NUTRITIONAL PROFILE OF PREGNANT WOMEN WITH REFERENCE TO IRON

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "**Nutritional profile of pregnant women with reference to iron**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the associateship, fellowship or other similar title of any other university or society.

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CERTIFICATE

Certified that this thesis entitled **"Nutrient profile of pregnant women with reference to iron"** is a record of research work done independently by **Smt. Juna. L. Paul** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

INTRODUCTION

Women in developing countries are often in poor health, and overburdened with work. Most of them are anaemic, suffering from malnutrition, parasitism and chronic ill health from lack of personal attention and adequate health care, especially during pregnancy and child birth. Early marriage, repeated child bearing, ignorance, poverty and manual labour are observed to have deleterious effects. Women's special needs have often been ignored by health planners and women have thus had to bear a disproportionate share of unmet health needs (Hautvast, 1997).

In the industrialized countries the average lifetime risk for a women dying of pregnancy related causes is between one in 4,000 and one in 10,000 (Ogibeide *et al.*, 1994). In contrast, for a women in the developing countries the average risk is between one in 15 and one in 50. The latter countries commonly have maternal mortality rates 200 times higher than those of Europe and North America (Cook, 1994).

As stated by Chiwuzie *et al.* (1995), half a million women-wives, daughters, sisters, mothers of families, 'pillars of the community' - die each year from causes related to pregnancy and childbirth. Only a tiny fraction (6,000) of those (500,000) deaths take place in developed countries.

All the rest occur in developing countries, where they are responsible for one-fourth to one-third of all deaths of women of child bearing age. Over half of all maternal deaths occur in South Asia, predominantly in Bangladesh, India and Pakistan.

Barvazian (1990) opined that in contrast to the dramatic decline in infant mortality rate in recent years, there has been no significant reduction in maternal mortality rates in the past two decades.

Pregnancy and post partum anaemia occurs worldwide, particularly in developing countries where it accounts for substantial maternal and infant morbidity and mortality (Huch, 1999). The main cause is iron deficiency, primarily of dietary origin: 20 per cent of the world population are estimated to have some degree of trace element deficiency (Kapil *et al.*, 1996). Even in industrialized countries iron deficiency anaemia is common in pregnancy due to the negative iron balance created by the high foetal demand for iron and is compounded by blood loss during and after delivery.

The present study entitled "Nutritional profile of pregnant women with reference to iron" is proposed with objectives to identify pregnant women suffering from iron deficiency and to ascertain the influence of various socio economic and dietary factors on the development of such situations.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

This chapter encompasses earlier studies conducted on iron deficiency anaemia during pregnancy and associated factors.

Nutritional requirements during pregnancy

An expectant mother needs a good mixed diet, both before and during pregnancy, adequate in total number of calories, protein, vitamins and minerals (Messina and Messina, 1996). Her nutrition well before pregnancy is most important as this will establish the long-term prospects for her baby both as a child and into middle and even old age (Hautvast, 1997).

Throughout the pregnancy there is an increased need for all the basic nutrients, as indicated by the current Recommended Dietary Allowances (RDA's) outlined by the Indian Council of Medical Research (ICMR, 1998). But it is important that these guidelines and individual variances in need must be examined for each pregnancy, including body size, activity, and multiple pregnancy. Also, quantitative need for nourishment of pregnant adolescents must be noted as reported by Hemminki and Rimpala (1991).

Dawson and McGanity (1987) opined that maternal iron is also needed to supply iron stores for the developing foetal liver. Adequate maternal iron stores also help to fortify the mother against serum iron losses at delivery.

Energy

Maintenance of a normal pregnancy requires energy for increases in tissue mass and to meet the increased basal metabolic rate (BMR) and an energy reserve for lactation in the form of fat (2-2.4 kg). BMR increases by about 5 per cent during the first and second trimester and by about 12 per cent during the third trimester (Forsum *et al.*, 1988). A minimum of about 36 kcal/kg is found to be required for efficient use of protein during pregnancy (Ash, 1995).

According to Forsum *et al.* (1992) about 36,000 kcals is deposited as fat which is utilised subsequently during lactation. The energy cost of the changes in tissue mass during the whole of pregnancy is on average 40000 kcal (167 MJ) in women of 60 kg non-pregnant body weight. The total increase in BMR over the duration of the pregnancy is of the order of 30000 kcal (126 MJ), giving an overall total of about 70000 kcal (293 MJ) (Eastwood, 1997).

The total energy cost of pregnancy for a woman weighing 55 kg, has been estimated to be 80,000 kcals by WHO (1985). A direct estimate of energy expenditure during normal pregnancy through indirect calorimetry has shown that this is around 27,000 kcals.

The current RDA standard of ICMR (1998) is found to recommend an additional amount of energy of 300 kcal during the second and third trimesters of rapid growth, making a total of about 2200 to 2500 kcal, about a 10 per cent to 15 per cent increase over the mother's general pregnant need. This amount may be insufficient for active, large or nutritionally deficient women, who may need as much as 2500 to 3000 kcal.

A minimum of 1800 kcal is required just to avoid negative nitrogen balance, without considering the added pregnancy and activity needs. This primary positive emphasis on sufficient kilocalories is critical to ensure nutrient and energy support of the pregnancy (Cole *et al.*, 1989). Growing teenage mothers also need extra calories for their own growth as well as that of their baby (Bruner *et al.*, 1996). Other women may not need extra because of a decline in physical activity. For a reference Indian woman, whose body weight is 50 kg the total cost of pregnancy on this basis would be approximately 73,000 kcals and the energy expenditure during normal pregnancy would be 23000 kcals.

Protein

Protein requirement during pregnancy has been assessed by the factorial method. Protein requirement during pregnancy has been computed on the basis of nitrogen accretion for foetal growth and expansion of maternal tissue. Based on the body weight gain of 12 kg in a normal, healthy well nourished pregnant woman, the daily nitrogen deposited during the three trimesters is found to be estimated as 0.1, 0.5 and 0.9 g respectively. After increasing by 50 per cent to convert the factorial value into physiological value for nitrogen accretion, and 25 per cent for individual variation, the safe level of intake in terms of a high quality protein during the three trimesters has been prescribed as 1.2, 6.0 and 10.5 g respectively. When adjustments for dietary protein quality (NPU 65) is considered, the safe intake during the later half of pregnancy is found suggested by the Committee as 15 g/day (WHO, 1985).

The total amount of protein recommended for the pregnant women is about 60 g/day, an increase of about 10 to 15 g/day (ICMR, 1998).

Protein, with its essential nitrogen, is the nutrient basic to tissue growth. Nitrogen balance studies give some indication of the large amount of nitrogen used by the mother and child during pregnancy and emphasize the importance of maternal reserves to meet the initial needs even before the pregnancy is confirmed (Wordswoth, 1992).

More protein is necessary to meet tissue demands posed by rapid growth of the foetus, enlargement of the uterus, mammary glands, and placenta; increase in maternal circulating blood volume and subsequent demand for increased plasma proteins to maintain colloidal osmotic pressure and circulation of tissue fluids to nourish cells, and formation of amniotic fluid and storage reserves for labour, delivery, and lactation (Pine *et al.*, 1994; Bozhinova *et al.*, 1997).

Fat

Fat is observed to be a concentrated source of energy, since it supplies per unit weight more than twice the energy furnished by either protein or carbohydrate (Gorbitz *et al.*, 1995). Presence of fat in the diet is reported to be important for the absorption of fat soluble vitamins like vitamin A and carotene present in the diet. Certain fat constituents, viz. "Essential Fatty Acids" (EFA) which has vitamins like functions in body, are also important for the structure and function of cells.

The visible fat intake during pregnancy is considered to be 30 g/day. This level of fat intake would also provide the necessary calorie density to their diets (ICMR, 1998).

Minerals

According to Itsekson *et al.* (1993) and Ivanova (1996) all the major and trace minerals play roles in maternal health and two that have special functions in relation to pregnancy are calcium and iron and may deserve particular attention.

Calcium

The pregnant women needs 1000 mg of calcium daily, an increase of 600 mg/day from the normal stage (ICMR, 1998).

The rapid foetal mineralization of skeletal tissue during the final period of rapid growth demands more calcium (Campbell *et al.*, 1994).

There is some mobilization of maternal calcium depots rather than a dietary increment during foetal growth. Bone density may diminish in the first three months of both pregnancy and lactation in order to provide an internal calcium reservoir which is replenished by 6 months. A deficiency of absorbed calcium arises during pregnancy compared with non-pregnant women (Yoneyama and Ikeda, 1998).

As stated by Kuhnlein *et al.* (1996) if pregnancy occurs in adolescence, then the growth requirements of the mother and foetus require doubling of calcium provision.

Iron

In addition to determining the amounts of isolated nutrients required for physiological function and homeostatic control, setting Recommended Dietary Allowances requires a consideration of nutrient bioavailability from foods in common diets (Hunt, 1996). Haram *et al.* (1997) has reported that the pregnant woman needs 60 µg/kg/day of iron, a 50 per cent increase over her general needs since pregnancy leads to an increased demand for iron and it is not normally met by the iron content in food.

According to Marinov and Tsachev (1994) the iron cost of pregnancy is high. With increased demands for iron, often insufficient maternal stores, and inadequate provision through the usual diet, a daily supplement of 30 to 60 mg of iron may be prescribed (Breymann *et al.*, 1995; Chawla and Puri, 1995). If the women is anaemic at conception, a larger therapeutic amount of 120 to 200 mg of iron is also recommended (Reddaiah *et al.*, 1989; Guldholt *et al.*, 1991; Beaufrere *et al.*, 1995; Roodenburg, 1995; Ekstrom *et al.*, 1996; Kumpf, 1996; Menard, 1997).

However, there are problems with routine iron supplementation for all pregnant women, such as unpleasant gastrointestinal side effects and less motivation to maintain a good diet as reported by Rytter *et al.* (1993) and Long (1995). Also, there may be imbalances with other trace elements, such as zinc, which competes with iron for absorption (Campbell *et al.*, 1985; Ashmead, 1999).

Actually, excess iron intake when not needed may mask inadequate pregnancy induced haemodilution, a normal pregnancy adaptation that puts less strain on the maternal heart, minimizes haemoglobin loss with blood loss at delivery, and increases nutrient flow to the foetus (Dawson *et al.*, 1998).

Thus, as stated by Sibai (1991) some prenatal clinics are currently following revised protocols that prescribe regular prenatal vitamins with iron at the first clinic visit. Individual additional iron supplementation is used only when haemoglobin falls to 10.50 g/dl or less at any time during the pregnancy. This practice seems to be supported by current trails (Skinner and Carruth, 1991; Hallak *et al.*, 1997).

During pregnancy, the maternal circulating blood volume normally increases from 40 per cent to 50 per cent and may increase more with multiple births (Cavil, 1995; Casparis *et al.*, 1996).

Dawson and McGanity (1987) opined that maternal iron is also needed to supply iron stores for the developing foetal liver. Adequate maternal iron stores also help to fortify the mother against serum iron losses at delivery (Giulietti *et al.*, 1996).

Iron requirements during pregnancy is calculated from a knowledge of iron needs for foetal growth, expansion of maternal tissue including the red cells mass, the content of iron in the placenta and the blood loss during parturition (Ivanova, 1996).

As reported by (ICMR, 1998) the mean requirement during the first trimester of pregnancy is not increased

(0.70 mg) but during the second and third trimester, the daily requirement is 3.3 mg and 5 mg respectively.

Vitamins

Increased amounts of vitamin A, B-complex, C and D are needed during pregnancy (Charoenkiatkul *et al.*, 1985). If these needs are met, sufficient amounts of vitamin E and K are also available (Steegers-Theunissen, 1995).

Vitamin A

The daily amount of vitamin A recommended for pregnancy is 600 µg of retinol equivalents (RE), a continuance of the woman's regular need (Shatrugna *et al.*, 1997).

However, malnourished, underweight women, as well as those with multiple pregnancies, need more (Duitsman *et al.* 1995). Vitamin A is reported to be an essential factor in all development, maintenance of strong epithelial tissue, tooth formation and normal bone growth (Katz *et al.*, 1995).

High doses of vitamin A given in early pregnancy can be unsafe, and it is operationally difficult to provide daily small doses in developing countries. Intervention programmes to meet vitamin A needs of fertile women, therefore, must adjust dose levels and timing to ensure safety during pregnancy and lactation (IVACG, 1998).

Vitamin A requirements during pregnancy have been calculated on the basis of the vitamin content of liver of the newborn. Additional intake of vitamin A required for this purpose is about 25 µg/day throughout pregnancy (ICMR, 1998).

Vitamin D

Vitamin D is now considered more as a pro-hormone since it can be synthesized in the body in adequate amounts by simple exposure to sunlight even for 5 minutes per day. In prescribing medicinal vitamin D under certain situations where there is minimal exposure to sunlight, a specific recommendation of a daily supplement of 400 µg is made (ICMR, 1998).

Vitamin E

There is a paucity of Indian data both on the vitamin E (tocopherol) content of foods and on vitamin E status. Limited information suggest that Indians have blood levels of 0.5 mg/kg/ml which is regarded as satisfactory (Jagadeesan and Prema, 1980). Vitamin E requirement is linked to that of essential fatty acids like linoleic and linolenic acid and the requirement of vitamin E (tocopherol) suggested is 0.8 mg/g of essential fatty acids (ICMR, 1998).

Vitamin K

ICMR (1998) considered that no recommendation need be made for this vitamin since vitamin K deficiency in India is seen only occasionally in premature newborn infants.

B-complex vitamins

Thiamine

There are very few studies have directly measured thiamine requirements of pregnant women. In the absence of adequate information on thiamine requirements of pregnant women, the committee agrees with the earlier recommendation that RDA may be fixed at 0.5 mg per 1000 kcal and that the total daily intake be related to their energy allowance (ICMR, 1998).

Riboflavin

There are no specific studies on the riboflavin requirements of pregnant women. There are, however, studies to show that urinary excretion of riboflavin tends to be lower in pregnant women. Allowances during pregnancy is to be computed on the basis of energy allowance as in the case of other subjects. and the extra allowance for energy during pregnancy would take care of the additional needs for riboflavin as well. ICMR (1998) therefore, recommends that allowances for riboflavin during pregnancy be computed on the basis of 0.6 mg per 1000 kcals as for normal subjects.

Niacin

Information on the niacin requirements during pregnancy is scanty. The urinary excretion of metabolites of tryptophan is higher in pregnant women than in normals following an oral load of tryptophan and it has been suggested that the conversion of the amino acid into niacin is more efficient during pregnancy. ICMR (1998) recommends that dietary allowances for niacin be fixed at 6.6 mg niacin equivalents per 1000 kcals during pregnancy.

Pyridoxin

During pregnancy women are reported to excrete reduced amounts of vitamin B_6, have lower plasma Pyridoxal Phosphate (PLP) levels and show an abnormal tryptophan load test. More than 4 mg vitamin B_6 per day is required to maintain plasma PLP. The amounts of pyridoxin needed to correct these changes are found to be large and cannot be met from dietary sources alone and there is little indication of the minimal additional intake needed which is consistant with adequate correction of the deficiency. ICMR (1998) has suggested that the requirement needs to be fixed as 2.5 mg per day during pregnancy.

Folic acid

Results of studies in Indian women have suggested that between 200 and 300 µg of folates are needed to maintain plasma and red cell folate levels in the normal range during pregnancy (Leela, 1971). Birth weights of infants born to mothers who had received 300 µg folate a day during pregnancy were higher than those born to mothers who had received either 100 or 200 µg daily (Iyengar and Rajalakshmi, 1975). These findings suggest that pregnant women need 300 µg of additional folic acid daily. It is difficult to provide this amount through food and the additional needs have to be met through supplements of medicinal folate (Black *et al.*, 1994; Campbell, 1995).

Studies (National Research Council, 1977) have shown a reduced incidence of Intra Uterine Growth Retardation (IUGR) and neural tube defects and higher birth weights with medicinal folate supplementation during pregnancy. This higher requirement could be consequence of a lower initial body pool, but is more likely because placental demands raise folate requirement and folate plays a vital role in cell proliferation (Blot *et al.*, 1981).

ICMR (1998) suggests an aditional 300 µg and 50 µg folate during pregnancy even if these have to be supplied as medicinal supplements, since Indian diets may not be able to supply the substantially higher amounts required during pregnancy.

Vitamin B_{12}

As a component of several coenzymes, vitamin B_{12} has an important role in the synthesis of nucleic acids. Its metabolism is closely interrelated with that of folic acid. Deficiency of vitamin B_{12} is observed to result in abnormal haemopoiesis, leading to megaloblastic anaemia (Carretti *et al.*, 1998).

On the basis of the B_{12} content of foetuses, it has been estimated that foetal demands may be of the order of 0.3 µg per day. An additional intake of 0.5 µg per day may found to be sufficient to cover the need during pregnancy (ICMR, 1998).

Vitamin C

Vitamin C has been found to have an influence on the absorption and metabolism of iron (Lynch and Cook, 1980).

The foetal requirement of vitamin C is too small to justify an additional intake. Since the allowance of vitamin C for normal adults (40 mg/day) includes a sufficient safety margin, extra allowance during pregnancy is not suggested (ICMR, 1998).

Iron intake

The daily recommended dietary allowance (National Academy of Sciences, 1990) for iron (mg) is 30 during pregnancy. Additionally, a recent recommendation is that the allowance for menstruating women should be raised to 20 mg duly (Hallberg and Rossander-Hulten, 1991).

In populations residing in developing countries understandably, the proportion with low intakes is higher; and in such populations it has also been reported that there is the need for additional iron due to endemic infections like malaria and infestation by helminths (Fleming, 1989; Brussard *et al.*, 1997).

In a group of children of 7-8 years in the UK daily average iron intake was reported to be 9.4 mg (Ruxtan and Kirk, 1996), while in group aged 12-14 years, the mean intake was higher as 12.3 and 9.6 mg for boys and girls respectively and in groups aged 35-49 years, mean intake was 12.1 for males and 8.4 for females (Block and Subar, 1992). It is also claimed by Nelson *et al.* (1993) that iron intakes among adolescents have been declining in the last two decades.

In the UK in school children aged 12-14 years, only 1 per cent boys and 4 per cent girls had serum ferritin levels of < 10 μg/l (Nelson *et al.*, 1993). In contrast, in a study of Northern Ireland University students, 40 per cent, had serum ferritin levels < 10 μg/l; moreover a further 35 per cent was found to have levels of 10-20 μg/l (Armstrong, 1989). Serum ferritin levels (μg/l) averaged 34.9 in women in the age group

18-40 years (Weight *et al.*, 1992) and 27.5 among pregnant women in their first trimester (Guidozzi *et al.*, 1995).

A survey conducted among vegetarians and omnivores in New Zealand revealed, the iron intake to be high as 20.2 and 17.4 mg/d for men and 15.5 and 13.5 mg/d for women (Alexander *et al.*, 1994).

Among populations in developing countries, also, there was wide variation. Lamparelli *et al.* (1988) reported that the mean intake among 11 year old was 9.0 mg and 5 mg in rural and urban Africa. Thus, the daily intake of middle-aged African men in Cape Town was reported to consume 10 mg/day while for women, the iron intake was found to be 7 mg (Bourne *et al.*, 1993). In contrast among populations residing in rural Africa, where large amounts of vegetables and fruits were eaten, iron intake were usually high. As an example, in those living in Northern Province, South Africa, mean daily intakes were reported as 21.4 and 21.6 mg for men and women respectively (Vorster *et al.*, 1994).

Dietary iron intake and its availability

The iron content of several commonly consumed foods as reported in earlier food composition tables (Gopalan *et al.*, 1971) has since been shown to be rather high and reevaluation has yielded much lower figures for so-called iron rich foods, like green leafy vegetables. Studies conducted by Prabhavati and Rao (1981) have shown that iron contents based on analysis of food as purchased are higher due to contaminant iron. They had also observed that washing the foods free of contamination lower the iron content by about 20-30 per cent. Because of these reasons, the true iron intakes in India are to be considered about 20-30 per cent lower than those assessed earlier.

Factors influencing dietary iron absorption

Iron is an essential nutrient having an important role in oxygen transport and a number of enzyme systems (in particular oxidation reactions). Iron deficiency has adverse affects on physical capacities, increases the risk of death for pregnant women and the risk of premature birth and low body weight at birth, gives rise to behavioural and neurological disorders in children and leads to a reduced immune status (Prasad and Prasad, 1991; Allen, 1993; Beard *et al.*, 1993; Idjradinate and Pollitt, 1993; US Preventive Services Task Force, 1993; Yip, 1994; Simmons *et al.*, 1996).

Body Iron

The total iron content of normal adult man (70 kg wt) is estimated to be about 4 to 5 g. The body iron content of normal, adult men is approximately 50 mg/kg/body weight, whereas that of adult women is about 35 mg/kg (Brussard *et al.*, 1997). This disparity reflects the high incidence of iron deficiency in women.

It is evident that over 75 per cent of total iron is present in haemoglobin. The storage forms of iron, ferritin and haemosiderin, constitute about 30 per cent of the body's iron stores, or about 1 g in men. Smaller stores, 200 to 400 mg are found in women (Brussard *et al.*, 1997).

Iron Balance

A person is said to have iron balance when the dietary intake equals output or excretion (Mayes, 1991). Iron is not 'excreted' in the usual sense of the word. It is lost from the body only when cells are lost, especially epithelial cells from the gastrointestinal tract (Cook *et al.*, 1991). In normal subjects, the total iron content in the body tends to remain within relatively narrow limits (Hallberg *et al.*, 1995). Iron deficiency, in essence, is the result of an imbalance among iron uptake, iron utilization and iron loss.

Iron Cycle

Iron travels from plasma to the marrow where it is incorporated into haemoglobin. It is then released with the mature red blood cells into the circulation. After a life span of about 120 days, the red cell is engulfed by macrophages in the reticuloendothelial system. Here the iron is extracted from haemoglobin and returned to plasma where it becomes bound to transferrin, completing the cycle (Jameson, 1995).

Iron loss from the body

On the basis of long term studies of body iron turnover, the total average daily loss of iron has been estimated at about 1.0 mg (0.6 to 1.6 mg) in normal adult man and nonmenstrating women (Conrad, 1991).

Normal menstruating women lose about 3 to 4 times as much iron as adult men. Menstral blood loss averages about 0.006 mg/kg/days, but 10 per cent of women lose more than 0.025 mg/kg/day prorated over the entire menstral cycle (Fogelholm *et al.*, 1993).

Pregnancy makes particular severe demands on a women's iron status. In pregnant women, the rate of iron loss is about 3.5 times as great as in normal man (Haram *et al.*, 1997; Milman *et al.*, 1997).

Urinary iron amounts to less than 0.05 mg/day and is largely accounted for by desquamated cells. Although iron is a physiologic component of sweat, only tiny amounts of iron (22.5 µg/L) are lost by this route (Brune *et al.*, 1986).

Iron Absorption

In the deal situation, the iron losses through the above mentioned routes are balanced by an equivalent amount of iron absorbed from the diet. According to Earl *et al.* (1993), the average intake of iron in the American diet is about 6 mg per 1000 calories or between 10 and 30 mg per day, but variation is greater in different parts of the world and under various circumstances as opined by James *et al.* (1997).

Iron is a difficult nutrient to get from food. Most foods only contain a small amount of iron, and sometimes it is not in a form which passes easily through the gut wall. This means that the body absorbs only a small part of the iron that is in the food. The remainer of the iron passes out in the faeces. The amount of iron that a person absorbs depends on the total amount of iron in the meal, the type of iron in the food, the other foods in the meal and the amount of iron that the person needs.

Assuming that 1 mg enters the body to balance the amount lost, only 5 to 10 per cent of dietary iron is absorbed. This proportion can increase some three to fivefold if iron stores are depleted. Conversely, the proportion absorbed decreases in states of iron overload. Thus iron balance is unique in that it is achieved by control of absorption rather than by control of excretion.

Iron is absorbed chiefly in portions of the intestine, proximal to the midjejunum and absorptive capacity is less in more caudal intestinal segments (Chaudhuri, 1994).

This localization is related in part to such intraluminal factors as pH and redox potential. It is likely that the number of specific receptor in the brush border explains the difference in absorption capacity in various sites as reported by Banerjee *et al.* (1986).

Mechanism of iron absorption

Hulten *et al.* (1995) opined that man and other omnivorous mammals appear to have atleast two distinct pathways for iron absorption one for iron attached to haem and another for iron in the form of ferrous ion (or possibly, soluble ferrous chelates).

Haem iron is derived from haemoglobin, myoglobin and other haem proteins in foods of animal origin and is present mostly in the ferrous form. Haem iron is absorbed from the intestine by a process which is different from non-haem iron. Within the intestine, haem is released from haemoglobin, myoglobin or cytochromes by proteolytic degradation of the protein fraction. Haem is then transported through the brush border of epithelial cells bound to a receptor. Once absorbed within the cell the iron is liberated enzymatically from haem by a haem oxygenase. Haem iron is well absorbed from an aqueous solution and from a standard meal, with adequate increase of iron absorption in subjects with iron deficiency (Marx, 1997; Martinez *et al.*, 1998).

Non-haem iron is derived from plants, eggs and milk and is present in the ferric state. This has to be converted to the ferrous form to be absorbed.

At relatively high concentrations, iron crosses the mucosa passively. At the lower amounts found in normal diets, special absorptive mechanisms are used. These can be divided into two distinct steps : (i) mucosal uptake, and (2) transfer of iron from the mucosal cell to the lamina propria, where it enters plasma.

Because the total body iron content depends so greatly on absorption of iron, the mechanism by which the rate of absorption is regulated have been of great interest for many years. Two factors are of prime importance in determining absorptive rate. The first is the amount of storage iron - when it is depleted, iron absorption is increased; when it is excessive, iron absorption is decreased. The second is the overall rate of erythropoiesis whether 'effective' or 'ineffective'. Iron absorption in increased when the red cell production rate is increased and absorption is decreased when production is decreased.

The manner in which these two factors exert their effects remains the subject of active speculation and investigations (Cook, 1990). At the time it is formed in the intestinal crypts, the intestinal mucosal cell appears to be 'programmed' to a certain level of iron absorption. The 'mucosal block theory' held that the number of iron acceptor sites within the intestinal mucosa is limited; If these are saturated, either exogenously or enogenously a block in further iron absorption results.

In an extension of the theory, apoferritin was postulated to be the iron acceptor, and ferritin synthesis was thought to be an intermediate in the absorptive process. This theory gradually lost favor, however, when it was demonstrated that iron is absorbed even when tissues are laden with deposited iron.

A modified version of the mucosal block theory has been put forward on the basis of a series of experiments in rats (Wintrobe, 1993).

The columnar epithelium of the small intestine regulates iron absorption.

In the normal state, the musocal cell contains iron supplied from body stores, and this reduces the amount of iron that can be absorbed from the bowel. As a result, some iron remains in the gut lumen and is lost. Iron that enters the cell, but is not absorbed into the blood stream, also is lost when the columnar cell is sloughed at the end of its life span.

In iron deficiency, there is little to prevent entry of iron into the villous epithelial cells, nor is it retained there. It passes readily into the blood.

In iron-loaded subjects, the body iron that is incorporated into the epithelial cells is eventually lost as these cells are sloughed, but during the life span of the cells its presence inhibits the entry of iron the cells.

Factors affecting iron absorption

Absorption of haem iron is relatively unaffected by the composition of the diet; however, effects on the absorption of nonhame iron are profound. Thus the 'bioavailability' of food iron is variable (Hallberg, 1981; Morris, 1983). Depending on the various combinations of enhancing and inhibitory factors, iron absorption can vary as much as tenfold (Hallberg and Rossander-Hulten, 1982).

Factors enhancing iron absorption

Ascorbate is one of the major dietary enhancer of non haem iron absorption (Lynch and Cook, 1980; Annapurani and Murthy, 1985; Ballot *et al.*, 1987; Barrett *et al.*, 1994; Fairweather-Tait *et al.*, 1995; Gibson, 1997). Ascorbate exerts its effects by reducing ferric iron to the absorbable ferrous form.

Meat also is a major dietary factor favouring non haem iron absorption (Dallman, 1990; Hulten *et al.*, 1995; Brussard *et al.*, 1997; Yip, 1997). Various meats, including beef, lamb, pork, chicken and fish considerably enhance non heam iron absorption. The exact nature of the 'meat factor' is unknown, but it may be contained in certain low molecular weight intermediates of proteolytic digestion that bind iron in soluble complexes (Slatkavitz and Clydesdale, 1988).

Amino acids such as cysteine (Torres *et al.*, 1981; Gibson, 1997), exert similar effects as ascorbate. Methionine appears to counteract the negative effect of phytic acid on nonhaem iron absorption (House *et al.*, 1996). Lysine and histidine has also an enhancing effect on iron absorption (Eastwood, 1997). Glutathione, a reducing agent enhances nonheam iron absorption.

Other possible enhancers of nonhaem iron absorption include keto sugars like fructose (Hulten *et al.*, 1995). Fructose on reduction yields sorbitol which has been reported to favour nonhaem iron absorption by Eastwood (1997).

Organic acids like citric and lactic acid (King and Burgess, 1993; Garry *et al.*, 1995) produced during fermentation and malic and tartaric acid (Eastwood, 1997) also enhance non haem iron absorption possibly by forming soluble ligands with nonhaem iron or by forming complexes with iron, thereby preventing the formation of iron phytate.

Human breast milk has been found to improve iron absorption (Davidsson *et al.*, 1993; Whiting, 1995).

Ethanol, an alcohol present in food also has an enhancing effect on iron absorption (Fairweather-Tait, 1997).

Factors inhibiting iron absorption

Certain ingredients in food inhibit nonheam iron absorption.

Phytates, natural components of grains and some other vegetable foods from stable, poorly absorbable complexes with iron (Hazell and Johnson, 1987; Jandl, 1991; Brune, 1992; Hurrell *et al.*, 1992; Davidsson *et al.*, 1994; Larsson *et al.*, 1996). Bran (Simpson *et al.*, 1981; Brussard *et al.*, 1997) and other fibers (Reinhold *et al.*, 1981; Larsson *et al.*, 1996), inhibit iron absorption mainly because of their phytate content (Hallberg *et al.*, 1989; Bruvand *et al.*, 1995).

Oxalates present in certain vegetables forms insoluble iron oxalate and prevents the absorption of dietary iron (Swaminathan, 1998).

Polyphenols probably account for the poor absorption of iron from legumes (Gilloly, 1983; Lynch *et al.*, 1984; Derman *et al.*, 1987; Lynch *et al.*, 1994; Fly *et al.*, 1998) and wine (Bezwoda, 1985).

Phosphates and phosphoproteins inhibit iron absorption from egg yolks (Jandl. 1991).

The tannins in tea and certain other vegetable products inhibit iron absorption (Brussard *et al.*, 1997). Subjects when consume large quantities of phytate or polyphenolics, as present in tea have a greater chance to develop iron deficiency because iron complexes are formed from which iron is poorly absorbed.

Other structures such as chlorogenic acid present in a variety of fruits and vegetables, as well as coffee, also inhibit nonhaem iron absorption but to a lesser extent (Morck *et al.*, 1983; Brune *et al.*, 1989; Brussard *et al.*, 1997).

Zinc (Crofton, 1989; Rossander-Hulten, 1990). Cadmium (Huebers, 1987), Calcium (Hallberg, 1990; Hulten *et al.*, 1995; Whiting, 1995), Manganese, Copper and Cobalt (Eastwood, 1997) may also interfere with iron absorption.

Egg white especially egg albumin and egg yolk have a negative effect on iron absorption (Eastwood, 1997).

Bovine milk proteins actually inhibit iron absorption (Wintrobe, 1993).

Other factors which interfere with iron absorption are certain spices (Oregano), reg sorghum, vegetables (spinach and yod kratin) and cocoa. They all contain galloyl phenolic groups which form insoluble iron-phenolic complexes and inhibit nonhaem iron absorption (Gibson, 1997).

Impared absorption

Gastric hydrochloric acid facilitates the absorption of nonhaem iron by converting ferric to ferrous iron (Skikne *et al.*, 1981; Skikne and Baynes, 1994). Thus, absorption of inorganic iron is profoundly impaired in patients with achylia gastrica (Jandl, 1991). Histamine fast achlorhydria is common in iron deficient subjects (Wintrobe, 1993).

Measures used to reduce gastric acidity in peptic ulcer disease, such as administration of H_2 blockers or the use of antacids, impair iron absorption but usually not to be extent of affecting iron nutrition to be a significant degree (Skikne and Baynes, 1994).

Iron deficiency anaemia is a frequent complication of gastric operations, including total gastrectomy, partial gastrectomy and vagotomy with gastroenterostomy (Wintrobe, 1993). Reduction in gastric acidity is only one factor in the impared iron absorption that follows such operations. Other gastric secretions essential to iron absorption may be lost. Also, because the most active site of iron absorption are in the duodenum, the rapid intestinal transit that follows loss of the reservoir function of the stomach may lead to decreased absorption. For the same reason, iron deficiency is more common when the duodenum is surgically bypassed, as in Billroth II or Polya procedures, than when the normal channel is preserved (Fairbanks, 1994).

In addition to gastrectomy, other defects in the gastrointestinal tract may lead to malabsorption of iron, contributing to the development of iron deficiency (Pippard, 1990).

Initial reports indicated that pancreatic secretions contain a factor that decreases iron absorption. It was proposed that the pancreas might play an important role in regulation of iron absorption. Evidence for this hypothesis, however, is wanting (Wintrobe, 1993).

Pica is the habitual ingestion of unusual substances, the most common of which is earth or clay, laundry starch and ice are also ingested. Pica is usually a manifestation of iron deficiency and is relieved when the condition is treated. Clay can behave in the gut as an ion exchange resin and can interfere with iron absorption. Laundry starch may interfere with iron absorption. Furthermore, it is an almost pure carbohydrate with a low iron content (Wintrobe, 1993) .

Although the rate of iron absorption is usually increased in iron-deficient subjects, severe deficiency in infants can be associated with impaired iron absorption (Sheard, 1994).

Dietary modification or diversification

Various dietary strategies can be used to maximise the bioavailability of both the fortificant and the intrinsic food iron (Fox *et al.*, 1998; Gonzalez-Penas *et al.*, 1998).

1. Increase intake of foods rich in iron such as flesh foods, a rich source of readily available haem iron. Introduction of new cereal cultivars which have grains with a high content of iron and zinc (Graham *et al.*, 1992) and amino acids such as methionine and cysteine (House *et al.*, 1996) will be a solution to solve the global problem of iron deficiency by way of providing cost effective dietary source of iron.

2. Increase intake of foods which enhance nonhaem iron absorption such as ascorbic acid - rich fruits and vegetables, provided they are consumed at the same meal as the iron - fortified food (Monsen, 1988).

3. Decrease intake of foods and beverages with meals which inhibit nonhaem iron absorption.

4. Promote enzymatic hydrolysis of phytic acid in whole grain cereals and legumes by enhancing the activity of endogenous or microbial fermentation (Lorenz, 1980; Chavan and Kadam, 1989).

5. Use non-enzymatic methods for reducing phytic acid content of plant based staples such as thermal processing, soaking and milling. Mild heat treatment is said to reduce the phytic acid content of tubers but not cereals and legumes (Marfo *et al.*, 1990); excessive and/or harsh heat treatment should be avoided because it may induce chemical changes such as the Maillard reaction and / or form insoluble salts which reduce mineral bioavailability (Davidsson *et al.*, 1997).

To meet the challenge of improving iron nutrition will require the co-operation of major sectors - health, nutrition, industry and agriculture - in the process. Given the nature of iron deficiency and high requirement of iron for infants and women, it will require the sum of this effort to reach a critical mass for the meaningful reduction of iron deficiency. Hopefully, through the joint effort of different sectors and the cost-effective utilization of intervention systems, major progress for improving iron nutrition will be a reality in the near future.

Iron absorption from Indian diets

In habitual Indian diets, cereals are found to contribute from 60 to 80 per cent of total daily calorie intake, depending upon socio economic class. Cereals and millets are normally observed to be consumed unrefined and hence are rich in phytates which interfere with iron absorption. Some millets (ragi, sorghum), beans, some vegetables and condiments, are also reported to contribute strong inhibitors of iron absorption like tannins (Rao and Prabhavati, 1982). However during pregnancy, the demands for absorbed iron increase from 0.8 to 7.5 mg/day due to certain physiological changes as reported by (Milman *et al.*, 1997).

Rate of iron absorption from common Indian diets determined earlier using the chemical balance method were found to yield iron ranging from 7 to 20 per cent, with a median figures around 10 per cent (Apte ad Venkatachalam, 1962). This method is found to be accurate, but laborius and expensive, way to study iron absorption (Glahn *et al.*, 1996; Wienk *et al.*, 1999).

Since early 1970s, a more reliable extrinsic tagging technique for measuring food iron absorption has been established. Employing this method, a systematic study of iron absorption from Indian diets based on cereals and millets has shown that in a normal male adult, iron absorption is quite low since it ranges from 2.0 - 5.0 per cent depending upon the type of staple, the absorption being highest from rice based diets and lowest from diets based on millets like ragi (Rao *et al.*, 1983). Iron absorption from the daily diet determined by multiple tagging of different meals are reported to give an average value of 3.0 per cent in a range of 2.6 - 3.6 (Anand and Seshadri, 1995).

Prevalence of iron deficiency anaemia

Eventhough, the second most abundant metal in the earth's crust is iron, iron deficiency in infants, children and women of child bearing age still continues to be a global nutritional problem (Singh *et al.*, 1998a; Walker, 1998; Devadas, 1999; Tiwari, 1999).

As reported by Marx (1997) world wide iron deficiency anaemia remains an enormous problem as more than 500 million people suffer from this condition.

Anaemia is the most common haematologic complication in pregnancy with iron deficiency anaemia accounting for the majority of cases (Engstrom and Sittler, 1994; Lops *et al.*, 1995; Mani and Duffy, 1995; Bermejo *et al.*, 1996; Allen, 1997; Hodgins *et al.*, 1998; Sing *et al.*, 1998b; Massawe *et al.*, 1999).

Yip (1997) has stated that an estimated 30-60 per cent of children and women of child bearing age in developing countries are anaemic, an indicator of iron deficiency. Even in developed countries such as the United States, iron deficiency continues to warrant significant public health concern because 5 per cent of young children and 5-10 per cent of women of child bearing age are affected by iron deficiency as observed by Looker *et al.* (1997) and Benito *et al.* (1997).

The associated ill-effects by anaemia have been described as 'devastating' (Scrimshaw, 1991) and in some contexts as 'irreversible' (Lozoff *et al.* 1991). According to Ivanova *et al.* (1995) and Moffatt (1995) the high prevalence of iron deficiency world wide is largely due to the result of inadequate dietary iron intake to meet the relatively high iron requirements of early childhood and the reproductive years.

Among the micronutrient disorders, iron deficiency anaemia is most common among pregnant women in India with a prevalence rate of 50-80 per cent (Tiwari, 1999). Devadas (1999) reported that in India two out of every three women suffer from iron deficiency anaemia.

According to Bidinger *et al.* (1986), the last major nutritional problem commonly cited by workers in India is anaemia. It has been estimated globally that about one half of all anaemia is due to iron deficiency. Iron deficiency is seen commonly in women during their reproductive years and particularly during pregnancy (Carretti *et al.*, 1992; Schwartz and Thurnau, 1995). Iron deficiency occurs when the rate of loss of utilisation exceeds it's assimilation (Rani *et al.*, 1995). However, subclinical iron deficiency and low body-iron stores without frank anaemia, is often as widespread as iron deficiency with anaemia (Cook, 1982; Liljestrand *et al.*, 1986; al-Momen *et al.*, 1996; Carretti and Paticchio, 1999).

In a report published by WHO (1986) it was said that, iron deficiency anaemia affected large number of women belonging to low socio-economic groups in Latin America. It was also said that nutritional anaemia was widespread among women of child bearing age and contributed significantly to maternal morbidity and mortality (Allen, 1997; Ascarelli *et al.*, 1998; Becerra *et al.*, 1998).

Because of the universal commonness of the deficiency it would be expected that there would be ample data, past and updated, in both developed and developing populations. Unfortunately in all these various respects, knowledge is limited in both developed and developing populations (Walker *et al.*, 1994). Studies have been almost wholly of the randomized clinical type, which have numerous limitations (Block, 1995). Moreover, few attempts have been made to learn to what extent benefits from trials are identifiable in 'real life' (Kretchmer *et al.*, 1996). One authority has gone so far as to assert that 'successful intervention programmes in the last decade have been virtually non-existant' (Beard, 1996).

Diwan (1992) reported that 88 per cent of the pregnant women in the urban slums of Bombay were anaemic. In surveys conducted in India and Indonesia, before and after the introduction of an iron supplemental programme, the prevalence of maternal anaemia was reported to persist at high levels ($\geq$80 per cent in India and $\geq$60 per cent in Indonesia; Yip, 1996).

Moreover, 20-30 per cent of low income pregnant women in the United States are found to have iron deficiency anaemia during the third trimester as reported by Kim. (1992).

As stated by Gopalan (1996) eventhough florid nutritional deficiency diseases have shown a steep decline over the last two decades, iron deficiency anaemia continues to be a major public health problem in India.

Primigravida/Adolescent

Bearing children before the age of 18 or so is a very different experience from having children in the 'prime' reproductive years of 20-34. For teenage mothers there is a greater risk of a premature and low-birth weight baby, obstructed labour (because the pelvis is not yet fully grown), and complications that can cause permanent damage and even death. And this is one statement about women's health that holds true across the globe. (King, 1983; Sadik, 1989; Schneck, 1990). In developed and developing regions alike, early pregnancy is risky for the health of mother and child, not to mention the social costs if early motherhood reduces the young women's chances for education and employment (Johnson, 1991; Diallo *et al.*, 1995).

According to a report in Safe Motherhood Newsletter (Anon., 1990a), girls in Jamaica and Nigeria who conceive at 10-14 years are five times as likely to die as a result of pregnancy and childbirth compared with 20-24 year-olds.

Sadik (1989) reported that in Bangladesh four out of five teenage girls are mothers. He has further observed that in Africa 40 per cent of teenage births are to women aged 17 or under, compared with 39 per cent in Latin America, 31 per cent in Asia and 22 per cent in Europe. And yet, early marriage and early pregnancy remain an accepted way of life for vast numbers of women.

Iron deficiency disorders

According to WHO, iron-deficiency anaemia in pregnant women is present if the haemoglobin (Hg; g/l) concentration is <110 (De Maeyer *et al.*, 1989). However, Hb level is considered by many to be a relatively crude indicator of iron stores. Of different biochemical markers, the most widely used is serum ferritin concentration (Goh and Hariharan, 1986; Kumar *et al.* 1989). The lowest limit of adaptation fixed for serum ferritin level is 12 µg/l and below which iron stores are considered to be fully depleted (Cook *et al.*, 1992; Fogelholm *et al.* 1994). Another iron marker is serum transferrin receptor (Skikne *et al.*, 1990; Cooper and Zlotkin, 1996). As opined by these authors, this marker is less likely to be affected by chronic infection, as in the case with ferritin level and when the receptor level falls below 7.0 mg/l, it is considered that there is a deficit in tissue iron.

In an investigation made in the USA, 9-11 per cent of adolescent girls and women of child-bearing age were considered to be iron deficient; of these iron-deficiency anaemia was detected in 2-5 per cent (Looker *et al.*, 1997).

A further puzzling situation was revealed in New Zealand, where a group of vegetarian women in good health had a very low mean ferritin level (13.6 µg/l) as stated by Alexander *et al.* (1994). Among these surveyed population, 4.7 per cent were considered to be iron deficient. While among omnivorous women, despite their higher intakes of haem-iron, the percentage considered deficient was only slightly less (4.2), although they had a higher average ferritin level of 33.6 µg/l.

Among less prosperous and developing populations in the world according to Rosado *et al.* (1995), half the children and women and one-quarter of the men are iron deficient, despite the fact that in most studies iron intake was found to be greater than the recommended.

In Zaire, in a study of women, mean Hb and serum ferritin levels were 111 g/l and 62 µg/l respectively and none had a level of ferritin <12 µg/l (Kuvibidila *et al.*, 1994).

But even among Africans, who were the poorest of the poor, serum ferritin values were observed to be high; the mean being 312 in a range of 135-355 µg/l in men and 150 in a range of 9-285 µg/l in women. Among these populations, only 3 per cent of women were considered to be iron deficient (Johnson and Van der Westhuyzen, 1990).

In Africa, since, as indicated, ferritin levels are affected by infection and by iron overload, it is probable that the level of serum transferrin receptor will be a more reliable measures of iron status; however, relevant studies are few. In Nigeria, severe malnutrition in young children was found to be associated with decreased levels of this component (Akenami *et al.*, 1997). It is interesting that the mean level in the control group was higher than that reported in Finnish children (Kivivuori *et al.*, 1993); the African group was regarded as having adequate iron status.

Of Asian populations, in India in a study among girls aged 11-14 years from rural area and from urban slums, 25 and 13 per cent respectively had low serum ferritin levels (< 12 µg/l) as observed by Vasanthi *et al.* (1994). In Indonesia in a group of pregnant women, 49 per cent had a Hb level <105 g/l, mean ferritin level was 28.0 µg/l and 33.8 per cent had levels < 20 µg/l (Ridwan *et al.*, 1996).

There is much that is difficult to explain with regard to serum iron levels and their significance to health (Arnaud *et al.*, 1994). Moreover, several studies have shown a lack of association between iron intake and serum ferritin levels (Heitmann *et al.*, 1996).

Effect of socio economic factors on iron status of pregnant women

Factors influencing women's health

First, each individual is born with a genetic or biological inheritance that predisposes to certain health conditions and reduces the likelihood of others. Second, the environment in which a person lives has a profound influence on what becomes of the biological inheritance (using the word environment in its broadest sense to include physical, social, cultural, economic and other environments). A person's health is influenced also by the availability of health information and health care, both preventive and curative. Finally the individual's behaviour, or lifestyle, plays a major part in determining the state of her or his health (Smyke, 1991).

Numerous studies and clinical observations indicate that lack of prenatal care, often associated with racial prejudices and fears as well as poverty, places the expectant mother in grave difficulty (Schneck, 1990; Hansell, 1991; Mitchell and Lerner, 1992).

Social class differences in health are seen at all ages. with low socio economic groups having greater incidence of premature and low birthweight babies and poor diet which is often lower in essential nutrients such as calcium, iron, magnesium, folate and vitamin C than that of the higher socio economic group (James *et al*.. 1997).

Economic factors

More than one billion people, most of them women, live in extreme poverty. Women are likely to be poor than men and to be among the poorest of the poor (Erben, 1990).

Households headed by women, estimated to be one-third of the total worldwide, are many times more likely to be poor than those headed by men, and the number of such households is increasing. Households headed by women tend to have more dependants and fewer members doing paid work (Anon, 1990b).

According to Gupta and Chaudhary (1976) and Lazovic and Pocekovac (1996) high parity increases risks in poor socio economic group because of associated under nutrition, anaemia, infection, poverty and poor sanitation and he had also stated that with the burden of increased pregnancy, maternal health deteriorates at an early age and finally may end up in premature aging with less working efficiency and early death of the mother, number of abortions, still births, neonatal deaths are observed to increase with increased pregnancies leading to more foetal wastage.

In UNICEF (1991) reports women were identified to be the most undernourished, economically the most vulnerable and socially the most depressed groups of workers in society, eventhough they performed tasks essential to any society's survival from raising children to growing food and to feed thair families.

According to Rao (1987), outside employment taken up by the women led to negligence of their own health and had led to various nutritional problems. But Elson (1989) quotes that

"It is women who must cope, and devise survival strategies, when household incomes fall and prices rise". Women's self-employed has risen drastically during the 80s due to the economic crisis in Tanzania and that there is an apparent change in the attitude of both urban men and women step by step towards women's new economic importance in the households (Anon, 1990c).

Zinc nutriture of pregnant women from a poor urban community in USA (Scholl *et al.*, 1993) and a peri-urban Egyptian village (Kirksey, 1994) revealed that a low zinc intake was associated with about a 2-fold increase in the risk of low birth weight (<2500 g) after controlling for energy and other confounding variables. A low intake of dietary zinc earlier in pregnancy was associated with a greater than 3-fold increase in the risk of very preterm delivery (<33 completed weeks) (Jameson and Burstrom, 1994).

Moffatt (1995) reported that the Aborginal people of Canada have low intakes of many nutrients such as iron, vitamin D, calcium, folate, vitamin A and fluoride. The author further stated that recent surveys suggested no change in the situation. A study conducted by Job *et al.* (1995) on the nutrient intakes of pregnant and non-pregnant teenagers (mean age 16.9 years) of a similar socio-economic status revealed that there was no significant differences in the intakes of energy, protein, iron, zinc, vitamin A and vitamin C of the pregnant teenagers and pregnant adults and the pregnant teenagers and non-pregnant teenagers. The study also showed that the energy intakes were less than estimated requirements for Australian women and zinc and iron intakes were less than the recommended dietary intake (RDI's) for pregnant women.

Effect of nutritional factors on iron status of pregnant women

Pica

Pica is a pathological craving for normal food constituents or for substances not commonly regarded as food by the local culture, most common of which is earth or clay (geophagia); laundary starch (amylophagia), and ice (pagophagia) (Wintrobe, 1993). The name 'Pica' is derived from a mediaeval Latin word meaning 'magpie'. The magpie was known to pick up a range of objects to satisfy hunger or curiosity.

Nutritional status may be affected by pica; the consumption of excessive amounts of a single substance may reduce the intake of normal dietary sources of nutrients and may reduce the bioavailability of minerals (Hurrell, 1997; Hurrell *et al.*, 1998).

The craving for particular food substances during pregnancy is a widely recognized phenomenon. In a survey in among pregnant women it was observed that cravings for fruit and other sweet, sour or sharp tasting foods were not uncommon (Kent, 1992). Pica usually is a manifestation of iron deficiency and is relieved when the condition is treated.

Effects of dietary factors on iron status of pregnant women

Food fads and fallacies

In recent decades there is need for nutrition education, especially for women, to counteract media advertising and to understand what is at stake for themselves and their families if they make poor nutritional choices and if they indulge in junk food, food fads and diet fads (Heise, 1990). Smyke (1991) reported that the customs reflect the relative status or value, assigned ages ago to different members of the family.

In developing countries, good nutrition or malnutrition is the pivotal factor in many of the circular relationships between women, health and development (Anon., 1990d).

Varma (1990) opined that in some areas, one important task of nutrition education is to persuade people to abandon the food taboos and customs that contribute to malnutrition among women. As pointed out by Varma (1990) the custom of women and girls eating what is left over, causes serious nutritional problems for them where food is scarce.

Maternal weight gain

A mother-to-be needs to gain weight during pregnancy to nourish her growing baby (Husaini, 1986). Women who do not gain enough weight often have babies that weigh too little (Anon. 1995b). A baby that weighs less than 2.5 kg is more likely to have both physical and mental problems as reported by Achadi *et al.* (1995) and Anon. (1997).

Reports of the Caribbean Food and Nutrition Institute (CFNI, 1993) along with the World Health Organisation (WHO) had advocated that a women should gain at least 11 kg during pregnancy.

Pre-term birth and low birth weight (LBW)

It has been claimed that severe anaemia is responsible for 40 per cent of the half million deaths, associated with child birth each year (Seymour, 1996).

Studies among poor pregnant women in New York, revealed that iron-deficiency anaemia was found to be associated with a higher risk of preterm delivery and low birth weight (Allen, 1993). However, three quarters of the pregnant women diagnosed with anaemia were not iron deficient.

In an inner-city population in Canden, New Jersey, the risk of preterm birth attributed to iron-deficiency anaemia was reported to amount to 5.5 per cent overall and 11.1 per cent in the case of African-Americans (Scholl *et al.*, 1992). It was concluded that iron-deficiency anaemia made only a modest contribution to the aetiology preterm delivery in the group of poor urban women studied. In another study relating to disadvantage in the anaemic group, 12.7 per cent had previous low birth weight, 15.2 per cent had previous preterm birth and 9.8 per cent were in the non anaemic group (Scholl and Hediger, 1994). Based on these observations the view expressed was that only women who are frankly anaemic, with a Hb level of $\leq$ 95-100 g/l, require supplementation.

In developing populations, as in Africa, in areas where malaria and hookworm are widespread, additional iron intake has been shown to benefit the outcome of pregnancy (Fleming, 1989).

A study conducted by the US Public Health Service Expert Committee Panel on the content of prenatal care revealed no significant benefit to patients given prophylactic iron and vitamin supplements during pregnancy (Blankson, 1990). In a review on pregnancy in Western women, it has been reported that it was uncertain whether iron and vitamin supplements exert a beneficial effect on length of gestation, birth weight or on infant and maternal mortality or morbidity (Williams and Wheby, 1992). A policy statement of the US Preventive Services Task Force (1993), reported, that there is currently little evidence from published clinical research to suggest that routine iron supplementation during pregnancy is beneficial in improving clinical outcomes for the mother, foetus or newborn. In Finland after many studies, it was concluded that for pregnant women, for everyday good health, routine iron prophylaxis is unnecessary (Hemminki and Merilainen, 1995).

A recent study on 153602 pregnancies in inter-ethnic women in the north-west Thames region of the UK concluded that 'haemoglobin concentrations < 95 g/l seem to be remarkably harmless' (Steer *et al.*, 1995). 'It may be that haemoglobin concentrations, birth weight, and length of gestation are genetically programmed to be different in these groups and are therefore physiological' (Steer *et al.*, 1995). A number of authors have drawn attention to dangers in the provision of unselected iron medication for all pregnant women (Klebanoff *et al.*, 1991; Hollan, 1996).

As stated by Walker (1998) in the large majority of contexts described, iron supplementation in pregnancy is appeared to be unwarranted.

As to other suggestions made in this field, it has been felt that longitudinal measurements of iron status should be made, to determine the stages of pregnancy during which iron-defciency anaemia predicts poor pregnancy outcome (Kuizon *et al.*, 1985; Allen, 1997).

The crucial problem concerns the insufficiency of information on the translation of the results of clinical trials to the conditions of everyday life mainly the real impact of interventions on 'at risk' segments of populations' (Beard, 1996) from the developed countries (Dean, 1995; Awuonda, 1996), and much more so from generally impoverished developing countries (Gilks and Haran, 1995; Amanor-Wilks, 1996).

According to Owen and Owen (1997) prevalence of LBW and very LBW among infants and the prevalence of iron deficiency anaemia among toddlers and preschool children is lower for those participating in the special supplemental Nuritional Programme for women, infants, and children (WIC) then for those not participating in WIC.

Complications of pregnancy and their consequences

Effects on the Mother

About 80 per cent of maternal deaths in developing countries are direct obstetric deaths - they result from obstetric complications of the pregnant state. The remaining maternal deaths are from indirect causes aggravated by pregnancy or its management such as malaria, viral hepatitis, diabetes, anaemia or rheumatic heart disease. One of the worst chronic consequences of child birth is obstetric fistula particularly common when the first pregnancy occurs soon after puberty (Cottingham and Royston, 1991). Other consequences are uterine prolapse (Omran and Standley, 1981; Zurayk, 1991), unwanted pregnancies (Royston and Armstrong, 1989; Hord *et al.*, 1991) and AIDS (WHO, 1992b). Malaria is more prevalent in pregnant women than in non pregnant women and is most common in the first pregnancy. Viral hepatitis is far more prevalent in pregnant than non pregnant women in developing countries and 3.5 times as likely to prove fatal (WHO, 1991).

In anaemia of the pregnant women the immunity B-systems gets suppressed with progression of anaemia, CIG tend to be on the increase, I_gM and I_gG get augmented during the second and third trimesters of pregnancy. The above changes suggest some inadequacy of humoral immunity in anaemia of pregnancy (Leush and Futornyi, 1997; Berkane *et al.*, 1999).

From 60 to 70 per cent of pregnant women in developing countries are estimated to be anaemic (Sloan *et al.*, 1992). An infant may secure adequate iron stores at the expense of the mother's reserves. The resulting anaemia in the mother may impede her ability to resist infection or survive haemorrhage, increasing likelihood of death in children by a factor of four (Chi *et al.*, 1981; Harris *et al.* 1996; Wolfe, 1997).

Effects on the Foetus or Newborn

Pregnancy involves a dyad - the mother and the foetus. When the mother suffers, the foetus or newborn is vulnarable. Of the 13 million deaths each year in children under 5 years old in the developing world, 3 million occur in the first weak after delivery (Delgado *et al.*, 1985). In addition, these are some 4 million stillbirths or late foetal deaths each year (Koenig *et al.*, 1988; WHO, 1989b). These 7 million perinatal deaths are associated with maternal complications, poor management techniques during labour and delivery, and the woman's general health and nutritional status before and during pregnancy (Mari *et al.*, 1995).

Poor management during labour and delivery is associated with an additional 1.5 million perinatal deaths and many more developmental impairments among children (CAMHADD, 1990; Mother Care Project, 1993; Menendez *et al.*, 1994; Ouzounian *et al.*, 1996).

At least 3 million additional perinatal deaths and an unknown number of infant deaths are associated with women's health problems during pregnancy (WHO, 1989b). Women suffering from malaria (USAID, 1991), persistant low nutritional status and high energy expenditure (Gracia and Lofti, 1991) and women with poor nutritional status (Short stature, low pre-pregnancy weight, inadequate weight gain during pregnancy and anaemia) or other infections during pregnancy (WHO and UNICEF, 1992) are more likely to deliver a low-birth weight infant (ICMR, 1990a; Bouvier *et al.*, 1997).

A woman with HIV has a 25 to 40 per cent chance of passing the infection on to her foetus in the womb or at birth (Chin, 1990).

Effects on the household and community

The death of a woman of reproductive age can bring economic hardship to a family in poverty. At least one-fourth of male-headed households rely on female earnings for more than half of total income (Agarwal *et al.*, 1990). In India, women head one-third of all families below the poverty line (World Bank, 1991).

It is estimated that of women's unpaid household labour were enumerated the gross national product of most developing countries would increase by about one-third (Sivard, 1985).

Barriers to Maternal Health Care

Despite the clearly demonstrated need for family planning and maternal health services, women often lack access to relevant information, trained providers and supplies, emergency transport, and other essential services. Furthermore, cultural attitudes and practices may impede women's use of services that are available. Decisions about whether to seek care are generally not the woman's alone, but are often made by the husband or mother-in-law (Thaddeus and Maine. 1990; Huque *et al.*, 1991).

Most pregnant women in the developing world receive insufficient or no prenatal care and deliver without help from appropriately trained health care provides. Only about half of the married women of reproductive age in the developing world practice contraception. In some countries in Africa, family planning and maternity care coverage is less than 10 per cent (WHO, 1992a). Even in countries with relatively well-developed health systems, preventable maternal morbidity and mortality persist. A study of four institutions in Merico City classified 85 per cent of the maternal deaths examined as potentially preventable; clinical or surgical misjudgement was blamed for more than eight out of ten of the preventable deaths (Bobadilla *et al.*, 1992).

Differentials in Health

Many of the health problems affecting women of reproductive age, their newborn and older women begin in childhood and adolescence. Inadequate diet in youth and adolescence can lead to anaemia or stunting, which contribute to complications in childbirth and underweight babies.

Fertility rates have dropped substantially in developing countries over the past three decades. From 1962 to 1922 fertility rates fell by 40 per cent (UN, 1993).

Progress has been much slower in other areas significant to women's health. In sub-saharan Africa, where the ratio is 700 maternal deaths per 100,000 live births, a woman runs a one in twenty-two risk of dying from pregnancy-related causes during her lifetime; in South Asia the risk is one in thirty - four ; in South America, one in 115 - the risk drops in Northern Europe to one in 10,000 (UN, 1993; Herz and Measham, 1987). In Bangladesh, although the total fertility rate declined by one-third, the maternal mortality ratio remained virtually unchanged (World Bank, 1992; World Bank 1993a).

Biological determinants of women's health

Under optimal conditions for both men and women a woman's life expectancy at birth is 1.03 that of men (Coale and Demeny, 1983; World Bank, 1993b).

In most developing countries, however, the ratio is much lower, even droping below one in parts of Asia, to a low of 0.97 in Bhutan - a sign of socio economic conditions particularly inimical to women and girls (Keyfitz and Flieger, 1990).

Socioeconomic influences on women's health

The cultural and socioeconomic environment affects women's exposure to disease and injury, their diet, their access to and use of health services, and the manifestations and consequences of disease. Indoor cooking is one of the most serious occupational health and environmental hazards in the developing world because of the acute and chronic - and sometimes fatal - consequences of inhalation of smoke and toxic gases, as well as accidental burnings (WHO, 1986; World Bank, 1992d).

A study in India found women's exposure to cooking fumes to be equivalent to smoking twenty packs of cigarettes a day (Smyke, 1991).

The general level of underdevelopment may pose additional health risks for women. Poor roads and lack of transport, as well as inadequate obstetric facilities, hinder women from receiving timely medical treatment for obstructed labour, hemorrhage, and other pregnancy-related complications. Inadequate water supply, lack of electricity and poor sanitation impose extra hardships and burdens on women because of their household responsibilities such as fetching water and fuelwood, cooking and caring for children.

Iron requirements are increased in pregnancy. In theory they are met through the combined actions of mobilization of maternal iron stores (Taylor *et al.*, 1982), increased dietary iron absorption (Barrett *et al.*, 1994) and from savings made in basal iron losses during the period of amenorrhoea. For women who start pregnancy with adequate iron reserves these adaptations should allow the additional iron requirements to be met without any need to increase dietary iron intake (Department of Health, 1991).

In developing populations, the results of some trials in which efforts were made to remedy iron deficiency have been disappointing (Ekjidokun *et al.*, 1996; Nakazawa *et al.*, 1996).

In some groups of less-privileged populations, in which it would be desirable to increase iron intakes by supplementation, there is now evidence that the cost can be reduced by providing equally effective weekly instead of daily pills (Stephenson, 1995; Galloway and McGuire, 1996; Berger *et al.*, 1997).

Apart from food fortification, increased dietary intakes of iron should be encouraged, despite the general indifference of the general public to measure for health improvements (Austoker, 1995). It is gratifying that there are now new worldwide initiatives through WHO to make guidelines more positive, practical and understandable and therefore, more sustainable for the general public (Joint FAO/WHO Consultation Committee, 1996).

Maternal Morbidity and Mortality and the consequences

More than 150 million women become pregnant in developing countries each year and an estimated 500,000 of these women die from pregnancy-related causes (Tinker and Koblinsky, 1994). One-fourth of all deaths to women of reproductive age in many developing countries are pregnancy related (Tinker *et al.*, 1994; Tsai *et al.*, 1994).

The death toll is greatest in sub-saharan Africa and South Asia, where maternal mortality ratios (maternal deaths per 100,000 live births) may be as 200 times higher than those in industrial countries. This is the widest disparity in human development indicators yet reported. The profound difference in maternal health and mortality between developing and industrial countries is expressed even more starkly by comparing lifetime risk : one in every 21 women in Africa dies of complications of pregnancy, delivery, or abortion, compared with only one in every 10,000 in Northern Europe (Rochat, 1987).

Maternal mortality is not the only adverse outcome of pregnancy (Barvazian, 1990). Because of miscarriage and other factors, well over 40 per cent of the pregnancies in developing countries result in complications, illnesses, or permanent disability for the mother or child (WHO 1992a). More than 7 million newborn deaths are believed to result from maternal health problems and their mismanagement (Tewari, 1998).

Poor maternal health hurts women's productivity, their families welfare, and socio-economic development. The death of a pregnant women is often attributed to fate. Changing this prevailing attitude to a belief that "pregnancy is special" is the major challenge for safe motherhood programs (Winnard, 1991).

MATERIALS AND METHODS

3.0 MATERIALS AND METHODS

This study on the "Nutritional profile of pregnant women with reference to iron" is proposed to elicit information on the influence of various socio economic and dietary factors on the development of iron deficiency symptoms among pregnant women.

3.1 Location of the study

Government hospitals with maternity wards in Trivandrum city namely Government Hospital, Peroorkada and Government Hospital, Thycaud were selected for the study.

3.2 Selection of subject

Two hundred pregnant women who were primi, with age below 25 and free of metabolic or genetic disorders were selected for the experiment (macro sample).

For detailed study, 20 pregnant women from the macro sample were selected.

3.3.1 Investigations on macro samples (200)

Surveys were conducted to ascertain:

(i) Socio-economic characteristics of the respondents

(ii) their food consumption pattern

(iii) their dietary habits

(iv) and their daily time utilization pattern.

Twenty four hour recall method was applied to determine the meal pattern of the respondents.

The health profile of the respondents were assessed with reference to

(i) Anthropometric measurements

(ii) and clinical examination.

3.3.2 Investigations on micro samples (20)

Based on the above informations elicited from macro samples, 20 pregnant women suffering from severe or moderate iron deficiency disorders were selected for indepth study.

Major data generated from the micro sample were:

(i) Actual food intake

(ii) Bioavailability of iron from the daily diet

(iii) Presence of worm infestation

(iv) Iron status of the women through selected biochemical and clinical tests.

3.4 Tools selected for data collection

Internationally accepted tools based on earlier studies were selected for data collection.

3.4.1 Oral questionnaire

Oral questionnaire method which is the most commonly used method to conduct surveys among large number of families in a relatively short time was used for collecting information regarding the socio-economic and dietary characteristics of the families and the pregnant women in particular.

Infrastructural facilities at the household level and social participation of the respondents were also collected.

The schedules formulated for the above data collection were pretested prior to administration is presented in Appendix I, II, III and IV.

Assessment of nutritional status

Assessment of nutritional status could be achieved through one or a combination of several methods. In the present study four methods, viz. food intake by recall, anthropometric measurements, clinical examination and energy/protein adequacy were used to assess the nutritional status of macrosamples while actual food intake, anthropometric measurements, clinical examination and selected biochemical estimations were considered to assess the nutritional status of microsamples.

3.4.2 Oral questionnaire (24 hour recall)

In this recall method of diet survey, a set of "standardised cups", suited to local conditions were used. The individuals interviewed were asked a systematic series of questions to ensure recollection and description of all food and drink consumed in the 24 hours before the interview with emphasis on food consumption meal-by-meal.

Maternal weight gain

Pre pregnancy weight and the weight towards the last month of the third trimester were recorded and the gestational weight gain was assessed.

Birth weight of newborn

The birth weight of babies delivered by the 200 respondents were recorded.

Age of the respondent, age at menarche and marital status were also recorded.

Food use frequency score

Frequency of use of different food groups would give an indication about the adequacy of the family diet pattern.

Food use frequency was measured on a 'Five point' scale. On the basis of the frequency of use, the foods were classified into five groups and scored as given below.

Frequency of use	Score
Never	0
Occasionally	1
Less than 3 days in a week	2
More than 3 days in a week	3
Daily	4

The total scores for each of the food groups were calculated (Reabrun *et al.*, 1979). Based on the percentage score obtained, the food articles were further classified in to four groups based on the frequency scores obtained.

Frequency of use of various factors favouring and hindering iron absorption were collected and the various nutrients present in different meals in a day along with different haemopoetic constituents in food were calculated.

Information regarding food fads related to micronutrients and the use of pica were collected.

3.4.3 Anthropometric measurements

Anthropometric assessment of nutritional status during the reproductive cycle, particularly during pregnancy is a widely used, low-technology procedure that has seldom been rigorously evaluated (Anon, 1995 a). Anthropometry provides the single most portable, universally applicable, inexpensive and non-evasive technique for assessing the size, proportions and composition of the human body.

Details of different measurements recorded were:

Anthropometric measurements	Recording technique
1. Body weight	Vijayaraghavan, 1987
2. Height	Vijayaraghavan, 1987
3. Skinfold thickness	Jelliffee, 1966
4. Body Mass Index (BMI)	Beaton *et al.*, 1990
5. Weight Height Product Index (WHPI)	Bhatia *et al.*, 1988
6. Weight Height Ratio Index (WHRI)	Bhatia *et al.*, 1988
7. Broka's Index (BI)	Balakrishna *et al.*,1998

Protein sufficiency

Following indices were worked out from the data generated.

Body Mass Index (BMI) indicator of the magnitude of the protein calorie malnutrition was computed from the recorded height and weight using the formula Wt/Ht^2.

Weight for Height Ratio Index (WHRI) was computed by

$$\frac{\text{Weight (kg)}}{\text{Height}^2\text{ (m)}} \times 100$$

Weight and Height Product Index (WHPI) was also computed by

$$\frac{\text{Weight (kg)} \times \text{Height (cm)}}{45\text{ kg} \times 150\text{ cm}} \times 100$$

Broka's Index (BI) was computed by

$$\frac{\text{Actual weight (kg)}}{\text{Height (cm)} - 100} \times 100$$

Energy sufficiency

To find out energy sufficiency, energy intake, requirement and expenditure of the respondents were also determined.

The energy expenditure pattern of the respondent was worked out using Time and Activity schedule (Appendix IV). Each and every activity undertaken by the respondent along with the time spent in minutes for a whole day was recorded for three consecutive days. Daily energy expenditure of each woman was worked out using standards specified by ICMR (1998). Energy intake of the respondents were worked out from the actual food intake and using the energy value of common Indian foods as given in Nutritive Value of Indian Foods (Gopalan *et al.*, 1996).

Energy balance for each respondent was worked out by comparing the energy expended and energy consumed.

3.4.4 Clinical examination

All the 200 pregnant women selected for the study were subjected to clinical examination for the detection of signs and symptoms of anaemia with the help of a qualified medical practioner.

The schedule used for recording the clinical signs is presented in Appendix V.

3.4.5 Actual food intake (Weighment Method)

The actual food intake of 20 pregnant women suffering from severe/moderate iron deficiency was determined by food weighment method to assess the quantity and quality of their diet.

The schedule used for recording actual food intake is presented in Appendix VI.

Bioavailability of iron from the diet was estimated by the method suggested by Rao and Prabhavathi (1978).

3.4.6 Biochemical estimations

Biochemical estimation is a direct method to assess nutritional status of the pregnant women. Biochemical measurements selected for the study were estimation of haemoglobin of the macrosamples and estimation of haemoglobin, RBC count, platelet count, packed cell volume or haematocrit, total protein, serum albumin, serum globulin, serum iron, TIBC, transferrin saturation and ferritin in blood samples collected from 20 pregnant women (micro sample) suffering from severe/moderate iron deficiency disorder.

Biochemical estimations	Recording technique
1. Haemoglobin	Graitcer, 1981
2. RBC Count (Red Blood Cell count)	Marsh and Koenig, 1982
3. Platelet count	Fairbanks, 1980
4. PCV (Packed Cell Volume)/ Haematocrit	Fairbanks, 1980
5. Total protein	NIN, 1983
6. Albumin	NIN, 1983
7. Globulin	NIN, 1983
8. Serum iron	Dallman, 1984
9. TIBC (Total Iron Binding Capacity)	Guindi *et al.*, 1988
10. Transferrin saturation	Ravel, 1984
11. Ferritin	Worwood, 1986

Blood samples (10 cc) were taken from 10 women for all the above estimations and 5 cc from 10 women for the above estimations except serum iron, TIBC, transferrin saturation and ferritin.

Blood (2 cc) was collected in EDTA bottles for the measurement of haemoglobin, RBC count, platelet count and PCV and blood (8 cc) was collected in plain bottles for the measurement of total protein, albumin, globulin, iron, TIBC, transferrin saturation and ferritin. Aerobic conditions were preserved throughout collection and analysis as long as possible. Particular attention was paid to avoid environmental mineral contamination during blood collection and analysis by using stainless needles and acid rinsed glassware. The blood in the plain tubes were allowed to clot at room temperature and centrifuged after which the serum was separated. Haemolytic samples were excluded.

Indices worked out from biochemical estimations

Useful indices to demonstrate certain characteristics of RBC's (Wintrobe, 1993) were worked out.

1. Mean Corpuscular Volume (MCV)

$$MCV = \frac{\text{Volume (in ml) of RBC in 1 ml blood}}{\text{No. of RBC in 1 ml blood}}$$

$$= \frac{\text{PCV} \times 10}{\text{RBC count}}$$

2. Mean Corpuscular Haemoglobin (MCH)

$$MCH = \frac{\text{Hb in g/litre of blood}}{\text{RBC count (in millions/cmm)}}$$

$$= \frac{\text{Hb} \times 10}{\text{RBC count}}$$

3. Mean Corpuscular Haemoglobin Concentration (MCHC)

$$MCHC = \frac{\text{Hb in g/100 ml}}{\text{PCV}} \times 100$$

$$= \frac{\text{Hb}}{\text{PCV}}$$

4. Albumin to Globulin Ratio (A/G ratio)

3.5 Mode of data collection

Interview method was selected in the study since this method was reported to be a suitable way to proceed systematically and quickly to collect information. In this method, there is a face to face interchange between the interviewer and respondent before eliciting information. The information collected was found more reliable, as the accuracy of the statements were checked by supplementary questions wherever necessary. An interviewer administered questionnaire also ensures answers to more complex questions, completion of all questions and an explanation of problems (Eastwood, 1997).

3.6 Analysis of data

3.6.1 Developing a "quality of life index" based on selected socio-economic variables

Socio economic variables selected were caste, educational status of the respondent, occupational status of the respondent, total monthly income of the family, per capita monthly income, monthly expenditure on food along with calorie and protein intake of the pregnant women. Each of the variables were rated by giving scores. The scores given for each parameter ranged from 0 to 8 (as detailed below) depending on the variations observed within the families studied. Following the method suggested by Dhanasekran (1991) a Physical Quality of Life Index (PQLI) was developed.

Caste	Scheduled caste (0) Scheduled tribe (1) Other backward communities (2) Forward communities (3)
Educational status	Illiterate (0) Lower primary (1) Upper primary (2) High School (3) S.S.L.C.(4) Pre-Degree (5)Graduate(6) Post-Graduate (7)
Occupational category	Unemployed (0) Employed (1)
Family income in Rs. (monthly)	≤1000 (0) 1001 - 2000 (1) 2001 - 3000 (2) 3001 - 4000 (3) 4001 - 6000 (4) 6001-8000(5) 8001-10000(6) >10000 (7)
Per capita income in Rs. (monthly)	≤ 100 (0) 101 - 500 (1) 501 - 900 (2) 901-1300(3) 1301-1700(4) 1701-2100(5) 2101-2500 (6)
Calorie intake/day (kcals)	≤ 1800 (0) 1801 - 2100 (1) 2101 - 2400(2)2401-2700(3) ≥ 2701(4)
Protein intake/day (g)	≤ 40 (0) 41-45 (1) 46-50 (2) 51-55 (3) 56-60 (4) 61-70 (5)
Monthly food expenditure expressed as percentage of income	≤ 50 (0) 51-55 (1) 56-60 (2) 61-65(3) 66-70 (4) 71-75 (5) 76-80 (6) 81-85 (7) 86 - 90 (8)

Scores assigned for each parameter for a family when summed up would give the total score for that family. Sum total of the score of a family would give the physical quality of life index of that particular family. Maximum score that can be obtained by a family would be 37. Based on the total score obtained, the families were classified into 4 groups, viz., families with a PQLI between 11 and 15 (Group I), families with a PQLI between 16 and 20 (Group II), families with a PQLI between 21 and 25 (Group III) and families with a PQLI from 26 to 30 (Group IV).

Association of PQLI with socio economic, dietary, nutritional, anthropometric and haematological variables were tested.

3.6.2 Developing Nutritional Status Index (NSI)

In the present study for developing the nutritional status index of the pregnant women, their height, weight gain, skinfold thickness and haemoglobin level were taken into consideration.

Suppose kij be the observation corresponding to the j^{th} variable for the i^{th} sample *$wj = 1/-j^2$, the weight assigned* to the observation corresponding to j^{th} variable the nutritional status of i^{th} individual is calculated as follows:

$$Ni = {}^{k} wi \times ij,$$

$$i = 1, 2, \ldots\ldots\ldots\ldots, N$$

N = No. of respondents

k = No. of variables

NSI developed was also tested statistically against PQLI developed for individual respondents.

RESULTS

4.0 RESULTS

Results of the study entitled "Nutritional profile of pregnant women with reference to iron" comprises information on the influence of various socio-economic and dietary factors on the development of iron deficiency in pregnant women. Two hundred families surveyed were grouped into four categories based on the Physical Quality of Life Index (PQLI) developed. Few variables like caste, educational and occupational status of the respondents, monthly family income, per capita income, monthly food expenditure and calorie and protein intake per day were considered for developing this index. The physical quality of life index for each family was worked out by summing up the scores obtained for the variables individually. Based on this index, the families were classified into four groups and their distribution is presented in Table 1 and details are given in Appendix VII.

As indicated in Table 1, families (6.50 per cent) with PQLI <15 were categorised under group I and families (37.00 per cent) with PQLI in the range 15-20 were categorised under group II. Fifty three (52.50) per cent families surveyed were identified under group III with PQLI ranging between 20-25 while 4.00 per cent families surveyed were under group IV with PQLI of 25-30.

Table 1 Distribution of families based on Physical Quality of Life Index (PQLI)

Distribution of families	PQLI (in range)	Number of families
Group I	≤15	13 (6.50)
Group II	15 - 20	74 (37.00)
Group III	20 - 25	105 (52.50)
Group IV	25 - 30	8 (4.00)
Total		200 (100.00)

Data generated about these families and the respondents are presented under:

Investigations on macrosamples (n=200)

4.1 Socio-economic indicators

4.2 Dietary indicators

4.3 Nutritional indicators

4.4 Anthropometric measurements

4.5 Indices based on nutritional status

Investigations on microsamples (n=20)

4.6 Actual food intake

4.7 Haematological findings

Data collection from respondent

4.1 Socio-economic indicators

The socio-economic profile of the families were studied with reference to their social status, occupational status, economic status and monthly per capita expenditure.

4.1.1 Social status of the families

Among the 200 families surveyed, many families (76.50 per cent) followed the religion of Hinduism and most of them (48.00 per cent) belonged to the forward communities (Table 2).

As summarised in Table 2, 76.50 per cent of the families surveyed were Hindus, 12 per cent were Christians and 11.50 per cent were Muslims.

Twenty one per cent of the families surveyed belonged to the scheduled caste and 1.50 per cent to the scheduled tribe and 29.50 per cent belonged to the other backward communities and 48.00 per cent belonged to the forward communities.

Distribution of the families based on their religion were uniform in all the groups while distribution of caste was not uniform.

Information on type of family, family size and composition are presented in Table 3.

A large number of families were either joint families (52.00 per cent) or extended families (39.00 per cent). Very

Table 2 Distribution of families based on religious status

Distribution of families	Religion			Caste				Total
	1	2	3	1	2	3	4	
Group I	10 (5.00)	3 (1.50)	0 (0.00)	9 (4.50)	0 (0.00)	3 (1.50)	1 (0.50)	13 (6.50)
Group II	58 (29.00)	10 (5.00)	6 (3.00)	20 (10.00)	2 (1.00)	23 (11.50)	29 (14.50)	74 (37.00)
Group III	80 (40.00)	9 (4.50)	16 (8.00)	12 (6.00)	1 (0.50)	30 (15.00)	62 (31.00)	105 (52.50)
Group IV	5 (2.50)	2 (1.00)	1 (0.50)	1 (0.50)	0 (0.00)	3 (1.50)	4 (2.00)	8 (4.00)
Total	153 (76.50)	24 (12.00)	23 (11.50)	42 (21.00)	3 (1.50)	59 (29.50)	96 (48.00)	200 (100.00)

Religion
1 - Hindu
2 - Christian
3 - Muslim
Caste
1 - Scheduled Caste (SC)
2 - Scheduled Tribe (ST)
3 - Other Backward Communities (OBC)
4 - Forward Communities

Table 3 Distribution of families based on type of family and family size

Distribution of families	Type of family			Family size and compostion										Total
	Joint	Nuclear	Extended	Males					Females					
				1	2	3	4	5	1	2	3	4	5	
Group I	5 (2.50)	2 (1.00)	6 (3.00)	7 (3.50)	4 (2.00)	0 (0.00)	1 (0.50)	1 (0.50)	3 (1.50)	5 (2.50)	2 (1.00)	3 (1.50)	0 (3.00)	13 (6.50)
Group II	30 (15.00)	10 (5.00)	34 (17.00)	26 (13.00)	32 (16.00)	14 (7.00)	2 (1.00)	0 (0.00)	21 (10.50)	31 (15.50)	13 (6.50)	7 (3.50)	2 (1.00)	74 (37.00)
Group III	64 (32.00)	6 (3.00)	35 (17.50)	20 (10.00)	43 (21.50)	32 (16.00)	9 (4.50)	1 (0.50)	9 (4.50)	54 (27.00)	27 (13.50)	10 (5.00)	5 (2.50)	105 (52.50)
Group IV	5 (2.50)	0 (0.50)	3 (1.50)	2 (1.00)	3 (1.50)	3 (1.50)	0 (0.00)	0 (0.00)	1 (0.50)	4 (2.00)	2 (1.00)	0 (0.00)	1 (0.50)	8 (4.00)
Total	104 (52.00)	18 (9.00)	78 (39.00)	55 (27.50)	82 (41.00)	49 (24.50)	12 (6.00)	2 (1.00)	34 (17.00)	94 (47.00)	44 (22.00)	20 (10.00)	8 (4.00)	200 (100.00)

few families (9.00 per cent) were identified as nuclear families.

The data collected about family size and composition revealed that 27.50 per cent of the families had only one male member, 41.00 per cent had two male members, 24.50 per cent had three male members, 6.00 per cent had four male members and the remaining one per cent of the families had five male members each.

In the case of females, 18.00 per cent of the families had one female member, 47.00 per cent had two members, 22.00 per cent had three members, 10.50 per cent had four members and four per cent had five female members in the family.

Distribution of respondents based on the amenities available at the household level is presented in Table 4.

The table revealed that out of the 200 respondents only 78.50 per cent of the families had their own homes. Amenities like electricity, water, toilet and drainage facilities were enjoyed by 49.00 per cent of the respondents but 7.50 per cent of the families had only electricity and toilet facility, while 16 per cent of the families did not have any of these basic amenities.

Group wise distribution revealed that 76.93 per cent in group I, 79.73 per cent in group II, 77.14 per cent in

Table 4 Distribution of respondents based on the amenities available at the household level

Distribution of women	Ownership of House		Total	Amenities available					Total
	Rented	Owned		Nil	1	2	3	4	
Group I	3 (1.50)	10 (5.00)	13 (6.50)	1 (0.50)	4 (2.00)	3 (1.50)	2 (1.00)	3 (1.50)	13 (6.50)
Group II	15 (7.50)	59 (29.50)	74 (37.00)	17 (8.50)	5 (2.50)	4 (2.00)	14 (7.00)	34 (17.00)	74 (37.00)
Group III	24 (12.00)	81 (40.50)	105 (52.50)	13 (6.50)	10 (5.00)	8 (4.00)	18 (9.00)	56 (28.00)	105 (52.50)
Group IV	1 (0.50)	7 (3.50)	8 (4.00)	1 (0.50)	1 (0.50)	0 (0.00)	1 (0.50)	5 (2.50)	8 (4.00)
Total	43 (21.50)	157 (78.50)	200 (100.00)	32 (16.00)	20 (10.00)	15 (7.50)	35 (17.50)	98 (49.00)	200 (100.00)

1 - Electricity
2 - Electricity + Toilet facility
3 - Electricity + Toilet + Water facility
4 - Electricity + Toilet + Water + Drainage facility

group III and 87.50 per cent in group IV had their own houses and 23.08 per cent in group I, 45.95 per cent in group II, 53.33 per cent in group III and 62.50 per cent in group IV had all the basic amenities at home.

4.1.2 Economic status of the families

Distribution of families based on their economic status (Table 5) revealed that out of the 200 families surveyed, less than two (1.50) per cent of the families had a monthly income greater than Rs.6000 and 16.50 per cent of the families had an income ranging between Rs.4001 and Rs.6000. But many families were identified with a lower income since 51.00 per cent were observed to have an income between Rs.2001 and Rs.4000 and the remaining 31.00 per cent had an income less than Rs.2000 per month.

Group wise distribution of the families revealed that in all the groups, many families were having a monthly income, below Rs.4000 (11 families under group I, 68 families in group II, 82 families in group III and 3 families in group IV).

Table 5 also depicts the number of earning members in each of the 200 families surveyed. Thirty eight per cent of the families had only one earning member in the family, 41.00 per cent had two earning members, 16.50 per cent had three members, 3.00 per cent had four earning members, 1.00 per cent

Table 5 Distribution of families based on economic status

Distribution of families	Actual monthly income (Rs.)				Earning members in the family						Major source of income				Total
	≤2000	2001-4000	4001-6000	>6000	1	2	3	4	5	6	1	2	3	4	
Group I	8 (4.00)	3 (1.50)	2 (1.00)	0 (0.00)	7 (3.50)	5 (2.50)	1 (0.50)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.50)	11 (5.50)	0 (0.00)	1 (0.50)	13 (6.50)
Group II	34 (17.00)	34 (17.00)	5 (2.50)	1 (0.50)	40 (20.00)	25 (12.50)	8 (4.00)	1 (0.50)	0 (0.00)	0 (0.00)	5 (2.50)	67 (33.50)	1 (0.50)	1 (0.50)	74 (37.00)
Group III	19 (9.50)	63 (31.50)	23 (11.50)	0 (0.00)	30 (15.00)	47 (23.50)	20 (10.00)	5 (2.50)	2 (1.00)	1 (0.50)	10 (5.00)	95 (47.50)	0 (0.00)	0 (0.00)	105 (52.50)
Group IV	1 (0.50)	2 (1.00)	3 (1.50)	2 (1.00)	1 (0.50)	4 (2.00)	3 (1.50)	0 (0.00)	0 (0.00)	0 (0.00)	2 (1.00)	5 (2.50)	0 (0.00)	1 (0.50)	8 (4.00)
Total	62 (31.00)	102 (51.00)	33 (16.50)	3 (1.50)	78 (39.00)	81 (40.50)	32 (16.00)	6 (3.00)	2 (1.00)	1 (0.50)	18 (9.00)	178 (84.00)	1 (0.50)	3 (1.50)	200 (100.00)

had five members and the remaining 0.50 per cent of the families had more than five earning members.

In group I, 3.50 per cent of the families had only one earning member, 2.50 per cent had two earning members and 0.50 per cent had three earning members. Where as in group II, 20.00 per cent had only one earning member in the family, 12.50 per cent had two earning members, 4.00 per cent had three earning members and 0.50 per cent had four earning members. In group III 15.00 per cent were having only one earning member, 23.50 per cent families with two earning members, 10.00 per cent families with three earning members, 2.50 per cent families with three earning members, 2.50 per cent families with four earning members, 1.00 per cent families with five earning members and 0.50 per cent families with more than five earning members. In group IV, 0.50 per cent of the families had one earning member, 2.00 per cent families had two earning members and 1.50 per cent had three earning members.

Out of the 200 families surveyed only nine per cent of the families had members with regular employment and the rest (89.00 per cent) of the families had their own business, land. domestic animals, farm production or were manual labourers. Two (1.50) per cent of the families had a member with regular employment along with a member involved in business activities and 0.50 per cent of the families had subsidiary occupation.

Group wise classification shows that in group I most members did not have regular employment (84.62 per cent).

Correlation studies revealed direct significant relation between economic status of the families and earning members of the families ($r = 0.7144^{**}$), major source of income ($r = 0.1876^{**}$), monthly food expenditure pattern ($r = 0.8152^{**}$), monthly expenditure on medicine ($r = 0.5752^{**}$), educational status ($r = 0.2053^{**}$), decision making ($r = -0.1317^{**}$), percentage expenditure on food ($r = -0.3328^{**}$) and the details presented in Appendix VIII.

4.1.3 Socio-economic indicators related to women

All the women surveyed were not employed and did not have active social participation. Other indicators considered were age, educational status and role as decision maker in the family and are presented in Table 6.

Out of the 200 respondents, it was found that 44.50 per cent of them belonged to the age group of 22 to 25, 24.00 per cent were in the age group 20-22, 24.00 per cent were in the age group of 18-20 and the remaining 7.50 per cent were either 18 years old or less than that.

As per group wise classification, proportion of respondents either 18 years old or less in group I were more when compared to the other three groups while many respondents in groups II, III and IV were in the age group of 19 to 25.

Table 6 Distribution of respondents based on selected characteristics

Distribution of families	Age				Educational status								Decision making			Food habit			Total
	≤18	18-20	20-22	22-25	1	2	3	4	5	6	7	8	1	2	3	1	2	3	
Group I	1 (0.50)	3 (1.50)	2 (1.00)	7 (3.50)	5 (2.50)	3 (1.50)	1 (0.50)	1 (0.50)	3 (1.50)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	5 (2.50)	8 (4.00)	0 (0.00)	12 (6.00)	1 (0.50)	13 (6.50)
Group II	5 (2.50)	16 (8.00)	20 (10.00)	33 (16.50)	6 (3.00)	5 (2.50)	16 (8.00)	16 (8.00)	23 (11.50)	4 (2.00)	4 (2.00)	0 (0.00)	0 (0.00)	31 (15.50)	43 (21.50)	1 (0.50)	73 (36.50)	0 (0.00)	74 (37.00)
Group III	9 (4.50)	28 (14.00)	25 (12.50)	43 (21.50)	1 (0.50)	3 (1.50)	7 (3.50)	11 (5.50)	47 (23.50)	25 (12.50)	10 (5.00)	1 (0.50)	2 (1.00)	48 (24.00)	55 (27.50)	3 (1.50)	102 (51.00)	0 (0.00)	105 (52.50)
Group IV	0 (0.00)	1 (0.50)	1 (0.50)	6 (3.00)	0 (0.00)	1 (0.50)	0 (0.00)	0 (0.00)	2 (1.00)	1 (0.50)	1 (0.50)	3 (1.50)	0 (0.00)	8 (4.00)	0 (0.00)	0 (0.00)	8 (4.00)	0 (0.00)	8 (4.00)
Total	15 (7.50)	48 (24.00)	48 (24.00)	89 (44.50)	12 (6.00)	12 (6.00)	24 (12.00)	28 (14.00)	75 (37.50)	30 (15.00)	15 (7.50)	4 (2.00)	2 (1.00)	92 (46.00)	106 (53.00)	4 (2.00)	195 (97.50)	1 (0.00)	200 (100.00)

According to the distribution of respondents based on their educational status, it was seen that 6.00 per cent of the respondents were illiterate and 6.00 per cent had only lower primary education. Twelve per cent of the respondents had upper primary level of education; 14.00 per cent had high school level of education and 37.50 per cent of the respondents had completed their tenth standard. Fifteen per cent of the respondents had college level education and had completed their Pre degree course, while 7.00 per cent of the respondents were graduates and the remaining 2.00 per cent were post graduates.

Proportion of illiterates among respondents were uniform in group I and group II while it was less in the other two groups. Similarly proportion of respondents studied upto S.S.L.C. and above were also found to be more in the four groups.

The table revealed that when it comes to decision making at the household level, many respondents(53.00 per cent) were not involved in decision making and 46.00 per cent of the respondents contributed to the decisions finally taken by their husbands.

In group I and II distribution of respondents permitted to take decisions and not permitted for the same were found to be more or less uniform while the proportion of latter were found to increase in group III and the proportion of former in group IV.

Statistical analysis of the data revealed that educational status of the respondents had a positive relationship with monthly income ($r = 0.2053^{**}$), amenities available at the household level ($r = 0.1885^{**}$), food expenditure pattern ($r = 0.1624^{**}$), expenditure on medicine ($r = 0.1457^{*}$) and with their role as decision makers ($r = ^{-}0.2484^{**}$) and details prevented in Appendix VIII.

4.2 Dietary indicators

Under dietary indicators, variables studied were monthly food expenditure pattern, frequency of use of various foods and food consumption pattern.

4.2.1 Monthly food expenditure pattern

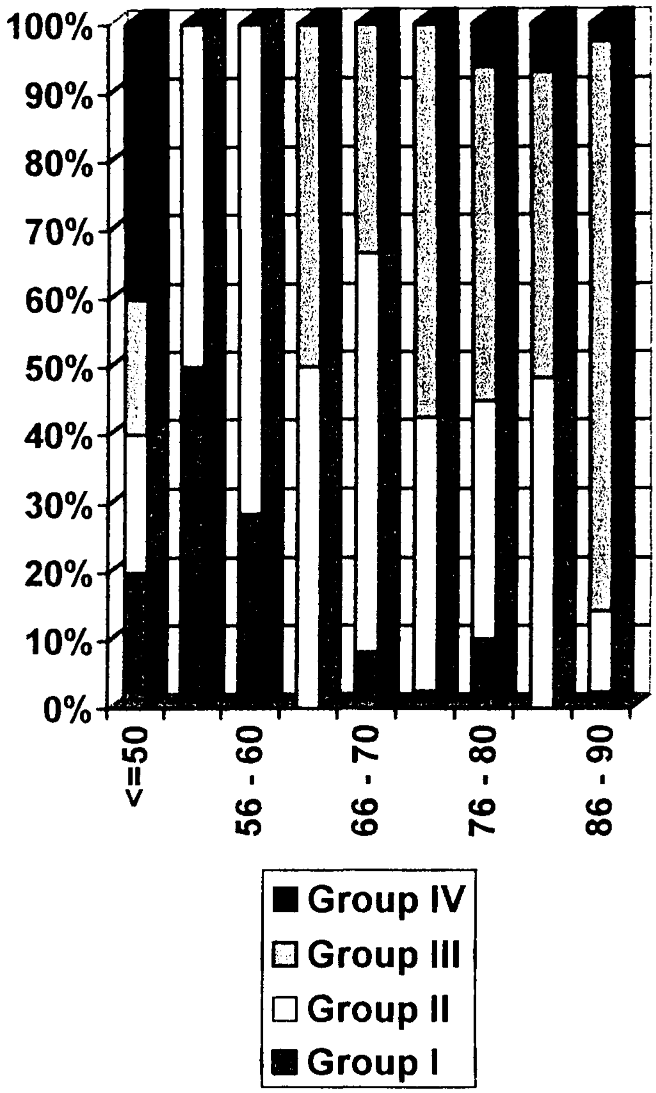
Monthly food expenditure pattern of the families is given in Table 7 (Fig. 1).

From the table it is clear that out of the 200 families surveyed, only 2.50 per cent of the families spent less than 50.00 per cent of their monthly income on food, while 1.00 per cent spent 51 to 55 per cent of their monthly income on food; 3.50 per cent 56 to 60 per cent; and 1.00 per cent, about 61 to 65 per cent, 66 to 70 per cent of the income was spent for food by 12 per cent, 71 to 75 per cent by 20.00 per cent and 76 to 80 per cent by 24.50 per cent. A higher percentage of income (81 to 85 per cent and 86 to 90 per cent)

Table 7 Distribution of families based on their monthly food expenditure pattern (Percentage)

Distribution of families	Percentage monthly food expenditure									Total
	≤50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	
Group I	1 (0.50)	1 (0.50)	2 (1.00)	0 (0.00)	2 (1.00)	1 (0.50)	5 (2.50)	0 (0.00)	1 (0.50)	13 (6.50)
Group II	1 (0.50)	1 (0.50)	5 (2.50)	1 (0.50)	14 (7.00)	16 (8.00)	17 (8.50)	14 (7.00)	5 (2.50)	74 (37.00)
Group III	1 (0.50)	0 (0.00)	0 (0.00)	1 (0.50)	8 (4.00)	23 (11.50)	24 (12.00)	13 (6.50)	35 (17.50)	105 (52.50)
Group IV	2 (1.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (1.50)	2 (1.00)	1 (0.50)	8 (4.00)
Total	5 (2.50)	2 (1.00)	7 (3.50)	2 (1.00)	24 (12.00)	40 (20.00)	49 (24.50)	29 (14.50)	42 (21.00)	200 (100.00)

Fig. 1 **Distribution of families based on their monthly food expenditure pattern (%)**



were spent for food by 14.50 per cent and 21.00 per cent of the families surveyed.

Families placed on different groups based on selected socio-economic factors had shown variation in this respect. Less than 50 per cent of their income on food was spent by 0.50 to 1.00 per cent of the families included from group I to group IV. Distribution of families in group II and group III revealed a steady increase in the number of families in the enhancement of food expenditure from 51 to 55 per cent, to 81 to 85 per cent. In group IV, few families (3.00 per cent) located were observed to spend more than 66 per cent of their income on food.

Actual food expenditure pattern of the families were found to have statistically significant relationship with the type of the family ($r = {}^{-}0.4705^{**}$), family size (males : $r=0.6009^{**}$; females : $r = 0.5270^{**}$), number of earning members in the family ($r = 0.7856^{**}$), expenditure on medicine ($r=0.2287^{**}$), educational status of the respondent ($r=0.1624^{*}$), percentage of food expenditure against family income ($r = 0.1360^{*}$) and monthly income ($r = 0.8152^{**}$) and details presented in Appendix VIII.

Table 8 gives the actual monthly expenditure of the 200 families on food and medicine.

Table 8 Distribution of families based on their monthly expenditure pattern (Actual in Rs.)

Distribution of families	Food				Medicine			Total
	<1000	1001-2000	2001-3000	>3001	≤100	101-200	>200	
Group I	2 (1.00)	8 (4.00)	3 (1.50)	0 (0.00)	12 (6.00)	1 (0.50)	0 (0.00)	13 (6.50)
Group II	8 (4.00)	43 (21.50)	16 (8.00)	7 (3.50)	71 (35.50)	2 (1.00)	1 (0.50)	74 (37.00)
Group III	4 (2.00)	27 (13.50)	42 (21.00)	32 (16.00)	104 (52.00)	1 (0.50)	0 (0.00)	105 (52.50)
Group IV	0 (0.00)	2 (1.00)	1 (0.50)	5 (2.50)	7 (3.50)	0 (0.00)	1 (0.50)	8 (4.00)
Total	14 (7.00)	80 (40.00)	62 (31.00)	44 (22.00)	194 (97.00)	4 (2.00)	2 (1.00)	200 (100.00)

Many families (40.00 per cent) spent Rs.1001 to Rs.2000 on food per month. 31.00 per cent spent Rs.2001 to Rs.3000 and 22.00 per cent spent more than Rs.3000 on food. Only seven per cent of the families spent less than or equal to Rs.1000 for the same purpose.

Group wise distribution revealed that 62.50 per cent of the families under group IV spent more than Rs.3000 and not even one family under group I spent more than Rs.3000.

Monthly expenditure on medicines revealed that 97.00 per cent of the respondents spent less than or equal to Rs.100, 2.00 per cent spent Rs.101 to Rs.200 and 1.00 per cent spent greater than Rs.200 per month for the same.

Group wise classification revealed that most of the families under group II spent more money on medicines.

In Table 7 distribution of families based on their monthly food expenditure pattern is presented while in Table 9 the influence of per capita income on the monthly food expenditure pattern is detailed. Based on monthly per capita income, the 200 families surveyed were classified into five groups with mean $\pm$ SD viz. group with a monthly per capita income less than or equal to Rs.600 (31.50 per cent), group with a monthly per capita income of Rs.601 to Rs.710 (20.50 per cent) with a per capita income of Rs.711 to Rs.730

Table 9 Influence of percapita income on the monthly food expenditure pattern

PQLI	Percapita income					Total	% monthly food expenditure									Total	PQLI
	≤600	601-710	711-730	731-751	≥752		≤50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90		
≤ 15	11 (5.50)	5 (2.50)	0 (0.00)	3 (1.50)	2 (1.00)	21 (10.50)	1 (0.50)	1 (0.50)	2 (1.00)	0 (0.00)	2 (1.00)	1 (0.50)	5 (2.50)	0 (0.00)	1 (0.50)	13 (6.50)	<15
16-20	31 (15.50)	11 (5.50)	1 (0.50)	14 (7.00)	30 (15.00)	87 (43.50)	1 (0.50)	1 (0.50)	5 (2.50)	1 (0.50)	14 (7.00)	16 (8.00)	17 (8.50)	14 (7.00)	5 (2.50)	74 (37.00)	15-19
21-25	21 (10.50)	24 (12.00)	2 (1.00)	15 (7.50)	27 (13.50)	91 (45.50)	1 (0.50)	0 (0.00)	0 (0.00)	1 (0.50)	8 (4.00)	23 (11.50)	24 (12.00)	13 (6.50)	35 (17.50)	105 (52.50)	20-24
>25	0 (0.00)	1 (0.50)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.50)	2 (1.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (1.50)	2 (1.00)	1 (0.50)	8 (4.00)	>24
Total	63 (31.50)	41 (20.50)	3 (1.50)	32 (16.00)	59 (29.50)	200 (100.00)	5 (2.50)	2 (1.00)	7 (3.50)	2 (1.00)	24 (12.00)	40 (20.00)	49 (24.50)	29 (14.50)	42 (21.00)	200 (100.00)	

(1.50 per cent) with a per capita income of Rs.731 to Rs.751 (16.00 per cent) and group with a per capita income greater than Rs.752 (29.50 per cent).

Percentage of monthly food expenditure against per capita income revealed that majority of the families surveyed (93.00 per cent) were found to spend more than 60 per cent of their income on food with a distribution of 13 per cent spending 61 to 70 per cent of their income on food, 43.50 per cent spending 71 to 80 per cent for food and 36.50 per cent spending upto 81 to 90 per cent of their income for food.

Group wise classification showed that PQLI have a direct and positive influence on the percentage of income spent on food.

Association between Physical Quality of Life Index (PQLI) and selected socio-economic variables when tested statistically (Appendix VIII) revealed a direct significant relationship with caste ($r = 0.4182^{**}$), number of male members in the family ($r = 0.2187^{**}$), actual monthly income ($r = 0.3559^{**}$), per capita income ($r = 0.1893^{**}$), earning members in the family ($r = 0.3072^{**}$), monthly food expenditure pattern ($r = 0.4758^{**}$), educational status ($r = 0.5379^{**}$), percentage food expenditure ($r = 0.2711^{**}$) and indirect significant relationship with decision making power of the respondent in the family ($r = {}^{-}0.1766^{*}$).

4.2.2 Frequency of use of different foods rich in various nutrients

Energy rich foods

Distribution of families based on the frequency of use of energy rich foods are presented in Table 10.

The various energy rich foods taken into consideration were cereals, roots and tubers, nuts and oil seeds, fats and oils and sugar and jaggery.

Table 10 revealed that cereals, nuts and oilseeds, fats and oils and sugar and jaggery were consumed daily by all the respondents. Rice which is a cereal, was consumed daily as it was their staple food. Like wise coconut (oil seed), oil and sugar were also used daily for various preparations.

Roots and tubers were included less than three days in a week by 56.00 per cent of the families; occasionally by 27.00 per cent of the families and more than three days in a week by 10.50 per cent of the families. But in 5.00 per cent of the families' dietary pattern, roots and tubers were absent and 1.50 per cent of the families included them daily in their diet. Roots and tubers were mainly used for the preparation of side dishes.

Table 10 Distribution of families based on the frequency of use of different foods rich in various nutrients (Energy rich foods)

Distribution of families	Cereals	Roots and Tubers					Nuts and oil seeds	Fats and oils	Sugar and jaggery
	1	1	2	3	4	5	1	1	1
Group I	13 (6.50)	0 (0.00)	0 (0.00)	9 (4.50)	3 (1.50)	1 (0.50)	13 (6.50)	13 (6.50)	13 (6.50)
Group II	74 (37.00)	0 (0.00)	11 (5.50)	23 (11.50)	37 (18.50)	3 (1.50)	74 (37.00)	74 (37.00)	74 (37.00)
Group III	105 (52.50)	2 (1.00)	9 (4.50)	78 (39.00)	10 (5.00)	6 (3.00)	105 (52.50)	105 (52.50)	105 (52.50)
Group IV	8 (4.00)	1 (0.50)	1 (0.50)	2 (1.00)	4 (2.00)	0 (0.00)	8 (4.00)	8 (4.00)	8 (4.00)
Total	200 (100.00)	3 (1.50)	21 (10.50)	112 (56.00)	54 (27.00)	10 (5.00)	200 (100.00)	200 (100.00)	200 (100.00)

1 - Daily
2 - More than 3 days in a week
3 - Less than 3 days in a week
4 - Occasionally
5 - Never

Protein rich foods

Distribution of respondents based on their frequency of use of various protein rich foods are presented in Table 11.

Food articles such as pulses, milk, milk products, egg, meat and fish were listed as protein rich foods.

When frequency of consumption of these foods were considered, it was found that many respondents (60.50 per cent) took pulses occasionally while milk was included in the daily diets of all the respondents. Milk was taken along with tea. Milk products were used only occasionally in the meal pattern by most of the respondents (98.50 per cent). Egg was included occasionally by 86.50 per cent of the families and in 13.50 per cent of the families egg was not included. Majority of the respondents (87.50 per cent) took meat occasionally. Fish was included in the daily diets by two per cent of the families for more than three days in a week by 9.00 per cent of the families; for less than three days in a week by 15.00 per cent of the families, and occasionally by 69.00 per cent of the families. In 5.00 per cent of the families fish was absent in their dietaries.

Among the different protein rich foods, milk was found to be popular since all the respondents surveyed were observed to be including this food item in their daily diets.

Table 11 Frequency of use of protein rich foods

Distribution of families	Pulses				Milk	Milk products			Egg		Meat		Fish				
	2	3	4	5	1	3	4	5	4	5	4	5	1	2	3	4	5
Group I	0 (0.00)	4 (2.00)	9 (4.50)	0 (0.00)	13 (6.50)	0 (0.00)	11 (5.50)	2 (1.00)	10 (5.00)	3 (1.50)	9 (4.50)	4 (2.00)	0 (0.00)	0 (0.00)	2 (1.00)	11 (5.50)	0 (0.00)
Group II	5 (2.50)	30 (15.00)	38 (19.00)	1 (0.50)	74 (37.00)	0 (0.00)	74 (37.00)	0 (0.00)	67 (33.50)	7 (3.50)	64 (32.00)	10 (5.00)	0 (0.00)	6 (3.00)	14 (7.00)	52 (26.00)	2 (1.00)
Group III	11 (5.50)	27 (13.50)	67 (33.50)	0 (0.00)	105 (52.50)	1 (0.50)	104 (52.00)	0 (0.00)	91 (45.50)	14 (7.00)	96 (48.00)	9 (4.50)	2 (1.00)	9 (4.50)	14 (7.00)	73 (36.50)	7 (3.50)
Group IV	0 (0.00)	0 (0.00)	7 (3.50)	0 (0.00)	8 (4.00)	0 (0.00)	8 (4.00)	0 (0.00)	5 (2.50)	3 (3.50)	6 (3.00)	2 (1.00)	2 (1.00)	3 (1.50)	0 (0.00)	2 (1.00)	1 (0.50)
Total	16 (8.00)	61 (30.50)	121 (60.50)	1 (0.50)	200 (100.00)	1 (0.50)	197 (98.50)	2 (1.00)	173 (86.50)	27 (13.50)	175 (87.50)	25 (12.50)	4 (2.00)	18 (9.00)	30 (15.00)	138 (69.00)	10 (5.00)

1 - Daily
2 - More than 3 days in a week
3 - Less than 3 days in a week
4 - Occasionally
5 - Never

Group wise distribution revealed that frequency of pulse consumption was more in the families identified in group III followed by group II, group I and group IV.

Egg consumption was poor in many families identified under group IV followed by group I, group III and group II. Similar trend was observed in the frequency of meat consumption as "occasional" or "never" by all the families in group I followed by group IV, group II and group III.

Unlike egg and meat, fish consumption was very frequent, in group I followed by groups II, III and IV. In few families belonging to group III (3.50 per cent), group II (1.00 per cent) and group IV (0.50 per cent) fish was not included in the daily diet.

Mineral/vitamin rich foods

Table 12 depicts the frequency of use of various mineral and vitamin rich foods.

The table showed that many respondents (98.50 per cent) included green leafy vegetables occasionally, other vegetables daily (98.00 per cent) and fruits occasionally (86.00 per cent).

Among families in group I, none of the above food articles were regularly consumed except "other vegetables" (6.00 per cent).

Table 12 Frequency of use of mineral/vitamin rich foods

Distribution of families	Green leafy vegetables		Other vegetables		Fruits		
	4	5	1	2	2	3	4
Group I	11 (5.50)	2 (1.00)	12 (6.00)	1 (0.50)	0 (0.00)	0 (0.00)	13 (6.50)
Group II	74 (37.00)	0 (0.00)	73 (36.50)	1 (0.50)	0 (0.00)	10 (5.00)	64 (32.00)
Group III	104 (52.00)	1 (0.50)	103 (51.50)	2 (1.00)	2 (1.00)	13 (6.50)	90 (45.00)
Group IV	8 (4.00)	0 (0.00)	8 (4.00)	0 (0.00)	0 (0.00)	3 (1.50)	5 (2.50)
Total	197 (98.50)	3 (1.50)	196 (98.00)	4 (2.00)	2 (1.00)	26 (13.00)	172 (86.00)

1 - Daily
2 - More than 3 days in a week
3 - Less than 3 days in a week
4 - Occasionally
5 - Never

Group wise comparison about the frequency of consumption of green leafy vegetables revealed that most of the respondents in group IV included them occasionally. Similar findings were observed among respondents in group II followed by group III and group I.

However a similar comparison about the fruit consumption pattern revealed a different view. Fruits were generally consumed either less than three days [group IV (37.50 per cent) group II (13.50 per cent) and group III (12.40 per cent)] or occasionally [group I (100.00 per cent) followed by group II (86.50 per cent), group III (87.50 per cent) and group IV (62.50 per cent)].

A group wise comparison revealed that irrespective of the group variation, fruits were not an essential item in the daily dietaries since many families in group II and group IV were satisfied with the inclusion of these foods "once in a week" or "occasionally" and in group I only "occasionally".

Other foods

Table 13 gives the distribution of respondents based on the frequency of use of other foods. Under other foods, beverages like tea, coffee and commercially prepared foods like bakery items and other snacks (bought from outside) were included. Beverages were found in the daily dietary pattern of all the families surveyed.

Table 13 Frequency of use of other foods

Distribution of families	Beverages	Commercially prepared foods		
	1	2	3	4
Group I	13 (6.50)	0 (0.00)	1 (0.50)	12 (6.00)
Group II	74 (37.00)	4 (2.00)	8 (4.00)	62 (31.00)
Group III	105 (52.50)	2 (1.00)	1 (0.50)	102 (51.00)
Group IV	8 (4.00)	1 (0.50)	4 (2.00)	3 (1.50)
Total	200 (100.00)	7 (3.50)	14 (7.00)	179 (89.50)

1 - Daily
2 - More than 3 days in a week
3 - Less than 3 days in a week
4 - Occasionally

Commercially prepared foods were not frequently consumed by many families since these foods were found to be used either occasionally (89.50 per cent) or in less than three days in a week (7.00 per cent) or more than three days in a week (3.50 per cent).

A comparison of consumption pattern among the four groups also revealed that these foods were more frequently consumed by the families identified under group IV and group II.

All the respondents were not in the habit of taking either "special foods" or "pica" during the pregnancy period.

Frequency of use of food enhancers favouring iron absorption

Foods such as amaranth, cabbage, chekkurmanis, coriander leaves, curry leaves, drumstick leaves, mint leaves, drumstick, capsicum, bittergourd, cauliflower, clusterbeans, gooseberry, guava and orange were commonly used in Kerala and these foods have been reported to have a role in favouring iron absorption.

Chekkurmanis (1.00 per cent in group III and 0.50 per cent in group IV), mint leaves (1.00 per cent in group III and 0.50 per cent in group IV), capsicum (2.00 per cent in group III and 0.50 pr cent in group IV) and cauliflower (1.50 per cent in group III and 0.50 per cent in group IV) were found to be included by very few respondents identified in economically better off strata (Group III and Group IV).

Among the various food enhancers favouring iron absorption, curry leaf was the only leafy vegetable included daily in the diets of all the respondents surveyed. This food article can be considered either as food enhancers or food inhibitor.

In the respondents identified under group I (5.50 per cent), group II(37.00 per cent), group III (52.00 per cent) and group IV (3.50 per cent), amaranth was found to be included "occasionally".

Cabbage was found to be included "occasionally" by 5.50 per cent (Group I), 37.00 per cent (Group II), 50.50 per cent (Group III) and 4.00 per cent (Group IV) of the respondents.

Out of the 200 respondents surveyed coriander leaves were used 'occasionally' by 86.50 per cent. Cluster beans was consumed "less than three days in a week" by 0.50 per cent (Group III) of families and majority of the respondents (99.50 per cent) included this in the dietary regimen "occasionally". Goose berry/amla was included "occasionally" by 99.50 per cent of the respondents.

Drumstick was consumed "more than three days in a week" by 9.00 per cent of the respondents. Eighty nine (88.50) per cent of the respondents consumed drumstick "less than three days in a week" and 2.50 per cent of the respondents included this "occasionally".

Bittergourd was used occasionally by 94.00 per cent of the respondents while 1.00 per cent of the respondents included it "less than three days in a week".

Drumstick leaves and fruits like guava and orange were used "occasionally" by the respondents.

Frequency of use of food inhibitors hindering iron absorption

Food inhibitors are identified more in cereal grains and products, pulses and legumes, roots and tubers, green leafy vegetables, other vegetables, condiments and spices.

Foods like rice, chillies (dry), coriander, fenugreek seeds, cumin seeds and turmeric were used by all the respondents daily. Wheat (0.50 per cent) and black gram (3.50 per cent) were included "more than three days in a week".

The foods which were consumed in "less than three days in a week" includes wheat (4.00 per cent), black gram (81.00 per cent), red gram (7.00 per cent) and potato (17.50 per cent).

Most of the food items hindering iron absorption were either used occasionally or were never used. Those foods used "occasionally" were barley (2.00 per cent), ragi (4.00 per cent), wheat (95.50 per cent), vermicelli (100.00 per cent), bengal gram (97.00 per cent), black gram (15.50 per cent), green gram (100.00 per cent), peas (86.00 per cent), red gram (93.00 per cent), potato (69.50 per cent), tapioca chips (86.00), yam (91.00 per cent) and green mango (1.00 per cent).

4.2.3 Food restriction pattern

Table 14 gives the distribution of women based on the habit of restricting food during pregnancy.

Table 14 Distribution of respondents based on the habit of restricting food during pregnancy

Foods restricted	Distribution of respondents				Total
	Group I	Group II	Group III	Group IV	
Egg	3 (1.50)	7 (3.50)	14 (7.00)	3 (1.50)	27 (13.50)
Pineapple	13 (6.50)	74 (37.00)	105 (52.50)	8 (4.00)	200 (100.00)
Papaya	13 (6.50)	74 (37.00)	104 (52.00)	6 (3.00)	197 (98.50)
Tapioca^	9 4.50)	61 (30.50)	83 (41.50)	2 (1.00)	155 (77.50)
Spices*	0 (0.00)	8 (4.00)	50 (25.00)	6 (3.00)	64 (32.00)
Salt*	0 (0.00)	0 (0.00)	50 (25.00)	6 (3.00)	56 (28.00)

^ - in the last trimester
* - in lesser amounts

Use of foods such as egg, pineapple, papaya and tapioca were found to be restricted in the diets of pregnant women.

Egg was restricted by 13.50 per cent of the respondents, (1.50 per cent in group I, 3.50 per cent in group II, 7.00 per cent in group III and 1.50 per cent in group IV). Many respondents were observed to avoid papaya (98.50 per cent) and pineapple (100 per cent) while tapioca was excluded by 77.50 per cent of the respondents (4.50 per cent in group I, 30.50 per cent in group II, 41.50 per cent in group III and 1.00 per cent in group IV) only during the last trimester of pregnancy.

Spices (32.00 per cent) and salt (28.00 per cent) were also found to be used in lesser amounts.

4.2.4 Food consumption pattern

Daily food consumption pattern of the 200 women were collected through the oral questionnaire diet survey method (24 hour recall) and the data are presented in Table 15. A set of 'standardised cups', suited to local conditions were used. The member of the household who cooks and serves food to the family members were asked about the types of food preparations made at breakfast, lunch, afternoon, tea time and dinner. An account of the raw ingredients used for each of the preparations was obtained. Information on the total cooked volume/weight of each preparation was noted in terms of standardised cup(s). The intake of each food item (preparation) by the specific individual in the family (pregnant women) was assessed using the cups. The cups were used mainly to aid the respondents to recall the quantities prepared and fed to the individual members.

Many respondents (88.50 per cent) had the habit of taking hot beverages like tea or black coffee early in the morning.

Table 15   Distribution of respondents based on their daily meal pattern (Percentage)

Meal	Type of food	Distribution of respondents				Total
		Group I	Group II	Group III	Group IV	
Early morning	(i) Not taking any food	1 (0.50)	8 (4.00)	13 (6.50)	0 (0.00)	22 (11.00)
	(ii) Hot beverage (Tea/Coffee)	12 (6.00)	66 (33.00)	92 (46.00)	7 (3.50)	177 (88.50)
	(iii) Milk	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.50)	1 (0.50)
Breakfast	(i) Cereals + Coconut + Fruit	3 (1.50)	1 (0.50)	3 (1.50)	0 (0.00)	7 (3.50)
	(ii) Cereals + Pulse + Coconut	0 (0.00)	28 (14.00)	45 (22.50)	4 (2.00)	77 (38.50)
	(iii) Cereals + Pulse + Vegetables	0 (0.00)	23 (11.50)	11 (5.50)	2 (1.00)	36 (18.00)
	(iv) Cereals + Coconut + Tea/Coffee	9 (4.50)	8 (4.00)	24 (12.00)	1 (0.50)	42 (21.00)
	(v) Cereals + Pulse + Coconut + Fruit	0 (0.00)	5 (2.50)	6 (3.00)	0 (0.00)	11 (5.50)
	(vi) Cereals + Coconut + Fruit + Tea/Coffee	0 (0.00)	0 (0.00)	5 (2.50)	0 (0.00)	5 (2.50)
	(vii) Cereals + Pulse + Coconut + Tea/Coffee	1 (0.50)	7 (3.50)	8 (4.00)	1 (0.50)	17 (8.50)
	(viii) Cereals + Pulse + Vegetables + Tea/Coffee	0 (0.00)	2 (1.00)	0 (0.00)	0 (0.00)	2 (1.00)
	(ix) Cereals + Pulse + Coconut + Fruit + Tea/Coffee	0 (0.00)	0 (0.00)	3 (1.50)	0 (0.00)	3 (1.50)

Table 15 continued

Meal	Type of food	Distribution of respondents				Total
		Group I	Group II	Group III	Group IV	
Mid morning	(i) Not taking any food	13 (6.50)	72 (36.00)	104 (52.00)	6 (3.00)	195 (97.50)
	(ii) Fruit	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.50)	1 (0.50)
	(iii) Commercially prepared foods	0 (0.00)	2 (1.00)	1 (0.50)	0 (0.00)	3 (1.50)
	(iv) Milk + Fruit	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.50)	1 (0.50)
Lunch	(i) Rice + Vegetables + Coconut	10 (5.00)	51 (25.50)	58 (29.00)	1 (0.50)	120 (60.00)
	(ii) Rice + Fish + Tapioca + Coconut	1 (0.50)	0 (0.00)	4 (2.00)	2 (1.00)	7 (3.50)
	(iii) Rice + Fish + Vegetables + Coconut	2 (1.00)	23 (11.50)	42 (21.00)	4 (2.00)	71 (35.50)
	(iv) Rice + Fish + Vegetables + Milk (Curd)+Coconut	0 (0.00)	0 (0.00)	1 (0.50)	1 (0.50)	2 (1.00)
Evening	(i) Not taking any food	0 (0.00)	1 (0.50)	2 (1.00)	0 (0.00)	3 (1.50)
	(ii) Hot beverage	1 (0.50)	0 (0.00)	5 (2.50)	0 (0.00)	6 (3.00)
	(iii) Hot beverage + Commercially prepared foods	0 (0.00)	3 (1.50)	11 (5.50)	6 (3.00)	20 (10.00)
	(iv) Hot beverage + Cereal + Fruit	0 (0.00)	6 (3.00)	18 (9.00)	1 (0.50)	23 (11.50)

Table 15 continued

Meal	Type of food	Distribution of respondents				Total
		Group I	Group II	Group III	Group IV	
	(v) Hot beverage + Cereal + Pulse	4 (2.00)	34 (17.00)	39 (19.50)	1 (0.50)	78 (39.00)
	(vi) Hot beverage + Cereal + Coconut + Sugar	8 (4.00)	30 (15.00)	28 (14.00)	0 (0.00)	66 (33.00)
	(vii) Hot beverage + Cereal + Coconut + Jaggery	0 (0.00)	0 (0.00)	2 (1.00)	0 (0.00)	2 (1.00)
Dinner	(i) Rice + Vegetables + Coconut	10 (5.00)	51 (25.50)	59 (29.50)	1 (0.50)	121 (60.50)
	(ii) Rice + Fish + Tapioca + Coconut	1 (0.50)	0 (0.00)	3 (1.50)	2 (1.00)	6 (3.00)
	(iii) Rice + Fish + Vegetables + Coconut	2 (1.00)	23 (11.50)	42 (21.00)	4 (2.00)	71 (35.50)
	(iv) Rice + Fish + Vegetables + Milk (Curd)+Coconut	0 (0.00)	0 (0.00)	1 (0.50)	1 (0.50)	2 (1.00)
Bed time	(i) Not taking any food	13 (6.50)	74 (37.00)	105 (52.50)	7 (3.50)	199 (99.50)
	(ii) Milk	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.50)	1 (0.50)
Total		13 (6.50)	74 (37.00)	105 (52.50)	8 (4.00)	200 (100.00)

Breakfast was a meal taken by all the respondents. Generally three to six food articles were included in the breakfast. The major food combination for breakfast was cereal pulse combination along with either a coconut based side dish (38.50 per cent) or vegetable based side dish (18.00 per cent). About 34.50 per cent of the respondents consumed tea or coffee also along with this breakfast.

Majority of the respondents were not in the habit of taking any food at mid morning (97.50 per cent) and at bed time (99.50 per cent). Similarly none of the respondents were in the habit of taking any beverages after evening tea and before dinner.

Rice along with various vegetable curries (vegetables + coconut) was the common menu for lunch (60.00 per cent) and dinner (60.50 per cent). Fish was included for lunch by 40.00 per cent of the respondents and 39.50 per cent consumed fish at dinner. Rice with fish curry (fish + coconut) and tapioca were included in lunch and dinner by 3.50 per cent of the respondents. Coconut was liberally used by all the respondents in the main meals like lunch and dinner.

Evening tea or coffee was essential for 98.50 per cent of the respondents.

Distribution of respondents based on the inclusion of various type of foods in the daily diet are given in Table 16.

Table 16 Distribution of respondents based on the inclusion of various types of foods in daily diet

Food combination	Distribution of respondents				Total
	Group I	Group II	Group III	Group IV	
Pulse + Vegetables	7 (3.50)	45 (22.50)	41 (20.50)	1 (0.50)	94 (47.00)
Pulse + Fish	1 (0.50)	4 (2.00)	13 (6.50	3 (1.50)	21 (10.50)
Pulse + Fruit	1 (0.50)	2 (1.00)	0 (0.00)	0 (0.00)	3 (1.50)
Vegetables + Fish	2 (1.00)	19 (9.50)	33 (16.50)	3 (1.50)	57 (28.50)
Vegetables + Fruit	2 (1.00)	4 (2.00)	18 (9.00)	1 (0.50)	25 (12.50)
Total	13 (6.50)	74 (37.00)	105 (52.50)	8 (4.00)	200 (100.00)

Various types of foods included were cereals, pulses, vegetables, meat or fish, nuts and oil seeds, fats and oils spices and condiments, milk and milk products and roots and tubers.

It was found that all the respondents included cereals, nuts and oil seeds (coconut), fats and oils, spices and condiments, milk and milk products and roots and tubers in their daily diets. The data revealed that forty seven per cent of the respondents included pulses and vegetables along with other food groups. Pulses and fish were additionally added by 10.50 per cent of the respondents and 1.50 per cent consumed fruit along with pulse. Twenty nine (28.50) per cent took fish along with vegetables and 12.50 per cent consumed fruit along with vegetables.

The quantity of different food items consumed, as assessed by recall method were compared with respective RDA suggested by ICMR (1998) and the details presented in Table 17.

Table 17 Distribution of respondents based on their mean food intake

Food item	Food intake (mean)	RDA	Variation	Per cent diet adequacy
Cereals	300.89	350	-49.11	85.97
Pulses	32.60	60	-27.40	54.33
Green leafy vegetables	6.25	150	-143.75	4.17
Roots and Tubers	43.53	50	-6.47	87.06
Other vegetables	63.40	75	-11.60	84.53
Nuts and Oilseeds	39.73	$	-	-
Fruits	20.81	30	-9.19	69.37
Fish/Meat/Egg	31.50	$	-	-
Fats and Oils	15.20	30	-14.80	50.67
Milk and Milk products	118.35	325	-206.65	36.42
Sugar and Jaggery	24.50	30	-5.50	81.67

$ - RDA not available

The table revealed that the diet consumed by the pregnant women was not balanced and did not meet RDA for cereals (85.97 per cent), roots and tubers (87.06 per cent), other vegetables (84.53 per cent) and sugars and jaggery (81.67 per cent). The intake of pulses, fruits, fats and oils and milk and milk products were also insufficient and the consumption rate was below 70.00 per cent of the RDA. The consumption of green leafy vegetables were highly inadequate since only 4.17 per cent of RDA was met.

The nutrients present in the food items were calculated using food composition tables (Gopalan *et al.*, 1996) and results are presented in Table 18. The mean intake of calories (2032.77 kcals), protein (45.09g), calcium (451.94 mg), iron (19.11 mg), β-carotene (430.78 mg) and riboflavin (0.73 mg) were below the RDA specified. Intake of other nutrients like fat, thiamine, niacin and vitamin C were higher than the prescribed RDA.

Correlation studies were carried out among the various nutrients present in the diets of the respondents and the matrix presented in Appendix IX.

The various nutrients had a very high significant relationship among themselves.

Table 18 Distribution of respondents based on their mean nutrient intake

Nutrient	Nutrient intake (mean)	RDA	Variation	Per cent diet adequacy
Calorie (Kcal)	2032.77	2175	-142.23	93.46
Protein (g)	45.09	65	-19.91	69.37
Fat (g)	36.84	30	+6.84	122.80
Calcium (mg)	451.94	1000	-548.06	45.19
Iron (mg)	19.11	38	-18.89	50.29
B-Carotene (mg)	430.78	600	-169.22	71.80
Thiamine (mg)	1.26	1.1	+0.16	114.55
Niacin (mg)	19.10	14	+5.10	136.43
Riboflavin (mg)	0.73	1.3	-0.57	56.15
Vitamin C (mg)	49.61	40	+9.61	124.03
Free folic acid (µg)	62.48	$	-	-
Total folic acid (µg)	112.87	400	-287.13	28.22
Vitamin B_{12} (µg)	0.61	1	-0.84	16.00

$ - RDA not available

Certain constituents in foods like oxalic acid, phytin and fibre are known to have an inhibitory role in the absorption of iron and data presented in Table 19. Mean availability of constituents like oxalic acid (132.61 mg), phytin phosphorous (568.53 mg) and total dietary fibre (5.74 g: intake/MJ) were found to be sufficiently higher than their desirable limits.

Table 19 Concentration of iron inhibitors in the daily diets of the pregnant women

Nutrients	Nutrient intake (Mean)
Oxalic acid (mg)	132.61
Phytin P* (mg)	568.53
Phytin P* as per cent of total P*	312.66
Total dietary fibre (g:intake/MJ)	5.74

* - Phosphorous

Among these women, pica intake was also found to be absent.

4.3 Nutritional indicators

Few variables related to the marital status of the respondents, energy expenditure pattern, haemoglobin level and certain clinical symptoms were identified as nutritional indicators.

4.3.1 Marital status of the respondents

Table 20 reveals some of the characteristics of the respondents like age at menarche, age at marriage and their marital status.

From the table it is clear that only three per cent of the respondents reported their menarche at the age of 11 or

Table 20 Distribution of respondents based on their marital status

Distribution of families	Age at menarche						Age at marriage				Marital status (yr)		Total
	≤11	12	13	14	15	16	≤15	16–18	19–21	22–25	1	2	
Group I	0 (0.00)	1 (0.50)	7 (3.50)	3 (1.50)	2 (1.00)	0 (0.00)	0 (0.00)	4 (2.00)	3 (1.50)	6 (3.00)	13 (6.50)	0 (0.00)	13 (6.50)
Group II	1 (0.50)	6 (3.00)	23 (11.50)	24 (12.00)	13 (6.50)	7 (3.50)	1 (0.50)	7 (3.50)	36 (18.00)	30 (15.00)	69 (34.50)	5 (2.50)	74 (37.00)
Group III	4 (2.00)	17 (8.50)	32 (16.00)	27 (13.50)	19 (9.50)	6 (3.00)	0 (0.00)	24 (12.00)	39 (19.50)	41 (20.50)	99 (49.50)	6 (3.00)	105 (52.50)
Group IV	1 (0.50)	0 (0.00)	3 (1.50)	1 (0.50)	3 (1.50)	0 (0.00)	0 (0.00)	1 (0.50)	0 (0.00)	7 (3.50)	7 (3.50)	1 (0.50)	8 (4.00)
Total	6 (3.00)	24 (12.00)	65 (32.50)	55 (27.50)	37 (18.50)	13 (6.50)	1 (0.50)	36 (18.00)	70 (35.00)	84 (42.00)	188 (94.00)	12 (6.00)	200 (100.00)

less, while 12.00 per cent reached menarche at the age of 12, 32.50 per cent at 13, 27.50 per cent at 14, 18.50 per cent at 15 and 6.50 per cent at 16.

Most of the respondents (42.00 per cent) got married between the age of 22 to 25. Thirty five per cent of the respondents married between the age group 19 to 21; 18.00 per cent got married between the age group 16 to 18 and 0.50 per cent of the respondents got married when they were 15 years old.

Group wise classification revealed that 87.50 per cent of the respondents married between the age group 22 to 25 in group IV.

The data also revealed that ninety four per cent of the respondents conceived within one year after their marriage and 6.00 per cent of the respondents conceived only after one year of their married life.

4.3.2 Daily time utilization pattern of the respondents

A major determinant influencing the nutritional status of women is the physical exertion they undergo. This is indicated in the time allocated for various activities. Hence information related to the time utilization pattern of the respondents were collected and are presented in Table 21.

Table 21 Distribution of respondents based on their time utilization pattern

Time (hr)	Distribution of respondents		
	Household activities	Personal need and leisure	Sleep
1	5 (2.50)	-	-
2	59 (29.50)	-	-
3	99 (49.50)	-	-
4	28 (14.00)	-	-
5	9 (4.50)	-	-
6	-	1 (0.50)	-
7	-	9 (4.50)	11 (5.50)
8	-	86 (43.00)	43 (21.50)
9	-	73 (36.50)	91 (45.50)
10	-	19 (9.50)	52 (26.00)
11	-	12 (6.00)	3 (1.50)
Total	200 (100.00)	200 (100.00)	200 (100.00)

The table revealed that many respondents (49.50 per cent) on an average spent about three hours for household activities while 43.00 per cent spent eight hours for their personal activities and leisure and 45.50 per cent spent around nine hours for sleep.

It was seen that 29.50 per cent of the respondents spent two hours for fulfilling daily household routine; 14.00 per cent spent four hours 4.50 per cent spent five hours while 2.50 per cent spent only one hour for the same responsibilities.

It was also found that 36.50 per cent spent nine hours attending to their personal needs and leisure activities; ten hours were spent for the same work by 9.50 per cent of the respondents while eleven hours were spent by 6.00 per cent of the respondents while seven hours by 4.50 per cent and only six hours by 0.50 per cent of the respondents were observed to be spent for their personal needs and leisure.

Time taken for sleep was ten hours by 26.00 per cent of the respondents, eight hours by 21.50 per cent, seven hours by 5.50 per cent while 1.50 per cent took eleven hours for sleep. Many respondents had the habit of taking a short sleep after their lunch.

4.3.3 Energy expenditure pattern of the respondents

Energy expenditure by an individual will be influenced by the type of activity and time spent for each activity. Since energy expenditure of the women will influence their nutritional status, details pertaining to the energy expended for different activities in a day were ascertained.

Total energy expenditure of the respondents for a day for fulfilling all their duties was calculated and is given in Table 22. Energy expenditure was calculated by prediction equation into BMR factor for different activities based on their time utilisation pattern (ICMR, 1998). It was observed that 59.50 per cent of the respondents spent 1401 to 1600 kilo calories per day for their daily activities and that only 2.00 per cent of the respondents spent more than 1800 kilo calories per day for their daily activities. Twenty eight per cent of the respondents spent 1201 to 1400 kilo calories, 9.00 per cent spent 1601 to 1800 kilo calories while only $\leq$1200 kilo calories were spent by 1.50 per cent of the respondents.

Group wise classification revealed that the energy expenditure was in the range of 1201 to 1600 kilo calories for many respondents in group II (91.89 per cent), group IV (87.50 per cent), group III (84.76 per cent) and group I (84.62 per cent). Many respondents in group I (15.38 per cent), group III (13.33 per cent), group IV (12.50 per cent) and group II

(6.76 per cent) spent more than 1600 kilo calories while 1.35 per cent in group II and 1.90 per cent in group 3 spent ≤1200 kilo calories every day, to do various domestic activities.

A comparison of daily energy consumption and daily energy expenditure by individual respondents revealed that only one per cent was in negative balance.

Table 22 Distribution of respondents based on the daily energy expenditure pattern

Distribution of families	Energy expenditure (Kcals)					Total
	≤1200	1201-1400	1401-1600	1601-1800	≥1801	
Group I	0 (0.00)	4 (2.00)	7 (3.50)	1 (0.50)	1 (0.50)	13 (6.50)
Group II	1 (0.50)	21 (10.50)	47 (23.50)	4 (2.00)	1 (0.50)	74 (37.00)
Group III	2 (1.00)	31 (15.50)	58 (29.00)	12 (6.00)	2 (1.00)	105 (52.50)
Group IV	0 (0.00)	0 (0.00)	7 (3.50)	1 (0.50)	0 (0.00)	8 (4.00)
Total	3 (1.50)	56 (28.00)	119 (59.50)	18 (9.00)	4 (2.00)	200 (100.00)

4.3.4 Haemoglobin level of the respondents

Table 23 (Figure 2) gives the distribution of the respondents based on the level of the haemoglobin (Hb) in blood. It is clear from the table that 1.50 per cent of the respondents had a Hb ≤ level of 9.0 g%. There was wide

Table 23 Distribution of respondents based on the level of Haemoglobin (Hb) in blood

Distribution of families	Haemoglobin level (g%)						Total
	≤ 9.0	9.1-9.5	9.6-10.0	10.1-10.5	10.6-11.0	11.1-11.5	
Group I	1 (0.50)	1 (0.50)	0 (0.00)	5 (2.50)	5 (2.50)	1 (0.50)	13 (6.50)
Group II	0 (0.00)	5 (2.50)	12 (6.00)	29 (14.50)	22 (11.00)	6 (3.00)	74 (37.00)
Group III	2 (1.00)	0 (0.00)	10 (5.00)	49 (24.50)	31 (15.50)	13 (6.50)	105 (52.50)
Group IV	0 (0.00)	0 (0.00)	1 (0.50)	3 (1.50)	3 (1.50)	1 (0.50)	8 (4.00)
Total	3 (1.50)	6 (3.00)	23 (11.50)	86 (43.00)	61 (30.50)	21 (10.50)	200 (100.00)

Fig. 2 **Distribution of respondents based on the level of Haemoglobin (g%) in blood**

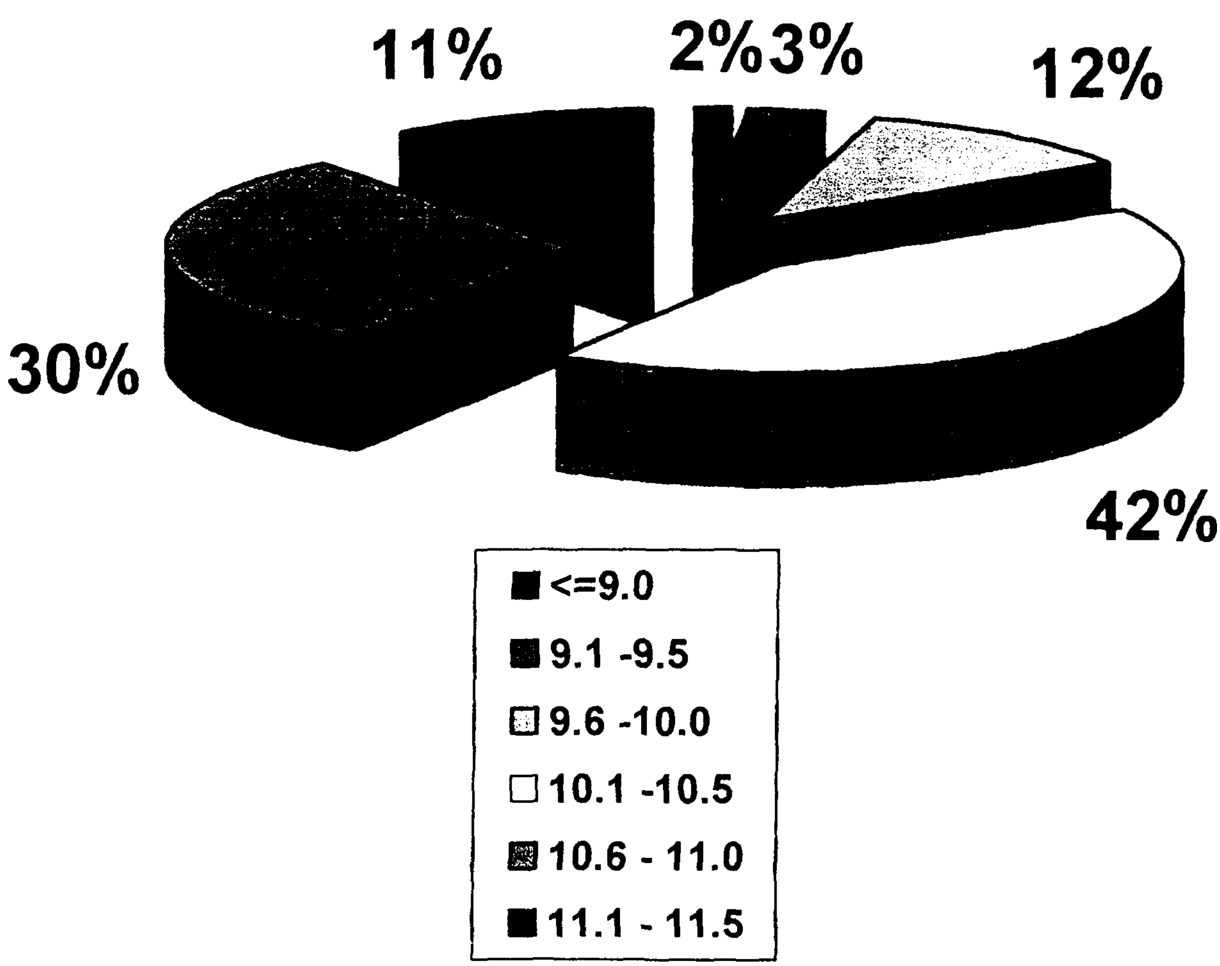


Table 24 Distribution of respondents based on clinical symptoms

Clinical Symptoms	No. of respondents
No symptoms	28 (14.00)
P	6 (3.00)
F	22 (11.00)
B	3 (1.50)
G	13 (6.50)
P + F	54 (27.00)
P + B	28 (14.00)
P + G	31 (15.50)
P + F + G	9 (4.50)
P + F + B	6 (3.00)
Total	200 (100.00)

P - Pallor of the skin

F - General Fatigue

B - Breathlessness on exertion

G - Giddiness

Clinical examination of respondent at Women
and Children Hospital, Thycaud

fatigue at times and three per cent reported in addition to a pallor, fatigue and breathlessness on exertion.

However 14.00 per cent of the respondents showed no clinical symptoms of anaemia.

4.4 Anthropometric measurements

Table 25 shows the anthropometric measurements recorded in the 200 women surveyed. Age wise classification revealed that many respondents (44.50 per cent) were in the age group between 22-25.

Height of the respondents were in the range of 145 to 150 cm (52.00 per cent) and 150 to 155 cm (38.00 per cent). Weight gain was calculated from the initial and final weight of the pregnant women during the gestation period.

Out of the 200 respondents surveyed, 39.50 per cent had an initial weight in the range of 40 to 45 kg and 34.50 per cent in the range of 45-50 kg. Final weight of the respondents on completion of the gestation period revealed that 42.00 per cent had 50 to 55 kg and 35.50 per cent had 55 to 65 kg. Weight gain was found to be unsatisfactory for majority of the women. None of the respondents had a history of miscarriage.

Table 25 Distribution of respondents based on selected anthropometric measurements and birth weight of newborn

Variables		Group I		Group II		Group III		Group IV	
		No.of women	Mean value	No.of women	Mean value	No.of women	Mean value	No.of women	Mean value
Age (Year)	≤18	1 (0.50)	18.00	6 (3.00)	17.50	8 (4.00)	18.00	0 (0.00)	0.00
	18 - 20	6 (3.00)	19.50	17 (8.50)	19.71	25 (12.50)	19.40	0 (0.00)	0.00
	20 - 22	4 (2.00)	21.25	25 (12.50)	21.76	19 (9.50)	21.53	0 (0.00)	0.00
	22 - 25	10 (5.00)	24.00	39 (19.50)	23.72	39 (19.50)	23.74	1 (0.50)	24.00
Height (cm)	≤145	2 (1.00)	143.50	3 (1.50)	144.33	2 (1.00)	144.50	0 (0.00)	0.00
	145 - 150	9 (4.50)	148.22	49 (24.50)	148.47	45 (22.50)	148.53	1 (0.50)	149.00
	150 - 155	9 (4.50)	152.00	29 (14.50)	152.79	39 (19.50)	152.82	0 (0.00)	0.00
	155 - 160	1 (0.50)	156.00	4 (2.00)	158.00	5 (2.00)	157.80	0 (0.00)	0.00
	>160	0 (0.00)	0.00	2 (1.00)	161.50	0 (0.00)	0.00	0 (0.00)	0.00

(Distribution of respondents)

Table 25 contd.

Variables		Distribution of respondents							
		Group I		Group II		Group III		Group IV	
		No.of women	Mean value	No.of women	Mean value	No.of women	Mean value	No.of women	Mean value
Initial weight (kg)	≤40	5 (2.50)	39.60	15 (7.50)	39.27	15 (7.50)	39.40	0 (0.00)	0.00
	40 - 45	8 (4.00)	43.00	36 (18.00)	43.14	33 (16.50)	43.21	0 (0.00)	0.00
	45 - 50	7 (3.50)	48.57	27 (13.50)	47.89	34 (17.00)	47.85	1 (0.50)	48.00
	50 - 55	1 (0.50)	52.00	7 (3.50)	51.71	9 (4.50)	52.33	0 (0.00)	0.00
	> 55	0 (0.00)	0.00	2 (1.00)	59.00	0 (0.00)	0.00	0 (0.00)	0.00
Final weight (kg)	≤45	0 (0.00)	0.00	1 (0.50)	45.00	1 (0.50)	45.00	0 (0.00)	0.00
	45 - 50	6 (3.00)	48.00	16 (8.00)	47.81	18 (9.00)	48.22	0 (0.00)	0.00
	50 - 55	7 (3.50)	53.00	42 (21.00)	52.93	35 (17.50)	52.94	0 (0.00)	0.00
	55 - 65	8 (4.00)	58.63	26 (13.00)	57.81	37 (18.50)	58.35	1 (0.50)	58.00
	> 65	0 (0.00)	0.00	2 (1.00)	71.00	0 (0.00)	0.00	0 (0.00)	0.00

Table 25 continued

Variables		Distribution of respondents							
		Group I		Group II		Group III		Group IV	
		No.of women	Mean value	No.of women	Mean value	No.of women	Mean value	No.of women	Mean value
Weight gain (kg)	≤8	7 (3.50)	7.71	33 (16.50)	7.58	30 (15.00)	7.33	0 (0.00)	0.00
	9 - 10	6 (3.00)	9.33	43 (21.50)	9.28	47 (23.50)	9.43	1 (0.50)	10.00
	≥11	5 (2.50)	11.80	14 (7.00)	11.36	14 (7.00)	11.07	0 (0.00)	0.00
Skin-fold thick-ness	≤18.1	7 (3.50)	16.43	25 (12.50)	17.04	27 (13.50)	16.96	0 (0.00)	0.00
	18.2 - 20	3 (1.50)	20.00	23 (11.50)	19.52	23 (11.50)	19.43	0 (0.00)	0.00
	20.1 - 22	5 (2.50)	21.20	17 (8.50)	21.71	23 (11.50)	21.48	0 (0.00)	0.00
	22.1 - 24	5 (2.50)	23.40	16 (8.00)	23.50	15 (7.50)	23.20	1 (0.50)	24.00
	24.1 - 25.1	0 (0.00)	0.00	4 (2.00)	25.00	2 (1.00)	25.00	0 (0.00)	0.00
	> 25.1	1 (0.50)	26.00	2 (1.00)	26.50	1 (0.50)	26.00	0 (0.00)	0.00

Table 25 contd.

Variables		Distribution of respondents							
		Group I		Group II		Group III		Group IV	
		No.of women	Mean value	No.of women	Mean value	No.of women	Mean value	No.of women	Mean value
Birth weight of newborn (kg)	≤2.35	0 (0.00)	0.00	8 (4.00)	2.17	4 (2.00)	2.19	0 (0.00)	0.00
	2.36 - 2.60	6 (3.00)	2.48	15 (7.50)	2.50	18 (9.00)	2.48	0 (0.00)	0.00
	2.61 - 2.85	5 (2.50)	2.72	23 (11.50)	2.71	24 (12.00)	2.71	0 (0.00)	0.00
	2.86 - 3.10	3 (1.50)	3.00	19 (9.50)	2.98	18 (9.00)	2.98	0 (0.00)	0.00
	> 3.10	7 (3.50)	3.37	22 (11.00)	3.33	27 (13.50)	3.31	1 (0.50)	3.25

Anthropometric measurement


ALKIN

Skinfold thickness measured using skinfold calipers is also presented in Table 25. The results showed that 59.00 per cent of the respondents had a skinfold thickness less than or equal to 18.10 mm while 49.00 per cent between 18.20 - 20.00 mm and 45.00 per cent in the range of 20.10 - 22.00 mm. Only 2.00 per cent had a skinfold thickness greater than 25.10 mm.

The table also revealed that 25.50 per cent of the respondents had babies weighing 2.60 kg or less. However 28.50 per cent of the respondents delivered babies weighing greater than 3.10 kg and 26.00 per cent had babies weighing 2.61 - 2.85 kg.

A positive association of PQLI with initial BMI ($r=0.1975^{**}$), initial WHRI ($r=0.1975^{**}$), final BMI ($r=0.1924^{**}$), and final WHRI ($r = 0.1923^{**}$) was observed (Appendix X).

Based on the anthropometric measurements recorded, several indices like Body Mass Index (BMI), Weight Height Ratio Index (WHRI), Weight Height Product Index (WHPI) and Broka's Index (BI) were calculated for all the 200 pregnant women. The results are presented in Table 26.

The table revealed that in all the groups there was gradual increase in the BMI from 18 to 25 and above 25. Many of the respondents (79.44 per cent) had a BMI above 25.00.

Table 26 Distribution of respondents based on selected anthropometric indices

Indices		Group I No.of women	Group I Mean value	Group II No.of women	Group II Mean value	Group III No.of women	Group III Mean value	Group IV No.of women	Group IV Mean value
BMI	≤18	1 (0.50)	17.53	0 (0.00)	0.00	1 (0.50)	17.91	0 (0.00)	0.00
	18.1 - 20	2 (1.00)	19.43	4 (2.00)	19.37	3 (1.50)	19.32	0 (0.00)	0.00
	20.1 - 22	5 (2.50)	21.10	11 (5.50)	21.47	13 (6.50)	21.37	0 (0.00)	0.00
	22.1 - 24	3 (1.50)	23.22	24 (12.00)	23.21	24 (12.00)	23.16	1 (0.50)	22.10
	24.1 - 25	3 (1.50)	24.50	13 (6.50)	24.52	8 (4.00)	24.61	0 (0.00)	0.00
	> 25	7 (3.50)	26.30	35 (17.50)	26.34	42 (21.00)	26.80	0 (0.00)	0.00
WHRI	≤ 0.180	1 (0.50)	0.175	0 (0.00)	0.00	1 (0.50)	0.179	0 (0.00)	0.00
	0.180 - 0.219	6 (3.00)	0.204	15 (7.50)	0.209	14 (7.00)	0.208	0 (0.00)	0.00
	0.220 - 0.239	4 (2.00)	0.229	21 (10.50)	0.231	24 (12.00)	0.230	1 (0.50)	0.221
	0.240 - 0.259	4 (2.00)	0.247	31 (15.50)	0.249	21 (10.50)	0.250	0 (0.00)	0.00
	0.260 - 0.279	6 (3.00)	0.265	17 (8.50)	0.267	23 (11.50)	0.266	0 (0.00)	0.00
	≥ 0.280	0 (0.00)	0.00	3 (1.50)	0.289	8 (4.00)	0.291	0 (0.00)	0.00

Table 26 Continued

Indices		Group I		Group II		Group III		Group IV	
		No.of women	Mean value	No.of women	Mean value	No.of women	Mean value	No.of women	Mean value
WHPI	≤100	1 (0.50)	96.77	2 (1.00)	97.73	2 (1.00)	99.41	0 (0.00)	0.00
	101 - 110.9	4 (2.00)	105.58	13 (6.50)	104.23	16 (8.00)	105.92	0 (0.00)	0.00
	111 - 120.9	6 (3.00)	113.98	30 (15.00)	114.67	25 (12.50)	115.05	0 (0.00)	0.00
	121 - 130.9	5 (2.50)	125.08	27 (13.50)	124.34	27 (13.50)	125.16	1 (0.50)	128.03
	131 - 140.9	5 (2.50)	135.35	12 (6.00)	134.34	16 (8.00)	134.04	0 (0.00)	0.00
	141 - 150.9	0 (0.00)	0.00	1 (0.50)	146.96	5 (2.50)	144.04	0 (0.00)	0.00
	≥ 160	0 (0.00)	0.00	2 (1.00)	169.38	0 (0.00)	0.00	0 (0.00)	0.00
Broka's index	≤100	4 (2.00)	97.05	17 (8.50)	97.05	14 (7.00)	96.04	0 (0.00)	0.00
	101 - 110	10 (5.00)	106.16	45 (22.50)	105.84	51 (25.50)	105.70	0 (0.00)	0.00
	111 - 120	6 (3.00)	115.20	22 (11.00)	113.07	25 (12.50)	113.67	1 (0.50)	118.37
	>120	1 (0.50)	128.57	3 (1.50)	122.21	1 (0.50)	124.49	0 (0.00)	0.00

WHRI was found to be in the range of 0.240 to 0.259 in 28.00 per cent of the respondents while a lower range in the index, viz., 0.220 - 0.239 was observed among 25.00 per cent and 0.260 - 0.279 among 23.00 per cent.

Many of the respondents (30.50 per cent) had a WHPI. in the range of 111.00 - 120.90 and 30.00 per cent fell in the range of 121.00 - 130.90. Among the remaining respondents (16.50 per cent) the WHPI were observed to be in the range of 101.00 - 110.90 and 131.00 -140.90.

Out of the 200 respondents, 53.00 per cent had a Broka's Index in the range of 101-110; 27.00 per cent were in the range between 111 - 120; 17.50 per cent had an index less than 100 and the remaining 2.50 per cent had an index greater than 120.

Variation in the anthropometric measurements and Nutritional Status Index (NSI) according to the differences in PQLI and haemoglobin level of the respondents are presented in Table 27.

The table showed that the mean values of NSI and weight gain increased with the increase in the haemoglobin level, age and socio-economic status. Variation in superscripts between mean values by haemoglobin levels/ages and PQLI were found to be significant.

Table 27 Mean values of anthropometric measurements/indices by socio-economic status and haemoglobin level

PQLI	Age (yrs)	Hb level (g%)	Sample size	Height (cm)	Initial weight (kg)	Final weight (kg)	Initial BMI	Final BMI	Initial WHRI	Final WHRI	Initial WHPI	Final WHPI	Initial BI	Final BI	NSI	Weight gain (kg)
P1 ≤20	≤20	A : <11	26	149.96	44.35	53.04	20.18	23.96	0.202	0.240	98.64	117.10	88.72	105.40	66.47^{dfe}	8.69
		B : >11	4	148.50	42.75	53.25	18.26	22.74	0.183	0.228	94.07	117.13	88.28	110.11	70.08^{abc}	10.50
P1 >20	>20	A : <11	68	150.37	44.84	53.78	20.05	24.05	0.201	0.241	100.05	119.96	89.02	106.87	67.24^{d}	8.94
		B : >11	10	152.10	47.60	57.70	21.06	25.07	0.211	0.251	107.52	128.04	91.28	108.84	71.92^{a}	10.10
P2 ≤20	≤20	A : <11	29	151.14	45.38	54.45	21.03	20.11	0.210	0.251	101.73	121.27	88.77	105.87	67.21^{de}	9.07
		B : >11	4	151.50	45.50	56.00	20.78	25.57	0.208	0.256	102.21	125.76	88.29	108.75	71.42^{ab}	10.50
P2 >20	>20	A : <11	47	150.43	45.32	54.00	20.27	24.16	0.203	0.242	101.10	120.44	89.90	107.17	66.97^{def}	8.68
		B : >11	12	151.08	44.92	55.33	19.70	23.91	0.197	0.239	100.72	122.19	87.87	106.66	70.75^{abc}	10.42
F ratio (df=7.192)				0.915	0.890	1.418	1.428	1.197	1.416	1.196	0.957	1.071	0.449	0.560	17.958^{**}	5.526^{*}

The common alphabets in superscript indicate that they are in par with each other.

The mean height of the respondents ranged from 148.50 cm to 152.10 cm, weight gain, 8.69 kg to 10.50 kg, initial BMI, 18.26 to 21.06, WHRI, 0.228 to 0.256, WHPI, 117.10 to 128.04, BI 105.40 to 110.11 and mean NSI from 66.47 to 71.92.

Physical Quality of Life Index (PQLI) and the various anthropometric indices were statistically tested and the data generated revealed positive relationship between PQLI and BMI ($r = 0.1975^{**}$), WHRI ($r = 0.7588^{**}$), WHPI ($r = 0.9856^{**}$) and Broka's index ($r=0.6450^{**}$) and details presented in Appendix X.

4.5 Indices based on nutritional status

Nutritional Status Index (NSI) for each respondent was worked out using the variables like height, weight gain, skinfold thickness and haemoglobin level and the details are presented in Table 28. The influence of PQLI on the NSI of the pregnant women is shown in Fig. 3.

The Table reveals that 10.50 per cent of the respondents had NSI in the range of 60.000 to 65.000, 74.00 per cent in the range of 65.001 to 70.000, 15.00 per cent in the range 70.001 to 75.000 and 0.50 per cent had an NSI greater than 75.000.

Fig. 3 **Influence of PQLI on the NSI of the pregnant women**

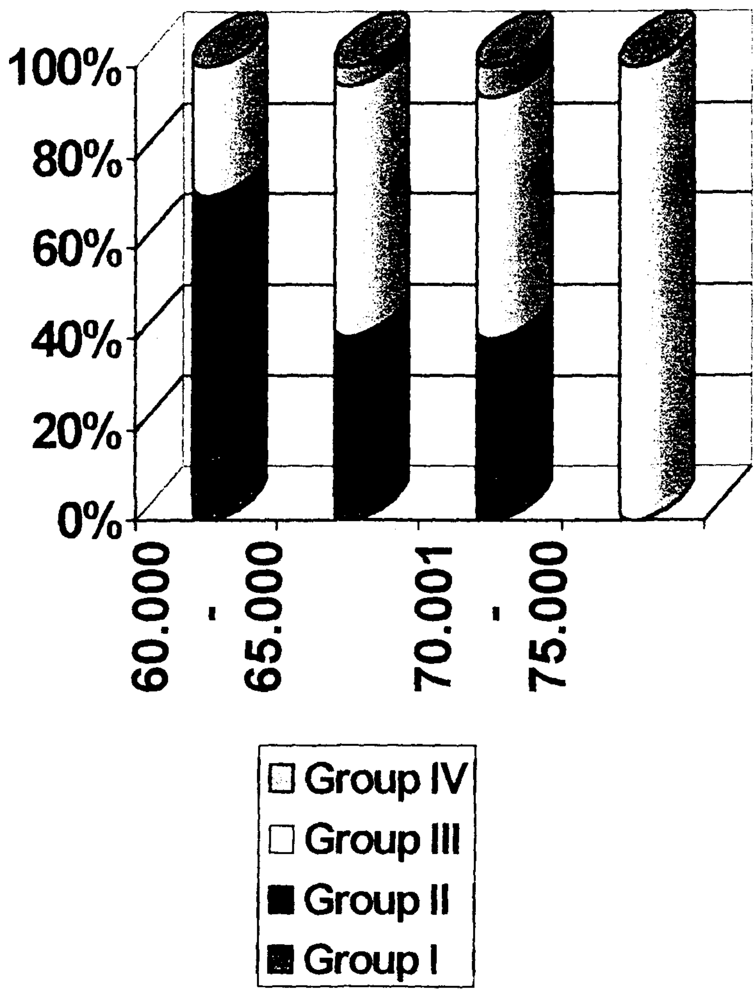


Table 28 Nutritional Status Index of the respondents

Distribution of families	NSI				Total
	60.000-65.000	65.000-70.000	70.000-75.000	>75.00	
Group I	3 (1.50)	7 (3.50)	3 (1.50)	0 (0.00)	13 (6.50)
Group II	12 (6.00)	53 (26.50)	9 (4.50)	0 (0.00)	74 (37.00)
Group III	6 (3.00)	82 (41.00)	16 (8.00)	1 (0.50)	105 (52.50)
Group IV	0 (0.00)	6 (3.00)	2 (1.00)	0 (0.00)	8 (4.00)
Total	21 (10.50)	148 (74.00)	30 (15.00)	1 (0.00)	200 (100.00)

Groupwise classification reveals that the NSI between 60.000 to 65.000 were more in Group II (6.00 per cent) and many respondents under Group III (41.00 per cent) had an NSI in the range 65.001 to 70.000 and 8.00 per cent in the same group were observed to be in the range of 70.001 to 75.000.

Distribution of respondents based on age and age at menarche against NSI and Hb are presented in Table 29.

The table revealed that 15.50 per cent of the respondents had an NSI ≤65.26. The respondents who were 18 years old or less (7.50 per cent) had an NSI as ≤65.26 for 2.00 per cent, 65.26 to 67.66 for 1.00 per cent, 67.66 to 70.05 for

Table 29 Influence of age and age at menarche of the respondents on Hb level and NSI developed

Variables		NSI				Hb		Total
		≤65.26	65.26–67.66	67.66–70.05	70.05–100	≤11	>11	
Age	≤ 18	4 (2.00)	2 (1.00)	7 (3.50)	2 (1.00)	14 (7.00)	1 (0.50)	15 (7.50)
	18–20	10 (5.00)	15 (7.50)	17 (8.50)	6 (3.00)	41 (20.50)	7 (3.50)	48 (24.00)
	20–22	2 (1.00)	14 (7.00)	24 (12.00)	8 (4.00)	38 (19.00)	10 (5.00)	48 (24.00)
	22–25	15 (7.50)	32 (16.00)	29 (14.50)	13 (6.50)	77 (38.50)	12 (6.00)	89 (44.50)
Age at menarche	≤ 11	0 (0.00)	2 (1.00)	4 (2.00)	0 (0.00)	5 (2.50)	1 (0.50)	6 (3.00)
	12	4 (2.00)	7 (3.50)	12 (6.00)	1 (0.50)	21 (10.50)	3 (1.50)	24 (12.00)
	13	14 (7.00)	16 (8.00)	22 (11.00)	13 (6.50)	53 (26.50)	12 (6.00)	65 (32.50)
	14	4 (2.00)	19 (9.50)	25 (12.50)	7 (3.50)	47 (23.50)	8 (4.00)	55 (27.50)
	15	6 (3.00)	17 (8.50)	10 (5.00)	4 (2.00)	33 (16.50)	4 (2.00)	37 (18.50)
	16	3 (1.50)	2 (1.00)	4 (2.00)	4 (2.00)	11 (5.50)	2 (1.00)	13 (6.50)

3.50 per cent and 70.05 to 100 for 1.00 per cent. Among the respondents in the age group of 18 to 20, NSI ranged as ≤65.26 for 5.00 per cent, 65.26 - 67.66 for 7.50 per cent, 67.66 to 70.05 for 8.50 per cent, 70.05 to 100 for 3.00 per cent and those in the age group 20 to 22, 1.00 per cent had an NSI ≤65.26, and followed by 7.00 per cent with 65.26 to 67.66, 12.00 per cent with 67.66 to 70.05, and 4.00 per cent with NSI in the range of 70.05 to 100. Whereas in the case of older respondents (20-25 year old), NSI ranged from ≤65.26 for 7.50 per cent, 65.26 to 67.66 for 16.00 per cent, 67.66 to 70.05 for 14.50 per cent and 70.05 to 100 for 6.50 per cent of the respondents.

When the Hb status of the respondents were considered, the distribution was found to be 7.00 per cent for ≤ 11 g%; 0.50 per cent for >11 g%, in the age group of 18 years old or less, 20.50 per cent (≤11 g%) and 3.50 per cent (>11g%), in the age group of 18 to 20 years 19.00 per cent (≤11 g%) and 5.00 per cent (> 11g%) in the age group 20-22 years and 38.50 per cent (≤ 11 g%) and 6.00 per cent in the age group 22 to 25 years.

Respondents who had reached menarche by 11 years was found to have an NSI in the range of 65.26 to 67.66 for 1.00 per cent, 67.66 per cent to 70.05 for 2.00 per cent and the respondents who reached menarche at the age of 12 had an NSI ≤ 65.26 for 2.00 per cent, 65.26 to 67.66 for 3.50 per cent, 67.66 to 70.05 for 6.00 per cent and 70.05 to 100 for 0.50 per cent. Those who reported their age at menarche as 13 had an NSI ≤65.26 for 7.00 per cent, 65.26 to 67.66 for 8.00 per cent, 67.66 to 70.05 for 11.00 per cent and 70.05 to 100 for 6.50 per cent and those who reported as 14 had an NSI ≤ 65.20 for 2.00 per cent, 65.26 to 67.66 for 8.50 per cent, 67.66 to 70.05 for 12.50 per cent and 70.05 to 100 for 3.50 per cent. NSI was in the range of ≤65.26 (3.00 per cent), 65.26 to 67.66 (8.50 per cent), 67.66 to 70.05 (5.00 per cent) and 70.05 to 100 (2.00 per cent) for those who reached menarche at 15. The distribution based on NSI was found to be 1.50 per cent (≤65.26), 1.00 per cent (65.26 to 67.66), 2.00 per cent (67.66 to 70.05) and 2.00 per cent had an NSI in the range 70.05 to 100 for the respondents who reached menarche by 16 years.

Classification based on age at menarche and Hb level revealed that the respondents who had a Hb level ≤11g% were 2.50 per cent (age at menarche = ≤11 years), 10.50 per cent (12 years), 26.50 per cent (13 years), 23.50 per cent (14 years), 16.50 per cent (15 years) and 5.50 per cent (16 years) and those who had Hb level >11 g% were 0.50 per cent (≤11 years), 1.50 per cent (12 years), 6.00 per cent (13 years), 4.00 per cent (14 years) 2.00 per cent (15 years) and 1.00 per cent (16 years).

Table 30 reveals the influence of Hb level and NSI of the respondents on the birth weight of newborn.

Table 30 Influence of Hb level and NSI of the respondents on the birth weight of new born

Variable		NSI				Hb		Total
		<65.26	65.26-67.66	67.66-70.05	70.05-100	≤11	>11	
Birth weight of newborn (kg)	≤2.5	16 (8.00)	27 (13.50)	7 (3.50)	1 (0.50)	50 (25.00)	1 (0.50)	51 (25.50)
	2.5 - 3.0	11 (5.50)	26 (13.00)	46 (23.00)	9 (4.50)	82 (41.00)	10 (5.00)	92 (46.00)
	>3.0	4 (2.00)	10 (5.00)	24 (12.00)	19 (9.50)	38 (19.00)	19 (9.50)	57 (28.50)
Total		31 (15.50)	63 (31.50)	77 (38.50)	29 (14.50)	170 (85.00)	30 (15.00)	200 (100.00)

The table revealed that as the NSI of the respondents improved, the number of babies with low birth weight were found to decrease.

Similar association was observed between the haemoglobin level of the respondents and birth weight of newborn.

NSI was positively related to haemoglobin level of the respondents ($r = 0.9249^{**}$), height ($r = 0.3482^{**}$), initial weight ($r=0.2771^{**}$), final weight ($r=0.4232^{**}$), BMI ($r=0.1808^{*}$), WHRI ($r = 0.2833^{**}$), WHPI ($r = 0.4342^{**}$) and Broka's index ($r = 0.1989^{**}$) and the details are presented in Appendix X.

Investigations on microsamples (20)

An indepth study on the moderately anaemic pregnant women (20) were undertaken to find out the association between the food iron content and selected haematological factors. For this purpose actual food intake of the respondents were ascertained through weighment method. From the cooked food samples collected bioavailability of iron was estimated in the laboratory. Haematological profile with specific reference to Haemoglobin (Hb). Red Blood Cell (RBC) Count, platelet count, Packed Cell Volume (PCV), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), total protein, albumin, globulin and

Albumin - Globulin ratio (A/G ratio) were estimated in 10 cc blood collected from the subsamples. Biochemical variables such as serum iron, Total Iron Binding Capacity (TIBC), percentage TIBC saturation and ferritin were estimated only in 10 cc blood samples collected.

4.6 Actual food intake

Distribution of anaemic pregnant women based on mean food intake is presented in Table 31 (Fig. 4). The table revealed that their diets were not balanced and insufficient to meet RDA except in the case of cereals. The intake of roots and tubers met 73.20 per cent of the RDA specification while from other vegetables around 75.60 per cent were met. The intake of all the other foods viz. sugar and jaggery (58.50 per cent), fruits (58.33 per cent), fats and oils (45.00 per cent), milk and milk products (37.15 per cent) and pulses (32.50 per cent) were found to be insufficient, meeting only less than 60.00 per cent of RDA specification. Inclusion of green leafy vegetables were far from satisfactory meeting only 2.33 per cent of the prescribed RDA.

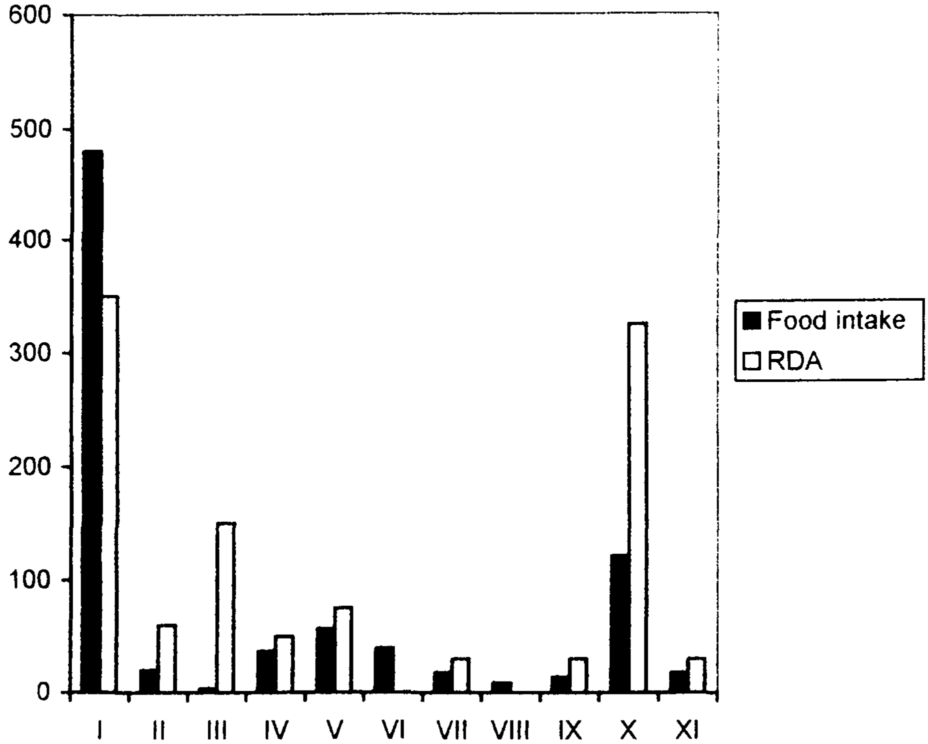
Nutrients present in the diets were calculated using food composition tables (Gopalan *et al.*, 1996) and results are presented in Table 32 (Fig. 5). Except for fats (132.17 per cent adequate), thiamine (115.45 per cent) and nicotinic acid (137.86 per cent) all the other nutrients were insufficient and did not meet RDA specifications. Mean calorie

Table 31 Mean food intake of the pregnant women (n=20)

Food items	Food intake (mean)	RDA	Variation	Per cent diet adequacy
Cereals	480.00	350	+130.00	137.14
Pulses	19.50	60	-40.50	32.50
Green leafy vegetables	3.50	150	-146.50	2.33
Roots and Tubers	36.60	50	-13.40	73.20
Other vegetables	56.70	75	-18.30	75.60
Nuts and Oilseeds	38.85	$	-	-
Fruits	17.50	30	-12.50	58.33
Fish/Meat/Egg	8.40	$	-	-
Fats and Oils	13.50	30	-16.50	45.00
Milk and milk products	120.75	325	-204.25	37.15
Sugar and Jaggery	17.55	30	-12.45	58.50

$ - RDA not available

Fig. 4 **Mean food intake of the pregnant women (n=20)**



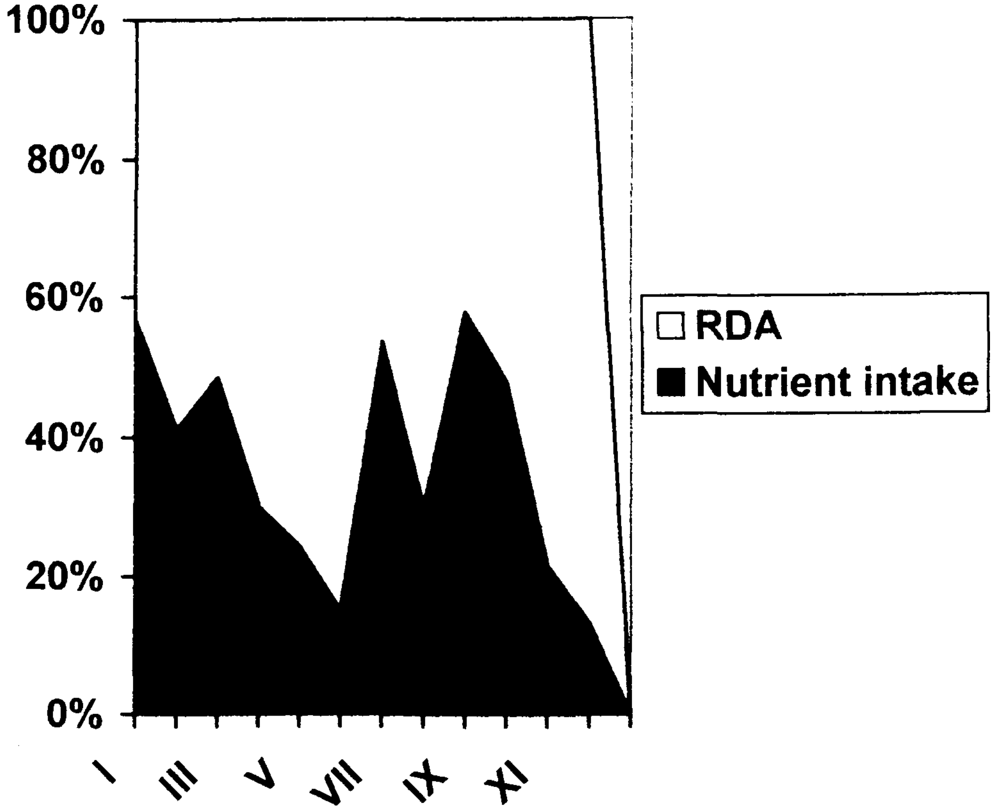
I. Cereals
II. Pulses
III. Green leafy vegetables
IV. Roots and Tubers
V. Other vegetables
VI. Nuts and Oil seeds
VII. Fruits
VIII. Fish/Meat/Egg
IX. Fats and Oils
X. Milk and Milk products
XI. Sugar and Jaggery

Table 32 Mean nutrient intake of the pregnant women (n=20)

Nutrient	Nutrient intake (mean)	RDA	Variation	Per cent diet adequacy
Fat (g)	39.65	30	+9.65	132.17
Protein (g)	45.06	65	-19.94	69.32
Calorie (kcal)	2049.73	2175	-125.27	94.24
Calcium (mg)	427.96	1000	-572.04	42.80
Iron (mg)	12.15	38	-25.85	31.97
B carotene (mg)	417.79	2400	-1982.21	17.41
Thiamine (mg)	1.27	1.1	+0.17	115.45
Riboflavin (mg)	0.55	1.3	-0.75	42.31
Nicotinic acid (mg)	19.30	14	+5.30	137.86
Vitamin C (mg)	36.43	40	-3.57	91.08
Free folic acid (µg)	60.32	$	-	-
Total folic acid (µg)	108.97	400	-291.03	27.24
Vitamin B_{12} (µg)	0.15	1	-0.85	15.00

$ - RDA not available

Fig. 5 **Mean nutrient intake of the pregnant women (n = 20)**



I.	Fat (g)
II.	Protein (g)
III.	Calorie (k cal)
IV	Calcium (mg)
V.	Iron (mg)
VI.	β carotene (mg)
VII.	Thiamine (mg)
VIII.	Riboflavin (mg)
IX.	Nicotinic acid (mg)
X.	Vitamin C (mg)
XI.	Free Folic acid (μg)
XII.	Vitamin B 12 (μg)

intake of the respondents were observed to be meeting 94.37 per cent of the RDA, while the requirements for vitamin C (91.08 per cent), protein (69.32 per cent) and β-carotene (17.41 per cent) were less than RDA specification. Intake of nutrients like calcium (427.96 mg), iron (12.15 mg), folic acid (108.97 µg) and vitamin B_{12} (0.15 µg) were inadequate since only less than 50.00 per cent of the RDA was met.

Food constituents like oxalic acid, phytin phosphorus and fibre were computed in the 20 diets and data generated are presented in Table 33.

Table 33 Concentration of iron inhibitors in the daily diets of the pregnant women (n=20)

Nutrients	Nutrient intake (mean)
Oxalic acid (mg)	120.35
Phytin P* (mg)	530.23
Phytin P* as per cent of total P*	291.60
Total dietary fibre (g; intake/MJ)	4.61

* - Phosphorus

As revealed in the table the diets were found to be rich in oxalic acid (120.35 mg), phytin phosphorus (530.23 mg) and fibre (4.61 g : intake/MJ).

Mean intake of certain nutrients like iron, protein, calorie, vitamin A, vitamin C and vitamin B_{12} on women distributed according to haemoglobin level variation were computed and presented in Table 34.

The table showed that except in the case of calorie intake viz. 2437. 31 kcals in Group I, 2274.94 kcals in Group II and 2130.72 kcals in Group III and protein intake (49.61 g in Group I, 51.69 g in Group II and 44.23 g in Group III) all the other nutrients like iron, vitamin A, vitamin C and vitamin B_{12} intake were found to increase as the Hb level increases.

Bioavailability of iron

Food combinations were worked out in the diets of 20 respondents recorded by actual weighment. Iron content of these combinations were computed and bioavailability of the same combinations were estimated by *in vitro* method (Rao and Prabhavathi, 1978). Mean values obtained for the above parameters are presented in Table 35 (Fig. 6).

The iron content of the different food combinations were found to range from 10-20 mg while bioavailable iron estimated in these diets were observed to range from 3 to 6 per cent. Iron content of food combinations were found to have a direct effect on the bioavailability of iron. Addition of fish (haem iron) in the diet was found to improve the bioavailability of iron from the diet.

Table 34 Mean intake of certain nutrients in the diet of the pregnant women (n=20)

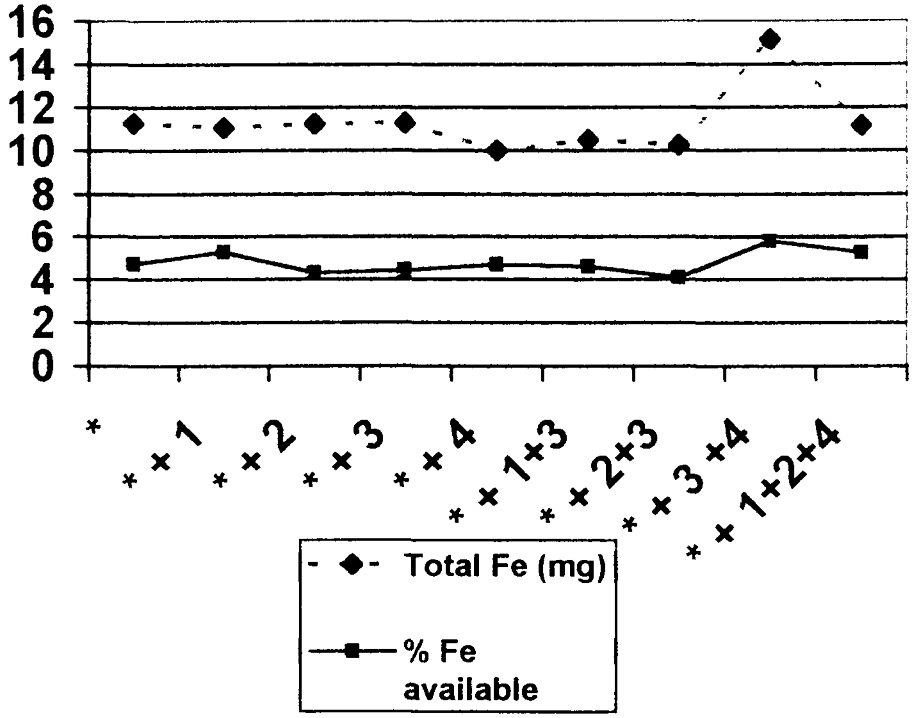
Haemoglobin levels (range)	Sample size	Nutrient intake					
		Iron (mg)	Protein (g)	Calorie (kcals)	B carotene (mg)	Vitamin C (mg)	Vitamin B_{12} (µg)
9.0 - 9.5	2	8.70	49.61	2437.31	219.02	15.36	0.147
10.0 ≤ 10.5	9	10.58	51.69	2274.94	168.18	35.75	0.154
10.6 - 11.0	9	12.76	44.23	2130.72	429.64	41.78	0.155
9.0 - 11.0	20	11.37	48.13	2226.28	344.73	36.43	0.154

Table 35 Bioavailability of iron from the diets (n=20)

FC	No.of women	Total iron (mean) (mg)	Per cent iron available (mean)
*	3	11.30	4.70
* + 1	3	11.07	5.24
* + 2	1	11.27	4.30
* + 3	4	11.29	4.42
* + 4	1	10.02	4.68
* + 1 + 3	4	10.51	4.59
* + 2 + 3	1	10.28	4.08
* + 3 + 4	2	15.18	5.79
* + 1 + 2 + 4	1	11.17	5.25

FC - Food combinations
* - Cereals + Roots and tubers + Other vegetables + Nuts and oil seeds + Fats and oils + Milk and milk products + sugar and jaggery
1 - Pulses
2 - Green leafy vegetables
3 - Fruits
4 - Fish

Fig. 6 **Bioavailability of Iron (Fe) from the diets of the pregnant women (n = 20)**



X – axis : Food combinations

* Cereals + Roots and tubers + Other vegetables + Nuts and Oil seeds + Fats and Oils + Milk and Milk products + Sugar and Jaggery

1. Pulses
2. Green leafy vegetables
3. Fruits
4. Fish

Investigation for hookworm infestation

None of the respondents had hookworm infestation as per the hospital records.

4.7 Haematological findings

Variables such as Haemoglobin (Hb), Red Blood Cell (RBC) count, platelet count, Packed Cell Volume (PCV), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), total protein, albumin, globulin and Albumin to Globulin (A/G) ratio were estimated from the blood samples collected from 20 respondents and the details are presented in Table 36. Out of the 20 anaemic women two had a haemoglobin level less than 9.5g% (9.3 and 9.0). The highest haemoglobin level was 10.9g%. RBC count and platelet count were lower than the normal values for all the 20 women. However the indices viz. MCV, MCH and MCHC were found to be in the normal range for all the respondents.

RBC count was found to increase as the Hb level rises. Mean platelet count was 1.7 in group I, 1.47 in group II and 1.81 in group III. Mean value for PCV was 27 per cent in group I, 30.67 per cent in group II and 31.78 per cent in group III. Mean MCV was 97.35 μ^3, MCH 32.85 per cent and MCHC 33.9.

Table 36 Haematological profile of the respondents (n=20) (Mean values)

Haemoglobin (range)	Sample size	Haemoglobin (g%)	RBC count (ml/cm^2)	Platelet count (lakhs)	PCV (%)	MCV (μ^3)	MCH (%)	MCHC
9.0 - 9.5	2	9.15	2.70	1.7	27	100	34	34
10.0 ≤ 10.5	9	10.34	3.16	1.47	30.67	97	32.78	34
10.6 - 11.0	9	10.71	3.28	1.81	31.78	97.11	32.67	33.78
9.0 - 11.0	20	10.39	3.17	1.65	30.80	97.35	32.85	33.90

Blood Sample Collection

Serum constituents like total protein, albumin, globulin. Albumin - Globulin ratio (A/G) were estimated and are given in Table 37.

Table 37 Serum profile of the respondents (n=20) (Mean values)

Haemoglobin levels (range)	Sample size	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G Ratio (g/dl)
9.0 - 9.5	2	7.30	3.85	3.60	1.05
10.0 $\leq$ 10.5	9	7.46	3.87	3.58	1.09
10.6 - 11.0	9	7.52	4.06	3.66	1.11
9.0 - 11.0	20	7.47	3.95	3.62	1.10

Total protein and albumin content in serum was increasing with increasing Hb. Mean Albumin was observed to be 3.95 g/dl; globulin 3.62 g/dl and A/G ratio 1.10 g/dl.

Statistical analysis proved a direct and significant relationship between the haemoglobin content of the respondents and certain blood constituents like RBC ($r = 0.8747^{**}$), PCV (0.6840^{**}) and the bioavailable iron from their diets ($r = 0.5091^{*}$).

RBC correlated well against PCV ($r = 0.5693^{**}$), MCV ($r = 0.4744^{*}$), MCH ($r = -0.7736^{**}$) and the bioavailable iron ($r = 0.4757^{*}$). There was a positive association between platelet count and albumin content ($r = 0.5132^{*}$) while PCV had a positive association with MCHC ($r = 0.7144^{**}$) and MCV ($r = 0.4530^{*}$). MCV had significant relationship with MCH ($r = 0.5656^{**}$) and MCHC ($r = -0.8618^{**}$). Total protein was positively associated with albumin ($r = 0.5399^{*}$) and globulin ($r = 0.7008^{**}$) where as albumin was positively related to globulin ($r = 0.4536^{*}$) and globulin had significant relation with A/G ratio ($r = -0.6637^{**}$) and the details are furnished in Appendix XI.

Out of the 20 sub samples, 10 respondents were selected and grouped into three based on their level of haemoglobin in blood (Table 38) for the estimation of selected serum constituents like serum iron, TIBC, percentage TIBC saturation and ferritin and the details are presented in Table 39.

Table 38 Haematological profile of selected respondents (n=10)

Group	Haemoglobin (g%)	Number of respondents
Group I	9.0 - 9.5	1 (10.00)
Group II	10.0 - $\leq$ 10.50	3 (30.00)
Group III	10.6 - 11.0	6 (60.00)
Total		10 (100.00)

Table 39 Selected serum profile of the respondents (n=10)
(Mean values)

Haemoglobin levels (range)	Sample size	Serum iron (μg/dl)	TIBC (μg/dl)	% TIBC saturation	Ferritin (ng/dl)
9.0 - 9.5	1	90.00	362.00	24.80	12.50
10.0 ≤ 10.5	3	111.33	388.33	28.03	18.33
10.6 - 11.0	6	82.17	317.00	24.20	23.68
9.0 - 11.0	10	4.64	91.70	342.90	25.41

Serum ferritin was found to increase with the rise in haemoglobin (12.5 ng/ml in Group I, 18.33 ng/ml in Group II and 23.68 ng/ml in Group III). Mean value for serum iron was 4.64 μg/dl, TIBC 91.7 μg/dl and 342.9 for per cent TIBC saturation.

Association between haemoglobin and bioavailability of iron against selected blood cell constituents and indices when tested statistically (Appendix XII) revealed a direct significant relationship between Hb and RBC count ($r = 0.8863^{**}$) and PCV ($r = 0.6203^{*}$). RBC count had significant relation with serum iron ($r = 0.6067^{*}$). Platelet count correlated positively with per cent TIBC saturation ($r = 0.7907^{**}$), ferritin ($r=0.9907^{**}$) and bioavailability of iron ($r=0.7798^{**}$). MCV had significant relation with MCH ($r = 0.6027^{*}$), MCHC ($r = -0.8824^{**}$) and serum iron ($r = -0.6865^{*}$). MCHC had a positive significant relation with serum iron ($r = 0.6737^{*}$). Total protein was correlated with albumin (r = 0.6224*), globulin (r = 0.8644**) and A/G ratio (r = -0.7403*). Globulin content had an indirect significant relationship with A/G ratio (r = -0.8417**). TIBC had direct significant relation with per cent TIBC saturation (r=0.7907**), ferritin (r=0.9907**) and bioavailability of iron (r = 0.7798**). Per cent TIBC saturation had positive relation with ferritin (r = 0.7104*) and ferritin had a direct and significant relation with bioavailability of iron (r = 0.8286**).

Table 40 gives the distribution of women based on the Nutritional Status Index (NSI) worked out with variables like height, weight gain, skinfold thickness, Hb level and Haematological Index (HI) formulated from the laboratory estimations.

Table 40 Distribution of respondents based on their level of Haemoglobin (Hb), Nutrition Status Index (NSI) and Haematological Index (HI)

Haemoglobin (range)	Sample size	Haemoglobin (g%)	NSI	Haematological index
9.0 - 9.5	1	9.30	62.96	665.39
10.0 ≤ 10.5	3	10.20	66.26	665.68
10.6 - 11.0	6	10.73	68.68	684.47
Overall average	10	10.43	67.38	676.93

Mean NSI was found to be 62.96 for Group I, 66.26 for Group II and 68.66 for Group III.

The table shows that for Group I, HI is 665.39, for Group II it is 665.68 and for Group III it is 684.47. We can see a gradual increase in the HI as we go up the group (increasing Hb levels).

Mean NSI and HI for the ten women are 67.38 and 676.93 respectively.

DISCUSSION

5.0 DISCUSSION

This chapter encompasses a critical appraisal of the salient findings of "Nutritional profile of pregnant women with reference to iron" and the discussion is presented under:

5.1 Socio-economic indicators

Socio-economic factors have a definite bearing on the dietary habits of the people and thereby on their dietary intake and nutritional status. Among the various factors affecting the nutritional status of an individual, diet with its close association with socio economic factors emerge as an important force of influence. To assess the socio economic status, details pertaining to the type of family, family size, monthly income and caste are to be ascertained. There is an increasing awareness of the relationship between malnutrition and socio-economic factors. Devadas and Eswaran (1986) had opined that food habits of the people depended on availability of foods and food availability was observed to be influenced by climate, socio economic conditions and cultural environment. Ghosh (1989) reported that social factors like religion, occupation, economic status, education, beliefs and culture had important bearing on health.

5.1.1 Social status of the families

Religion and caste have a profound influence on the food habits. According to a study conducted by Shatenstein *et al.* (1993) on Jewish religion and dietary laws on family food habits revealed marginal intakes of vitamin D, zinc and iron among children and pregnant women. The study reinforced existing anecdotal impressions as to the importance of religion and the religious dietary laws in the daily life of the community.

Area of residence of the respondents is an important social factor to be considered while studying the dietary habits as regional variations have shown to have a profound influence on food intake. The particular culinary practice in a region are clearly powerful determinants of dietary intake even over riding the constraints of income.

In the modern era, type of family comes to bear definite influence on food habits. A nuclear family with lots of freedom on spending habits and time to take care of the health of limited members of family spent a sizable portion of their budget on food, which invariably results in consuming carbohydrate rich fatty foods. This also results in higher percapita availability of food within the family. So also in a nuclear family where the husband and wife work, they come to depend very often on processed foods.

In this study the average size of the family was found to be 4.5. According to Park (1997) the average family size in India is four.

The 200 families surveyed had a total population of 898 members. Age and sex wise distribution of the selected population revealed that 47.22 per cent were adult males, and 52.78 per cent were adult females. The respondents selected for the present study were primigravida. Hence the general composition shows that adults predominate in all the 200 families surveyed.

Park (1997) had reported that the demographic profile of India is fast changing and is characterised by adult population forming 60 per cent and young population (below the age of 15 years) forming 40 per cent.

According to UNICEF (1990) lack of ready access to water and poor environmental sanitation were important underlying causes of various types of infections resulting in malnutrition. In the marine sectors of Kerala, 40.56 per cent of the households had the facility of protected water supply through public taps and 54.91 per cent had wells (Government of Kerala, 1990). In the present study it was found that many lived in homes lacking in basic amenities like protected water supply and electricity.

5.1.2 Economic status of the families

Issaragrisil *et al.* (1995), reported that the relationship of socio economic status to the risk of aplastic anaemia which increased with decreasing income. Thus low socio economic status may be a surrogate for one or more environmental factors that would cause anaemia.

The economic status directly or indirectly influence the purchasing power, standard of living quality of life, family size and pattern of disease and deviant behaviour in the community. Park (1997) reported that Keralites are enjoying high standard of living inspite of low per capita income. The main source of income of the families surveyed was not from regular employment.

5.1.3 Socio economic indicators related to women

Social class differences in health are seen at all ages, with lower socio economic groups having greater incidence of premature and low birth weight babies. James *et al.* (1997) are of the opinion that risk factors including lack of breast feeding, smoking, physical inactivity, obesity, hypertension and poor diet are clustered in the lower socio economic groups and that their diet is lower in essential nutrients such as calcium, iron, magnesium, folate and vitamin C than that of the higher socio economic groups. Singh *et al.* (1998b) reported that the occurrence of anaemia in pregnancy is related to the socio economic status of the women. The author also reported that multiparous women of the lower socio economic class who tend to book late in pregnancy was found to have the highest risk of anaemia.

Educational status and literacy rate have been proved to be powerful determinants of nutritional status (Park, 1997) as it may influence the awareness about importance of good nutrition, which can affect food choice. So also those who are well educated will be placed in higher positions, drawing a good salary which will increase the purchasing power of the family. Ballara (1993) is of the opinion that mothers' education may be even more important to her children's health than flush toilets or piped water or even food intake. Studies put the difference in child mortality (deaths of children between one and five) as high as 9 per cent for every year the mother was at school.

In Southern Asia and Africa nearly 40 per cent of the young girls of primary school age are not attending school. The greatest sex disparity in primary school attendance is in Southern Asia and West Asia where more than twice as many girls as boys are not attending primary school (UNICEF, 1988).

The literacy level of fisher women of Valiayaveli was lesser (Karuna, 1993) than the literacy level of women agricultural labourers in Trivandrum which is reported to be 84.00 per cent (Suja, 1989). Kuttykrishnan and Suchetha (1989) reported that the main reason for illiteracy among women was the poor economic background, baby sitting, constant failure and early marriage. However, no relations between the literacy level and the food habits during pregnancy was seen in a study among pregnant women in Saudi Arabia (al-kanhal and Bani, 1995).

The educational status of the respondents in a way reflects to be a representative sample of Kerala population. A major social problem is the educated unemployed population in the lower strata of the society. PQLI is also found to have a direct association with this variable since higher percentage of this category is located in group III and group IV.

Out of the 200 respondents surveyed not even a single women was employed. This condition may be due to various related factors like the reduced age level for marriage, state of pregnancy, poor health and lower literacy rate.

Sadik (1990) stated that in most developing countries, births to young women below 20 represent an increasing proportion of all births, due to the young age structure of the population.

In this study, the respondents were selected such that their age falls below 25. Age wise classification showed that only 7 per cent belonged to the age group below 18 suggesting a teenage pregnancy and the rest in the age group 19 to 25.

As featured in a publication of the World YMCA(1989), there are several barriers to women's community participation. In the present study also not even a single women participated in social organisations. It has been reported that women fear particular obstacles both from their circumstances in the community itself and also from the attitudes of community workers.

According to Willenz (1983), in many countries and regions of the world, qualified, capable women leaders are making their mark in large and small ways. They are heads of government and intergovernmental agencies, they direct health and health related ministries, they serve in legislative bodies and in all kinds of private organisations dealing with health issues. The increased participation of women in decision-making at all levels and in all spheres of activity is surely one of the more positive developments of the last decade. However as reported by Willenz (1983), in all countries, there is a long way to go for women.

5.2 Dietary indicators

Both economic and nutritional considerations are relevant to any discussion on food intake. Dietary intake was found to be markedly influence by income level as revealed in the diet surveys conducted by NNMB (1996). Although dietary deficiencies of nutrients are primary causes of deficiencies like iron, iodine and vitamin A, they are aggravated by infective morbidity among the poor due to bad environmental and personal hygiene. Foods like pulses, vegetables, fruits, animal products including milk and fat are consumed only in small quantities, that too infrequently by the poor and hence their diets are found to be inadequate with respect to many nutrients, particularly vitamin A, iron and riboflavin. Only diets of high income and middle income groups in urban areas can be said to be satisfactory.

5.2.1 Monthly food expenditure pattern

Monthly expenditure pattern of the families were found to increase in accordance with the rise in income. Majority of the families spent 76 to 80 per cent of their income on food. In many families more than 75.00 per cent of the family's income was found used up for providing food.

Expenditure on food is generally associated with various socio economic factors. Wong (1985) found a direct relation between family income and expenditure on food.

If income is lower, there are families spending only less than 50 per cent of the total income on food, indicating a highly inadequate diet quantitatively and qualitatively.

Probably the remaining 50 per cent of income is needed to meet either other basic needs of the family or the special needs of the wage earner. Whatever may be the total income of the family, many families in group II (33.00 per cent) and group III (51.50 per cent) spent more than 66.00 per cent of their income on food.

Food expenditure varied from 59.90 to 62.30 per cent of the total income among fishermen families of Maharashtra (Anon, 1988). Earlier studies conducted in Trivandrum coastal area revealed that on an average, each family spent about Rs.125.89 per head for food alone (Anon, 1989). In this study the percentage monthly expenditure on food was found to be above 66 per cent. Among the women engaged in fishvending in Trivandrum district, percentage of food expenditure varied from 39.65 per cent to 66.60 per cent depending upon their income (Karuna, 1993).

5.2.2 Frequency of use of different foods rich in various nutrients

Energy rich foods

Frequency of use of various energy rich food items depicted that the daily diet in most of the women comprised of food articles like cereals especially rice, fats and oils and sugar. This dietary pattern was observed in studies conducted by Johnson *et al.* (1994).

Protein rich foods

Earlier surveys conducted in Trivandrum district among women engaged in stone breaking found that they consumed pulses and eggs occasionally. The author further reported that this might be due to high cost, non availability and ignorance (Sujatha, 1990). Similar findings were observed in surveys conducted by Karuna (1993).

Similar trend was observed in this study among pregnant women also.

Mineral or vitamin rich foods

Among these families foods like green leafy vegetables which were the major sources of vitamins and iron were rarely included in the diet. Karuna (1993) reported that green leafy vegetables and fruits were absent in the diets of women engaged in fish vending in Trivandrum district.

Other foods

In the present study, all the 200 pregnant women surveyed were found to include beverages like coffee or tea in their daily diets. However commercially prepared foods were found absent.

5.2.3 Food restriction

A common custom in developing countries is reduction of food intake during pregnancy especially in the last trimester. In the research area in South India, women mentioned that they reduce food intake late in pregnancy. The average daily energy intake among pregnant women residing in rural area of Karnataka was observed to be 1700 kcal (Hutter, 1996).

Energy balance can be affected by factors such as pregnancy and food restriction. It was found that offspring studied were not affected by food restriction during the first half of the pregnancy period but when food restriction was continued, offsprings were born with less energy and weight (Griggio *et al.*, 1997).

Studies conducted by Vaquero and Navarro (1996) confirm that moderate food restriction during pregnancy produces intra uterine growth retardation and that newborns have low trace element contents (particularly in copper), which make them depend on correct postnatal supply.

5.2.4 Food consumption pattern

Majority of our pregnant women eat two main meals; it is difficult to distribute the quantities of food stuffs recommended in any balanced diet between two meals without making the menu uncomfortably large (Venkatachalam and Rebello, 1996). The current study revealed that the pregnant women in Trivandrum district ate three main meals. It is advisable, therefore, that a pregnant women eats 'a little' but 'often' giving added scope for the introduction of a variety of food stuffs from all the food groups. Venkatachalam and Rebello (1996) however realises that the practical implementation of this suggested meal pattern may be difficult in a large majority of pregnant women in our country.

The diet during pregnancy should contain larger amounts of 'tissue building' and 'protective foods' without any great increase in the 'energy-yielding foods. A judicious combination of food stuffs can yield a nutritionally satisfactory diet. Studies conducted by ICMR reveals that the prevalent diet during pregnancy in South India consisted mainly of rice, supplemented with a little pulse and vegetables and that the choice of food stuffs is also extremely limited (Venkatachalam and Rebello, 1996). Study among pregnant women in Trivandrum yielded similar results.

The pattern of diet commonly consumed by the pregnant women belonging to the low income group in South India was observed to be 275 g cereals, 20 g fats and oils, 12 g jaggery, 40 g milk and curds, pulses and nuts 20 g, egg/meat/fish 20g, 25g fruits, 8g green leafy vegetables and 20 g other vegetables (Venkatachalam and Rebello, 1996). The finding of the current study at Trivandrum district are in accordance with the above except in the case of fish, milk, pulse and other vegetables which are consumed more even though it did not meet the RDA.

Nutrient intake by fisherwomen (Karuna, 1993) in Trivandrum revealed that the diets were inadequate in calories, vitamins (retinol, thiamine, niacin, riboflavin and vitamin C) and minerals (calcium and iron). Child bearing imposes a great strain and it is important that the would-be-mother leads a healthy life throughout pregnancy. One of the major factors that promotes health and well being, both of the mother and the baby in the womb, is wholesome, nourishing food. Gorbitz *et al.* (1995) concluded that even among health-conscious, pregnant Norwegian women the diet did not meet the national dietary recommendations especially in the case of vitamin D and iron. Present study also revealed similar results except in the case of niacin and vitamin C where the intake was sufficient.

Studies conducted by Ackurt *et al.* (1995) among pre- and post-natal Turkish women reported high percentages of subjects at risk for deficiencies of haemopoetic constituents like vitamin B_{12} (48.8 per cent) and folate (59.7 per cent) in early pregnancy; vitamin B2 (38.8 per cent), vitamin B_{12} (80.9 per cent), and folate (76.4 per cent) during late pregnancy; and vitamin B2 (43.1 per cent), B6 (36.4 per cent), B_{12} (60.0 per cent), and folate (73.3 per cent) at the post-partum stage. Current study revealed deficient intake of haemopoetic constituents like vitamin B_{12}, folate, riboflavin and vitamin A.

Bruvand *et al.* (1995) found out that the content of inositol hexaphosphate (Phytate) and insitol pentaphosphate, well known inhibitors of iron absorption were higher in the diets of pregnant Pakistani women. Huddle *et al.* (1998) reported high daily intakes of phytate and dietary fibre (4.7g: intake/MJ) among pregnant Malawian women. In the present study intake of iron inhibitors like phytin, oxalic acid and fibre were observed to be high in the diets of pregnant women in Trivandrum.

al-kanhal and Bani (1995) reported that among pregnant Saudi women, the percentages of women with dietary cravings, pica and aversions were 38 per cent, 8.8 per cent and 66.4 per cent respectively and that they craved for milk, salty and sour foods, sweets and dates. The avoidances included spicy foods and beverages.

Studies conducted among pregnant women in Oklahoma city revealed (Splinter *et al.*, 1997) that the percentages of women using caffeine, tobacco, alcohol, and illicit drugs decreased during pregnancy.

5.3 Nutritional indicators

5.3.1 Marital status of the respondents

A major factor which influences family status is the marital status of the pregnant women. According to a report published by the Government of Kerala (1990), 39.81 per cent women living in the coastal areas were married. Kuttykrishnan and Suchetha (1989) reported that among rural labour households of Kerala 80.10 per cent of the women were married before the age of 18 years. As reported by Suja (1989) and Karuna (1993), early marriage was common among the women engaged in agricultural and fishing activities respectively in Trivandrum district. Present study revealed similar results.

5.3.2 Daily time utilization pattern of the respondents

George and Bafna (1983) found that the home-makers spent most of their time in preparing food and other household activities and the time used was greatly influenced by the size of the family and age of the home makers.

Choudary (1988) reported that 80.00 per cent of the working women had to work for 8 hours daily. But in the present study none of the pregnant women had regular employment. This may be due to early marriage and conception within the first year of marriage. Saha and Kanchan (1991) reported that real women spent maximum time for domestic work due to lack of proper fuel supply, cooking facilities, cleaning the utensils and also lack of modern living facilities. In Valiyaveli area, women spent one hour 30 minutes to 2 hours 16 minutes for cooking alone and an average time of one hour 54 minutes for their house hold activities and one hour two minutes for fetching water (Karuna, 1993). The pregnant women in Trivandrum district were found to spent 2 to 3 hours for household activities about 8 to 9 hours attending personal needs and leisure and about 8 to 10 hours for sleep.

5.3.3 Energy expenditure pattern of the respondents

Studies conducted in Trivandrum revealed that the energy consumption was very low and expenditure was high among majority of women working as farm labourers (Suja, 1989 and Laisamma, 1992) and women engaged in stone breaking (Sujatha, 1990).

Florence (1989) reported positive energy balance in working women, in the organised sector in Trivandrum. Present study conducted among pregnant women revealed similar results probably because of their present physiological condition they had comparatively less workload and better food intake.

5.3.4 Haemoglobin level of the respondents

Kochupillai (1997) has reported 47 per cent prevalence of moderate to severe anaemia (Hb <9 g%) among pregnant mothers in India. But in the present study only 16 per cent of the pregnant women had a Hb level $\leq$10.0 g%.

5.3.5 Clinical symptoms identified among the respondents

Clinical examination of an individual would help to assess the level of health as influenced by the diet they consumed. Mohiuddin (1989) observed that in some villages of Uttar Pradesh, the diet of the people was inadequate and there was a general deficiency of vitamin A associated with which diseases like anaemia, scurvy and night blindness were associated. In the current study the percentage of pregnant women with pallor of skin (characteristic clinical symptom of anaemia) was high.

5.4 Anthropometric measurements

Anthropometric assessment of nutritional status during the reproductive cycle, particularly during pregnancy, is a widely used, low-technology procedure that has seldom been rigorously evaluated (Anon, 1995b). Anthrompometry provides the single most portable universally applicable, inexpensive and non-evasive technique for assessing the size, proportions and composition of the human body.

Major indices worked out from the anthropometric data generated were Body Mass Index (BMI), Weight for Height Ratio Index (WHRI). Weight and Height Product Index (WHPI) and Broka's Index (BI).

Aujula *et al.* (1989) found that 10.00 per cent of the working women had their body weight below 38.00 kg and height less than 145 cm. According to Karuna (1993) 70.00 per cent of the fisherwomen surveyed in Trivandrum coastal areas were below the ideal height and 88.67 per cent were below ideal weight when compared with the Indian reference women as per the norms of ICMR (1990b). In the present study 90.50 per cent of the pregnant women had their initial body weight $\leq$ 50 kg and 55.50 per cent had height $\leq$ 150 cm.

Women who do not gain enough weight during pregnancy often have babies that weigh too little. In this experiment birth weight of all the babies delivered by the 200 respondents were recorded and this monitoring indicates that the incidence of LBW was high.

Mean weight gain in pregnancy was 11.4 +/- 3.7 kg; and mean birth weight of the infants was 3.06 +\- 0.41 kg among well nourished Indian pregnant women (Piers *et al.*, 1995). The mean birth weight of infants born to pregnant women in Kenya was 3178 grams (Perry *et al.*, 1996).

A sub committee of International Dietary Energy Consultative Group (IDECG) suggested that BMI can be used as a parameter for detecting Chronic Energy Deficiency (CED) for purposes of classifying subjects of deficient caloric intake. According to NIN (1991), BMI values between 18.5 and 25 was considered to be compatible with health for both men and women. Studies conducted by Karuna (1993) reported that 33.33 per cent women were found to be deficient in energy. Among pregnant women, only 5.50 per cent had a BMI $\leq$ 20.

Body weight and BMI were increased but within the expected values in a population of pregnant women at term in Portuguese (Morais *et al.*, 1997).

Kramer *et al.* (1995) reports maternal short stature, low pre-pregnancy BMI and low rate of gestational weight gain may lead to shortened gestation by increasing the risk of idiopathic preterm labour.

Body Mass Index (BMI) computed from the recorded height and weight as Wt/Ht^2 of pregnant women indicates the magnitude of the protein calorie malnutrition. Present findings indicate unsatisfactory results.

According to Karim and Taylor (1997) the best cut offs for detecting LBW and normal weight infants were maternal weight of 50 kg (odds ratio 4.6) and body mass index of 20.5 (odds ratio 6.5). In this experiment also the incidence of LBW was high.

Bhatia *et al.* (1988) had reported that to account for weight and height together, WHRI has been used to assess nutritional status of mother during pregnancy and has also been related to birth weight of offspring.

Weight for Height Ratio Index (WHRI) was computed by

$$\frac{\text{Weight (kg)}}{\text{Height}^2\text{ (cm)}} \times 100$$

The mean triceps skinfold thickness (TSFT) among non-pregnant, non-lactating farm women of middle income Indians were 16.5 mm (Bargava and Kawatra, 1999). In the experiment among pregnant women the TSFT was found to be greater.

In WHPI, 45 kg and 150 cm were used as denominators because of two reasons: (i) above these cut-off limits of maternal weight and maternal height, the incidence of low birth weight babies drops considerably, and (ii) this will eliminate the units of kg and cm from the index. According to Bhatia *et al.* (1988), weight and height or WHPI amongst the anthropometric parameters and haemoglobin from biochemical nutritional parameters were found to be parameters of choice for assessing the maternal nutritional status during pregnancy.

Weight and Height Product Index (WHPI) was also computed by

$$\frac{\text{Weight (kg)} \times \text{Height (cm)}}{45\text{ kg} \times 150\text{ cm}} \times 100$$

The nutritional status (including both anthropometric and biochemical) of pregnant women was found to be far from satisfactory as evidenced by the per cent distribution. Majority of the women were under weight with widely variable height spectrum due to nutritional deprivation of varying severity and duration in their formative years. To account for weight and height together, WHRI has been used to assess nutritional status of mother during pregnancy and has also been related to birth weight of offspring. The mean values of WHRI for well nourished women range between 0.200 - 0.239. Thus the present study reveals satisfactory WHRI. However, WHRI is reported to have certain drawbacks. One is that in short satured mothers and where weight and height have a retardation of similar degree, the value of WHRI is in the normal range, and in similar weight mothers with decreasing height the value of WHRI goes on increasing and with increasing height values decrease progressively (Bhatia *et al.*, 1988). In this experiment WHRI revealed satisfactory results.

5.5 Indices based on nutritional status

Suter and Hunter (1980) reviewed that nutritional status was influenced by factors such as psychological, socio cultural and physiological influences.

George (1999) had opined that the nutritional status of the people of Kerala improved over the years even with a comparatively low intake of nutrients, but, still have a long way to go.

Nair (1999) reported that the prevalence of low birth weight in Kerala is high. While for India it is 33 per cent, that for Kerala it is between 19 to 26 per cent and that for the capital of Kerala, Trivandrum is 24.5 per cent. In the present study in Trivandrum, it was found that as the nutritional status index of the pregnant women increased, the number of babies with LBW decreased.

5.6 Actual food intake

Regional differences in energy, protein, fat and fibre intake among the pregnant women in London and Edinburg (Schofield *et al.*, 1987) outweighed social-class differences and their energy intakes were greater than when non-pregnant. Studies conducted by Borrud *et al.* (1993) revealed that many pregnant women consume less than recommended amounts of vegetables, fruits, meat, poultry, fish and meat alternates. Food intake among the pregnant women in the present study showed that, except in the case of cereals, the intake of all other food items were less than the recommended amounts.

The intake of iron, retinol, ascorbic acid and folic acid were lower than the RDA in pregnant and post-pregnant women of London and Edinburgh (Schofield, 1989). Dietary assessment of pregnant Spanish women revealed lower intake of thiamine, riboflavin, folates, vitamin B_{12}, C, A, D, iodine, calcium, zinc, magnesium and iron (Ortegea *et al.*, 1994).

Present study reveal similar results except for fat, thiamine and niacin were the intake was sufficient.

Worm infestation

Many pregnant women (93 per cent) of Ecador were infected with at least one species of pathogenic intestinal parasite : 88 per cent with Entamoeba histolytica (Weigel *et al.*, 1996). The authors further reported that greater parasite burdens were associated with poorer maternal iron status and reduced foetal growth. The present study revealed that none of the pregnant woman was infected with intestinal parasites.

Bioavailability of iron

Studies of the molecular mechanisms involved in the absorption and bioavailability of iron are important to attempts made worldwide to control the high incidence of iron associated disorders (Hurrell, 1997; Latunde-Dada *et al.*, 1998).

On studying the effect of phytic acid on iron bioavailability, Davidsson *et al.* (1994) reported that the mean fractional iron incorporation increased from 3.9 (native phytic acid) to 8.7 per cent (zero phytic acid; $p < 0.001$).

Whiting (1995) has reported that high intakes of dietary calcium can inhibit iron absorption if both are present in the same meal.

Studies conducted by Fairweather-Tait *et al.* (1995) revealed that the geometric mean bioavailability was 3.0 per cent in a proprietary dehydrated vegetable product, 3.0 per cent in weetabix whole-wheat breakfast cereal, 3.1 per cent in whole meal bread, and 4.3 per cent in baked beans.

The iron bioavailability from three typical diets consumed by socio economic status IV (working class) of the Venezuelan population (Taylor *et al.*, 1995) showed no significant difference in the percentage iron absorption from the same meals eaten in the morning after an overnight fast, and when eaten at the customary time of day.

Anand and Seshadri (1995) have developed a model that integrates the effect of various enhancers and inhibitors which provide an estimate of iron availability from typical Indian meals with a limitation that phytate could not be incorporated into the equation.

The results of Glahn *et al.* (1996) suggest the digestion products of the meat proteins were at least partially responsible for the enhancement of iron uptake and that their study supports the usefulness of the model developed by them as a means of assessing iron bioavailability.

The bioavailability of ferritin iron was evaluated in human subjects (Skikne *et al.*, 1997) and the geometric mean absorption from 5 mg of ferritin iron was 3.8 per cent when without and 3.2 per cent when taken with food and confirmed that ferritin iron was poorly absorbed.

Davidsson *et al.* (1997) reported that dephytinization of infant cereals containing a relatively low native phytic acid content and high amounts of ascorbic acid is thus unnecessary to ensure adequate bioavailability of iron. Dawson *et al.* (1998) found out that the absolute amount of elemental iron contained in a prenatal multivitamin/multimineral formulation does not ensure availability. Fox *et al.* (1998) concluded that chelation does not improve the bioavailability of iron in the presence of dietary inhibitors.

Barrett *et al.* (1994) concluded that an increase in the absorption of iron from food is a physiological consequence of normal pregnancy and not the result of developing anaemia during pregnancy, and such an increase is large enough to meet the increased requirements of pregnancy provided that the dietary intake is adequate.

Iron bioavailability must be considered when evaluating the adequacy of dietary iron in relation to requirement estimates. In this experiment with elevated iron inhibitors and low intakes of flesh foods, iron bioavailability was estimated as 3.6 per cent. In early pregnancy the level of iron absorption is strongly influenced by dietary iron bioavailability as reported by Robinson *et al.* (1998). This may have implications for the projected increases in iron absorption believed to occur during pregnancy.

The results of the present study reveal low levels of poorly available dietary iron in the diets of these pregnant women living in Trivandrum district. The increased consumption of fish resulted in higher calcium intakes (Ferguson *et al.*, 1995) although dietary calcium levels were probably still too low to exacerbate any phytate induced inhibition of iron absorption.

In non-pregnant women, Hulten *et al.* (1995) have shown independent effects of iron status and dietary iron bioavailability in determining the level of iron absorption. Whilst large increases in iron absorption have been measured in pregnant women consuming test diets (Barrett *et al.*, 1994) it is not known how the bioavailability of iron in a woman's free-living diet could influence these changes. Present findings suggest that iron bioavailability may have important effects on iron absorption in pregnancy.

5.7 Haematological findings

Zimna-Walendzik *et al.* (1997) showed that there were significant relationship between pregestational body weight, height, body mass index, body weight and body composition in pregnancy and the values of iron status indicators in blood throughout gestation.

Serum iron, TIBC and per cent iron saturation of transferrin are more sensitive indices of iron status and provide us an opportunity to replenish iron stores of an iron deficient pregnant mother at an earlier data thus preventing anaemia (Lin *et al.*, 1997).

Earlier studies conducted by Samuels *et al.* (1987) opined that a clinically silent ongoing haemolytic reaction is responsible for the increase in serum iron seen in patients with pregnancy-induced hypertension.

In pregnancy Banerjee *et al.* (1986) and Rosenmund *et al.* (1986) reported a progressive increase of TIBC and transferrin and an intermittent decline of serum-ferritin, followed by a rise shortly before delivery.

Serum ferritin level should be used to screen for and diagnose iron depletion and deficiency in pregnancy (Thompson. 1988; Lockitch, 1993). Towards the end of pregnancy, some decrease in ferritin ($\leq$ 15 µg/ml) is physiological, and in the absence of anaemia, iron supplements are not necessary (Carretti *et al.* 1992; Hemminki and Merilainen, 1995). However Milman *et al.* (1995) concluded that haemoglobin, transferrin saturation and serum ferritin values measured in the beginning of the second trimester appear to be unsuitable as guidelines for an individual iron prophylaxis in pregnant women.

In the present study, the various blood cell indices and the concentration of selected blood constituents in the pregnant women were low confirming their anaemic state as per the earlier investigation quoted above.

Findings of Robinson *et al.* (1996) rely on the use of serum ferritin concentration as a marker of the amount of iron stored.

Interpretation of ferritin values in pregnant individuals is complicated by the effects of haemo dilution occurring in early pregnancy (Whittaker and Lind, 1993). Although serum ferritin concentration correlates well with the level of iron stores in non-pregnant individuals (British Nutrition Foundation, 1995). Additional problems in the interpreation of ferritin values arise from its normal day-to-day variability (Cooper and Zlotkin, 1996).

Mean serum ferritin level among pregnant women was found to be 27.5 μg/l (Guidozzi *et al.*, 1995). Present study reveal much lower values.

Elima and Usha (1989) reported that inadequacies in the intake of basic food was the root cause of widely prevalent malnutriton in the country especially during physiological stress periods like pregnancy and lactation. This calls for much care and increases the need for nutritious foods in the diet.

Nutritional status is an indiator of social well being of a community. Studies conducted among women engaged in stone breaking (Sujatha, 1990), agriculture related operations (Suja, 1989; Laisamma, 1992) and fishing (Karuna, 1993) had indicated that women, in the lower income strata, even though economically independent were found to have poor nutritional status. Present study among pregnant women revealed similar results.

The number of babies weighing less than 2500g at birth is on the rise. Nutritionists are well aware of the dietary factors that may influence this increase, especially poor weight gain during pregnancy. The obsession with weight control during pregnancy can lead to harmful restrictions of vital energy and nutrients. Weight reduction should never be attempted during pregnancy. Such regimens are extremely dangerous to the foetus.

Nondietary factors influencing the incidence of LBW or premature babies have been identified as:

* Rise in number of older primigravidas (ie. over 35 years of age)
* Rise in number of teenage pregnancies
* Low socioeconomic status, low educational level
* Poor nutritional status, including low prepregnant weight for height, low energy intake during pregnancy, low haemoglobin level and haematocrit, inadequate early weight gain.

* Clinical problems such as pregnancy-induced hypertension (PIH).

* Behavioral/environmental risk factors, smoking, alcohol and drug abuse.

* Single marital status (often as indicator of low economic status)

To reduce the risk of LBW infants in populations the following may be done:

* Explain the rationale for gaining around 11 to 15 kg.

* Discourage the use of cigarettes, alcohol and drugs.

* Monitor excessive weight gain and sodium intake in older primigravidas, who are often at risk for prenatal essential hypertension and obesity.

* Explore eating habit of adolescents in the local community, working with the girl and her significant others to incorporate nutrient-dense foods into her meal and snack selections.

* Keep abreast of state, and local supplemental food programmes available to low-income women to ensure an adequate intake of nutrients and kilocalories.

* Encourage regular eating patterns throughout pregnancy.

Hence if we have to reduce LBW rate by next year we need to concentrate on the nutrition of the pregnant women of today.

SUMMARY

SUMMARY

The study entitled "Nutritional profile of pregnant women with reference to iron" comprises information on the influence of various socio-economic and dietary factors on the development of iron deficiency in pregnant women.

Based on selected socio-economic variables a Physical Quality of Life Index (PQLI) was developed and based on this index the respondents were classified under four groups.

Respondents surveyed were mainly Hindus (forward communities) residing in joint or extended families in their own homes where minimum basic amenities were available.

Sources of family income was from (the wages of one to three earning members in each family) agriculture, business and subsidiary occupations and per capita income was ≤ Rs.600.

Pregnant women surveyed were in the age group of 22-25 with sound education; with a passive role in decision making at home and in the activities of social organisations.

Percentage of monthly food expenditure in the families ranged from 76 to 80 per cent of income. Most frequently used foods were energy rich food like cereals, roots and tubers, nuts and oil seeds (coconut), fats and oils, sugar and jaggery, protein rich foods like milk (insufficient quantity) and mineral/vitamin rich foods like other vegetables.

Occasionally used foods were pulses, green leafy vegetables, milk products, egg, meat and fruits. Foods like egg, pineapple, papaya and tapioca especially in the last trimester were restricted by majority of the pregnant women.

Daily meal pattern of the pregnant women assessed by recall method revealed the inclusion of break fast (cereal pulse combination with tea), lunch (rice, coconut and vegetables or fish combination), evening snack (hot beverage and a cereal pulse or cereal sugar snack) and dinner (rice, coconut and vegetables or fish combination). Mid morning food, hot drinks before bed time or any special foods did not find a place in the meal pattern. Pulses and vegetables or vegetables and fish were used daily. Comparison with RDA revealed sufficiency only in the case of cereals and roots and tubers and the meal were deficient in calories, protein, calcium, iron, B-carotene and riboflavin. Haemopoetic constituents like vitamin A, vitamin B_{12}, folic acid and iron were deficient in their diets. Iron inhibitors like oxalic acid, phytin phosphorous and fibre were also higher in their meal.

Age at menarche was in the range of 13-14. Many got married either when they completed 21 years or when they were 19. Most of the respondents conceived within one year after marriage.

Time utilization pattern of the pregnant women revealed judicial distribution of time for various activities. Energy expenditure and consumption pattern revealed positive energy balance existing for 61 to 70.99 per cent of the women.

However 89.50 per cent of the women were found anaemic ($\leq$ 11.0 g% of Hb) with symptoms like pallor of the skin, general fatigue, breathlessness on exertion and giddiness.

Anthropometric measurements revealed that many women did not reach standard norms of Indian women fixed for height (56.00 per cent), initial weight (90.50 per cent) and gestational weight gain (83.50 per cent) resulting in low birth weight babies (25.50 per cent). Indices such as BMI, WHRI, WHPI and Broka's index were also not up to the normal level. Nutritional Status Index (NSI) and weight gain were also found to increase with increasing PQLI, age and haemoglobin level. As the NSI of the respondents improved, the number of babies with low birth weight were found to decrease.

Mean food intake assessed by weighment method among 200 pregnant women revealed that their diets did not meet RDA for all foods except cereals. Assessment of mean nutrient intake revealed that fat, thiamine and niacin intake were adequate while haemopoetic constituents like vitamin A, vitamin B_{12}, folic acid and iron) in the food were inadequate.

Constituents of iron inhibitors (oxalic acid, phytin and fibre) in the daily diets were also found to be high. Bioavailable iron in the diets were also found to be very low.

Haematological investigations confirmed the anaemic state ($\leq$ 11.0 g% of Hb) of these women with low RBC count, MCV and MCH. Serum profile was found to be deficient in albumin, globulin and A/G ratio. Indepth studies on selected serum profile (n=10) again confirmed the insufficient levels of iron, TIBC, ferritin and per cent TIBC saturation.

A comparison of NSI and HI worked for the 10 women selected from micro sample revealed positive and direct association between the two indices.

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APPENDICES

APPENDIX - I

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE
DEPARTMENT OF HOME SCIENCE, VELLAYANI

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE SOCIO-ECONOMIC STATUS OF THE PREGNANT WOMEN

1. Name of the respondent :
2. Full address :
3. Age :
4. Religion :
5. Caste :
6. Type of family :
7. Family size and composition :

   Members   Number

   (1) Males

   (2) Females
8. Economic status of the family : (Actual monthly income)
9. Earning members in the family :
10. Major source of income :
11. Amenities available at the household level :

10. Monthly expenditure pattern

    Item   Amount

    Food

    Medicines

11. Total monthly food expenditure of the family (Percentage) :

APPENDIX - II

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE
DEPARTMENT OF HOME SCIENCE, VELLAYANI

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE FOOD CONSUMPTION PATTERN OF THE PREGNANT WOMEN

1. Name of the respondent :

2. Food habit :

3. Frequency of use of various foods :

   (i) Cereals :

   (ii) Pulses :

   (iii) Green leafy vegetables :

   (iv) Other vegetables :

   (v) Roots and tubbers :

   (vi) Fruits :

   (vii) Nuts and oil seeds :

   (viii) Milk :

   (ix) Milk products ;

   (x) Fats and oils :

   (xi) Sugar and jaggery :

   (xii) Egg :

   (xiii) Meat :

   (xiv) Fish :

   (xv) Beverages :

   (xvi) Commercially prepared foods :

7. Frequency of use of food enhancers favouring iron absorption :

8. Frequency of use of food inhibitors hindering iron absorption :

9. Food fads/fallacies/believes :

10. Frequency of use of Pica

    (i) Ash :

    (ii) Chalk :

    (iii) Mud :

    (iv) Others :

11. Frequency of taking special foods during pregnancy :

12. Frequency of foods restricted during pregnancy :

13. Daily meal pattern of the respondent

    (i) Early morning :

    (ii) Break fast :

    (iii) Mid morning :

    (iv) Lunch (if packed, specify) :

    (v) Evening :

    (vi) In between drinks taken at the work spot :

    (vii) Dinner :

    (viii) Bed time :

APPENDIX - III

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE
DEPARTMENT OF HOME SCIENCE, VELLAYANI

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE PERSONAL CHARACTERISTICS OF THE PREGNANT WOMEN

1. Name of the respondent :
2. Age :
3. Age at menarche :
4. Age at marriage :
5. Marital status (in years) :
6. Educational status :
7. Employment status :
8. Social participation :
8. Decision maker for all matters in the family :
9. Pregnency period when engaged in outside employment :
10. Rest period after delivery, before resuming outside employment :
11. History of miscarraige/still birth :
12. Gap between deliveries (in case of still birth) :

APPENDIX - IV

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE
DEPARTMENT OF HOME SCIENCE, VELLAYANI

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE TIME UTILIZATION PATTERN OF THE PREGNANT WOMEN

1. Name of the respondent :

Daily routine of the respondent (EMPLOYED)

2. Time of waking up :

3. The household wake done before going to work

Type of work	Time spent

4. Time you start for work from the home :

5. Time taken to reach the workspot :

6. Mode of conveyance to reach the work spot from home :

7. Type of work :

8. Total time spent for outside work at the work place :

9. Time fo return to home after work :

10. Time taken to reach home :

11. Mode of conveyance from work place to home :

12. Type of domestic chores attended after reaching home :

Type of ativities	Time spent

13. Assistance available for different house hold chores

Activities	Time taken for work	Person rending assistance

14. Time at which you will retire to bed:

Daily routine of the respondent (UNEMPLOYED)

1. Time of waking up :

2. House hold chores attended during the day

Activities	Time spent

3. Assessment available for different house hold chores

Activities	Time taken for work	Person rendering assistance

4. Time at which you will retire to bed:

APPENDIX - V

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE
DEPARTMENT OF HOME SCIENCE, VELLAYANI

SCHEDULE USED FOR ASSESSING ANTHROPOMETRIC MEASUREMENTS AND CLINICAL SYMPTOMS OF THE PREGNANT WOMEN

1. Name of the respondent :

Anthropometric measurements

2. Height (cm)
3. Weight (kg): Initial Final Wt gain
4. Skinfold thickness (mm) :
5. Birth weight of the newborn infant :

Anthropometric indices

1. BMI :
2. WHRI :
3. WHPI :
4. Broka's Index (BI) :

Clinical symptoms

1. Pallor of mucous membrane :
2. General fatigue :
3. Breathlessness on exertion :
4. Giddiness :
5. Koilonychia :
6. Atrophic lingual papillae :

APPENDIX - VI

KERALA AGRICULTURAL UNIVERSITY
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DEPARTMENT OF HOME SCIENCE, VELLAYANI

SCHEDULE USED FOR ASSESSING THE ACTUAL FOOD INTAKE OF THE PREGNANT WOMEN
(BY FOOD WEIGHMENT METHOD)

1. Name of the respondent :

Meal	Menu	Wt. of total raw ingredients used by the family (g)	Wt. of total cooked food consumed by the family (g)	Amount of cooked food consumed by the respondents (g)	Raw equivalents used by the individuals (g)
Early morning					
Break fast					
Lunch					
Tea					
Dinner					
Others					

APPENDIX - VII

KERALA AGRICULTURAL UNIVERSITY
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DEPARTMENT OF HOME SCIENCE, VELLAYANI

DISTRIBUTION OF FAMILIES BASED ON VARIABLES SELECTED FOR PQLI

Sl.No.	Variables	Distribution of families								Total
1.	Caste	ST 3 (1.50)	SC 41 (20.00)	OBC 59 (29.50)	Forward 97 (48.50)					200 (100.00)
2.	Educational status	Illiterate 11 (5.50)	Lower primary 11 (5.50)	Upper primary 24 (12.00)	High school 27 (13.50)	SSLC 76 (38.00)	Pre Degree 31 (15.50)	Graduate 16 (8.00)	PG 4 (2.00)	200 (100.00)
3.	Occupational status	Unemployed 200 (100.00)	Employed 0 (0.00)							200 (100.00)
4.	Monthly family income (Rs.)	< 2000 62 (31.00)	2001-4000 101 (50.50)	4001-8000 34 (17.00)	> 8000 3 (1.50)					200 (100.00)
5.	Per capita income	< 500 49 (24.50)	501 - 900 119 (59.50)	901-1300 27 (13.50)	1301-1700 2 (1.00)	1701-2100 1 (0.50)	> 2100 2 (1.00)			200 (100.00)
6.	Calorie intake/day (kcals)	≤1800 1 (0.50)	1801-2100 87 (43.50)	2101-2400 99 (49.50)	> 2400 13 (6.50)					200 (100.00)
7.	Protein intake/day (g)	≤50 81 (40.50)	51-55 72 (36.00)	56-60 45 (22.50)	>60 2 (1.00)					200 (100.00)
8.	Monthly food expenditure	≤50 5 (2.50)	51-60 9 (4.50)	61-70 26 (13.00)	71-80 87 (43.50)	81-90 73 (36.50)				200 (100.00)

APPENDIX VIII

Association between PQLI, NSI and Hb against selected socio economic variables

	PQLI	NSI	Hb	0	1	2	3	4	5	6	7	8
A	1.0000	0.1091	0.0978	0.1893	-0.0438	0.0573	0.4182**	-0.1265	0.2187**	0.1289	0.3559**	0.3072**
B	0.1091	1.0000	0.9249**	-0.0550	0.0023	-0.0207	-0.0105	-0.0594	0.0660	0.0436	0.0196	0.0758
C	0.0978	0.9249**	1.0000	-0.0792	-0.0061	0.0214	-0.0098	-0.0645	0.0215	0.0809	0.0064	0.0947
0	0.1893	-0.0550	-0.0792	1.0000	0.1485	-0.0745	-0.1598	0.1403	-0.0870	-0.2243	0.6472	0.2261
1	-0.0438	0.0023	-0.0061	0.1485	1.0000	-0.1679*	0.0019	0.1564*	-0.1265	-0.0990	0.0292	0.0439
2	0.0573	-0.0207	0.0214	-0.0745	-0.1679*	1.0000	0.0567	-0.2182**	0.2151**	0.1697*	0.1007	0.0114
3	0.4182**	-0.0105	-0.0098	-0.1598	0.0019	0.0567	1.0000	-0.0313	-0.0051	-0.0358	-0.1170	-0.0568
4	-0.1265	-0.0594	-0.0645	0.1403	0.1564*	-0.2182**	-0.0313	1.0000	-0.4797**	-0.5329**	-0.3533**	-0.3734**
5	0.2187**	0.0660	0.0215	-0.0870	-0.1265	0.2151**	-0.0051	-0.4797**	1.0000	0.2615**	0.4939**	0.5712**
6	0.1289	0.0436	0.0809	-0.2243	-0.0990	0.1697*	-0.0358	-0.5329**	0.2615**	1.0000	0.4251**	0.4640**
7	0.3559**	0.0196	0.0064	0.6472	0.0292	0.1007	-0.1170	-0.3533**	0.4939**	0.4251**	1.0000	0.7144**
8	0.3072**	0.0758	0.0947	0.2261	0.0439	0.0114	-0.0568	-0.3734**	0.5712**	0.4640**	0.7144**	1.0000
9	-0.0654	-0.1067	-0.1072	0.2858	0.0693	-0.0415	0.0017	0.0490	0.0624	-0.0700	0.1876**	0.1370*
10	0.0245	-0.0154	-0.0798	0.0083	0.0484	0.0368	0.1755*	0.0139	0.0806	-0.0412	0.0354	-0.0080
11	0.4758**	0.0695	0.0483	0.3246	-0.0904	0.0719	-0.0678	-0.4705**	0.6009**	0.5270**	0.8152**	0.7856**
12	0.1247	-0.0223	-0.0368	0.5790	0.1225	0.0328	-0.1628	-0.0207	0.1173	0.0792	0.5752**	0.1782*
13	-0.0210	-0.0176	-0.0648	-0.0103	0.1566*	0.0175	-0.0363	0.0900	-0.0085	-0.0832	-0.0763	-0.0936
14	-0.0103	0.0671	0.0705	0.0946	0.9074**	-0.1824**	-0.0110	0.1735*	-0.1243	-0.0864	0.0010	0.0586
15	0.0278	0.0098	-0.0843	0.0134	0.0457	-0.0996	-0.0281	0.0793	0.0129	-0.0510	0.0035	-0.0825
16	0.5379**	-0.0003	-0.0086	0.1691	0.1275	0.0129	0.0568	-0.0345	0.0498	0.0266	0.2053**	0.1116
17	-0.1766*	-0.0259	0.0100	-0.1031	-0.0713	0.0085	-0.1141	0.1276	-0.0261	-0.1577*	-0.1737*	-0.0373
18	-0.1007	-0.0624	-0.0247	-0.0065	0.0053	0.0493	-0.0513	0.0205	0.0125	0.0035	-0.0091	-0.0126
19	0.2711**	0.0657	0.0648	-0.6099	-0.2043**	-0.0426	0.1172	-0.0926	0.1480*	0.1639*	-0.3328**	-0.0195
20	0.1181	0.3482**	0.1170	0.0159	-0.0147	-0.0326	0.0646	-0.1187	0.1012	0.0201	0.0701	-0.0030
21	0.1180	0.2771**	0.0114	0.1543	0.0550	-0.1341*	0.0830	-0.1039	0.1036	-0.0218	0.1546*	0.0464
22	0.1086	0.4232**	0.0952	0.1158	0.0520	-0.1062	0.0330	-0.0530	0.1078	-0.0503	0.1105	0.0397
23	-0.0183	0.1934**	-0.0745	0.0756	0.0229	-0.2068**	0.0349	-0.0064	0.1156	-0.0733	0.0484	-0.0619
24	0.0617	0.5277**	0.5043**	0.0024	0.0027	0.0055	-0.0693	-0.0149	0.0060	-0.0332	-0.0221	0.0550
25	0.0871	-0.0048	-0.0976	0.0349	-0.0245	0.0009	0.0942	-0.0849	0.0554	0.0594	0.1033	0.0648
26	0.1238	-0.0659	-0.0635	0.0663	0.0862	0.0897	0.1626	0.0419	0.1302	-0.0923	0.0826	0.0311

Appendix VIII Contd.

9	10	11	12	13	14	15	16	17	18	19	20
-0.0654	0.0245	0.4758**	0.1247	-0.0210	-0.0103	0.0278	0.5379**	-0.1766*	-0.1007	0.2711**	0.1181
-0.1067	-0.0154	0.0695	-0.0223	-0.0176	0.0671	0.0098	-0.0003	-0.0259	-0.0624	0.0657	0.3482**
-0.1072	-0.0798	0.0483	-0.0368	-0.0648	0.0705	-0.0843	-0.0086	0.0100	-0.0247	0.0648	0.1170
0.2858	0.0083	0.3246	0.5790	-0.0103	0.0946	0.0134	0.1691	-0.1031	-0.0065	-0.6099	0.0159
0.0693	0.0484	-0.0904	0.1225	0.1566*	0.9074**	0.0457	0.1275	-0.0713	0.0053	-0.2043**	-0.0147
-0.0415	0.0368	0.0719	0.0328	0.0175	-0.1824**	-0.0996	0.0129	0.0085	0.0493	-0.0426	-0.0326
0.0017	0.1755**	-0.0678	-0.1628*	-0.0363	-0.0110	-0.0281	0.0568	-0.1141	-0.0513	0.1172	0.0646
0.0490	0.0139	-0.4705**	-0.0207	0.0900	0.1735*	0.0793	-0.0345	0.1276	0.0205	-0.0926	-0.1187
0.0624	0.0806	0.6009**	0.1173	-0.0085	-0.1243	0.0129	0.0498	-0.0261	0.0125	0.1480*	0.1012
-0.0700	-0.0412	0.5270**	0.0792	-0.0832	-0.0864	-0.0510	0.0266	-0.1577*	0.0035	0.1639*	0.0201
0.1876**	0.0354	0.8152**	0.5752**	-0.0763	0.0010	0.0035	0.2053**	-0.1737*	-0.0091	-0.3328**	0.0701
0.1370*	-0.0080	0.7856**	0.1782*	-0.0936	0.0586	-0.0825	0.1116	-0.0373	-0.0126	-0.0195	-0.0030
1.0000	0.0137	0.1140	-0.0532	0.0387	0.0890	-0.0255	-0.0714	-0.0233	-0.0041	-0.1552*	-0.0928
0.0137	1.0000	-0.0411	0.1162	-0.1429*	0.0323	-0.0115	0.1885**	0.0329	0.0991	-0.1082	0.1622*
0.1140	-0.0411	1.0000	0.2287**	-0.0402	-0.0768	-0.0157	0.1624*	-0.1265	-0.0594	0.1360	0.0792
-0.0532	0.1162	0.2287**	1.0000	-0.0485	0.0527	-0.0397	0.1457*	-0.0845	0.0189	-0.4675**	0.0810
0.0387	-0.1429*	-0.0402	-0.0485	1.0000	0.1989**	0.0903	-0.0103	0.0354	-0.0541	0.0273	0.0493
0.0890	0.0323	-0.0768	0.0527	0.1989**	1.0000	-0.0094	0.1308	-0.0865	-0.0075	-0.1417*	-0.0278
-0.0255	-0.0115	-0.0157	-0.0397	0.0903	-0.0094	1.0000	0.0827	-0.0097	-0.1097	-0.0463	0.2076**
-0.0714	0.1885**	0.1624*	0.1457*	-0.0103	0.1308	0.0827	1.0000	-0.2484**	0.0135	-0.0709	0.0394
-0.0233	0.0329	-0.1265	-0.0845	0.0354	-0.0865	-0.0097	-0.2484**	1.0000	-0.0881	0.0767	0.0053
-0.0041	0.0991	-0.0594	0.0189	-0.0541	-0.0075	-0.1097	0.0135	-0.0881	1.0000	-0.0962	-0.0904
-0.1552*	-0.1082	0.1360*	-0.4675**	0.0273	-0.1417*	-0.0463	-0.0709	0.0767	-0.0962	1.0000	0.0137
-0.0928	0.1622*	0.0792	0.0810	0.0493	-0.0278	0.2076**	0.0394	0.0053	-0.0904	0.0137	1.0000
0.0027	0.1486*	0.1508*	0.0988	0.0664	0.0255	0.1919**	0.0598	-0.0923	-0.0138	-0.0712	0.7136**
0.0014	0.1672*	0.1324*	0.0512	0.0738	0.0318	0.2167**	0.0684	-0.1110	-0.0502	-0.0204	0.6579**
-0.0060	0.0198	0.0406	0.0757	0.1281	0.0132	0.1107	-0.0706	-0.0807	-0.0505	-0.0671	0.3274**
-0.0490	0.0797	0.0302	-0.0050	-0.0512	0.0440	-0.0524	0.0696	0.0100	-0.0266	0.0382	0.0488
0.0195	0.6372	0.0739	0.0965	-0.1501	-0.0300	-0.0215	0.1452	-0.0384	0.1048	-0.0202	0.1246
-0.0018	0.6705	0.0123	0.1099	-0.1077	0.0638	-0.0526	0.2552	-0.0091	0.0874	-0.1052	0.0280

Appendix VIII contd.

21	22	23	24	25	26
0.1180	0.1086	-0.0183	0.0617	0.0871	0.1238
0.2771**	0.4232**	0.1934**	0.5277**	-0.0048	-0.0659
0.0114	0.0952	-0.0745	0.5043	-0.0976	-0.0635
0.1543	0.1158	0.0756	0.0024	0.0349	0.0663
0.0550	0.0520	0.0229	0.0027	-0.0245	0.0862
-0.1341	-0.1062	-0.2068	0.0055	0.0009	0.0897
0.0830	0.0330	0.0349	-0.0693	0.0942	0.1626
-0.1039	-0.0530	-0.0064	-0.0149	-0.0849	0.0419
0.1036	0.1078	0.1156	0.0060	0.0554	0.1302
-0.0218	-0.0503	-0.0733	-0.0332	0.0594	-0.0923
0.1546*	0.1105	0.0484	-0.0221	0.1033	0.0826
0.0464	0.0397	-0.0619	0.0550	0.0648	0.0311
0.0027	0.0014	-0.0060	-0.0490	0.0195	-0.0018
0.1486*	0.1672*	0.0198	0.0797	0.6372	0.6705
0.1508*	0.1324	0.0406	0.0302	0.0739	0.0123
0.0988	0.0512	0.0757	-0.0050	0.0965	0.1099
0.0664	0.0738	0.1281	-0.0512	-0.1501	-0.1077
0.0255	0.0318	0.0132	0.0440	-0.0300	0.0638
0.1919**	0.2167**	0.1107	-0.0524	-0.0215	-0.0526
0.0598	0.0684	-0.0706	0.0696	0.1452	0.2552
-0.0923	-0.1110	-0.0807	0.0100	-0.0384	-0.0017
-0.0138	-0.0502	-0.0505	-0.0266	0.1048	0.0874
-0.0712	-0.0204	-0.0671	0.0382	-0.0202	-0.1052
0.7136**	0.6579**	0.3274**	0.0488	0.1246	0.0280
1.0000	0.9110**	0.5576**	0.0906	0.1437	0.0118
0.9110**	1.0000	0.5323**	0.2345**	0.2031	0.0058
0.5576**	0.5323**	1.0000	-0.0644	0.0823	-0.0807
0.0906	0.2345**	-0.0644	1.0000	0.0122	0.0344
0.1437	0.2031	0.0823	0.0122	1.0000	0.1402
0.0118	0.0058	-0.0807	0.0344	0.1402	1.0000

A - PQLI
B - NSI
C - Hb
0 - Per capita income
1 - Age
2 - Religion
3 - Caste
4 - Type of family
5 - Family size (males)
6 - Family size (females)
7 - Economic status
8 - Earning members
9 - Source of income
10 - Amenities at home
11 - Food expenditure
12 - Medicine expenditure
13 - Age at menarche
14 - Age at marriage
15 - Marital status
16 - Educational status
17 - Decision making
18 - Food habit
19 - % Food expenditure
20 - Height
21 - Weight initial
22 - Weight final
23 - SFT
24 - Birth weight
25 - House - R/O
26 - Amenities

* - Significant at 5% level
** - Significant at 1% level

APPENDIX IX

Association between PQLI, NSI, Hb, Per capita income, Food expenditure (%) and Education against nutrient intake

	PQLI	Hb	NSI	Per capita income	Food expn. (%)	Education	Calorie	Protein
PQLI	1.0000	0.0978	0.1091	0.1893**	0.2711**	0.5379**	-0.0719	0.0708
Hb	0.0978	1.0000	0.9249**	-0.0792	0.0648	-0.0086	-0.0013	0.0354
NSI	0.1091	0.9249**	1.0000	-0.0550	0.0657	-0.0003	0.0018	0.0267
Per cap income	0.1893**	-0.0792	-0.0550	1.0000	-0.6099**	0.1691*	0.0441	-0.0299
Food expn (%)	0.2711**	0.0648	0.0657	-0.6099**	1.0000	-0.0709	-0.0528	0.0403
Education	0.5379**	-0.0086	-0.0003	0.1691*	-0.0709	1.0000	-0.0342	0.0040
Calorie	-0.0719	-0.0013	0.0018	0.0441	-0.0528	-0.0342	1.0000	-0.9336**
Protein	0.0708	0.0354	0.0267	-0.0299	0.0403	0.0040	-0.9336**	1.0000
Cereal	-0.0195	0.0324	0.0229	0.1016	-0.0519	-0.0174	0.8503**	-0.8150**
Calcium	-0.0181	0.0220	0.0381	-0.0264	0.0511	0.0022	0.8105**	-0.8519**
Iron	0.0746	0.0335	0.0231	-0.0369	0.0442	0.0095	-0.9358**	0.9967**
Vitamin A	-0.0705	0.0158	0.0279	-0.0208	0.0175	0.0140	0.8555**	-0.8898**
Thiamine	0.0765	0.0310	0.0221	-0.0362	0.0448	0.0130	-0.9375**	0.9966**
Niacin	0.0169	0.0880	0.1172	-0.0119	0.0046	0.0197	0.4537**	-0.4682**
Riboflavin	0.0678	0.0161	0.0149	0.0042	0.0461	0.0028	-0.8711**	0.9359**
Vitamin C	-0.0851	-0.0080	0.0050	-0.0650	-0.0640	-0.0043	0.6361**	-0.6062**

Appendix IX contd.

Cereal	Pulse	Fat	Calcium	Iron	Vit. A	Thia-mine	Niacin	Ribo-flavin	Vit. C
-0.0195	0.0757	-0.0417	-0.0181	0.0746	-0.0705	0.0765	0.0169	0.0678	-0.0851
0.0324	0.0326	-0.0266	0.0220	0.0335	0.0158	0.0310	0.0880	0.0161	-0.0080
0.0229	0.0280	-0.0365	0.0381	0.0231	0.0279	0.0221	0.1172	0.0149	0.0050
0.1016	-0.0039	0.0407	-0.0264	-0.0369	-0.0208	-0.0362	-0.0119	0.0042	-0.0650
-0.0519	0.0183	-0.0919	0.0511	0.0442	0.0175	0.0448	0.0046	0.0461	-0.0640
-0.0174	0.0122	0.0620	0.0022	0.0095	0.0140	0.0130	0.0197	0.0028	-0.0043
0.8503**	-0.9127**	0.6979**	0.8105**	-0.9358**	0.8555**	-0.9375**	0.4537**	-0.8711**	0.6361**
-0.8150**	0.9841**	-0.6563**	-0.8519**	0.9967**	-0.8898**	0.9966**	-0.4682**	0.9359**	-0.6062**
1.0000	-0.7913**	0.6827**	0.7267**	-0.8175**	0.7444**	-0.8193**	0.4393**	-0.7540**	0.4791**
0.7267**	-0.8472**	0.5978**	1.0000	-0.8505**	0.8672**	-0.8545**	0.4021**	-0.7967**	0.5245**
-0.8175**	0.9802**	-0.6517**	-0.8505**	1.0000	-0.8877**	0.9992**	-0.4698**	0.9281**	-0.6061**
0.7444**	-0.8888**	0.6081**	0.8672**	-0.8877**	1.0000	-0.8920**	0.3720**	-0.8319**	0.5405**
-0.8193**	0.9803**	-0.6543**	-0.8545**	0.9992**	-0.8920**	1.0000	-0.4710**	0.9323**	-0.6096**
0.4393**	-0.4326**	0.4080**	0.4021**	-0.4698**	0.3720**	-0.4710**	1.0000	-0.4797**	0.4027**
-0.7540**	0.9219**	-0.6081**	-0.7967**	0.9281**	-0.8319**	0.9323**	-0.4797**	1.0000	-0.6189**
0.4791**	-0.6125**	0.4577**	0.5245**	-0.6061**	0.5405**	-0.6096**	0.4027**	-0.6189**	1.0000

* - Significant at 5% level
** - Significant at 1% level

APPENDIX X

Association between PQLI, NSI and Hb against certain anthropometric measurements and indices

PQLI	NSI	Hb	Age	Height	Wt-i	BMI-i	WHRI-i	WHPI-i	BI-i	Wt-f	BMI-f	WHRI-f	WHPI-f	BI-f
1.0000														
).1091	1.0000													
).0978	0.9249**	1.0000												
0.0438	0.0023	-0.0061	1.0000											
0.1181	0.3482**	0.1170	-0.0147	1.0000										
0.1180	0.2771**	0.0144	0.0550	0.7136**	1.0000									
0.1975**	0.1808*	-0.0450	-0.0708	0.6289**	0.7896**	1.0000								
0.1975**	0.1808*	-0.0449	-0.0708	0.6288**	0.7897**	0.4773**	1.0000							
0.1225	0.3066**	0.0350	0.0460	0.8061**	0.9894**	0.7926**	0.7926**	1.0000						
0.0507	0.0427	-0.1065	0.0897	0.0226	0.7154**	0.5015**	0.5014**	0.6076**	1.0000					
0.1086	0.4232**	0.0952	0.0520	0.6579**	0.9110**	0.7256**	0.7256**	0.9037**	0.6420**	1.0000				
0.1924**	0.2833**	0.0187	-0.0857	0.5556**	0.6769**	0.9383**	0.9383**	0.6828**	0.4123**	0.7588**	1.0000			
0.1923**	0.2833**	0.0186	-0.0857	0.5556**	0.6768**	0.9383**	0.9383**	0.6828**	0.4123**	0.7588**	0.5075**	1.0000		
0.1167	0.4342**	0.1073	0.0432	0.7748**	0.9228**	0.7455**	0.7455**	0.9379**	0.5426**	0.9856**	0.7572**	0.7572**	1.0000	
0.0203	0.1989**	0.0015	0.0800	-0.1486*	0.4727**	0.3202**	0.3200**	0.3689**	0.8225**	0.6450**	0.4373**	0.4373**	0.5075**	1.0000

APPENDIX XI

Association between haemoglobin and bioavailability of iron against selected blood cell constituents and indices (n=20)

Hb	RBC count	Platelet count	PCV	MCV	MCH	MCHC	Total protein	Albumin	Globulin	A/G ratio	Bioavailability (iron)
1.0000											
0.8747**	1.0000										
0.2356	0.1965	1.0000									
0.6840**	0.5693**	0.2013	1.0000								
-0.2197	-0.4744*	0.0111	0.4530*	1.0000							
-0.3991	-0.7736**	-0.1714	-0.2540	0.5656**	1.0000						
-0.0013	0.0873	-0.1374	-0.7144**	-0.8618**	-0.1005	1.0000					
0.1925	0.2229	0.3832	0.2174	-0.0074	-0.2207	-0.1450	1.0000				
0.3139	0.3890	0.5132*	0.1773	-0.2214	-0.3571	0.0265	0.5399*	1.0000			
0.0694	0.1105	0.2007	0.1288	0.0273	-0.1147	-0.1287	0.7008**	0.4536	1.0000		
0.2109	0.2224	0.1326	0.0530	-0.1885	-0.2261	0.1085	-0.3255	0.2963	-0.6637**	1.0000	
0.5091*	0.4757*	0.1554	0.2821	-0.2208	-0.2617	0.0579	0.0837	0.2661	0.1830	0.0198	1.0000

* - Significant at 5% level
** - Significant at 1% level

APPENDIX XII

Association between haemoglobin and bioavailability of iron against selected blood cell constitutents and indices (n=10)

Hb	RBC count	Platelet count	PCV	MCV	MCH	MCHC	Total protein	Albumin	Globulin	A/G ratio	Serum iron	TIBC	%TIBC saturation	Ferritin	Bioavailability (iron)
1.0000															
0.8863**	1.0000														
-0.0531	-0.1974	1.0000													
0.6230*	0.5416	-0.5382	1.0000												
-0.3806	-0.5852	-0.3006	0.3648	1.0000											
-0.0408	-0.4828	0.1721	0.0706	0.6027*	1.0000										
0.4471	0.4397	0.4735	-0.4098	-0.8824**	-0.1564	1.0000									
0.2893	-0.1929	0.0987	-0.4064	-0.1783	-0.0662	0.1817	1.0000								
0.0177	0.0435	0.2843	-0.4094	-0.4432	-0.0742	0.5047	0.6224*	1.0000							
-0.1156	-0.0701	-0.1047	-0.2552	-0.1686	-0.0326	0.1894	0.8644**	0.5123	1.0000						
0.1422	0.0793	0.2074	0.0911	0.0000	0.0001	0.0000	-0.7403	-0.0609	-0.8417**	1.0000					
0.5929	0.6067*	0.2111	-0.0151	-0.6865*	-0.2985	0.6737*	0.0686	0.2808	0.1176	0.0629	1.0000				
-0.1027	0.0638	-0.0123	-0.2356	0.1566	-0.4457	-0.4566	-0.0996	-0.4559	-0.1007	-0.0420	0.0016	1.0000			
0.4067	-0.1260	-0.1547	-0.0128	0.1272	-0.4995	-0.4519	0.3285	-0.2623	0.1546	0.3388	-0.0493	0.7907**	1.0000		
-0.0458	0.1106	0.0178	0.2549	0.1234	-0.4565	-0.4218	-0.2030	-0.4741	-0.1766	0.0485	0.0128	0.9907**	0.7104*	1.0000	
0.2469	0.2433	0.0640	0.5041	0.2058	-0.1871	-0.3650	-0.5455	-0.5512	-0.5394	0.3992	-0.0456	0.7798**	0.3414	0.8286**	1.0000

* - Significant at 5% level
** - Significant at 1% level

ABSTRACT

NUTRITIONAL PROFILE OF PREGNANT WOMEN WITH REFERENCE TO IRON

By

JUNA L. PAUL

ABSTRACT OF THE THESIS
SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE OF
MASTER OF SCIENCE IN HOME SCIENE
(FOOD SCIENCE AND NUTRITION)
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF HOME SCIENCE
COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM

1999

ABSTRACT

The study entitled "Nutritional profile of pregnant women with reference to iron" comprises information on the influence of various socio-economic and dietary factors on the development of iron deficiency in pregnant women.

The pregnant women surveyed were classified into four groups based on selected socio-economic variables. They were Hindus (forward communities) residing in joint/extended families and had their own homes and source of income were not from regular employment. Eventhough educated they had no role in social organisations and decision making. Expenditure on food was high but was insufficient in quantity and quality. This was reflected in the daily meal pattern adopted by these women. Their diets contained very low amounts of iron enhancers and haemopoetic constituents but high amounts of iron inhibitors.

Daily time utilization by the women revealed judicious distribution. Energy expenditure and consumption pattern also revealed positive balance in energy utilization. However anaemia was widely prevalent among these women. Anthropometric measurements also indicated deficient nutritional profile.

Data generated from micro samples on food intake by weighment was also supporting the information elicited through recall method from macro samples. Bioavailable iron from their diets was also found to be low. Haematological findings through laboratory analysis confirmed the data generated through clinical examination.