

METHODOLOGY

“When planning for an year, plant food crops

When planning for a decade, plant trees

When planning for generation, train and educate people”

When planning for achievements in sports and games, improve the health and nutritional status of athletes. In this direction the present research on “Health status and the impact of pregame supplements on the performance capabilities of sports persons and athletes were undertaken. The methodology followed in the research is described under the following heads:

A. Selection of Area

B. Selection of Subjects

C. Conduct of the Study

Phase I : Collection of socio- economic and athletic profile of the selected athletes

Phase II : Assessment of the nutritional status of the selected athletes

Phase III : Measurement of performance capabilities of the selected athletes

Phase IV : Formulation and standardization of pregame supplements

Phase V : Administration and evaluation of the efficacy of the pregame supplements formulated.

A. Selection of Area

The present research was carried out in Chennai city in Tamilnadu, India. As the study involved female athletes participating in sports and games, institutions which had well established sports and games departments were

identified. Thus three colleges namely Queen Mary's College (QMC), Quaid-e-millath Government College for Women (QMGCW) and Ethiraj College for Women (ECW) were selected for the study. These institutions issued necessary permission and extended co-operation to carry out the research.

B. Selection of the Subjects

The success of any research depends on the careful selection of the study subjects. According to Kothari (2011) study subjects, referred as study sample is the portion of the total population that is considered for the research and analysis. The size of the sample must be optimum in nature. An ideal sample should have the qualities such as representativeness, independence, adequacy and homogeneity (Gupta and Gupta, 2013). Study sample for the present research included 530 female sports persons and athletes in the age group of 18 to 24 years, who were young adults, in their prime productive stage. This is a significant period of human growth and maturation. The proximity of this age group to biological maturity and adulthood may provide final opportunities to implement certain activities designed to prevent adult health problems and enhance their capabilities.

Inclusion criteria considered were

- Female athletes in the age group of 18 to 24 years
- Subjects involved in sports and games
- Free from visible signs of nutritional deficiency, chronic diseases or disability
- Willing to participate in the research

Exclusion criteria comprised of

- Sports persons and athletes below 18 years or above 24 years
- Male subjects
- Those with symptoms of severe nutritional deficiency, chronic diseases or disabilities

All the 530 sports persons and athletes from the selected three colleges who fulfilled the inclusion/ exclusion criteria were selected for the study. Thus

complete enumeration was used in the selection of subjects. Socio- economic status and nutritional status were assessed for all the selected 530 athletes. From this 530, a subsample of 100 athletes were selected by Judgment sampling method for evaluating the endurance capabilities and to test the efficacy of pregame sports supplements .These athletes were divided into three groups. Two groups consisted of 33 each and third group had 34 athletes. First group (Group I) was selected to supplement nutridrink that was formulated. Group II was supplemented with the formulated nutribar and the third group (Group III) did not receive any supplement and served as control group. The selected subjects received all the necessary instructions about the study procedure. Written consent to serve as sample in the present research was obtained from all the selected subjects.

C. Conduct of the study

The study was conducted in five phases

- Phase I** Collection of socio-economic and athletic profile of the selected athletes
- Phase II** Assessment of nutritional status of the selected athletes
- Phase III** Measurement of performance capabilities of the selected athletes
- Phase IV** Formulation and standardization of pregame supplements
- Phase V** Administration and evaluation of the pregame supplements formulated

Phase I

Collection of socio-economic and athletic profile of the selected athletes

The socio-economic status can influence the health status of the athletes and thus have an impact on athletic performance. Hence as a first step to study the socio economic and athletic profile of the selected subjects an interview schedule was developed by the investigator (Annexure I)

Interview schedule is the name usually applied to a set of questions in which the interviewer reads out each question and makes a note of the respondents' answers (Chawla and Sondhi, 2011). Direct personal interview was used to collect the required data. All the 530 subjects were personally interviewed by the investigator and relevant data were recorded. Ramamoorthy (2012) had pointed out that the structured interview provides in depth knowledge of the topic and helps in getting responses from a large population.

The interview schedule included questions on socio economic profile pertaining to age, type of family, size of the family, order of birth and the details of the parents of the subjects namely educational, occupational and income status.

Questions on athletic profile namely type of sports activity of the selected athletes, type of exercise, intensity of exercise, levels of achievement, dimensions of wellness, health problems as expressed by the subjects were recorded. Maximum reliability of the data was ensured by questioning and cross questioning the athletes. Plate 1 shows the interview conducted by the investigator.



Plate I

Interview being conducted

Phase II

Assessment of the nutritional status of the selected athletes

Assessment of nutritional status is one of the first steps in the evaluation of health status of the athletes. The assessment of nutritional status can be summarized by ABCD representing Anthropometric measurements, Biochemical estimation, Clinical examination and Dietary assessment. Hence in Phase II the nutritional status of the selected athletes was studied by collecting data on anthropometric measurements, biochemical estimations, clinical examination and dietary pattern.

1. Anthropometric measurements

Nutritional anthropometry is a measurement of human body at different age and levels of nutritional status. It is based on the concept that appropriate measurements should reflect any morphological variation occurring due to significant functional physiological change (Bamji et al., 2009). Anthropometry has been accepted as one of the most important tools for the assessment of nutritional status. Nutritional assessment helps to maintain the assessed status and to attain a healthier state (Christie, 2010).

a. Measurement of Height

Height is an anthropometric measurement used frequently for assessing nutritional status (Viji, 2011). Height of an individual is influenced by genetic and environmental factors. Inadequate dietary intake or infections reduce nutrients availability at cellular level resulting in growth retardation. Height is affected by long term nutritional deprivation and is considered as a sign of chronic or long duration malnutrition (NIN, 2009).

The height of the selected athletes was measured using stadiometer. The athletes were made to stand on the stadiometer erect with heels together after removing shoes. The head was held comfortably erect and arms hanging at the sides, the buttocks, shoulders and back of the head were in line touching the vertical rod; height was measured in centi meters to the nearest 0.1cm. Plate II shows measurement of height of the athlete.



Plate II

Measurement of height of the athletes

b. Measurement of Weight

Body weight is the most widely used simple and sensitive and reproducible measurement to assess the growth of an individual. According to Arora (2011) the body weight is a gross measure of the body. In the present study using an electronic bathroom scale the weight was measured while the subjects were made to stand bare footed without touching anything, knee not bent, head straight and looking forward with light clothing. The reading was carefully viewed and recorded in kilograms to the nearest 0.1kg. Plate III shows the measurement of weight.



Plate III

Weight of the athletes being recorded

c. Quetelet's Index or Body Mass Index (BMI)

Body Mass Index or weight for height is the index commonly used for classifying underweight, overweight and obese (WHO, 2011). It is the most commonly used index for all nutrition related assessments. It is expressed as the ratio of body weight in kilogram to height in meters squared and is an indicator of health status (Sen Ray et al., 2011). This is also known as Quetelet's Index and can be expressed as:

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

Following this formula Body Mass Index was calculated for all the five hundred and thirty subjects.

d. Waist Circumference

Waist circumference which assesses the abdominal fat is an independent predictor of disease risk. WHO (2008 b) protocol for measuring waist circumference instructs that the measurement be made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest. The subjects were made to stand erect and relaxed with light clothing. A fiber glass tape was kept parallel to the floor and measured around the waist (umbilicus). This was measured to an accuracy of 0.1 cm.

e. Hip Circumference

WHO (2011) suggests that the hip measurement should be taken around the widest portion of the buttocks. The stepwise approach to surveillance protocol recommends that the subjects stand with arms at the sides, feet positioned close together, and weight evenly distributed across the feet. Hip circumference should be measured at the end of a normal expiration, when the lungs are at their functional residual capacity. The tape was positioned around the hip at the symphysis pubis at the greatest gluteal protuberance and the circumference was measured using a non-stretch fibre glass tape. The measurement of waist and hip circumference are depicted in Plate IV.

f. Waist Hip Ratio (WHR)

Waist and hip circumference ratio is an indicator of nutritional status. It reflects the proportion of the body fat located intra abdominally as opposed to that in the subcutaneous region. Waist hip ratio was calculated using the formula:

$$\text{Waist Hip Ratio} = \text{Waist circumference (cms)} / \text{Hip circumference (cms)}$$



Plate IV

Measuring the waist hip circumference of the athletes

g. Triceps Skin Fold Thickness

The measurement of skin fold thickness is an indirect estimation of the body fat. Since subcutaneous fat is the largest depot of body fat, measurement of these fat depots may be useful in estimating the total body fat (Birch et al., 2007). The selected subjects were made to stand erect, arms normally hanging down by the sides, using the thumb and forefinger, fold of skin and fat on the posterior aspect at the person's left upper arm, mid-way between the acromion process of the scapula and the olecranon process at the tip of the elbow was gently pulled away from the underlying muscle; using the skin fold calipers avoiding excessive pressure at the triceps, skin fold thickness was measured and recorded nearest to 0.1mm.

h. Body Fat Percent

Body composition is a factor that can influence athletic performance and as such is of considerable interest to athletes and coaches (Arora, 2011).

Omeron scientific body composition analyzer estimates the body fat percent by the bioelectrical impedance method. Muscles, blood, bones and body tissues with high water content conduct electricity easily. On the other hand, body fat does not store much water and therefore it has minimal electric conductivity. An extremely weak electric current of 50 Hz is sent through the body to determine the amount of water in each tissue. As hydrostatic weight is impractical to use in large epidemiological studies and magnetic resonance imaging (MRI) scans is expensive, bio electrical impedance method is considered the most valid and reliable method to assess the body fat. The body fat percent, visceral fat, muscle mass and BMR were measured for all the selected subjects using Omeron scientific body composition analyzer.

2. Biochemical Estimation

a. Blood Haemoglobin

Haemoglobin estimation is the most important laboratory test that is carried out in nutrition surveys. Park (2011) says that haemoglobin level is a useful index of the overall state of nutrition, irrespective of its significance in anaemias. The blood haemoglobin of the selected sub sample (N=100) was estimated by Cyanmeth-haemoglobin method recommended by Sood (1991). The procedure followed is given in Appendix II.

b. Blood Glucose Level

The fasting blood glucose of the selected subjects was estimated using GOD- POD method. The procedure followed is given in the Appendix III.

3. Clinical Examination

Frieden (2010) has pointed out that physical signs and symptoms are valuable aids in detecting nutritional deficiency. Clinical examination is an essential feature of all nutrition surveys since its ultimate objective is to assess

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 ascertaining the nutritional status of a group of individuals. There are a number of physical signs, some specific and many non-specific known to be associated with states of malnutrition (Park, 2011). Clinical examination was carried out using the clinical examination schedule recommended by ICMR.

4. Dietary Assessment

The nutrient intake of athletes should be adequate to meet the specific requirements for sports activity and in addition for the general requirements of an individual specific to age and gender. It should also take care of the general needs including tissue maintenance and repair to ensure proper health in later life (Venkataramana, 2012). According to Appukutty (2012) healthy and properly designed diet is one aspect of a comprehensive approach to improve performance and overall health.

The dietary profile was evaluated using the interview schedule (Appendix I) developed. Type of diet consumed, diet pattern, diet during competition and non-competition, foods avoided and included during sports activity, sports supplements used and snacking pattern of athletes were studied.

The food and nutrient intake of the subsample of 100 athletes were computed through three days food recall method. All the food items consumed were recorded in terms of standardized cups and measures. From this the weight of the individual cooked foods consumed and the equivalent raw ingredients were calculated. From this the mean food and nutrient intake of the subjects were computed using the book, "Nutritive value of Indian foods" by Gopalan (2010). The adequacy of intake by the athletes were compared with the Recommended Dietary Allowances of athletes given by Pasricha and Thimmayamma (2005).

Phase III

Measurement of performance capabilities of selected athletes

Health status is determined by the nutrition and complemented by physical activity and exercise. Physical fitness is defined as a set of abilities individuals

possess to perform specific types of physical activity. American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) has categorized fitness components into two namely health related fitness and sports related fitness. Both types of fitness may be influenced by nutrition and exercise (Williams, 2005). Key concept of physical fitness assessment is that physical activity should be enjoyable and that physical activity contributes to good health, optimal functioning, learning, well-being and is important throughout a person's life time (Contractor, 2011).

The physical fitness assessment provides individuals with information regarding their physical ability and health status. The performance capabilities can be used as the basis for designing of sports supplements for athletes. It also provides information for program evaluation. In the present research to assess the performance capabilities of the selected athletes, the health related components namely cardio-respiratory tests in terms of Harvard step test, tread mill test, electronic bicycling, 2000 m brisk walking, 1500 m middle distance running and flexibility tests in terms of modified sit and reach test, muscular endurance test in terms of pushups were assessed.

Skill related tests namely speed in terms of 100 m dash and agility through shuttle run (4x10m) were assessed. The procedure followed in the assessment is described in the following:

1. Health related fitness tests

a. Cardio –respiratory endurance tests

i. Harvard step test

In Harvard step test the subjects step up and down for five minutes on a bench of 20 inches high. Each time with the body erect, the stepping process was performed in four counts as follows:

1. Left foot is placed on bench
2. Right foot is placed on bench
3. Left foot is placed on the floor
4. Right foot is placed on floor

The tester may lead off with the same foot each time or any change of feet as subject desires, so long as the four count step is maintained. The steps were counted the cadence as “up, up, down, down”.

The stepping exercise continued exactly for five minutes, unless the subject was forced to stop sooner due to exhaustion. In either case the duration of the exercise in seconds was recorded. Immediately after completing the exercise, the subject sat on a chair and the pulse was counted 1-1 ½, 2-2 ½ and 3-3 ½ minutes after the stepping ceased.

Scoring

Physical Efficiency Index (PEI) was computed utilizing the following formula:

$$\text{PEI} = \frac{\text{Duration of exercise in seconds} \times 100}{2 \times \text{sum of pulse count in recovery}}$$

ii. Tread mill test

The athletes were requested to run on the electronic tread mill at a speed of 10 kmph with four percent inclination for 12 minutes as suggested by cooper (1968) and the distance covered in kilometers by each athlete until they become fatigue was noted and recorded from the monitor display of the treadmill. Plate V depicts the treadmill test conducted for the subject.



Plate V

Performance of an athlete in tread mill

iii. Electronic bicycling

Electronic bicycling was used to measure the endurance capacity of the athletes. The athletes were requested to do the pedalling for 15 minutes as fast as they can and the distance covered by each athlete in kilo meters was recorded from the monitor display of the electronic cycling equipment and recorded.



Plate VI
Electronic bicycling

iv. 2000 metres brisk walking

Each athlete was made to perform 2000 metres brisk walking in the track. The time required to cover the distance was noted in minutes using stop watch.

v. 1500 metres middle distance running

Each athlete was made to run 1500 metres in the track. The time required by each athlete to cover the distance was noted in minutes using stop watch.

b. Flexibility – modified sit and reach test

Flexibility test is the range of motion (ROM) in a joint and series of joints. The sit and reach test was designed to measure flexibility in the lower back and ham string muscle (Charles et al., 2009). The purpose of the sit and reach flexibility test is an important factor in reducing the potential for injury and in improving performance and serves as an important component of overall fitness. Flexibility exercises help to stretch muscles, protect against injury and allows the maximum range of motion for joints (Yobu, 2010). The test requires a sit and reach box. The subjects sat with legs (knees) straight, shoes off and feet against box. Slowly and deliberately reached forward, keeping knees straight and hands even, holding the position for two to three seconds. The readings on the scale attached to the box was recorded and repeated twice. Plate 4 shows the performance of sit and reach test.



Plate VII

Sit and reach test

c. Muscular endurance- floor push-ups

It is the most important test of physical fitness. It is the ability of the body to withstand stress for a prolonged period of time. Performance of the heart and oxygen carrying capacity of the blood mainly determines the endurance. It

depends on the number of times the person can repeat the movement. It is measured in terms of floor pushups.



Plate VIII

Muscular endurance by floor push-ups

2. Skill related fitness tests

a. Speed

Skill related fitness comprised of speed test through 100 m dash. Each athlete was made to run as fast as they can. Time taken to cover the distance in seconds was recorded to the nearest 1/10th of a second using a stopwatch and tabulated.

b. Agility- shuttle run (4x 10m)

Agility is the ability to change the direction of the body or its path in an efficient and effective manner. Agility is achieved by a combination of four qualities such as balance, speed, strength and co-ordination (Goswami, 2011). This was measured using shuttle run. Each athlete was made to run back and forth between two parallel lines as fast as possible. The two lines of cones were set apart by 4x10 meters. The time required to cover the distance was measured in seconds and recorded to the nearest 1/10th of a second using a stop watch.

Phase IV

Formulation and standardization of pregame supplements

A. Formulation of Nutrimix Powder

Assessment of nutritional status and performance capabilities of selected athletes pointed out the need for enhancing the health status and endurance capacity of the sports persons and athletes. Due to low income, poor purchasing power and lack of low cost pregame supplements the selected athletes showed poor performance capabilities. Feeding of the athletes with nutritious supplement prior to an event would enhance the strength, stamina and performance capabilities. A food based approach would be a practical solution in addressing the poor performance and nutritional anaemia which could provide immediate relief. Sridevi and Sarojini, (2008) have pointed out that supplementation may be designed with the locally available, cost effective ingredients to improve the situation.

Indian Science Congress (2016) focal theme emphasizes that the products suited to Indian needs can be designed and developed indigenously.

Karnik (2010) had pointed out that rice, wheat and millets are the cheapest sources of calories. And iron fortified foods such as cereals can be a good way to get iron along with carbohydrates needed to fuel the training. FAO (2009) had declared that cereal based foods as the most important sources of nutrients for the mankind.

Hence keeping cereals and millets as the main ingredients several permutations and combinations were examined and final combinations of three types of nutrimix powders were developed. These variations had red rice (*Oryza sativa*), sago (*Manihot esculenta*), roasted Bengal gram dhal (*Cicer arietinum*), green gram dhal (*Phaseolus aures Roxb*), gingelly seeds (*Sesamum indicum*), niger seeds (*Guizotia abyssinica*) and peanuts (*Arachis hypogaea*) as common ingredients. The type of millet was changed and three different variations of nutrimix powders were developed. Variation I (V1) had ragi (*Eleusine coracana*), variation II (V2) had the millet jowar (*Sorghum vulgare*) and variation III (V3) had

bajra (*Pennisetum typhoideum*). All the ingredients were roasted till the acceptable aroma arose, cooled and powdered in the flour mill.

Shelf life

The formulated nutrimix powder was examined initially, periodically after every 15 days and after a storage period of three months for their microbial content. Standard plate count, yeast and mould count were carried out.

The composition of the three variations of the nutrimix powders developed is given in Table 3.

Table 3

Composition of the three variations of nutrimix powders formulated

Variations	Ingredients	Quantity (g)	Total Weight (g)
V1	Red rice Sago Roasted Bengal gram dhal Green gram dhal Gingelly seeds Peanuts Niger seeds Ragi	100 100 100 100 30 30 30 100	590
V2	Red rice Sago Roasted Bengal gram dhal Green gram dhal Gingelly seeds Peanuts Niger seeds Jowar	100 100 100 100 30 30 30 100	590
V3	Red rice Sago Roasted Bengal gram dhal Green gram dhal Gingelly seeds Peanuts Niger seeds Bajra	100 100 100 100 30 30 30 100	590



Plate IX

Nutrimix powder formulated



Plate X

Pregame supplements formulated

Acceptability of the nutrimix powders

Palatability is the ultimate criteria of any new food product developed. The palatability and acceptability of the nutrimix powders formulated were organoleptically evaluated by a panel of judges. For this purpose a panel was formulated with 10 well trained nutrition experts, 10 athletes and 5 coaches. The products were numbered and presented for evaluation separately for each judge.

The nutrimix powder was evaluated for its appearance, color, taste, mouth feel and flavor. Each criterion carried five scores and the products were evaluated for a total score of 25. A five point hedonic rating scale was used. Rating scale used is presented in Appendix IV. The mean scores of the nutrimix powders developed are presented in Table 4.

Table 4
Mean acceptability scores of the nutrimix powders

Variations	Organoleptic criteria					Mean score (Max. score 25)	Percentage score
	Appearance (5)	Taste (5)	Texture (5)	Mouth feel (5)	Flavour (5)		
I	4	4	4	4	4	20	80
II	3	3.5	3.5	4	3	17	68
III	4	4	3.5	3.5	3	18	72

Variation one had obtained maximum score. Hence this variation I of nutrimix powder was chosen to develop the pregame supplements.

B. Formulation of pregame supplements

The variation I of the nutrimix powder which had scored high in acceptability tests was incorporated into several recipes. Finally three recipes were chosen to serve as pregame supplements. They were:

- Nutridrink which was in liquid form
- Nutribar which had chewable consistency and
- Nutriball which had very soft mouth feel were selected for evaluation.

The composition, nutritive value and acceptability of these three supplements were organoleptically evaluated following the same evaluation procedure used in the development of nutrimix powders. Nutridrink and nutribar had scored high and nutriball had scored low. Hence nutridrink and nutri bar were selected for supplementation to athletes and evaluation.

Phase V

Administration and evaluation of the efficacy of the pregame supplements formulated

The two pregame sports supplements namely nutridrink and nutribar were selected for administration and evaluation by studying the performance capabilities and health status of the selected athletes. For this purpose the sub sample of 100 athletes were divided into two groups of 33 athletes each. Group III had 34 athletes. Group I was supplemented with nutridrink and group II with nutribar. The third group of 34 athletes did not receive any supplement and served as control group.

Prior to supplementation all the 100 subjects were gathered in one place and their initial height, weight, waist circumference, hip circumference and body fat were measured. Blood samples were collected from all the subjects and Blood haemoglobin values were estimated.

The performance capabilities of this sub sample of 100 subjects were studied initially through health related and skill related physical fitness tests.

The nutridrink required for supplementation was prepared by the investigator in the college hostel kitchen. Nutribar was prepared on the previous day by the investigator. All the sub samples in nutridrink group and nutribar group were collected in one place and were requested to follow the instructions given by the investigator.

Every day the practice started at 7.00 am. So, the subjects in the experimental groups namely Group I and Group II were requested to assemble in the ground at 6.00 am. Then Group I was served with 200 ml of nutridrink and Group II with 100 g of nutribar. After consuming the supplement they proceeded for practice. Care was taken to see that the subjects did not miss or waste the supplement served. Each group had three subjects in excess to compensate for the dropouts or irregular subjects.

The supplementation process continued for a period of 90 days. At the end of 90th day all the tests namely anthropometric measurements, biochemical estimation, body composition and performance capabilities tests were again recorded.

The difference in the initial and final values were calculated and statistically analyzed. The mean, standard deviation and tests of significance were performed to analyze the efficacy of the pregame supplements developed.