pre and Post Intervention among Control

4.4.2. Comparison between and within the Experimental and Control Groups of Pre-Intervention among Selected Obese Women (ANOVA)

4.4.3. Comparison between and within the Experimental and Control Groups of Post Intervention among Selected Obese Women (ANOVA)

The results pertaining to the study are depicted and discussed below under the following headings:

4.1. PHASE I: SOCIO-ECONOMIC ATTRIBUTES

4.1.1. Distribution of Age of the Adult Women

The age-wise distribution among 960 adult women is depicted in Table IX and Figure 2.

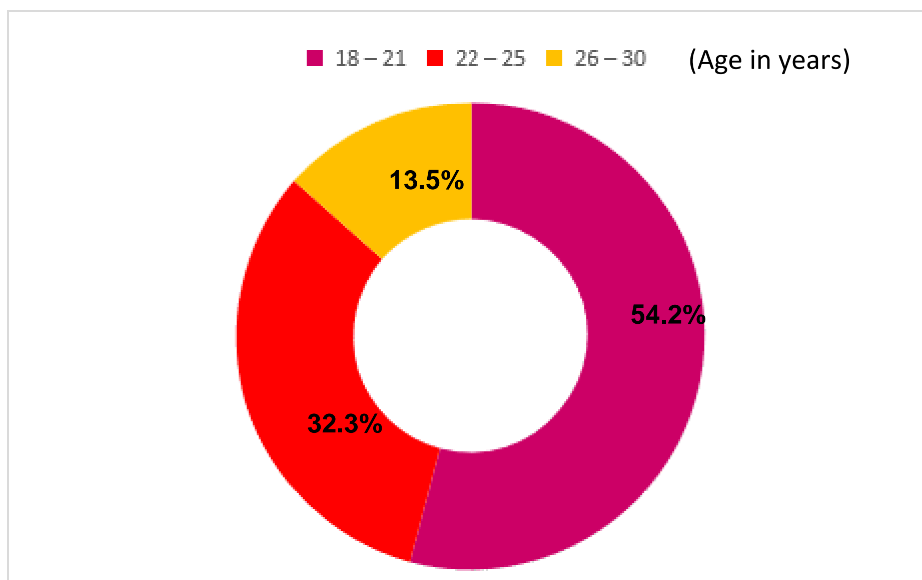
Table IX

Distribution of Age

Age (years)	N = 960	Per cent	Mean±SD	Mean
18 – 21	520	54.2	20.11±0.91	21.54±1.69
22 – 25	310	32.3	24.18±1.52	
26 – 30	130	13.5	27.15±1.72	

Figure 2

Age Distribution



Among the 960 adult women, 54.2 per cent were in the age group of 18 – 21 years and 13.5 per cent were in the age group of 26-30 years. The mean age was found to be 21.54±1.69. Age is an important non-modifiable risk factor

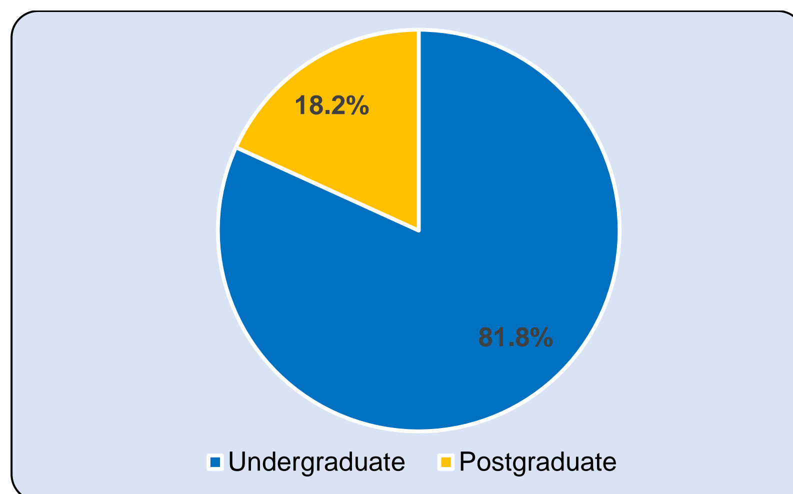
directly associated with lifestyle and behavior-related risk among the younger age group (Akseer et al., 2020) compared to older and middle-aged adults; younger adults had substandard NCD's risk perceptions (Kaba et al.,2017). Additionally, fat mass increases with progression in age among early and middle adulthood (Kuk et al., 2009). So, addressing younger age adults is integral (Mogre et al., 2014).

4.1.2. Educational Qualification

The educational qualification among the selected women is shown in Figure 3.

Figure 3

Educational Qualification



Eighty-two per cent were undergraduates, and 18.2 per cent were postgraduates since the participants were mainly from the university. Higher educational qualification is related to obesity (Pujilestari et al., 2017). The educated women in India have a significant role and strongly relate to health outcomes (Feinstein et al., 2006). Education increases the ability to adopt healthy lifestyle changes and well-being among women (Miller et al., 2017).

4.1.3. Income Level

Table X and Figure 4 presents the income status among adult women.

Table X

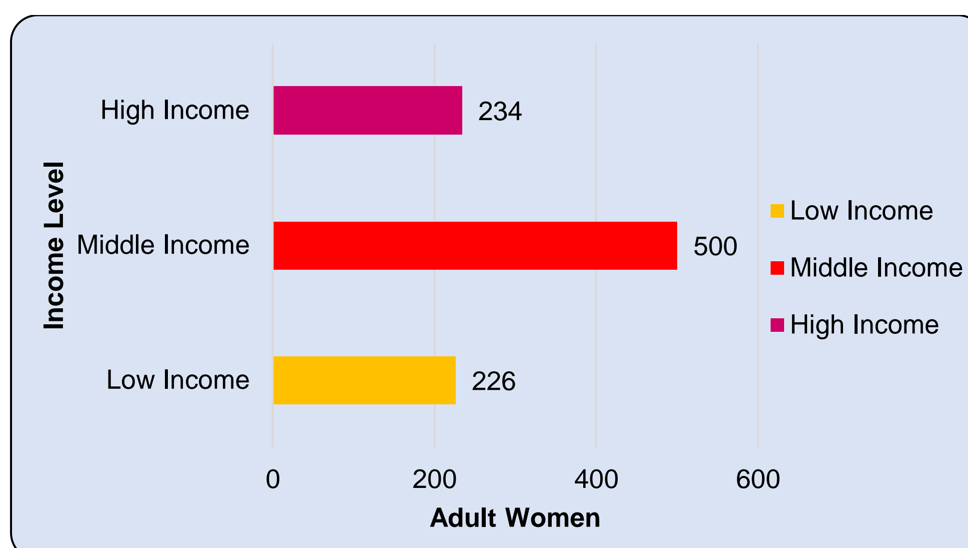
Monthly Income Level

Monthly Income (Rs)*	N = 960	Per cent
Low Income (3300-7300)	226	23.6
Middle Income (7300-14500)	500	52.1
High Income (> 14500)	234	24.3

* HUDCO, 2010

Figure 4

Monthly Income Level



The income status revealed that 52.1 per cent were in the middle income and 24.3 per cent were in the high-income status. All around the world, people with lower socioeconomic backgrounds experience lower health levels and life expectancy is reduced (Graham, 2007). As rural and urban populations are concerned, socioeconomic status was associated with high adverse health risk factors (Sameul et al., 2012). The low economic status resulted in 56% of surplus cause-specific mortality compared to high-income status and it has a higher incidence of mortality among all age groups (Mohan & Muliyil, 2009).

As Luhar et al (2018) point out, obesity prevalence was consistently highest among higher-income individuals. Between 1998 and 2016, the prevalence of

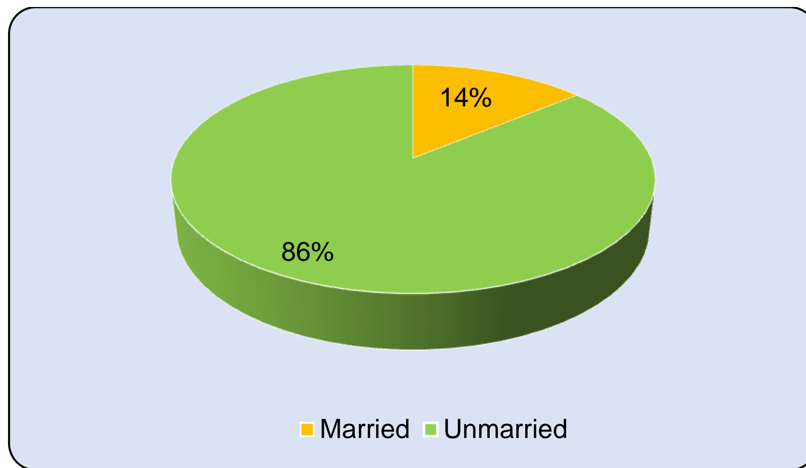
overweight/obesity increased from approximately 15% to 32% among urban women with no education.

4.1.4. Marital Status

The marital status among 960 adult women is depicted in Figure 5.

Figure 5

Marital Status



Marital status and the onset of metabolic changes are positively related (Mogre et al., 2014). The women are more likely to engage in less physical activity, have more stable dietary patterns, and are less active after marriage (Janghorbani et al., 2008). Among the adult women, 86 per cent (825) were unmarried.

Women face many biological determinants of health and illness, including genetic vulnerability factors, physiological factors, and reproductive and hormonal factors during life compared to the male gender. However, determining biological and social determinants is important considering women's health (Vlassoff, 2007).

4.2. PHASE II: PREVALENCE OF OBESITY AMONG ADULT WOMEN

4.2.1. Results on Screening of Obesity

4.2.1.1. Details on Height and Weight

The anthropometric details like the height and weight of the 960 adult women are shown in Table XI.

Table XI

Mean of Height and Weight depending on Age

Age (years)	ICMR Standard (adults 18-30 years)	Mean Height (cm)	Deficit/ Excess	Mean Weight (kg)	Deficit/ Excess
18 – 21	Height = 162 cm Weight = 55 kg	157.14±6.43	- 4.86	54.78±10.99	- 0.22
22 – 25		155.4±8.37	- 6.60	53.13±11.19	- 1.87
26 – 30		153.17±7.00	- 8.83	55.19±10.99	+ 0.19

The mean height of the women ranged from 153.17 to 157.14 and the mean weight ranged from 53.13 to 55.19. Compared with the ICMR standards except for the 26-30 years age group, adult women's weight showed a 0.22 and 1.87 kgs deficit. The results point out that the height is lower by 8.83 cm, pointing out that South Indians' genetic makeup has a greater fat presence than the height (Misra & Srivastava, 2013).

4.2.1.2. Body Mass Index (BMI)

The body mass index among adult women is elicited in Table XII and Figure 6.

Table XII

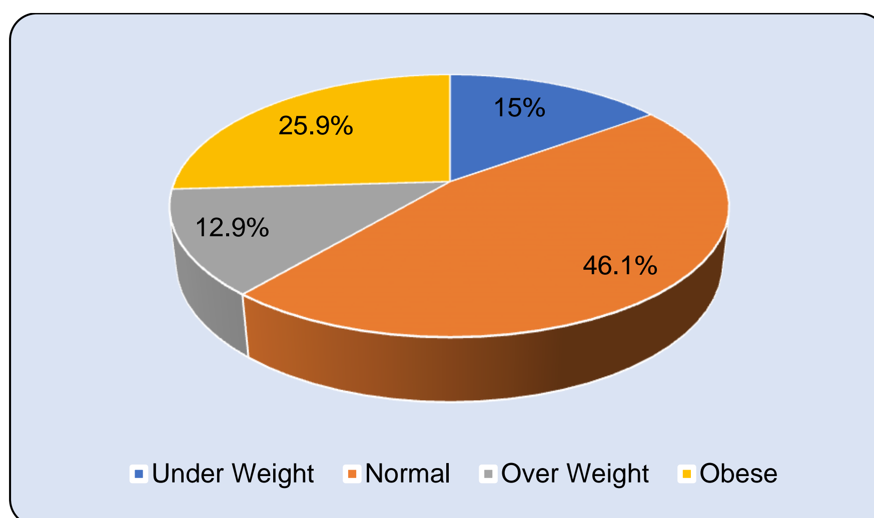
Body Mass Index

BMI^	N = 960	Per cent	Mean±SD
Under Weight	144	15.0	17.08±1.05
Normal	443	46.1	20.52±1.23
Over Weight	124	12.9	23.89±0.54
Obese	249	25.9	28.46±2.91

^ WHO, Asian Standards, 2004

Figure 6

Body Mass Index



The body mass index among adults pointed out that 15 per cent were underweight, 12.9 per cent were overweight, and 25.9 per cent were obese as Dutta et al (2019) state underweight co-exist with the prevalence of overweight and obesity in India, which is also the finding from the current study. The double burden of malnutrition coexists with both under and over nutrition among the same population across which is expected that early in life stage undernutrition will contribute to an increased adult over nutrition (Roger & Claudia, 2012).

The health risk of individuals increases with the level of visceral adiposity, within the normal, overweight and obese (Janssen et al., 2002). Shields et al (2012) suggested that it is essential to measure and monitor visceral adiposity within the categories of BMI.

4.2.1.3. Details on Waist and Hip Circumference

The waist and hip circumference among adult women is shown in Table XIII.

Table XIII

Mean of Waist and Hip Circumference depending on Age

Age (years)	International Diabetes Federation (IDF) Standards^	Mean Waist Circumference^	Deficit/ Excess	Mean Hip Circumference
18 – 21	Waist Circumference for South Asians = 80 cm	72.10±9.09	- 7.9	92.57±9.59
22 – 25		72.47±10.26	-7.53	91.90±10.15
26 – 30		82.98±8.50	+ 2.98	92.86±8.87

^ IDF, 2006

The mean waist circumference among the age group of 26-30 years was higher (82.98±8.50). The mean hip circumference was greater among 26-30 years of 92.86±8.87, followed by 18-21 years of 92.57±9.59. Despite having a higher waist circumference, the hip circumference was also associated with increased cardiovascular disease risk and the effects of adiposity (Cameron et al., 2012).

An interesting finding from the study was as the age progressed, the corresponding waist and hip circumference were increased. A similar result was observed as age strongly correlates with increased waist and hip circumference (Howel, 2012). Compared to IDF (2006), the waist circumference was 2.98 in excess among 26-30 years of age. The older young age group women are prone to physiological conditions due to the reproduction age and tend to put on the waist and hip circumference, leading to NCD's (Oli et al., 2013).

4.2.1.4. Waist Hip Ratio (WHR)

Table XIV represents the waist-hip ratio among adult women.

Table XIV

Waist Hip Ratio

BMI	Waist Hip Ratio^ (N=960)			
	<0.80		>0.80	
	N=606	Per cent	N=354	Per cent
Underweight (n=144)	95	66	49	34
Normal (n=443)	373	84.2	70	15.8
Overweight (n=124)	55	44.4	69	55.6
Obese (n=249)	83	33.3	166	66.7

^ WHO, 2008

The waist-hip ratio independently aggregates the major metabolic cardiovascular risk factors (Seidell et al., 2001). The waist-hip ratio (>0.80) was found higher among obese (66.7 per cent), followed by overweight (55.6 per cent). The table also pointed out that underweight and normal adult women also had a higher waist-hip ratio of 34 per cent and 15.8 per cent, respectively, which signifies the 'Asian Indian Phenotype.' 'Asian Indian Phenotype' possesses higher visceral fat at a lower BMI range (Patel et al., 2016). The risk of heart disease and type 2 diabetes increases with a higher waist-hip ratio. The waist-hip ratio has managed to identify more women in normal and underweight as abdominally obese. On the other hand, the waist-hip ratio (<0.80) was found predominantly among normal (84.2 per cent) adult women.

4.2.1.5. Waist Height Ratio (WHtR)

Table XV shows the waist and height ratio among adult women

Table XV

Waist Height Ratio

BMI	Waist Height Ratio^ (N=960)			
	<0.50		>0.50	
	N= 691	Per cent	N= 269	Per cent
Underweight (n=144)	120	83.3	24	16.7
Normal (n=443)	414	93.5	29	6.5
Overweight (n=124)	81	65.3	43	34.7
Obese (n=249)	76	30.5	173	69.5

^ Browning et al., 2010

The waist to height ratio has recently gained attention as an anthropometric index for measuring visceral adiposity. Ashwell and Gibson (2014) stated that the cut-off of WHtR of 0.5 can be used in different sex and ethnic groups.

Among the 960 adult women, WHtR greater than 0.5 (>0.50) indicates abdominal obesity, which was found predominantly among obese of 69.5 per cent and overweight adult women of 34.7 per cent. The cardiometabolic risk is higher

when the WHtR increases within the BMI range (Khoury et al., 2013; Montero et al., 2014)

. At the same time, considering the WHtR (<0.50), normal and underweight women had 93.5 per cent and 83.3 per cent respectively.

4.2.1.6. Prevalence of Obesity

Table XVI shows the prevalence of obesity among the selected adult women.

Table XVI

Prevalence of Obesity

Variables	N = 960	Per cent
BMI^		
Under Weight	144	15.0
Normal	443	46.1
Over Weight	124	12.9
Obese	**249**	**25.9**
WHR^^		
<0.80	606	63.1
>0.80	**354**	**36.9**
WHtR^^^		
<0.5	691	72.1
>0.5	**269**	**27.9**

^ WHO, Asian Standards, 2004; ^^ WHO, 2008; ^^^ Browning et al., 2010

Table XVI shows that the prevalence of obesity was observed among 25.6 per cent (249) adult women. On considering the waist-hip ratio and waist-height ratio, 36.9 per cent had WHR (>0.80), whereas the WHtR (>0.50) was seen among 27.9 per cent of adult women. The effects and complications will be long-term if the onset of obesity is seen in the 18-30 years adult age group (Easwaran et al., 2019). Along with BMI measurements, it is important to analyze the other anthropometrics for better risk assessment, and by maintaining a healthy

weight, visceral adiposity can be prevented concurrently (Goh et al., 2014). Body fat deposition was predominant even though obesity and visceral fat increase with age (Sarvottam et al., 2020).

4.2.2. Relationship of the Socio-economic Attributes with Obesity

To attain the relationship between the socio-economic attributes like age, income status and education with body mass index (BMI), waist-hip ratio (WHR) and waist-height ratio (WHtR), chi-square analysis was performed and the tables are discussed below.

4.2.2.1. Chi-square Analysis of Age with BMI, WHR and WHtR

The age was compared with BMI, WHR and WHtR using Chi-square analysis and the results are depicted in Table XVII.

Table XVII

Chi-square Analysis of Age with BMI, WHR and WHtR among Adult Women

Variables		AGE (years) (N=960)						Chi-Square value	P value
		18 – 21 (N=520)		22 – 25 (N=310)		26 – 30 (N=130)			
		N	Per cent	N	Per cent	N	Per cent		
BMI	Underweight	78	15	61	19.7	5	3.8	38.981	<0.001*
	Normal	240	46.2	123	39.7	80	61.5		
	Overweight	69	13.3	42	13.5	13	10		
	Obese	133	25.5	84	27.1	32	24.7		
WHR	<0.80	308	59.2	203	65.5	95	73.1	190.955	<0.001*
	>0.80	212	40.8	107	34.5	35	26.9		
WHtR	<0.5	105	20.2	75	24.2	48	36.9	62.922	<0.001*
	>0.5	415	79.8	235	75.8	82	63.1		

*** Significant at 1% level**

The chi-square analysis of age with BMI showed that among the age of 22-25 years the prevalence of obesity, overweight and underweight was significantly higher of 27.1 per cent, 13.5 per cent and 19.7 per cent adult women respectively. Comparatively, obesity was seen predominantly among 22-25 years of 27.1 per cent, 18-21 years of 25.5 per cent and 26-30 years of 24.7 per cent.

The WHR (>0.80) was seen higher among the age group of 18-21 years of 40.8 per cent whereas WHR (<0.80) was seen among higher the age group of 26-30 years of 73.1 per cent. Likewise, considering the WHtR (>0.05), 79.8 per cent was seen among the age of 18-21 years and WHtR (<0.05) was seen among 36.9 per cent of 26-30 years of age.

The chi-square analysis showed a 1% significant difference between age with BMI, WHR and WHtR. The Chi-square analysis between BMI, WHR and WC was associated with gender obesity being common among women (Okafor et al., 2011).

4.2.2.2. Chi-square Analysis of Income with BMI, WHR and WHtR

The income was compared with BMI, WHR and WHtR using Chi-square analysis and the results are depicted in Table XVIII.

Table XVIII
Chi-square Analysis of Income with BMI, WHR and WHtR among Adult Women

Variables		INCOME (N=960)						Chi-Square value	P value
		Low Income (N=226)		Middle Income (N=500)		High Income (N=234)			
		N	Per cent	N	Per cent	N	Per cent		
BMI	Underweight	36	15.9	84	16.8	24	10.3	27.682	0.001*
	Normal	115	50.9	235	47	93	39.9		
	Overweight	32	14.1	61	12.2	31	13.3		
	Obese	43	19.1	120	24	85	36.5		
WHR	<0.80	213	94.2	443	88.6	164	70.4	60.776	<0.001*
	>0.80	13	5.8	57	11.4	69	29.6		
WHtR	<0.5	181	80.1	372	74.4	138	59.2	27.469	0.001*
	>0.5	45	19.9	128	25.6	95	40.8		

* Significant at 1% level

The chi-square value of income with BMI showed that 36.5 per cent and 13.3 per cent were obese and overweight among high-income levels respectively. On the other hand, 50.9 per cent were normal among the low-income levels.

While considering the WHR, 29.6 per cent had greater values (>0.80) among the high-income levels, whereas WHR (<0.80) was seen among 94.2 per cent of low-income levels. The WHtR (>0.5) was seen predominantly among high-income levels of 40.8 per cent and WHtR (<0.05) was seen among low-income levels of 80.1 per cent. There was an increase between obesity and high socio-economic level among women in developing countries (Anyanwu et al., 2010).

BMI, WHR and WHtR were statistically significant with a 1% level between the variables. Low and high education level was a strong determinant of obesity among women. Also, women with higher education had significantly lower BMI and WC (Shahraki et al., 2008). Women were more susceptible to obesity of low socioeconomic status (Pan et al., 2021).

4.2.2.3. Chi-square Analysis of Education with BMI, WHR and WHtR

The educational qualification among the adult women is compared with BMI, WHT and WHtR using Chi-square analysis and the results are depicted in Table XIX.

Table XIX
Chi-square Analysis of Education with BMI, WHR and WHtR among Adult Women

Variables		EDUCATION (N=960)				Chi-Square value	P value
		UG (N=784)		PG (N=176)			
		N	Per cent	N	Per cent		
BMI	Underweight	141	18.0	4	2.3	41.948	<0.001*
	Normal	364	46.4	74	42.3		
	Overweight	95	12.6	30	16.6		
	Obese	184	23.0	68	38.8		
WHR	<0.80	685	87.4	104	59.4	76.598	<0.001*
	>0.80	99	12.6	72	40.6		
WHtR	<0.5	599	76.4	92	52.6	40.325	<0.001*
	>0.5	185	23.6	84	47.4		

* Significant at 1% level

The chi-square analysis showed that 38.8 per cent of postgraduates were obese compared to undergraduates. The underweight and normal were seen predominantly among undergraduates of 18 per cent and 46.4 per cent respectively.

The WHR with education revealed that 40.6 per cent of postgraduates had greater WHR (>0.80), whereas 87.4 per cent of undergraduates had lesser WHR (<0.80). The WHtR (>0.50) was seen among 47.4 per cent of postgraduates and 76.4 per cent of undergraduates had WHtR (<0.05).

The chi-square analyses between education with BMI, WHR and WHtR showed a 1% significance level between the variables. A study conducted by Anyanwu et al (2010) showed that the prevalence of obesity and cardiovascular disease risk was highest amongst females, and visceral obesity was worse among females of the various education group.

Among the 960 adult women, the prevalence of obesity was 25.9 percent (249). One- sixty obese women were the experimental and 160 non-obese normal women were the control.

4.2.2.4. Association of Anthropometric Variables among Experimental and Control Group

Table XX shows the t-test significance and the mean of anthropometry among experimental and control (n=320). Along with BMI measurements, it is important to analyze the other anthropometrics for better risk assessment and by maintaining a healthy weight, visceral adiposity can be prevented concurrently (Goh et al., 2014).

Table XX

Anthropometry among Experimental and Control

Variables		Experimental (N=160)	Control (N=160)	T-Value	P value
Body Mass Index^		27.13±3.36	20.25±1.37	-23.961	**<0.001***
Waist Circumference (cm) ¥	< 80cm	75.73±3.14 (n=45)	68.01±4.48 (n=148)	-19.705	**<0.001***
	> 80cm	87.87±6.44 (n=115)	82.58±4.40 (n=12)	-10.527	**0.0064****
Hip Circumference (cm)		98.09±8.33	86.73±5.57	-14.355	**<0.001***
Waist Hip Ratio#	< 0.80	0.76±0.02 (n=35)	0.74±0.02 (n=100)	-7.685	0.9000 NS
	> 0.80	0.89±0.08 (n=125)	0.87±0.06 (n=60)	-0.150	0.0876 NS
Waist Height Ratio$	< 0.05	0.47±0.03 (n=33)	0.43±0.03 (n=144)	-17.793	**<0.001***
	> 0.05	0.53±0.03 (n=127)	0.52±0.01 (n=16)	-0.173	0.1888 NS

*** Significant at 1% level, ** Significant at 5% level, NS Not Significant**

^ WHO, Asian Standards, 2004; ¥ IDF, 2006; # WHO, 2008; $ Browning et al., 2010

It was evident from the table that a 1% significance difference was found on the mean of age, weight, body mass index, waist and hip circumference, waist-hip, and waist-height ratio. The results revealed that the BMI of the experimental (27.13±3.36) was higher compared to the control (20.25±1.37).

It was also evident that the mean WC of the experimental group (n=115) was 87.87±6.44 and the control group (n=12) was 82.58±4.40 had abnormal waist circumference (>80 cm). The waist circumference between experimental and control women below 80 cm and above 80 cm was statistically significant, of p-value <0.0001 and 0.0064 respectively. The waist circumference (WC) indicates intra-abdominal adipose tissue, high levels above 80 cm, which confer an increased risk of cardiometabolic disease (Tran et al., 2018). A cross-sectional

study showed that 11.6 per cent control group had abdominal obesity among young and middle-aged women (Lakucs et al., 2019).

The mean hip circumference was higher (98.09±8.33) than the control group (86.73±5.57) and showed a 1% significance level. A long-term prospective cohort study among women revealed that even normal weight abdominal obese women had the highest risk of cardiovascular disease mortality, similar to women with obese abdominal obesity (Sun et al., 2019).

The waist-hip ratio signifies central obesity and predicts the development of several conditions associated with over-accumulation of fat. The WHR of greater than 0.80 shows the severity of the risk. It is evident from the table that the mean WHR of the experimental group (n=125) was 0.89±0.08 and the control group (n=60) was 0.87±0.06 which was not significant. It signifies that the WHR does not vary across the experimental and control groups.

The waist-height ratio (WHtR) is useful for central fat distribution (Hsieh et al., 2003). The high WHtR (>0.05) was found among the n=127 experimental group with a mean of 0.53±0.03, whereas among the control was found among n=16 (0.52±0.01) which was not statistically significant. The low WHtR (>0.05) value among experimental and control was significant of mean 0.47±0.03 and 0.43±0.03 respectively of (p=<0.0001*). In a study, the WHtR among women was found to be 0.50 and was statistically significant and found to increase the risk of Mets (Wu et al., 2021). Several studies proved that high WC and WHtR were important risk factors for diabetes among women. A study has resulted that normal-weight adults of 12.2 per cent had higher WC, and women of 13.3 per cent had a higher WHtR, which indicated even non-obese might have visceral fat dysfunction (Zeng et al., 2014). The waist-height ratio was associated with visceral adiposity and cardiovascular risk among the general population and type 2 diabetes individuals (Parente et al., 2020).

4.2.3. Biochemical Details of the Experimental and Control Groups

4.2.3.1. Details on Lipid Profile

The changes in lipid profile among experimental and control is shown in Table XXI and Figure 7.

Table XXI

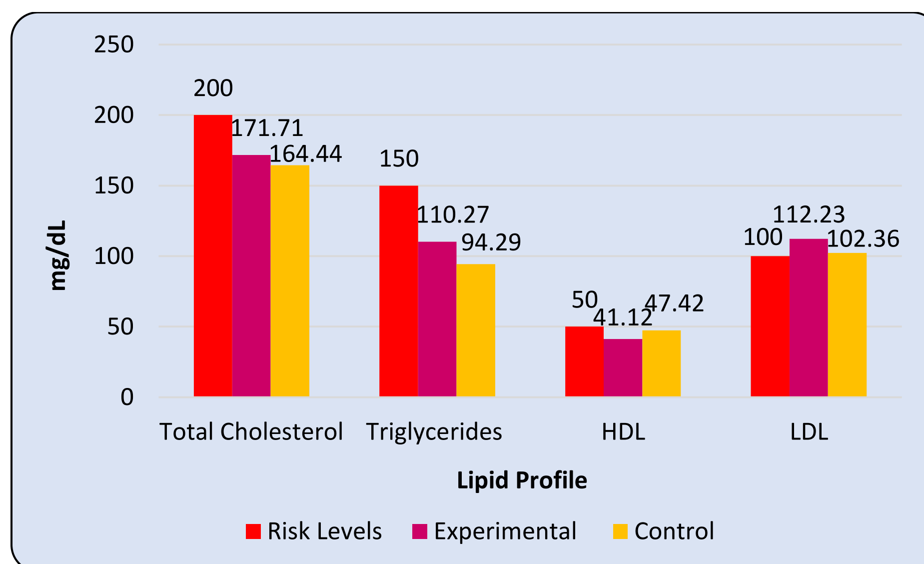
Mean Lipid Profile

Variables	Risk Levels#	Experimental (N=160)	Control (N=160)	T-Value	P value
Total Cholesterol (mg/dl)	>200	171.71±31.25	164.44±29.88	-2.126**	**0.034****
Triglycerides (mg/dl)	>150	110.27±43.75	94.29±39.19	-3.441*	**0.001***
HDL (mg/dl)	<50	41.12±8.31	47.42±9.06	6.484*	**<0.001***
LDL (mg/dl)	>100	112.23±29.54	102.36±27.00	-3.119*	**0.002***

*** Significant at 1% level, ** Significant at 5% level,**
#National Cholesterol Education Programme (NCEP)

Figure 7

Lipid Profile



The mean lipid fractions, namely total cholesterol (TC) and triglycerides (TG), were within the normal range for the experimental and control groups. The

high-density lipoprotein (HDL) fraction was less than the recommended values, i.e., 41.12±8.31 and 47.42±9.06 among experimental and control groups, but comparatively, the control group had a high HDL level of HDL (47.42±9.06). The mean low-density lipoprotein (LDL) levels were higher than the risk level but to a negligible extent 112.23±29.54 for experimental and 102.36±27.00 for control. TG, HDL and LDL were significant at 1% while TC was 5% significant.

Interestingly, HDL levels were lower and LDL levels were higher even among control individuals, signifying that the control group individuals were at risk. It shows the need to access the visceral adiposity to analyze the additional risk.

The result coincided with the study where there was a significant increase seen in serum cholesterol and LDL levels and a significant HDL decrease among obese women and men. Several lipid abnormalities occur not only among obese but also among non-obese (Aljaffar, 2018). White et al (2020) observed a high prevalence of lipid abnormalities among university students, leading to complications in the future. It was also found that the lipid parameters were higher among obese than non-obese students.

4.2.3.2. Details on Fasting Blood Glucose and Insulin

Table XXII shows the fasting blood glucose and insulin levels among experimental and control adult women. Figures 8 and 9 illustrate the fasting blood and fasting insulin.

Table XXII

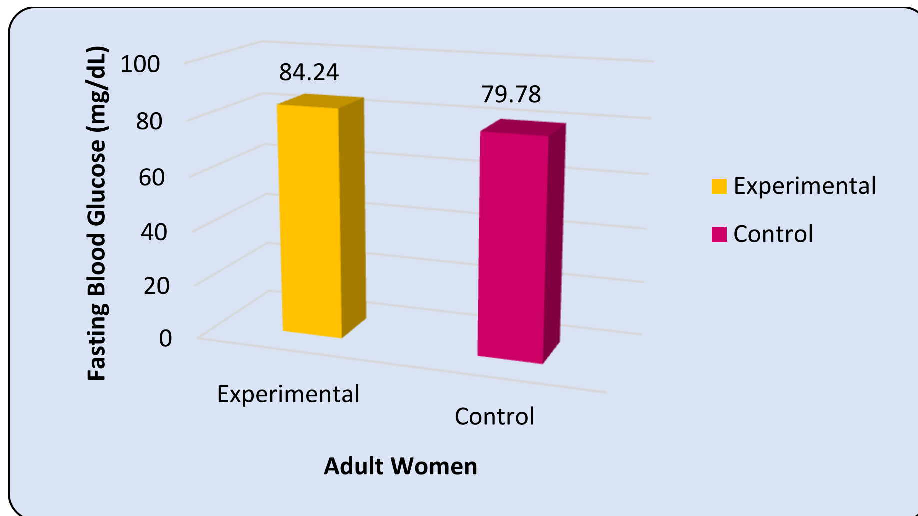
Fasting Blood Glucose and Insulin Values

Variables	Risk Levels	Experimental (N=160)	Control (N=160)	T-Value	P value
Fasting Blood Glucose (mg/dl)	> 100 mg/dl	84.24±14.76	79.78±9.94	-5.462*	**<0.001***
Fasting Insulin (μIU/ml)	> 25 μIU/ml	12.70±18.12	5.86±3.09	-3.171*	**0.002***

*** Significant at 1% level**

Figure 8

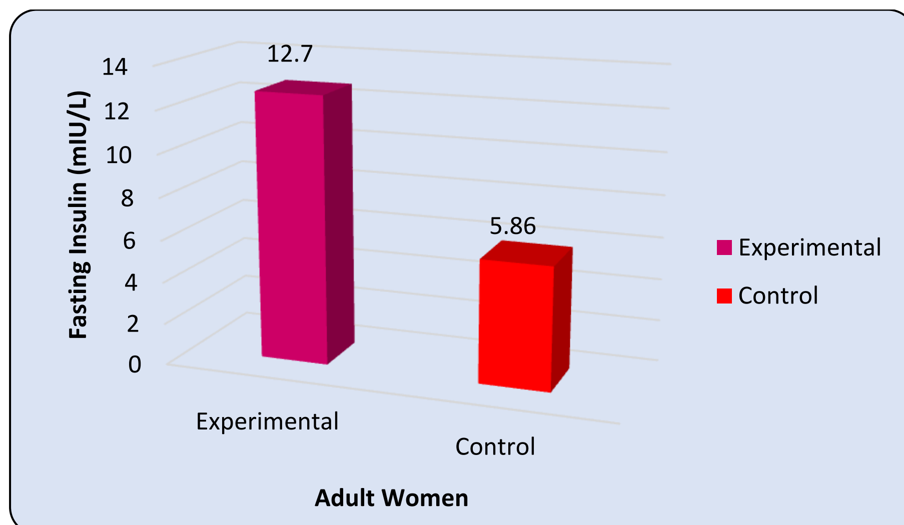
Fasting Blood Glucose



The mean fasting blood glucose (FBG) and insulin levels (FI) were normal for both the experimental and control groups. The mean fasting blood glucose was less than the recommended risk values, i.e., 84.24±14.76 and 79.78±9.94 among experimental and control respectively but, comparatively the experimental group had a higher level.

Figure 9

Fasting Insulin



The fasting blood sugar values among obese people were more prone to develop metabolic and cardiovascular diseases, resulting in high morbidity and

mortality. The study also suggested regular fasting blood glucose estimation is essential to prevent obesity-related complications (Akter et al., 2017). Obese students have significant ($p<0.001$) high blood glucose levels compared to non-obese students (Chaudhari et al., 2020).

The mean fasting insulin levels were lower than the risk level of 12.70±18.12 for experimental and 5.86±3.09 for control. It was also found that the mean fasting insulin levels were twice among the experimental than the control group. FBG and FI were significant at the 1% level.

Hyperinsulinaemia has been hypothesized as the earliest physiological risk marker of metabolic and cardiovascular diseases among obese (Libman et al., 2010). The fasting insulin measurement has been long considered the practical approach and well correlated with insulin resistance. Moreover, a significant positive correlation was found between fasting insulin and body mass index in the study group ($P < 0.005$) (Goyal et al., 2014). Girls had significantly higher fasting insulin levels than boys and showed that gender, body mass index and waist circumference are simple predictors of fasting insulin among obese adolescents (Ling et al., 2016).

4.2.3.3. Details on Blood Pressure

The mean blood pressure (systolic and diastolic) among the experimental and control is shown in Table XXIII.

Table XXIII

Blood Pressure

Variables	Normal Blood Pressure (mmHg) #	Experimental (N=160)	Control (N=160)	T-Value	P value
Blood pressure (Systolic mmHg)	<120	108.88±8.61	102.20±9.65	-4.594*	**<0.001***
Blood pressure (Diastolic mmHg)	<80	71.06±8.29	66.19±7.64	-6.528*	**<0.001***

* Significant at 1% level, ** Significant at 5% level, # WHO, 2013

Among Asian populations, a positive association was observed between body mass index and blood pressure. The systolic blood pressure among the experimental was slightly higher than the control group adult women of 108.88±8.61 and 102.20±9.65 respectively. A similar increase was seen in the diastolic blood pressure as 71.06±8.29 among experimental and 66.19±7.64 among control which was statistically significant at 1% level ($p<0.001$). The systolic and diastolic blood pressure was normal among the experimental and control groups. A study from Delhi revealed that the systolic blood pressure among females was found to be 114.4±11.67 and diastolic blood pressure was 78.0±7.78 and which was similar to the derived value (Dua et al., 2014).

4.2.4. Details on Visceral Adiposity Indices

4.2.4.1. Details on VAI and LAP

The VAI and LAP among experimental and control are shown in Table XXIV and Figures 10 and 11.

Table XXIV

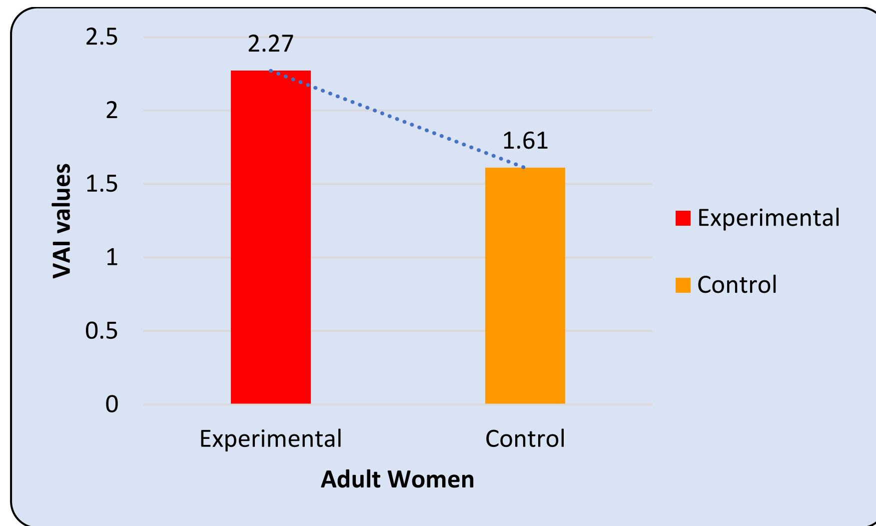
Visceral Adiposity Index and Lipid Accumulation Product

Variables	Experimental (N=160)	Control (N=160)	T-Value	P value
VAI	2.27±1.27	1.61±0.92	-5.284*	**<0.001***
LAP	27.52±17.01	12.27±8.50	-10.138*	**<0.001***

*** Significant at 1% level**

Figure 10

Visceral Adiposity Index

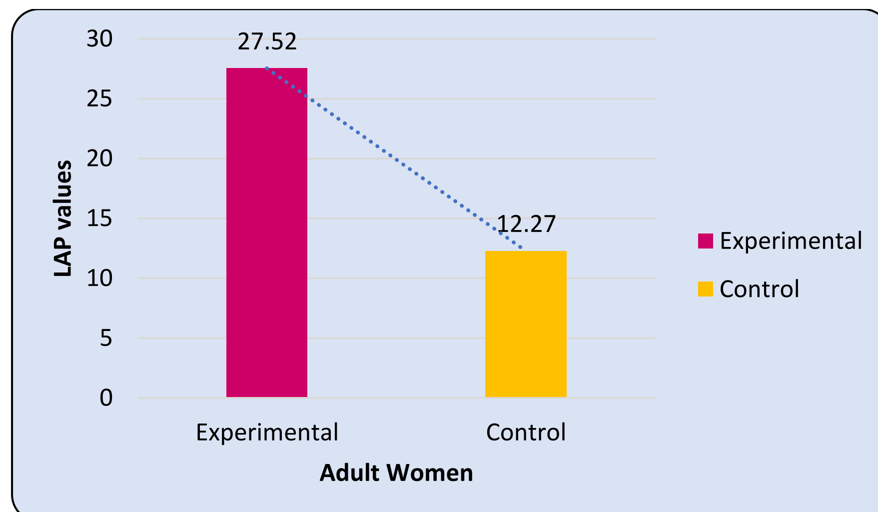


VAI value was higher among the experimental group (2.27±1.27) than the control group (1.61±0.92). A 1% significance was seen between the experimental and control group. A value of VAI observed in diverse studies has often been increased risk of cardiometabolic diseases (Munusamy et al., 2015).

According to Du et al (2015), lower VAI value (< 1.59) individuals were considered 'metabolically healthy' and higher VAI value (> 1.59) individuals as 'metabolically unhealthy.'

Figure 11

Lipid Accumulation Product



A mean LAP value of 27.52 was seen among the experimental group, which was twice that of the control group (12.27) and a 1% significant difference was noted. The LAP value among normal women was 18.09 and among overweight/ obese PCOS women was 36.61 (Huang et al., 2019). The LAP value among females was observed to be 30.7±16.5 (Sharaye & Eboh, 2020). A lesser LAP value was observed among the females irrespective of obese or non-obese of 23.99 (Xia et al., 2012).

4.2.4.2. Details on Insulin Resistance

The Insulin Resistance (IR) among experimental and control women is depicted in Table XXV and Figure 12.

Table XXV

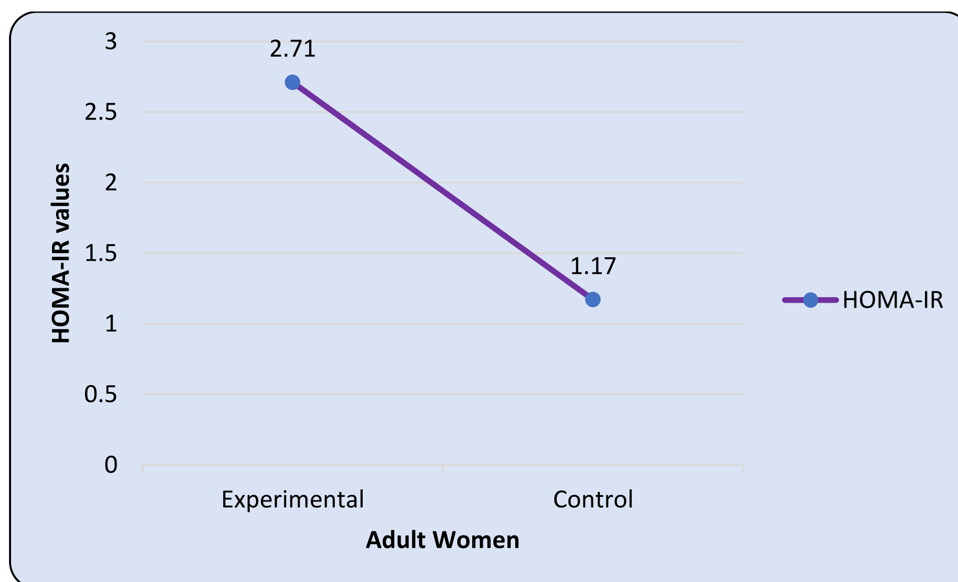
Insulin Resistance

Variables	Experimental (N=160)	Control (N=160)	T-Value	P value
Insulin Resistance (HOMA-IR)	2.71±4.18	1.17±0.67	-4.707*	**<0.001***

*** Significant at 1% level**

Figure 12

Insulin Resistance



Visceral adiposity and increased body fat are the risk factors of insulin resistance among Asian Indians (Fahed et al., 2020). The HOMA-IR method can further stratify the risk of diabetes among adults, thus identifying the high risk of non-obese and low risk of obese individuals. The mean insulin resistance (IR) value among the experimental was 2.71 when compared with control of 1.17, which was found to be at a 1% significance difference between the groups. The insulin resistance value greater than 2.5 to 3.0 was considered insulin resistant (Gutch et al., 2015).

A study among US Adults showed that the insulin resistance values increased significantly as BMI levels increased between the BMI categories. The higher levels of insulin resistance were associated with higher body fat levels, thus, indicating that high BMI and body fat percentage were strongly related to insulin resistance. The insulin resistance among obese was 3.9 (0.14) and among non-obese was 1.6 (0.08) (Martinez et al., 2017) and which was higher than the acquired value from the study.

Another study where adults were divided as metabolically healthy and unhealthy obese had insulin resistance values of 2.26±1.64 and 2.94±2.62 respectively, whereas metabolically healthy and unhealthy non-obese had 1.34±1.30 and 1.74±1.78 respectively (Liao et al., 2021).

4.2.5. Association of VAI and LAP with Insulin Resistance

4.2.5.1. Correlation Analysis of VAI

The correlation analysis of VAI with other indices like anthropometric and biochemical values of selected experimental and control adult women is shown in Table XXVI.

Table XXVI

Correlation of VAI with Anthropometry and Biochemical Values

Variables	VAI	
	r	p
Age	0.161	**0.004***
Weight	.228	**<0.001***
Body Mass Index	.245	**<0.001***
Waist Circumference	.255	**<0.001***
Hip Circumference	.208	**<0.001***
Waist Hip Ratio	.137	**0.014***
Waist Height Ratio	.249	**<0.001***
Total Cholesterol	.206	**<0.001***
Triglycerides	.835	**<0.001***
High Density Lipoprotein	-.636	**<0.001***
Low Density Lipoprotein	0.078	0.164 NS
Fasting Blood Glucose	.120	**0.032****
Fasting Insulin	0.070	0.209 NS
Insulin Resistance	0.072	0.213 NS
LAP	.127	**0.023****

*** Significant at 1% level, ** Significant at 5% level, NS Not Significant**

A positive correlation of VAI with age, weight, BMI, WC, HC, WHtR, TC and TG with 1% significance was noted. A negative correlation (r= -.636, p=<0.001) was noted with HDL, which indicates that there will be a decrease in VAI if HDL increases.

Waist Hip Ratio (r = 0.137, p=0.014), Fasting Blood Glucose (r = 0.120, p=0.032) and LAP (r = 0.127, p=0.023) showed a 5% significant difference. There was no correlation between VAI with LDL, fasting insulin and insulin resistance. This study points out that VAI and insulin resistance were not correlated among the general adult women population, but in studies conducted earlier, there was a strong relationship seen between visceral adiposity and insulin resistance. Hence H_0 of hypothesis 1 was accepted. VAI had the strongest correlation with FBG, TG, TC, HDL and BP, as supported by (Goldani et al., 2015).

Likewise, a similar result was found in which VAI was not correlated with IR ($r = 0.132$, $p = 0.119$) among healthy adult women (control). Still, it showed a significant positive correlation with insulin resistance ($r = 0.299$, $p = 0.003$) among prediabetic adult women population and stated that the higher level of VAI among adults was due to significantly higher BMI, WC, TG and lower HDL (Morshed et al., 2021).

On the contrary, a significant positive correlation was found between VAI and insulin resistance (Pathak et al., 2018; Munusamy et al., 2015). VAI was also correlated positively with cardiometabolic risk among women (Agrawal et al., 2019).

4.2.5.2. Correlation Analysis of LAP

Table XXVII shows the correlation analysis of LAP with other indices like anthropometric and biochemical values of selected experimental and control adult women.

Table XXVII

Correlation of LAP with Anthropometry and Biochemical Values

Variables	LAP	
	R	p
Age	.447	**<0.001***
Weight	.598	**<0.001***
Body Mass Index	.665	**<0.001***
Waist Circumference	.753	**<0.001***
Hip Circumference	.501	**<0.001***
Waist Hip Ratio	.515	**<0.001***
Waist Height Ratio	.745	**<0.001***
Total Cholesterol	0.002	0.969 NS
Triglycerides	0.007	0.897 NS
High Density Lipoprotein	-.166	**0.003***
Low Density Lipoprotein	0.027	0.627 NS
Fasting Blood Glucose	0.076	0.175 NS
Fasting Insulin	0.251	**<0.001***
Insulin Resistance	0.254	**<0.001***
VAI	.127	**0.023****

*** Significant at 1% level, ** Significant at 5% level, NS Not Significant**

A positive correlation (1% significance) was seen between LAP and age, weight, BMI, WC, HC, WHR, WHtR, FI, IR and VAI of 5% significance. It signifies that LAP has a strong relationship with insulin resistance. A significant negative correlation was seen between LAP and HDL levels (r= -0.166, p=0.003). The results also showed no correlation between LAP with TC, TG, LDL and FBG levels.

A significant positive correlation was seen WC, TG, FBG and IR and a negative correlation with HDL (Abruzzese et al., 2017). LAP was negatively correlated with HDL-c (Ilhan & Yildizhan, 2019).

The present study shows a strong association between LAP and insulin resistance. Hence the H_1 of hypothesis 1 was accepted. Even though higher VAI and LAP levels were associated with a higher level of insulin resistance, there was significance seen on only LAP levels (Salazar et al., 2021). Mazidi et al (2018) reported a significantly greater correlation between insulin resistance and LAP than other indexes. The findings were similar among healthy Korean women and reported as high LAP levels were associated with higher insulin resistance levels (Oh et al., 2013). Also, insulin resistance values increased significantly among Chinese nondiabetics as LAP increased (Xia et al., 2012).

4.2.5.2. Regression Analysis

4.2.5.2.1. Regression Analysis of VAI

The regression analysis was statistically analyzed for VAI and other experimental and control confounders, as shown in Table XXVIII- a, b & c and Figure 13.

Table XXVIII-a

Regression Analysis of VAI

Modal Summary			
R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
.940	.884	.879	.401

Table XXVIII-b

ANOVA					
Model	**Sum of Squares**	**Df**	**Mean Square**	**F**	**P value**
Regression	375.617	13	28.894	179.291	**<0.001***
Residual	49.313	306	.161		
Total	424.930	319			

*** Significant at 1% level**

Table XXVIII-c

Coefficients			
Variables	**Standardized Coefficients**	**T**	**P value**
Age	.026	1.014	.311 NS
WC	.201	2.962	**.003****
BMI	-.232	-4.629	**<0.001**
WHR	-.043	-1.242	.215 NS
WHtR	.074	.933	**0.001***
TC	.175	5.083	**<0.001***
TG	.693	29.160	**<0.001***
HDL	-.432	-18.644	**<0.001***
LDL	-.243	-7.639	**<0.001***
FBS	.007	.257	.798 NS
FI	-.039	-.193	.847 NS
IR	.025	.126	.900 NS
LAP	.018	.583	.560 NS

*** Significant at 1% level, ** Significant at 5% level, NS Not Significant**

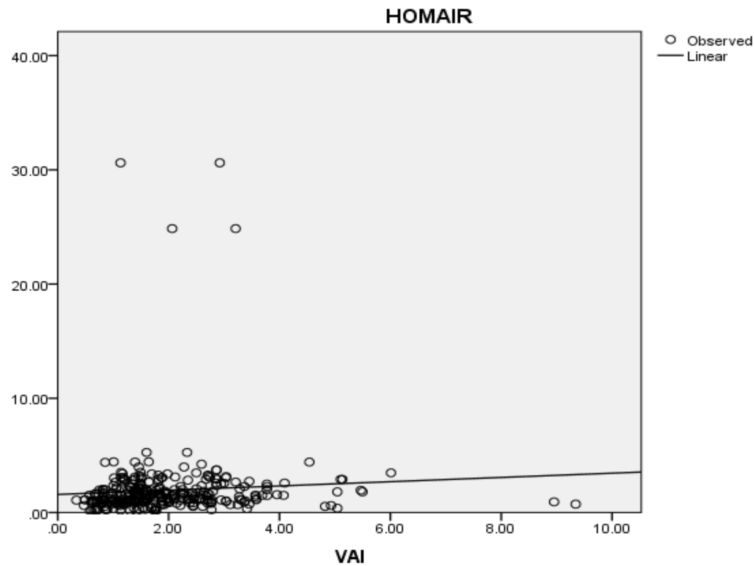
Dependent Variable: VAI

The R-value derived from the regression analysis was 0.940 and the degree of determination R square value was 0.884 for VAI. The adjusted R square value (0.879) shows the extent to which BMI, WHtR, TC, TG, HDL and

LDL influences the value of VAI. The results show that the VAI was determined to the extent of 88% by all the other confounders.

Figure 13

Linear Graph of VAI and IR



The ANOVA shows that the significant value was less than 0.05 (p=<0.001), which means independent variables significantly predicted the dependent variable VAI at a 95% confidence level. It indicates that the regression model for VAI was significant.

The multiple regression results for VAI were predicted by the WC, BMI, WHtR, TC, TG, HDL and LDL. In the analysis, mentioned variables have a P-value less than 0.05. Those variables are statistically significant with VAI. Hence, this proves a relation among the study's significant variables (BMI, WHtR, TC, TG, HDL and LDL on VAI).

Figure 13 shows the scatterplot linear graph between VAI and IR. The picture elicits the cluster towards the lower left, indicating a horizontal line with the slope. The r-value (0.025) indicates no strength of linear relation between VAI and IR, depicted in the scatterplot graph with minimal outliers. The outliers were not removed since the cut-off value must be derived using the ROC curve.

4.2.5.2.2. Regression Analysis of LAP

Table XXIX- a, b, and c shows the regression analysis of LAP on other confounding factors among experimental and control.

Table XXIX-a

Regression Analysis of LAP

Model Summary			
R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
.778	.606	.588	9.880

Table XXIX-b

ANOVA					
Model	**Sum of Squares**	**Df**	**Mean Square**	**F**	**P value**
Regression	45930.512	13	3533.116	36.193	**<0.001***
Residual	29871.678	306	97.620		
Total	75802.190	319			

*** Significant at 1% level**

Table XXIX-c

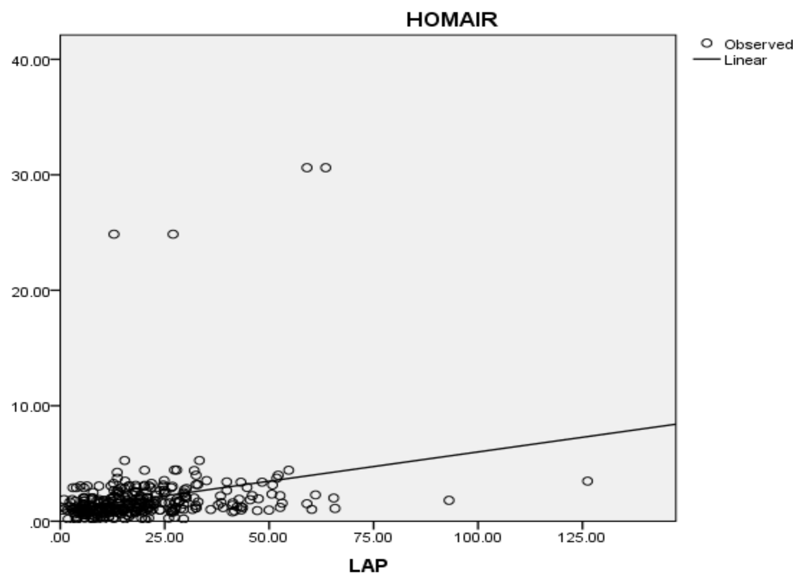
Coefficients			
Variables	**Standardized Coefficients**	**T**	**P value**
Age	.149	3.169	**.002****
WC	.509	4.120	**<0.001***
BMI	.077	.811	.418 NS
WHR	-.008	-.126	.899 NS
WHtR	.688	5.810	**<0.001***
TC	-.079	-1.164	.245 NS
TG	-.147	-1.696	.091 NS
HDL	.104	1.642	.102 NS
LDL	.035	.526	.599 NS
FBS	-.070	-1.350	.178 NS
FI	-.599	-1.592	.112 NS
IR	.680	1.785	**.045****
VAI	.142	1.331	.184 NS

*** Significant at 1% level, ** Significant at 5% level, NS Not Significant**

Dependent Variable: LAP

Figure 14

Linear Graph of LAP and IR



The R-value derived from the regression analysis was 0.778 and the degree of determination R square value was 0.606 with an adjusted R square value of 0.588 for LAP. The R and R square value found was lower than VAI and showed the extent to which BMI, WHR, WHtR, TC, TG, HDL, LDL, FBS, FI, IR and VAI influences the value of LAP. The results show that the LAP was determined to the extent of 57.8% by all the other confounders.

ANOVA shows that the significant value was p=<0.001, which means independent variables significantly predicted the dependent variable LAP at a 95% confidence level. It indicates that the regression model for LAP was significant.

The multiple regression results for LAP were predicted by Age, WC, WHtR and IR values. The mentioned variables are statistically significant with LAP. Hence this proves a relation among the significant variables (Age, WC, WHtR and IR on LAP) in the study, proving that LAP is dependent on age (as age increases, there will be a significant increase in LAP value). It signifies that LAP has a strong relationship with IR, and among the other confounding indices, WHtR was related.

From the derived R and R square value, it was observed that VAI and LAP have the predictive ability in which the model value of VAI (R=0.940, R square

value=0.884) was higher compared to LAP (R=0.778, R square value=0.606), which shows to be a good predictive indicator of visceral adiposity. The result also signifies that LAP had a strong relationship with IR, whereas VAI was insignificant. A similar result of LAP having a positive correlation with IR than VAI has been established (Fiorentino et al., 2019; Ilhan et al., 2018; Xia et al., 2012).

Figure 14 shows the plotted linear graph between LAP and IR. The points were clustered towards the lower-left nearing to zero axis, indicating a 45-degree angle with the slope, compared to the VAI scatter plot with IR. “The R-value (0.680) is close to 1, which means a linear relationship between LAP and IR scatterplot which falls close to the regression line points with minimal outliers, so predictions based on the line were accurate”. The outliers were not removed since the cut-off value must be derived using the ROC curve.

4.2.6. Deriving the Cut-off Value for the Assessment of Visceral Adiposity Indices

4.2.6.1. Receiver Operating Characteristic (ROC) Curve for Deriving the Cut-off Value

The ROC area under the curve (ROC-AUC) of WC, WHR, WHtR, VAI, LAP and IR with the area under the curve, cut-off value, sensitivity, 1-specificity, odds ratio, 95% confidence interval and youden index is depicted in Table XXX and Figure 15.

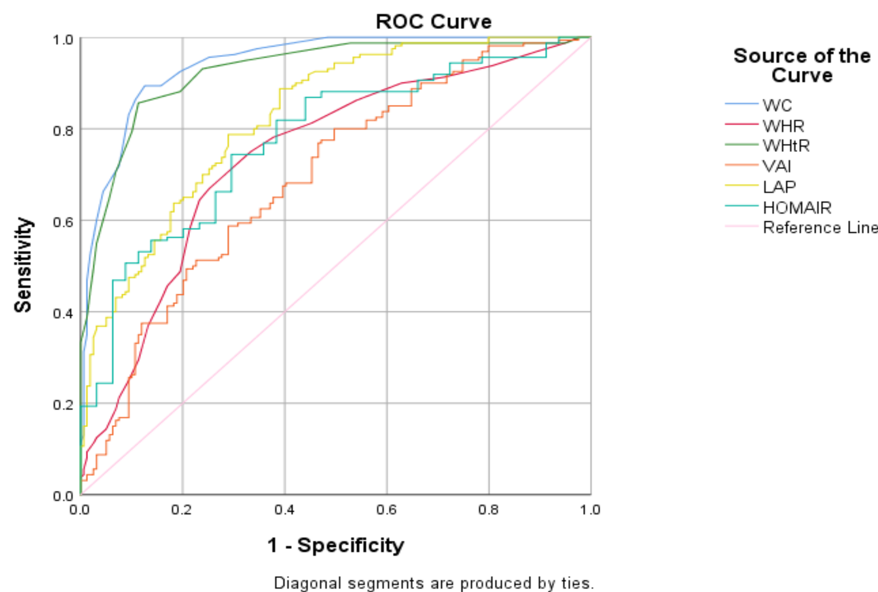
Table XXX

ROC Characteristics of WC, WHR, WHtR, VAI and LAP

Characteristics	WC	WHtR	LAP	IR	WHR	VAI
Area Under Curve (AUC)	0.944	0.926	0.827	0.777	0.741	0.716
Lower Limit	0.920	0.897	0.784	0.726	0.686	0.636
Upper Limit	0.967	0.955	0.871	0.828	0.796	0.751
Cut-off Value	73.5	0.4850	14.02	1.33	0.80	1.70
Sensitivity (%)	92.5	85.6	86.0	74.4	75.0	61.4
1- Specificity (%)	24.4	34.4	60.2	29.4	33.1	58.8
Odds Ratio (95% Confidence Interval)	3.864 (2.974-5.020)	4.737 (3.464-6.477)	2.966 (2.158-4.075)	2.163 (1.693-2.764)	2.587 (1.913-3.498)	1.711 (1.363-2.148)
Youden’s Index	0.169	0.190	0.462	0.038	0.081	0.202

Figure 15

ROC Curve of WC, WHR, WHtR, VAI, LAP and IR



The general distribution of cut-off value with corresponding predictive values and overall comparison of the diagnostic performance of WC, WHR, WHtR, VAI and LAP showed that WC had a greater area under the curve followed by WHtR, LAP, WHR and VAI. The AUC of WC was 0.944, greater than other predictors with a 73.5 cut-off value and high sensitivity of 92.5 and lower than the study, which was 0.97 of AUC (Tutunchi et al., 2020). The possible reason for the high value is that the study was conducted among the general population. The derived cut-off value of WC was lesser than the WHO and IDF criteria (WC=80 CM) which have to be noted (WHO, 2008; IDF, 2006).

The cut-off value of WHtR was found to be 0.485, whereas for WHR, the cut-off value found was to be 0.80 for adult women. From the AUC of WHtR and WHR, it was evident that the WHtR AUC of 0.926 with 85.6 of sensitivity was higher than WHR AUC 0.741 (0.686-0.796 95%CI). It signifies that WHtR has predictive ability than WHR. Among Chinese adults, WHtR was the best predictor among obese individuals (Lam et al., 2015). Non-obese adults with AUC 0.857 and 0.846–0.868 95%CI (Huang et al., 2019) especially was noted. The waist Height Ratio can be an effective index to predict CVD (Pasdar et al., 2020), but as stated, the cut-off value was higher than that of the present study.

The LAP cut-off was 14.02 and an AUC of 0.827. The highest sensitivity (%) of 86.0 and 1-specificity (%) of 54.4 was noted compared to other indicators. A similar AUC for LAP (Vassilatou et al., 2018). Age has a significant influence in deriving the cut-off value of LAP. The LAP was termed a better predictor than BMI and WC, a cut-off of 38.05 among the Indian population (Ray et al., 2018).

The VAI had the least AUC value of 0.716 (0.636-0.751 95%CI), and the cut-off was calculated to be 1.70 for adult women. A similar cut-off was found by (Agrawal et al., 2019). While comparing the AUC of LAP and VAI, LAP had higher AUC depicting higher sensitivity and specificity. It was also observed that LAP has a good predictive ability than VAI. A study carried out found out that LAP had more AUC of LAP (AUC: 0.923, p=0.029) compared to VAI (Salazar et al., 2021; Ching et al., 2020).

The IR had an AUC of 0.777 (0.726-0.828 95% CI) with a derived cut-off value of 1.18. The derived cut-off value intimates that the presence of visceral adiposity can induce insulin resistance (Bhosle et al., 2016). The AUC of IR was found to be 0.790 (0.758–0.822 95% CI) among women, similar to the derived AUC (Ahn et al., 2019).

The odds ratio intimates the percentage of risk towards visceral adiposity. A unit increase in WHtR value is associated with a 4.7 times greater risk of visceral adiposity. A unit increase in LAP value was 2.9 times greater risk of visceral adiposity (AOR= 2.966, 2.158-4.075 95%CI). Among all the variables, LAP showed the highest Youden's index of 0.462, which showed great diagnostic ability. A similar result was seen of LAP showing the highest Youden's index value of 0.571 than other indicators (Guo et al., 2016)

4.2.6.2. Visceral Adiposity among Experimental and Control Group using the Derived VAI and LAP Cut-off Value

4.2.6.2.1. Visceral Adiposity by Derived VAI Cut-off Value

The derived cut-off value of VAI was 1.70, which was used to evaluate the visceral adiposity among adult women. Table XXXI shows the prevalence of visceral adiposity among the experimental and control group.

Table XXXI

Visceral Adiposity using Derived VAI Cut-off Value

Variables	Experimental (N=160)		Control (N=160)	
VAI Cut-off Value	**<1.70**	**>1.70**	**<1.70**	**>1.70**
Number (N=160)	64	96	106	54
Percent	40	59	66.3	33.7
Mean±SD	1.29±0.28	2.91±1.26	1.12±0.35	2.58±0.91
P value	**0.0012***	0.0929 [NS]	**0.0012***	0.0929 [NS]

*** Significant at 1% level, [NS] Not Significant**

The prevalence of visceral adiposity among the experimental and control groups was 59 per cent and 33.7 per cent, respectively. The mean of greater visceral adiposity cut-off value (>1.70) among the experimental group was higher (2.91±1.26) than among the control group (2.58±0.91), which was not statistically significant ($p<0.05$).

The VAI value for normal body weight women (control group) was higher than the derived cut-off value. The experimental group having visceral adiposity was relatable, but nearly 34% of adult women had visceral adiposity among the control group. It indicates the presence of invisible fat within the normal BMI adult, indicating metabolically unhealthy. It provides a health indication among the general population using visceral adiposity indices.

4.2.6.2.2. Visceral Adiposity by Derived LAP Cut-off Value

The LAP cut-off value was derived as 14.02 for adult women. Table XXXII shows the visceral adiposity among the experimental and control group.

Table XXXII

Visceral Adiposity using Derived LAP Cut-off Value

Variables	Experimental (N=160)		Control (N=160)	
LAP Cut-off Value	**<14.02**	**>14.02**	**<14.02**	**>14.02**
Number (N=160)	32	128	105	55
Percent	20	80	65.6	34.4
Mean±SD	11.21±2.48	31.69±16.59	7.31±3.49	21.72±7.12
P value	**0.0001***	**0.0001***	**0.0001***	**0.0001***

*** Significant at 1% level**

Using the derived LAP cut-off value, the prevalence of visceral adiposity among the experimental was 80 per cent, and among control was found to be 34.4 per cent. The mean of greater LAP cut-off value (>14.02) among the experimental group was 31.69±16.59, which was higher than the control mean of 21.72±7.12 and was found statistically significant (p = 0.0001).

From the prevalence of visceral adiposity using LAP cut-off value, it was evident that 20 per cent of the experimental group were metabolically healthy obese (MHO), and 80 per cent were metabolically unhealthy obese (MUO). On the other hand, among the control group, 65.6 per cent were metabolically healthy non-obese (MHNO), and 34.4% were metabolically unhealthy non-obese (MUNO). A significant 1% difference was seen between the metabolically healthy and unhealthy obese (experimental) and metabolically healthy and unhealthy non-obese (control).

These findings point out the need to evaluate the predictive ability of indicators among the normal-weight adult women who will be metabolically obese. Interestingly, 20% of experimental (obese) adult women were metabolically healthy.

Even though the prevalence of obesity among adults is considerably lesser than the normal adults (a considerable prevalence of underweight also observed

proving double burden of malnutrition), India is the capital of diabetes and many other metabolic disorders. The important reasons were the genetic build-up and the predisposition of the high amount of fat within the body.

The real task will be observing visceral adiposity by differentiating the subcutaneous and visceral fat responsible for metabolic dysfunction. So accurate means to measure the visceral adiposity, which is economical, will be useful for sustainable use.

India is a land full of diversity and varying ethnicities. The derived cut-off value for a given population might not suit other countries. India has a broad genetic pool from the population of north and south, and an estimate to derive the cut-off values to represent will be sustainably beneficial and clinical potential.

4.3. PHASE III

DIETARY PATTERN, PHYSICAL ACTIVITY AND THE CORRESPONDING ANTHROPOGENS

4.3.1. Details on Dietary Pattern

4.3.1.1. Dietary Habits

Table XXXIII and Figure 16 shows the dietary habits among experimental and control adult women.

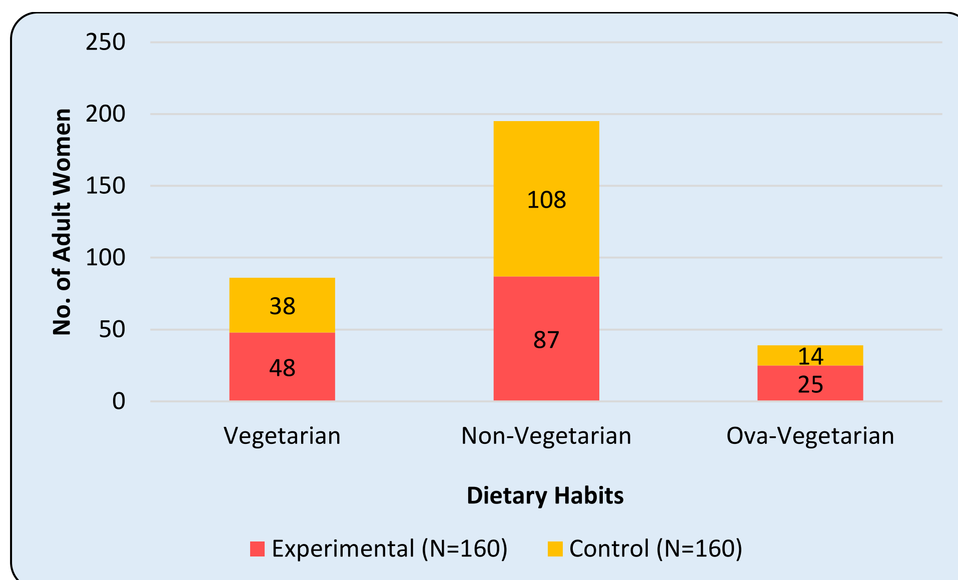
Table XXXIII

Dietary Habits

Dietary Habits	Experimental		Control	
	N=160	Per cent	N=160	Per cent
Vegetarian	48	30.0	38	23.8
Non-Vegetarian	87	54.4	108	67.5
Ova-Vegetarian	25	15.6	14	8.75

Figure 16

Dietary Habits



The dietary habits showed that among the control, 67.5 per cent were non-vegetarians which was higher than the experimental of 54.38 per cent. Surprisingly, in the experimental group, non-vegetarians were low compared to the control group, but ova-vegetarians were high (15.62 per cent).

The vegetarians among the selected experimental and control group were 30 per cent and 23.75 per cent, respectively. Non-vegetarians (34.1 per cent) had an unhealthy body fat percentage range than vegetarians (Gan et al., 2018).

4.3.1.2. Frequency of Meal Pattern

The meal pattern frequency among experimental and control adult women is elicited in Table XXXIV and Figure 17.

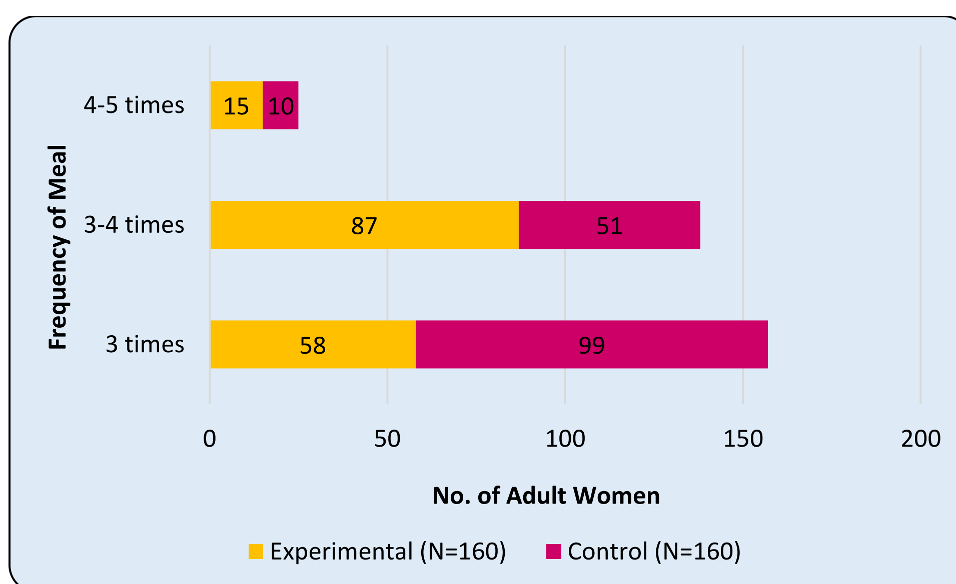
Table XXXIV

Frequency of Meal Consumption

Frequency of Meal Consumption	Experimental		Control	
	N=160	Per cent	N=160	Per cent
3 times	58	36.2	99	61.9
3-4 times	87	54.4	51	31.9
4-5 times	15	9.4	10	6.2

Figure 17

Frequency of Meal Consumption



Three times/ day meal consumption was seen among the 61.9 per cent control group, which was higher than the 36.2 per cent experimental group. Table XXIV showed that 54.4 per cent of the experimental group, whereas only 31.9 per

cent of the control group consumed 3-4 times/ day. The frequency of 4-5 meals was higher among the experimental whereas the frequency of 3 times meal/week among the control group.

Aparicio et al (2017) suggested that the frequency and timing of meal consumption should be considered to reduce obesity and to derive dietary strategies. A cross-sectional study concluded that higher meal frequency was positively associated with increased obesity and central obesity (Murakami & Livingstone, 2015).

Only five experimental and 17 control adult women reported skipping breakfast. Alexander et al (2009) concluded that skipping breakfast was associated with increased intra-abdominal adipose tissue and the visceral adiposity was lowered among youths consuming breakfast.

4.3.1.3. Nutrient Intake

The mean nutrient intake of energy, protein, fat, carbohydrate and dietary fibre is elicited in Table XXXV.

Table XXXV

Mean Nutrient Intake

Nutrients	RDA 2020	Experimental (N=160)		Control (N=160)	
		Intake	excess/ deficit	Intake	excess/ deficit
Energy (kcal)	1660	1835.51±410.15	+175.51	1363.74±157.61	-296.26
Protein (g)	45.7	35.77±6.42	-9.93	33.93±6.80	-11.77
Fat (g)	20	34.41±6.03	+14.41	32.77±4.12	+12.77
Carbohydrate (g)	130	214.22±39.69	+84.22	203.69±35.25	+73.69
Dietary Fibre (g)	29.7	9.15±11.03	-20.55	14.24±12.95	-15.46

The results revealed that the mean energy intake of the experimental was 1835.51±410.15, which was higher than the control of 1363.74±157.61. The result also signified that the per cent of energy was excess among the experimental group of +175.51 and was a deficit of 296.26 among the control group, and the

higher energy intake could be a reason for higher body weight among the experimental group. The concept of improving macronutrients and preparing food has a favorable effect among individuals with obesity and visceral fat (Freedland, 2004).

The mean nutrient intake of both the experimental and control groups showed an excess for fat (+14.41 and +12.77 respectively) and carbohydrate (+84.22 and +73.69 respectively) consumption compared with RDA. The mean fat and carbohydrate intake among the experimental and control group was 34.41±6.03 and 32.77±4.12; 214.22±39.69 and 203.69±35.25, respectively.

On the other hand, protein and dietary fibre were less than RDA. It was evident from the table that the mean protein intake was high among the experimental (35.77±6.42) than control (33.93±6.80). The consumption of protein on behalf of carbohydrates was associated with obesity (Merchant et al., 2005).

The mean dietary fibre intake was only in the range of 9-14 grams, less than 50% among both groups. This finding shows the need to educate women to include foods rich in dietary fibre daily. The lower the dietary fibre intake may lead to additional risk (Mannisto et al., 2013).

Considering all the nutrient intake, the findings reveal that a high calorie, fat and carbohydrate as well as low protein and dietary fibre intake was observed among the experimental group whereas a high fat, carbohydrate (lower compared to the experimental group) and low energy, protein (lower than experimental) and dietary fibre (better than experimental) was observed among the control group. The result also signifies the high fat and carbohydrate intake and lower protein and dietary fibre was seen among experimental and control groups.

4.3.1.4. Correlation Analysis

4.3.1.4.1. Correlation of VAI with Nutrient Intake

The correlation between the intake of energy, protein, fat, carbohydrate, and fibre with 'VAI' is discussed below.

Table XXXVI

Correlation of VAI with Dietary Intake

Control Variable			Energy	Protein	Fat	Carbohydrate	Dietary Fiber
VAI	Energy	r	1.000	0.204	0.246	-0.023	0.042
		p	-	**0.000***	**0.000***	0.685	0.456
	Protein	r	0.204	1.000	0.604	-0.010	0.101
		p	**0.000***	-	**0.000***	0.862	0.071
	Fat	r	0.246	0.604	1.000	0.056	-0.051
		p	**0.000***	**0.000***	-	0.321	0.361
	Carbohydrate	r	-0.023	-0.010	0.056	1.000	-0.119
		p	0.685	0.862	0.321	-	**0.034****
	Dietary Fiber	r	0.042	0.101	-0.051	-0.119	1.000
		p	0.456	0.071	0.361	**0.034****	-

* Significant at 1% level, ** Significant at 5% level

Since alterations influence visceral adipose tissue in diet (Veum et al., 2017), visceral adiposity index as a control variable was compared with the dietary intake. A positive correlation was seen between energy and protein (r= 0.204, p= 0.000) and fat (r= 0.246, p= 0.000). Carbohydrate intake had a negative partial correlation between carbohydrate and dietary fibre (r= -0.119, p=0.034) with 5% significance. However, Pearson's product-moment correlation (zero-order) showed that a statistically significant correlation was seen without controlling for VAI.

It signifies that 'VAI' had a minimal influence in controlling relationships with energy, protein, fat, carbohydrate and dietary fibre. Obesity and visceral fat were positively associated with high carbohydrate and sugar, high fat with saturated fatty acids, and negatively associated with vitamins, minerals, and fibre diet (Mazidi et al., 2018).

4.3.1.4.2. Correlation of LAP with Nutrient Intake

Table XXXVII elicits the correlation between energy intake, protein, fat, carbohydrate and fibre, controlling for 'LAP'.

Table XXXVII

Correlation of LAP with Dietary Intake

Control Variables			Energy	Protein	Fat	Carbohydrate	Dietary Fiber
LAP	Energy	r	1.000	0.153	0.201	-0.039	0.073
		p	-	**0.006****	**0.000***	0.492	0.191
	Protein	r	0.153	1.000	0.593	-0.026	0.115
		p	**0.006****	-	**0.000***	0.649	**0.040****
	Fat	r	0.201	0.593	1.000	0.044	-0.039
		p	**0.000***	**0.000***	-	0.435	0.490
	Carbohydrate	r	-0.039	-0.026	0.044	1.000	-0.113
		p	0.492	0.649	0.435	-	**0.044****
	Dietary Fiber	r	0.073	0.115	-0.039	-0.113	1.000
		p	0.191	**0.040****	0.490	**0.044****	-

* Significant at 1% level, ** Significant at 5% level

The partial correlation showed that there was positive correlation seen between energy with protein (r= 0.153, p= 0.006) and fat (r= 0.201, p= 0.000) with 5% and 1% level of significance by controlling for 'LAP'. The result also showed that protein was positively correlated with highest r value of 0.593 (p= 0.000, 1% significance difference) and additionally associated with dietary fibre (r= 0.115, p= 0.040; 5% significance. Adding to the results, carbohydrate was found to be negatively correlated with dietary fibre (r= -0.113, p=0.044) with 5% significance with 'LAP' being control variable.

Although the Pearson's product-moment correlation (zero-order correlation) showed statistically significant correlation with and without control variable of

'LAP', additionally protein showed a positive relationship with dietary fibre with 'LAP' as control variable signifying LAP showed a considerable influence controlling relationships with energy, protein, fat, carbohydrate and dietary fibre among experimental and control groups. Prolonged intake of healthy dietary patterns was associated with decreased visceral fat and LAP value (Shahavandi et al., 2020).

4.3.2. Details on Physical Activity Pattern

4.3.2.1. Frequency of Physical Activity

The frequency of physical activity was recorded and elicited in Table XXXVIII among experimental and control adult women.

Table XXXVIII

Frequency of Physical Activity

Frequency of Physical Activity	Experimental (N=160)		Control (N=160)	
	N (49)	Per cent	N (61)	Per cent
3 times/ Week	5	10.2	11	18
Weekly once	11	22.5	27	44.3
Occasionally	33	67.3	23	37.7

The physical activity performance was seen among 30.6 per cent (49) of the experimental group and 38.1 per cent (61) control group. The frequency of physical activity is an important criterion to be evaluated while considering the performance for a particular period (Kim & Jee, 2017). The result showed that none of the experimental and control adult women performed physical activity daily. Experimental of 22.5 per cent and 44.3 per cent control group performed physical activity only once a week.

On the other hand, 67.3 per cent experimental and 37.7 per cent control reported physical activity occasionally. Obese adults were predominantly physically inactive compared to healthy adults (Linder et al., 2021).

4.3.2.2. Type of Physical Activity and Duration

The type of physical activity and duration among selected experimental and control adult women is shown in Table XXXIX.

Table XXXIX

Type of Physical Activity and Duration

Variables	Experimental (N=160)		Control (N=160)	
	N (49)	Per cent	N (61)	Per cent
Type of Physical Activity				
Walking	27	55.1	39	63.9
Treadmill	-	-	5	8.2
Yoga	9	18.4	3	4.9
Aerobics	13	26.5	14	23
Duration of Activity				
<30 mins	40	81.6	57	93.4
30-45 mins	9	18.4	4	6.6

The conduct of subjective measurement, like a type of physical activity, provides additional insights on the information of physical activity (Suryadinata et al., 2020). The results revealed that walking was the predominant physical activity performed among 55.1 per cent experimental and 63.9 per cent control group. It was also found that yoga and aerobics were performed among 18.4 per cent and 26.5 per cent, respectively among the experimental group, which was higher than the control group. Potential changes observed in the body's weight were associated with the type and impact of physical activity performed daily, and quantifying the type of activity among a large population is beneficial (Byambasukh et al., 2021).

The results of the duration of physical activity showed that 81.6 per cent experimental was lower than 93.4 per cent control group exercise less than 30 mins whereas 18.4 per cent experimental, which was also significantly lower than the 6.6 per cent control group exercise between 30-45 mins. A study showed that there was a significant difference seen among obese (experimental) and non-obese (control) individuals (Ramya et al., 2017). Another study concluded that longer durations of physical activity which exceeds 35 minutes with lower

intensities have the same effect as high intensities performed at short durations (Ito, 2019).

4.3.2.3 Physical Activity Levels

The physical activity was assessed and evaluated by IPAQ, expressed in MET-min/week and the results are discussed below in Table XL.

Table XL

Physical Activity Level

Variables	Experimental (N=160)	Control (N=160)	P value
IPAQ (MET-min/week)	475.55±457.60	564.26±629.05	0.002*

*** Significant at 1% level**

The IPAQ levels among control were higher, about 564.26 MET-min/week compared to experimental adult women of 475.55 MET-min/week. The values were calculated considering the walking (MET-min/week), which added to be a major part of the activity. It was noted that there was a statistical significance of 1% level seen among experimental and control women (p= 0.002). Overall, the MET-min/week levels were lower and indicated a sedentary lifestyle among the population. A study found that physical activity was lower among obese compared to non-obese. Among obese, the median of physical activity was calculated as 420 (940) (MET-min/week) (Warner et al., 2012).

4.3.2.4. Physical Activity Status

The physical activity status was evaluated by the levels expressed in MET-min/week, and the results are elicited below.

Table XLI

Status of Physical Activity

Physical Activity Status	Experimental (N=160)		Control (N=160)	
	Number	Percent	Number	Percent
Inactive/ Low	119	74.4	106	66.3
Moderate	41	25.6	54	33.8

The physical activity and obesity relationship are intricate. The physical activity status revealed that 74.4 per cent (119) experimental were involved in low/ inactive physical activity whereas 25.6 per cent (41) experimental involved in moderate physical activity. Among control, 66.3 per cent (106) were inactive/ low and 33.8 per cent (95) were under moderate physical activity. The result also revealed that the status of physical activity considering the inactive/ low experimental group of adult women was seen high compared to control, and to consider the moderate physical activity status control was seen higher. Another finding was that vigorous physical activity was not practiced among experimental and control adult women.

Lower physical activity is generally connected with an increase in the body's weight over time. Conversely, an increase in body weight may result in physical inactivity (Tehard et al., 2005). A study reported that women had a high prevalence of low physical activity of 42.2% than men, and the low level of physical activity was associated with obesity. Further, the association was significantly stronger with visceral fat (Costa et al., 2015).

4.3.2.5. Correlation Analysis of VAI and LAP with Physical Activity

Table XLII illustrates the relationship between VAI and LAP with Physical Activity status and IPAQ.

Table XLII

Correlation of VAI and LAP with Physical Activity

Control Variable			IPAQ	Status
VAI	IPAQ	r	1	.566
		p	-	**< 0.001***
	Status	r	.566	1
		p	**< 0.001***	-
LAP	IPAQ	r	1.000	0.567
		p	-	**< 0.001***
	Status	r	0.567	1.000
		p	**< 0.001***	-

* Significant at 1% level, IPAQ is expressed in **(MET-min/week)**

The partial correlation analysis between VAI and physical activity resulted in a significant positive correlation between IPAQ and physical activity status (r= 0.566, p= <0.001) by controlling for 'VAI'. On the other hand, 'LAP' as the control variable showed a significant positive relation between IPAQ and physical activity status (r= 0.567, p= <0.001). It signifies that controlling for 'VAI' and 'LAP' had a minimal influence on relationships with physical activity status and IPAQ. A cross-sectional study showed that obesity specifically increased waist circumference individuals and lower physical activity was associated with insulin resistance. A sedentary lifestyle results in lipid alterations, insulin resistance and increased inflammatory states (Rodríguez et al., 2014).

4.3.5. Anthropogens and Risk Assessment for Metabolic Dysfunction

The anthropogens were assessed among experimental and group and their corresponding high and low risk was analyzed in Table XLIII.

Table XLIII

Anthropogens among Experimental and Control Group

Anthropogens	Experimental (N=160)				Control (N=160)			
	Low Risk		**High Risk**		**Low Risk**		**High Risk**	
	N	Per cent	N	Per cent	N	Per cent	N	Per cent
Diet	64	40	96	60	157	98.1	3	1.9
Physical Activity	41	25.6	119	74.4	54	33.8	106	66.2
Sleep Pattern	37	23.1	123	76.9	28	17.5	132	82.5
Sun exposure	19	11.9	141	88.1	22	13.7	138	86.3

The term "anthropogens" are man-made environment by-products or lifestyles encouraged which may be detrimental to human health. The proximal downstream determinants like diet, inactivity, smoking, alcohol/ drugs, sleep pattern and sun exposure were addressed among the experimental and control group. The diet factor among the experimental group showed that 60 per cent were at the high risk, which was much higher than the control high risk (1.9%). On the other hand, 40 per cent experimental and 98 per cent control were at low risk.

The physical activity risk factor revealed that the 33.8 per cent control group, which was higher than the 25.6 per cent experimental group, was at low risk. The high risk was predominant among the experimental group of 74.4 per cent than control of 66.2 per cent. The integral finding was that smoking and alcohol were not found among the experimental and control and it was mainly because of the women-centric population.

The sleep pattern resulted in 23.1 per cent being at low risk and 76.9 per cent being at high risk among experimental whereas IN the control group, 17.5 per cent were at low risk and 82.5 per cent were at high risk. The sun exposure revealed that only adult women were exposed to the sun while traveling. The results showed that among the experimental 11.9 per cent and control 13.7 percent were at low risk, and 88.1 per cent and 86.3 per cent were at high risk among experimental and control groups, respectively.

Overall, the integral result of the anthropogens assessment revealed that the experimental group was at higher risk than the control group, which could be one of the contributing factors for the onset of metabolic dysfunction and lifestyle diseases.

4.4. PHASE IV

IMPACT OF INTERVENTION ON VISCERAL ADIPOSITY INDICES AMONG SELECTED EXPERIMENTAL GROUP

4.4.1. Evaluation of Pre and Post Intervention on Visceral Adiposity Indices

4.4.1.1. Details on Pre and Post Diet Intervention (N=37)

Considering the evaluation of diet intervention was necessary to understand the changes in the anthropometry, lipid profile and visceral adiposity indices of the experimental pre- and post-intervention period. Initially, 40 experimental group women were recruited, but only 37 completed the study period successfully. Table (XLIV) shows the T-test result for data computed regarding pre and post-evaluation of diet intervention among the selected experimental group.

Table - XLIV

Pre and post evaluation in Diet Intervention

Variables Control	Pre-Intervention (N=37)	Post-Intervention (N=37)	T- Value	P-Value
Weight	68.43±8.00	65.43±8.23	16.757	**<0.0001***
BMI	27.67±2.28	26.59±2.34	10.476	**<0.0001***
WC	82.74±6.54	80.81±6.76	9.500	**<0.0001***
HC	103.52±7.80	101.31±7.48	5.453	**<0.0001***
WHR	1.05±1.39	0.80±0.05	.915	.368^{NS}
TC	170.51±27.78	165.11±28.08	10.200	**<0.0001***
TG	107.20±45.13	104.19±44.14	7.099	**<0.0001***
HDL	43.76±10.26	46.07±10.63	-7.849	**<0.0001***
LDL	114.70±23.87	110.85±23.79	5.201	**<0.0001***
VAI	2.04±1.12	1.86±0.97	3.455	**<0.0001***
LAP	30.18±14.73	27.11±13.83	7.854	**<0.0001***

***Significant at 1% level, ^{NS} Not Significant**

The t-test performed among the experimental group showed that the variables such as weight, BMI, WC, HC, TC, TG, HD, LDL and LAP had a statistical significance between the pre and post-intervention among the experimental group with the diet intervention induced as those variables were significant at 1% level of significance. The VAI and LAP were reduced post-intervention significantly but not below the derived cut-off value. The result signified no association between WHR and diet intervention among the experimental group of pre and post and was insignificant. It indicates the association between the experimental groups' visceral adiposity indices of pre and post-diet intervention. The mean VAI post-intervention was 1.86±0.97 from 2.04±1.12, whereas the mean LAP post-intervention was 19.11±13.83 from 22.18±14.73. The mean weight reduction was calculated to be 3.15±0.93 (kg).

Differences in dietary patterns, as well as physiological and behavioral (for example, reduced physical activity), changes associated with aging, higher levels of body fat and the ability to store more fat fluctuations in sex hormone concentrations dysmorphia, are all possible causes of sex differences (Manini, 2010).

4.4.1.2. Details on Pre and Post Physical Activity Intervention (N=37)

The same result can be seen in the table (XLV). The physical activity intervention group had dropouts, and finally, 37 completed the study.

The pre and post physical activity intervention results revealed that the variables such as weight, BMI, WC, TC, TG, HDL, LDL, VAI and LAP were strongly significant among the experimental group, as these variables were statistically significant at 1% level of the significance level. The hip circumference was significant at a 5% level of significance. But WHR was not significant, indicating no association among the experimental group and physical activity both pre and post-intervention. The mean VAI post-intervention was 1.96±1.01 from 2.51±1.22, whereas the mean LAP post-intervention was 21.00±15.87 from 34.89±16.94. The mean weight reduction in the post-intervention of physical activity was found to be 4.13±0.98.

Table XLV

Pre and post evaluation in Physical Activity Intervention

Variables Control	Pre-Intervention (N=37)	Post-Intervention (N=37)	T- Value	P-Value
Weight	66.47±9.55	62.33±9.70	21.895	**<0.0001***
BMI	27.37±2.92	25.78±3.07	13.421	**<0.0001***
WC	85.81±7.59	82.89±7.50	11.983	**<0.0001***
HC	98.89±9.81	96.87±8.13	2.606	**.015****
WHR	0.88±0.12	0.86±0.09	1.075	.292 NS
TC	173.14±29.46	162.52±27.41	9.085	**<0.0001***
TG	114.38±48.88	109.56±48.49	10.522	**<0.0001***
HDL	41.32±7.77	45.44±7.92	-8.976	**<0.0001***
LDL	113.11±21.71	108.22±22.20	3.928	**.001***
VAI	2.31±1.22	1.80±1.01	6.662	**<0.0001***
LAP	34.89±16.94	21.00±15.87	12.199	**<0.0001***

***Significant at 1% level, ** Significant at 5% level, NS Not Significant**

Donnelly et al (2013) demonstrated weight reduction in a group of overweight and obese men and women with exercise alone in the Midwest Exercise Trial 2. The activity was supervised for ten months for five days per week and a completion rate of 65%. In the completion group, weight reductions were 3.9 ± 4.9 and 5.2 ± 5.6 kg, respectively. The amount of activity to achieve the weight reduction was again greater than the general exercise recommendations for health. Weight reduction (7% over 16.8 weeks) was not alone effective with exercise, but also the preservation of lean body mass and improvement of maximal oxygen consumption (VO_{2max}) when compared to weight reduction with a comparable energy deficit through calorie restriction alone; the latter resulted in both a reduction of lean body mass and a decrease in VO_{2max}. In addition, as with

other studies that have demonstrated weight reduction with exercise, the amount of activity was substantial at 7.4 ± 0.5 hours/week (Weiss et al., 2017).

4.4.1.3. Details on Pre and Post Diet and Physical Activity Intervention (N=36)

A comparative analysis on the effect of diet and physical activity intervention on anthropometry, lipid profile and visceral adiposity indices of the experimental group to understand the effectiveness. To examine the effect of diet and physical activity on pre and post was evaluated in Table (XLVI).

Table XLVI

Pre and Post evaluation in Diet and Physical Activity Intervention

Variables Control	Pre- Intervention (N=36)	Post-Intervention (N=36)	T- Value	P-Value
Weight	69.58±9.30	64.58±9.02	21.862	**<0.0001***
BMI	28.46±3.48	26.41±3.39	22.642	**<0.0001***
WC	88.40±7.90	85.12±7.74	18.258	**<0.0001***
HC	100.87±11.84	97.79±11.71	20.025	**<0.0001***
WHR	0.89±0.11	0.88±0.12	2.170	**.040****
TC	170.45±29.92	162.15±27.41	8.192	**<0.0001***
TG	105.02±24.17	98.88±22.02	5.327	**<0.0001***
HDL	42.86±6.66	51.08±6.82	-10.638	**<0.0001***
LDL	117.57±30.94	98.37±29.12	6.550	**<0.0001***
VAI	2.02±0.59	1.70±0.49	9.860	**<0.0001***
LAP	36.13±12.32	16.49±11.49	12.032	**<0.0001***

*** Significant at 1% level, ** Significant at 5% level**

The pre and post-diet and physical activity intervention results revealed that the variables such as Weight, BMI, WC, TC, TG, HDL, LDL, VAI and LAP showed a statistical significance on visceral adiposity (by visceral adiposity indices) which showed a 1% level of significance. In contrast, hip circumference showed the association for the same at a 5% level of significance. The mean weight reduced among the experimental group was calculated to be 5.08±1.17. Additionally, the VAI and LAP post-intervention reduced to 1.70±0.49 and 16.49±11.49, similar to the derived cut-off value. Hence diet along with appropriate physical activity aids in reducing the visceral adiposity more effectively in the specified study period.

The focus was on increasing physical activity as means of chronic disease prevention and focused on the diet component of the energy balance equation. In a study where 68% study group reported of been received information on healthy eating through the education program. Additionally, 55% of patients in the subsample analyzed in the study reported that changing diet and physical activity was beneficial (Eliot & Hamlin 2018). From a physiological perspective, the energy balance of increasing physical activity and changing diet were major preventive therapies, particularly for weight reduction (Jhons et al., 2014; Prochaska, 2011) and metabolic syndrome and cardiovascular disease.

4.4.1.4. Details on Pre and Post Intervention among Control (N=37)

The control group was evaluated separately to compare with the three experimental groups individually, and the pre and post result in selected control respondents. The result is discussed below.

Table XLVII

Pre and Post evaluation in Control Group

Variables Control	Pre-Intervention (N=37)	Post-Intervention (N=37)	T- Value	P-Value
Weight	64.62±7.08	65.70±7.75	-2.178	**0.039****
BMI	27.57±2.83	28.04±3.19	-2.211	**0.036****
WC	87.63±5.94	88.44±5.71	-2.158	**0.040****
HC	96.33±6.28	96.41±5.97	-.146	0.885^{NS}
WHR	0.91±0.05	0.92±0.05	-2.034	0.052^{NS}
TC	173.63±30.93	171.44±28.38	1.099	0.282^{NS}
TG	108.15±35.98	109.41±34.87	-1.018	0.318^{NS}
HDL	38.96±8.00	37.96±7.18	2.135	**0.042****
LDL	111.37±36.85	113.96±28.60	-.825	$.417^{NS}$
VAI	2.46±1.57	2.55±1.58	-2.293	**0.030****
LAP	35.75±12.84	37.01±12.06	-1.739	0.094^{NS}

****Significant at 5% level, ^{NS} Not Significant**

The control group results of pre and post-evaluation showed that weight, BMI, WC, HDL, and VAI were statistically significant at a 5% level of significance, indicating a difference between pre and post-evaluation. The results also revealed slight changes observed pre and post in which post-evaluation variables increased. It was noted that there was no statistical significance seen between HC, WHR, TC, TG, LDL and LAP, indicating no considerable changes observed between pre & post-evaluation. The main reason was the control group was not given any intervention. Still, on the other hand, there were minimal changes observed stipulating the changes in eating behavior during the study period. The impact on health and well-being had accumulated over time during Covid-19 (Curtis et al., 2021).

4.4.2. Comparison between and within the Experimental and Control Groups of Pre-Intervention among Selected Obese Women (ANOVA)

All the experimental and control groups were compared to determine the difference between and within the groups pre-intervention using ANOVA. The results are tabulated and discussed in Table (XLVIII).

Table XLVIII

ANOVA of Experimental and Control Groups of Pre-Intervention

Variables Control	Control (N=37)	Diet Intervention (E1) (N=37)	Physical Activity Intervention (E2) (N=37)	Diet & Physical Activity Intervention (E3) (N=36)	P-Value
Weight	64.62±7.08	68.43±8.00	66.47±9.55	69.58±9.30	.162^{NS}
BMI	27.57±2.83	27.67±2.28	27.37±2.92	28.46±3.48	.549^{NS}
WC	87.63±5.94	82.74±6.54	85.81±7.59	88.40±7.90	**.020****
HC	96.33±6.28	103.52±7.80	98.89±9.81	100.87±11.84	**.035****
WHR	0.91±0.05	1.05±1.39	0.88±0.12	0.89±0.11	.800^{NS}
TC	173.63±30.93	170.51±27.78	173.14±29.46	170.45±29.92	.967^{NS}
TG	108.15±35.98	107.20±45.13	114.38±48.88	105.02±24.17	.846^{NS}
HDL	38.96±8.00	43.76±10.26	41.32±7.77	42.86±6.66	.167^{NS}
LDL	111.37±36.85	114.70±23.87	113.11±21.71	117.57±30.94	.883^{NS}
VAI	2.46±1.57	2.04±1.12	2.31±1.22	2.02±0.59	.450^{NS}
LAP	35.75±12.84	30.18±14.73	34.89±16.94	36.13±12.32	.400^{NS}

****Significant at 5% level, ^{NS} Not Significant**

The ANOVA result signified that waist and hip circumference were significant at a 5% level of significance, indicating that these variables' values differed between and within the groups. In contrast, the other variables were not

statistically significant between and within groups, stating no difference between the groups pre-intervention. It signifies that there was no significant difference among the selected experimental group before the study period.

4.4.3. Comparison between and within the Experimental and Control Groups of Post Intervention among Selected Obese Women (ANOVA)

It is necessary to observe the changes post-intervention to determine the significant difference between and within the experimental and control group post-intervention. The result is elicited in the table (XLIX).

Table XLIX

ANOVA of Experimental and Control Groups of Post Intervention

Variables Control	Control (N=37)	Diet Intervention (E1) (N=37)	Physical Activity Intervention (E2) (N=37)	Diet & Physical Activity Intervention (E3) (N=36)	P-Value
Weight	65.70±7.75	65.43±8.23	62.33±9.70	64.58±9.02	.479[NS]
BMI	28.04±3.19	26.59±2.34	25.78±3.07	26.41±3.39	**.049****
WC	88.44±5.71	80.81±6.76	82.89±7.50	85.12±7.74	**.001***
HC	96.41±5.97	101.31±7.48	96.87±8.13	97.79±11.71	.148[NS]
WHR	0.92±0.05	0.80±0.05	0.86±0.09	0.88±0.12	**<.001***
TC	171.44±28.38	165.11±28.08	162.52±27.41	162.15±27.41	.591[NS]
TG	109.41±34.87	104.19±44.14	109.56±48.49	98.88±22.02	.718[NS]
HDL	37.96±7.18	46.07±10.63	45.44±7.92	48.08±6.82	**<.001***
LDL	113.96±28.60	110.85±23.79	108.22±22.20	98.37±29.12	**.043****
VAI	2.55±1.58	1.86±0.97	1.80±1.01	1.70±0.49	**.031****
LAP	37.01±12.06	27.11±13.83	21.00±15.87	16.49±11.49	**.045****

*** Significant at 1% level, **Significant at 5% level, [NS] Not Significant**

The results showed that considering the variables, there was statistically significant seen between waist circumference, waist-hip ratio and HDL at 1% significance and body mass index, LDL, VAI and LAP showed a 5% significance difference between and within the groups. Hence H_0 was rejected, and H_1 was accepted.

It signifies a significant increase in HDL, and a decrease in LDL levels will aid in visceral adiposity reduction. The weight, hip circumference, total cholesterol and triglycerides showed no significance between and within the groups.

The table illustrates that the visceral adiposity indices like visceral adiposity index and lipid accumulation product reduced significantly within and between the groups. Additionally, the diet and physical activity intervention experimental group saw high mean weight reduction.