

Methodology

III METHODOLOGY

The methodology followed in the conduct of the present research entitled, **“Development and Promotion of Low Glycemic Foods among Employees of Tamil Nadu State Transport Corporation, Coimbatore Division”** comprised of the following three phases as depicted with flow chart :

Phase I : Assessment of prevalence of diabetes mellitus among employees of Tamil Nadu State Transport Corporation, Coimbatore Division.

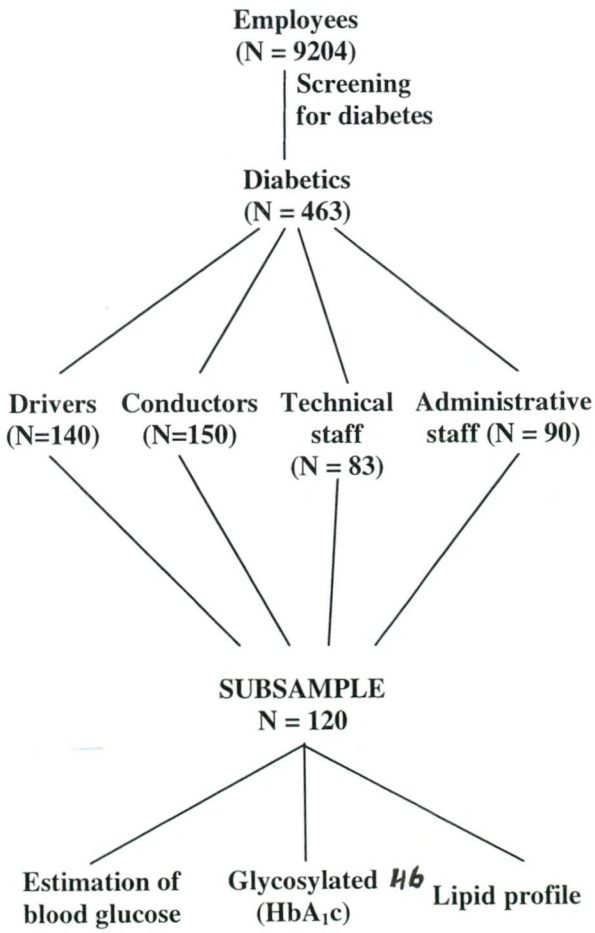
Phase I of the study involved the following steps:

- A. Selection of Area
- B. Selection of sample
- C. Extraction of background information of the selected diabetics

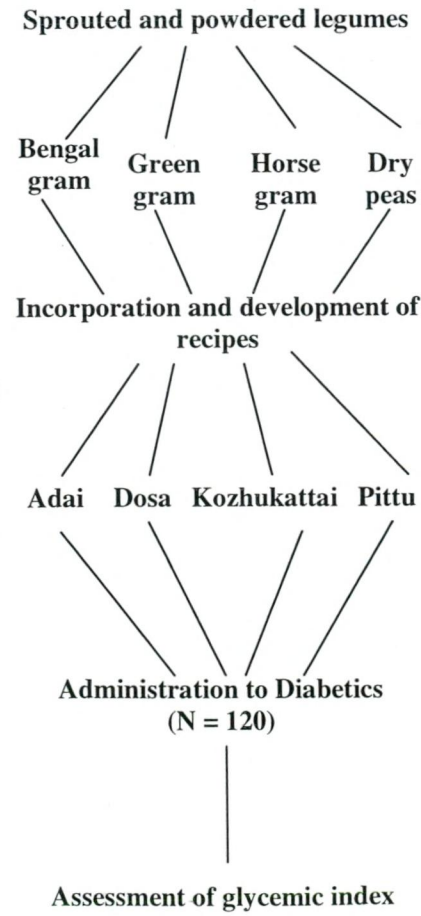
A. SELECTION OF AREA

Tamil Nadu State Transport Corporation, Coimbatore division was the area selected for the study. Tamil Nadu State Transport Corporation, Coimbatore division is a state government undertaking sector, with a total number of 1,666 buses plying in the city catering to the needs of rural and urban population. Totally 9204 employees were engaged in different sectors in the unit. Adequate number of subjects were available in this sector and the authorities of Coimbatore division, permitted the investigator to conduct the present research in Tamil Nadu State Transport Corporation, Coimbatore division. This transport corporation was selected through judgement sampling.

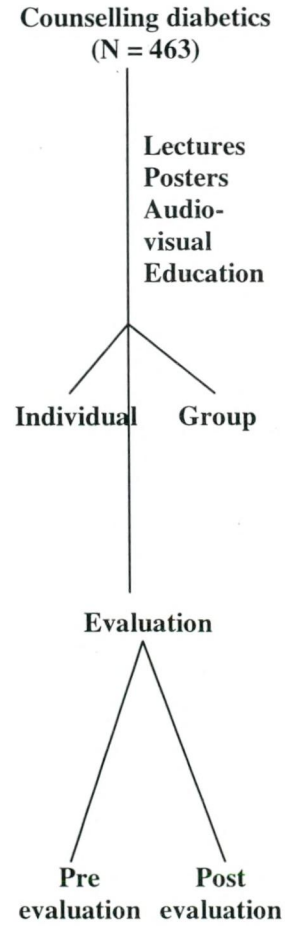
PHASE - I
Assessment of prevalence of diabetes mellitus among employees of Tamil Nadu State Transport Corporation, Coimbatore Division



PHASE - II
Development of low glycemic recipes incorporating sprouted legume powders and evaluation of glycemic index



PHASE - III
Promotion of low glycemic recipes through diet and therapeutic life style counselling



B. SELECTION OF SUBJECTS

All the 9204 employees working at various branches in Coimbatore division were initially examined to identify diabetics. The entire work force of the transport corporation was selected, as the study involved calculation of rate of prevalence of diabetes mellitus in this sector. The selected sample comprised of 804 administrative staff, 6923 running crews (3184 drivers, 3739 conductors) and 1477 technical staff. Technical staff were the employees working in the industrial unit who were involved in manual work such as repairing tyres and unit assembly works.

Random blood glucose examination was done for all the 9204 employees using an one touch basic plus glucometer (Bayer), which gives the test results in 45 seconds. The subjects who were known diabetics and those who had random blood glucose level more than 140mg/dl were judged as diabetics to be included in the study. This examination revealed that totally 463 were diabetics out of the 9204 employees. The diabetics included 140 drivers, 150 conductors, 90 administrative staff and 83 technical staff. These 463 diabetics were selected to study the socio-economic status, dietary habits, life style pattern, health status, details regarding diabetes mellitus and anthropometric data.

Sample should be true representative of population characteristics without any bias so that it may result in valid and reliable conclusions (Kothari, 2004). Having this in mind a sub sample of 120 diabetics, 30 each from the four categories of workers were randomly selected. Systematic random sampling was used to select subsample. Every k^{th} item in the different categories of workers were selected to get 30 sub-sample from each category, where $k = \frac{\text{Total number of units}}{\text{Number of sample required}}$

These diabetics were selected from 40 to 50 years age group having normal body mass index. This sub sample was latter used for evaluating the glycemic index of the sprouted legume incorporated recipes. Review of literature indicated great

controversy on whether diabetics or non diabetics should be used for calculating glycemic index. The investigator decided to evaluate glycemic index both on diabetics and non diabetics. Hence a group of 120 non diabetic subjects were selected from the same transport corporation for evaluating glycemic index of the sprouted legume incorporated recipes. These non diabetics were in the age group of 40 to 50 years, having normal body mass index.

C. EXTRACTION OF BACKGROUND INFORMATION OF THE SELECTED DIABETICS

1. Formulation of the Interview Schedule

An interview schedule is a structural set of questions which are usually asked orally and recorded by the interviewer (Saravanel, 2004).

An interview schedule was formulated, to elicit required information from the selected diabetics. The interview schedule was alienated into three parts.

The first part of the interview schedule contained questions on the socio-economic background namely, total monthly income, age and educational qualifications.

The second part of the interview schedule included questions on meal pattern, type of foods consumed and frequency and pattern of food consumption. Diet survey was conducted using the 24 hour food recall method for three consecutive days on the sub sample of 120 subjects. The volume of each food consumed was recorded using the standard cups and measures and from this the food and nutrients intake of the diabetics were computed using the Table of Food Composition (ICMR, 2000). Information regarding the life style habits like alcoholism, smoking, chewing pan parag / betel leaves, exercise pattern, sleeping pattern, stress and the reasons for stress were also included in the second part.

The third part of the interview schedule elicited information about the health status of the diabetics in terms of onset of diabetes, duration and type of treatment undertaken, familial tendency, signs and symptoms observed during the onset of diabetes and symptoms of hypoglycemia if experienced, prevalence of other diseases and complications of diabetes mellitus.

To evaluate the validity of the questionnaire, a pilot study was conducted on a small sample of 30 subjects selected using convenient sampling to test the validity of the questionnaire and the interview schedule was modified to the final form, which is presented in Appendix I.

2. Collection of data

Personal interview method was used to collect the data. The investigator contacted the diabetics individually and put forth the questions. The information provided by the diabetics were recorded in the interview schedule. The truthfulness of the answers were verified by questioning and cross questioning. According to Pawar (2004) in personal interview method, the interviewer and the respondent interact directly and purposefully. The interviewer asks questions and the respondent provides responses, in turn the interviewer records the responses.

3. Recording Anthropometric indices

Anthropometry is the science of measuring the size, weight and proportions of human body (Krause, 2004). Anthropometric parameters such as weight, height, waist circumference and hip circumference were measured for all the selected diabetics adopting standard procedures prescribed by Jelliffe and Jelliffe (1989).

a. Weight : Weight is the most popular and reliable time honoured basic indicator in clinical practice. It is more indicative of recent nutritional status. The weight of the diabetics was measured using a human weighing balance

nearest to 0.5kg. A spring balance was used and the sensitivity of the instrument was tested from time to time using standard weights.

b. Height : The height of the diabetics was measured using non-stretch, PVC coated, fibre glass tape accurate to 0.5cm. The tape was stuck to the wall. The subject was made to stand erect, barefoot with heels, buttocks and shoulders touching the wall, feet parallel and arms hanging at the sides in a natural manner. The subject was requested to look straight at the eye level. A foot ruler was placed on the head and the reading was noted to the nearest centimeter. Plate 1 shows the measurement of height and weight of a diabetic.

c. Body Mass Index (BMI)

The Quetlets index (W/H^2) is commonly referred to as Body Mass Index and is a valid measurement of nutritional status that has a high correlation with adiposity (Garrow, 2000). Body mass index was calculated for all the diabetics using the weight and height measurements.

$$\text{Body Mass Index} = \text{Weight (kg)} / \text{Height (m}^2\text{)}$$

The recently published BMI values of International Obesity Task Force (IOTF, 2004) given in the following was used to classify the diabetics.

Normal	-	18.5 to 22.9
At risk of obesity	-	23 to 25
Grade I obesity	-	25 to 29.9
Grade II obesity	-	more than 30

MEASUREMENT OF HEIGHT & WEIGHT



Recording height for a diabetic



Recording weight for a diabetic

PLATE - 1

d. Waist circumference

Waist circumference which assesses the abdominal fat accumulation is an independent predictor of disease risk. When the subject is standing erect and relaxed with very light clothing, a fibre glass tape is kept parallel to the floor and the distance around the smallest area below the ribcage and above the umbilicus bone, is measured. Following this procedure waist circumference was measured for all the diabetics to an accuracy of 0.1cm.

e. Hip circumference

The hip circumference was measured using a fibre glass tape (up to 0.1 cm accuracy) at the fullest part of the hip (maximum posterior extension) between the iliac crest and buttocks, keeping the tape parallel to the floor.

f. Waist Hip ratio

Abdominal obesity is often measured as the waist to hip ratio (WHR) which is the ratio of obesity in the upper trunk to that in the lower trunk. A high WHR is associated with increased risk of diseases. The waist hip ratio was calculated using the formula:

Waist Hip ratio = Waist circumference (cms) / Hip circumference (cms) (ICMR, 2005). The standard ratio prescribed by American Council on exercise testing and prescription presented in the following was used to classify the diabetics.

Classification	Men	Women
High risk	> 1.0	> 0.85
Moderately high risk	0.90 - 1.0	0.80 - 0.85
Low risk	< 0.90	< 0.80

4. Estimation of Biochemical parameters

To assess the health condition of the diabetics the biochemical profile namely fasting and post prandial blood glucose levels, glycosylated haemoglobin values and lipid profile were recorded for the sub sample of 120 diabetics.

a. Blood glucose

The fasting blood glucose levels and post prandial blood glucose were assessed by the investigator using glucometer.

b. Glycosylated haemoglobin (HbA_{1C})

As glycosylated haemoglobin values predict the extent of glucose control for a period of past three months, this index was estimated for the sub sample of 120 subjects. Fasting venous blood was drawn to estimate HbA_{1C} values by chromatographic-spectrometric ion exchange method described in Appendix IIa.

c. Lipid profile

Lipid profile namely total cholesterol, Low Density Lipoprotein(LDL), Very Low Density Lipoprotein (VLDL), high density lipoprotein (HDL) and triglyceride were estimated.

The serum total cholesterol (TC) was estimated by colorimetric method as per the procedure recommended by Trinder (1969) and Roeschian *et al.*, (1974). The high density lipoprotein cholesterol (HDLC) was estimated using colorimetric method of Gordon (1977). Serum triglyceride was estimated by Bucolo and David (1973).

The respective procedures followed are presented in Appendix IIb.

Low density lipoprotein cholesterol (LDLC) and very low density lipoprotein cholesterol (VLDLC) were computed using the formula given by Fried Wald *et al.*, (1992).

$$\text{LDL - C} = \text{Total cholesterol} - \frac{\text{TG}}{5} - \text{HDL - C}$$

$$\text{VLDL - C} = \text{Total cholesterol} - \text{LDL - C} - \text{HDL - C}$$

The subjects were requested to be on an overnight fast of 12 hours. Then 5ml of fasting venous blood was drawn and the lipid profile was analysed.

Phase II : Development of low glycemic recipes incorporating sprouted legume powders and evaluation of glycemic index

The methodology followed in the second phase of the research consisted of the following steps.

- A. Selection of legumes
- B. Preparation of sprouted legume powders
- C. Analysis of nutritive value of legume powders
- D. Incorporation of sprouted legume powders in selected South Indian breakfast recipes
- E. Standardisation of selected recipes
- F. Evaluation of glycemic index of standardized recipes

A. SELECTION OF LEGUMES

For proper control of diabetes, the diet should include a balance of high protein, low fat, complex carbohydrates and high fibre which are digested slowly without causing a rapid rise in blood glucose. Whole gram legumes rank second to cereals in supplying calories and form an important source of protein. Quality of legumes increases with sprouting. Sprouted grams are the freshest and most nutritious

of all vegetables available to the human diet. By a process of natural transmutation sprouted legumes acquire vastly improved nutritional qualities when compared to non-sprouts. There is an amazing increase in nutrients in sprouted legumes. Energy content of sprouts decrease by five percent, total carbohydrate content decreases by 10 percent and protein availability increases by 30 percent. (www.isga_sproutes.org). Hence four legumes were selected due to their high protein, high fibre and complex carbohydrate content and local availability. These legumes are locally cultivated and hence available at a low cost compared to other legumes. The four legumes thus selected were, 1) Bengal gram (*cicer arietinum*) 2) Green gram (*phaseolus aureus roxb.*) 3) Horse gram (*Dolichos biflorus*) and 4) Dry peas (*pisum sativum*).

B. PREPARATION OF SPROUTED LEGUME POWDERS

The selected legumes were washed thoroughly and soaked for eight hours. Then the water was completely drained and the soaked legumes were tied in a cloth and kept in a warm place for germination for 48 hours. The sprouted legumes were then sun dried and roasted till a good aroma arose. It was then cooled and ground to a fine powder in a mechanical grinder. One hundred gram of dry legume finally yielded 65g of dry powder. Every step of preparation of legume powder was carefully followed to avoid contamination. Plate 2 depicts the sprouted legume powders.

C. ANALYSIS OF PROXIMATE PRINCIPLE AND DIETARY FIBRE OF THE SPROUTED LEGUME POWDERS

The legume powders were analysed for carbohydrate, protein, fat and fibre contents. Carbohydrate estimation was carried out by Anthrone method. Protein was estimated by macrokjeldhal method, fat was estimated by Soxhlet extraction method (Sadasivam and Manickam, 1996). From these values, energy content was calculated. Dietary fibre estimation was carried out by the procedure of AOAC (2000).

SPROUTED LEGUME POWDERS

Green Gram

Horse Gram



Bengal Gram

Peas

LEGUMES



SPROUTED LEGUMES



LEGUME POWDERS

PLATE - 2

D. INCORPORATION OF SPROUTED LEGUME POWDERS IN SELECTED BREAKFAST RECIPES

Four most common South Indian breakfast recipes namely dosai*, adai**, pittu*** and kozukattai**** were selected for incorporating the sprouted legume powders. Also these recipes are rice based and normally contain high carbohydrate and energy and low protein and fibre. Rice is one of the foods most tested for its glycemic index, as most South Indians eat a lot of rice and it has a high glycemic index ranging from 54 to 132. Foods of low glycemic index raise the blood glucose to a lesser extent. Atkinson (2006) established that combining foods of different glycemic index alters the overall glycemic index of a meal. Incorporating the sprouted legume powders in the selected recipes would lower the availability of carbohydrate and increase the protein and dietary fibre contents and hence might lower the glycemic index.

The sprouted legume powders were incorporated at the levels of 20, 40 and 60 percent along with rice and other ingredients in standard recipes. The quantity of rice in the recipe was proportionately reduced for different percentage of incorporation. These recipes were subjected to acceptability trials.

E. STANDARDISATION OF THE SELECTED RECIPES

A recipe is a formula by which weighed and measured ingredients are combined in a specific procedure to meet pre-determined standards.

* Pan cake made out of fermented batter prepared using soaked rice and black gram dhal.

** Pan cake prepared by soaking and grinding rice, black gram dhal, and red gram dhal.

*** Steamed rice flour seasoned with mustard, black gram dhal, onions, green chillies, curry leaves and coriander leaves.

**** Steamed rice balls prepared out of coarsely ground rice seasoned with mustard, onion, chillies, curry leaves and coriander leaves.

The standard method of preparation described in Appendix IV was followed for all the recipes. Preparations were repeated for all the three variations until concordant results were obtained in the aspects of volume, preparation time, method of preparation and consistency. Thus the recipes were standardized in the laboratory.

According to Khan (1998) standardized recipes are the recipes that are produced to form a particular product in a standard form. Standardized recipes serve as a valuable tool in obtaining control over food production.

Table I presents the ingredients and composition of the standardized recipes. Plate 3 shows the legume powder incorporated recipes.

Sensory Evaluation

The standardized recipes were evaluated by a trained panel of 15 members using a five point rating scale for quality attributes such as appearance, flavour, texture/consistency, taste and overall acceptability. The evaluation procedure recommended by Potter (1996) was followed in the selection of judges for evaluation and formulation of score card. Based on the overall scores the products were rated as excellent, good and acceptable. Each panel member evaluated the recipes individually and scored the product for each of the quality attributes in the rating scale. The score card used is given in Appendix III. The most accepted variations were finally identified and selected for the evaluation of glycemic index. Along with this the standard preparations without incorporation were also included for evaluation of glycemic index.

F. EVALUATION OF GLYCEMIC INDEX OF STANDARDIZED RECIPES

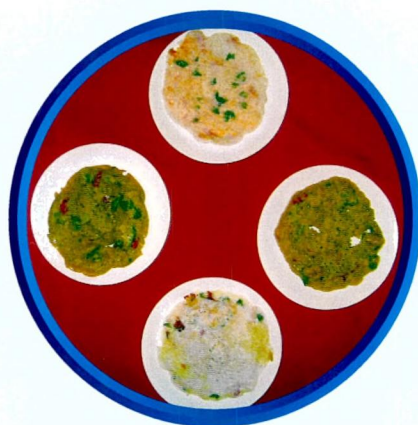
Glycemic index was assessed by feeding the standardized recipes (hereafter referred as test recipes) to 120 non-insulin dependent diabetics and 120 non-diabetic subjects.

TABLE I

COMPOSITION OF STANDARDISED RECIPES

Recipe	Sprouted Bengal gram				Sprouted green gram				Sprouted horse gram				Sprouted Peas			
	Rice (g)	Red gram dhal (g)	Black gram dhal (g)	Sprouted Bengal gram powder (g)	Rice (g)	Red gram dhal (g)	Black gram dhal (g)	Sprouted Green gram powder (g)	Rice (g)	Red gram dhal (g)	Black gram dhal (g)	Sprouted Horse gram powder (g)	Rice (g)	Red gram dhal (g)	Black gram dhal (g)	Sprouted Peas powder (g)
Legume in corporated Adai	40	20	20	20	20	20	20	40	20	20	20	40	40	20	20	20
Standard Adai	60	20	20	-												
Legume in corporated Dosai	60	-	20	20	40	-	20	40	60	-	20	20	60	-	20	20
Standard Dosai	80	-	20	-												
Legume in corporated Kozhu-kattai	80	-	-	20	80	-	-	20	60	-	-	40	80	-	-	20
Standard Kozhu-Kattai	100	-	-	-												
Legume in corporated Pittu	80	-	-	20	80	-	-	20	80	-	-	20	80	-	20	-
Standard Pittu	100	-	-	-												

ADAI



**LEGUME
POWDER
INCORPORATED
RECIPES**



PITTU



DOSAI



KOZHUKATTAI

PLATE - 3

The diabetics and non-diabetic subjects selected for evaluating the glycemic index were between 40 to 50 years of age. The diabetics who had fasting blood glucose level of around 140mg/dl, who were on oral hypoglycemic drugs and who did not have any other complications were selected, while the non diabetics who had fasting blood glucose level of 85mg/dl were selected.

The selected diabetics and non-diabetics were divided into 20 groups of six subjects each. The diabetics were grouped in such a way that the mean blood glucose levels of all the groups were almost same. Three days before the test period all the subjects were instructed to avoid sweet preparations and steroid containing drugs. On the fourth day fasting blood glucose was estimated and then all of them were served white bread (75g) providing 50g of carbohydrate for breakfast.

Blood samples were collected every half an hour for two hours. Again after a wash out period of one week the food intake of the diabetics was controlled for three days as before. On the fourth day, the fasting blood was drawn to estimate fasting blood glucose and then they were served the respective test food containing 50g of carbohydrate, for breakfast. The groups and the respective recipe fed are shown in Table II and flow chart. It was ascertained that the diabetics did not leave any plate waste and took same length of time for consuming the breakfast served. The blood samples were collected at periodic intervals of 0,30,60,90 and 120 minutes. Blood glucose levels of all the sample were estimated.

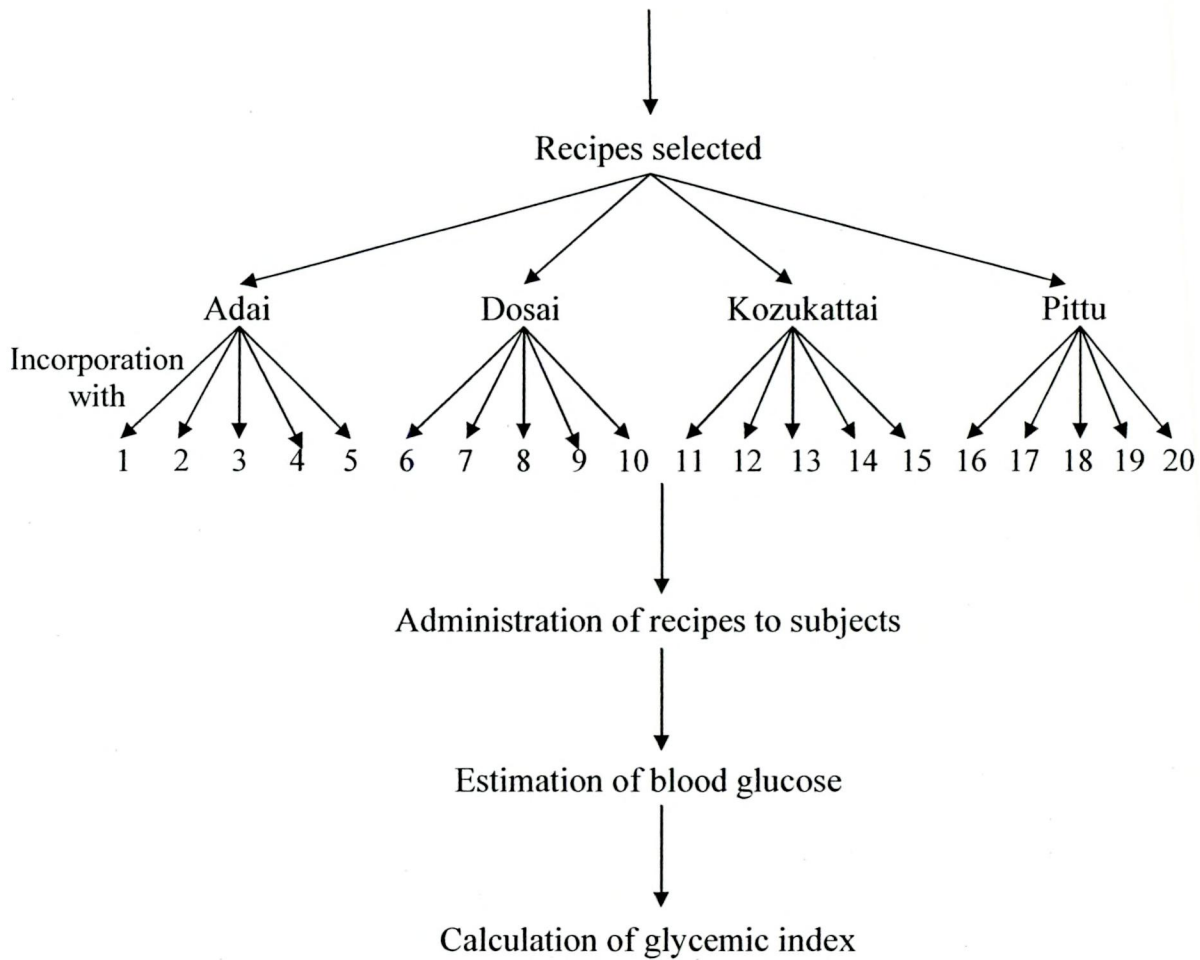
Non diabetic subjects were also divided into 20 groups of six subjects each and blood glucose levels were estimated with white bread and the test recipes. Glycemic index was calculated using the following formula suggested by Jenkins *et al.*, (1981) and Trout *et al.*, (1993) for both diabetics and non-diabetic subjects.

$$\text{Glycemic Index} = \frac{\text{Area under the curve of test food}}{\text{Area under the curve of reference food (white bread)}} \times 100$$

TABLE II
GROUPS AND THE RESPECTIVE RECIPE FED FOR EVALUATING
GLYCEMIC INDEX

Groups (N = 6)	Recipe	%Incorporation of sprouted powder
	Adai	
Group I	Bengal gram powder	20
Group II	Green gram powder	40
Group III	Horse gram powder	40
Group IV	Peas powder	20
Group V	Standard	
	Dosai	
Group VI	Bengal gram powder	20
Group VII	Green gram powder	40
Group VIII	Horse gram powder	20
Group IX	Peas powder	20
Group X	Standard	
	Kozukattai	
Group XI	Bengal gram powder	20
Group XII	Green gram powder	20
Group XIII	Horse gram powder	40
Group XIV	Peas powder	20
Group XV	Standard	
	Pittu	
Group XVI	Bengal gram powder	20
Group XVII	Green gram powder	20
Group XVIII	Horse gram powder	20
Group XIX	Peas powder	20
Group XX	Standard	

**EVALUATION OF GLYCEMIC INDEX OF SPROUTED LEGUME POWDER
INCORPORATED RECIPES**



- | | | | | |
|---------------|---|-----|---|-----------------------------|
| 1, 6, 11, 16 | → | BG | - | Bengal gram |
| 2, 7, 12, 17 | → | GG | - | Green gram |
| 3, 8, 13, 18 | → | HG | - | Horse gram |
| 4, 9, 14, 19 | → | DP | - | Dry peas |
| 5, 10, 15, 20 | → | Std | - | Standard (No incorporation) |

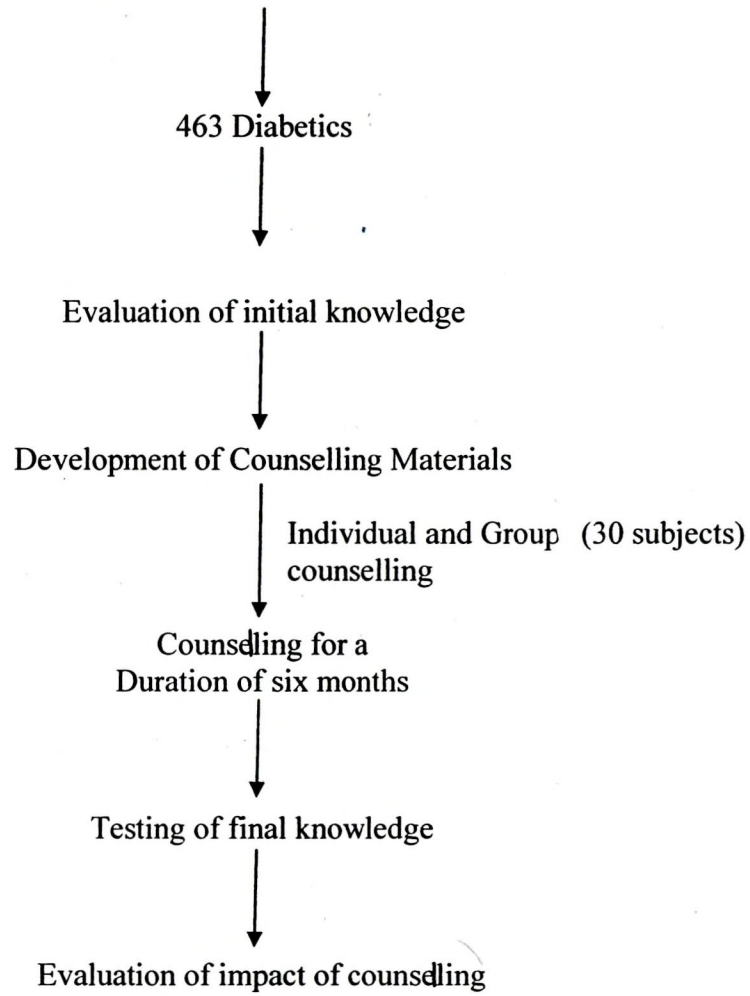
Phase III : Promotion of low glyceic recipes through diet and therapeutic life style counselling

Effective patient education and diet counselling on the nature of disease and the outcomes of good diabetic control are essential in reducing complications and diabetic problems.

Hence diet counselling was organized for all the 463 diabetics in the Tamil Nadu State Transport Corporation, Coimbatore Division (Flow chart). All the diabetics were requested to assemble in the office of the transport corporation in groups of thirty in accordance with their work schedule and shift timings. All the diabetics extended their cooperation and attended the counselling sessions with eagerness and enthusiasm. Prior to diet counselling the initial knowledge of all the diabetics were tested using a questionnaire (Appendix V). The questionnaire contained questions on meaning, causes, symptoms, management and complications of diabetes. The questionnaire also evaluated the knowledge regarding importance of exercise, stress free peaceful life and other life style factors. Scores were allotted for each question and the percentage scores of all the diabetics were computed before imparting counselling.

Based on the initial knowledge of diabetics, themes for counselling were developed using different audio visual methods. The different themes developed and the aids used for each theme are presented in figure I .All the aids were produced both in English and Tamil (regional language Appendix X).

DIET AND LIFE STYLE COUNSELLING



Topics	Contents of counselling	Aids used in counselling
 <p>Facts of diabetes</p>	<p>Meaning, types, normal blood glucose levels, causative factors and symptoms</p>	<p>Pamphlet, Lecture, Posters (Appendix VI)</p>
 <p>Dietary management of diabetes</p>	<p>↙ Dietary recommendations, menu planning, fibre rich foods, glycemic index ↘ Breakfast recipes incorporated with sprouted legume powders</p>	<p>Lecture, food exhibits (plate 4, Posters, handout (Appendix VII) Demonstration, Handout (Appendix VIII)</p>
 <p>Complications of diabetes</p>	<p>Micro vascular and Macro vascular complications</p>	<p>Lecture, posters</p>
 <p>Therapeutic life style modification</p>	<p>Exercises, life style modification, yoga and meditation</p>	<p>Lecture, interactive sessions, demonstration, leaf let (Appendix IX)</p>

THEMES DEVELOPED AND AIDS USED IN COUNSELLING

FIGURE 1

COUNSELLING METHODS

LECTURE



FOOD EXHIBITS



DEMONSTRATION



PLATE - 4

SYMPTOMS OF DIABETES MELLITUS



Tiredness



Very Thirsty



Frequent Urination



Leg Pain



Over Eating



Weightloss



Blurred Vision



Tiredness and Headache

POSTER I

FOODS TO BE INCLUDED LIBERALLY



Cabbages, Ladies Finger, Ash Gourd and other Gourd Vegetables, Beans, Lablab, Radish, Brinjal.



Drum stick leaves, Agathi, Fenugreek, Amaranth, Palak and Manathakkali Greens



Sprouted Legumes and Egg White

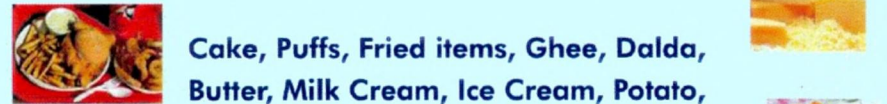


Gingelly Oil, Sunflower Oil, Corn Oil, Ground Nut Oil.

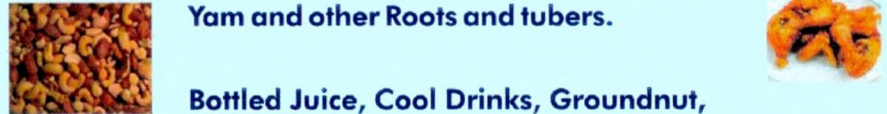
FOODS TO BE AVOIDED



Sugar, Honey, Jaggery and Sweet Preparations.



Cake, Puffs, Fried items, Ghee, Dalda, Butter, Milk Cream, Ice Cream, Potato, Yam and other Roots and tubers.



Bottled Juice, Cool Drinks, Groundnut, Badam, Cashew, Dry Fruits, Egg Yolk, dry fish and alcohol.





Whole Cereals

Fibre Rich Foods



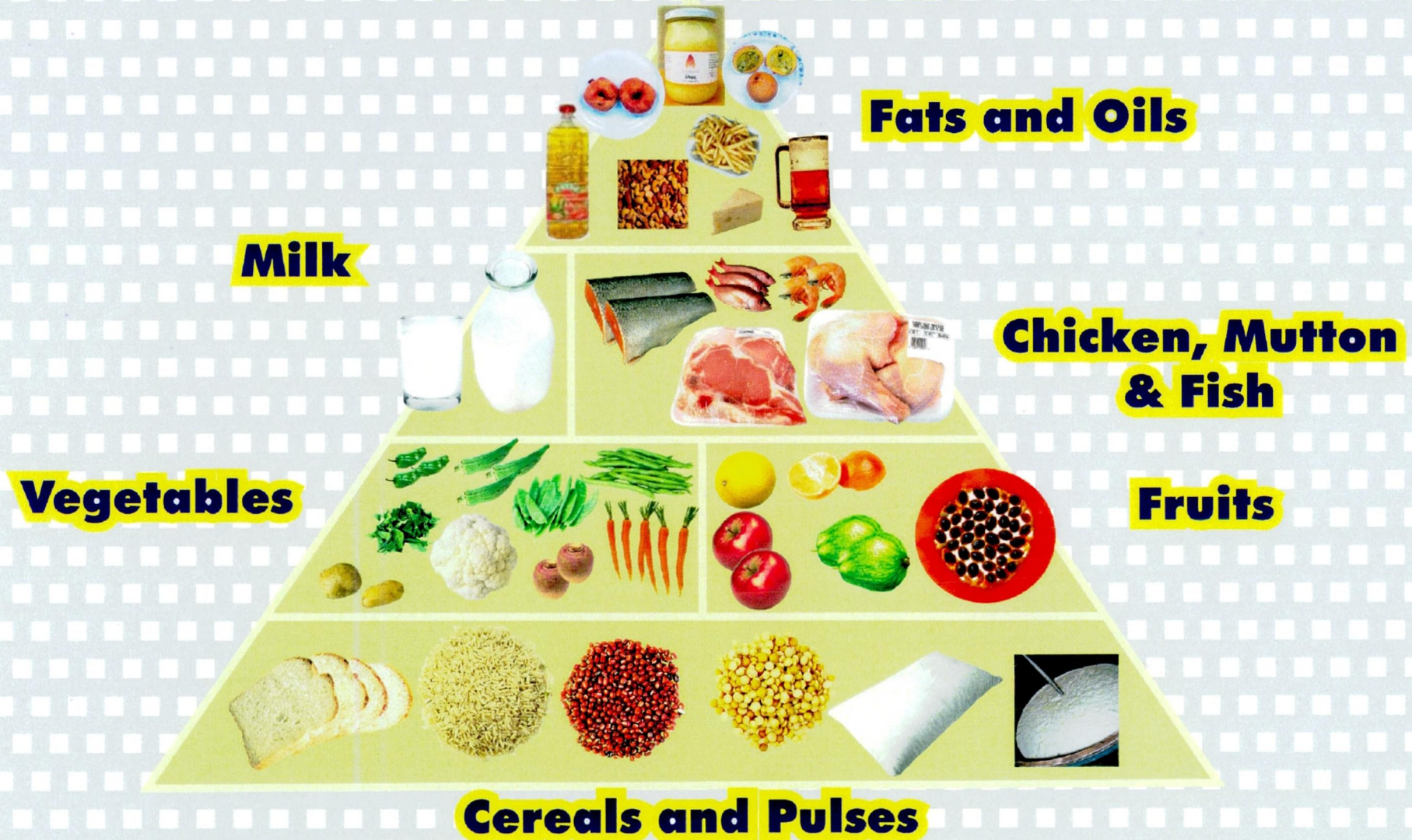
Whole Grains

Vegetables & Green Leafy Vegetables



POSTER III

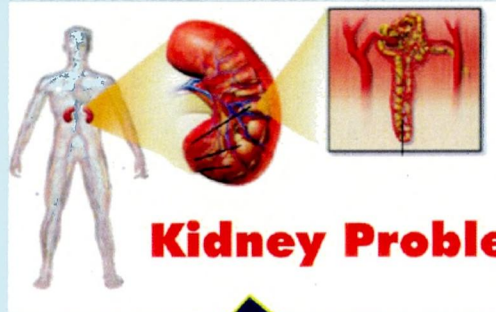
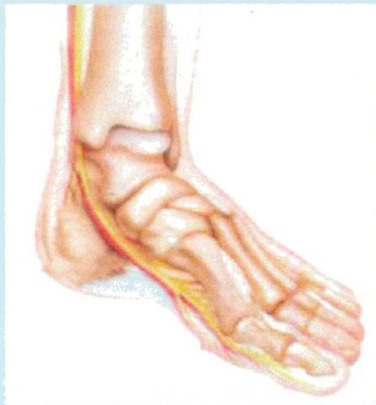
FOOD PYRAMID



POSTER IV

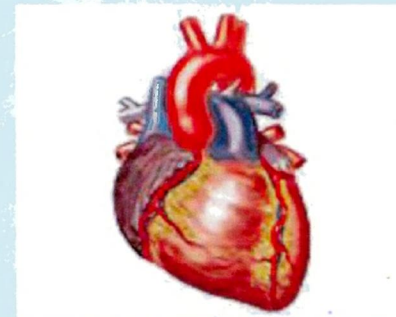
COMPLICATIONS OF DIABETES MELLITUS

Nervous Weakness

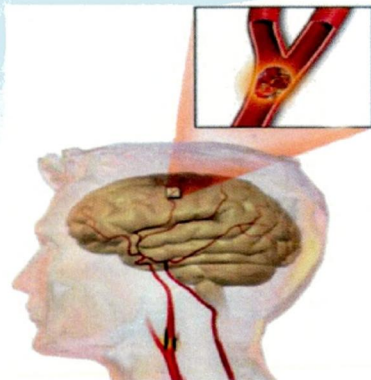


Kidney Problems

Chest Pain and Heart Attack



Paralytic Attack



Complications in Eye



POSTER V

Wound in the Leg



METHODOLOGY – AT A GLANCE

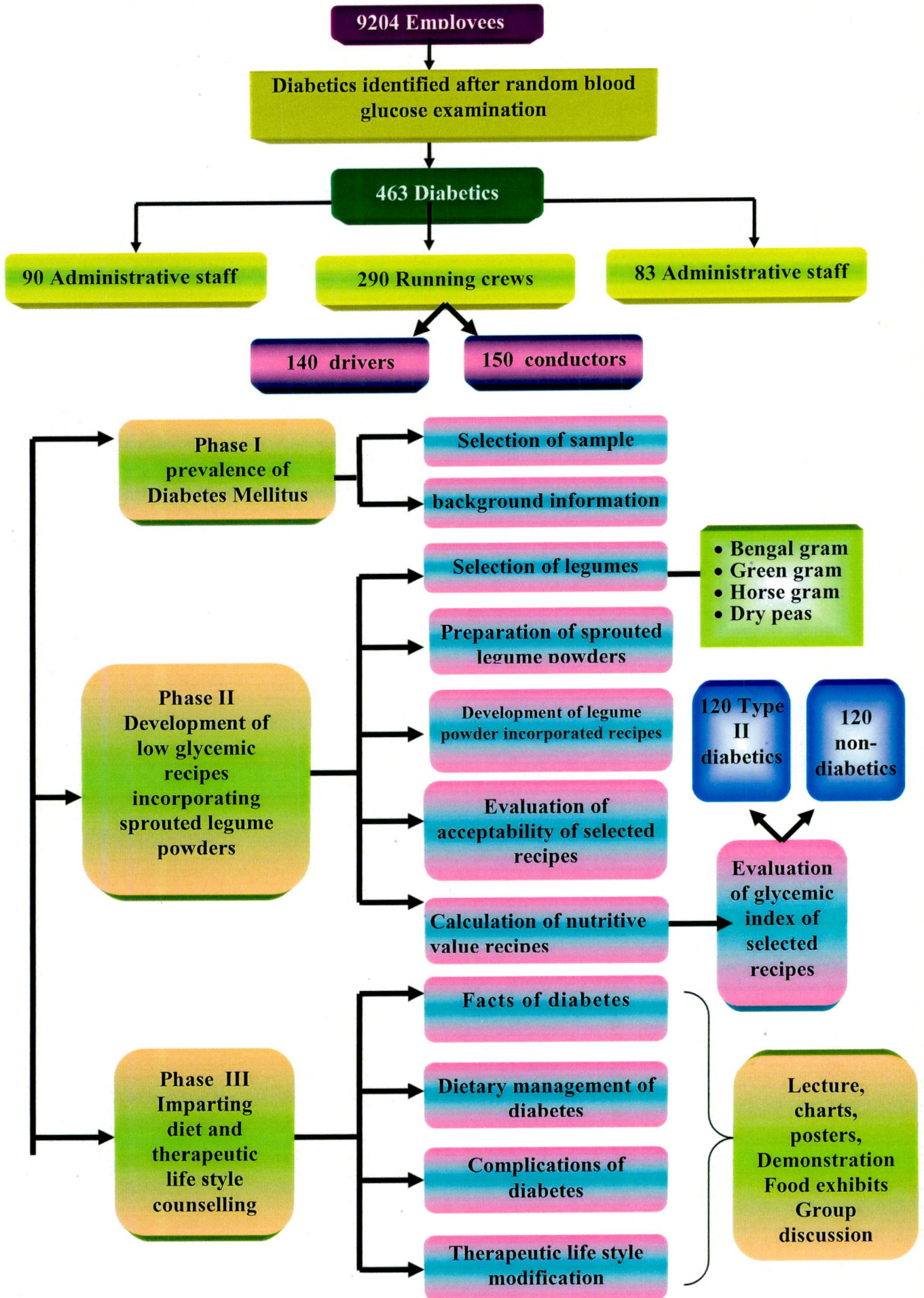


FIGURE 2