3

Methodology

The methodology of the study entitled, "**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:

3.1. PHASE I: Selection of Area and Target Group

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3.3.3. Assessment of Anthropogens

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3.5. PHASE V: Statistical Analysis

The study was approved by the Institutional Human Ethics Committee Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore **AUW/IHEC-18-19/FSMD/FHP-01 (Appendix I)**.

3.1. PHASE I: SELECTION OF AREA AND TARGET GROUP

3.1.1. Locale of the Study

The area chosen for the study was Coimbatore. Coimbatore has a female population of 1,241,117 literate (Census, 2011). According to the National Family Health Survey 2015-16 (NFHS-4), women who were overweight or obese were 34.4% in Coimbatore, which points out the need for the promotion of health interventions among women.

The target group of adult women was selected from Avinashilingam Institute for Home Science and Higher Education for Women, a women university and Karuna Women’s Clinic, Coimbatore, a specialty women’s center catering to the health needs of women. These two institutions were selected by purposive sampling to identify the target group. According to Kothari (2019), purposive sampling is defined as deliberately selecting participants for the study by the researcher whose choice concerning the selection remains supreme. Due permissions were obtained from the authorities for the conduct of the study in both the selected locations.

3.1.2. Recruitment of the target group

The target age group was 18 - 30 years of women. Early adulthood span aged 18 to 30 years is a critical period of development, with long-lasting implications for a person's health and well-being (Bonnie et al., 2015) and adiposity causes significant health problems. Adiposity leads to consequences for reproductive health, as stated by (EBCOG Scientific Committee, 2014). Hence, the target age group selected for the study was 18-30 years of age.

The participants' informed consent was obtained **(Appendix II)** and recruited purposively based on the inclusion and exclusion criteria below.

Inclusion Criteria

- Willingness to participate
- Age between 18 - 30 years
- Students, working and non-working women
- Married and unmarried women
- No known history of chronic diseases

Exclusion Criteria

- Age <18 years and >30 years
- Pregnant and Lactating women
- Morbid Obese women
- Differently-abled women
- Women with known diabetes and hypertension
- Women with any other complications or undergoing infertility treatment.

3.1.3. Estimation of Sample Size

The sample size was calculated keeping the overall prevalence of abdominal obesity given by the Indian Council of Medical Research – India Diabetes (ICMR-INDIAB, 2015) study. It was a National cross-sectional study on the prevalence of diabetes and related disorders such as obesity and hypertension, funded by the ICMR and the Department of Health Research (DHR), Government of India. The prevalence of abdominal obesity (AO) was 32.3% among women in Tamil Nadu (Pradeepa et al., 2015). Using the formula

given below, the effect size was determined to estimate the sample size as the denominator **(Appendix III)**.

Effect size (ES)

$$ES = \frac{p1-p0}{\sqrt{p0(1-p0)}} = \frac{0.05}{\sqrt{0.323(1-.323)}} = 0.11$$

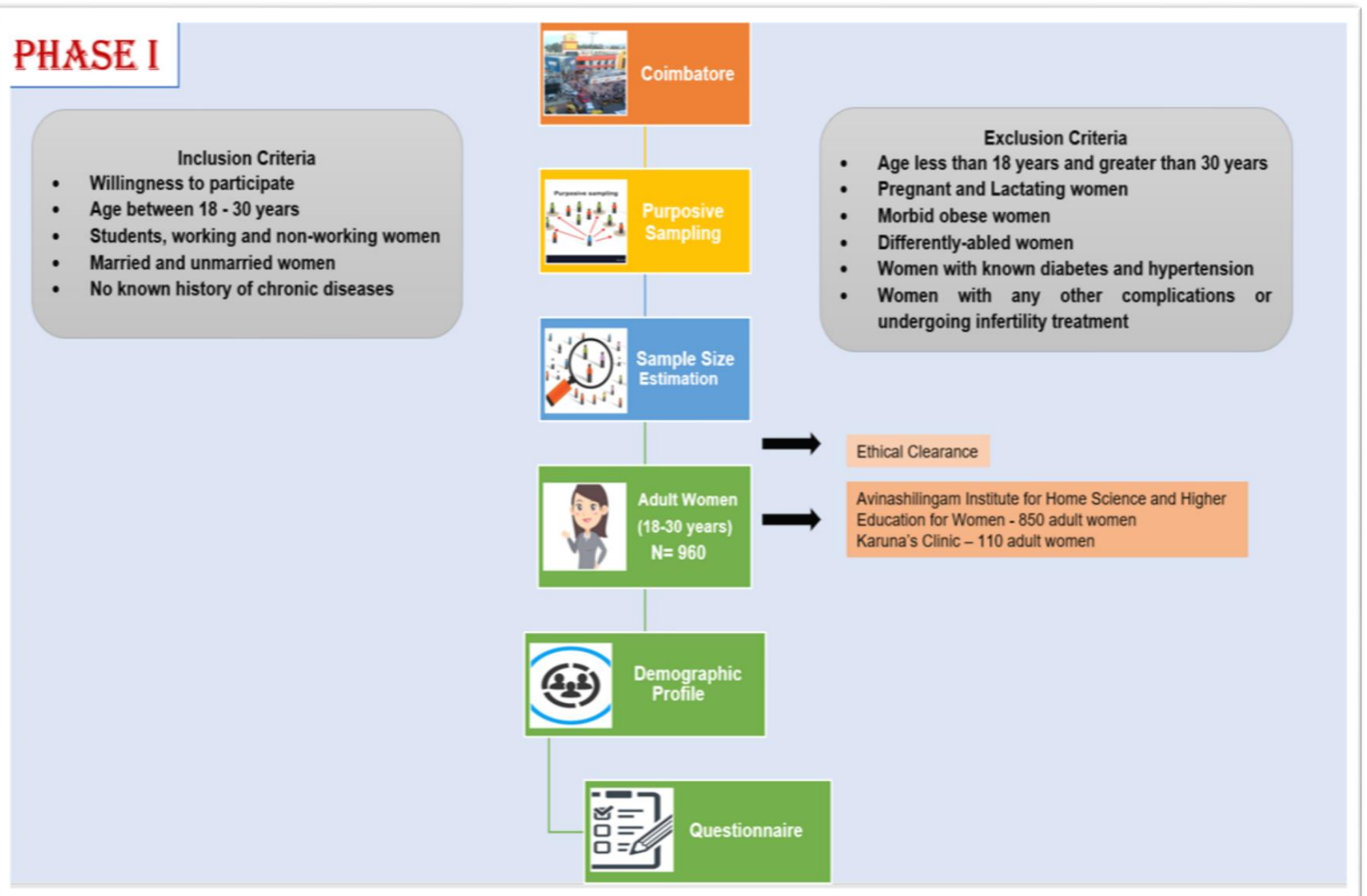
$$N = \left[\frac{Z1-\alpha/2+Z1-\beta}{ES}\right]^2 = \left[\frac{1.96+1.282}{0.11}\right]^2$$

= **868.48** (which is rounded off to 870)

A sample size of 970 was finalized to study the prevalence, considering the possible dropouts during the study.

3.1.4. Eliciting Background Information

The background information was collected from 960 (as 10 were dropouts) adult women aged 18-30 years using an interview schedule **(Appendix IV)**. An interview schedule contains a list of structured questions. The method is served to use as a guide for interviewers, researchers, and investigators wherein collecting primary or secondary data about a specific thrust topic or research question (Kothari, 2019). The baseline information such as age, education, occupation, income and marital status was collected from all the respondents.


PHASE I
Inclusion Criteria
Willingness to participate
Age between 18 - 30 years
Students, working and non-working women
Married and unmarried women
No known history of chronic diseases
Coimbatore
Purposive Sampling
Sample Size Estimation
Adult Women (18-30 years) N= 960
Demographic Profile
Questionnaire
Exclusion Criteria
Age less than 18 years and greater than 30 years
Pregnant and Lactating women
Morbid obese women
Differently-abled women
Women with known diabetes and hypertension
Women with any other complications or undergoing infertility treatment
Ethical Clearance
Avinashilingam Institute for Home Science and Higher Education for Women - 850 adult women
Karuna's Clinic – 110 adult women

3.2. PHASE II

STUDY THE PREVALENCE OF OBESITY

3.2.1. Assessment of Anthropometry to Identify Obese Women

Anthropometric measurements are a form of quantitative measurements by which the bone and muscle measurements were used to assess the body's composition and represent diagnostic criteria for obesity. The anthropometric measurements were done for all the 960 adult women, such as height (cm), weight (kg), Waist Circumference (WC) (cm) and Hip Circumference (HC) (cm) were measured using standard procedures. By using the measurements calculative index like Body Mass Index (BMI), Waist Height Ratio (WHR), Waist Height Ratio (WHtR) using standard formulas was calculated.

3.2.1.1. Height

The height was measured using a wall-mounted stadiometer. The stadiometer has an easily horizontal headboard of at least 3 inches wide, and it is brought into contact on the superior part of the head to measure the height. The adult women were allowed to stand straight barefoot on a stable platform or firm uncarpeted floor as the base. The measurement was taken in 0.1 cm or 1/8-inch increments against a perpendicular with feet and heels, shoulder and back parallel to touching the wall **(Plate I)**.

Plate I. Measuring Height

3.2.1.2. Weight

The weight of the adult women was measured by a weighing balance. The participants were asked to remove shoes and heavy outer clothing to the possible extent. The measurement was done by placing both the feet on the platform and at the side with arms hanging naturally and looking forward. The weight value was read to the nearest 0.1 (1/10) kilogram. A second measurement was taken to ensure the standard value **(Plate II)**.

Plate II. Measuring Weight

3.2.1.3. Body Mass Index (BMI)

Body Mass Index is the most straightforward index and most used anthropometric indicator. It is also an acceptable index for thinness and fatness and has been directly related to health risks in many populations (Nishida et al., 2004). BMI values were calculated using the International Obesity Task Force classification (Table I) among the Asian population (WHO, Asian Standards, 2002).

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

Table I

Body Mass Index Standards

BODY MASS INDEX	CATEGORY
<18.5	Underweight
18.5-22.9	Normal
23.0-24.9	Overweight
25-29.9	Obese I
$\geq$ 30.0	Obese II

WHO, Asian Standards, 2002

3.2.1.4. Waist Circumference

Waist circumference is an essential measure of abdominal obesity compared to waist-hip ratio, which can be low in some obese people because of high hip circumference in the denominator (Ahmed et al., 2016). Waist Circumference is a precise and sensitive measure of upper body fat among young people. Thus, it is essential to identify overweight and obese adult women at risk of developing metabolic complications (Bacopoulou et al.,2015). The waist circumference was measured using a measuring tape, and the adult women were asked to stand straight and relaxed. Waist circumference was measured by palpating the hip area to locate the right ilium of the pelvis by nearing 0.1 cm measurement. In a horizontal plane, the tape was positioned at the level of the measurement mark and ensured the horizontal alignment of the tape, and the measurement was recorded **(Plate III)**.

Plate III. Measuring the Waist Circumference

3.2.1.5. Hip Circumference

The hip circumference was measured using a measuring tape. The hip circumference was measured at the level of the widest circumference over the great trochanters while the adult women were standing erect with feet together by nearing 0.1cm measurement. The tape was placed so that it sits parallel to the floor and lies snug but does not compress the skin and the zero end of the tape was positioned below the section containing the measurement value and the value was recorded **(Plate IV)**.

Plate IV. Measuring the Hip Circumference

3.2.1.6. Waist to Hip Ratio (WHR)

The Waist-Hip Ratio is a simple and vital parametric ratio and it is a reliable indicator of visceral adiposity (Gupta & Mehrishi, 1997). WHR is also considered a viable tool to assess adiposity. WHR was calculated using waist circumference (cm) divided by hip circumference (cm). For women, more than 0.80 are considered a risk of abdominal obesity for Asians (Lean et al., 1995).

$$\text{WHR} = \frac{\text{Waist Circumference}}{\text{Hip Circumference}}$$

3.2.1.7. Waist to Height Ratio (WHtR)

The occurrence of hypertension and abnormal glucose tolerance can be predicted by an independent variable known as Waist to Height Ratio (WHtR) (Hsieh & Muto, 2005). It is an indicator of visceral and body fat, which might be another simple index used to predict the risk of type II diabetes (Cheng et al., 2010). The waist to Height Ratio was calculated by dividing waist in cm by height (cm). The higher values of WHtR will indicate an increased risk of obesity and cardiovascular diseases; additionally, it is correlated with visceral adiposity (Lee et al., 2008). A WHtR of over 0.5 was critical and signified an increased cardiometric risk (Browning et al., 2010).

$$\text{WHtR} = \frac{\text{Waist Circumference (cm)}}{\text{Height (cm)}}$$

From the phase I results among the 960 women, the prevalence of obesity was 25.9 percent (249). One sixty obese women were taken as the experimental group from the 249 and 160 normal women were selected as the control group for further study.

3.2.2. Assessment of Visceral Adiposity Indices

Obese women aged 20 – 30 years, BMI >24.9 and willing to participate in the study were included as experimental group and overweight, normal and underweight women were excluded. Adult women of the same age group with a normal BMI range between 18.5 – 22.9 were included as the control group and underweight, overweight and obese women were excluded.

Visceral adiposity is the increased amount of fat present in the abdominal region. The body's fat distribution interpretation is essential and timely for clinical implications. The active component of total body fat is visceral adipose tissue which comprises biochemical implications that influence normal and pathological processes in the body (Shuster et al., 2012).

Numerous methods can determine visceral adiposity. The most advantageous, although primitive and easily accessible methods were anthropometric measurements (like waist circumference and waist-hip ratio) and bioelectrical impedance analysis (BIA). These come under indirect methods of measurement and have medium-accuracy overdetermination. The direct

assessment method was only CT and MRI scans which measure the cross-sectional dimensions of fat present. But these two methods have their disadvantages while performing.

On the other hand, VAI can be calculated using anthropometric measurements (WC and BMI) and biochemical parameters (triglycerides and HDL) (Amato et al., 2010). Considering the points, numerous researches made the visceral adiposity assessment easily accessible. VAI and LAP are non-invasive and cost-effective in determining the visceral adiposity and are currently used in various population studies (Borruel et al., 2014; Kim et al., 2018).

3.2.2.1. Biochemical Estimations

The biochemical estimations were done two-fold, one to assess the VAI and LAP and the second to study the insulin resistance. Five ml of blood samples (venous) were collected from 320 adult women (160 Experimental and 160 Control) after overnight fasting (preferably 8 hours of fasting) with the help of a well-trained technician. The collected blood sample was centrifuged for serum separation. The Total Cholesterol (TC), Triglycerides (TG), Low-Density Lipoprotein (LDL), and High-Density Lipoprotein (HDL) **(Appendix V, VI, VII, VIII)** were estimated using standard procedures (Table II)**.** Total cholesterol and low-density lipoprotein are strongly associated with visceral adiposity (Luo et al., 2014). The estimated total, HDL and LDL cholesterol measured in mg/dl were converted to mmol/l by dividing mg/dL by 38.67 and triglycerides were converted by dividing mg/dL by 88.57 by using the lipid conversion factors (Rugge et al., 2011) **(Appendix XI & XII)**.

Table II

Biochemical Estimations to calculate Visceral Adiposity Indices

Biochemical Parameters	Methods	Reference
Total cholesterol	CHOD POD	Trinder, 1969
Triglycerides	GPO-PAP	Fossati & Lorenzo, 1982
High-Density Lipoprotein	Enzyme Selective Protection Method	Rifai et al., 1999
Low-Density Lipoprotein	Homogeneous Enzymatic Colorimetric Assay	Nauck et al., 2002

For the calculation of the HOMA-IR, the fasting serum glucose (FSG) (mg/dl) and fasting insulin (FI) (μU/ml) measurements are necessary (Bhosle et al., 2016). To calculate the insulin resistance, fasting insulin and fasting blood glucose levels **(Appendix IX, X)** were estimated (Table III).

Table III

Biochemical Estimations to calculate Insulin Resistance

Biochemical Parameters	Methods	Reference
Fasting Blood Glucose (mg/dL)	GOD-PAP	Trinder, 1969
Fasting Insulin μIU/ml	Enzyme-linked Immunosorbent Assay	Eastham, 1985

3.2.2.2. Blood Pressure

Hypertension is a significant risk factor among obese women but is often underrated and unrecognized. Hypertension and obesity were associated with cardiovascular mortality by increasing the risk (Gonzalez et al., 2010). Blood pressure assessment among adult women is essential in clinical health assessment, which can markedly reduce cardiovascular morbidity and mortality (Gudmundsdottir et al., 2012) as an individual's blood pressure is a clinical marker. The blood pressure among the adult women was measured using a standard sphygmomanometer **(Plate V)**. The readings were taken once and were repeated if the machine showed an error. The systolic and diastolic pressures were compared against the standard given by the WHO classification (Table IV).

Table IV

Blood Pressure Standards

Blood Pressure Category	Systolic mm Hg	Diastolic mm Hg
Normal	< 120	<80
Elevated	120-129	<80
Blood pressure Stage 1	130-139	80-89
Blood pressure Stage 2	>140	>90

***WHO, 2013**

Plate V. Measuring Blood Pressure

3.2.3. Calculations of VAI, LAP and Insulin Resistance

3.2.3.1. Visceral Adiposity Index

The VAI is an empirical, gender-specific index that includes both anthropometric measurements like Waist Circumference (WC) and Body Mass Index (BMI); biochemical parameters like Triglycerides (TG) and High-Density Lipoprotein (HDL) to calculate the visceral fat distribution in the body. VAI was first calculated by the Model of Adipose Distribution (MOAD) among healthy individuals (Amato et al., 2010).

$$\textbf{VAI for Women} = \frac{WC}{36.58 + (1.89 \times BMI)} \times \frac{TG}{0.81} \times \frac{1.52}{HDL}$$

The Calculation of VAI was done where

- WC – Waist Circumference (cm)
- BMI – Body Mass Index
- TG – Triglycerides (mmol)
- HDL – High-Density Lipoprotein (mmol)
- The waist circumference and body mass index had a positive correlation in which the constant 36.58 correspond to the respective intercepts and the constant 1.89 correspond to the regression line slopes **(Appendix XI)**.

- To correct fat distribution (MOAD) for fat function, TG and HDL levels were introduced in the formula. The healthy participants median TG and HDL values were used (Females: median TG = 0.81 mmol/l, median HDL = 1.52 mmol/l). Visceral adipose dysfunction was arbitrarily set for Triglycerides values higher than median value (0.81) and HDL values lower than median value (1.52) (Amato et al., 2010).

3.2.3.2. Lipid Accumulation Product

Lipid accumulation product (LAP) is an empirical formula of visceral adipose accumulation. It has been recommended to accurately indicate insulin resistance risk, metabolic syndrome, Type II diabetes, and cardiovascular diseases (Ilhan & Yıldızhan 2019). Many studies reported that LAP could be a representative marker to assess metabolic disturbances and insulin resistance among the young population (Abruzzese et al., 2017).

LAP for women = (WC - 58) x TG

The calculation of LAP was done where

- WC – Waist Circumference (cm)
- TG – Triglycerides (mmol)
- It was computed by multiplying a sex-specific estimate based on a combination of population-based frequency plots of adult waist circumferences, a measure of truncal fat that includes the visceral depot and circulating triglyceride concentrations.
- The waist circumference was empirically set as 58 cm for women **(Appendix XII)** (Kahn, 2006).

3.2.3.3. Assessment of Insulin Resistance

Visceral adiposity has been associated with insulin resistance and increased cardiovascular risk. A higher rate of lipid breakdown and pro-inflammatory secretion of adipokines will lead to low-level inflammation, which modifies insulin's signal in visceral adipose tissue (Verboven et al., 2018). The individuals with risk can be identified directly by measuring insulin resistance

associated with developing metabolic disturbances and other lifestyle diseases (Salazar et al., 2021).

The Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) concept is a robust marker for defining insulin resistance. The most practical, ethical, and economical hyperinsulinemic-euglycemic clamp is the standard gold test for measuring insulin resistance. This method measures insulin resistance and beta-cell function from fasting glucose and insulin (or C-peptide) concentrations **(Appendix XIII).** HOMA-IR is the relation of glucose and insulin dynamics that predicts fasting steady glucose and concentration of insulin for a wide range of possible combinations of insulin resistance and β-cell function (Gutch et al., 2015). HOMA-IR is an easy method for evaluating insulin sensitivity and correlates with the results of glucose clamp test in subjects with mild diabetes without significant hyperglycemia. For the calculation of the HOMA-IR, the fasting serum glucose (FSG) (mg/dl) and fasting insulin (FI) (µU/ml) measurements are necessary (Bhosle et al., 2016).

$$\textbf{HOMA-IR} = \frac{\textbf{fasting glucose x fasting insulin}}{\textbf{405}}$$

The Insulin resistance was calculated where

- FBG – Fasting Blood Glucose (mg/dL)
- FI – Fasting Insulin (µIU/ml)
- The fasting serum glucose and insulin are divided by constant 405 since the fasting serum glucose are expressed

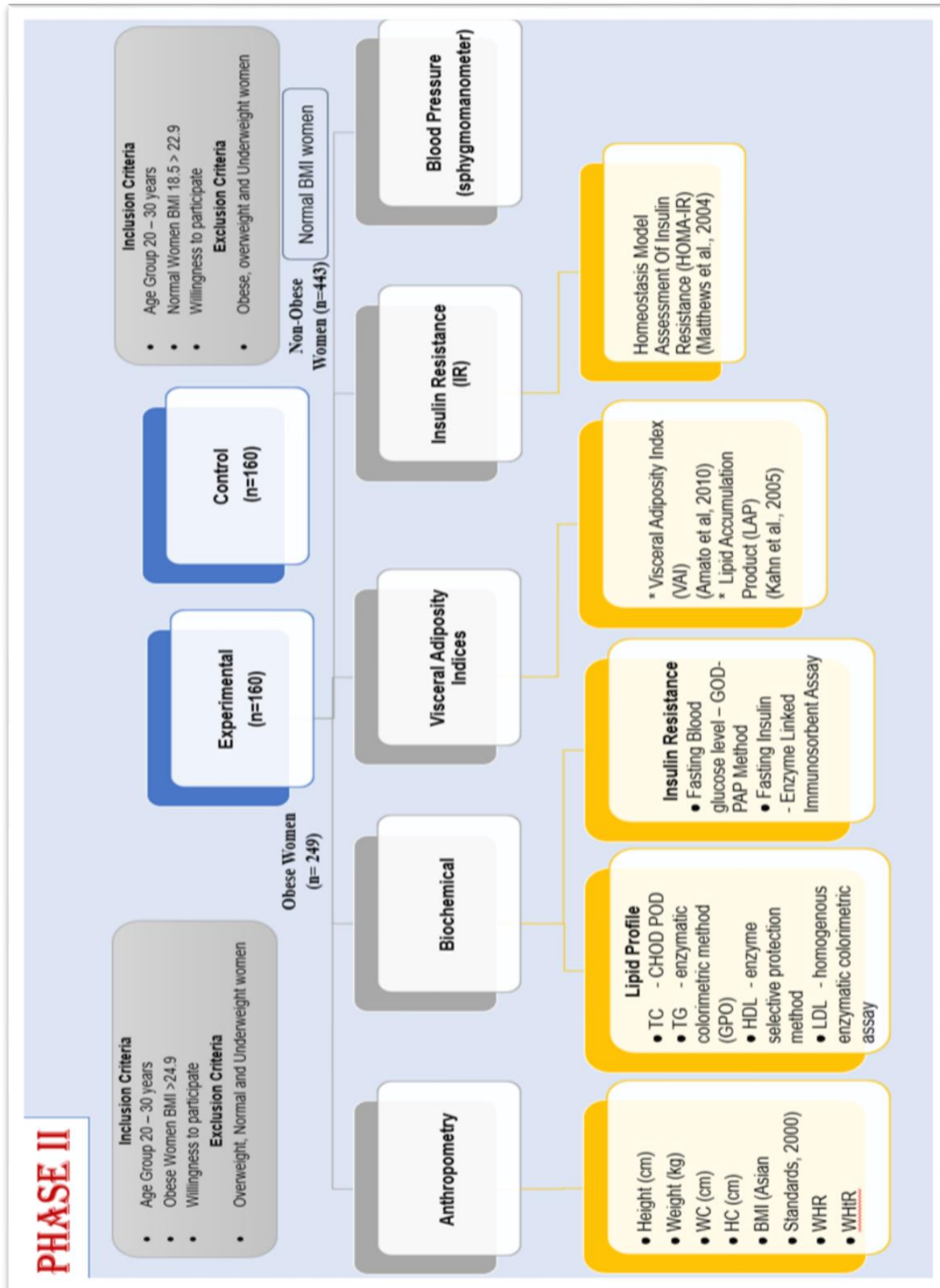
3.2.4. Deriving the Cut-Off Value of Visceral Adiposity Indices

The VAI and LAP cut-off points were derived by Receiver Operating Characteristic (ROC) Area Under Curve (AUC).

Obesity, a condition being heterogenous, results in metabolic dysfunction and cardiometabolic risk, which vary among obese individuals in which a significant portion is considered to be “metabolically healthy.” The need to evaluate the predictive ability of indicators even among the normal adult women

and obese women who are prone to be metabolically unhealthy and metabolically healthy respectively can be conducted. Visceral adiposity responsible for metabolic dysfunction may be possible which is economical and be useful at the screening levels in the community.

The visceral adiposity indicators (VAI and LAP) were performed logistic regression analysis and used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) for experimental and control for potentially confounding variables such as age, BMI, WHR, WHtR and biochemical parameters. Using receiver operating characteristic (ROC) analysis, ROC curves for WC, WHR, WHtR, VAI, LAP and IR were drawn to find the visceral adiposity specifically by using SPSS software version 21 to show the visceral adiposity specifically how well they could separate subjects into groups. The sensitivity and specificity of each adiposity indicator have been calculated at all possible cut of points to find the optimal cut-off values. The optimal sensitivity and specificity were the values yielding maximum sums from the ROC curves.



PHASE II
Inclusion Criteria
Age Group 20 – 30 years
Obese Women BMI >24.9
Willingness to participate
Exclusion Criteria
Overweight, Normal and Underweight women
Obese Women (n= 249)
Experimental (n=160)
Control (n=160)
Inclusion Criteria
Age Group 20 – 30 years
Normal Women BMI 18.5 > 22.9
Willingness to participate
Exclusion Criteria
Obese, overweight and Underweight women
Non-Obese Women (n=443)
Normal BMI women
Anthropometry
Biochemical
Visceral Adiposity Indices
Insulin Resistance (IR)
Blood Pressure (sphygmomanometer)
Height (cm)
Weight (kg)
WC (cm)
HC (cm)
BMI (Asian Standards, 2000)
WHR
WHtR
Lipid Profile
TC - CHOD POD
TG - enzymatic colorimetric method (GPO)
HDL - enzyme selective protection method
LDL - homogenous enzymatic colorimetric assay
Insulin Resistance
Fasting Blood glucose level – GOD-PAP Method
Fasting Insulin - Enzyme Linked Immunosorbent Assay
* Visceral Adiposity Index (VAI) (Amato et al, 2010)
* Lipid Accumulation Product (LAP) (Kahn et al., 2005)
Homeostasis Model Assessment Of Insulin Resistance (HOMA-IR) (Matthews et al., 2004)

3.3. PHASE III

ASSESSMENT OF DIETARY PATTERN AND PHYSICAL ACTIVITY AND THE CORRESPONDING ANTHROPOGENS

3.3.1. Assessment of Dietary Pattern

The dietary pattern among the 160 Experimental and 160 Control adult women was assessed by the 24-hour dietary recall method for three consecutive days (Yang et al., 2010) by interview method to associate the diet's role with adiposity. One of the determinants of visceral adipose tissue (VAT) includes diet (Fischer et al., 2015). The use of self-reported, 24-hour dietary recalls for estimating dietary intake has received a great deal of previous attention (Hebert et al., 2014). The 24-hour dietary recall (24-hr) method is widely used in national and international epidemiological and dietary monitoring surveys investigating different target populations (Elmadfa et al., 2009).

The dietary recalls were done by interview schedule, using visual aids like measuring cups and spoons or booklets **(Appendix XIV)**. The nutrient intake was calculated for energy, carbohydrate, protein, fat and fiber using the Nutrition Society of India (NSI) Diet Calculator by Indian Food Composition Tables (NIN, ICMR, IFCT 2017). The calculated values were compared with Recommended Dietary Allowance (RDA, 2020).

3.3.2. Assessment of Physical Activity

Physical activity has been regarded as one of the most critical habitual behaviors, which leads to a healthy life by preventing diseases and increasing health benefits (Powell et al., 2011). The use of questionnaires in assessing physical activity is frequent in clinical settings and epidemiological studies (Rivero et al., 2020). The physical activity among Experimental and Control was evaluated by International Physical Activity Questionnaire (IPAQ) - Short Form (2004) **(Appendix XV)**. The IPAQ is a frequently used measurement tool. It is an instrument designed primarily for population surveillance of physical activity among adults across various socio-economic settings.

The IPAQ-SF records the last 7-day recall for four intensity levels of physical activity: vigorous-intensity activity, moderate-intensity activity, walking and sitting **(Appendix XVI)**. The validation and validity of IPAQ-SF were done by Lee et al. (2011). From IPAQ-SF, data were converted to Metabolic Equivalent minutes per week (MET-min/week) using the published formulation by Ainsworth et al. (2011).

Table V

Compendium average MET Score

Category	METs*
Walking	3.3
Moderate physical activity	4.0
Vigorous physical activity	8.0

***Hagstomer et al., 2006**

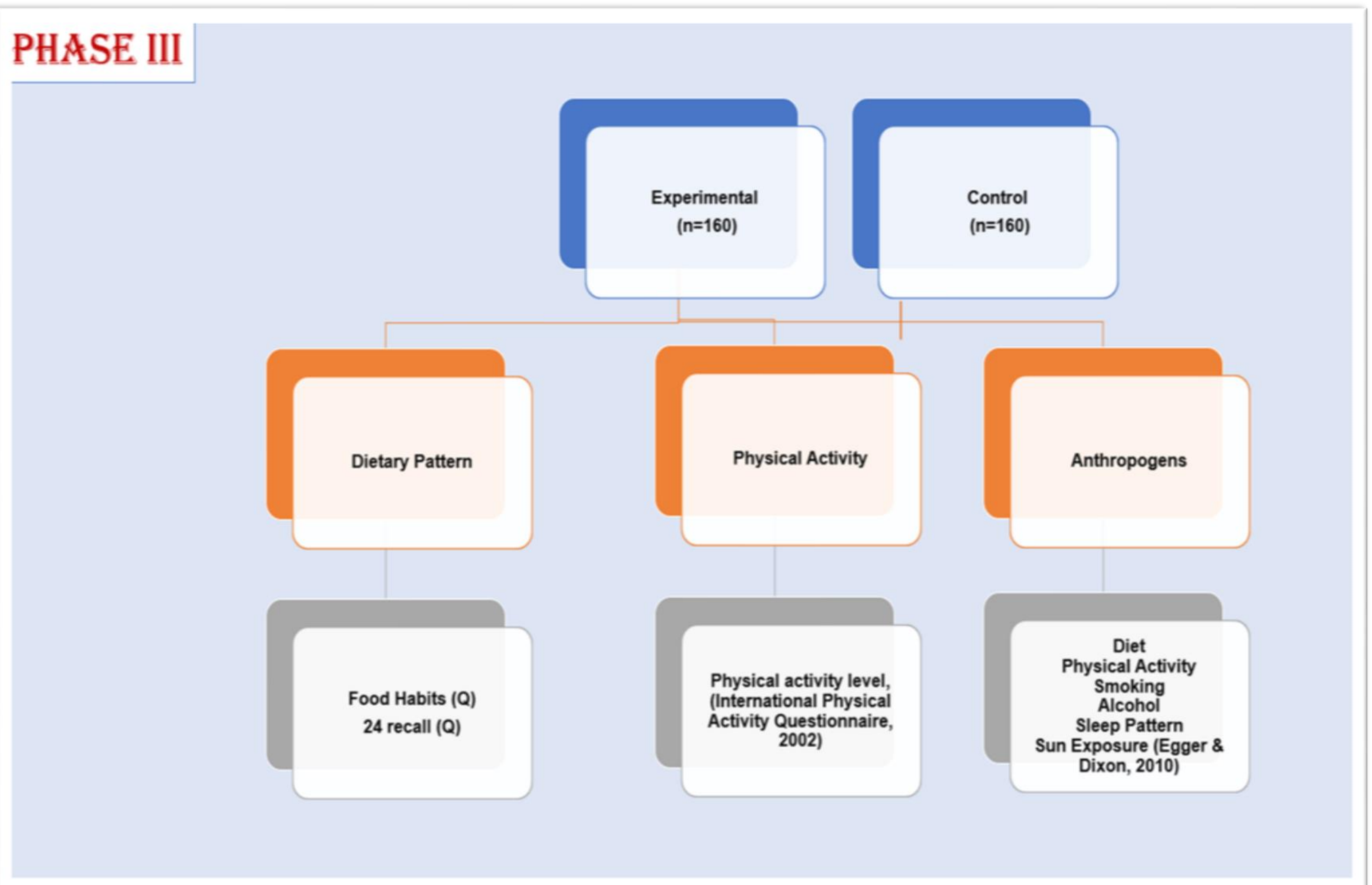
Total MET-min/week = (Walk METs*min*days) + (Moderate METs*min*days) + Vigorous METs*min*days)

3.3.3. Assessment of Anthropogens:

The term “anthropogens” are man-made environment by-products or lifestyles encouraged which may be detrimental to human health. It provides a monocausal focus for chronic diseases similar to the germ theory of infectious diseases. Anthropogens have in common an ability to induce a form of chronic, low-level systemic inflammation (“metaflammation”). A review of anthropogens, based on inducers with a metaflammatory association, was conducted with the evidence for each connected with several chronic diseases (Egger & Dixon, 2014). This is particularly relevant for understanding the chronic, non-communicable diseases often linked to obesity, in contrast to infectious/communicable diseases that have prevailed (Harris, 2004). The anthropogens were studied since they will be at risk for visceral adiposity and insulin resistance. The hierarchy or determinants and risk factors in chronic diseases were classified as distal (upstream), medial, proximal (downstream) determinants, and risk factors/ markers (Egger & Dixon, 2010). The proximal downstream determinants like diet, inactivity, smoking, alcohol/ drugs, sleep

pattern and sun exposure were addressed among selected Experimental and Control adult women **(Appendix XVII)**. An attempt was made to analyze the anthropogens among experimental and control groups to determine the risk involved.

The 'diet' anthropogen was evaluated and compared by the RDA value. The high risk was termed to adult women whose consumption was more than or equal to 100 kcal of energy intake and 10 grams of carbohydrate and fat excess to RDA values, particularly of higher energy-dense but low nutrient-dense products. On the other hand, less than 100 kcal of energy intake and 10 grams of carbohydrate and fat deficit to RDA values, intake of fruit/ vegetables, adequate dietary fibre, whole grains and healthy eating patterns were termed low risk. The physical activity was assessed by the IPAQ levels by which the physical activity status was determined. Physically active was taken as low risk, and physically inactive like longer sitting/ sedentary work was taken as high risk. The sleep hours were calculated, and above and below 8 hours of sleep was termed as high risk.


PHASE III
Experimental
(n=160)
Control
(n=160)
Dietary Pattern
Physical Activity
Anthropogens
Food Habits (Q)
24 recall (Q)
Physical activity level,
(International Physical
Activity Questionnaire,
2002)
Diet
Physical Activity
Smoking
Alcohol
Sleep Pattern
Sun Exposure (Egger &
Dixon, 2010)

3.4. PHASE IV

IMPACT OF INTERVENTION ON ADIPOSITY INDICES AMONG SELECTED EXPERIMENTAL WOMEN

Obesity prevention or reduction essentially involves lifestyle modification through behavioral change at the individual level (Chan & Woo, 2010). Lifestyle interventions involving nutrition education and physical activity were effective in improving the health of obese women. In particular, the possibility of infertility in obese women is high (Nho, 2017).

Obese women of 18-30 years of age, willing to participate and whose VAI and LAP were greater than 1.7 and 14.2, respectively, were included in the intervention study. The exclusion criteria were not willing to participate; differently-abled, insulin resistant, unhealthy women were excluded from the intervention study.

The inclusion criterion for the intervention groups is shown in (Table VI). Study duration ranging between 2.5 months and above was advisable to alter lipid profile parameters as major studies were performed in a systemic review and network meta-analysis (Schwingshackl et al., 2013). Hence, the intervention phase was carried out for 90 days. After selecting participants in each intervention group, they were added into separate Whats App groups. The pre and post-intervention evaluation was done to find the impact of the intervention. The participants who completed the study till the end were evaluated for the impact. The intervention groups were based on the range of VAI and LAP values. Individuals having higher VAI and LAP values were included for Experimental Group III (Diet and Physical Activity), intermediate VAI and LAP values were included for Experimental Group II (Physical Activity) and lower VAI and LAP values were included for Experimental Group I (Diet) as shown in (Table VI).

Table VI

Intervention Groups depending on VAI and LAP

Intervention Groups (N=160)	Intervention Strategies	VAI and LAP Value
Experimental Group I (N=40)	Diet Intervention	VAI >1.70 to 2.30 LAP >14.02 to 23.00
Experimental Group II (N=40)	Physical Activity Intervention	VAI >2.40 to 2.70 LAP >24.00 to 37.00
Experimental Group III (N=40)	Diet and Physical Activity Intervention	VAI >2.80 to 9.30 LAP >38.00 to 65.80
Control (N=40)	No Intervention	VAI >1.70 and LAP >14.02

The pre-intervention phase included the prior consent before the onset of the intervention study period. The data was recorded using pre-evaluated Google forms to re-assess the weight, dietary habits and physical activity pattern to check whether there was any difference compared to the initial data collected. Before the intervention, a general health education session was carried out for adult women. The session lasted for about 20-30 minutes through educational tools like PowerPoint presentations **(Plate VI)**. The adult women were educated on basic nutrition principles, basic food groups, good eating practices, food hygiene and the importance of good nutrition was educated and stressed among the adult women **(Appendix XVIII)**.

Diet Intervention included customized cycle menus, which involved formulating three diet plans. Depending on the VAI and LAP values, the experimental group I women were recommended the calorie restriction based on the RDA and energy where the higher VAI and LAP values were provided with 500 kcals, intermediate VAI and LAP values were provided with 300 kcals and lower VAI and LAP values were provided with 200 kcals (Table VII).

Table VII

Calorie Restriction based on VAI and LAP values for Diet Intervention Group

Energy/ Calorie restricted	VAI and LAP Values
500 kcal	VAI 2.14 to 2.30 LAP 19.03 to 23.00
300 kcal	VAI 1.94 to 2.13 LAP 17.03
200 kcal	VAI 1.70 to 1.93 LAP 14.02 to 17.02

The menu planned for each calorie restriction is shown in **(Appendix XIX).** Information on sample meal plates, food included and restricted, cooking methods, dietary modifications and general guidelines were provided. Food Plate Surveillance was done to check the quantity of food intake through whats app images and to include new food. Depending on the food plate, Tele- Counselling was carried out periodically. Food Plate Adjustments were made accordingly and were followed throughout the study period **(Appendix XX)**.

Physical Activity Intervention included developing high-intensity training exercises with gradually increasing the counts. The intervention comprised 30 minutes of brisk walking and cyclic aerobic exercises like jumping jacks, super brain yoga, wall push-ups, side-lying leg lift (left and right), abdominal crunches, bicycle crunches, mountain climbers and toe touch **(Appendix XXI)**. The aerobic exercises were shared by .GIF files and videos to show the performance of the activity. The intensity of the aerobic exercises was increased every 20th day after the feedback. Physical Activity Surveillance was done virtually.

The experimental group III (Diet and Physical Activity), information on both Diet Intervention and Physical Activity Intervention was explained wherein both the diet and physical activity components were included. Depending on the VAI and LAP values, the calorie restriction was recommended based on the RDA and energy where the higher VAI and LAP values were provided with 500 kcals, intermediate VAI and LAP values were provided with 300 kcals and lower VAI and

LAP values were provided with 200 kcals and physical activity was commonly recommended (Table VIII).

Table VIII

Calorie Restriction based on VAI and LAP values for Diet and Physical Activity Intervention Group

Energy/ Calorie restricted	Physical Activity	VAI and LAP Values
500 kcal	Brisk walking – 30 minutes Aerobic Exercises – jumping jacks, super brain yoga, wall push-ups, side-lying leg lift (left and right), abdominal crunches, bicycle crunches, mountain climbers and toe touch	VAI 8.00 to 9.30 LAP 58.00 to 65.80
300 kcal		VAI 2.80 to 4.99 LAP 38.00 to 48.00
200 kcal		VAI 5.00 to 7.99 LAP 48.01 to 57.99

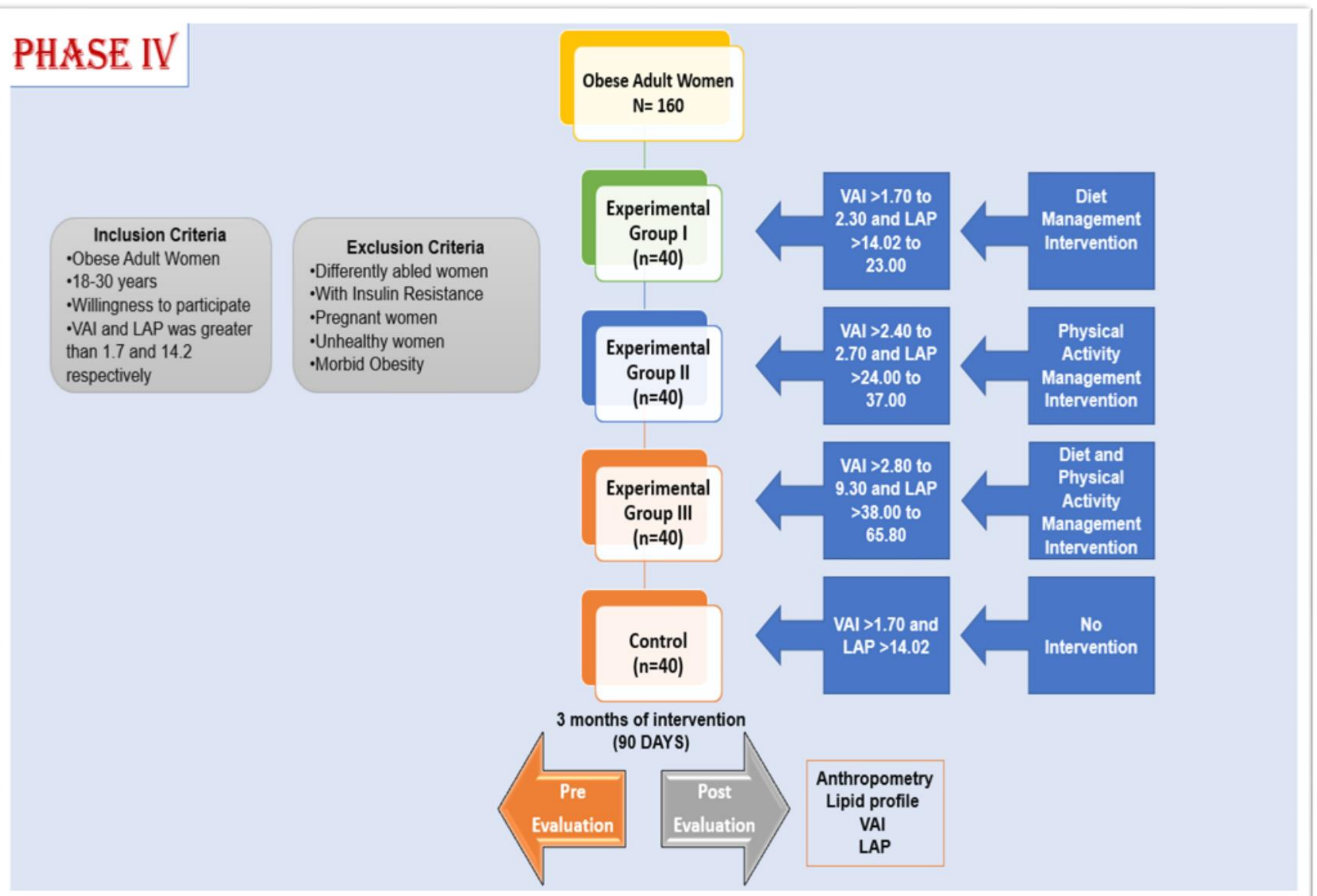
The post-intervention included the assessment of the participants monthly and to evaluate the anthropometric measurements, biochemical parameters and the adiposity indices like visceral adiposity index (VAI) and lipid accumulation product (LAP) was performed and calculated using standard procedures pre and post the study period to compare the results and to find the impact of the intervention.

Plate VI. General Health Education

PHASE V: Statistical Analysis

Statistical analysis was performed using the SPSS 21 statistical software. Numerical variables were reported as mean ± standard deviation. Comparisons were conducted between experimental and control groups using the t-test. Comparison of prevalence data was performed by $\chi 2$ analysis. Pearson's correlation, scatter plots and multiple linear regression were used to evaluate the possible association between the independent and the dependent variables to find the predictive ability of the visceral adiposity indices.

For each visceral adiposity indices (VAI and LAP), logistic regression analysis was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) for experimental and control groups adjusting for potentially confounding variables such as age, WC, BMI, WHR, WHtR and biochemical parameters like TG, TC, HDL, LDL, FI, FBS and IR. Using receiver operating characteristic (ROC) analysis, ROC curves of each adiposity indicator were drawn to show how well they could predict the severance among experimental and control adult women. The sensitivity and specificity of each adiposity indices have been calculated at all possible cut-off points to find the optimal cut-off values.


PHASE IV
Obese Adult Women N= 160
Inclusion Criteria
•Obese Adult Women
•18-30 years
•Willingness to participate
•VAI and LAP was greater than 1.7 and 14.2 respectively
Exclusion Criteria
•Differently abled women
•With Insulin Resistance
•Pregnant women
•Unhealthy women
•Morbid Obesity
Experimental Group I (n=40)
VAI >1.70 to 2.30 and LAP >14.02 to 23.00
Diet Management Intervention
Experimental Group II (n=40)
VAI >2.40 to 2.70 and LAP >24.00 to 37.00
Physical Activity Management Intervention
Experimental Group III (n=40)
VAI >2.80 to 9.30 and LAP >38.00 to 65.80
Diet and Physical Activity Management Intervention
Control (n=40)
VAI >1.70 and LAP >14.02
No Intervention
3 months of intervention (90 DAYS)
Pre Evaluation
Post Evaluation
Anthropometry
Lipid profile
VAI
LAP