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METHODOLOGY

The methodology pertaining to the study on **Prevalence of Micronutrient Deficiencies among Self Help Group Women and the Impact of Interventions** consists of the following steps.

A. Selection of the Area

B. Selection of the Sample

C. Selection of the Tool

D. Conduct of the Survey on Socioeconomic, Dietary Background and Assessment of Nutritional Knowledge

E. Assessment of the Health and Nutritional Status of the Selected Women through

1. Anthropometric Measurements
2. Clinical Examination
3. Biochemical Estimation
4. Food and Nutrient Intake
5. Health Profile of the Subjects

F. Conduct of Nutritional Interventions

1. Formulation and Supplementation of Nutritious Mixes
2. Nutrition Education

G. Evaluation of the Effect of Nutritional Interventions

1. Effect of Supplementation
2. Effect of Nutrition Education

H. Analysis of the Data Collected

A. Selection of the Area

Mahalir Thittam (Programme for women) is a socioeconomic empowerment programme for women implemented by Tamil Nadu Government. Mahalir Thittam is based on the Self Help Group (SHG) approach and is implemented in partnership with the Non Governmental Organisations (NGOs) and the Community based organizations. The SHG approach was started in a small way in Dharmapuri district in 1989 vide G.O.Ms.No.764, Social Welfare and Nutritious Meal Programme (NMP) Department dated 1.9.1989 with the assistance of the International Fund for Agricultural Development (IFAD).

Following the success of the IFAD project, Mahalir Thittam project was launched with the State Government funding from 1997-1998 vide G.O.Ms.No.292 Social Welfare & NMP Department dated 4.12.1996 and was progressively introduced in all the districts of the State. Today the SHG movement is a very vibrant movement spread across all the districts of the State (http://tnrd.gov.in/schemes/st_mahalirthittam.html).

There are 5, 56, 311 SHGs with 85,69,676 members in Tamil Nadu as on 30.09.2012. In Coimbatore district 19,236 SHG groups were formed as on 31.03.2012 with 2,95,754 members (TCDW, 2013). Out of which 1044 groups are in Karamadai Block among the 17 Panchayat villages and 595 groups are in Periyanaickenpalyam block among the 9 Panchayat villages (Saravanakumar and Mamta, 2012).

The investigator is familiar to this area and the co-operation extended by the Self Help Group Women who are actively involved in SHG activities formed the basis for selection of Karamadai and Periyanaickenpalyam Blocks for the study.

B. Selection of the Sample

Among the 1044 groups in Karamadai Block and 595 groups in Periyanaickenpalyam Block, 100 Self Help Groups were selected at random from each block for the study (Figure 1). The areas selected are as follows

Periyanaickenpalayam Block

1. Periyanaickenpalayam
2. Narasimhanaickenpalayam
3. Kurudampalayam
4. Veerapandi
5. Somayampalayam

Karamadai Block

1. Karamadai
2. Chikrampalayam
3. Marudur
4. Kalampalayam
5. Tholampalayam

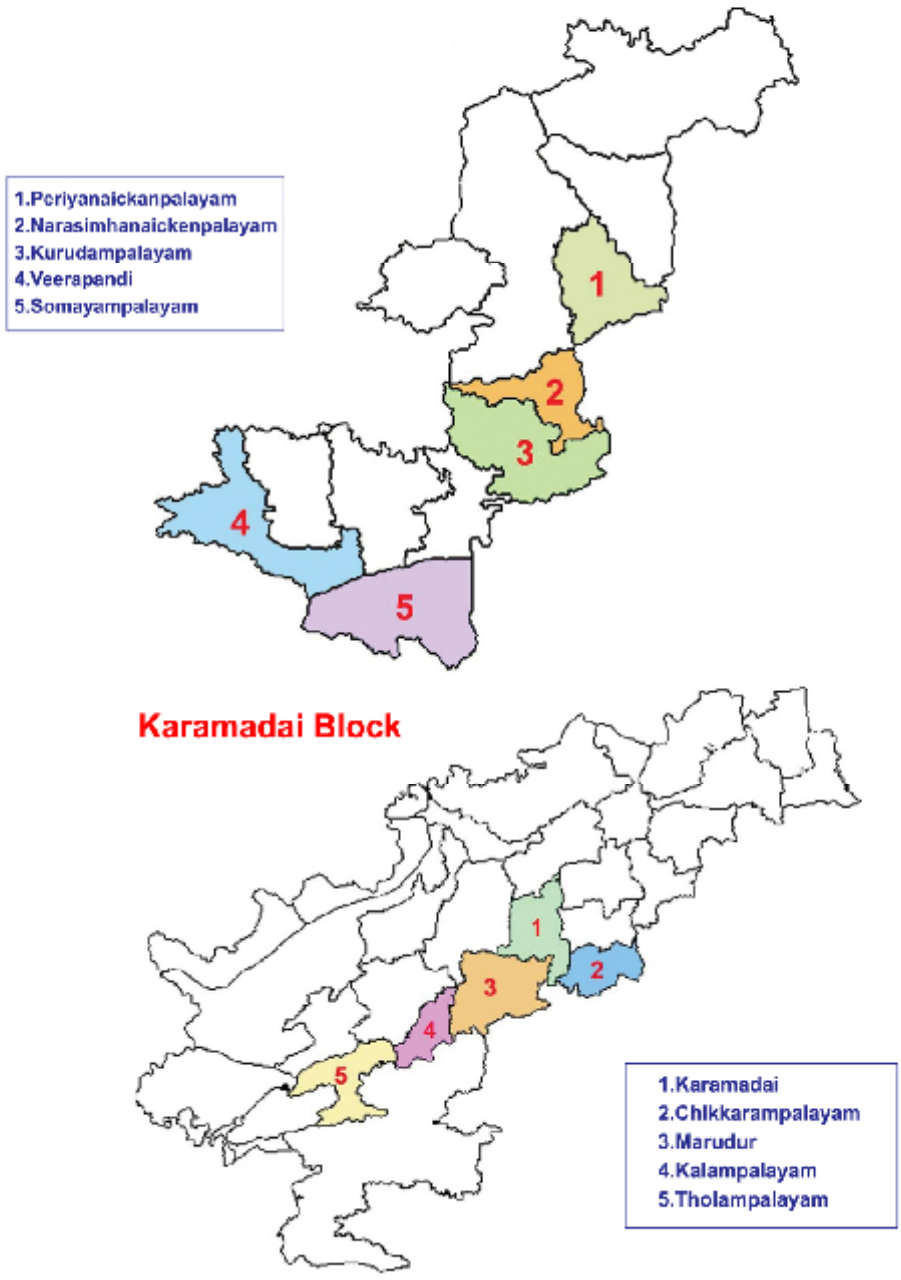
Among the ten villages identified in Periyanaickenpalyam and Karamadai blocks, 20 SHG groups were selected from each village, thus 100 Self Help Groups were selected from each block. From each group five women in the age group of 30 – 45 years were selected at random. Thus a number of 1000 women from 200 SHG groups formed the sample for the general study.

C. Selection of the Tool

According to Kothari (2004) in dealing with any real life problem, it is often found that data on hand are inadequate, and hence, it becomes necessary to collect the appropriate data. No survey can achieve success without a well-designed questionnaire, which is effective mechanism for the efficient collection of certain kinds of information.

A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms (Kothari, 2004). Two questionnaires were formulated to elicit information on the socioeconomic and dietary background and awareness on the food and nutritional aspects among the SHG women. Each questionnaire was pretested on a sample of ten subjects and necessary modifications were made.

Figure 1
Areas selected for the study



Questionnaire to Elicit Information about the Socioeconomic and Dietary Background

The questionnaire on socio-economic background included details such as age, marital status, family size, educational qualification, occupation and annual income and expenditure pattern of the families of the respondents.

The information regarding the dietary background of the respondent was gathered by the same questionnaire by including questions on the type of diet, frequency of meals per day, food and nutrient intake, food beliefs and taboos and food consumption pattern and type of diet taken during illness. Expenditure on foods, frequency of purchase, percentage of expenditure on different food groups were also collected with the same questionnaire (Appendix I).

D. Conduct of the Survey on Socioeconomic, Dietary Background and Assessment of Nutritional Knowledge

Nutritional problems have serious public health significance influencing psychological and physical development and behaviour and work performance, Nutritional problems may be caused not only by deficiency of protein, calorie, iron, Vitamin C etc, but by other conditions like bacterial infections, worm infestation, adverse environmental and socio-demographic factors. Various socioeconomic factors indirectly influence the nutritional status of the people in a community (Madhavi and Singh, 2011)

The ethnic background and the educational level of people influence their knowledge in various fields and indirectly influence the food availability and food choice. Again the level of income influences the quantity and quality of foods available and finally the diet and dietary habits. Taking all these factors into consideration and based on the requirements of the study, the socioeconomic background of the selected women was collected using the structured questionnaire developed for this purpose. With the help of the Panchayat Level Federation (PLF) Leader, the investigator approached the SHG women and collected the required information after establishing a good rapport with them. The investigator interviewed the SHG women during their group meetings conducted weekly once in their area or at their house over a period of 12 months (Plate 1).

Plate 1

Collection of Background Information

E. Assessment of the Health and Nutritional Status of the Selected Women

As the population of adults continues to increase, there is even more an urgency to establish nutrition assessment standards to evaluate the nutritional status of this vulnerable population, and to provide appropriate nutrition education and intervention. There is a high prevalence of under nutrition among older adults and the cases of insufficient energy or micro and macronutrients are alarming. Unfortunately, this nutritional state is often misdiagnosed because of inappropriate assessment. The nutrition diagnosis needs to be accurate in order to provide effective intervention (Wunderlich, 2013).

A nutrition assessment is an in-depth evaluation of both objective and subjective data related to an individual's food and nutrient intake, lifestyle, and medical history. Once the data on an individual is collected and organized, the nutrition practitioner can assess and evaluate the nutritional status of that person. The assessment leads to a plan of care, or intervention, designed to help the individual to either maintain the assessed status or to attain a healthier status (www.diet.com).

Assessment of the nutritional status was done by direct methods such as anthropometric measurement, clinical examination, biochemical estimation, food

and nutrient intake and health profile of the SHG women involving the actual examination of the individuals. The common methods of direct assessment used are,

1. Anthropometric Measurements
2. Clinical Examination
3. Biochemical Estimation
4. Food and Nutrient Intake
5. Health Profile of the Subjects

1. Anthropometric Measurements

Anthropometry is the most frequently used method to assess the nutritional status of individuals or population groups (www.fao.org). Nutritional anthropometry deals with the measurement of body at various ages and levels of nutritional status (Yankanchi *et al*., 2002). Anthropometry provides the simple, most universally applicable, inexpensive and non-invasive method available to assess the size, proportions and compositions of the human body (WHO, 1995). Anthropometric variables, particularly weight and height, are the most commonly employed measures of nutritional status in epidemiologic studies due to their simplicity and ease of collection (Willett and Hu, 2013). Anthropometry is generally considered as the most easily obtainable, inexpensive and noninvasive method that reflects body composition (Tarnus and Bourdon, 2006).

Nutritional anthropometry is a measurement of human body at different ages and levels of nutritional status. It is based on the concept that an appropriate measurement should reflect any morphological variation occurring due to significant functional physiological change (Anitha and Sushma, 2014). Anthropometry is relatively efficient to detect individuals at high risk of mortality associated with malnutrition (Bamji *et al*., 2010). Anthropometric measurements such as height, weight, Body Mass Index and Waist Hip Ratio were measured for all the selected SHG women.

a. Height

Height is affected only by long-term nutritional deprivation. It is considered as an index for chronic or long term duration malnutrition (Srilakshmi, 2007).

The heights of all the women were determined using a non stretchable tape fixed to a vertical flat wall. The subjects were made to stand barefoot against the wall in which the measuring tape was fixed with their head, back, shoulder, buttocks and heels touching the wall and their head held erect. A scale was gently placed over the head so that it touched the head without pressing and the readings were recorded to the nearest 0.1 cm (Plate 2).

b. Weight

Body weight is one of the most sensitive indicators of nutritional status and it indicates the body mass and is composite of all body constituents (Srilakshmi, 2007).

Body weights of all the selected 1000 SHG women were determined using a portable weighing machine to the nearest 0.1 kg accuracy. Care was taken to keep their feet parallel, hands on both sides and head straight. Weighings were done without slippers and with minimum garments on. The weighing machine was checked periodically for accuracy using standard weights. The normal precautions as advised by Jelliffe and Jelliffe (1991) were taken care while using the weighing machine (Plate 3).

Plate 2

Measurement of Height

Plate 3

Measurement of Weight

c. Body Mass Index (BMI)

BMI is a simple measure and most commonly used parameter to characterize a person as being undernourished, normal or overweight (pre obese and obese) (WHO, 2000). BMI is the most widely used anthropometric index for the assessment of the nutritional status in adults as it reflects the effect of both acute and chronic energy deficiency or excess (Tenth Five year plan, 2002 - 2007).

From the recorded height and weight of the selected SHG women BMI was calculated using the following formula.

BMI = Weight (kg) / Height (m^2)

BMI is the simple index of weight for height that is commonly used to classify underweight, overweight and obesity in adults (WHO,2011).

Classification	BMI range*
Underweight	< 18.5
Normal	18.5 – 24.9
Pre-obese	25.0 – 29.9
Obese class I	30.0 – 34.9
Obese Class II	35.0 – 39.9
Obese Class III	≥ 40.0

* (WHO, 2011)

The BMI of the selected SHG women were categorized based on WHO, (2011) classification to know the percentage of women under each class.

d. Waist Circumference

Waist circumference is a valuable, convenient and a simple measurement which can be used for identifying the individuals who are at an increased risk for type 2 diabetes mellitus, hypertension, dyslipidaemia and cardiovascular diseases (Ra and Ruma, 2012).

WHO Expert Committee on Obesity in Asian and Pacific populations suggested revised cutoff points for waist circumference as 90 cm for men and 80 cm for women for identifying persons with abdominal obesity (WHO, 2004).

The selected women were made to stand erect with feet close to each other. The investigator used a cross handed technique suggested by WHO (2008) to measure waist circumference by positioning a non stretchable fiber glass tape at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest. Then the circumference was measured to the nearest centimeter and recorded (Plate 4).

e. Hip Circumference

For taking the hip circumference the selected women were made to stand erect with feet together and the tape was positioned around the hip and the circumference was measured using a non stretchable fiber glass tape. The readings were taken to the nearest centimeter and recorded (Plate 5).

Plate 4
Measurement of Waist Circumference

Plate 5
Measurement of Hip Circumference

f. Waist to Hip Ratio (WHR)

WHR is used as a measurement of obesity, which in turn is a possible indicator of other more serious health conditions. WHO states that abdominal

obesity is defined as a Waist to Hip Ratio above 0.90 for males and above 0.85 for females, or a Body Mass Index (BMI) above 30.0 (WHO,2011). Waist to Hip Ratio being the superior clinical measurement for predicting all the causes and cardiovascular disease mortality (Welborn and Dhaliwal, 2007)).

Waist to Hip Ratio was calculated for the selected SHG women with the help of the following formula

$$\text{Waist to Hip Ratio} = \frac{\text{Waist Circumference in Cm}}{\text{Hip circumference in Cm}}$$

2. Clinical Examination

Clinical examination is the most essential part of all nutritional surveys, since the ultimate objective is to assess levels of health of individuals and population groups as influenced by the diet they consume (Swaminathan, 2009). Clinical examination assesses levels of health of individuals or of population groups in relation to the food they consume. It is the simplest and practical method for nutritional assessment (Srilakshmi, 2007).

Clinical examination is an essential feature of all nutritional assessment since their ultimate objective is to assess the levels of health of individuals or of population groups in relation to the foods they consume. It is the simplest and most practical method of assessing the nutritional status of a group of individuals (Park, 2015).

A modified ICMR clinical assessment schedule (Appendix II) was used to assess the micronutrient deficiencies. Clinical assessment was done with the help of the medical practitioner for all the selected 1000 SHG women.

3. Biochemical Estimation

Variations in the intake of different nutrients present in the diet are reflected by changes in the concentration of the corresponding nutrients or metabolites influenced by the nutrients, in blood, tissues and in urine. The levels of several vitamins in blood are lowered when the dietary intakes are low. (Swaminathan, 2009). The biochemical parameters assessed were blood haemoglbin, serum iron,

serum ferritin, TIBC, Packed Cell Volume, RBC count and Serum Calcium related to micronutrient deficiencies.

a. Haemoglobin Estimation

In the development of any deficiency disease, biochemical changes can be expected to occur prior to clinical manifestation. Haemoglobin is a useful index for the overall nutritional status irrespective of its role in anaemia (Srilakshmi, 2007). The haemoglobin estimation was done for all the selected 1000 SHG women by following the cyanmethaemoglobin method described by NIN (1990) using 0.02 ml of blood from each women obtained by finger prick method, with the help of the laboratory technician (Plate 6). The readings were compared with the WHO standards in order to find out the anaemic women.

b. Estimation of Packed Cell Volume (PCV)

Packed Cell Volume is the volume percentage of red blood cells of whole blood. For women it is normally 40 per cent. PCV was estimated by using Wintrobe's tube method (Sood, 1990) for the selected 60 SHG women.

c. Estimation of RBC count

RBC count or erythrocyte count was estimated by using Neubaurer method (Webster, 2004) to determine the amount of oxygen received by the tissues to function effectively.

d. Estimation of Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC)

Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were calculated using the values of haemoglobin, PCV and RBC count for the selected 60 SHG women.

$$MCV = \frac{PCV\ \% \times 10}{\text{Red cell count (million/mm}^3\text{)}}\ \text{fl}$$

$$MCH = \frac{\text{Haemoglobin (g/dl)X 10}}{\text{RBC count/ (million/mm}^3\text{)}} \text{ pg}$$

$$MCHC = \frac{\text{Haemoglobin (g)/dl}}{\text{PCV \%}} \text{X 100}$$

e. Estimation of Serum Iron

Serum iron shows a consistent and progressive fall when negative iron balance occurs (Agarwal *et al*., 2013). During iron deficiency serum iron levels are reduced and anaemia becomes evident with reduction in haemoglobin concentration. Based on the clinical symptoms revealed by the 1000 SHG women, 112 were screened for serum iron. Among them 60 were selected for intervention study. Serum iron was estimated using the standard dipyridyl method recommended by Varley (1988). For the estimation of serum iron 3 ml of blood was collected by the trained laboratory technician from the selected SHG women.

Plate 6 Collection of Blood Samples

f. Transferrin saturation

Less than 20 per cent of transferrin saturation indicates iron deficiency (Wish, 2006). Transferrin saturation was calculated using the values of serum iron and TIBC.

g. Estimation of Serum Calcium

Calcium is a mineral that helps bones stay strong. Our bodies continually remove small amounts of calcium from our bones and replace it with new calcium, a bone "remodeling" process. If the body removes more calcium from bones than it replaces, they slowly become weaker and more prone to breaking. Eating a diet rich in calcium allows the body to deposit calcium in bones so they stay strong (National Institute of Health, 2014).

When serum calcium level falls below the normal range of 9.0 – 10.6 mg/dl it will lead to several problems. Calcium deficiency ailment is osteoporosis in which bones become porous and fragile (www.localhealth.com/article/calcium-deficiency). Osteoporosis is a systemic disease of the skeleton, characterized by reduction of bone mass and concurrent deterioration of bone structure. Consequently, bones become more fragile and there is increased risk of fractures (Zittermann, 2007). Osteoporosis is not exclusive to older age. It is however one of diseases preventable by adequate nutrition and physical activity (Stransky and Rysava, 2009). Among the 1000 SHG women 143 were screened for serum calcium based on clinical signs and symptoms reported. Among them 60 were selected for intervention study. Serum calcium was estimated using calcium reagent kit, which is intended for in vitro quantitative determination of calcium in serum.

4. Food and Nutrient Intake

Dietary assessment aims to measure food consumption and to estimate the intake of nutrients (Geissler and Powers, 2008). According to Bamji *et al*. (2010), precise information on food consumption pattern of people through application of appropriate methodology is often needed not only for assessing the nutritional status of people, but also for elucidating the relationship of nutrient intake with deficiency diseases. A 24 hour recall method is a widely used one for the dietary assessment in which the respondents were asked to recall the food intake and this information was used to calculate the mean food and nutrient intake of the selected women in the experimental and control group. In this recall method, dietary data is obtained from the respondents through an oral questionnaire of diet survey, using a set of ‘standard cups’, suited to local condition.

With the help of 24 hour recall method the information regarding the food intake of the selected 120 women was collected for three days and this was used to calculate the mean intake per day. The raw equivalent weights of the foods consumed by the women were determined. From this, the intake of nutrients including micronutrients was computed using the Nutritive Value of Indian foods and compared with ICMR Recommended Dietary Allowances (2010) for women.

5. Health Profile of the Subjects

Based on the observations and health records from Primary Health Centre, the prevalence of deficiencies such as iron, vitamin A, calcium and other related illnesses were found out among the women of Self Help Groups in Karamadai and Periyanaickenpalyam Block.

In addition details regarding the various health problems of the selected women were obtained by including relevant questions which were listed with the options 'yes' or 'no'. The respondents were asked to tick the relevant option (Appendix III).

F. Conduct of Nutritional Interventions

1. Formulation and Supplementation of Nutritious Mixes

Today, nutritional assessment in many low income countries emphasizes new simple, non invasive approaches that can be used to measure the risk of both nutrient deficit and excesses, as well as to monitor and evaluate the impact of nutrition interventions (Solomons, 2002).

Nutrition interventions often target population subgroups identified as "at-risk" during nutrition surveys or by nutrition screening. There are three types of nutrition interventions: supplementation, fortification and dietary approaches (Hill and Nalubola, 2002). Food supplementation and nutrition education were the methods used to conduct the nutrition interventions for the SHG women.

a. Need for Supplementation

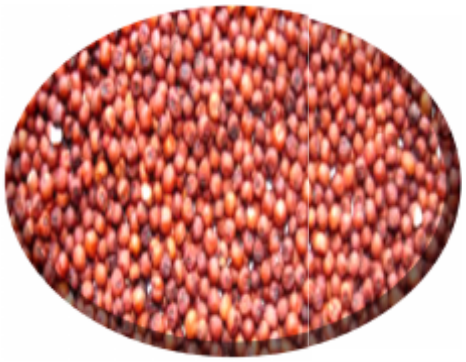
Based on the dietary pattern, food and nutrient intake, the intake of micronutrient rich foods was found to be inadequate and the major micronutrients

like Vitamin A, iron and calcium were also found to be very low among the selected SHG women. Hence in order to correct these deficiencies supplementation was planned.

b. Selection of Ingredients

Rice, wheat, jowar, bajra and ragi are the common cereals and millets which play an important role in Indian dietaries. The major pulses, which find an important place in Indian cuisine are red gram, bengal gram, black gram and green gram. Groundnut is an important oil seed grown in large quantities in our country. Sugar and jaggery are sweetening agents used in beverages and other foods to increase palatability. The following are the selected ingredients for the development of nutritious mixes.

i. Ragi (*Eleusine Coracana*)



Ragi is the principal food grain of the rural population in India, especially in the Southern Region. The nutritive value of ragi is better than that of rice and other cereals. It is rich in calcium, phosphorus and iron, the calcium content is higher than the common cereals and millets (Manay and Shadaksharaswamy, 2001). Ragi is also known as finger millet. It constitutes a little over 255 of the food grains grown in India. It is widely consumed practically without any refining by the poorer section of the population. The major proteins of ragi are prolamines and glutelins and they appear to be adequate in all the essential aminoacids. Ragi is rich in minerals especially calcium (Srilakshmi, 2007).

Ragi which is rich in iron is an extremely low cost nutritious cereal and is very beneficial for maintaining good health. Of all the cereals and millets, finger millet has the highest amount of calcium (344mg %) and potassium (408mg%) (Kathy *et al*., 2013). Ragi is also recognized for the health benefits, such as anti-diabetic, antitumerogenic, antiatherosclerogenic effects, antioxidant and antimicrobial

properties (Devi *et al.*, 2014). It is considered as a nutricereal as it is rich in macro, as well as micronutrients along with phyto-chemicals (Chaudhary and Vyas, 2014).

ii. Bengal Gram (Roasted) (*Cicer arietinum*)

It is the most important pulse crop of India, ranking fourth among the grain crops in area and production. The proteins are more digestible and better assimilated than those in other pulses. On the whole, Bengal gram protein is the best pulse protein owing to its high Net Protein Utilization (NPU) value (Manay and Shadaksharaswamy, 2001). In India, almost every region has some special delicacies and recipes made with split Bengal gram. They look and taste like small kernels of sweet corn and work well in soups, salads, and rice dishes. Combined with rice and roti, it provides the essential amino acids for complete protein. (http://healthytips-foryou.blogspot.in/2014/11/health-benefits-of-chana-dal.html).

iii. Groundnut (*Arachis hypogaea*)

Groundnut or peanut is the most important oil crop of India. With 31 per cent of world production, India ranks first in ground nut production. Groundnuts are rich in oil and protein as also in B-Vitamins and are thus of good nutritional value. Groundnut proteins are easily digestible and have high biological value. The nuts are eaten either raw, roasted, steamed or fried. In India, roasted groundnut eaten with some jaggery, forms a cheap and sustaining food for millions of people (Manay, and Shadaksharaswamy, 2001).

Groundnuts are exceptionally rich in niacin. Combination of groundnut and Bengal gram with millet, sesame seed or milk powder

should result in a mixture with a favourable amino acid composition (Srilakshmi, 2007). Peanuts are rich in energy (567 kcal per 100 g) and contain health benefiting nutrients, minerals, antioxidants and vitamins that are essential for optimum health. The nuts are packed with many important B-complex group of vitamins such as riboflavin, niacin, thiamin, pantothenic acid, vitamin B-6, and folates. Hundred grams of peanuts provide about 85 per cent of RDI of niacin, which contribute to brain health and blood flow to brain. The nuts are rich source of minerals like copper, manganese, potassium, calcium, iron, magnesium, zinc, and selenium (http://www.nutrition-and-you.com/peanuts.html).

iv. Jaggery (Saccharum offinarum)

In India, jaggery is commonly called as gur/vellam and when obtained from palm trees,it is called panai vellam or palm jaggery. Jaggery is commonly obtained from sugar cane juice and sometimes from neera of palm trees. It contains 90 per cent sucrose and 5.2 per cent invert sugar. Jaggery is preferred to sugar as it is a good source of iron and imparts colour and typical flavor to food preparations. It is widely produced and consumed in India (Usha Chandrasekhar, 2002). According to ICMR (2011) among the sweetening agents jaggery contains more iron and also contributes energy.

v. Green Leafy Vegetables

Green leafy vegetables are a storehouse of many micronutrients and they occupy an important place in the diets of millions of people in India. Green leafy vegetables are a rich source of vitamin A, iron and other micronutrients; they are even cheap in cost but because of lack of nutrition education and their perishable nature, people are unaware of their rich composition (Gupta and Prakash, 2011). Green Leafy Vegetables are rich in micronutrients and could be

used to prepare nutritious mixes to enhance their nutrient content (Kowsalya and Indira, 2010).

Dehydration is one of the most possible strategies for the preservation of green leafy vegetables, which are highly seasonal and perishable too. The abundantly available inexpensive drumstick leaves (Moringa Oleifera) can serve as a house of nutrients and can be used in the developing countries to combat micronutrient deficiencies(Joshi and Mehta, 2010).

Koul and Chase (2015) reported that drumstick leaves have a high total antioxidant capacity (260 mg/100g) and are rich in total polyphenol content (260mg/100g) and beta carotene (34 mg/100g). Drumstick leaves are highly nutritious, being a significant source of betacarotene, Vitamin A, C, protein, iron, calcium and potassium (Fahey, 2005).

Araikeerai leaves (Amaranthus tristis) contain dietary fibre, folic acid and perhaps other bioactive nutrients such as bioflavonoids. Further, araikeerai leaves contain magnesium, an antimutagen and chlorophyllin, a proven efficient antimutagen and antioxidants (Anilakumar *et al.*, 2006).

The investigator selected drumstick leaves and araikeerai leaves for the formulation of nutritious mixes. In total the ingredients selected for the nutritious mixes included ragi (cereal), roasted bengal gram (pulse), groundnut(nut), jaggery and green leafy vegetables.

c. Preparation of Nutritious mixes

For the preparation of nutritious mixes ingredients namely ragi, roasted bengal gram and groundnuts were purchased from the departmental store and cleaned thoroughly. Ragi and groundnuts were roasted and powdered in a flour mill including roasted Bengal gram separately and used for basic nutritious mixes (Plate 7).

Green Leafy Vegetables (GLV) can be made available throughout the year by drying or dehydrating the vegetables. Dehydrating food by removing its water content is effective because bacteria and enzymes are not active without water.

A. Ragi B. Roasted Bengal Gram Dhal
C. Groundnut D. Jaggery
Plate 7
Raw ingredients used in the preparation of basic nutri mix

A. Ragi B. Roasted Bengal Gram Dhal
C. Groundnut D. Jaggery E.Shade Dried Araikeerai Leaves
Plate 8
Ingredients used in the preparation of nutri mix I

A. Ragi B. Roasted Bengal Gram Dhal
C. Groundnut D. Jaggery E. Shade Dried Drumstick Leaves
Plate 9
Ingredients used in the preparation of nutri mix II

Nutritional content of dried food is superior (Davies, 2006) Drumstick leaves and araikeerai leaves which are available in plenty in the selected area were purchased , sorted, washed and placed in a white muslin cloth and shade dried (i.e.,) avoiding direct sunlight for a period of six days between the temperatures 29-30^{o}C. The dehydrated leaves were powdered and stored in polyethylene bags. These two powders were used for the preparation of two different nutritious mixes with high amounts of calcium, phosphorus and iron to overcome the micronutrient deficiencies such as anaemia, bone related problems and vitamin A deficiency conditions.

The ingredients selected for the preparation of nutritious mixes are

Nutri Mix I : Ragi, Roasted Bengal gram dhal,groundnuts, araikeerai leaves powder and Jaggery (Plate 8).

Nutri Mix II : Ragi, Roasted Bengal gram dhal , groundnuts, drumstick leaves powder and jaggery (Plate 9).

d. Acceptability Testing of the Developed Nutritious Mixes

Quality is the ultimate criterion for the desirability of any food product, ruled over by the organoleptic properties such as appearance, colour, texture, flavor and taste. A nine point hedonic scale score card was used for acceptability testing. Various combinations of the ingredients selected for the mix were tried out with different levels of green leafy vegetable powders

Acceptability tests were carried out by a panel of selected 21 members constituted by the faculty members and post graduate students of the department. The nutritious mixes with a composition of cereal, pulse, groundnut and jaggery in the ratio of 3.5:2.2:1:2.2 were found to be well accepted by the panel members and had the potential to improve the nutritional status of the targeted population namely women. Different levels of dehydrated leafy vegetables were tried out and the combination which scored the maximum (10 per cent incorporation) was selected for the study.

Acceptability trials revealed that among the Araikeerai leaves powder and Drumstick leaves powder incorporated nutritious mixes, the nutritious mix I incorporated with araikeerai leaves ranked first followed by the drumstick leaves powder incorporated mix II.

The composition of the highly accepted mixes is indicated in Table I.

TABLE I

COMPOSITION OF THE HIGHLY ACCEPTED NUTRITIOUS MIXES

Ingredients	Amount (g)	Ingredients	Amount (g)
Mix I - Araikeerai leaves powder Incorporated		**Mix II - Drumstick leaves powder incorporated**	
Ragi	35.0	Ragi	35.0
Roasted Bengal gram	22.5	Roasted Bengal gram	22.5
Groundnut	10.0	Groundnut	10.0
Jaggery	22.5	Jaggery	22.5
Araikeerai leaves powder	10.0	Drumstick leaves powder	10.0
Total	**100**		**100**

e. Analysis of Nutrients of the Highly Accepted Nutritious Mixes

The nutrients present in the two highly accepted mixes were analysed using standard procedures. Energy and Carbohydrates were analysed using NIN (2004) procedures. Moisture content, fat, ash, crude protein and crude fiber were estimated by the standard methods as per AOAC (2000). Iron, calcium and phosphorus were also estimated by AOAC, (2000) method. Vitamin C, thiamine and riboflavin were determined using ISI (2004) procedures. Total and beta carotene were estimated by HPLC using Zakaria *et al.* (1979) method. Nutrient analysis were done in triplicates and used for reporting.

f. Anti Nutritional factors in the Formulated Nutritious Mixes

Anti nutritional factors present in some of the food stuff may interfere with the utilization of the important nutrients in our body. Oxalates are rich in green leafy vegetables, hence oxalate content of the nutri mixes was analysed using Ukpabi

and Ejidoh (1989) method. Phytates present in cereals interfere with the absorption of iron, hence phytate content of the nutri mixes was analysed by using Lucas and Markaka (1975) method. Tannin interferes with iron absorption, hence tannin content of the nutri mixes was analysed by Sujata *et al*.. (2012) method. The alkaloid content of the mixes was estimated gravimetrically as per Harborne (1973).

g. Keeping Quality and Cost of the Highly Accepted Nutritious Mixes

The selected two mixes were packed in three polythene bags of 50g each, sealed and kept at room temperature for 90 days. Every month, the changes in storage was observed. The moisture content of the nutritious mixes was analysed using NIN (1983) method. Total Bacterial Count, yeasts and mould by AOAC (1990) method and compared with the permissible limits.

Calculation of the cost of the mixes will help us to evaluate the feasibility of the mixes for commercial exploitation. The cost of the developed nutritious mixes were calculated for 100g by making use of the cost of the raw materials prevalent in the market at the time of the study.

h. Supplementation of the Nutritious Mixes

Among the 1000 Self Help Group women surveyed, 120 women based on their low haemoglon and serum iron and serum calcium levels were selected for the supplementation study. The inclusion criteria are Self Help Group Women in the age group of 30 – 45 years, not taking any medications and not suffering from chronic diseases like diabetes mellitus, heart disease etc. All of them were well informed regarding the objective of the study and their willingness and co-operation throughout the four months supplementation study was confirmed through their consent letters.

The 120 women thus selected were divided into two groups of sixty each.

Group 1 – 60 anaemic Self Help Group women (30 in experimental group 1 +30 in control group 1)

Group 2 – 60 Self Help Group women with low calcium levels (30 in experimental group 2 + 30 in control group 2)

For the Experimental group 1 nutri mix incorporated with dehydrated araikerrai leaves powder and for the Experimental group 2 nutri mix incorporated with dehydrated drumstick leaves powders were given. Based on the food and nutrient intake data the amount of the supplement was planned to supply the required amount of iron and calcium in their diet. The calculated iron content of 100g of Mix I was 9 mg and the calcium content of 100 g of mix II was 630 mg. De worming was done for experimental group 1 with the advice of physician before supplementation. For supplementation, 30g each of the nutrimixes per day was decided to supply the required iron and calcium in the diets. Thirty grams of the mix per day was packed in 120 gauge /30 micron clear food grade polyethylene bags and 7 such small bags were put into a larger polyethylene bag. The investigator distributed one such cover once in a week for a period of four months to the selected women. Supplements were prepared once in seven days and was distributed in person to the target groups. During the entire intervention period the investigator visited the area and assessed for proper intake of supplements.

2. Nutrition Education

Women are often responsible for producing and preparing food for the household, so their knowledge or lack there of about nutrition can affect the health and nutritional status of the entire family. Improving women's nutrition can also help a nation to achieve three of the Millennium Development Goals, which are commonly accepted as a framework for measuring development progress (Ransom and Elder, 2015). Using a specially designed questionnaire the nutrition Knowledge, Attitude and Practices (KAP) of the women in Experimental and Control groups were assessed (Appendix IV). For each question of Knowledge and Attitude and Practice that was answered correctly, a score of one was awarded. The KAP questionnaire was administered to all the women before and after the nutrition education. Based on the results, the changes in KAP of the women of both the groups were found out.

Nutrition Education can serve as an effective tool to modify dietary habits of population groups (Food and Nutrition Service, 2010). In this study an attempt has been made to educate the Self Help Group women on nutrition and health issues.

Nutrition Education to the experimental group of 30 SHG women was imparted during their Self Help Group meetings. There was a control group of 30 SHG women maintained without any nutrition and health education.

Education on basic knowledge on nutrition and health was imparted through lectures with the help of charts and posters, exhibition, demonstrations and pamphlets by the investigator through group contacts for a duration of two hours per week over a period of four months.

Seven charts were developed by covering the aspects like Food habits and menu planning, foods rich in micronutrients, importance of nutritious foods in our life, Benefits of nutritious and healthy life, foods rich in calcium and foods rich in iron. These charts were used for educating the SHG women (Plate 10).

Seven posters were prepared for educating the SHG women on foods rich in essential nutrients and their importance, significance of balanced diet, breast feeding and its importance, basics of food and nutrients, nutritional deficiencies, preventive measures – diagnosis, treatment and control measures and foods to be taken, personal hygiene and kitchen gardening and terrace gardening (Plate 11).

Three pamphlets in regional language were developed and distributed to the SHG women during nutrition education. The aspects covered in the pamphlets are importance of iron, calcium and iodine in our diet, signs and symptoms of iron, calcium and iodine deficiency, preventive measures to avoid anaemia, goiter and osteoporosis and foods rich in iron, calcium and iodine to be included in the diet (Plate 12).

With the help of charts, posters and pamphlets, nutrition education was imparted by lecture method to the SHG women. An exhibition on foods rich in micronutrients, types of foods were also arranged. Demonstrations on how to prepare nutri mixes and methods of cooking foods to avoid nutrient loss was also delivered to the SHG women (Plate 13).

Plate 10 - Charts developed

Plate 11 - Posters develope

Plate 12 - Pamphlets prepared

Plate 13 - Nutrition Education in Progress

G. Evaluation of the Effect of Nutritional Interventions

1. Effect of Supplementation

The effect of supplementation of nutritious mixes incorporated with micronutrient rich foods among the women were studied by comparing the anthropometric, clinical and biochemical parameters like haemoglobin, iron and serum calcium levels and the nutritional knowledge of the subjects before and after supplementation.

a. **Anthropometric Measurements** - Anthropometry is considered to be the most sensitive parameter for assessing the nutritional status of the women. The anthropometric measurements, namely, height, weight, BMI, Waist to Hip Ratio of all the selected 60 experimental group and 30 control group women were recorded before and after the supplementation.

b. **Clinical Examination** - Changes in the Signs and symptoms of micronutrient deficiencies were recorded before and after the intervention among all the selected women with the help of a trained medical practitioner using the ICMR modified Clinical schedule (2010).

c. **Biochemical Estimation** – Biochemical tests help to detect deficiencies before symptoms are clinically evident. Biochemical estimations also help to confirm clinical and dietary data, so that, biochemical parameters like Haemoglobin, serum iron, serum ferritin, TIBC, PCV, RBC count and serum calcium levels were estimated among the experimental and control group women before and after intervention using standard procedures.

2. **Effect of Nutrition Education** – The same proforma for assessing the nutritional knowledge of the women was administered to all the selected women of the control and experimental groups 1 and 2 was given after nutrition education to assess the changes in KAP scores.

Approval from Institutional Human Ethics Committee (IHEC) and Clinical Trial Registry of India (CTRI)

The study has been presented and approved in Institutional Human Ethics Committee of Avinashilingam University for Women and the Approval number is - AUW/IHEC/13-14/FHP-11. The study has been registered in CTRI and the register Number is - CTRI/2015/02/005550.

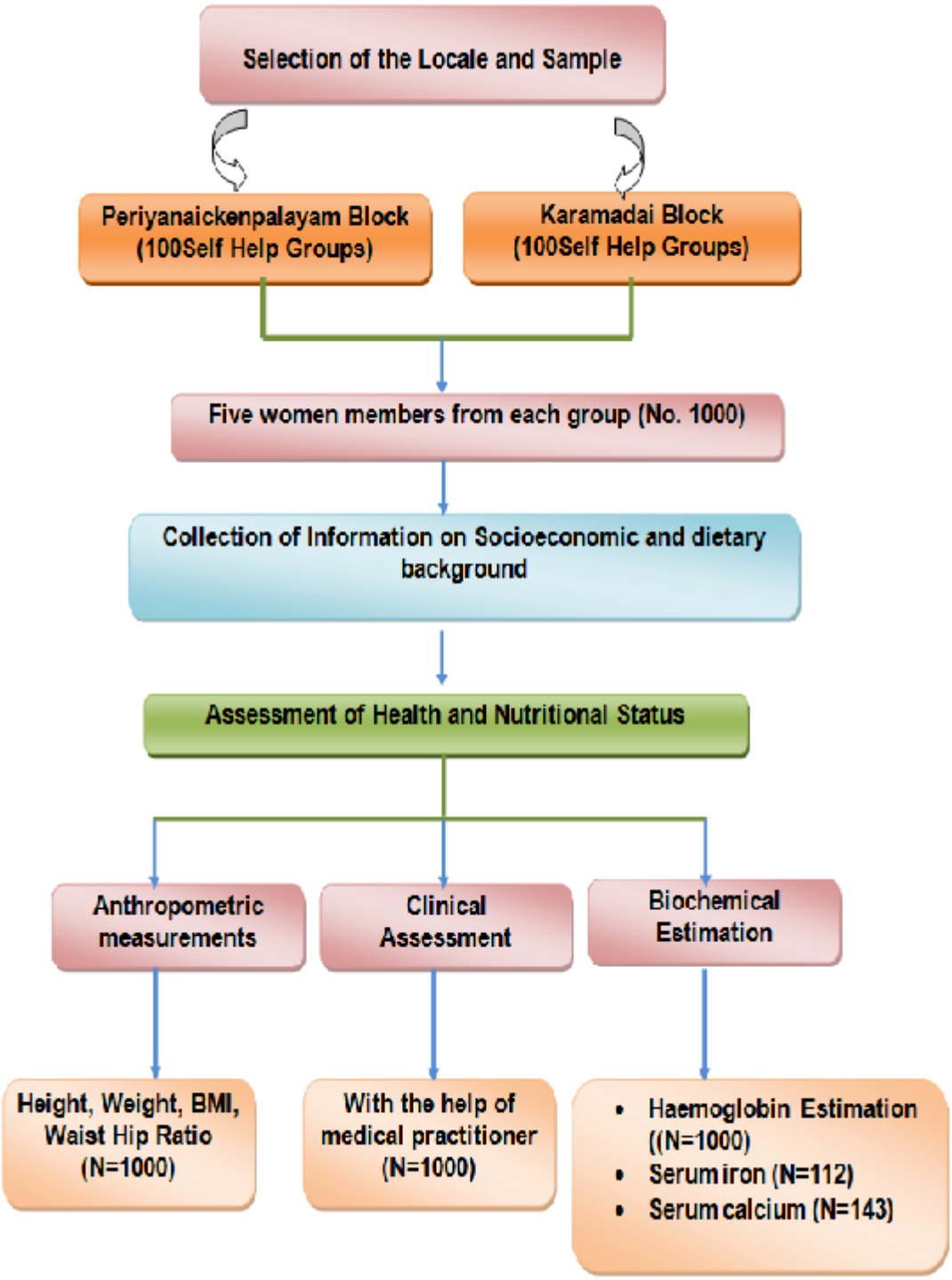
H. Analysis of the Data Collected

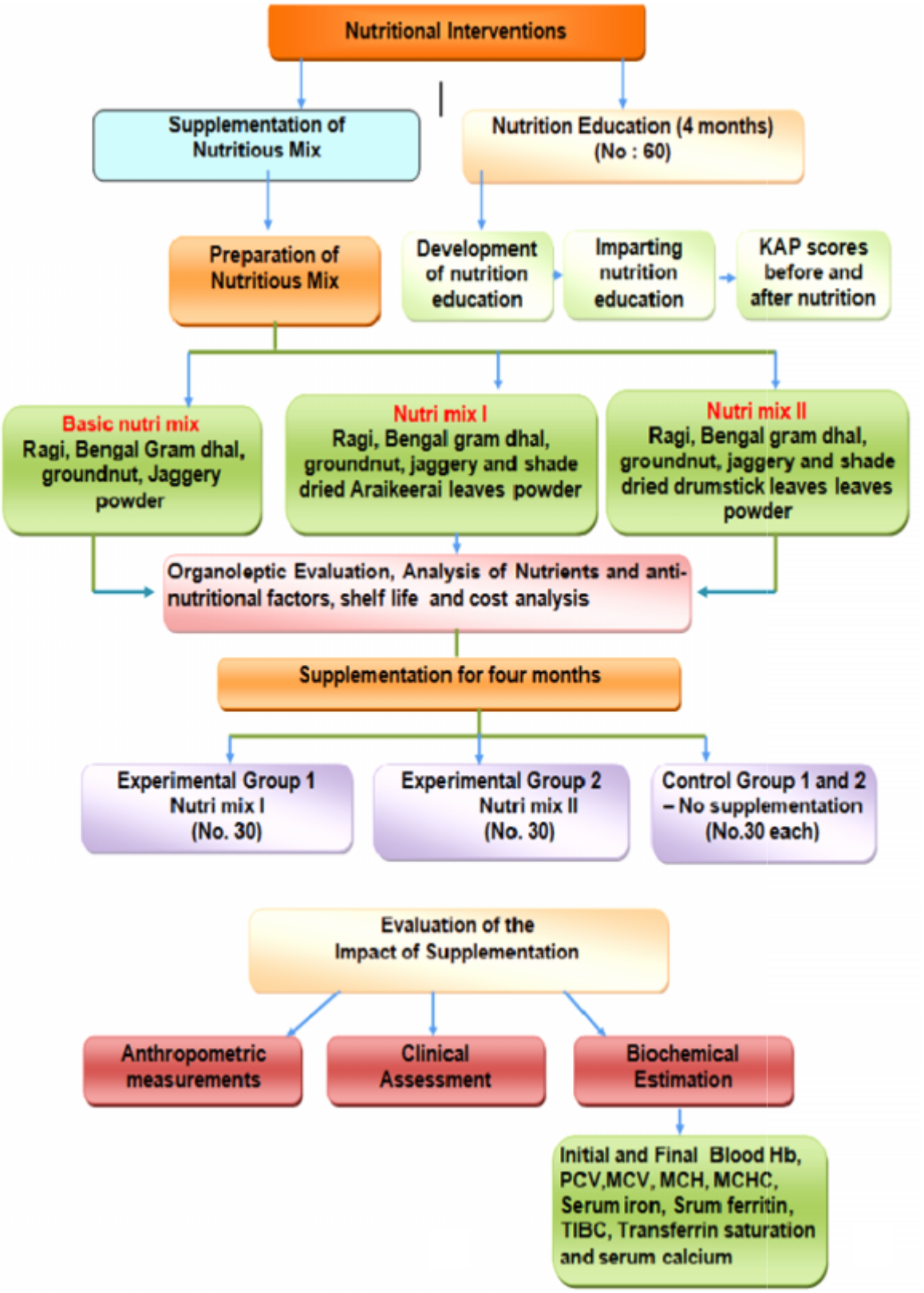
The data obtained from the study was consolidated and tabulated. The impact of supplementation and nutrition education among the women of the experimental and control groups were assessed using statistical techniques.

The research design of the study on “Prevalence of Micronutrient Deficiencies among Self Help Group Women and the Impact of Interventions” is presented in Figure 2.

FIGURE 2

RESEARCH DESIGN OF THE STUDY




Nutritional Interventions
Supplementation of Nutritious Mix
Nutrition Education (4 months) (No : 60)
Preparation of Nutritious Mix
Development of nutrition education
Imparting nutrition education
KAP scores before and after nutrition
Basic nutri mix
Ragi, Bengal Gram dhal, groundnut, Jaggery powder
Nutri mix I
Ragi, Bengal gram dhal, groundnut, jaggery and shade dried Araikeerai leaves powder
Nutri mix II
Ragi, Bengal gram dhal, groundnut, jaggery and shade dried drumstick leaves leaves powder
Organoleptic Evaluation, Analysis of Nutrients and anti-nutritional factors, shelf life and cost analysis
Supplementation for four months
Experimental Group 1 Nutri mix I (No. 30)
Experimental Group 2 Nutri mix II (No. 30)
Control Group 1 and 2 – No supplementation (No.30 each)
Evaluation of the Impact of Supplementation
Anthropometric measurements
Clinical Assessment
Biochemical Estimation
Initial and Final Blood Hb, PCV,MCV, MCH, MCHC, Serum iron, Srum ferritin, TIBC, Transferrin saturation and serum calcium