ANAEMIA AND WORK PERFORMANCE OF PRE-ADOLESCENT GIRLS ENGAGED IN SPORTS ACTIVITIES

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THESIS

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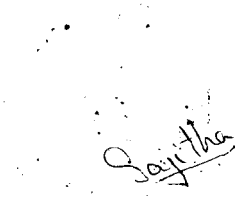
DECLARATION

I hereby declare that this thesis, entitled "Anaemia and work performance of pre-adolescent girls engaged in sports activities" is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree. diploma, associateship, fellowship or other similar title of any other University or Society.



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Dedicated

to

my family

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INTRODUCTION

1. INTRODUCTION

Nutrition assumes a vital role in the field of sports because it plays an important role in maintaining the individual's physical fitness (Chandrasekaran and Easwaran, 2000).

Sports persons and athletes should be considered as a special group as far as their nutritional requirements are concerned (Anon, 1987). According to Eberle (2000), the intense and exhaustive efforts endurance athletes often undertake wouldn't be possible unless they eat the right foods in optimal amounts. The food and fluids the athletes consume before, during and after exercise provide the fuel and nutrient the body needs to perform at its best.

There is no dispute that the most effective way of enhancing athletic performance is through systematic and consistent training. Nutrition makes its greatest impact by supporting training process to acquire improvements in strength, power or endurance. The approach to arrive at the nutritional requirement of athletes must be different from the one used for normal subjects.

The optimum diet providing all the essential nutrients for the athlete must be event specific and suited to individuals needs to maintain optimum body build and composition. Of the essential nutrients iron, plays a vital role in maintaining the oxygen transport system and the

capacity to perform muscular work. Sakurada and Tanaka (1996) found high prevalence of anaemia and iron deficiency state among athletes.

Hallberg and Magnusson (1984) described 'sports anaemia' as a side effect of the hard training in endurance sports, a physiological response of the regulatory systems controlling the haemoglobin concentration in blood to an unphysiological heavy and prolonged exercise load. According to Raunikar and Sabie (1992) the major cause of anaemia in adolescent athletes is nutritional iron deficiency

The research concerning iron deficiency and athletic performance by the McDonald and Carlkeen (1988) and Eberle (2000) has shown that athletic performance is clearly diminished in anaemic, iron deficient athletes, through a lowered oxygen carrying capacity. Nielsen and Nachtigall (1998) viewed that endurance athletes really are at risk of becoming iron deficient due to an imbalance between absorption of dietary iron and exercise induced iron loss.

Data pertaining to the consequences of anaemia on the performance of pre-adolescent girls engaged in sports activities are very meagre and scanty. Hence the present study entitled "anaemia and performance of pre-adolescent girls engaged in sports activities was taken up to identify iron deficiency anaemia among pre-adolescent girls engaged in sports activities and to assess its impact on performance.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Literature pertaining to the study entitled "Anaemia and work performance of Pre-adolescent girls engaged in sports activities" are reviewed under the following headings.

2.1 Prevalence of anaemia

2.2 Factors contributing development of anaemia

2.3 Consequences of anaemia on work performance

2.4 Sports anaemia and its impact on performance

2.5 Effect of supplementation on anaemia

2.1 Prevalence of anaemia

WHO (1991) reported that two billion people suffer from anaemia largely due to iron deficiency. As stated by Marx (1997) iron deficiency anaemia remains as an enormous problem since more than 500 million people suffer from this condition. According to Narasinga Rao (1999) iron deficiency anaemia is the most widespread nutritional deficiency disorder among population with high prevalence particularly among women, children and pregnant women, with a less extent among adult men.

Gebriel *et al.* (1993) reported that anaemia is prevalent in many parts of the world particularly in the developing countries. Stephenson (1995) explained iron

deficiency anaemia as the most common and widespread nutritional problem in both developed and developing countries and its prevalency in preschool children is similar to or greater than pregnant women.

Devadas (1999) reported that in India two out of every three women suffer from iron deficiency anaemia. According to Gopalan (1999) among the nutritional deficiencies currently afflicting women, anaemia is the most widespread.

Nair (1999) reported that anaemia is a major public health problem of India and other developing countries which is more common among reproductive age women and young children. According to Balgir (1999) anaemia is mostly attributed to iron, folic acid and other nutritional deficiencies and is more common among the under privileged communities in India.

According to Raunikar and Sabio (1992); Randhawa and Kanwatra (1994) anaemia is a major health problem among adolescent girls of high as well as low middle class group. Vasanthi *et al.* (1994) reported that there was no significant differences in haemoglobin and haematocrit values among adolescent girls of different age groups.

Jondhale *et al.* (1999) viewed that prevalence of anaemia among adolescent girls is a matter of great concern as these girls enter reproductive life soon after the attainment of their menarche. Nelson *et al.* (1994) stated that in

adolescent girls, anaemia if persisted into the reproductive years will affect the health of their offspring.

Chopdar and Mishra (1981) stated that vitamin deficiency anaemia is common among adolescents. Godfrey *et al.* (1991) stressed that adolescent girls who enter their reproductive phase with low iron stores, need special care and attention. According to Barbin and Barbin (1992) adolescents develop iron deficiency anaemia because of rapid growth and the start of menstruation.

According to Sakurada and Tanaka (1996) and Faintuch *et al.* (1998) iron deficiency anaemia have been reported frequently in athletes.

Brown *et al.* (1985) reported that adolescent female athletes had significantly lower serum ferritin levels and transferrin saturation than non athletes. Rowland (1990) stated that depletion of body iron stores is common among adolescent female athletes due to poor dietary iron intake, menstruation and increased iron losses associated with physical training.

Raman *et al.* (1985) reported that incidence of anaemia was higher in rural girls than urban girls. The observation of NIN (1988-89) on adolescent girls of rural and urban slums indicated that 10-20 per ent of the girls had poor haemoglobin levels.

Studies in UK (Department of Health, 1989; Nelson *et al.*, 1990: Adamson *et al.*, 1992) suggested that iron intakes in adolescent girls is well below the reference nutrient intake. Nelson and co-workers (1993) shown that in a group of apparently healthy white school girls aged 12 to 14 years, 10.5 per cent were anaemic. Nelson *et al.* (1994) found that lov haemoglobin level is more common in the Indian population than white population.

Bruner *et al.* (1996) found that 25 per cent of adolescent girls in U.S.A. are iron deficient. As per the investigation carried out in U.S.A. by Looker *et al.* (1997) it was found that 9 to 11 per cent of adolescent girls were iron deficient and 2 to 5 per cent of them had iron deficiency anaemia.

According to International Anaemia consultative group (INACG) (1985) about 33 per cent of the cumeroonian adolescent were anaemic. Armstrong (1989) reported that 7 per cent of girls aged 14 to 18 years living in county sligo, Republic of Ireland had haemoglobin level below 130 and 120 g/l. Layris *et al.* (1996) conducted a survey in Venezula in Carcas and found tht 36.6 per cent of children had low serum ferritin and 19 per cent of them are anaemic.

2.2 Factors contributing to the development of anaemia

Charlton and Bothwell. (1983) Demayer *et al.*, (1985) and Layrisse *et al.*, (1990) reported that the major causative factor of iron deficiency is the low bioavailability of iron due to phytate particularly in the cereal based diets.

Gopalan (1999) found that the high phytate content present in habitual high cereal diet reduces the bioavailability of iron.

According to Nair (1999) the primary cause of iron deficiency among the people of the developing countries is the insufficient intake of iron from the predominantly vegetarian diets consumed by them.

Weight *et al.* (1992) found that the habitual consumption of iron poor diet is a factor in the aetiology of iron deficiency.

Sumati and Kapoor (1986) has the opinion that anaemia in India is due to reduced amount of iron in cereals and also due to the antinutritional factors present in them.

Balgir *et al.* (1999) found that the common cause of anaemia among under privileged communities in India is due to iron, folic acid and other nutritional deficiencies occuring in them.

Demaeyer *et al.* (1985) had reported that iron deficiency is attributed to increased demand for iron due to chronic blood loss.

Nuviala *et al.* (1996) reported that anaemia is due to depleted iron stores as reflected by poor iron intake and poor intestinal absorption.

Mejia and Arroyava (1982); Bloem *et al.* (1989); Wolde-Gebriel *et al.* (1993) reported that low plasma retinol level is associated with low concentration of haemoglobin and serum iron and low degree of transferrin saturation.

According to Agarwal (1991) anaemia is due to inadequate supply of nutrients like iron, folic acid and vitamin B_{12}. Powers *et al.* (1988) reported that riboflavin deficiency enhances iron loss.

Hallberg *et al.* (1992) found that calcium is a potent inhibitor of iron absorption. Calcium added to meal reduce iron absorption.

According to Weiner *et al.* (1980) mean haemoglobin level of adolescents were lowest when they were consuming the diet containing high amount of cellulose. Wooton (1989) reported that the absorption of iron from vegetables is relatively poor compared to red meat or liver. Beard *et al.* (1996) found that haem iron from animal sources is more readily absorbed than non-haem derived from plant food sources.

Yona (1986) viewed that the practice of feeding tea to young children should be discouraged as it causes anaemia in children.

According to Ayurveda News (1996) the major cause of iron deficiency is internal or external bleeding due to ulcer or haemorrhoids, due to menustral blood loss or may be due to inadequate iron in diet or inability to absorb.

Hallberg and Magnusson (1984) found that anaemia is due to increased mechanical destruction of red cells and due to greater loss of iron through urine and sweat. According to Fleming (1989) iron losses are enhanced by excessive sweating in tropical climate, hook worm infection, malaria and gastrointestinal bleeding due to peptic ulcer or haemorrhoids.

Kripke and Sanders (1990) reported that infestations by worms and repeated episodes of infection predisposes to iron deficiency anaemia.

According to Hutchison (1984) iron deficiency can also occur as a result of chronic blood loss following post operative conditions.

2.3 Consequences of anaemia on work performance

Iron deficiency is the commonest of nutritional deficiencies world wide which leads to lower working capacity

(Walker, 1998). Yip (1994) found that anaemia results in lower growth rate and also lower working capacity.

According to Narasinga Rao (1999) iron deficiency anaemia particularly moderate and severe forms of anaemia (haemoglobin below 10g/dl) leads to several functional abnormalities of health including poor work capacity.

Bradley *et al.* (1988) noticed a reduction in productivity due to anaemia among tea pluckers in Srilanka. A study conducted by Scholz *et al.* (1997) reported that work efficiency was poor among the jute factory workers of Indonesia who has iron deficiency anaemia.

Purushothaman (1989) observed that anaemia affect the productivity and he found that non-anaemic women performed better and their work output was higher when compared to the anaemic women. Leela and Sarma (1998) found that anaemia result in poor work output since the work capacity is reduced considerably due to muscle fatigue.

Vijayalakshmi and Jayanthi (1986) found that anaemia decreases productivity and supplementation with iron improves work output. Sheshadri (1988) demonstrated that anaemic children had lower work tolerance than children with normal haemoglobin level.

Nelson *et al.* (1994) analysed the step test performance of a group of 11-14 year old school girls and found that

the oxygen capacity of the blood was lower in girls with lower haemoglobin levels.

As per the Nutritional Reviews (1983) severe anaemia is claimed to impair work capacity, learning ability and immune functions. Ghosh (1987) stated that anaemia has a profound effect on health, it lowers resistance to fatigue and disease and affects working capacity.

Devadas (1988) revealed that non anaemic expended less energy than anaemics for the same activity. According to Nair (1990) iron deficiency anaemia, apart from its other metabolic effects including those on immune-competence, impairs physical stamina and work efficiency.

Rowland *et al.* (1988) and Rowland and Kellcher (1989) found that iron requirements for adolescent may increase by strenous athletic programmes and their performance may be impaired by the development of iron deficiency.

According to Ghosh (1979) and Agarwal (1989) iron deficiency is found to have an effect on cognitive function in addition to affecting human behaviour, work performance and psychological development.

Devadas (1988) opined that an anaemic women get tired easily while doing household work than an non-anaemic women. Agarwal (1983) stated that food taken by most of the Indians is deficient in iron which adversely affect their work efficiency.

Viteri and Torum (1974) conducted some studies in human beings and found that even milder anaemia can decrease performance in hard exercise. Finch *et al.* (1979) conducted experiments in rats and found that dietary iron deficiency, in addition to anaemia results in a marked impairement in the oxidative production of cellular energy in skeletal muscels. Edgerton *et al.* (1979) found that the productivity of iron deficient individual was significantly less than that of workers with normal haemoglobin concentration.

Reddy (1983) reported that moderate reduction in the haemoglobin level can reduce the work efficiency and lower the resistance to infection. Viteria (1994) found a relationship between anaemia and working capacity in both men and women and found that anaemia reduces working capacity.

Wheeler and Tan (1983) viewed that the nutritional status of an individual has a direct and identifiable effect on his or her productivity at work.

Sheshadri and Malhotra (1984) indicated that the aerobic capacity is reduced in anaemic children which would lead to early fatigue. Bhatia (1987) found that anaemic children had poor endurance capacity and their heart rates were found higher than the normal children for the same level of work.

Nair (1999) found that in adults, low levels of iron can affect work capacity, productivity and impairment of the immune system.

2.4 Sports anaemia and its impact on performance

According to Devries and Housh (1966) the term 'Sports Anaemia' was coined to describe the anaemia that occur in response to heavy endurance training in the absence of any recognisable disease process.

Hallberg and Magnusson (1984) explained sports anaemia as a 'Side-effect' of the hard training in edurance sports, a physiological response of the regulatory systems controlling the haemoglobin concentration in blood to an unphysiologically heavy and prolonged exercise load.

Sakurada and Tanaka (1996) found high prevalence of anaemia and iron deficiency state among athletes.

According to Fintuch *et al.* (1998) sports anaemia is used to describe both pseudodilutional anaemia and the true anaemia of athletes.

Chatard *et al.* (1999) found that trained athletes frequently experience low levels of blood haemoglobin plus low haematocrit and low ferritin levels.

According to McDonal and Carlkeen (1988) the greater risk to athletes is marginal iron deficiency caused by increased erythrocyte fragilty due to training.

According to Faintuch *et al.* (1998) among elite athletes overt anaemia is uncommon but they were in a border line anaemic state.

Eastwood (1997) found that sports women especially those who engaged in highly demanding and competitive sports like running and gymnastics are most susceptible to anaemia.

Nelson and Nachtigall (1998) proposed that endurance athletes really are at risk of becoming iron deficient due to an imbalance between absorption of dietary iron and exercise induced iron loss.

Weight *et al.* (1992) found that the habitual consumption of iron poor diet is a factor in the aetiology of athletes iron deficiency.

Increased serum ferritin levels suggestive of a precarious iron balance is widely reported among the endurance trained athletes (Clement and Asmundsen, 1982; Nelson *et al.*, 1982; Magnusson *et al.*, 1984a,b; Weight *et al.*, 1988) particularly in women (Colt and Heyman, 1984; Lampe *et al.*, 1986; Matter *et al.*, 1987). Sakurada and Tanaka (1996) found that daily exercise is closely associated with the increased risk of iron deficiency state among athletes.

Rowland *et al.* (1991) indicated a high prevalence of non anaemic iron deficiency in female pre adolescent endurance athletes sports particularly running increase the incidence of iron depletion with training.

Nieman and Coworkers (1990) reported that endurance athletes have to evaluate their body iron stores periodically, inorder to check their haemoglobin level which has a major role in performance.

Nickerson *et al.* (1989) found that female cross-country runners have high incidence of iron deficiency which is associated with decreased iron stores and gastro intestinal bleeding. Rowland (1990) found that depletion of body iron stores is common among adolescent female athletes. He also explained that athletes with low ferritin levels are at risk for impaired erythropoiesis and should receive therapeutic iron supplementation.

Rudzki *et al.* (1995) examined the blood and faecal samples of male athletes during intense training and found that eight per cent of the group exhibited faecal blood loss which confirms the Gastrointestinal blood loss.

2.5 Effect of supplementation on anaemia

Vijayalakshmi and Selvasundari (1983): Nutrition Reviews (1983) stated that iron supplementation is an effective

way of combating anaemia and for increasing the work out put of the population.

Walker (1998) found that iron supplements are needed in certain segments of population and the increased dietary intakes could be achieved by food fortification as well as by improvement in individual intake.

According to Vijayalakshmi and Jayanthi (1986) work output of working population can be remarkably increased by suitable iron supplementation.

Purushothaman (1989) observed that iron supplementation conserves energy and their work output was found to increase after supplementation. Bartsch *et al.* (1998) indicated that iron supplementation improves performance only when haemoglobin concentration increases.

Sheshadri and Malhotra (1984) reported that iron supplementation not only raise the haemoglobin level but also the work performance. Devadas (1988) stress the need for iron supplementation to improve work capacity. Sheshadri (1988) observed a significant improvement in working time after iron therapy in serum deficient individuals.

A study conducted in China by Li *et al.* (1994) indicated that iron supplementation to anaemic cotton mill workers improve their production efficiency.

Iron supplementation in toddlers resulted in an increased rate of weight gain and improvement in psychomotor development (Auckett *et al.*, 1986).

Powers *et al* (1988) reported that supplementation with riboflavin, thiamin, vitamin C and iron together had the effect of raising work performance in children.

Iron supplementation studies carried out on rubber tappers in Indonesia (Basta *et al.* (1979), on tea pickers in Srilanka (Bradley *et al.*, 1988) indicated significant gains in productivity after the treatment of individual for iron deficiency.

A study conducted in Canada by Quinn (1996) found that the incidence of anaemia in infants has been reduced from more than 50 per cent to less than 5 per cent due to the provision of an iron fortified formula.

In a survey conducted by Layrisse *et al.* (1996) found that in a group of school children there was a reduction in the prevalence of low serum ferritin and anaemia due to iron deficiency after the introduction of fortified wheat flour and fortified pre cooked maize.

According to Weink *et al.* (1997) ascorbic acid is thought to increase iron absorption because of its reducing properties by which it converts and keeps iron in the ferrous state.

According to McDonald and Carlkeen (1988) iron supplementation has been shown to reverse the loss in athletic performance in iron deficient athletes.

Rowland (1990) stated that athletes with low ferritin levels are at risk for impaired erythropoiesis and should receive therapeutic iron supplementation, otherwise exercise performance may impair.

Chatard *et al.* (1999) found that anaemia in athletes can be treated by preventing decreased iron stores through a balanced food intake or iron supplements.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The methodology adopted for the study entitled "Anaemia and workperformance of pre-adolescent girls engaged in sports activities" is presented below.

1. Locale of experiment

G.V. Raja sports school located at Sanghumugham, Trivandrum, is an institution financed by the government of Kerala and sports authority of India with the purpose of educating and giving intense training to selected children in sports and athletic events. For this particular study, subjects were drawn from the G.V. Raja Sports school and also from the schools engaged in similar activities were purposively selected.

2. Selection of sample

Earlier studies conducted by Rowland (1990) and Nieman and coworkers (1990) indicate that, female adolescent athletes show depleted body iron stores due to poor dietary iron intake, menstruation and increased iron lossess associated with physical training. They also show low haemoglobin level. Hence in this study pre-adolescent girls belonging to the age group 13 to 15 years engaged in sports and athletic events were purposively selected.

Locale of the experiment

50 pre-adolescent girls from G.V.Raja Sports school and 50 from other schools were selected for the study.

Development of tools and conduct of study

3.1 Assessment of the socioeconomic variables of the respondents

In order to elicit information regarding socio-economic background of the respondents details regarding family income, type and size of the family, religion, family composition, educational and employment status of the parents as well as of the respondents are to be collected. Incorporating the above variables a suitable questionnaire was developed which was pretested and administered among the respondents. Questionnaire used for the purpose is presented in Appendix I.

3.2 Assessing the dietary habits of the respondents

Diet survey was conducted to assess the dietary habits of the respondents. Diet survey constitute an essential part of any complete study of nutritional status of an individual providing information on nutrient intake levels (Gopaldas and Seshadri, 1987).

In the present study, diet survey was conducted to assess the eating habits of the respondents, frequency of use of different food items, meal frequency, food preference of the

subjects and also the haemopoetic constituents presents in their food.

A suitable questionnaire was developed incorporating all the variables which was pretested and administered among the respondents. Questionnaire used is presented in Appendedix II.

Frequency of use of different food items in the dietaries of the respondents clearly indicate the adequacy of the diet consumed by them.

In this study food use frequency was measured on a 'seven point' rating scale and the ratings are given below.

Frequency of use	Scores
Daily	7
Thrice in a week	6
Twice in a week	5
Once in a week	4
Fortnightly	3
Occassionally	2
Rarely	1

The total scores for each of the food groups used by the respondents were calculated using the formula suggested by Reaburn *et al.* (1979) which is given below.

$$\text{Percentage of total score} = \frac{R_1S_1 + R_2S_2 + \ldots\ldots + R_nS_n}{n}$$

S_n = Scale of rating

R_n = Percentage of respondents selecting a rating

n = Maximum scale rating

Schedule required for finding the food preference of the respondents was also formulated. The preference of the respondents for different food items was rated on a seven point scale as stated.

Preference score	Scores
Most extremely liked	7
Extremely liked	6
Less extremely liked	5
Liked	4
Slightly liked	3
Not liked that much	2
Not at all liked	1

The preference scores of the respondents for different food items were calculated as suggested by Reaburn *et al.* (1979).

3.3 Assessing the food consumption pattern of the subjects through dietary recall method

In the dietary recall method the respondents were asked to recall the actual food and drinks consumed by them in the previous day. Gore *et al.* (1977) opined that actual food intake was assessed through food weighment method and it gives reasonably accurate values of individual dietary intake. According to Visweswara Rao (1975) any single day or 2 day weighment method would be as efficient a tool as that of 7 days. The questionnaire developed for the purpose was pretested before administration and is given in Appendix III.

3.4 Assessing the energy balance

In order to determine the energy balance, the energy expenditure and energy intake pattern of the respondents are to be determined. Energy expenditure was determined using prediction equation as suggested by ICMR (1989) given in Appendix IV. According to Groot and Staveren (1995) the body's energy reserves are regulated via the balance between energy intake and energy expended. Actual energy intake was assessed by conducting one day recall dietary survey.

3.5 Assessing the nutritional status of the respondents

Kamath (1986) defined nutritional status as the State of health enjoyed as a result of nutrition. Wheelar and Tan (1983) have the view that the nutritional status of an

individual has a direct and identifiable effect on his or her productivity at work.

Techniques used for assessment of the nutritional status of the respondents in this study include evaluation of anthropometric measurements, food adequacy, clinical examination and bio-chemical investigation. The schedule used for the assessment is presented in Appendix V.

3.5.1 Anthropometric measurements

For assessing the nutritional status of the subjects anthropometric measurement is considered as an effective measure. Anthropometry has been accepted as an important tool for the assessment of nutritional status (Vijayaraghavan, 1987) According to Chen *et al.* (1978) anthropometric measurements are considered to be an internationally accepted system for determining nutritional status. Weisell and Francois (1982) reported that anthropometric data are being used increasingly in estimating nutritional status. Body weight and height along with measures of subcutaneous fat such as Skinfold thickness are considered to provide adequate information about the body size and fitness of the athlete (Fransancho *et al.*, 1982).

Anthropometric measurements viz. weight for age, height for age, body mass index, mid upper arm circumference, waist hip ratio, triceps skinfold thickness, arm muscle, body

fat percentage and lean body mass of the respondents were taken in the present study to assess the nutritional status.

3.5.1.1 Weight for age

Weight is a measurement of body mass. Comparison of weight for age value, with regional standards at corresponding age will help to determine the degree of undernutrition in a community. According to Kaul and Nyamongo (1990) a change in body weight may be the result of changes in the health of an individual, changes in dietary supplies or even change in one's physical activity.

For weighing, platform weighing balance was used, as it is portable and convenient to use in the field. The weighing scale was checked periodically for accuracy. The scale was adjusted to zero before each measurement. The subject was having minimum clothing and was asked to stand on the plat form of the scale, without touching anything and looking straight ahead. The weight was recorded to the nearest 0.25 kg. Each reading was taken twice to ensure correctness of the measurement.

3.5.1.2 Height for age

Height or the total length, apart from nutritional and other environmental factors is influenced by hereditary factors. The extend of height deficit in relation to age as

compared to regional standards may be regraded as a measure of the duration of malnutrition (Gopaldas and Seshadri, 1987).

To determine height, a measuring tape was fixed vertically on a smooth wall, perpendicular to the ground, taking care to see that the floor area was even and not rough. The subject was asked to remove her slippers, stand with the centre of her back touching the scale with her feet parallel and heels, buttocks, shoulders and back of the head touching the wall. The head was held comfortabily erect, the arms hanging loosely by the side. A smooth, thin ruler was held on the top of the head in the centre, crushing the hair at right angle to the scale, and the height read off from the lower edge of the ruler to the nearest 0.5 cm. Each reading was taken twice to ensure correctness of the measurement.

3.5.1.3 Body Mass Index

Body Mass Index (BMI) is expressed as the ratio of weight to height square ie. (weight (kg)/Height^2 (m)), can be used as a good parameter to grade Chronic Energy Deficiency (CED) (Nutrition News, 1991). Chronic Energy Deficiency has been defined as a steady state in which a person is, in energy balance, although at a cost either in terms of risk to health or an impairment of function and health. Body Mass Index is regarded as a good indicator of nutritional status. The normal BMI values of children is between 19 and 24.

3.5.1.4 Mid-Uppr arm circumference

Measurement of the mid-upper arm circumference is the most useful, practical method for assessing muscle mass, as this region is easily accessible and measurement requires only a flexible fibre glass tape (Gopaldas and Sheshadri, 1987).

Mid arm circumference was measured to the nearest 0.1 cm with a tape by placing gently but firmly round the limb to avoid compression of the soft tissues. The left arm was measured while hanging at its mid point.

3.5.1.5 Waist-Hip Ratio

According to Lean *et al.* (1995) the Waist-Hip Ratio (WHR), reflects the proportion of body fat located intra-abdominally as opposed to that in the subcutaneous region. After documenting the waist and hip measurements of the respondents their Waist Hip Ratio was calculated. Chadha *et al.* (1995) suggested that the Waist-Hip Ratio was calculated by dividing the circumference of the waist by the circumference of the hip.

3.5.1.6 Triceps skin fold thickness

According to (Malina *et al.*, 1974) measurement of skinfold (fat fold) at triceps is one of the methods for assessment of the amount of subcutaneous fat, which gives an

indication of the calorie reserves in the body of an individual.

Skinfold thickness was determined using a Langares caliper. A lengthwise skinfold was firmly grasped and slightly lifted up between finger and thumb of left hand. Care was taken not to include underlying muscle. The calipers was applied about 1 cm below the operators finger at a depth about equal to the skinfold, while the skinfold was still gently held throughout the measurement. The measurement was read to 0.1 mm accuracy and the results averaged.

3.5.1.7 Arm muscle area

Arm muscle area is determined by using arm circumference measurements and also with the measurements of triceps skinfold thickness by the formula suggested by Gurney and Jelliffee (1973).

$$\text{Arm muscle area} = [(Ac - TSF)^2 / 4\pi - 6.5]$$

where

Ac = arm circumference and

TSF - Triceps skinfold thickness

3.5.1.8 Body Fat Percentage

The assessment of Body fat percentage from BMI, Sex and age provide accurate estimate of body composition.

Body fat percentage (BF per cent) is determined using the formula suggested by Deurenberg *et al.* (1991).

BF per cent = 1.51 x BMI - 0.70 x age - 3.6 x Sex + 1.4

3.5.1.9 Lean body mass

According to Garn *et al.* (1985) during childhood and adolescence, fatter individuals were also taller, had more lean body mass and exhibit developmental advancements including early maturity.

Lean body mass of subjects are evaluated using the formula recommended by Cole *et al.* (1997).

Lean body mass = Body weight (kg) - Body fat (kg)

3.5.2 Clinical examination

Clinical examination is stated to be one of the most essential and the simplest tool used in the evaluation of nutritional status (Gupta *et al.*, 1989). It is part of nutritional assessment through which direct information of signs and symptoms of dietary deficiency prevalent among the school children can be collected. The presence or absence of clinical deficiency symptoms which is an index of nutritional status was assessed by a qualified physician.

3.5.3 Biochemical investigations

Biochemical measurement is one of the most important tool for assessing the nutritional status of the subject. There are several biochemical indicators of malnutrition specified for different nutritional deficiencies.

3.5.3.1 Haemoglobin

Park and Park (1991) states that haemoglobin level is an useful index of the overall state of nutrition irrespective of its significance in anaemia.

The haemoglobin level of 100 children was estimated by cyanmethaemoglobin method suggested by Dacie *et al.* (1975).

3.5.3.2 Packed cell volume (PCV) or Haematocrit %

Haematocrit per cent or PCV gives the volume of RBC/Packed cell present in 100 ml of blood. Swash and Manson (1984) found that haematocrit percentage or packed cell volume is the basic value revealing the degree of anaemia.

3.5.3.3 Blood pressure

Assessing blood pressure in a subject is to understand any cardiac abnormalities present. It is measured using an instrument called the sphygnomanometer.

Biochemical profile of the respondents

3.5.3.4 Pulse rate

Reddy (1983) reported that the pulse, cardiac out put and oxygen uptake are related to the physical work done by an individual. To assess the rate of heart beat, the radial pulse at the wrist is generally used (Swash and Mason, 1984).

3.5.3.5 Red blood cell count

The technique suggested by Dacie and Lewis (1975) was followed for the measurement of red blood cell count. Enumeration of red blood corpscles gives an index of anaemia.

3.5.3.6 Differential leucocyte count

Differential leucocyte count is an useful estimation for detecting abnormalities in the leucocyte or WBC as stated by Lois *et al.* (1986) and according to Chatterjee (1987) variation in the normal count of leucocytes occur after hostile invasion with parasites in asthma and in skin diseases. The method suggested by Dacie and Lewis (1975) was used in present study.

3.5.3.7 Serum iron

Using Wong's method the amount of serum iron present in blood was estimated from which the extend of iron deficiency can be detected.

3.5.3.8 Total Iron Binding Capacity (TIBC)

Total Iron Binding Capacity was estimated because it helps to confirm the extend of iron deficiency as suggested by Rajajee (1989). TIBC was measured after saturation of transferrin by an iron solution and absorption of the excess iron on magnesium hydroxy carbonate as suggested by Ramsay (1957) and Piccardi *et al* (1972).

3.6 Assessing the bioavailability of iron from cooked foods

According to Beard *et al.* (1996) Haem-Fe from animal sources is more readily absorbed than non-haem Fe from plant sources. Wong's method was used to determine the iron content of cooked foods (NIN, 1991).

3.7 Assessing the physical endurance abilities of the respondents

Iron deficiency anaemia can cause marked impairments in physical performance, particularly in endurance activities (Wooton, 1989). Inadequate iron intake results in loss of strength and endurance, easy fatigability, shortened attention span and loss of visual perception - all vital attributes for sports. Physical endurance capacity of the respondents were assessed in this study to identify the impact of anaemia on the performance of the athletes. The physical endurance indicators used in this study are strength test which include bench press

test and overhead press test. Anaerobic test viz. the sergent jump and aerobic step test was also conducted among the respondents.

3.7.1 Bench press test

In order to conduct Bench press test, the subjects were asked to lie on a bench or supreme position by holding the barbell in front of the chest lower the weight near to chest by flexing the elbow and take it up. This is repeated for a maximum of repetition between 2-20.

3.7.2 Over head press

To conduct over head press the subject was asked to lift the barbell above the head with sufficient distant of feet and well balance. Flare the elbow and bring the weight in front of the body by lowering the elbow below the shoulder level. This is repeated for a maximum of repetition between 2-20.

3.7.3 Sergent jump test

This test is named after its originator Surgent. D.A. This consist of a vertical leap into the air and is primarily a test of the ability of the body to develop power in relation to the weight of the individual himself. In this jump the individual swings his arms downward and backward taking a

crouch position with knees bend approximately to a right angle. The subject passes in this position to eliminate the possibility of double jump and leaps upward as high as possible, swinging the arms forcefully forward and upward. Just before the highest point of the jump is reached the arms should be swinging at forward and downward motion being timed to coincide with the height of the jump. The specified arm movements in executing the jump are extremely important, the test developing serious in accuracies without them. The best of 3 trials are to be recorded.

3.7.4 Step test

Nelson *et al.* (1994) found that there is an elevation of heart rate in subjects with low haemoglobin after the step test.

In this test the subjects step up and down 30 times a minute on a bench 20 inches high. Each time the subject should step all the way up on a bench with the body erect. The stepping exercise continues for exactly 4 minutes unless the subject is forced to stop sooner due to exhaustion. Immediately after the completion of the exercise the subject siles on a chair. The pulse is counted to 1 to 1.5, 2 to 2.5 and 3 to 3.5 minutes after the stepping ceases.

3.8 Developing performance Index of the respondents

Physical endurance indicators assessed in the respondents such as bench press, overhead press, sergent jump test and step test were taken in to account for developing the performance Index of the respondents.

Suppose Kij be the observation corresponding to the j^{th} variable for the i^{th} sample Wj = $1/Si^2$, Si^2 being the variance of the i^{th} variable based on a sample of N size, the performance index of i^{th} individual is calculated as follows.

N = $K\leq$ wi x ij,

i = 1, 2, ... N

N = No of respondents

k = No. of variables

3.9 Developing Nutritional Status Index (NSI) of respondents

For developing the Nutritional Status Index of the respondents. The most relevant parameters assessed in the respondents such as body weight, height, BMI, MUAC, WHR, body fat percentage, lean body mass, dietary variables viz. calorie and protein intake and biochemical parameter viz. haemoglobin levels were taken into consideration. Procedure followed is similar to that described above.

Statistical analysis

The data collected through the schedules and direct measurements were subjected to and interpreted in terms of frequency and percentage analysis, mean, correlation analysis and test of significance.

RESULTS

4. RESULT

The result of the present study entitled 'Anaemia and work performance of the pre-adolescent girls engaged in sports activities' are presented under the following heads.

4.1 Socio economic status of the respondents

4.2 Dietary habits of the respondents

4.3 Food consumption pattern of the respondents

4.4 Assessing the energy balance of the respondents

4.5 Nutritional status of the respondents

4.6 Assessing the bioavailability of iron from cooked foods

4.7 Physical endurance capacity of the respondents

4.1 Socio-economic status of the respondents

Socio-economic status have a very distinct role in moulding the behaviour of the adolescents.

Socio-economic background of the respondents were assessed with regard to income, religion, caste, type and size of the family, number of adults and children, educational and employment status of the parents, educational status of the respondents, family composition and birth order of the respondents.

In this study all the respondents selected were from low income families. as the selection of the athletes to be admitted in sports school is from lower income families.

Religion play a dominant role in the process of socialization and it maintains the stability of the social system and social relationships. Table 1 depicts the religion and castewise distribution of the respondents. Among the respondents of the study, 51 per cent were christians, 48 per cent were Hindus. Only negligible respondents belonged to Muslim community. Caste wise distribution of the families revealed that 49 per cent of them belong to backward communities, 43 per cent belong to forward and only 8 per cent were from schedule caste community.

Table 1

Distribution of the respondents as per religion and caste

	Particulars	Respondents
a.	Religion	Percentage
	Hindu	48
	Christian	51
	Muslim	1
	Total	100
b.	Caste	Percentage
	Forward	43
	Backward	49
	Schedule caste	8
	Total	100

Type and size of the family are two socical factors which influence the nutritional status of the family members. The data collected indicated that majority of the respondents (79 per cent) are from nuclear type families while only 21 per cent belong to Joint/extended type families.

Family size has a direct and favourable impact on the nutritional status of the respondents. Family size of the respondents indicated that more than half (58 per cent) are medium sized with 5 to 7 members while 39 per cent are small sized with only 4 members. Negligible families are having members more than seven.

Table 2

Distribution of families according to type and size

a. Type of family	Respondents Percentage
Nuclear	79
Joint/Extended	21
Total	100
b. Size of family	**Percentage**
Small size (Upto 4)	39
Medium size (5 to 7)	58
Large size (Above 7)	3
Total	100

Table 3 depicts the number of adults and children in the families. As indicated in table 3 majority (52 per cent) of the families are having two adults and two children while 25 per cent are having 3 adults and 3 children.

Table 3

Composition of families of the respondents

a. Number of adults	Respondents Percentage
One adult	1
Two adults	52
Three adults	25
Four and above	22
Total	100
b. Number of children	**Percentage**
One child	18
Two children	52
Three children	25
Four and above	5
Total	100

A definite inverse relationship was observed between the birth interval of children and the prevalence of moderate or severe malnutrition. As the birth order increased nutritional status was found to decrease especially among the low socio-economic families. The birth order of the respondents revealed that 44 per cent of the respondents are

in the first birth order while 29 and 22 per cent respectively are in the second and third birth order, and negligible respondents (5 per cent) are found to be in the fourth birth order.

Table 4

Distribution of respondents as per ordinal position

Ordinal position	Percentage
First	44
Second	29
Third	22
Fourth	5
Total	100

Educational status is a powerful determinant of economic position. More over it is found to influence the growth and development of the children.

As indicated in table 5 majority of the respondent's parents have education upto high school level (63-67 per cent). While approximately 20 per cent respondent's parents are found to have higher educational attainments (College level). Among the respondents, both the parents having upper primary education was found to be comparatively less (12-14 per cent).

With regard to the educational status of the respondents, it was found that 41 per cent are studying in the eighth standard, 33 per cent in the tenth standard and 26 per cent in the ninth standard.

Table 5

Distribution of the respondents and their parents based on their educational status

a. Educational level	Father (in per cent)	Mother
Upper primary	12	14
High School	67	63
College	18	20
Graduate	0	1
Others	3	2
Total	100	100

b. Education level	Respondents (in per cent)
Eight standard	41
Ninth standard	26
Tenth standard	33
Total	100

Higher level of employment is found to have a favourable impact on the nutritional status, as it has a direct influence on income and purchasing power.

Employment status of the respondent's parents are depicted in table 6. It was observed that nearly half of the respondent's fathers (42 per cent) are self employed. However 81 per cent of the respondent's mothers are found to be house wives. Few of the respondent's parents are employed in

Government sector (11-14 per cent). However 7 to 19 per cent of the respondent's parents are found to be casual labourers.

With regard to the number of employed persons in the family it was found that majority (82 per cent) of the families are having only one employed member, while in 14 per cent families both the parents are found to be wage earners.

Table 6

Distribution of families based on the employment status of parents

Employment status of a. Parents	Father (in per cent)	Mother
Employed	91	19
Not employed	9	81
Total	100	100
b. Type of employment	**Father (in per cent)**	**Mother**
Government	14	11
Private	4	0
Part time	12	1
Casual labourer	19	7
Self employed	42	0
Total	100	100
c. Number of person employed in the family		**Percentage**
One		82
Two		14
Three		2

4.2 Assessment of the Dietary habits of the respondents

Dietary habits of the respondents were assessed through diet survey. Details regarding eating habits, frequency of use of different food items, meal frequency followed. food preferences of the respondents, haemopoetic constituents present in their dietaries were collected and results obtained are presented.

Eating habits of the respondents showed that all of them were non-vegetarians. Irrespective of the economic level, the habit of taking animal foods daily in the dietaries was noticed.

Frequency of use of different food items were depicted in Table 7. Among the various food groups, cereals and milk was found to be used daily by the respondents, as the frequency score obtained was centum. Similarly food adjuncts such as fats, sugar, spices and condiments were also included in the dietaries of the respondents. Pulses, vegetables, roots and tubers, fruits, meat, fish and egg were found to be used frequently by the respondents as indicated from the frequency scores (83, 99, 90, 88, 82, 89, 86 respectively). Among the various foods, least frequency score was obtained for green leafy vegetables (72), which indicate comparatively limited use of this food item in the dietaries.

Table 7

Distribution of respondents based on the frequency of use of different food stuffs

Sl.No.	Food stuffs	Scores obtained
1.	Cereals	100
2.	Pulses	83
3.	Vegetables	99
4.	Green leafy vegetables	72
5.	Roots and tubers	90
6.	Fruits	88
7.	Milk	100
8.	Meat	82
9.	Fish	89
10.	Egg	86
11.	Fat	100
12.	Sugar	100
13.	Spices and condiments	100

On assessing the meal frequency it was found that four meal pattern viz., breakfast, lunch, evening tea and dinner was followed in majority (78 per cent) of the families surveyed and only 22 per cent followed 3 meal pattern viz. breakfast, lunch and dinner.

Biological, psychological and developmental changes during adolescence have a dynamic effect on the food preferences, food habits and eating behaviour of adolescents.

These food preferences and habits are formed as a result of the complex interaction of many factors, within the individual and with that of his environment (Mahan and Rees, 1984).

Food preference of the pre-adolescent athletes was assessed on 7 point rating scale as suggested by Reaburn *et al.* (1979). Table 8 depicts food preference scores of the respondents as per the individual food items.

Preference score for cereals ranged between 60 to 81. Among the cereals rice was found to be the most preferred one (81 per cent) by the respondents followed by wheat (76 per cent) and ragi (60 per cent).

With regard to pulses, green peas was the most preferred (82 per cent) pulse among the respondents followed by greengram (79 per cent) and pegeonpea (77 per cent). Preference score for black gram and horsegram was found to be 58 per cent each, while that of the red gram dhal was only 54 per cent.

Preference score for green leafy vegetables indicated that amaranthus (78 per cent) was preferred most by the respondents followed by drumstick leaves (73 per cent), cabbage (72 per cent) and cauliflower (58 per cent). Fenugreek leaves was found to be the less preferred greens for the respondents.

The preference scores obtained for vegetables ranged between 51 to 85 per cent. Field beans is the most preferred

(85 per cent) vegetable among the respondents while ashgourd was seen to be the least preferred one (51 per cent). Bread fruit and green plantain scored around 80 per cent for preference by the respondents. Preference scores were around 70 per cent for vegetables like ladies finger, cucumber and ivygourd.

Among roots and tubers tapioca (90 per cent) was the most preferred item. Tubers like sweet potato (79 per cent) potato (75 per cent) elephant yam (75 per cent) carrot (67 per cent) white yam (66 per cent) onion (65 per cent) and beet root (63 per cent) were also found to be liked by the respondents.

Almost all the fruits are found to be extremely preferred by the respondents. The scores ranged between 70 to 100. Mango and plantain are preferred by all the respondents.

Among nuts and oil seeds highest preference was obtained for cashewnut (centum) followed by groundnut (94 per cent) and coconut (85 per cent). Gingelly seed was the least preferred (67 per cent) oil seed.

Preference scores for milk and milk products was found to be ranged between 75-100 among the respondents. As expected the icecream was highly preferred by all the respondents followed by curd (96 per cent) buttermilk (95 per cent) milk (92 per cent) and ghee (75 per cent).

The preference scores obtained for animal foods ranged between 67 and centum. Chicken was the most preferred item (100 per cent) by the respondents.

Preference of the pre-adolescents for bakery and other processed foods indicated that these foods are very much liked by the respondents. The preference scores ranged between 73 and 100. Respondents were also in the habit of taking health drinks and the preference scores ranged between 93 to 96.

Table 8

Distribution of respondents based on the food preference score

Sl.No.	Name of food stuffs	Range of scores
1.	Cereals	60 - 81
2.	Pulses	54 - 82
3.	Green leafy vegetables	42 - 78
4.	Vegetables	51 - 85
5.	Roots and tubers	43 - 90
6.	Fruits	70 - 100
7.	Oil seeds	67 - 100
8.	Milk and milk products	75 - 100
9.	Animal foods	67 - 100
10.	Bakery	79 - 100
11.	Processed foods	73 - 92
12.	Health drinks	93 - 96

Details regarding the foods which inhibit and enhance iron absorption in the dietaries of the pre-adolescent athletes were analysed.

The iron present in the foods are of two types haem iron (obtained from animal source) and non haem iron (obtained from vegetable source). Haem iron is more easily absorbed by the body. But in the case of non haem iron. there are several factors which enhance and inhibit its absorption (Nieman and Coworkers. 1990).

Respondents were found to include foods such as amaranthus. cabbage. chekkurmanis. drumstick leaves. drumstick, bittergourd, clusterbeans, gooseberry, guava and orange in their dietaries. Juna (1999) reported that above foods were found to enhance iron absorption. Besides, they have the habit of taking meat and fish thrice in a week. Ascorbic, citric. lactic, pyruvic and succinic acids and fructose and sorbitol and many amino acids present in these foods are found to enhance iron absorption (Eckstein, 1980).

According to Martin and coolidge (1978) protein rich foods are concentrated sources of iron but some protein rich foods like milk, egg, cheese decreases iron absorption. Foods which inhibit iron absorption are found more in cereal grains, pulses and legumes. roots and tubers and condiments and spices. The presence of calcium and phosphate salt in the food may completely block iron absorption, Phosvitin of egg yolk, phytic acid from

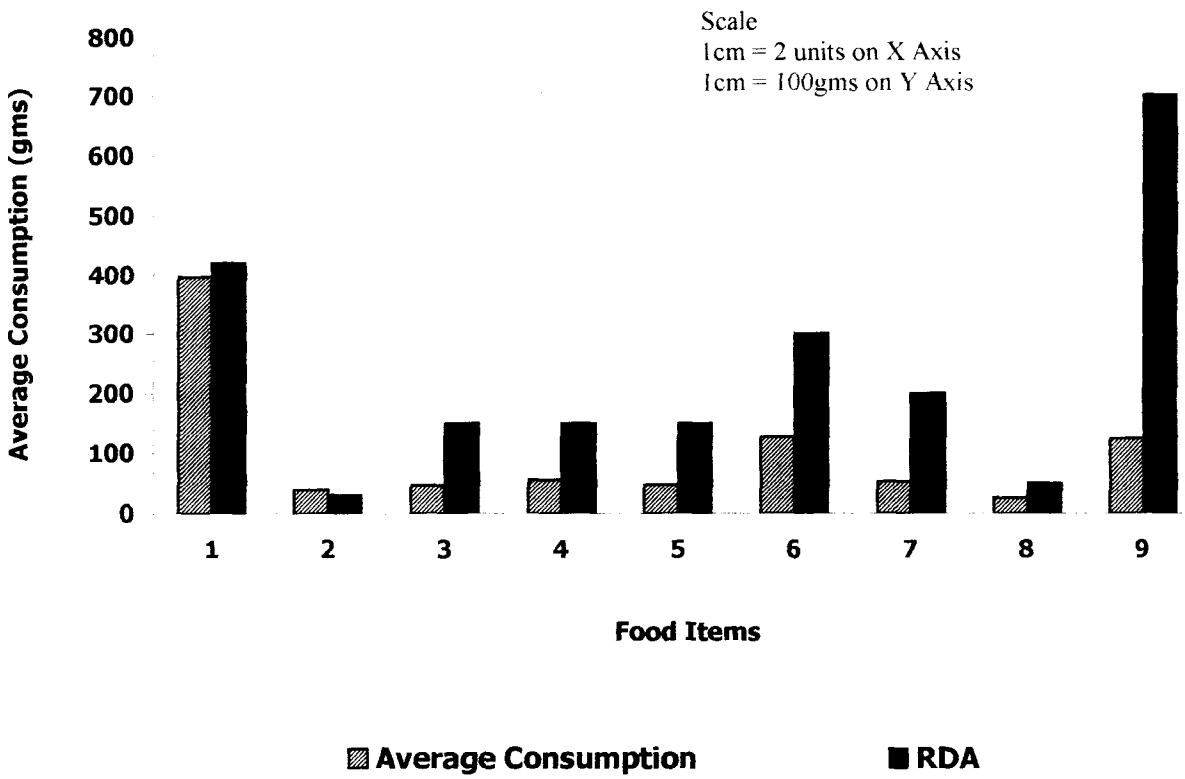
cereal grains polyphenols from tea and several trace elements like copper, zinc, cadmium, cobalt and manganese interferes in iron absorption. In this particular study respondents were found to include milk, egg and tea in their dietaries besides cereals which affect the iron absorption so also iron availability from dietary sources.

4.3 Food consumption pattern of the respondents

The food consumption pattern of the respondents was assessed by 24 hour dietary recall method. In this method the respondents were asked to report the food item used in the previous 24 hours which was then compared with the suggested allowances for Indian Sports women suggested by Narasinga Rao (1996).

As indicated in table 9 (Fig. 1) it was found that the average cereal consumption of the pre-adolescents was 397 g which was found to meet 95 per cent of the suggested allowances for athletes. The average intake of pulses was found to be 39 g as against the suggested daily allowances of 30 g. The average food consumption with respect to green leafy vegetables, other vegetables, roots and tubers were 47, 56, 48 g respectively which was found to meet only 31, 37 and 32 per cent respectively of the suggested daily allowances. The average fruit consumption was found to meet 42 per cent of the allowances suggested for the athletes. While only quarter of

Fig.1
AVERAGE FOOD CONSUMPTION OF ATHLETES



1	Cereals	6	Fruits
2	Pulses	7	Meat and Fish
3	Green Leafy Vegetables	8	Egg
4	Vegetables	9	Milk and Milk Products
5	Roots and Tubers		

the amount was met by the respondents for meat and fish. With regard to egg, consumption was only 51 per cent of the suggested allowances for sports women. Consumption of milk and milk products was found to be 125 g which was found far less to the suggested level for athletes.

Table 9

Average food consumption pattern of athletes

Food groups	Amount consumed (g)	* Suggested daily allowances for athletes	Percentage of suggested daily allowances
Cereals	397	420	95
Pulses	39	30	132
Green leafy vegetables	47	150	31
Vegetables	56	150	37
Roots and tubers	48	150	32
Fruits	127	300	42
Meat and Fish	53	200	26
Egg	26	50	51
Milk and milk products	125	700	18

* Narasinga Rao (1996)

Average nutrient intake of the respondents was compared with recommended allowances for athletes. It was observed that the average protein intake of the respondents was 68 g which was found to meet about 50 per cent of the recommended allowances. The average consumption of calories and iron was found to be 2481 kcal and 35 mg respectively which

was found to meet 83 per cent and 70 per cent respectively of the suggested allowances for athletes. The mean intake of nutrients like calcium (638 mg), Riboflavin (1.0 mg), were below the recommended allowances and the percentage of RDA met by these nutrients were 43 and 36 per cent respectively. The mean intake of vitamin A (1223 mcg) and ascorbic acid (96 mg) was higher than the prescribed RDA (130 and 120 per cent respectively). Nutrients like thiamin and niacin consumed by the respondents (1.4 mg and 17 mg respectively) which was found to meet 49 and 57 per cent respectively of the suggested allowances.

Table 10

Average nutrient intake of the athletes

Nutrient	Average nutrient intake	*Suggested nutrient intake for athletes (Minimum level)	Percentage of RDA met
Protein (g)	68	135	50
Calories (kcal)	2481	3000	83
Calcium (mg)	638	1500	43
Iron (mg)	35	50	70
Vitamin A (mcg)	1223	1080	113
Thiamin (mg)	1.4	3	49
RIboflavin (mg)	1.0	3	36
Niacin (mg)	17	30	57
Ascorbic acid (mg)	96	80	120

* Narasinga Rao (1996)

4.4 Energy balance of the respondents

The energy balance of an individual is the level of energy intake from food that will balance energy expenditure when the individual has a body size and composition and level of physical activity consistent with long term good health and that will allow for maintenance of economically necessary and socially desirable activity.

The energy balance of a subject is the level of energy intake from food which will balance energy expenditure of the subject. Average energy intake of the respondents ranged between 1735 to 2995 kcal with an average energy intake of 2481 kcal. In contrast energy expenditure of the respondents was found to be between 1666 and 2411 kcal and the mean energy expenditure was 2055 kcal. The difference of energy intake and energy expenditure among the respondents ranged from $^{-}210$ to $^{+}869$. Respondents having positive energy balance was found to be 88 per cent while negative energy balance was observed among 12 per cent respondents. This indicate that except in few respondents, all others spent less energy than their intake.

4.5 Assessment of the nutritional status of the respondents

Choudhury (1995) stated that nutritional status is the prerequisite as well as an integral part of human development. According to Mourya and Jaya (1997) nutritional

status is one of the critical indicators of health, therefore, regular nutritional assessment is important to monitor the health of the children.

Assessment of nutritional status of the respondents in this study was done using anthropometric, clinical and biochemical parameters.

4.5.1 Anthropometric measurements

Anthropometry is the measurement of human body at various ages and levels of nutritional status which is helpful in assessing sub-clinical stages of malnutrition (Rao and Vijayaraghavan, 1998).

4.5.1.1 Weight for age

Use of weight for age in assessing the nutritional status of an individual gives the current status of the subject and are presented in Table 11 (Fig. 2). It gives a clear picture of the changes in nutritional supplies. The observed average weight of the athletes was compared with standards suggested by Gopaldas and Seshadri (1987) and NCHS standards (1980). Observed average weight was 42kg in 13 years, 43kg in 14 years and 47kg in 15 years which was found to be slightly lower than Indian standards as well as NCHS Standards but the difference was found to be non significant at 5 per cent levels of significance.

Fig.2
WEIGHT FOR AGE PROFILE OF RESPONDENTS

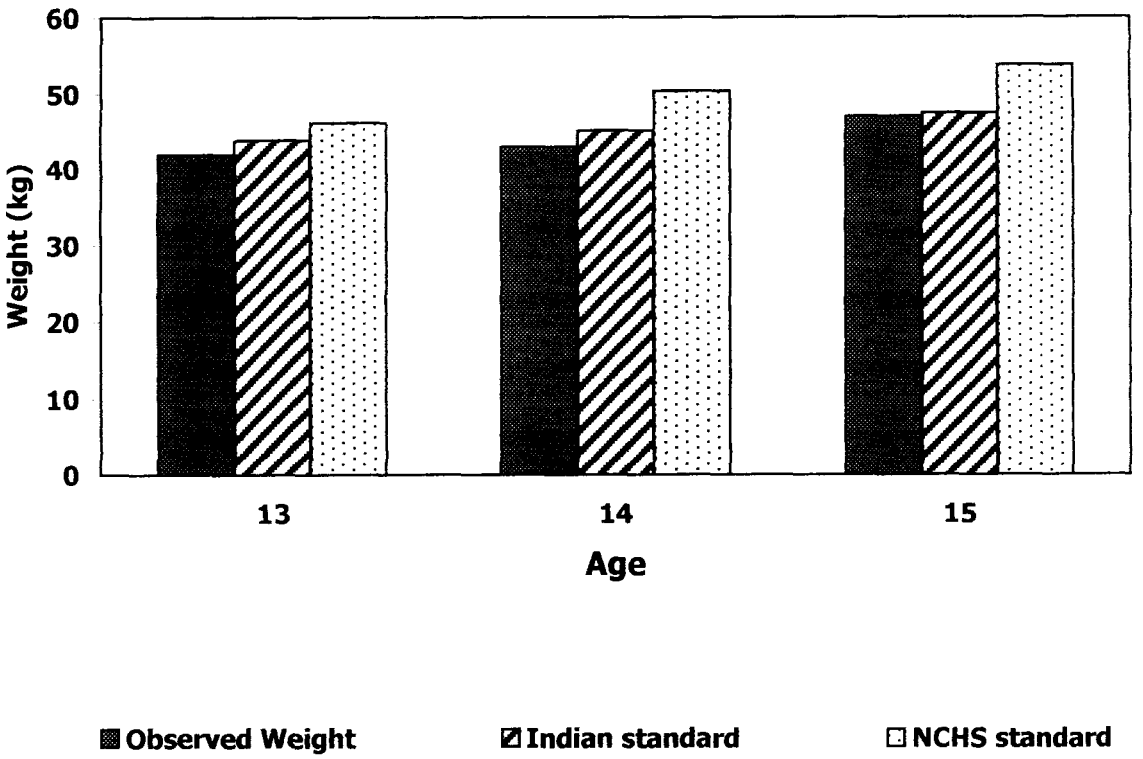


Table 11

Distribution of respondents based on their 'weight for age' profile

Age	Sample size	Observed average weight (kg)	Standard weight (Indian)	t_{n-1}	NCHS standard (1980)	t_{n-1}
13	36	41.94	43.85	0.38	46.1	0.83
14	39	42.90	45.00	0.38	50.3	0.38
15	25	46.84	47.27	0.08	53.7	0.19

4.5.1.2 Height for age

Height deficit gives a picture of the past nutritional status. The observed average height of the pre adolescent athletes belonging to 13, 14 and 15 years was found to be 154.4 cm, 155.8 cm and 159.3 cm and are depicted in Table 12 (Fig. 3) respectively. Statistical analysis of the data indicated that average height of the pre-adolescent athletes of 13, 14, 15 years was found to be comparable with standard height prescribed for Indian children, though the height of the girl athletes were found to be slightly below the NCHS standard. The differentials were found to be not significant at 5 per cent levels of significance.

Fig.3
HEIGHT FOR AGE PROFILE OF RESPONDENTS

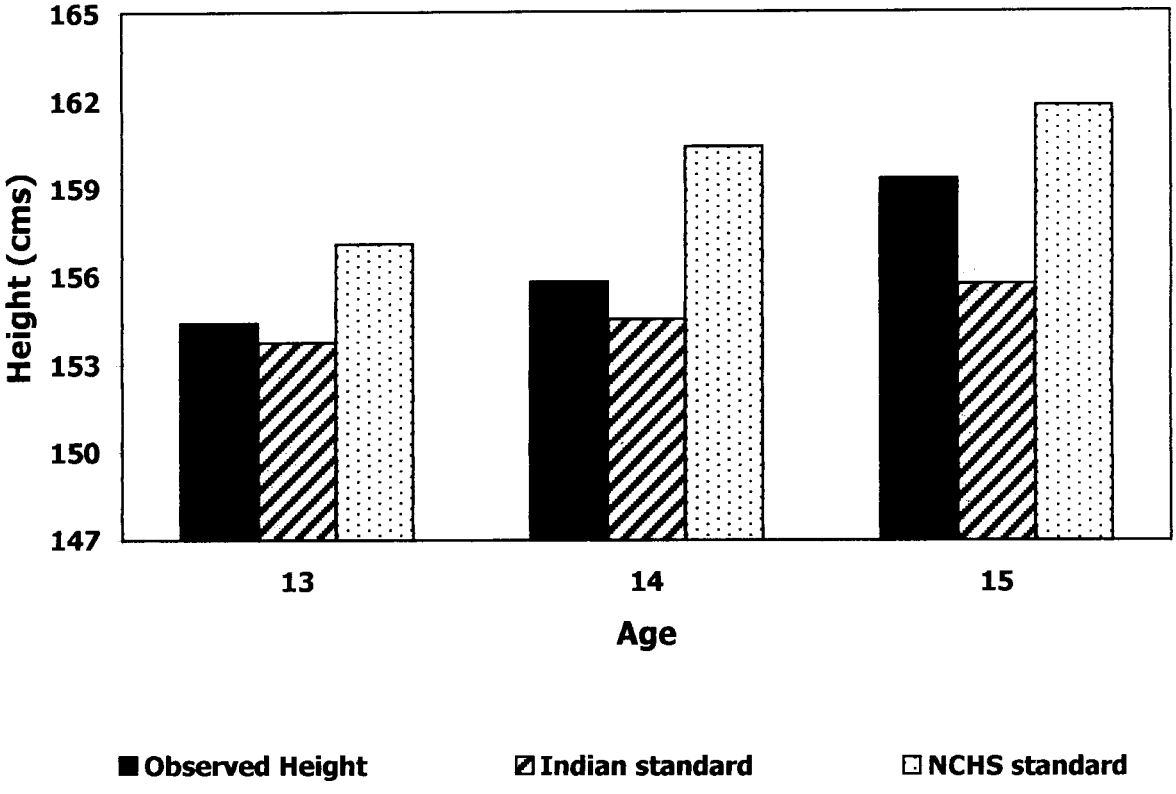


Table 12

Distribution of respondents based on their 'height for age' profile

Age	Sample size	Observed average height (cm)	Standard height (Indian)	t_{n-1}	NCHS standard (1980)	t_{n-1}
13	36	154.4	153.75	0.14	157.1	0.55
14	39	155.8	154.54	0.20	160.4	0.73
15	25	159.3	155.73	0.54	161.8	0.36

4.5.1.3 Body Mass Index (B.M.I.)

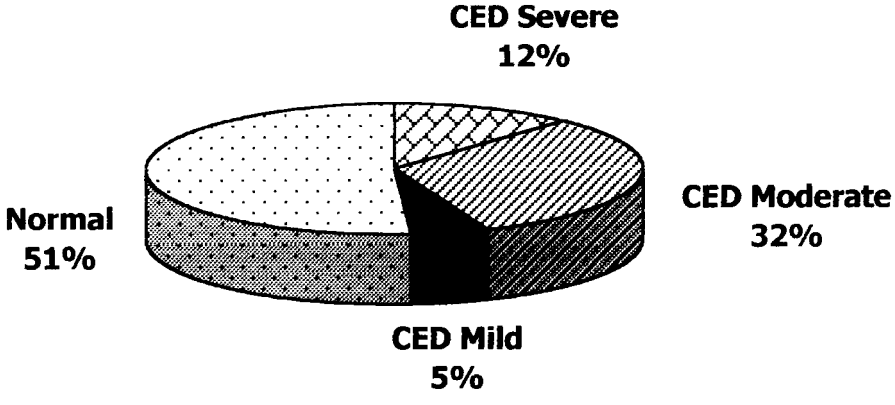
Body Mass Index is of value in distinguishing the nutritional status of different groups monitoring the adequacy of food and in specifying the proportion of Malnourished in a population (Royston and Lopez, 1987). In this study as per body mass index given in Table 13 (Fig. 4) 51 per cent of the respondents belong to normal groups while mild to moderate energy deficit was observed among 37 per cent respondents. However 12 per cent of them were found to have severe energy deficit.

Table 13

Distribution of respondents based on their Body Mass Index

Levels of BMI		Percentage of respondents
< 16.0	CED Grade III (Severe)	12
16 - 17	CED Grade II (Moderate)	32
17 - 18.5	CED Grade I (Mild)	5
18.5 - 25	Normal	51

Fig. 4
BODY MASS INDEX OF RESPONDENTS



4.5.1.4 Mid upper arm circumference

The upper arm circumference taken between the acromion process and the elbow is an integrated measure for the skeletal. muscular and the subcutaneous tissue components. As revealed in table 14 mid upper arm circumference of the adolescents belonging to 13, 14 and 15 years were 21.6 cm. 21.9 cm and 22.0 cm respectively which were slightly below the standard suggested by Gopaldas and Seshadri (1987), except for age 13 but statistical analysis show no significant difference.

Table 14

Distribution of respondents based on their mid upper arm circumference

Age	Observed arm circumference	t_{n-1}	Standard arm circumference
13	21.63	0.12	21.43
14	21.92	0.09	22.06
15	22.20	0.27	22.62

4.5.1.5 Waist Hip Ratio/W.H.R

An increased waist Hip Ratio is an indicator of accumulated abdominal fat in the subjects. In this study 67 per cent of the athletes were found to have normal waist Hip Ratio while 33 per cent was having values below normal range.

Table 15

Distribution of the respondents based on their waist hip ratio

W.H.R. level	Percentage of respondents
Below normal	33
Normal (0.8cm)	51
Above normal	16

3.5.1.6 Triceps skinfold thickness

Measurement of skinfold at triceps is one of the methods for assessment of the amount of subcutaneous fat which gives an indication of the calorie reserve in the body of an individual (Malina *et al.*, 1974). The values of skin fold thickness ranged between 4 to 11 which were below the standard suggested by Vijayaraghavan *et al.* (1971). (13.21mm 13.72mm and 14.06mm respectively for 13, 14 and 15 years).

Table 16

Distribution of respondents based on their skinfold thickness

Levels of skinfold thickness (mm)	Percentage of respondents
Below 5	10
5 to 10	85
Above 10	5

4.5.1.7 Arm muscle area

Arm muscle area of the respondents was assessed using the formula suggested by Gurney and Jeliffee (1973). As indicated in table 17 it was found that the arm muscle area of the respondents fall between 4000 to 7578 mm^2. Majority of the respondents (55 per cent) were found to have arm muscle area of 6001 to 7000 mm^2. While 30 per cent were found to have arm muscle area of 5001 to 6000 mm^2.

Table 17

Distribution of respondents based on their arm muscle area

Level of arm muscle area (mm^2)	Percentage of respondents
4000 - 5000	10
5001 - 6000	30
6001 - 7000	55
Above 7000	5

4.5.1.8 Body fat percentage

To provide accurate estimation of body composition, parameters like BMI. Sex and age are to be taken into account. Body fat percentage of athletes belonging to ages 13, 14 and 15 years were determined using the formula suggested by Deurenberg *et al.*(1991) and the mean values are 17.9 kg, 18.3 kg and 21 kg respectively.

4.5.1.9 Lean Body Mass

Lean body mass of respondents under study was determined using body weight and body fat of respondents using the formula recommended by Cole *et al.* (1997). Lean body mass increases as length increases. In this study the mean values of lean body mass of athletes of ages 13, 14 and 15 were found to be 33.9 kg, 35 kg and 37.6 kg respectively.

Table 18

Distribution of respondents based on body fat percentage and lean body mass

Particulars

a. Body fat percentage

Age	Average body fat percentage of respondents (kg)
13	17.9
14	18.3
15	21.0

b. Lean body mass

Age	Mean lean body mass of of respondents (kg)
13	33.9
14	35.0
15	37.6

4.5.2 Clinical examination

The clinical examination of the people forms an important practical method for the assessment of nutrition of a community (Gopaldas and Seshadri, 1987).

Assessment of the incidence of clinical sings and symptoms of the respondents indicated that 50 per cent of subjects under study was not showing any clinical symptoms of deficiency diseases. While half of them were found to show mild symptoms of anaemia. In 5 per cent of the respondents thyroid enlargement was present. Dental caries was observed in 10 per cent of the respondents.

Table 19

Distribution of respondents based on the incidence of clinical symptoms

Deficiencies/incidences	Symptoms	Number and Percentage of respondents
Nutritional		
Iron	Anaemia (Slight-Pallor)	50 (10)
Iodine	Thyroid enlargement	5 (1)
Non-nutritional		
Dental caries	Dental caries	10 (2)
Not having any clinical deficiencies or incidences		50 (10)

4.5.3 Biochemical assessment

Biochemical assessment represents the most objective assessment of the nutritional status of an individual, frequently providing pre or sub-clinical information (Sausberlich *et al.*, 1977). In the present study, the iron status of the respondents were assessed with regard to their iron intake using biochemical indicators such as haemoglobin, packed cell volume, blood count, serum iron and total iron binding capacity.

4.5.3.1 Haemoglobin levels

For estimating iron insufficiency measurement of haemoglobin is the most commonly employed biochemical indicator. As revealed from the table 20 the mean values of haemoglobin levels of the respondents belonging to the ages 13, 14 and 15 years were 11.61, 10.7 and 11.8 respectively.

Table 20

Distribution of respondents based on their haemoglobin levels

Age	Sample size	Mean haemoglobin values of respondents
13	36	11.61
14	39	10.70
15	25	11.80

4.5.3.2 Packed Cell Volume (PCV)

Haematocrit % or PCV is the basic value revealing the degree of anaemia. Haematocrit values of the respondents as indicated in table 23 reveal that 90 per cent of them are having normal value for packed cell volume (36.47) while 10 per cent were found to have low values (below 36).

4.5.3.3 Blood pressure

Abnormal blood pressure is found to affect the physical performance of people engaged in certain activities. In this study blood pressure of the respondents revealed that 80 per cent are having normal values while 10 per cent each were having either lower or higher values.

Table 21

Distribution of respondents based on their Blood pressure values

Blood pressure (mm of Hg)	Percentage of respondents
Below normal	10
Normal (120/80)	80
Above normal	10

4.5.3.4 Pulse rate

The physiological indicator of physical work capacity is reflected in pulse rate which is presented in table 22.

Ninety per cent of pre-adolescents had normal pulse rate while 10 per cent of them were having pulse rate below normal range.

Table 22

Distribution of the respondents based on their pulse rate values

Pulse rate (beats/minute)	Percentage of respondents
Below normal	10
Normal (72 beats/minute)	85
Above normal	5

Indepth analysis of the biochemical parameters like packed cell volume (PCV), blood count, serum iron, total iron binding capacity were carried out in venous blood, drawing a sub sample of twenty respondents and the results are presented below.

4.5.3.5 Blood count

According to Mason and Swash (1980) an abnormality in the number and/or distribution of white cells does not necessarily imply a white cell disorder as generally any illness can alter the total or differential white cell counts.

4.5.3.6 Total Count

Total count of the leucocytes assessed in the respondents showed that majority (95 per cent) of them are in

the normal range (5000 - 10000). Negligible respondents fall below the normal range (5 per cent) (below 5000).

4.5.3.7 Differential count

It was found that all the respondents have lymphocyte count in the normal range (20.40) and majority have (95 per cent) neutrophill in normal range (40-60) 45 per cent of the respondents were found to have eosinophill count above the normal (above 5) indicative of any infection, allergic disorders, parasitic infestation, skin diseases or pulmonary eosinophilia.

4.5.3.8 Serum iron

The direct measurement of iron in serum is extremely useful in detecting iron deficiency status. From the table 23 it was found that all the respondents have serum iron in normal range (41-132) which indicate good iron status of the subjects.

4.5.3.9 Total iron binding capacity

The Iron binding capacity estimate permits the distinction of nutritional deficiency from iron deficits due to infection, inflammation or neoplastic diseases. In this study the TIBC values of all respondents are in normal range (250-380).

Table 23

Haematological parameters assessed in the respondents

Parameters	Levels obtained	Percentage of respondents
a. Packed celled Volume	Below 36	10
	*36 - 47	90
b. Total count	Below 5000	5
	*5000 - 10000	95
c. Differential count		
Neutrophil polymorphs	Below 40	5
	*40 - 60	95
Lymphocytes	Below 20	0
	*20 - 40	100
Eosinophils	Above 5	45
	*1 - 5	55
d. Serum iron	Below 41	0
	*41 - 132	100
e. TIBC	Below 250	0
	*250 - 380	100

* Normal values

4.6 Assessing the bioavailability of iron from cooked foods

Among the different variables leading to iron deficiency, low availability of dietary iron is considered to be one of the most important factor. To evaluate causes of iron deficiency anaemia, determination of bioavailability of dietary iron is therefore important. In this study bioavailability of iron from the foods consumed by the

respondents was determined using in vitro method (Narasinga Rao and Prabhavathi, 1978). Results indicated that bioavailability of iron from the foods consumed by the respondent were found to be 4 to 5 per cent in 95 per cent respondents. In negligible respondents bioavailability was found to be above 5 per cent. Composition of the cooked diet for the analysis of the bioavailability of iron is given in Appendix IX.

Table 24

Bioavailability of iron from cooked foods

Range	Number of respondents	Percentage of respondents
4.0 to 4.5	1	5
4.6 to 5.0	18	90
Above 5 (5.1)	1	5

4.7 Assessment of physical endurance indicators in the respondents

Sports and game events can be divided into different categories. Participation of the children in sports and game activities presented in table 25 revealed that majority of the respondents (66 per cent) were engaged in athletics. Respondents engaged in hockey and volleyball was 10 per cent each while 14 per cent respondents were engaged in basket ball.

Table 25

Distribution of the respondents based on their participation in sports and game activities

Activity	Percentage of respondents
Athletics	66
Hockey	10
Basketball	14
Volleyball	10

Physical endurance indicators such as bench press, overhead press, sergent jump test and step test was used to determine the performance of athletes.

Bench press and overhead press are two strength test to measure the strength of athletes.

4.7.1 Bench press test

The mean values obtained by the respondents for bench press test ranged between 21.11 to 22.8 kg. The mean values obtained are 21.1, 21.9 and 22.8 for 13, 14 and 15 years respectively.

4.7.2 Over head press test

Over head press values of the respondents revealed that they ranged between 21.94 to 24.12 kg and the mean values are 22.5, 21.9 and 24.1 kg. respectively for age 13, 14 and 15.

4.7.3 Sergent jump test

To determine the anaerobic capacity of the athletes sergent jump test is used. The mean values calculated are 52.1, 56.93 and 62 kgms respectively for athletes for the age group. 13. 14 and 15.

Table 26

Physical endurance indicators assessed in the respondents

Endurance indicators	Mean values obtained as per age groups		
	13 years N=36	14 years N=39	15 years N=25
Bench press (1-RM)	21.11	21.92	22.80
Overhead press (1-RM)	22.50	21.94	24.12
Sergent jump (Power) (kgms)	52.10	56.93	62.00

4.7.4 Step test

Aerobic power of the athletes was assessed using step test measurements. From the table 27 it was clear that majority (76 per cent) are having values between 65 and 90 while 24 per cent are having values between 55 to 64.

Table 27

Distribution of respondents based on their step test performance

	Percentage of respondents
Below 55 (Poor physical condition)	5
55 to 64 Low average	19
65 to 79 High average	11
80 to 89 Good	16
Above 90 Excellent	49

4.8 Performance index of the respondents

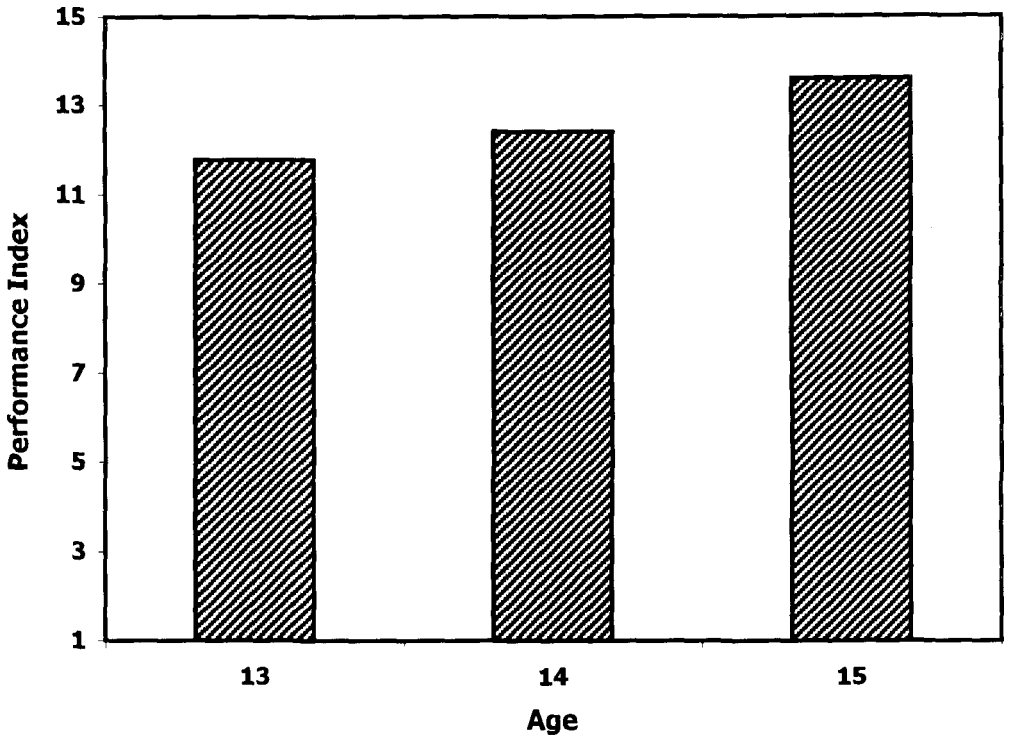
Performance index of the respondents was computed from collected data. Physical endurance indicators like bench press, over head press, sergent jump and step test were the parameters used in this study to compute the performance index.

Table 28

Distribution of the respondents based on their performance index

Age	Sample size	Mean values of respondents
13	36	11.77
14	39	12.41
15	25	13.60

Fig. 5
PERFORMANCE INDEX OF RESPONDENTS



The mean values of the respondents for performance index given in table 28 (Fig. 5) ranged between 11.77 to 13.6. The mean values obtained by the respondents for performance index were 11.77, 12.4 and 13.6 respectively for the years 13, 14 and 15. Performance of the respondents was found to be on an increasing trend as the age advances.

4.9 Nutritional status index of the respondents

According to Swaminathan (1986) nutritional status of an individual is the health status of the individual as influenced by the intake of essential nutrients. In corporating different parameter assessed for determining Nutritional Status, an Index was developed. The parameters selected in this study for finding the nutritional status index include anthropometric measurements like height, weight, BMI, mid upper arm circumference, waist hip ratio, body fat percentage, lean body mass, protein and calorie intake and the haemoglobin measurements of respondents.

As depicted in table 29 (Fig. 6) it was found that the mean values obtained by the respondents for N.S.I. ranged between 169 and 176. The mean values of NSI of respondents are 176, 169 and 175 respectively for 13, 14 and 15 years. It was found that NSI was higher for younger ages than elder ones.

Fig. 6
NUTRITIONAL STATUS INDEX OF RESPONDENTS

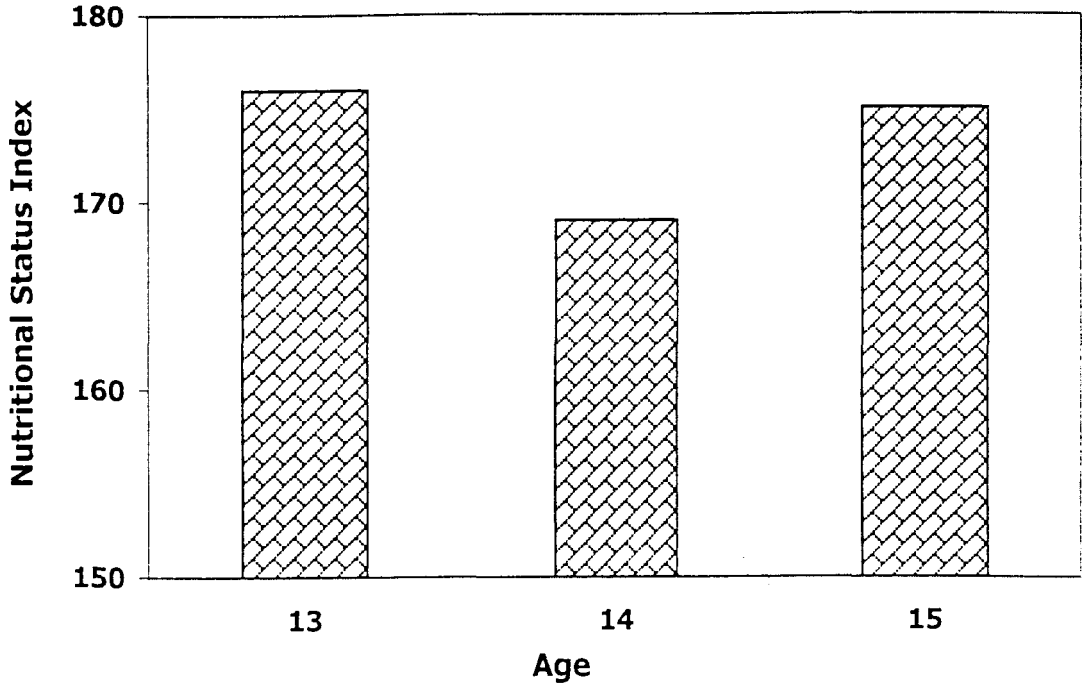


Table 29

Distribution of the respondents based on their Nutritional Status Index

Age	Sample size	Mean values of the respondents
13	36	176
14	39	169
15	25	175

4.10 Correlation between Nutritional Status Index and other selected independent variables

Inter relationship of Nutritional Status Index of the respondents with selected independent variables was computed.

Independent variables selected are socio economic variables like age of the respondents, family size (number of adults and children in the families) family type, employment status of parents, most important dietary variables viz. calorie and protein intake, energy balance of the respondents and anthropometric variables like weight, height, body mass index, mid upper arm circumference, waist hip ratio and biochemical parameter viz. haemoglobin.

Among the socioeconomic variables analysed age of the respondent (-0.0257) size of the family (Number of adult (-0.0602) Number of children in the family (-0.1419) was found

to affect negatively N.S.I. of the respondent though the relation was found to be non significant. However other socio economic variables like type of the family (0.1733) and employment status of the father (0.1092) showed a positive but non significant correlation with nutritional status of the respondents.

With regard to dietary variables, calorie intake (0.3152) showed positive and significant correlation with N.S.I. of the respondents where as protein intake (0.1686) of the respondents showed positive correlation but it was found to be non significant.

However N.S.I. of the respondents was found to be independent of the energy balance worked out for the respondents using energy intake and energy expenditure as suggested by ICMR (1981) (r = 0.1204).

Among the anthropometric variables body weight (0.4715), BMI (0.4878), M.U.A.C. (0.3777), W.H.R. (0.9915) show significant and positive correlation with nutritional status of respondents. However height of the respondent (0.1166) was found to be independent of N.S.I. of the respondents.

Among the biochemical parameters analysed haemoglobin level (0.2571) of the respondents found to show significant positive correlation with N.S.I. of respondents.

4.11 Inter relationship between performance Index with other selected variable

Inter relationship of performance Index of the respondents with 18 selected variables was analysed.

Eighteen independent variables selected include age, birth order, anthropometric variables viz. height, weight, B.M.I., M.U.A.C., W.H.R., body fat percentage, lean body mass, physical endurance indicaters namely step test, sergent jump, bench press, overhead press, biochemical parameter viz. haemoglobin, dietary variables viz. calories, protein and iron and energy balance of respondents. Among the socioeconomic variables age (0.2146) showed positive significant correlation with performance of respondents, while birth order (⁻0.0027) of the respondents was negatively correlated.

Anthropometric measurements like body weight (0.8124), BMI (0.8847), MUAC (0.6768), WHR (0.3419), body fat percentage (0.8623), lean body mass (0.4077) showed significant positive correlation while body height showed positive non significant correlation.

Physical endurance indicators like step test (0.5527), sergent jump (0.7423), bench press (0.9153), over head press (0.9129) showed significant and positive correlation with performance index of respondents.

Haemoglobin (0.4779) of the respondents was found to influence the performance index positively.

Major nutrient intake like calories (0.2435) protein (0.5192) and iron (0.3654) also showed positive significant correlation with performance of respondents.

Energy balance though showed a positive correlation with performance index, it was found to be non-significant.

4.12 Correlation between Nutritional Status Index and performance Index of respondents

Nutritional Status Index of the respondents was worked out using parameters like weight, height, BMI, MUAC, W.H.R., Body fat percentage, lean body mass, protein and calorie intake and also haemoglobin level of respondents. Performance of the respondents was assessed using physical endurance indicators like Bench press, over head press, sergent jump test and step test. A significant positive correlation was observed between Nutritional Status and performance of the respondents ($r = 0.4479$). The correlation was significant at 1% level.

Table 30
Correlation matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}
X_1	1.0000																					
X_2	0.0413	1.0000																				
X_3	0.1717	0.3636**	1.0000																			
X_4	-0.0520	-0.0214	-0.0526	1.0000																		
X_5	0.0976	-0.2292*	0.4443**	0.1887	1.0000																	
X_6	0.1350	-0.0994	-0.1193	0.0460	-0.0670	1.0000																
X_7	0.0546	-0.1146	-0.1714	0.0702	-0.1555	0.8684**	1.0000															
X_8	-0.1779	0.1009	-0.0107	0.0748	-0.1487	0.5638**	0.7083**	1.0000														
X_9	0.3604**	0.0706	0.0313	-0.0095	-0.0611	0.4147**	0.2682**	0.2469*	1.0000													
X_{10}	0.3208**	-0.0654	0.0827	-0.0406	-0.0181	0.0774	-0.0092	-0.0669	0.5601**	1.0000												
X_{11}	0.1970*	0.1338	-0.0131	0.0219	-0.0489	0.4499**	0.3318**	0.3573**	0.8005**	-0.0424	1.0000											
X_{12}	0.2017*	0.0972	0.0568	0.0231	-0.0006	0.3820	0.2659**	0.1995*	0.7150**	0.1827	0.7305**	1.0000										
X_{13}	-0.0085	0.1733	0.0522	-0.1590	-0.0140	0.2731**	0.1373	0.2655**	0.3682**	0.0831	0.3873**	0.2779**	1.0000									
X_{14}	0.0596	0.1570	0.0084	0.0177	-0.0166	0.4199**	0.2955**	0.3653**	0.7467**	-0.0919	0.9702**	0.7233**	0.4186**	1.0000								
X_{15}	0.4004**	0.0339	0.0315	-0.0277	-0.0757	0.3722**	0.2357*	0.1906	0.9738**	0.7138**	0.6576**	0.6523**	0.3158**	0.5872**	1.0000							
X_{16}	0.0570	-0.0987	0.1273	-0.0302	0.1990*	0.1763	0.0586	0.1683	0.3105**	0.1057	0.3000**	0.2183*	0.2303*	0.3528**	0.2566**	1.0000						
X_{17}	0.4484*	0.0274	-0.0471	0.0019	-0.1292	0.5402**	0.4320**	0.2696**	0.8639**	0.4654**	0.7064**	0.5951**	0.2323*	0.6286**	0.8403**	0.2071*	1.0000					
X_{18}	0.1674	0.0884	-0.0247	0.0431	-0.0332	0.4346**	0.3474**	0.3376**	0.7236**	-0.0627	0.9241**	0.6743**	0.3521**	0.9027**	0.5843**	0.3049**	0.6172**	1.0000				
X_{19}	0.1529	0.0971	-0.0336	0.0465	-0.0377	0.4362**	0.3300**	0.3122**	0.7616**	-0.0290	0.9421**	0.7129**	0.3787**	0.9260**	0.6242**	0.3032**	0.6430**	0.9809**	1.0000			
X_{20}	0.0159	-0.0358	0.1962	0.1231	0.1405	-0.0059	-0.0734	0.0985	0.2842**	0.0782	0.2853**	0.1711	0.1938	0.3177**	0.2290*	0.8477**	0.1505	0.2742**	0.2776**	1.0000		
X_{21}	0.2146*	0.0264	-0.0099	-0.0292	0.0027	0.2435*	0.5192	0.2435*	0.8124**	0.1357	0.8847**	0.6768**	0.3419**	0.8623**	0.7021**	0.5527**	0.7423**	0.9153**	0.9129**	0.4779**	1.0000	
X_{22}	-0.0257	0.1733	-0.0602	-0.1419	-0.0124	0.3152**	0.1686	0.2921**	0.4715**	0.1166	0.4878**	0.3777**	0.9913**	0.5150**	0.4103**	0.2899**	0.3231**	0.4452**	0.4746**	0.2571**	0.4479**	1.0000

X_1 - Age
X_2 - Family type
X_3 - Number of adults
X_4 - Number of children
X_5 - Birth order
X_6 - Calorie intake
X_7 - Protein intake
X_8 - Iron intake
X_9 - Weight
X_{10} - Height
X_{11} - Body Mass Index
X_{12} - Mid Upper Arm circumference
X_{13} - Waist Hip Ratio
X_{14} - Body Fat Percentage
X_{15} - Lean Body Mass
X_{16} - Step test
X_{17} - Sergent jump
X_{18} - Bunch press
X_{19} - Overhead press
X_{20} - Haemoglobin
X_{21} - Performance Index
X_{22} - Nutritional Status Index

DISCUSSION

5. DISCUSSION

The study entitled "Anaemia and work performance of pre-adolescent girls engaged in sports activities" was conducted to assess the magnitude of anaemia among pre-adolescent athletes and to find out its impact on performance.

5.1 Socio economic status of respondents

According to Ghosh (1989) social factors like religion, occupation, economic status, education, beliefs and culture had important bearing on health.

Ramankutty (1990) reported that better socio economic status of women is reflected in better literacy, better work participation and greater independence within and outside the family.

On assessing the economic status of the respondents it is observed that all of them belong to low economic strata, as their selection to sports school itself is based on the income. Among the surveyed respondents majority (51 per cent) of them belong to christian community. An early study conducted by Mini (1992) also indicated that majority belong to christian religion.

According to a report published by Government of India (1981) the caste system is reported to be one of the

factor responsible for perpetuating poverty in rural areas. It has been observed by Arora (1991) that caste is an unique institution of the Indian Society. Among the surveyed respondents 57 per cent are from under privileged sections of the communities.

Devadas *et al.* (1980) had the opinion that family size is an important factor which generally influence the all round development of children. Saxena (1986) reported that the nuclear type families are more popular in the State of Kerala and these families are considered to be generally better than joint type families for the healthy development of the children. In this study it was found that majority of the respondents are from the nuclear type families of medium size having 5 to 7 members. There is fading of joint family system in Kerala due to urbanisation which result in the formation of nuclear families.

On assessing the number of adults and children in the families it was found that majority of the families are having **2 adults and 2 children.**

On assessing the birth order of the pre-adolescent athletes it was found that 44 per cent of them are found to be in the first birth order.

Education is seen as a potential booster of the officially recorded female labour in developing countries

(Psacharopoulos, 1989). In the present study it was found that all respondents parents have got atleast upper primary level education and 63 per cent of respondents fathers and 67 per cent of respondents mothers obtained high school level education.

Regarding the employment status, it was observed that 91 per cent of the respondent's fathers are employed when compared to their mothers. Mankekar (1980) has reported that the women account for 40 per cent of total unemployment. Nair (1990) has reported that women in unorganised sector suffer from fewer and poorer opportunities to work, face greater impact of employment, unemployment and casual nature of work. With regard to employment perse of the parents, it is encouraging to note that many are self employed. According to 1981 census 89.5 per cent of the total family work force operate within the unorganised sector mainly as self employed wage earners.

5.2 Assessment of dietary habits of the respondents

Data pertaining to dietary habits of the respondents indicated that all of them are habitual non-vegetarians. Earlier studies conducted by Mini (1992) among adolescent athletes and Mony (1993) among the adolescents of agricultural families also support the above findings.

Frequency of use of food items among the respondents indicated that cereals and milk are used daily by the respondents. Fats, sugar and jaggery, spices and condiments are also found to be items frequently used in the dietaries as they are food adjuncts. Similar observations are reported earlier by Jyothi (1993). Frequency scores obtained for vegetables, roots and tubers, fruits, fish and egg were 99, 90, 88, 89 and 86 respectively which indicate that the above items are very frequently used by the respondents. However Mony (1993) found that daily consumption of roots and tubers were found to be poor in the diets of adolescent agricultural labourers. Lina and Reddy (1984) reported that a typical Kerala diet is based on rice, fish, tapioca and coconut. Frequency scores were found to be 80 per cent for pulses and meat. Comparatively low scores are obtained for green leafy vegetables (72 per cent) indicating that they are not as frequently used by the respondents. Anuradha (1981) reported that intake of pulses and leafy vegetables among the pre-adolescents of 13 to 15 years and adolescents of 16 to 18 years were found to be grossly deficient.

The meal frequency of an individual or family generally is influenced by purchasing power or in otherwords economic status. On assessing the meal frequency followed by the respondents it was found that majority of them follow four meal-a-day pattern. In a typical Kerala diet usually there

will be three main meals and as observed by Musgrave *et al.* (1981) most adolescents take only three meals a day. However in this study because of nature of training and activities respondents consume three main meals with snacks and other nutrient rich foods in between. According to Swaminathan (1986) increasing the frequency of meals in terms of size and number influence the work performance of individuals engaged in heavy activities. Jyothi (1993) in her study observed that the women engaged in heavy activities such as stone breaking followed three meal a day.

According to Bull (1988) adolescent's food preferences and food selection are influenced by social or external pressures.

Food preference of the pre-adolescent athletes surveyed indicated that the scores obtained for cereals ranged between 60 and 81. Among cereals almost all the respondents preferred rice. Earlier study conducted by Mony (1993) among adolescents of agricultural labourers also support the same.

Among pulses majority of the respondents preferred green pea the most. Preference score was found to be less for red gram dhal when compared to other pulses. Beatrice (1999) made an observation that pulses were highly preferred by the adolescents. Survey conducted by Jessy (1996) revealed that green gram was the most preferred pulse among the respondents surveyed.

Low preference score were obtained for green leafy vegetables among the respondents. This was in contrast with the findings of Beatrice (1999). She observed high preference for green leafy vegetables among adolescents. Amaranthus was preferred by majority of the respondents. Fenugreek leaves the least preferred one. Usha (1985) found that consumption of green leafy vegetables were rare in hostel diets.

Carlisle *et al* (1980) stated that vegetables had a low acceptance among adolescents, while Gnwecker and Pazola (1981) reported that raw vegetables, salad items especially tomato and carrot were popular among adolescents. Present study revealed that garden pea is the most preferred vegetable among the pre-adolescent athletes while ash gourd the least preferred one.

Preference scores obtained for roots and tubers ranged between 43 and 90. Tapioca was the most preferred root among the respondents. Early study conducted by Mony (1993) among adolescent agricultural labourers also supported the same. Food consumption survey NNMB (1994) reported that among roots and tubers tapioca is the most preferred tuber in the dietaries of Kerala.

Among fruits highest preference score was obtained for mango and plantain while all the fruits were liked by the pre-adolescent athletes as indicated from the score (70 to 100).

Easy availability of above fruits presumed be the reason for their highest preference.

Among oil seeds all the respondents liked cashewnut followed by groundnut and coconut. Gingelly seed is the least preferred one by the respondents.

Musgrave *et al* (1981) reported that high sucrose snacks were popular and milk was found to be the most popular drink. Present study also revealed that milk and milkproducts were preferred extremely by most of the respondents and the preference scores ranged between 75 to 100.

High preference scores were also obtained for animal foods and the scores ranged between 67 to 100. Sato *et al* (1984) reported that adolescents prefer meat and the like foods.

Robson *et al* (1991) studied the snacking habits of 1015 adolescents and found that majority of them preferred sweet preparations such as cake, puddings and biscuits. The scores obtained for bakery items among the pre-adolescent athletes under study ranged between 79 to 100.

According to Arya (1992) there is an increasing demand for processed foods round the globe as these are convenient to use and readily acceptable. High scores were also obtained for processed foods and health drinks among the respondents and the scores ranged between 73 and 92 and 93 and 96 respectively.

Haemopoetic constituents present in the dietaries of the pre-adolescent athletes were assessed. Among the various factors leading to iron deficiency low availability of dietary iron is considered to be most important. Narasinga Rao and Prabhavathi (1978) found that absorption of non heme iron from food is influenced by a variety of inhibitors and promotors of iron absorption.

On assessing the haemopoetic constituents present in the dietaries of the respondents it was found that the respondents though not liked, they have the habit of taking green leafy vegetables and fruits rich in ascorbic acid and citric acid. They also have the habit of taking meat and fish in which heme iron are present. According to Herbert (1987) absorption of non heme iron can be improved by including foods with Vitamin C at meal time or by consuming some meat. This gives an indication that in the dietaries of pre-adolescent athletes there are various constituents which may enhance iron absorption and at the same time some of the constituents inhibits its availability. Brise and Hallberg (1962); Sayers *et al* (1973) and Layrisse (1968) found that non heme iron absorption from vegetable foods can be significantly increased by the inclusion of ascorbic acid or meat. Studies in humans have shown that phytates (Sharpe *et al*., 1950, Hussain and Pathwanthi 1959; Apte and Venkitachalam 1962) and tannins (Disler *et al*., 1975) decreases the absorption of non heme iron from diets. Whiting (1995) has reported that high intakes of dietary calcium can inhibit iron

absorption if both are present in the same meal. Annapurani and Nirmala (1985) found that due to the presence of higher concentration of total and absolute available iron, wheat, ragi, jowar and bajra are preferred to rice as better source of iron.

5.3 Assessment of food consumption pattern of the respondents

Kardjati *et al* (1983) found that female adolescents were found to consume the monotonous type of food irrespective of their physiological state.

Results of the one day recall survey conducted among the respondents indicated that among the different categories of food consumed by them pulses was the only food group which exceeded the recommended dietary allowances suggested by Sathyanarayana (1985) for athletes, the percentage being above centum. The percentage of R.D.A. met by cereals was almost adequate (95 per cent). The consumption of milk and milk products and animal foods like meat and fish was found to be far below the satisfactory levels for athletes (18 per cent and 26 per cent respectively). Similarly the per cent of R.D.A. met by vegetables, roots and tubers fruits and egg was found to be only 37, 32, 42 and 51 per cent respectively. A study conducted by NIN in 1989 among the athletes indicated that green leafy vegetables were less in the dietaries of sports

women and men. In this study consumption of green leafy vegetables by pre-adolescent athletes was only 31 per cent of R.D.A. suggested for athletes. This finding was in harmony with Mini (1992) who found that the consumption of green leafy vegetables was poor among the adolescents.

Comparison of nutrients consumption of pre adolescent athletes with suggested R.D.A. it was revealed that the percentage of calorie protein, iron and niacin met by the pre-adolescents was 83, 50, 70 and 55 per cent respectively. Studies conducted by Weight *et al* (1988), Synder *et al* (1989), Mulligan and Butterfield (1990); Weight *et al* (1992) found that both male and female endurance athletes failed to meet the recommended energy intakes. According to Weight *et al* (1992) the intake of protein was adequate in the diets of endurance athletes. Among various nutrients intake of vitamin A and ascorbic acid was found to meet the R.D.A. suggested. Eventhough the preference of the respondents for green leafy vegetables was poor but it was found that during the food consumption survey the respondents were found to consume food items like chikkurmanis, carrot, tomato and egg which contribute to the vitamin A content. Gross inadequacies were noted in the dietaries of respondents with respect to nutrients such as calcium, thiamin and riboflavin when compared to suggested RDA for athletes. Survey conducted by Mini (1992) among athletes revealed that except calories, protein and

carotene all other nutrients were inadequate in the dietaries Weight *et al* (1992) found that female athletes failed to meet the suggested RDA with regard to iron. From the above observations it can be concluded that food and nutrient consumption of pre-adolescent athletes under study was not up to the suggested levels for athletes though they are found to be in line with the suggested level for normal subjects.

5.4 Energy balance of the respondents

According to Nair and Pochlman (1991) energy balance is determined by energy intake and energy expenditure. Studies conducted in Trivandrum among women labourers by Suja (1989), Sujatha (1990), Laisamma (1992) and Jyothi (1993) indicated negative energy balance while positive energy balance was reported among women working in organized sector in Trivandrum by Florence (1989). In this study also a positive energy balance was observed in majority (88 per cent) of pre-adolescent athletes surveyed. Mini (1992) also found that all the female athletes spent less energy than their intake.

5.5 Assessment of nutritional status of the respondents

According to Beaton *et al* (1990) anthropometry is useful because it provides strong and feasible predictors at individual levels of subsequent ill health, functional impairement or mortality.

5.5.1 Anthropometric measurements

Anthropometric measurements viz. weight, height, body mass index, mid upper arm circumference, waist hip ratio, skinfold thickness, arm muscle, body fat percentage and lean body mass were taken into account for assessing the nutritional status of the preadolescent athletes.

Kramer (1987) observed that adolescence is an important time for gain in weight as well as height. With respect to body weight of the pre-adolescent athletes, it is observed that the mean weight of the respondents were 41.9, 42.9 and 46.8 respectively for age 13, 14 and 15 which was significantly lower than the NCHS and Indian Standards. Bhat *et al* (1998) in their study among adolescent girls of Kashmir found that the mean weight of girls belonging to 13, 14 and 15 years were 43.7, 45.9 and 47 kg respectively. Deficit in body weight was reported among the rural and urban adolescents of low socioeconomic status by NIN (1990).

The average height for age of the pre-adolescents belonging to 13, 14 and 15 years were found to be below the NCHS standard but was found to be above Indian standards. Vijayaraghavan *et al* (1971) reported that well-to-do Indian children were found to be taller and heavier than the children belonging to lower income group of corresponding ages. A study

conducted by Bhat *et al* (1998) among adolescent Kashmir girls found that the mean height was 154, 155 and 156 respectively for 13, 14 and 15 years. Average height of the pre-adolescent athletes in this study for 13, 14 and 15 years was found to be 154.4, 155.8 and 159.3 respectively which is in tune with body height reported among adolescent athletes by Mini (1992). Pant and Solanki (1989) reported that the mean height and weight of adolescents were far below the NCHS standards. Yaima (1989) reported that after 12th year growth of Indian girls did not keep pace with that of American counter parts.

According to Royston and Lopez (1987) BMI is of value in distinguishing the nutritional state of different groups, monitoring the adequacy of food and in specifying the proportion of malnourished in a population. WHO (1995) revealed that undernutrition is used as an indicator of current nutritional status. BMI is an indicator of body's energy stores as reported by Choudhary and Solanki (1999). Average BMI values of the athletes under study fall between 18.5 to 25 in 51 per cent respondents. Experts from NIN (1991) are of the opinion that BMI values between 18.6 and 25.0 can be considered as compatible with health for both men and women. Thus more than half of the respondents were found to fall in the normal range of BMI implicating their current nutritional status is satisfactory.

Mid upper arm measurement helps to assess the amount of subcutaneous fat which in turn gives an indication of the calorie reserves in the body of an individual (Malina *et al.*, 1974). Mid upper arm circumference of respondents under study belonging to the ages 14 and 15 were slightly below the standards suggested by Vijayaraghavan *et al.* (1974) where as mid upper arm circumference of preadolescents of 13 years was found satisfactory. Bhat *et al* (1998) reported thatthe mid upper arm circumference observed in the adolescent Kashmir girls was comparable with the standards suggested.

An increase in waist Hip Ratio indicates increased accumulation of abdominal fat. In this study Waist Hip Ratio of majority of pre-adolescents were found to be in normal range and only few of them are having values above normal which indicate that majority of pre-adolescent athletes under study donot have accumilated fat stores which may be attributed to their physical nature of work. Beatrice (1999) also found similar observations in the adolescents surveyed.

Skinfold thickness represent a comparatively simple and reasonably accurate assessment of body fatness which is an important part of the estimation of nutritional state. According to Mc Neill *et al* (1991) skinfold may provide the most valid estimate of fatness. The observed skinfold thickness of the respondents was found to be below the standards suggested by Vijayaraghavan *et al* (1971).

Determination of arm muscle area of the respondents indicated that arm muscle area fall between 4000 and 7000 mm^2 Scholz *et al* (1977) reported that arm muscle area observed in Indonesian female factory workers was only 2966 mm^2. Thus in the present study all the pre-adolescent athletes were found to possess well arm muscle area. with less fat accumulation, representing good physique.

The assessment of body fat percentage from BMI, sex and age provide accurate estimate of body composition. Predicted body fat percentage of children in the age group 12 to 15 years ranged between 22.6 to 22.2 as reported by Slaughter *et al* (1988). In this study body fat percentage of respondents fall between 17.88 to 21.04. According to Forbes (1987) and Deurenberg (1990) in growing prepubertal children the body fat percentage remains fairly constant and slightly increase only in pubertal girls. According to Shaver (1981) high percentage of body fat, exceeding 15 and 25 per cent not only serves as dead weight, but it also lessens the relative ability to supply oxygen to the working muscles thus cutting down on ones cardiovascular endurance.

Cole *et al* (1997) found that tall individuals possess greater lean body mass than short subjects. In this study it was found that lean body mass of pre-adolescent ranged between 25 to 36. Cole *et al* (1989) found differences in proportion of

lean body mass among individuals with different energy and nutrient intake.

In short all the anthropometric indices assessed in the pre-adolescent athletes under study indicate good body structure essentially needed for athletic activity, with less body fat and well built muscle structure.

5.5.2 Assessment of clinical parameter in the respondents

Park and Park (1991) observed that the ultimate objective of clinical examination is to assess levels of health of individual in relation to the food they consume.

According to Kanani (1995) 65 to 75 per cent of the underprivileged adolescent girls of 10 to 18 years in India are anaemic. In this study mild forms of anaemia was found among 50 per cent of pre-adolescent athletes. Jondhale *et al* (1999) conducted a study among adolescent girls of 13 to 15 years, found that out of 300 girls surveyed 265 girls were found to have anaemia and majority of them were having mild to moderate degree of anaemia. 5 per cent of them showed thyroid enlargement which is an indication of iodine deficiency. No other deficiency disorders were located in the surveyed athletes. Among other clinical manifestation assessed in the respondents revealed that dental caries was evidenced in 5 per cent respondents Pant and Solanki (1989) reported the occurance of dental caries in adolescents.

5.5.3 Assessment of biochemical parameters in the respondents

Biochemical examination is a direct method to assess nutritional status of an individual Haemoglobin, Packed cell volume, blood pressure, pulse rate, blood count, serum iron, total iron binding capacity are the haematological parameters assessed in the respondents under study.

Haemoglobin content in the blood of pre-adolescent athletes of 13, 14 and 15 years were 11.6, 10.7 and 11.8 respectively. Sani and Verma (1989) reported that the mean haemoglobin values of girls from low socioeconomic group varied from 9.4 to 10.68 g/100 ml. Jondhale *et al* (1999) reported that the haemoglobin content in the blood of girls of 13 to 15 years of age was varying from 9.92 to 10.47 g/dl of blood. It was found that observed values of haemoglobin content in the blood of pre-adolescent athletes under study was found to be markedly higher than the values reported in previous studies. Weight *et al* (1992) found normal haemoglobin levels in athletes. Greisen (1986) found an increase in haemoglobin level in children who received iron treatments. Nickersen *et al* (1989) found that female cross country runners have high incidence of iron deficiency due to decreased iron stores and gastro intestinal bleeding.

According to Mason and Swash (1980) in addition to haemoglobin levels, accurate estimation of packed cell volume

(PCV) or haematocrit helps in indicating the degree of anaemia. Majority of respondents surveyed had normal PCV values (36 to 47) which again confirm that the respondents under study are free from anaemia. Nelson *et al* (1994) conducted a study among 11-14 years old school girls and found that the packed cell volume of these girls were in normal range. From a study conducted by Jondhale *et al* (1999) among adolescent girls, revealed that the haematocrit values were 31.47, 33.17 and 31.76 per cent for 13, 14 and 15 years respectively which was found to be lesser than the values of respondents in this study.

An analysis of the cardiac function of the pre-adolescent athletes under study with respect to pulse rate and blood pressure revealed that majority of the respondents have pulse rate in the normal range. Devadas (1988) observed increased pulse rate in the anaemic subjects. Seshadri (1988) reported that the post exercise pulse rates were significantly higher for anaemic children when compared to the normal children. Jyothi (1993) found higher pulse rate in subjects with anaemia Satyanarayana et al (1991) is of the opinion that higher heart rate and higher metabolic stress at a given work levels are signs of inferior physical fitness.

The blood pressure profile of the respondents indicated normal values (120/80) in majority of respondents. Jothi (1993) observed a rise in blood pressure, level above the

normal in women engaged in stone breaking. Devadas (1988) reported that anaemic subjects depict high blood pressure after an activity.

From the above observations it can be concluded that pre-adolescent athletes under study depict proper cardiae ability.

According to Mason and Swash (1980) an abnormality in the number and/or distribution of while cell doesnot necessarily imply a white cell disorder as almost any illness may alter the total or differential whilte cell counts. Differential and total count of all the respondents fall in the normal categories.

Iron status of the pre-adolescent athletes as reflected in serum iron levels indicated sufficiency of iron stores in majority of the respondents. Ohira *et al* (1981) revealed that subjects with low serum iron were able to exercise on a tread mill, for shorter length of time when compared to those who had higher serum iron levels. As reflected from body iron stores and haemoglobin level, respondents under study assumed to perform well in endurance capacity. Rowland *et al.* (1991) reported high prevalence of hypoferritinemia in female high school athletes. He also found that sports particularly running increase the incidence of iron depletion with training.

Bothwell *et al* (1979) reported that the exhausion of body iron reserves is associated with decrease in stainable iron in the bone marrow, fall in serum ferritin to levels below normal and increase in iron absorption and iron binding capacity. The increase in the TIBC in general occurs before a fall in serum iron and there fore higher level of serum iron increase suggests depletion of iron stores. In the present study it was found that TIBC levels and serum iron levels were normal and there by better iron status. Brown *et al* (1985) found significantly lower serum ferritin and transferrin saturation in athletes. According to Asheden *et al* (1998) the serum ferritin level of athletes may decline due to rigorous daily training. He also found that rowers had significantly higher ferritin concentration than basket ball players. Bartsch *et al* (1998) stated that haemoglobin concentration slightly below normal values in the presence of low-normal serum ferritin levels in athletes are usually due to a dilutional "Pseudoanaemia". Sakurada and Tanaka (1996) found low haemoglobin level, haematocrit values and serum ferritin in athletes. It is encouraging to note that, subjects in this study donot have depleted iron stores which assumed to enhance their skill in activities.

5.6 Assessment of bioavailability of iron in the respondents

Studies of the molecular mechanisms involved in the absorption and bioavailability of iron are important to

attempts. made world wide to control the high incidence of iron associated disorder (Hurrell, 1997, Latunde-Dada *et al.*, 1998). In evaluating causes of iron deficiency anaemia, determination of bioavailability of dietary iron is very important. The most reliable method for determining bioavailability of iron from diets is to measure iron absorption in humans using the extrinsic tag method (Cook *et al.*, 1972; Layrisse *et al.*, 1974 and Hallberg, 1974), but it is time consuming and expensive. An in vitro method for assessing the bioavailability of iron of food source have several advantage for rapid screening.

In vitro method for determining the bioavailability of iron from the food sources of the pre adolescent athletes under study indicated that the bioavailability of iron ranged between 3 to 5.1 per cent. According to Narasinga Rao (1983) found that dietary iron absorption from habitual diets consumed in India is quiet low being only 2 to 3 per cent. A study conducted by Juna (1999) found that the proportion of iron absorbed from the diet of pregnant women was 3.6 per cent. Kavitha (1999) reported that from a meal consisting of rice, rasam and cabbage pugath bioavailability of iron was 6 per cent. Observation found in the present study with respect to bioavailability of iron is in line with the above studies. Anand and Seshadri (1991) found that ascorbic acid and citric acid enhanced bioavailability in vitro.

5.7 Assessment of physical endurance indicators in the respondents

Devadas (1988) defines physical work capacity as potential of an individual to engage in activities involving muscle action. International Dietary Energy Consulting Group (1987) explained physical working capacity as the ability to perform maximal physical work. Functional consequences of malnutrition in the subjects can be assessed by their physical work capacity as reflected among endurance capacity.

Benchpress and Overhead press test were used to measure endurance capacity of the athletes. Strength test was conducted to measure the strength of the athletes. Rohini (1999) in her study to assessed the effect of energy foods to boost athletic performance and found that there was significant increase in the final 1-Rm values in both test (bench press and overhead press) after the introduction of energy foods to the athletes. In this study the mean values of bench press obtained by pre-adolescent athletes ranged between 21.1 to 28.8 while the mean values for overhead press ranged between 21.4 and 24.12.

The anaerobic capacity of athletes is determined using "Sergent jump" named after its originator. Dr. Dudley A. Sergent which consists of a vertical leap into the air, and is

primarily a test of the ability of the body to develop power in relation to the weight of the individual himself. In the present study the mean aerobic power of pre-adolescent athletes of 13 to 15 years ranged between 52.1 to 62. Adams (1992) found an aerobic power of 75 kgm. S^{-1} for senior year (18.19) physical education students in united states. Rohini (1999) found that there was an increase in the initial Sergent jump value from 50.6 to 54.9 after the introduction of energy rich foods to the subjects.

Assessment of aerobic power possess by the pre adolescent through Harvard step test indicate that 76 per cent of the respondents under study was found to be above High average which indicate that they have good aerobic power. Earlier studies undertaken in Guatemala indicated a linear relationship between Hb level and Harvard step test performance (Viteri and Torum, 1974). Bhatia and Sheshadri (1987) reported that the anaemic children in India perform significantly worse at both submaximal and maximal work load on step test.

From the above findings it can be concluded that all the endurance were in favour of better performance in them.

5.8 Computation of Performance Index in the respondents

An index was developed to measure the endurance performance of the respondents by utilising the assessed

indicators such as strength test, sergent jump test and step test. The result indicated that the average performance index of the respondents ranged between 11.7 and 13.6 with a mean value of 11.77 for 13 years, 12.4 for 14 years and 13.6 for 14 years.

5.9 Computation of Nutritional Status Index in the respondents

According to Rao and Vijayaraghavan (1998) assessing nutritional status is to determine the type, magnitude and distribution of malnutrition in different geographic areas, to identify the at-risk groups and to determine the contributing factors. Based on the various parameters assessed for determining nutritional status, most relavent factors like weight, height, BMI, M.U.A.C., Waist Hip Ratio, body fat percentage, lean body mass, protein and calorie intake, haemoglobin levels was taken for computing nutritional status Index of the respondents. Nutritional Status Index computed indicated that the average values obtained for 13, 14 and 15 years was 176, 169 and 175 respectively.

5.10 Correlation between Nutritional Status Index and other selected variables

Functional correlation of nutritional status can be a useful adjunct to anthropometric and laboratory indicators in the assessment of nutrition health and well being.

Inter correlation between nutritional status index with most relevent variables like socioeconomic variables, dietary variables, anthropometric and biochemical variables were analysed in detail.

Among the socioeconomic variables type of family, employment status of father showed positive non significant correlation with nutritional status index while age family size, employment of mother showed negative correlation.

Among the dietary variables calorie intake found to influence nutritional status index significantly while protein showed positive but non significant correlation.

Anthropometric measurements such as body weight, body mass index, mid upper arm circumference, waist hip ratio, except body height depicted positive significant correlation with nutritional status index.

Among the biochemical parameters haemoglobin level of the respondents was found to influence nutritional status index significantly.

5.11 Correlation between Performance Index and other variables

Interrelation ship between performance index with selected variables revealed that age of the respondents showed positive significant correlation while birth order showed negative correlation which means that as the birth order

increases performance index of the respondents was found to decrease.

All the anthropometric measurements viz. weight, BMI, M.U.A.C., W.H.R., body fat percentage, lean body mass were significantly correlated with performance index however height showed non significant positive correlation studies conducted by Davies (1973), Brooks *et al* (1979), spurr (1984) (1987), Buzina *et al* (1989) have shown significant positive correlations between weight, height, percentage body fat, lean body mass and work output.

Physical endurance indicators like step test, bench press, overhead press, sergent jump also show significant positive correlation with performance index of the respondents.

Positive correlation was observed between calorie protein and iron intake with performance index while energy balance of the respondents showed non significant correlation.

Biochemical variables viz. haemoglobin level of the respondents showed significant positive correlation with performance index of the respondents. Correlation was found between haemoglobin concentration and work output in Indonesian rubber tappers (Basta *et al.*, 1979) tea plantation workers (Husaini *et al.*, 1983); Industrial workers (Scholz *et al.*, 1997). Another study on tea-estate workers in Srilanka (Gardner *et al.*, 1977) and on road construction workers in

Kenya (Wolgemuth *et al.*, 1982) supported a similar relationship between work output and Iron Status.

5.12 Correlation between Nutritional Status Index and Performance Index of the respondents

A positive significant correlation was observed between performance index of the respondents with Nutritional Status Index indicating that Nutritional Status Index of the pre-adolescent athletes profoundly influence performance. N.S.I. of the respondents developed using anthropometric measurements like height, weight, BMI, M.U.A.C, W.H.R., body fat percentage, lean body mass and dietary variables like protein and calorie intake and biochemial parameter haemoglobin measurements found that better N.S.I. enhance the subjects ability to perform an activity.

SUMMARY

6. SUMMARY

The present study entitled "Anaemia and work performance of pre-adolescent girls engaged in sports activities" was conducted among 100 athletes in the age group of 13-15 years.

The study carried out threw light, upon the socioeconomic dietary and food consumption pattern of the pre-adolescent athletes, nutritional status of the athletes and its relation to endurance abilities of the subjects were also studied in detail.

Analysis of data on economic status of the respondents revealed that all the respondents belong to low economic strata. On assessing the Social Status it was observed that majority of the respondents were christians and predominantly belong to under privileged communities. Analysis of family structure revealed that nuclear type families of medium size were common. Majority of the families surveyed were having 2 adults and 2 children and nearly half of the surveyed pre-adolescent athletes were in the first birth order. Regarding the educational attainments, it was found that majority of respondent's parents got high school education. When compared to respondent's mothers, majority of their fathers were employed.

Dietary habits of the respondents indicated that all of them were habitual non-vegetarians and follow four meal a day pattern. Cereals, milk, fat, sugar and jaggery, spices and condiments, roots and tubers, fruits, fish and egg were the most frequently used food items, where as pulses, meat and green leafy vegetables were less frequently used items in their dietaries.

Food preference of respondents revealed that among cereals, rice was most preferred by all the respondents while greengram was found to be the most preferred pulse. Less preference was recorded for green leafy vegetables while vegetables were medium preferred food items in their dietaries. Tapioca was the most preferred roots and tubers among the respondents while mango and plantain were preferred by all of them. Milk and milkproducts, animal foods, bakery items and other processed foods and health drinks were found to be very much liked by them.

Food consumption of the respondents indicated that the average intake of pulses met above the R.D.A. suggested where as consumption of meat and fish, milk and milk products were found to be inadequate. Consumption of other food groups such as cereals, green leafy vegetables, roots and tubers, fruits, egg were below the R.D.A. With regard to nutrient intake, vitamin A and ascorbic acid was found to meet the RDA, where as calories and iron were adequately met. Rest of the

nutrients were found to be inadequate when compared with R.D.A. suggested for athletes.

Energy balance assessed in the respondents by estimating energy expenditure and energy intake revealed that majority of them were having positive energy balance.

The anthropometric assessment indicated that Body weight for age of the pre-adolescent athletes found to be slightly below the Indian and international standards whereas height for age of the respondents was found to be on par with the Indian Standards. Body mass index a measure to indicate chronic energy deficiency found to be in favour of the respondents. Mid upper arm circumference of athletes belonging to 13 years was found satisfactory where as those of 14 and 15 years was found to be slightly below the standards suggested. Waist hip ratio (WHR) was found to be satisfactory in half of the respondents under study. On the whole surveyed pre-adolescent athletes possess well built arm muscle area with adequate lean body mass and body fat.

Clinical examination of the respondents, locate only mild forms of anaemia and negligible evidence for other clinical manifestations.

Biochemical investigation carried out to assess the iron status of the respondents showed that haemoglobin, packed cell volume, blood pressure, pulse rate, blood count, serum

iron. total iron binding capacity of the respondents were in the normal range which indicate satisfactory iron balance among the preadolescent athletes.

Assessment of physical endurance indicators in the respondents as assessed through strength test, sergent jump test and step test, revealed good aerobic and anaerobic power in the respondents.

The performance index of the pre-adolescent athletes under study ranged between 11.7 to 13.6.

Nutritional status index of the respondents computed incorporating relavent parameters fall in the range of 169 to 176. More over Nutritional Status Index of the respondents showed positive significant correlation with calorie intake and also with the anthropometric measurements and haemoglobin levels.

A positive significant correlation was also observed between performance index, with age of the respondents, anthropometric parameters, dietary variables, biochemical parameters and physical endurance indicators.

Study also revealed that performance Index of the respondents was found to be significantly positively influenced by Nutritional Status Index.

Based on the results obtained from the study following conclusions are arrived.

1. Majority of the respondents in this study though failed to meet the R.D.A. suggested for athletes but were able to satisfy the R.D.A. suggested for normal subjects.

2. A positive energy balance was observed in the pre-adolescent athletes studied which assumed to have positive influence on their performance.

3. No serious deviation was observed with respect to anthropometric parameters in the studied subjects and they possessed well built arm muscle area with adequate lean body mass and body fat.

4. Biochemical parameters assessed were in support of good iron status in majority of respondents, though mild forms of anaemia was observed in some athletes which was found in no way influenced their athletic performance.

5. As indicated from endurance indicators, majority of pre-adolescent athletes perform well in their sports activity, which is a reflection of good nutritional status.

REFERENCES

REFERENCES

Adams, M.G. 1992. Exercise physiology lab manual. Brown and Benchmark. IOWA

Adamson, A., Rugg-Gunn, A., Butler, T., Appleton, D. and Hackett, A. 1992. Nutritional intake height and weight of 11-12 years old Northumbrian Children in 1990 compared with information obtained in 1980 *British Journal of Nutrition* **68**: 543-563

Agarwal, K.N. 1983. Indian Economy. Vikas Publishing House Pvt. Delhi **105**: 366-374. *Indian Journal of Nutrition and Dietetics* **24**: 253

Agarwal, K.N. 1991. Functional Consequences of Nutritional Anaemia. Proceedings of Nutritional Society of India. **37**: 127

Agarwal, D.K., Agarwal, K.N. and Upadhyay, S.K. 1989. Effect of mid-day meal programme on physical growth and mental function. *Indian Journal of Medical Research* **90**: 163-174

Anand, A.N. and Seshadri, S. 1991. A quantitative model for production of iron bioavailability from Indian meals : an experimental study. International Journal of FoodScience and Nutrition 46(4): 335-342

Annapurani and Nirmala, K.M. 1985. Bioavailability of Iron by invitro method II - From Selected Foods/diets and effect of processings. *The Indian Journal of Nutrition and Dietetics* 24: 95-105

Anon. 1987. Nutrition in sports. *Editorial Lancet* : 1297

Anuradha, K. 1981. A comparative study of food nutrient and nutritional status of farm families of Nalgonda district depending on Agriculture, Diary and other source of income MSc. thesis Andhrapradesh Agricultural University, Hyderabad

Apte, S.V. and Venkatachalam, P.S. 1962. Iron absorption in human volunteers using high phytate cereal diet. *Indian Journal of Medical Research* 50: 516

Armstrong, P.L. 1989. Iron deficiency in adolescents. *British Medical Journal* 298: 499

Arora, A. 1991. The Women Elite in India. Sangam Books Limited, London

Arya, S.S. 1992. Convenience Foods - Emerging Scenario. *Indian Food Industry* 11: 37

Ashenden, M.J., Martin, D.T., Dobson, G.P., Mackintosh, C. and Hahn, A.G. 1998. Serum ferritin and anaemia in trained female athletes. *International Journal of Sports Nutrition* 8(3): 223-229

Auckett, M.A., Parks, Y.A., Scott, P.H. and Wharton, B. 1986. Treatment with iron increases weight gain and psychomotor development. *Archives of Disease in childhood* 61: 849-857

Ayurveda News. 1996. Iron Deficiency Anaemia. The Himalaya Drug Co., Special Supplement

Balgir, R.S., Murumu, B. and Dash, B.P. 1999. Physical Growth, Health and nutritional status of the Ashram school tribal children in Northern Orrisa. *The Indian Journal of Nutrition and Dietetics* 36: 43

Barbin Lorelta and Barbin, J.B. 1992. The cost of successful adolescent growth and development in girls in relation to iron and vitamin A. Status. *American Journal of Clinical Nutrition* 55: 955-958

Bartsch, P., Mairbaur, H. and Friedmann, B. 1998. Pseudo-anaemia caused by sports. *Ther Umsch* 55(4): 251-255

Basta, S.S., Soekirman, N.S., Karyadi, D. and Scrimshaw, N.S. 1979. *American Journal of Clinical Nutrition* 32: 916

Beard, S.L., Dawson, H. and Pinero, D.J. 1996. Iron metabolism a comprehensive review. *Nutrition Reviews* 54: 295-317

Beaton, G., Kelly, A., Kevany, J., Martorell, R. and Mason, J. 1990. Appropriate use of anthropometric Indices in children. ACC/SCN Nutrition Discussion Paper 7: 8-15

Beatrice. P.J. 1999. Nutritional adequacy of diets in selected hostel messes. MSc. Home Science (FS&N) Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Bhat. I.A., Khan Neelofar and Ara Anjum. 1998. Physical growth among adoloscent Kashmir girls from elite class. The *Indian Journal of Nutrition and Dietetics* 35: 189-193

Bhatia. D. and Seshadri, S. 1987. *Indian Pediatrics* 24: 133

Bloem. M.W., Wedel, M., Egger, R.I., Speek, A.J., Schrijver, J., Saowakontha, S. and Schreurs, W.H.P. 1989. Iron metabolism and vitamin deficiency in children in North east Thailand. *American Journal of Clinical Nutrition* 50: 332-338

Bothwell. T.H., Charlton, R.W., Cook, J.D., Finch, C.A. 1979. Iron metabolism in Man. Oxford: Blackwell

Bradley. D.J., Rahmathullah. L. and Narayan, R. 1988. The tea plantation as a research ecosystem. In capacity for work in the Tropics. University Press, New York : 277-288

Brise. H. and Hallberg, L. 1962. Effect of ascorbic acid on iron absorption. *Acta Med. Scand Suppl.* 376: 51

Brooks, R.M., Latham, M.C. and Crompton, D.W.T. 1979. The relationship of nutrition and health to workers productivity in Kenya. *African Medical Journal* 56: 413-421

Brown, R.T., McIntosh, S.M., Seabolt, V.R. and Daniel, W.A. 1985. Iron Status of adolescent female athletes. *Journal of Adolescence Health Care* 6(5): 349-52

Bruner, A.B., Joffe, A., Duggan, A.K., Casella, J.F. and Brandt, J. 1996. Randomised study of cognitive effects of iron supplementation in non-anaemic iron deficient adolescent girls. *Lancet* 348: 992-996

Bull, N.L. 1988. Studies on the dietary habits, food consumption and nutrient intakes of adolescents and young adults. *World Review of Nutrition and Dietetics* 57: 57-74

Buzina, R., Bates, C.J. and Vander Beek, J. 1989. Workshop on the functional significance of mild-to-moderate malnutrition. *American Journal of Clinical Nutrition* 50: 172-176

Carlisle, J.C., Bass, M.A. and Onestey, D.W. 1980. Food preference and cannotative meaning of food of Alabanna teenagers. *School Food Serv. Res. Rev.* 4(1): 19

Chadha, S.L., Gopinath, N., Katyal, I. and Shekhawat, S. 1995. Dietary profile of adults in an urban and rural community. *The Indian Journal of Medical Research* 101(4): 258-267

Chandrasekaran, S. and Easwaran, P. 2000. Nutritional and physical fitness status of selected services athletes. The *Indian Journal of Nutrition and Dietetics* 37(1): 1-5

Charlton, R.W. and Bothwell, T.H. 1983. Iron absorption. *Annual Reveiw of Medicine* **34**: 55-68

Chatard, J.C., Mujika, I., Guy, C. and Lacour, J.R. 1999. Anaemia and iron deficiency in athletes. Practical recommendations for treatment. *Sports Medicine* 27(4): 229-240

Chatterjee, C.C. 1987. Human physiology Vol. 1. Medical Allied Agency, Calcutta

Chen, L.C., Chowdhary, A., Juffman, S. 1978. "Classification of energy protein malnutrition by anthropometry and subsequent risk of mortality". International Centre for diarrhoeal research Dacca, Bengladesh. 24

Chopdar and Mishra, P.K. 1981. Health status of rural school children in western Orissa. *Indian Journal of Paediatrics*

Choudhury, B. 1995. Anthropometry in the identification of malnutrition among the children of Gowahati city. *The Indian Journal of Nutrition and Dietetics* 32(2): 51

Choudhury, M. and Solanki, H. 1999. Body Mass Index (BMI) an indicator of Energy Stores and body proportions in female labourers. *Journal of Dairing Foods and Home Science* 18(2): 109-112

Clement, D.B. and Asmudsen, R.C. 1982. Nutritional intake and hematological parameters in endurance runners. *Physician and Sports Medicine* 10: 37-43

Cole, A.H., Ibeziako, P.A. and Bamgboye, E.A. 1989. Basal metabolic rate and energy expenditure of male and female farmers from upper - Volta. *British Journal of Nutrition* 62: 631-637

Cole, A.H., Taiwo, O.O., Nwaghara, N.I. and Cole, C.E. 1997. Energy intakes, anthropometry and body composition of Nigerian adolescent girls, a case study of an institutionalized secondary school in Ibadan. *British Journal of Nutrition* 77: 497-509

Colt, E. and Heyman, B. 1984. Low ferritin levels in runners. *Journal of Sports Medicine* 24: 13-17

Cook. I.D., Layrisse. M., Martinez-Torres, C., Walker, R., Monsen. E. and Finch, C.A. 1972. Food iron absorption measured by an extrinsic tag. *J. Clin. Invest.* 51: 805

Dacie. J.V., Lewis and Canon. D.S. 1975. Practical Hematology, Churchill Livington Pub. 3rd ed. 31

Davies. C.T.M. 1973. Relationship of maximum aerobic power output to productivity and absenteeism of East African Sugar cane workers. *British Journal of Industrial Medicine* 30: 146-154

DeMaeyer. E. and Adiels-Tegman, M.C. 1985. The prevalence of anaemia in the world. *World Health Statistics Quarterly* 38: 302-316

Department of Health. 1989. The DIets of British School Children Report on Health and Social subject No. 36 London. HM Stationery Office

Deurenberg. P., Pieter. J.J.L. and Hautvast, J.G.A.J. 1990. The assessment of body fat % by skinfold thickness measurement in childhood and young adolescent. *British Journal of Nutrition* 63: 293-303

Deurenberg. P., Weststrate, J.A. and Seidell, J.C. 1991. Body Mass Index as a measure of body fatness : age and sex-specific prediction formulas. *British Journal of Nutrition* 65: 105-114

Devadas, R.P. 1988. Nutrition and physical performance of selected categories of people involved. In certain activities. *Proceedings of Nutritional Society of India* 35-42

Devadas, R.P. 1999. Nutritional Adolescents. *Proc. 18th Nat. Sem. Nutr.* Adolescent Health Trivandrum : 6-8

Devadas, R.P., Rajalekshmi, R. and Kavery, R. 1980. Influence of Family Income and Parents education on the Nutritional Status of Pre-school Children. *Indian Journal of Nutrition and Dietetics* 17(7): 237-243

Devries, H.A., Housh, T.J. 1966. Physiology of Exercise for Physical Education. Athletics and Exercise Science WBC Brown and Benchmark Publishers: 572-573

Disler, P.B., Lynch, S.R., Charton, R.W., Torrance, J.D. Bothwell, T.H., Walker, P.B. and Mayet, F. 1975. The effect of tea on non absorption. Gut. 16: 193

Eastwood, M. 1997. Principles of Human Nutrition. Chapman and Hall. Now York

Eberle, S.G. 2000. Endurance sports Human Kinetics. U.S.A.

Eckstein, E.F. 1980. Food People and Nutrition. AVI Publishing Company, INC. Westport, Connecticut. 155-159

Edgerton, V.R., Gardner, G.W., Ohira, A.J., Gunawardana, K.A. and Senewirtane, B. 1979. *British Journal of Medicine* 2: 1546

Faintuch, J.J., Lima, F.R. and Carazzato, J.G. 1998. Iron deficiency in female athletes. Rev. Hosp. Clin. Fac. Med. Sao Pauls 53(41): 181-183

Finch, C.A., Gollnick, P.D., Hlastala, M.P., Miller, L., Dillmaw, E. and Macklen, B. 1979. Lactic acid as a result of iron deficiency. *Journal of Clinical Investigation* 64: 129-137

Fleming, A.F. 1989. Tropical obstetrics and Gynaecology. Anaemia in pregnancy in tropical Africa. *Transaction of the Royal Society of Tropical Medicine and Hygiene* 83: 441-448

Florence, V. 1989. Food consumption and energy expenditure pattern of employed home makers in organised sector in Trivandrum. MSc.(FS&N) thesis submitted to Kerala Agricultural University, Vellanikkara, Thrissur

Forbes, G.B. 1987. Human body composition. New York, Springer Verlay

Fransancho, A., Roberto, Flegel, Pamela, N. 1982. Relative metrits of old and new Indices of body mass with reference to skinfold thickness". American Journal of Clinical Nutrition 36(10): 697-699

Gardner. G.W., Edgerton. V.R., Senewiratne, B., Barnard. R.J. and Ohira. Y. 1977. *American Journal of Clinical Nutrition* 30: 910

Garn. S.M., Ryan. A.S. and Higgin. M.W. 1985. Implication of fatness and leaness. *American Journal of Physical Anthropometry* 57: 191

Gebriel. Z.W., West. C., Gabre, P., Aboye, C., Ayana, G. and Hautvast. J.G.A.J. 1993. Interrelationship between vitamin A. Iodine, iron status in school children in Shoa region -Central Ethiopia. *British Journal of Nutrition* 70: 593-607

Ghosh. S. 1987. Women's role in health and development Health for the millions. xiii (1 and 2) 2-7. NIN (1971) A manual of Laboratory Techniques: 116

Ghosh. D.K. 1989. IRDP and rural women. an assessemnt, *Kurukshetra* 37(10): 32-33

Ghosh. S., Zaidi. A. Anandalakshmy, Choudhary and Sharuva, A. 1979. Growth and development of children in different ecological settings. *Indian Journal of Nutrition and Dietetics* 16: 155

Gnweker. J., Pazola, Z. 1981. Food preference of young people during communal feeding and their relation to sensory sensitivity

Godfrey, K.M., Redman, C.W.A., Barker, D.J.P. and Osmond, C. 1991. The effect of maternal anaemia and iron deficiency on the ratio of fetal weight to placental weight. *British Journal of obsetrics and Gynaecology* 98: 886-891

Gopalan, C. 1999. Women and Nutrition in India. *The Indian Journal of Nutrition and Dietetics* 36: 95-107

Gopaldas, T. and Sheshadri, S. 1987. Nutrition Monitoring and Assessment. Oxford University Press, Delhi 110-112

Gore, A.P., Shoka Tilva and Madhavkulkarni, 1977. Nutritional status of tribes in the Indiravati river basis. *Indian Journal of Nutrition and Dietetics* 14: 167

Government of India. 1981. Sixth Five Year Plan 1980-85. Frame work. Planning Commission, New Delhi

Greisen, G. 1986. Mild anaemia in African school children effect on running performance an intervention trial. *Acta Paediatr Scand.* 75(4): 662-667

Groot, L. and Staveren, W.R.D. 1995. Reduced physical activity and its association with obesity. *Nutrition Reviews* 53(1): 11-18

Gupta, S., Kawatra, B.L. and Bajaj, S. 1989. Composition of Energy intake and Body weight of Indian Adult Women from Different Socio economic Groups. *Proceedings of Nutritional Society of India* 34: 130

Gurney, J.M. and Jelliffee, D.B. 1973. *American Journal of Clinical Nutrition* 26: 912-915

Hallberg, L., Garby, L., Suwanik, R. and Bjorn, Rasmussen, F. 1974. Iron absorption from South East Asian diets. *American Journal of Clinical Nutrition* 27: 826

Hallberg, L. and Magnusson, B. 1984. The etiology of 'Sports Anaemia' - A physiological adaptation of the oxygen dissociation curve of haemoglobin to an unphysiological exercise load. *Acta-Media-Scandinavica* 216(2): 145-148

Hallberg, L., Rossander-Hulthen, L., Brunem and Gleerup. A. 1992. Calcium and iron absorption mechanism of action and nutritional importance. *European Journal of Clinical Nutrition* 46: 317-327

Herbert, V. 1987. Recommended dietary intake (RDI) of iron in humans. *American Journal of Clinical Nutrition* 45: 679-686

Hurrell, R.F. 1997. Bioavailability of iron. *European journal of clinical Nutrition* 51(1): S4-S8

Husaini, M.A., Karyadi, D. and Gunadi, H. 1983. Evaluation of Nutritional anaemia intervention among anaemic female workers on a tea plantation in iron deficiency and work performance. Washington DC. *The Nutrition Foundation* : 73-78

Hussain. R. and Patwarthan. V.N. 1959. The influence of phytate on the absorption of iron. *The Indian Journal of Medical Research* 47: 676

Hutchison. 1984. Iron deficiency and the immune response. *American Journal of Clinical Nutrition* 46: 329-334

Indian Council of Medical Research (ICMR). 1989. Energy Nutrient Requirements and Recommended Dietary allowances for Indians, A report of the expert group of the ICMR, Hyderabad

International Anaemia Consultative Group (INACG). 1985. Measurements of iron status. A report of the international Nutritional Anaemia consultative Group. Washington. D.C. The Nutrient foundation

IDECG. 1987. Proceedings of International Dietary Energy Consultancy Group (IDECG) Meeting. Guatemalan City (In Press)

Jessy. 1996. Assessment of Quality of Selected Varieties of greengram and grain cowpea. Ph.D Home Science (FS&N) Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Jondhale. J.P., Reddy, S.N. and Nalwade, V.M. 1999. Prevalence of anaemia among school going adolescent girls of Parbhani. *The Indian Journal of Nutrition and Dietetics* 36: 268-274

Juna, L.P. 1999. Nutritional profile of pregnant women with reference to iron. M.Sc. Home Science (FS&N) Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Jyothi, A. 1993. Factors influencing the working efficiency of women engaged in stone breaking with Special reference to nutritional status. MSc. (FS&N) Thesis. Kerala Agricultural University. Vellanikkara. Thrissur

Kamath, S. 1986. "Nutritional Assessment". Health Assessment (3rd ed). C.V.Moshy Company Pub.

Kanani, S. 1995. Strategies for combating anaemia in adolescent girls. *The Indian Journal of Paediatrics* 62: 375-377

Kardjati, Jane, A., Husin. 1983. Food consumption of rural women in east Java - Indonesia. *Nutrition Reports International* 28(4): 1341

Kaul, S.S. and Nyamongo, K.I. 1990. Ecology, growth and nutritional status, Ashish Publishing House, New Delhi

Kavitha, M.S. 1999. Effect of iron and vitamin supplementation on Iron profile of Anaemic adolescent girls. Ph.D Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Kramer, M.S. 1987. Determinants of low birth weight Methodological assessment and meta analysis. Bulletin of the World Health Organisation. 65: 663-737

Kripke, S.S. and Sanders, E. 1990. Prevalence of iron deficiency anaemia among infants and young children seen at rural ambulatory clinics. *American Journal of Clinical Nutrition* 23: 716-724

Laisamma, C. 1992. Food consumption and energy expenditure pattern of agricultural labourers of Trivandrum district. M.Sc. Home Science (FS&N) Thesis, Kerala Agricultural University, Vellanikkara, Thrissur

Lampe, J.W., Slavin, J.L. and Apple, F.S. 1986. Poor iron status of women training for a marathon. *International Journal of Sports Medicine* 7: 111-114

Latunde-Dada, G.O., Bianchi, M.L., de Oliveira, J.E. 1998. On the methods for studying the mechanisms and bioavailability of iron. *Nutrition Reviews* 56(2): 76-80 Layrisse, M., Martinez-Torres, C. and Roche, M. 1968. Effect of interaction of various food on iron absorption. *American Journal of Clinical Nutrition* 21: 1175

Layrisse, M., Martinez-Torres, C. and Gonsalez, M. 1974. Measurement of the total daily dietary iron absorption by the extrinsic tag model. *American Journal of Clinical Nutrition* 23: 152

Layrisse, M., Chaves, J.F., Mendez-Castellano, H., Bosch, V., Tropper, E., Bastardo, B. and Gonzalez, E. 1996. Early response to the effect of iron Fortification in the Venezuelan population. *American Journal of Clinical Nutrition* 64: 903-907

Layrisse, M., Martinez-Torres, C., Mendez-Castellano, H., Taylor, P., Fossi, M., Lopezde Blanco, M., Landactajimes, M., Jaffe, W., Leet, S.I., Tropper, E. Garcia-Casal, M.N. and Ramirez, J. 1990. Relationship between iron bioavailability from diets and prevention of iron deficiency. *Food Nutrition Bulletin* 12: 301-309

Lean, M.E.J., Han, T.S. and Morrison, C.E. 1995. Waist circumference as a measure for indicating need for weight management. *British Medical Journal* 11(7): 638-641

Leela, R., Sarma, K.V.R. 1998. Text Book of Human Nutrition. Oxford IBA publishing Co. Pvt. Ltd. 267-277

Li, R., Chen, X., Yan, H., Deurenberg, P., Garby, L. and Hautvast, JGAJ. 1994. Functional consequenes of iron supplementation in iron deficient female cotton mill workers in Beijing, China, *American Journal of Clinical Nutrition* 59: 908-913

Lina, S. and Reddy, P.R. 1984. Development and evaluation of low cost indigenous food mixes of Pre-schoolers and formulation of diet. *The Indian Journal of Nutrition and Dietetics* 21(7): 241-250

Lois, M.R.N., Violet, B., Muriel, M. and Kathryn, S.A. 1986. Health Assessment. C.V.Mosby Co., Missouri

Looker, A.C., Dallman, P.R., Carrol, M.D. Gunter, E.W. and Johnson, C.L. 1997. Prevalence of iron deficiency in the United States. *Journal of American Medical Association* 277: 973-976

Magnusson, B., Hallberg, L., Rossander, L. and Swolin, B. 1984a. Iron metabolism and 'Sports anaemia' I.A. Study of several iron parameters in elite athletes with differences in iron status. *Acta Medica Scandinavica* 216: 149-156

Magnusson, B., Hallberg, L., Rossander, L. and Swolin, B. 1984b. Iron metabolism and 'Sports anaemia' II.A. haematologic comparison of elite runners and control subjects. *Acta Medica Scandinavica* 216: 159-164

Mahan, K. and Rees, J.M. 1984. Nutrition in Adolescence. Times Mirror/Mosky College Publishing. U.S.A.

Malina, R.M., Habicht, J.P., Yarbrough, C., Martorell, R. and Klecin, R.G. 1974. Skinfold thickness at seven sites in rural guatemalan Ladino children from birth through 7 years of age. *Human Biology* **46**(3): 453-469

Mankchar, K. 1980. Women working against odds. Yojana. 24(16): 13-14

Martin, E.A., Coolidge, A.A. 1978. Nutrition in action (4 ed) Von, Hoffmann Press, Missouri, 200-217

Marx, J.I.M. 1997. Iron deficiency in developed countries. Prevalance, influence of life style factors and hazards of prevention. *European Journal of Clinical Nutrition* 51: 491-494

Mason, S. and Swash, M. 1980. Hutchison's clinical methods. Cassell Ltd., London

Matter, M., Stitfall, T., Graves, J., Myburgh, K., Adams, B., Jacobs, P. and Noakes, T.D. 1987. The effect of iron and folate therapy on maximal exercise. Performance in female marathon runners with iron and folate deficiency. *Clinical Science* 72: 415-422

McDonal. R.M. and Carlkeen. 1988. Iron, zinc and magnesium. Nutrition and Athletic Performance. *Sports Medicine* 5: 171-184

McNeill. G. Fowler, P.A, Maughan, R.J., McGaw, B.A. Fuller, M.F., Gvozdanovie, D. and Gvozdanovic. S. 1991. Body fat in lean and overweight women estimated by six methods. *British Journal of Nutrition* 65: 95-103

Mejia, L.A. and Arrayava, G. 1982. The effect of vitamin A fortification of Sugar on iron metabolism in preschool children in Guatemala. *American Journal of Clinical Nutrition* 36: 87-93

Mini, K. 1992. Assessment of nutritional status of School children residing in G.V.Raja Sports School. MSc. (FS&N) Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Mony, E.P. 1993. Food preference and dietary habits of adolescents among agricultural labourers. MSc Home Science (FS&N) Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Mourya, S.P. and Jaya, N. 1997. Prevalence of malnutrition among tribal children. *The Indian Journal of Nutrition and Dietetics* 34(9): 214-219

Mulligan, K. and Butterfield, G.E. 1990. Discrepencies between energy intake and expenditure in physically active women. *British Journal of Nutrition* 64: 23-36

Musgrave, K.O., Ashterberg, C.L. and Thornkury, M. 1981. Strategies for measuring adolescent snacking patterns. *Nutrition Reports International* 24(3): 557-573

Nair, G.R. 1990. Women workers demand a better deal. *Yojana* 34(4): 19-20

Nair, K.M. 1999. Iron absorption and its implication in the control of iron deficiency anaemia. *Nutrition News* 20: 2

Nair, K.S. and Poehlman, E.T. 1991. Contribution of Protein Turnover to Energy Expenditure in Humans. Proceedings of Nutritional Society of India (1991) 37: 199

Narasinga Rao, B.S. 1983. Symposium on Nutritional anaemia in India and its prevention. *Proceedings of the Nutrition Society of India* 28: 1-6

Narasinga Rao, B.S. 1996. Nutrient requirement of sports persons and Athletes. *Proceedings of Nutritional Society of India* 43: 79-103

Narasinga Rao, B.S. 1999. Nutrient delivery strategies to combat malnutrition in India. Their strength weakness and Need. *The Indian Journal of Nutrition and Dietetics* 36: 153-167

Narasinga Rao, B.S. and Prabhavathi, T. 1978. An in vitro method for predicting the bioavailability of iron from foods. *American Journal of Clinical Nutrition* 31: 169-175

Neiman, C.D., Butterworth, D.E. and Nieman, C.N. 1990. Nutrition. WMC. Brown publishers U.S.A. 294-297

Nelson, M., White, J. and Rhodes. 1993. Haemoglobin, Ferritin and iron intakes in British children aged 12-14 years a preliminary investigation. *British journal of Nutrition* 70: 147-155

Nelson, M., Bakalopu, F. and Trivedi, A. 1994. Iron deficiency anaemia and physical performance in adolescent girls from different ethnic backgrounds. *British Journal of Nutrition* 72: 127-143

Nelson, M., Naismith, D.J., Burley, V., Gatenby, S. and Geddes, N. 1990. Nutrient intakes vitamin mineral supplementation and intelligence in British School children. *British Journal of Nutrition* 64: 13-22

Nickerson, H.J., Holubets, M.C., Weiler, B.R., Haas, R.G., Schwartz, S. and Ellefson, M.E. 1989. Causes of iron deficiency in adolescent athletes. *Journal of Pediatrics* 114: 657-663

Nielsen, P. and Nachtigall, D. 1998. Iron supplementation in athletes. *Current recommendations Sports Medicine* 26(4): 207-216

NIN. 1988-90. Iron deficiency anaemia. NIN Annual Report, Indian Council of Medical Research

NIN. 1989. Annual Report. Indian Council of Medical Research. 48-49

NIN. 1991. Maternal body Mass Index (BMI and birth weight) *Nutrition Reviews* 12(1): 2-3

NNNB. 1994. Report of Urban Survey Slums (1993-94). NIN. ICMR, Hyderabad

Nutrition News. 1990. National Institute of Nutrition. A Report of the Expert Group. 12: 2

Nutrition News. 1991. National Institute of Nutrition. 12(2)

Nutritional Reviews. 1983. Use of iron fortified salt to combat anaemia. The Indian experience 41(10): 302-303. *Indian Journal of Nutrition* 1987 24: 253

Nuviala, R.J., Castillo, M.C., Lapieza, M.G. and Escanero, J.F. 1996. Iron nutritional status in Female Karatekas, handball, and basket ball players and Runners. *British Journal of Nutrition* 59(3): 449-453

Ohira, Y., Edgerton, V.R., Gardner, G.W., Gunawardane, K.A., Senewirtane, B. and Ikawa, S. 1981. *Journal of Nutritional Science of Vitaminology* 27(12): 87-86. Nutrition Abstracts and Reviews Series A (1982) 52(6)

Pant, I. and Solanki, K. 1989. Assessment of health and nutritional status of under previleged school age boys with special emphasis on vitamin A deficiency. *Nutrition Society of India*

Park, J.E. and Park, K. 1991. Text book of preventive and social Medicine (13th edn.) Banarsidas Bhanot Publishers, Jabalpur

Piccardi, G., Nyssen, M. and Dorche, J. 1972. *Clin. Chim. Acta.* 40: 219

Powers, H.J., Bates, C.J., Downes, R., Brubacher, D., Sutcliffe, V. and Thurnhill, A. 1988. Running performance in Gambian children effects of water. Soluble vitamins or iron. *European Journal of clinical Nutrition* 42: 895-902

Psacharopoulos. G. 1989. Female labour force participation and international perspective. World Bank Research Observer. 4(2): 187-201. RDA (1991) 14(3)

Purushothaman, V. 1989. Anaemia and work output. Paper presented at Refresher course in Home Science for College/University in service teachers, sponsored by the UGC. Avinashilingam Institute of Home Science and Higher Education for women, Coimbatore, India

Quinn. M. 1996. Canadian programme reverses high anaemia incidence. *Lancet* 38: 394

Rajajee. S. 1989. Nutritional anaemias in childhood. *Proceedings of Nutritional Society of India* NIN

Raman. L.. Ran. P.. Rao. V. 1985. Nutritional Status and age at Menarche. *Proceedings of Nutrition Society of India* 31-83

Ramankutty. K. 1990. "Women's Health and child Health Linkages. Some lessons from Kerala". *Nutritional Society of India Scientific Programmes and Abstracts* (1989)

Ramsay. W.N.M. 1957. *Clin. Chim. Acta.* 2: 221

Randhawa. R.K. and Kanwatra. B.L. 1994. Biological evaluation of iron availability from Pre-adolescent diets by using anaemic rats. *Plant Food for Human Nutrition* 45(4): 315-320

Rao, D.H. and Vijayaraghavan, K. 1998. Anthropometric Assessment of Nutritional Status, Oxford and IBH Publishing Co. Pvt. LTD., New Delhi

Raunikar, R.A. and Sabio, H. 1992. Anaemia in the adolescent athlete. *American Journal of Diseases in Children* 146(10): 1201-1205

Reaburn, J.A., Krohdle, M. and Lau, D. 1979. Social determinants in food selection. *Journal of American Dietetic Association* 74: 637-641

Reddy, V. 1983. Nutritional Problems in India. Journal of food and nutrition 40(6): 155-157

Robson, P.J., Strain, J.J., Cran, G.W., Savage, I.N., Primose, E.D. and Borcham, C.A.P. 1991. Snack energy and nutrient intake of northern Ireland adolescents. *Proceedings of the Nutrition Society* (50); 180 A

Rohini, N. 1999. Impact of soya based energy foods on the nutritional status and performance of adolescent athletes. M.Sc. Home Science (FS&N) Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Rowland, T.W. 1990. Iron deficiency in the young athlete. *Pediatr. Clin. North AM* 37(5): 1153-63

Rowland, T.W. and Kelleher, J.F. 1989. Iron deficiency in athletes - insights from high school Swimmers. *American Journal of Disease in Children* **143**: 197-200

Rowland, T.W., Stagg, L. and Kelleher, J.F. 1991. Iron deficiency in adolescent girls. Are athletes at increased risk? *Journal of Adolescence Health* 12(1): 22-25

Rowland, T.W., Deisroth, M.B., Green, G.M. and Kelleher, J.F. 1988. The effect of iron therapy on the exercise capacity of non-anaemic iron deficient adolescent runners. *American Journal of Disease in children* 142: 165-169

Royston, L. and Lopee, R. 1987. On the assessment of maternal mortality. *World Health Statistics Quarterly* **40**: 214-224

Rudzki, S.J., Hazard, H. and Collinson, D. 1995. Gastrointestinal blood loss in triathletes its etiology and relationship to sports anaemia. *Aust. J. Sci. Med Sport* 27(1): 3-8

Sakurada, K. and Tanaka, J. 1996. Sport-anemia : Studies on hematological status in high school boy athletes. *Rinsho Byori* **44**(7): 616-621

Sani. M. and Verma. S. 1989. Assessment of nutritional status of school girls. Nutrition society of India. *Scientific programme and Abstracts*

Sathyanarayana, K., Nageswara Rao. C., Narasinga Rao, B.S. and Malhotra. M.S. 1985. "Recommended dietary intakes for Indian Sportsman and women" NIN, Hyderabad

Satyanarayana. K., Venkataramana, Y., Someswara, M. and Sudhakara Rao, S. 1991. *Proceedings of Nutritional Society of India* (1991): 37: 213

Sato. F., Milwa. S., Murayama, A. and Fujitoc, N. 1984. Breakfast and supper taken by Junior College students as reflected in combinations of group of dishes. *Japanese Journal of Nutrition* 42(2): 91-97

Sausberlich. H.E., Dowdy, R.P. and Skala, J.H. 1977. Laboratory Tests for the Assessment of Nutritional Status. CRC Press Inc. Cleveland, Ohio

Saxena. K.J. 1986. "The joint and nuclear family. A personal experience". *The Indian Journal of Social Work* XL.VII: 32-36

Sayers. M.H., Lynch, S.R., Jacobs, P., Charlton, R. Bothwell, T.H., Walker, R.B. and Mayet, F. 1973. The effect of ascorbic acid supplementation on the absorption of iron in maize. wheat and soya. *British Journal of Haematology* 24: 259

Scholz, B.D., Gross, R., Schultink, W. and Sastroamidjojo, S. 1997. Anaemia is associated with reduced productivity of women workers even in less physically strenuous tasks. *British Journal of Nutrition* 77: 47-57

Sharpe, L.M., Peacock, W.C., Cooke R and Harris, R.S. 1950. The effect of phytate and other food factors on iron absorption. *Journal of Nutrition* 41: 433

Shaver, L.G. 1981. Essentials of exercise physiology. Surjeet Publications Delhi : 185

Sheshadri, S. 1988. Effect of Anaemia on physical performance of children and the impact of iron supplements. *Proceedings of Nutritional Society of India* 34: 44-54

Sheshadri, S. and Malhotra, S. 1984. *Indian Pediatrics* 21: 529

Slaughter, M.H., Lohman, T.G., Boileau, R.A., Horswill, C.A., Stillman, R.J., Van Loan, M.D. and Bemben, D.A. 1988. Skinfold equations for estimation of body fatness in children and Youth. *Human Biology* 60: 709-723

Spurr, G.B. 1984. Physical activity, nutritional status and physical work capacity in relation to agricultural productivity. In Energy Intake and Activity: 207-261. New York : Alan Liss Inc.

Spurr, G.B. 1987. Effects of chronic energy deficiency on Stature, work capacity and, In Chronic Energy Deficiency consequences and Related Issues : *International Dietary Energy Consultation Group* 95-134

Stephenson, I.A. 1995. Nutrition Review 53: 23-20

Suja, P.T. 1989. Effect of birth order and spacing on the nutritional status of mother and child. M.Sc. Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Sujatha, A.S. 1990. Food consumption and energy expenditure pattern of self employed women in unorganised sector. M.Sc. (FS&N) Thesis. Kerala Agricultural University, Vellanikkara, Thrissur

Sumati and Kapoor, A.C. 1986. Effect of dietary iron levels on the bioavailability of iron, zinc and copper. *The Indian Journal of Nutrition and Dietetics* 23: 165

Swash, M. and Mason, S. 1984. The blood. Hutchison's clinical methods (18 ed.) The English Language Book Society; 429

Swaminathan, M. 1986. Principles of Nutrition and Dietetics. The Bangalore Printing and Publishing Company Ltd. 334

Synder, A.C., Dvorak, L.L. and Roepke, I.D. 1989. Influence of dietary iron source on measures of iron status among female runners. *Medicine and Science in Sport and Exercise* 21: 7-10

Usha Anne and Mushtari Begum. 1985. Nutritional Status of children attending the U.A.S. School". *Indian Journal of Nutrition and Dietetics* 22(7): 221

Vasanthi, G., Pawashe, A.B., Sushie, H., Sujatha, T. and Raman, L. 1994. Iron nutritional status of adolescent girls from rural area and urban slum. *Indian Pediatrics* 31: 127-132

Vijayalekshmi, P. and Selvasundari, S. 1983. Relationship between iron deficiency anaemia and energy expenditure of young adult women. *The Indian Journal of Nutrition and Dietetics* 20(4): 113

Vijayalekshmi, P. and Jayanthi, N. 1986. Anaemia and work output. *Indian Journal of Nutrition and Dietetics* 23(1): 279

Vijayaraghavan, K. 1987. Anthropometry for assessment of nutritional status. *Indian Journal of Pediatrics* 54: 511-520

Vijayaraghavan, K., Darshan Singh and Swaminathan, M.C. 1971. "Heights and weights in well nourished Indian School Children". *Indian Journal of Medical Research* 59: 648

Vijayaraghavan, K., Darshan Singh and Swaminathan, M.C. 1974. Arm Circumference and fat fold at triceps in well-nourished Indian School Children. *Indian Journal of Medical Research* 62: 994-1001

Visweswara Rao. 1975. Dietary Surveys - Methods

Viteria, F.E. 1994. The consequences of Iron deficiency and anaemia in pregnancy on maternal health, the foetus and the infant SCN News 11.ACC/SCN Report. U.N.

Viteri, F.E. and Torun, B. 1974. Anemia and physical work capacity. *In Clinics in Hematology* 3: 609-626

Walker, A.R.P. 1998. The remedying of iron deficiency : What priority should it have? *British Journal of Nutrition* 79: 227-235

Weight, L.M., Jacobs, P. and Noakes, T.D. 1992. Dietary iron deficiency and sports anaemia. *British Journal of Nutrition* 68: 253-260

Weight, L.M., Noakes, T.D., Labandarios, D., Graves, J., Jacobs, P. and Berman, P. 1988. Vitamin and mineral status of trained athletes including the effects of Supplementation. *American Journal of Clinical Nutrition* 47: 188-191

Weiner, K., KUS, C. and FOX, H.M. 1980. Fibre effect on iron utilization by human adolescents. *Nutrition Reports International* 24(4): 660-661

Weink, K.J.H., Marxm, J.J.M., Santor, M., Lemmens, A.G., Brint, E.J., Vander Meer, R. and Beymen, A.C. 1997. Dietary ascorbic acid raises iron absorption in anaemic rats through enhancing mucosal iron uptake independent of iron solubility in the digesta. *British Journal of Nutrition* 77(1): 123-131

Weisell, R.C. and Francois, P.S. 1982. Reference weight for height standards. An easier approach for computerisation. Food and Nutrition (FAO) *8(1)*: 12-18

Wheelar, E.F. and Tan, S.P. 1983. From concept to practice Food behaviour of Chinese immigrants in London. *Ecology of food and nutrition* 13: 51-57

Whiting, S.J. 1995. The inhibitory effect of dietary calcium on iron bioavailability. A cause for concern? *Nutrition Review* 53(3): 77-80

Wolde-Gebriel, Z., Halle Gebre, Fisseha, T. and West, C.E. 1993. Vitamin A. iron and iodine status on children with Severe vitamin A deficiency in a rural village in Hararge Region of Ethiopia. *European Journal of Clinical Nutrition* 47: 104-114

Wolgemuth, J.C., Latham, M.C., Chesher, A., Hall, A. and Crompton, D.W.T. 1982. Workers productivity and the nutritional status of Kenyan road Construction labourers. *American Journal of Clinical Nutrition* 36: 68-78

World Health Organization. 1991. National Strategies for over coming micronutrient malnutrition. Geneva. *World Health Organization*

World Health Organization. 1995. Physico Status. The use of interpretation of anthropometry. Report of a WHO expert committee. Technical Report. Geneva : World Health Organisation

Wooton. S. 1989. Nutrition for sports. Simon and Schuster, London 129-130

Yaima. E. and Narendra, R.K. 1989. A study of height and weight of urban school going children of Imphal. *Indian Journal of Public Health* 33: 15

Yip. R. 1994. Iron deficiency : Contemporary scientific issues and international programmatic approaches. Journal of Nutrition **124**: 1479S-1490S

Yona. 1986. Life News letter **18**(6): 25

APPENDICES

APPENDIX - I

KERALA AGRICULTURAL UNIVERSITY
College of Agriculture, Vellayani
Department of Home Science

Name of investigator :

Anaemia and work performance of pre-adolescent girls engaged in sports activities

Schedule to elicit the socioeconomic background of the respondents

1. Name of the respondent :
2. Address :
3. Age of the respondent :
4. Class :
5. Religion :
6. Caste :
7. Type of family :
8. Family size :
9. Number of adults in the family :
10. Number of children in the family :
11. Birth order of the respondent :
12. Educational status of father :
13. Educational status of mother :
14. Employment status of father :
15. Employment status of mother :
16. Number of employed persons in the family:
17. Percapita income of the family :

APPENDIX - II

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science, Vellayani

Name of investigator :

Name of subject :

Anaemia and work performance of pre-adolescent girls engaged in sports activities

Schedule to assess the dietary habits of the respondents

I Eating habit of the respondents

II Frequency of using food stuffs

1. Cereals
2. Pulses
3. Vegetables
4. Green leafy vegetables
5. Roots and tubers
6. Fruits
7. Milk
8. Meat
9. Fish
10. Egg
11. Fats and oils
12. Sugar and jaggery
13. Spices and condiments

III Meal frequency followed by respondents

IV Food preference of respondents

1. Rice
2. Wheat
3. Ragi
4. Blackgram
5. Redgram
6. Greengram
7. Peageonpea
8. Horsegram
9. Greenpeas
10. Beans
11. Drumstick
12. Ladiesfinger
13. Cucumber
14. Brinjal
15. Bittergourd
16. Ashgourd
17. Snakegourd
18. Plantaingreen
19. Gardenpeas
20. Pumpkin
21. Cauliflower
22. Ivygourd
23. Breadfruit
24. Plantain stem
25. Plantain flower
26. Amaranthus
27. Drumstick leaves
28. Coriander leaves
29. Cabbage
30. Carrot
31. Potato
32. Tapioca
33. Elephantyam
34. Whiteyam
35. Sweetpotato
36. Beetroot
37. Raddish
38. Onion small
39. Onion big
40. Banana
41. Tomato
42. Gooseberry
43. Jackfruit
44. Mango
45. Gauva
46. Orange
47. Apple
48. Pineapple

49. Sapota
50. Lemon
51. Cherry
52. Starapple
53. Watermelon
54. Dates
55. Sabergelly
56. Cashewfruit
57. Grapes
58. Plantain
59. Groundnut
60. Coconut
61. Gingelly seed
62. Cashewnut
63. Milk
64. Curd
65. Buttermilk
66. Ghee
67. Custard
68. Ice cream
69. Fruit salad
70. Pudding
71. Egg
72. Fish
73. Beaf
74. Goat meat
75. Chicken
76. Biscuit
77. Cake
78. Halwa
79. Jilabi
80. Ladoo
81. Mysore pak
82. Chips
83. Pakoda
84. Murukku
85. Mixture
86. Vadai
87. Banana roast
88. Baji
89. Cutlet
90. Puffs
91. Bonda
92. Cadberry
93. Toffee
94. Jam
95. Jelly
96. Squash
97. Colas
98. Noodles
99. Popcorn
100. Complan
101. Horlicks
102. Bournvita
103. Boost
104. Maltova

APPENDIX - III

KERALA AGRICULTURAL UNIVERSITY
College of Agriculture, Vellayani
Department of Home Science

Name of investigator :

Name of subject :

Anaemia and work performance of pre-adolescent girls engaged in sports activities

Individual food consumption pattern - 24 hour recall method

Meal pattern	Type of food preparation	Raw quantity of each ingredient (gm)	Total cooked amount (gm)
Early morning			
Break fast			
Evening snack			
Dinner			

APPENDIX - IV

Prediction equation for determining the energy expenditure pattern of the respondent

Energy expenditure = Basal Metabolic Rate (BMR) factor x BMR

BMR factor recommended for computing energy requirement = 1.9

BMR suggested by ICMR expert group for Indian female = 14 x Body weight (kg) + 471

APPENDIX - V

Energy balance of the respondents

Sl. No.	AGE (Years)	ENERGY BALANCE	Sl. No.	AGE (Years)	ENERGY BALANCE	Sl. No.	AGE (Years)	ENERGY BALANCE
1	14	747	35	15	848	69	15	-158
2	14	787	36	14	739	70	13	268
3	14	778	37	15	792	71	15	-36
4	14	768	38	14	680	72	15	181
5	14	850	39	14	670	73	15	14
6	14	832	40	14	670	74	14	-173
7	14	674	41	15	628	75	13	-78
8	14	800	42	15	526	76	13	116
9	14	773	43	14	625	77	13	630
10	13	764	44	15	507	78	13	351
11	14	755	45	14	-2	79	13	505
12	13	693	46	14	187	80	13	289
13	13	674	47	13	453	81	13	564
14	13	811	48	13	-68	82	13	372
15	14	723	49	14	1	83	13	460
16	14	818	50	14	4	84	13	431
17	14	614	51	14	6	85	13	466
18	14	711	52	14	158	86	13	404
19	14	576	53	13	69	87	13	397
20	14	789	54	13	-42	88	13	311
21	14	637	55	14	302	89	15	334
22	14	719	56	13	7	90	13	231
23	14	543	57	14	-210	91	13	195
24	13	770	58	13	119	92	13	324
25	15	648	59	13	208	93	13	399
26	15	656	60	14	25	94	13	218
27	14	903	61	15	-25	95	13	392
28	15	869	62	15	178	96	14	545
29	15	778	63	15	236	97	13	404
30	14	693	64	15	-96	98	14	184
31	14	835	65	15	158	99	13	364
32	15	723	66	15	-77	100	13	397
33	15	447	67	15	95			
34	15	810	68	15	-68			

APPENDIX - VI

KERALA AGRICULTURAL UNIVERSITY
College of Agriculture, Vellayani
Department of Home Science

Name of investigator :

Name of subject :

Anaemia and work performance of pre-adolescent girls engaged in sports activities

Nutritional Assessment Schedule

National Institute of Nutrition

A. ANTHROPOMETRY

1. Weight	2. Height	3. Body Mass Index
4. Mid Upper Arm Circumference		5. Waist Hip Ratio
6. Triceps Skinfold Thickness		7. Arm Muscle
8. Body Fat Percentage		9. Lean Body Mass

B. CLINICAL EXAMINATION

1. Parotid enlargement	2. Oedema
3. Emaciation	4. Marasmus
5. Conjunctival xerosis	6. Bitot's spots
7. Corneal xerosis/Keratomalacia	8. Night Blindness
9. Photophobia	10. Anaemia
11. Naso-labial dyssebacea	12. Angular stomatitis
13. Cheilosis	14. Tongue-Red and raw
15. Atrophic lingual papillae	16. Pellagra
17. Craz pavemant dermatosis	18. Pigmentation of Knuckles/fingers/ toes

19. Phynoderma
20. Koilonychia
21. Gums-spongy, bleeding
22. Knock-knees or bowlegs
23. Frontal and parietal bossing
24. Teeth caries
25. Mottled enamel
26. Enlargement of spleen
27. Enlargement of liver
    - Soft
    - Firm
    - Hard
28. Thyroid enlargement

C. BIOCHEMICAL EXAMINATION

1. Haemoglobin
2. Packed cell volume (PCV)
3. Blood pressure
4. Pulse rate
5. Blood count
6. Serum iron
7. Total iron binding capacity (TIBC)
9. Photophobia
10. Anaemia
11. Naso-labial dyssebacea
12. Angular stomatitis

APPENDIX - VII

Performance Index of respondents

Sl. No.	AGE (Years)	PERFOR-MANCE INDEX	Sl. No.	AGE (Years)	PERFOR-MANCE INDEX	Sl. No.	AGE (Years)	PERFOR-MANCE INDEX
1	14	17	35	15	10	69	15	17
2	14	10	36	14	17	70	13	6
3	14	8	37	15	9	71	15	7
4	14	9	38	14	15	72	15	9
5	14	6	39	14	10	73	15	15
6	14	5	40	14	14	74	14	16
7	14	18	41	15	11	75	13	12
8	14	14	42	15	19	76	13	10
9	14	19	43	14	13	77	13	4
10	13	15	44	15	17	78	13	8
11	14	11	45	14	8	79	13	8
12	13	17	46	14	12	80	13	17
13	13	20	47	13	19	81	13	9
14	13	11	48	13	14	82	13	20
15	14	13	49	14	8	83	13	6
16	14	12	50	14	5	84	13	11
17	14	15	51	14	5	85	13	14
18	14	14	52	14	6	86	13	17
19	14	19	53	13	6	87	13	12
20	14	13	54	13	9	88	13	11
21	14	20	55	14	9	89	15	16
22	14	18	56	13	6	90	13	10
23	14	6	57	14	9	91	13	13
24	13	19	58	13	12	92	13	15
25	15	18	59	13	14	93	13	8
26	15	17	60	14	15	94	13	6
27	14	18	61	15	19	95	13	7
28	15	17	62	15	15	96	14	14
29	15	11	63	15	15	97	13	17
30	14	16	64	15	19	98	14	14
31	14	13	65	15	5	99	13	9
32	15	11	66	15	18	100	13	12
33	15	15	67	15	6			
34	15	12	68	15	12			

APPENDIX - VIII

Nutritional Status Index of respondents

Sl. No.	AGE (Years)	NSI	Sl. No.	AGE (Years)	NSI	Sl. No.	AGE (Years)	NSI
1	14	178.10	35	15	175.07	69	15	180.01
2	14	156.17	36	14	196.77	70	13	174.00
3	14	155.32	37	15	176.07	71	15	156.47
4	14	155.96	38	14	177.26	72	15	157.79
5	14	135.27	39	14	158.15	73	15	158.67
6	14	154.44	40	14	176.76	74	14	197.96
7	14	178.94	41	15	157.28	75	13	177.18
8	14	158.47	42	15	198.93	76	13	157.51
9	14	177.14	43	14	177.41	77	13	170.39
10	13	196.71	44	15	198.95	78	13	193.63
11	14	177.28	45	14	156.63	79	13	155.06
12	13	177.74	46	14	157.70	80	13	178.00
13	13	178.81	47	13	180.36	81	13	194.94
14	13	176.35	48	13	159.70	82	13	161.74
15	14	157.25	49	14	156.77	83	13	174.00
16	14	176.16	50	14	136.52	84	13	176.59
17	14	177.54	51	14	135.83	85	13	177.20
18	14	158.47	52	14	155.33	86	13	177.70
19	14	178.79	53	13	154.69	87	13	176.72
20	14	177.49	54	13	175.41	88	13	194.88
21	14	179.67	55	14	156.16	89	15	179.16
22	14	178.17	56	13	174.61	90	13	176.83
23	14	155.38	57	14	175.87	91	13	178.79
24	13	178.42	58	13	174.60	92	13	178.39
25	15	160.03	59	13	195.08	93	13	175.73
26	15	178.02	60	14	176.66	94	13	192.54
27	14	178.14	61	15	179.22	95	13	174.11
28	15	196.88	62	15	159.51	96	14	176.94
29	15	157.99	63	15	176.33	97	13	178.59
30	14	196.83	64	15	180.53	98	14	177.01
31	14	195.70	65	15	192.39	99	13	176.23
32	15	157.92	66	15	179.28	100	13	159.57
33	15	198.10	67	15	154.33			
34	15	194.73	68	15	159.05			

NSI - Nutritional Status Index

APPENDIX - IX

Composition of the cooked diets for the analysis of bioavailability of iron

Diet. A	Diet. B
Rice	Rice
Rice flour	Rava
Red gram dhal	Red gram dhal
Cucumber	Cucumber
Mango	Beans
Cabbage	Chikkurmanis
Colocasia	Colocasia
Onion	Onion
Carrot	Carrot
Banana	Tomato
Meat	Fish
Fish	Egg
Milk	Coconut
Pappad	Milk
Coconut	Bread
Sugar	Sugar
Fat	Fat

ANAEMIA AND WORK PERFORMANCE OF PRE-ADOLESCENT GIRLS ENGAGED IN SPORTS ACTIVITIES

By
SAJITHA K.S.

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Home Science
(Food Science and Nutrition)

Faculty of Agriculture
Kerala Agricultural University

Department of Home Science
COLLEGE OF AGRICULTURE
Vellayani, Thiruvananthapuram
2000

ABSTRACT

A study on "Anaemia and work performance of pre-adolescent girls engaged in sports activities was carried out to assess the prevalence of anaemia and its consequences on performance. Details pertaining to the socio-economic variables, dietary habits, food consumption pattern, energy balance, nutritional status and physical endurance built up of the respondents were studied in detail.

The surveyed respondents under study belonged to low economic strata. Social status of the respondents indicated that majority belonged to christian community and are from under privileged communities. Nuclear type families of medium size are common among the surveyed respondents.

All the pre-adolescent athletes studied were habitual non-vegetarians. Frequency of use of various foods among the respondents revealed that cereals, milk, fat and sugars were the items used daily in the dietaries while roots and tubers, fruits, fish and egg were used frequently. Four meal-a-day pattern was followed by majority of the respondents.

Food preference of respondents indicated that rice was the most preferred cereal and green gram the most preferred pulse among the respondents. Less preference was recorded for green leafy vegetable while vegetables were medium preferred

food items among the respondents. Tapioca was the most preferred roots and tuber, while mango and plantain preferred by all the respondents. Milk and milk products, animal foods, bakery items and other processed foods and health drinks were found to be liked by all of them.

Food consumption pattern of the respondents indicated that except pulses all other food groups were inadequately met when compared with the suggested levels of food for athletes. With regard to nutrient intake, Vitamin A and Ascorbic acid were met above the RDA suggested, while calories and iron were almost adequately met. Rest of the nutrients were found to be inadequate in the dietaries of the athletes. However energy balance with respect to energy intake and expenditure was found to depict positive trend in majority of the respondents.

On analysing anthropometric data, it was found that weight for age of the athletes were found to be slightly below the national and international standards suggested where as height for age was found to be on par with the Indian Standards. Body mass index and waist hip ratio were found to be satisfactory in majority of respondents. It is encouraging to note that pre-adolescent athletes have well built arm muscle area with adequate lean body mass and body fat.

Clinical examination of the respondents revealed only mild forms of anaemia among some of the respondents.

Biochemical investigations carried out indicate satisfactory iron balance among the respondents.

It is interesting to note that physical endurance indicators assessed were in support of good aerobic and anaerobic power in the respondents.

The performance index of the respondents appeared to be sound and ranged between 11.7 to 13.6 and the nutritional status index of the respondents fall between 169 to 176.

A positive significant correlation was observed between Nutritional Status Index with calorie intake, anthropometric measurements and haemoglobin levels. Performance Index showed positive significant correlation with age of the respondents, anthropometric parameters, dietary variables, biochemical parameters and physical endurance indicators. Performance Index of the respondents was also found to be significantly influenced by Nutritional Status Index of the respondents.