Supplementation of A Low Cost High Calorie, High Protein Mix for Selected Pregnant Women

BY

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Introduction

I INTRODUCTION

Malnutrition is widespread in India mainly due to pervasive poverty (UNICEF, 1986). It is a problem of considerable magnitude amidst the vulnerable sections and expectant mothers are the worst sufferers of malnutrition. Its association with poverty in pregnancy is for reaching in consequences in terms of maternal mortality and low birth weight (Devadas, 1990).

Over 125,000 Indian mothers die every year from pregnancy related causes and statistics reveal that India's share in maternal mortality is disproportionately high, compared with the rest of the developing world (Carriere, 1989). Maternal mortality due to malnutrition in India stands at a staggering figure of 370 per 1,00,000 births (Baum, 1980). The main cause of widespread malnutrition is primarily lack of food, poor purchasing power, incomplete knowledge about nutrition and recurrent infection. These are responsible for its persistence in the poor communities (Gopalan, 1988).

The state of health and nutrition of the mother during pregnancy have profound influence on the health and development of the growing foetus (Perkin, 1981). The foetus inutero consistently makes increasing demands on the

mother as its nutritional needs gradually increase as pregnancy advances (Sai, 1986).

The average Indian diet consists primarily of cereals and pulses contributing to about 80 per cent of the total calorie intake. Pulses which are about ten per cent of the food grain consumption are the major source of protein of this cereal based diet (Ali, 1987).

The nutritional status of the Indian pregnant women belonging to the poor socio-economic group is far from satisfactory (Venkatesh, 1988). Researches from various parts of India show that the diets of the expectant mothers are inadequate in quality as well as quantity (Indian Council of Medical Research, 1988). The calorie intake of these women is only around 1200 to 1600 and protein nearly 40g, that too, mainly from vegetable sources (Isaac, 1988).

When the mother's diet is nutritionally inadequate she cannot transfer the required nutrients to the foetus. Hence the foetus tries to draw the nourishment from the mother's body reserves. When the physiological reserves of the mother are poor specially in case of prolonged under-nutrition, the mother or the foetus or both may suffer the stress of pregnancy (Indian Council of Medical Research, 1986). Thus mothers who are marginally deficient in nutrient reserves pass to frank malnutrition. This

weakens her and increases the risk of serious complications (Rawtani and Varma, 1989).

Low income is the major factor associated with dietary inadequacy (Mixon et al., 1986). Pregnant women of low income group in India do not normally increase their food intake during pregnancy (Ramalingaswamy, 1984). Besides this, with large family and financial obligations they usually neglect their dietary intake. Thus low income not only limit their food purchase but also the availability of food to the expectant mothers (Bagchi, et al.,1986).

Surveys indicate that there is a high incidence of malnutrition among the vulnerable groups of the poor socio-economic group. Fifty to sixty per cent of women belonging to the low socio-economic group are anaemic in the last trimester of pregnancy. A significant number of women enter pregnancy with depleted or no iron reserve because of previous pregnancies or menstrual loss. The relatively small amount or iron in the diet and the low stores of iron are inadequate to meet the increased iron requirements of pregnancy (Kumar and Kumar, 1988). Complications of pregnancies both foetal as well as maternal can result in an anaemic mother. Infants of anaemic mothers are frequently born with subnormal iron stores.

Low birth weight with subsequent increased infant morbidity and mortality are the immediate consequences of maternal anaemia (Bergum, 1989). High incidence of premature births, IUGR, perinatal mortality and post partum haemorrhage are associated with anaemia (Prema et al., 1981).

Various researches indicate that the weight gain of Indian women of the low socio-economic stratum is only about 6 to 7kg during pregnancy (Raman, 1980). Women who weigh too little lack the nutritional reserve required for healthy pregnancy (Rinehart, 1988). Women who are ten per cent or below the standard weight for height before pregnancy have an increased risk of complications during pregnancy (Mora, 1980).

Severe preeclampsia may develop in women who are markedly underweight at conception and who fail to gain weight normally during antenatal period (Olsen, 1980). Weight gain of the mother reflects on the foetal weight (Rohit, 1981). Inadequate weight gain increases the potential for low birth weight and perinatal mortality (Herrera et al.,1986).

Thus in India chronic undernutrition and imbalances in the intakes of food are major issues which adversely affect the pregnancy outcome (Devi, 1980). In addition,

maldistribution of food within the family and/or community, customs and beliefs in relation to food habits and poor environmental sanitation adversely affect the pregnancy outcome (Swaminathan and Gopalan, 1987).

Since the dietary intake of the low income group is low, there is a very large, calorie gap (Puri et al.,1983). The crucial factor that determines the maternal nutritional status and pregnancy outcome is the energy deficit that occurs due to the gap between the energy intake and energy expenditure. Among the poorer segments of population physical work during pregnancy cannot be reduced without serious social, economic and domestic sequelae (Ramachandran, 1989).

The third trimester of pregnancy is of particular importance for the growth of the foetus. Increasing the energy intake would raise the birth weight greatly and contribute to the reduction in maternal and infant mortality rate (WHO, 1981). Supplementation is the short term answer to tide over this crisis as it involves the provision of an extra amount of nourishment. Data from the studies undertaken in the National Institute of Nutrition, India and INCAP, Gautemala demonstrated that food supplementation during pregnancy results in improvement in birth weight and reduction in prematurity rate

(Varadarajan, S., 1983). Encouraged by such data, almost all developing countries embarked on food supplementation programmes for pregnant and nursing mothers. Many national supplementary programmes have been geared towards the nutritional needs of the expectant mothers. However, viability of such programmes is questionable since their success and continuity depends on the food aid and subsidies they receive (Bhooma et al., 1982). One of the major problems in food supplementation programmes is food sharing within the family of the recipient resulting in the target group getting the supplements only in insignificant quantities (Gopalan, 1989).

Nearly all these programmes have been research or pilot projects because a large on going effort would be quite expensive. These programmes face many other difficulties besides the high cost. Programmes should focus on those most in need and should identify those who would benefit most from supplementation amidst the undernourished expectant mothers. A further problem is ensuring that women eat the supplement and not give it away and not consume less at home (Sekar et al., 1988). Obviously these above facts may be responsible for the lack of beneficial effects. Thus, inspite of the various nutritional efforts in India, the number of chronically underfed pregnant women is still several millions. How to meet their needs

and improve their nutritional status is a tremendous task facing India (Devadas et al., 1982). Though many nutritious commercial supplements are available, they are mostly expensive and beyond the economic reach of the majority in India. Therefore, there is an urgent need to develop satisfactory mixes from locally available resources for use (Indian Council of Medical Research, 1986). Protein supplements of high nutritive value can be prepared by suitably blending two or more vegetable protein sources (Khader and Rao, 1987).

Hence the present study was undertaken with the following objectives:

1. To develop a low cost high energy - high protein supplementary mix using under exploited millets and soya flour and advocate it to the under-nourished mothers

2. To evaluate the effectiveness of supplementation on maternal weight gain, blood picture and infant weight at birth

3. To correlate the different parameter values to the birth weight of the new borns

Review of Literature

II REVIEW OF LITERATURE

The Review of Literature for the study on 'Supplementation of a low cost high calorie, high protein mix for selected pregnant women' is presented under the following headings:

A. Nutritional significance during pregnancy

B. Consequences of undernutrition

C. Existing dietary pattern of Indian pregnant women

D. Efforts taken in India to improve the nutritional status of pregnant women and

E. Need for supplementation with low cost nutritious food

A. Nutritional significance during pregnancy

Nutrition is the essence of life and women is the mother of life. Good nutrition in pregnancy sustains and nurtures life (Hofvander, 1983). Good nutritional status both before and during pregnancy is essential to provide an adequate supply of nutrients for the growth and development of the maternal tissues, maintenance of maternal stores and growth of the foetus and placenta (Virgina, 1980).

The growing foetus in utero constantly makes increasing demands on the mother. Upto the 12th week

the embryo relies wholly on the surrounding tissues for its nourishment, but after the 12th week nourishment is solely derived from the mother. It is therefore, necessary that throughout pregnancy the mother pays special attention to the kind and quantity of food (Agashe, 1989).

The energy requirement in the non-pregnancy state largely depends upon the woman's basic metabolism and extent of physical activity. During pregnancy, the energy requirements are elevated because of the increased basal metabolic rate, the additional energy required for the growth of maternal tissues and for the growth of the foetoplacental unit (Narayanan, 1989).

The total cost of pregnancy has been worked out to be 75,000 kcals (Ebrahim, 1983). Calorie expenditure increases sharply near the end of the first trimester and remains fairly constant until term (Chandra and Agarwal, 1986). In the second trimester most of the energy costs are attributed to maternal factors like the expansion of blood volume, enlargement of uterus and breasts as well as fat storage. In the third trimester mostly energy is needed for the growth of the foetus and placenta (Picone, et al.,1982).

Studies on nutritional requirements during pregnancy suggest that there is a need for an extra allowance of

300 kcal per day during the second and third trimesters. This has been computed on the basis that there is an increase in body weight during pregnancy and the extra energy needed to carry out normal activities cost as much as 20 per cent more energy. This is equivalent to a 15 per cent increase over the non-pregnant needs (Ramachandran, 1989).

About 925g protein is deposited in the foetus and maternal tissue during pregnancy. The rate of deposit in these tissues averages 0.6, 1.8, 4.8 and 6.1g daily during the four quarters of pregnancy (Food and Nutrition Board, 1980). Intake of one gram of protein per kilogram body weight plus 14g extra to meet the additional needs is essential (ICMR, 1989). It is advisable therefore to have atleast 50 per cent of this quantity as good quality protein (Widdowson, 1981).

During pregnancy iron requirement is increased markedly. Extra iron is needed for the expansion of mother's blood volume and also to meet the needs of the foetus and placenta. The total iron requirement during pregnancy is approximately 1000mg (Kumar and Kumar, 1988). Requirements during the first trimester are relatively small, 0.8mg per day, but rise considerably during the second and third trimester to as high as 6.3mg per day

(DeMaeyer, 1989). The daily iron requirement is six times greater for a woman in the last trimester of pregnancy than for a non pregnant women (Subramaniam, 1988).

Calcium and phosphorus are important elements for skeletal growth and there is an increased need of these during pregnancy (Antia, 1989). There is evidence of increased efficiency of calcium absorption during pregnancy. Placenta rapidly transfers these mineral from maternal to foetal circulation (Guthrie, 1986). There is also a progressive net retention ofthis in the growing foetus and the foetal content of calcium is directly related to its weight (Macintosh et al., 1989). During pregnancy there is a greater need for extra calcium of 300 - 400mg per day for foetal bone growth. To provide this level of extra calcium in addition to the normal need, an additional intake of one gram of dietary calcium has been suggested during pregnancy (ICMR, 1988).

Since the folate requirement is considerably increased during pregnancy, an additional intake of 300mg of folate over and above the normal intake of 100mg per day is essential (ICMR, 1980). An extra intake of 0.5mg of vitamin B_{12} has also been suggested during pregnancy Rao, 1989).

B. Consequences of undernutrition

Pregnant women constitute the most vulnerable segment of the population, and women in the reproductive period constitute about 2.3 per cent of the Indian Population (Mitra, 1988). Maternal nutrition is a well known determinant of foetal growth (Tyagi, 1989).

The nutritional needs during pregnancy include needs of increased amounts of protein, calories, minerals and vitamins above the normal allowances. A continuous supply of protein is necessary for the foetus to grow and develop. Protein is needed for the enlarging placenta, uterus and breasts (Davis, 1983). Additional protein is needed during pregnancy for the synthesis of maternal and foetal tissue. Adequate calorie intake is necessary for maximum utilization of protein for tissue synthesis (Shackelton, 1984).

Evidences show that there is increased risk associated with low protein intakes. Severe protein restriction during foetal life is associated with a decrease in the number of cells in tissues at the time of birth. The number of brain cells are likely to be reduced if the mother's diet is deficient in proteins. This may have long term effect on brain development and mental facilities (Helan, 1986).

There is evidence that, energy deficit of the maternal diet is the main limiting factor of foetal growth in many deprived areas of the developing countries (Briend, 1979). Increased intake of calories by 10 per cent is needed in normal pregnancy. Severe caloric restriction is harmful (Bhatt, 1981). Kilocalories restriction results in restricting the supply of nutrients and use of dietary protein for energy rather than for foetal and maternal protein synthesis. Also it results in excess fat catabolism and ketosis. Ketosis is hazardous to the neurologic development of the foetus (Rohif Susan, 1987).

A poor weight gain during pregnancy is a cause of serious concern because it is generally associated with low birth weight and probably high perinatal mortality (Poleman, 1989). Severe pre-eclampsia may develop in women who are markedly underweight at conception and who fail to gain weight normally during the antenatal period (Olson, 1980).

The growth of the foetus is restricted in severe maternal malnutrition as it affects the mental and physical development of the foetus (Singh, et al., 1990). Anaemia is common among pregnant women. WHO estimates that three out of every five pregnant women in developing countries are

anaemic, that is, their blood levels of haemoglobin is less than 11g/dl (Rinehart, 1988).

There is enough evidence that vegetarian diet inhibits the absorption of iron because of high phytate content. In India folic acid deficiency is reported to contribute significantly in the development of nutritional anaemia during pregnancy. The mean daily intake of folic acid was much lower than the ICMR recommended dietary allowance for pregnancy (ICMR, 1981).

Poor vitamin A status in the mother is one of the factors associated with prematurity and IUGR (Antiseptic, 1981). Adequate calcium is essential during pregnancy in their diet to prevent softening of bone and for the adequate growth of the foetus (Nagpal, 1989). If extra supply of calcium is not available from the diet then the calcium stores in the bones of the mother will be depleted. In extreme cases this will lead to osteomalacia (Antia, 1984).

According to Venkatachalam and Rebello (1983) poor maternal diet increases not only the risk of a series of complications during gestation but also often results in a difficult and some times prolonged labour. High rate of abortions and still births together with a fairly high prevalence of low birth weight and perinatal mortality

reflect poor state of maternal health and nutrition (Gopalan, 1987).

Malnutrition of the mother is a major cause of miscarriage and abortions. Gopalan says that 16-19 per cent of pregnancies among low income groups ends up in miscarriage and abortions. More detailed work indicates that 16-19 per cent is a gross underestimate of the true extent of wasted pregnancy in malnourished Indian communities (Gopalan, 1988).

For every single maternal mortality, there are atleast 20 women who suffer from morbidity. Anaemia is found in 60 to 80 per cent of poor urban and rural women. Anaemia is one of the important causes of maternal morbidity and it is a major nutritional problem in India as well as in developing countries (WHO, 1972).

C. Existing dietary pattern of Indian pregnant women

Under nutrition is the major problem affecting the health of the expectant mothers in the developing countries (Krause, 1984). The dietary surveys from different parts of India reveal that the diets of expectant mothers belonging to the low socio-economic group is deficient in quality as well as quantity (Menon, 1983). The nutrient intake of the women of child bearing age is grossly deficient

in nutrients when compared with the recommended allowances (Srikantia, 1989).

The main reasons for their poor intake of the nutritious food are poor purchasing power, ignorance regarding the nutritive value of the available less expensive food materials, cultural taboos and beliefs and large size of the families (Isaac, 1988).

The average Indian diets consists primarily of cereals contributing to about 80 per cent of total calories (Ali, 1987). Household surveys conducted by NNMB reveal that cereals and millets predominate in the diets of almost all the expectant mothers of all states in India, the lowest being in Kerala and highest in Karnataka (Rao, 1989).

The intake of protective foods like pulses, leafy vegetables, fruits, milk and fleshy foods are uniformly low in all states (Gopalan, 1989).

Studies from India show that women from the low income group take around 1200-1600 kcals per day. There is no increase in dietary intake during pregnancy (NIN Ann. Report, 1981). The dietary intake is lowest during the first trimester. This may be due to the food aversion connected with pregnancy as well as vomiting related with morning sickness (Agashe, 1989).

Pulses which contribute to about ten per cent of the food grain consumption are the major sources of protein in the cereal based diets. These vegetable proteins are poor in quality (Tandon et al., 1988). Besides these, their diets are deficient in essential minerals and vitamins (Kaul, 1975).

Surveys carried out in South India by Srikantia and Iyengar (1972) reveal that the diets of poor women during pregnancy provide only 1400-1800 kcals and 40g protein per day, all protein being of vegetable origin mostly derived from a single cereal. They observed that families with three or less children have a better energy intake of around 300 kcals and ten grams protein daily than families with four or more children.

In South India papaya which is an excellent source of vitamin A is avoided in fear of abortion. In the same way pumpkin, jack fruit, mangoes and jaggery are tabooed as hot foods (Begum, 1989). Also in certain places quantity of foods consumed during pregnancy is also cut down fearing a difficult delivery (Ghosh, 1981).

D. Efforts taken in India to improve the nutritional status of the expectant women

Supplementary feeding programmes have been one of the important measures to fight against malnutrition especially in developing countries, for over a quarter century. In India a large number of such programmes have been in operation both on adhoc and longitudinal basis (Devadas et al., 1983).

Different agencies such as CARE, CASA, UNICEF and FAO have assisted in the implementation various such programmes. Some have been 'On the spot' feeding type while others have been the 'take home' variety. Mostly these have operated through MCH centres, day care centres like creche, Balwadis and also through Integrated programmes like ICDS (Rao, 1983).

Programme designers and programme operators of supplementary feeding programmes anticipated to improve the nutritional status of the vulnerable group directly and indirectly they expected this to serve as an incentive for people to utilise other health care facilities including preventive and curative services (Rao, 1975). Though various types of feeding programmes are in operation through out India, malnutrition still criples the life of many especially the vulnerable group. Experience of feeding

programmes over the two decades has given definite indication that the benefits are often not measurable as they are mainly stop gap arrangements to alleviate malnutrition (Pushpamma, 1983).

Feeding programmes which have so far been employed were at best amiliorative measures. They have not produced lasting impressions because they were not coupled with activities which lead to improved purchasing power and better utilization of existing resources (Srikantia, 1983).

The attitudes and practices of functionaries at all levels were also not conducive to get reasonable returns, if not optimum results. The beneficiaries also always conceived the feeding programmes as a welfare measure in terms of monetary benefits (Swaminathan, 1983).

Besides, since most of these programmes have been research or pilot projects, they have not looked at changes in maternal morbidity or women's long term nutritional status (Hamilton et al., 1984). However these feeding programmes have been effectively operating through out the country with an aim of fighting against malnutrition among the vulnerable groups. Efforts are continuously on the way towards investigating the nutritional benefits of the feeding programmes (Premakumari, 1990).

E. Need for supplementation with low cost nutritious food

In many developing countries where malnutrition is a public health problem, supplementary feeding has been a major type of intervention (Srikantia, 1983). A wide variety of such intervention programmes have been in existence in India. These programmes have been implemented to raise the level of nutritionof the vulnerable segments of the population (Swaminathan, 1983).

Millions of people in India lack the minimum means to compete for food and obtain nutritionally a balanced diet (Varadarajan, 1983). Studies on Indian expectant mothers belonging to the low socio economic group reveal that the average calorie consumption per day is only 1390, 1520 and 1650 kcals during the first, second and third trimesters. Their protein intake is also sub-optimum (WHO, 1982). Thus the daily calorie gap may be as much as 500 to 600 kcals and this shortfall is reflected in the subsequent health of both the mother and child (Chatterjee, 1984). The use of protein calorie rich food supplementation therefore will fill in the gap among the expectant mothers (Kothari, et al., 1985).

Various studies have shown that there is significant increase in mean birth weight when there is food supplementation during pregnancy. The time at which food is provided

influences the effectiveness of supplementation (Gormican et al., 1981). Supplementation throughout pregnancy poses many practical problems as three per cent of the Indian population is always in the pregnancy stage. Therefore the critical period for effective supplementation is the third trimester since maximum intrauterine growth occurs in this period (Biswas, 1988).

A good programme therefore must identify an appropriate good supplement which supplies what is missing in the habitual diets of the pregnant women and also which is inexpensive locally available, simple to prepare and acceptable (Rinehart, 1988).

Since animals proteins are in short supply and costly, plant proteins have received considerable attention by virtue of their availability, low cost nutritional attributes (Sulebele, 1988).

Though efforts are being taken in the development and utilization of small millets, by and large their potentials are still underexploited. There is very little information on their flexibility of being used as culturally acceptable food product (Mosse, 1989). Although minor millets are consumed by certain segments of the low socio-economic groups of Indian population, the total

consumption of these is meagre. However, minor millets have a higher protein content than major cereals and also the quality of their proteins are better than cereal proteins. Their methionine content is quite high compared to other cereals (Eggum, 1989).

Among such under exploited millet, foxtail millet or Thenai (Stetaria italica) seems to have a higher nutritive value. It has been reported that in recent years foxtail millet has gained more popularity thereby there is a large scale propagation in India (Mosse et al., 1989). Protein quality of this millet is superior to many other millets as well as cereals. It has a fairly good content of lysine and a high content of methionine in which pulses are deficient (Ganapathy, 1972). Another millet which can supplement the diets of women of the poor, segment of Indian population is little millet or Samai (Panicum milliaredam). Its crude protein ranges from 11 to 16.5 per cent (Ramanathan, 1975).

In comparison to major cereals, minor millets are highly nutritious. However, they have not been in the priority list of Scientists, Agriculturalists and Nutriticnists. In recent years, some attempts are being made to increase the utilization of minor millets by exploiting their nutrient contribution and possibility of increased production (Geervani et al., 1989).

Sesame (Sesamum indicum) is one of the most ancient widespread and valuable oil seeds, which contains about 50 per cent oil and 25 per cent protein with a favourable balance of amino acids (Antoinette et al., 1980). Among the oil seed proteins, sesame is a exceptionally rich source of sulphur amino acid methionine and thus, this can serve as a very useful supplement in protein formulations (Subramaniam, 1980).

Soya bean, the 'wonder bean' is being accepted as a solution to the protein energy gap in the developing countries because of its high protein and energy concent (Soya Convention Report, 1987). In recent years soya protein has been utilised in many food preparations. It is being blended at different proportions with cereals, millets or pulses in order to make a wide range of supplementary foods (Gandhi, et al., 1983).

The improvement of the nutritional status of the rural communities cannot be brought about through adhoc and isolated supplementary feeding programmes. Adhoc feeding programmes, expensive as they are, can at best bring about only a temporary amelioration of malnutrition. The solution to the problem of malnutrition in India, does not call for expensive protein concentrates. It can be solved only by a judicious use of inexpensive local foods which

are available within the reach of the economically deprived population (Devadas, 1982). The most urgent and important need of the day is therefore, supplementation coupled with nutrition education. Educating the people about nutrition making them nutrition conscious and helping them to utilise the local resources to improve their diets appear to be the only solution to overcome malnutrition (Venkatrao, 1984).

Methodology

III METHODOLOGY

The methodology of the study on "Supplementation of a low cost high-calorie high protein mix for selected pregnant women" is dealt under the following headings:

A. Selection of the area

B. Selection of the sample

C. Selection of the tool

D. Conduct of the study and

E. Analysis of the data

A. Selection of the area

Valubai Vendaravan Shah maternity Home and Ramkurbai Maternity Home of the Coimbatore Corporation were chosen for the study. These hospitals were selected as expectant mothers from the low socio-economic group obtain antenatal check up regularly and required sample as well as the willing co-operation of the hospital authorities could be obtained.

B. Selection of the sample

The sample consisted of 150 expectant women who were in the third trimester of pregnancy and who were attending the antenatal clinics regularly were selected for the study. The third trimester was chosen because maximum rate of foetal growth takes place during this period when the weight of the

baby virtually doubles (Ebrahim, 1983). All the selected expectant mothers belonged to the low socio-economic group. Evidence from studies indicate that low socio-economic status of the mother has a direct relationship to low birth weight babies because of their poor dietary intake high suceptibility to infection and multiple pregnancies (Nadig, 1988). Care was also taken to see that all the expectant mothers were residents of Coimbatore City, co-operative and available for the investigator throughout the study period. Among 150 selected expectant mothers, a sub-sample 50 mothers were selected for the supplementation study. Selection of the samples were made on the basis of their poor weight gain. The sub samples were further divided equally into two groups for the purpose of supplementation as experimental group and control group.

C. Selection of the tool

Part I

A detailed interview schedule was prepared in two parts (Appendix A) to elicit information on socio-economic background, nutritional status and health status of the expectant mothers. As interview is effective in obtaining responses from the respondents in a face to face contact, this method was chosen for the study (Sindhu, 1987).

The parameters used to assess the intra-uterine growth

were weight gain (kg), abdominal girth (cm), fundal height (cm), haemoglobin, albumin, total blood protein and globulin. These parameters were chosen because they serve as simple indices for monitoring foetal growth (ICMR, 1980). The analytical procedures are appended (Appendix B).

Part II

Preparation and development of the high protein-calorie mix

The investigator formulated a high protein mix consisting of inexpensive, locally available, less exploited millets such as thenai (Setarica Italica) and samai (Panicum milliareham), defatted soya flour, gingelly seeds and jaggery. Millets were decorticated before incorporating in the mix. Dry whole millets such as thenai and samai have a fibrous seed coat, which is often indigestible and bitter in taste. Decortication increase digestibility and improves palatability and keeping quality (Siegal and Fawcett, 1976). Dehusking also eliminates the toxic substances and antinutrients of the seed coat (Babu, 1976).

Grains are usually malted to develop or activate enzyme systems in order to make the starch soluble and improve flavour. Besides germination enhances the nutritional value of grains, by increasing digestibility and availability of essential amino acids and vitamins such as thiamine, niacin and ascrobic acid (Fernandaz et al., 1988). Hence malting was done by soaking the dehusked millets for a period of 4 hours followed by malting with 15 per cent of already germi-

nated whole thenai for a period of 12 hours.

Heating process effectively eliminates most of the antinutritional toxic and bitter substances present in certain legumes and millets (Gupta et al., 1987). Therefore, after the completion of the malting process, these millets and the soya flour were roasted and the grains pulverised. Roasting was done as it improves the flavour, texture and the nutritive value of the product.

Jaggery was added to improve the palatability and elevate the caloric content of the mix. Gingelly seed was incorporated as it is an exceptionally rich source of sulphur containing amino acid methionine, it serves as an useful supplement in protein formulations in which the methionine is lacking (Subramanian, 1980).

The amino acid content of the mixes was calculated and the chemical scores worked out to match the amino acids of the mix with that of the reference protein, egg. (Appendix C). This mix was planned and prepared in five different combinations and were subjected to the taste panel (Appendix D) and (Figure 1). The taste panel consisted of 15 members and 75 per cent of the panel opted for the combination mix V. The composition of Mix V is given in Table I.

THE FIVE DIFFERENT MIXES

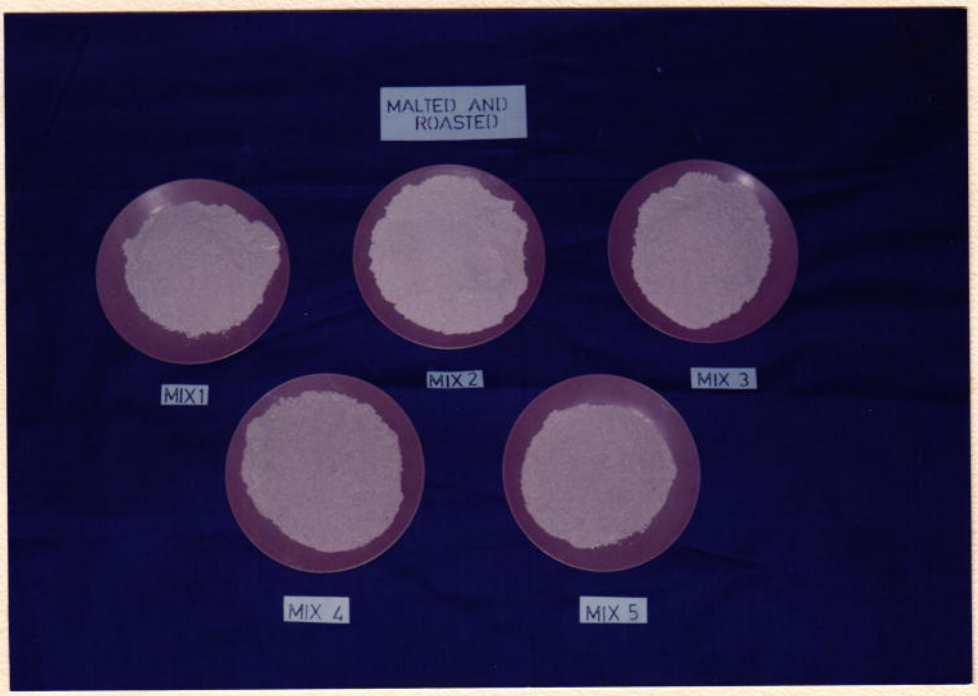


FIGURE - 1

TABLE I

COMPOSITION OF MIX V

Components (g)	Per cent
Thenai	25
Samai	20
Soya flour	25
Gingelly seed	10
Jaggery	20

The calculated nutrient content of Mix V is presented in Table II.

TABLE II

NUTRIENT CONTENT OF MIX V

Nutrients	Per sachet (100g)
Energy (Kcal)	392
Protein (g)	18
Calcium (mg)	232
Iron (mg)	7
β caroteine (µg)	121
Thiamine (mg)	0.5
Riboflavin (mg)	0.2
Niacin (mg)	3

The amino acid pattern of mix V comparision with egg protein with its chemical scores is depicted in Table III.

TABLE III

THE AMINO ACID PATTERN OF MIX V WITH ITS CHEMICAL SCORES

Amino acids (mg)	Mix V	Egg protein (mg)	Chemical score
Lysine	836.8	937.2	89
Tryptopnan	206.0	191.7	107
Phenyl alanine	914.7	766.8	119
Methionine	323.9	447.3	72
Threonine	620.3	681.6	91
Leucine	1674.9	1107.6	151
Isoleucine	953.9	873.3	109
Valine	935.7	958.5	97
Histidine	402.5	319.5	126

The cost of the mix was also calculated according to the market price of the items and the total computed cost was Rs.7.90/kg of the mix. Computation of the cost is shown in Table IV.

TABLE IV

COST OF MIX V PER SACHET

Components	Cost/kg (Rs)	Amount (g)	Cost (paise)
Italian millet (Thenai)	1.20	25	0.030
Samai (little millet)	1.20	20	0.024
Soya flour	9.00	25	0.225
Gingelly seed	35.00	10	0.350
Jaggery	8.00	20	0.160
		100	0.79

The different components of the powder mix were mixed thoroughly under hygenic conditions, and portions of 100g of the product were packed in sachets. These sachets were taken to the field for the distribution.

D. Conduct of the study

Phase I

Information on economic background, nutritional and health status.

The selected sample were interviewed and information regarding their age, parity, para of pregnancy and economic background were collected using the first section of the interview schedule.

Information regarding their nutritional status was obtained qualitatively through 48 hours recall schedule. Data on the frequency of consumption of food items, special foods consumed during pregnancy, food cravings and aversions, ommission of foods due to beliefs, coffee consumption and overt pica were also obtained.

Weighment survey was conducted for ten per cent of the sample for a period of three consecutive days. From the measurements of the food items raw equivalents were calculated. Details of the past and present obstetric histories were obtained through the third part of the schedule. Information on indirect causes of poor pregnancy outcome was also obtained.

Serial measurements of weight gain (kg) of the mother, abdominal girth (cm), fundal height (cm) were taken every month from seventh month of pregnancy to term by using plastic measuring tape. Three and a half millilitres of blood sample was drawn both at the commencement of the study for the entire group and at the end, from the experimental and control group alone for comparative purposes. Haemoglobin, albumin and total blood proteins were estimated from both the blood samples.

Phase II

Supplementation

Hundred grams of the power mix in the sachet was given to the supplementary group every day for a period of three

months from seventh month to term in their own homes. The subjects were asked to mix the mixture with hot water and consume it on the spot. This was done to ensure complete consumption of the mix. This supplement was well tolerated and generally, acceptance was very good. Birth weight of the new born, placental weight and its diameter were also recorded for the control and supplemented group.

E. Analysis of the data

The average daily food intake and nutrient intake were computed and compared with the dietary and nutrient allowances recommended by ICMR for pregnant women. Percentage analysis was done for other dietary habits, history of obstetric complications and maternal risk factors. Correlation was done between the monthly parameter values as well as the blood picture and the weight of the newborn. The effect of supplementation on the experimental group was assessed by the use of test of significance on the mothers anthropometric measurement, birthweight of the newborn, placental weight, placental diameter and blood picture of the control and supplemented groups.

Results and Discussion

IV RESULTS AND DISCUSSION

The results of the study on 'Supplementation of a low cost high calorie, high protein mix for selected pregnant women' are discussed under the following headings:

A. Findings of the survey

1. Occupation and income status of the selected pregnant women
2. Nutritional status of pregnant women
3. History of past obstetric complications
4. Maternal risk factors in the pregnant women

B. Anthropometry, Haemoglobin and blood protein picture of the selected pregnant women and their correlation with the new born's birth weight

C. Effect of supplementation

1. Anthropometric profile of the control and supplemented groups during the third trimester
2. Haemoglobin and blood protein picture of control and supplemented groups
3. Comparison of birth weight of the new born to the placental weight and placental diameter of control and supplemented groups

1. Occupation and income status of the selected pregnant women

Of the total sample of 150, only 11 had taken up employment outside as domestic servants. The rest were home makers. Seventy seven per cent had a monthly income of Rs.200 to 500 and the remaining had a monthly income of Rs.500 to 1000. The mean monthly income of the selected sample was Rs.419.

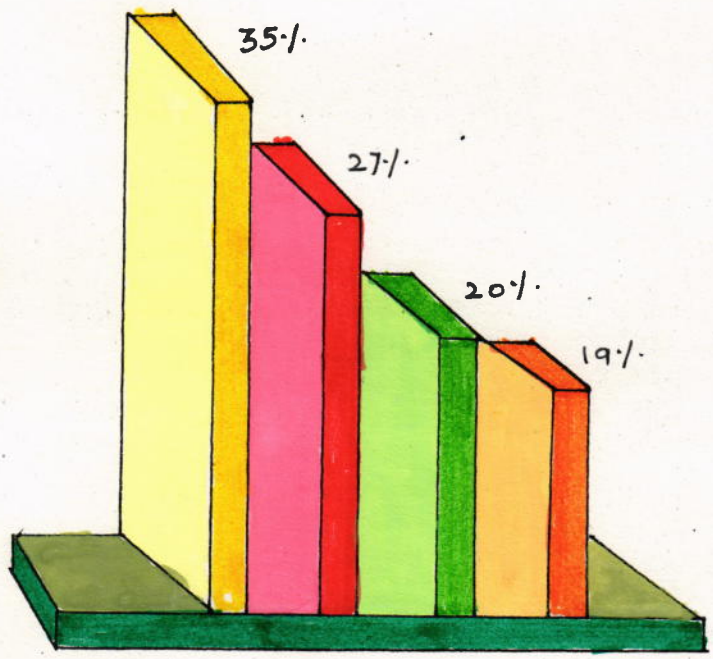
2. Nutritional status of the pregnant women

The aspects studied were food consumption pattern through recall survey method, frequency of consumption of body building and protective foods, mean food intake by weighment survey, mean nutrient intake, special foods consumed during pregnancy, food cravings and aversions during pregnancy, food fads, habits of betal chewing and craving for non food items.

a. Food consumption pattern through recall survey

The food consumption pattern of the sample is presented in Table V and Figure 2.

FOOD CONSUMPTION PATTERN THROUGH RECALL SURVEY



CEREALS ALONE

CEREALS AND PULSES

CEREALS, PULSES AND VEGETABLES

CEREALS, PULSES, VEGETABLES, FRUITS, MILK AND ITS PRODUCTS

FIGURE -2

TABLE V

FOOD CONSUMPTION PATTERN THROUGH RECALL SURVEY

Foodstuffs	Number (150)	Percentage
Cereals alone	52	35
Cereals and pulses	28	19
Cereals, pulses and vegetables	40	27
Cereals, pulses, vegetables, fruits and milk and milk products	30	20

Nearly one third of the sample consumed cereals alone, while 27 per cent consumed pulses and vegetables along with cereals. Twenty per cent of the sample had wholesome diet. Dietary surveys conducted in different parts of India have revealed that the diets of the poor income groups are grossly deficient both in quantity and quality (Ramachandran, 1986).

b. Frequency of consumption of body building and protective foods

Eighty one per cent of the selected pregnant women consumed mainly cereal. Consumption of green leafy vegetables and milk and milk products were rather meagre. Seventy five per cent of the sample consumed fleshy foods occassionally.

c. Mean food intake of the pregnant women

The mean food intake of the pregnant women is presented in Table VI and Figure 3.

TABLE VI

MEAN FOOD INTAKE

Food stuffs (g)	RDA ICMR (1981)	Experimental group (g)	Per cent deficit or surplus
Cereals (Rice)	475	363	-24
Pulses	60	30	-50
Green leafy vegetables	100	22	-78
Other vegetables	40	31	-23
Roots and tubers	100	40	-60
Fruits	30	33	+10
Milk	325	200	-38
Fats and oil	30	15	-50
Sugar and jaggery	30	25	-17

The computed mean food intakes were poor compared to ICMR recommendations (1989). With the exception of fruits all the other food items were much below the recommended values. Gross inadequacy was noted in green leafy vegetable consumption followed by roots and tubers, pulses and oil consumption. The per cent deficit was found to be 78, 60, 50 and 50 respectively. Ignorance regarding the

FOOD INTAKE

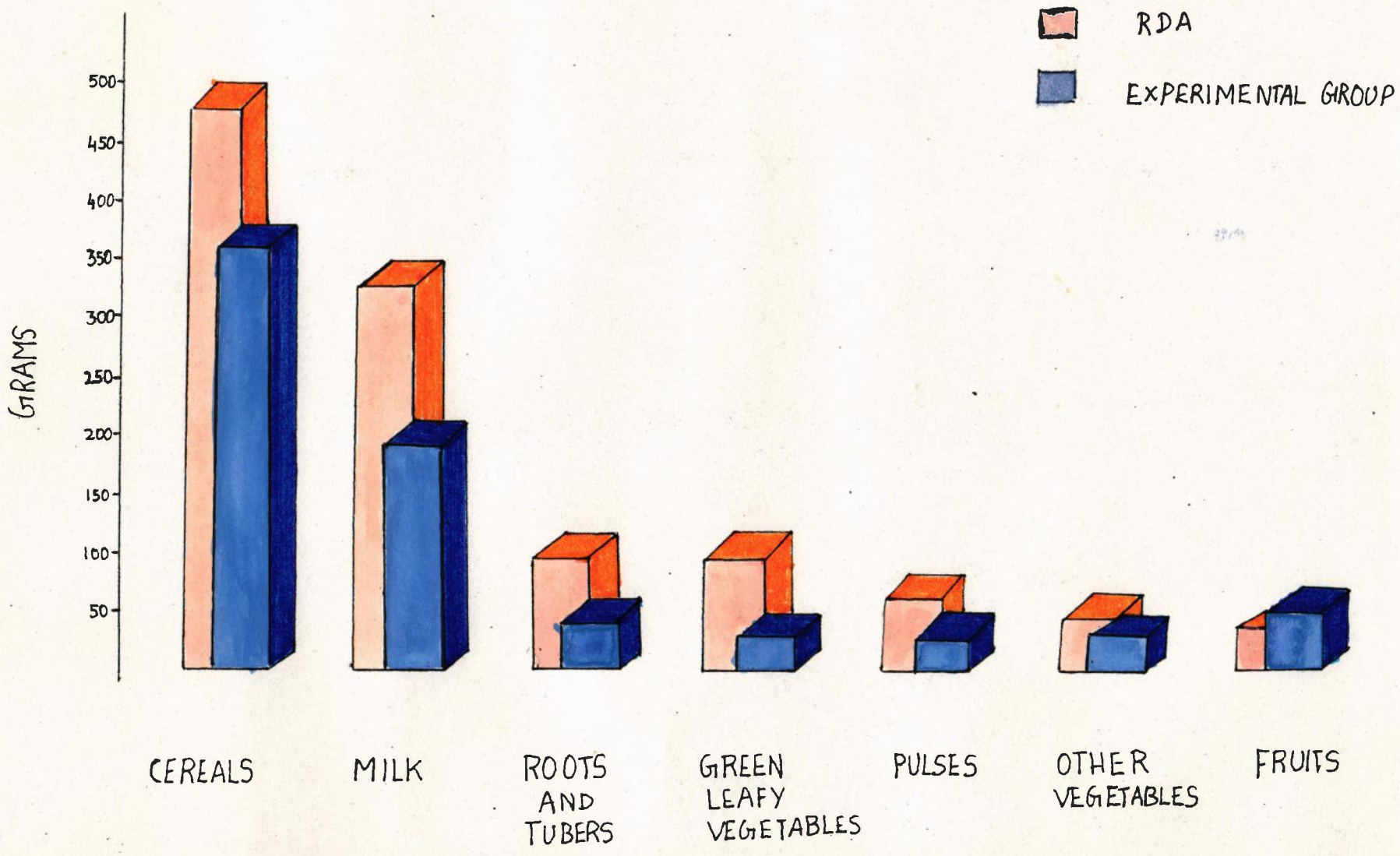


FIGURE - 3

nutritive value of readily available, inexpensive food materials along with poor purchasing capacity are responsible for the low intake of nutritious food. Also above 40 per cent of India's population lives below the 'poverty line' which cannot afford even the least expensive balanced diet (Agashe, 1989).

d. Mean nutrient intake of the pregnant women

The mean nutrient intake of the pregnant women in comparison with ICMR (1989) recommended allowances is depicted in Table VII.

TABLE VII

MEAN NUTRIENT INTAKE

NUTRIENTS	RDA ICMR (1989)	Consumption n=150	per cent deficit or surplus
Energy, Kcal	2100	1670	-20
Protein, g	65	49	-25
Calcium, mg	1000	366	-63
Iron, mg	38	24	-37
Retinol, µg	600	283	-53
Thiamine, mg	1.1	1.9	+73
Riboflavin, mg	1.3	1.5	+15
Niacin, mg	14	12	-14
Vitamin C, mg	40	38	-5

Observing the nutrient intake of the expectant mothers, it was noted that the nutrient intake was lower than the ICMR recommendations. Pronounced inadequacy was noted

in the intake of calcium and Retinol. On an average the mothers had taken only 1670 Kcal showing a deficit of 20 per cent. This is in line with the findings of various dietary surveys that the calorie intake of low income group ranges from 1200-1600 Kcal per day (Gopalan, 1986).

The protein intake was only 49 g showing a deficit of 25 per cent. Except thiamine and riboflavin, all the other nutrients were lower than the recommended allowance. Data based on NNMB reveal that nutrient intake of women is lower than RDA in the case of energy, calcium, iron, vitamin A and folic acid (Rao, 1989).

e. Special foods consumed during pregnancy

All the sample expressed that special foods such as meat, fish and egg were included in their diets occasionally. Though many believed that the protein rich and protective foods are essential for healthy pregnancy, due to financial restraints they could not incorporate these into their diets.

f. Food cravings and aversions

Food cravings and aversions are common features during pregnancy. Twenty six per cent of the expectant mothers expressed a strong desire for fleshy foods while 12 per cent had shown a liking for sour items. However, 74 per cent had expressed aversion for fleshy foods.

Ninety two per cent of the study group did not include

papaya in their diets for fear of abortions. Eight per cent avoided pineapple for the same reason. Due to tradition and habits many food habits are prevailing in India. Many mistaken beliefs still prevent pregnant women from consuming nutritious food stuffs. Papaya an excellent source of β carotene, is avoided for fear of abortion (Begum, 1989).

g. Betal chewing

Thirty three per cent of the sample took sizeable quantities of betal leaves almost all through the days of pregnancy. However 67 per cent did not have this habit.

h. Craving for non food items

Craving for non food items was observed in a few expectant mothers. Eleven per cent of the pregnant women expressed their craving to consume ash. However no other non food item was expressed by the rest of the sample.

3. History of obstetric complications

The details of the history of obstetric complications are given in Table VIII and Figure 4.

HISTORY OF OBSTETRIC COMPLICATIONS

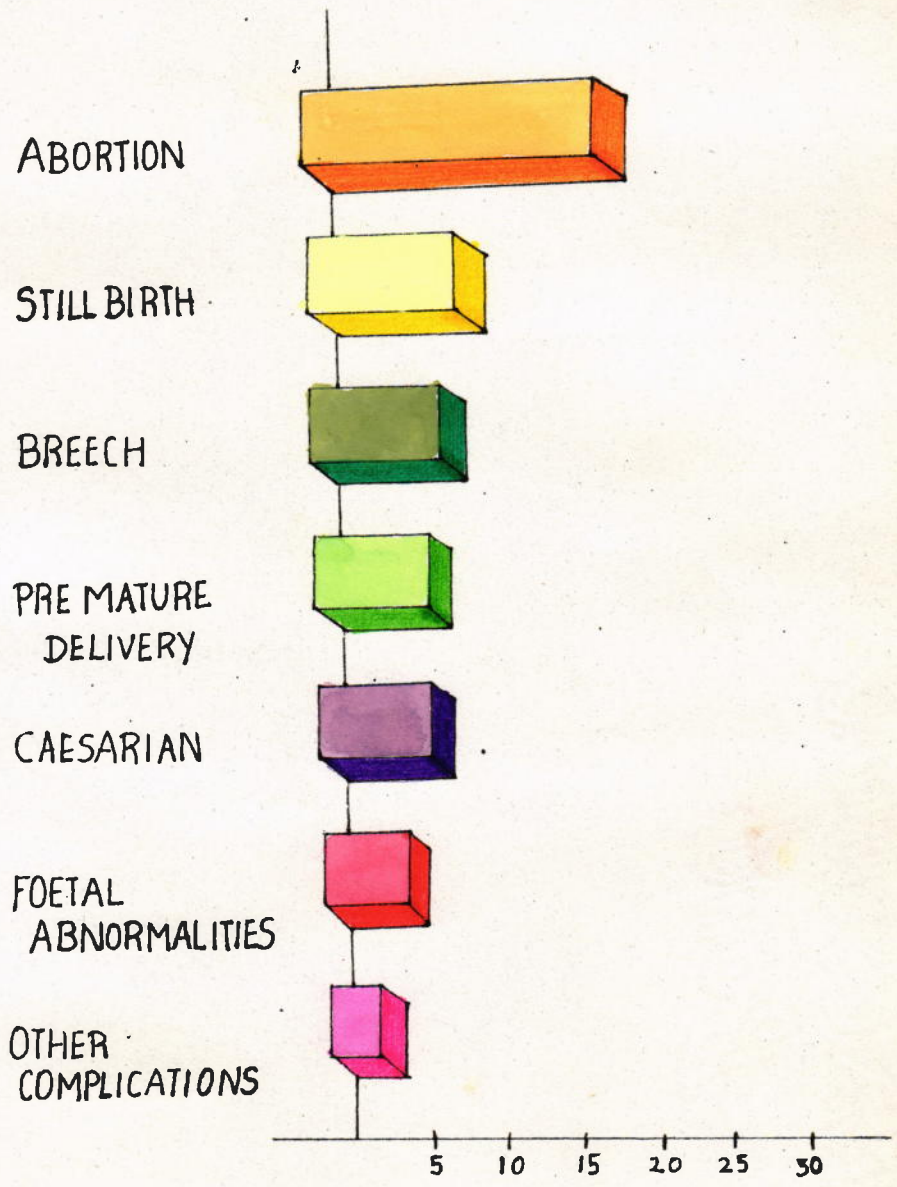


FIGURE - 4

TABLE VIII

HISTORY OF OBSTETRIC COMPLICATIONS

Obstetric profile	Number n=150	Percentage
Abortion	24	16
Still birth	11	7
Complications during pregnancy	9	6
Caesarian	7	5
Premature delivery	7	5
Fetal abnormalities	3	2
Oedema	6	4
No complications	83	55

Pregnant women who had previous reproductive loss and complications during delivery are usually graded as risk group (Datta and Das, 1990). Based on this grouping it was found that 45 per cent of the mothers fell into this group. A history of problems such as premature labour, still birth or repeated miscarriages is respective in nature and women who had a history of preterm delivery and/or spontaneous abortion in the past have an increased risk of prematurity in the succeeding pregnancies. Prematurity is an important cause of perinatal mortality and morbidity in India (Jain et al., 1988). However, 55 per cent did not have any past obstetric complication.

4. Maternal risk factors

Maternal risk factors are present in Table IX.

TABLE IX

MATERNAL RISK FACTORS

Risk factors	n=150	Percentage
Anaemia	115	77
Anaemia, diabetes combined with hypertension	17	11
Toxemia	9	6
Antepartum haemorrhage	6	4
Asthma and heart disease	3	2

Eighty eight per cent of the selected expectant mothers had haemoglobin values less than 11g per cent. Maternal haemoglobin is a good indicator of the nutritional status of the expectant mothers (Natu and Patnaik, 1988). Investigations undertaken among the women of low socio economic status reveal that the prevalence of anaemia is between 50 to 90 per cent in the third trimester of pregnancy (Gopalan and Kaur, 1989).

B. Anthropometry, Haemoglobin and serum protein picture of the selected pregnant mothers and their correlation with the new born's birth weight

Correlation of the different parameter values to the new born's birth weight is presented in Table X.

TABLE X

CORRELATION OF THE DIFFERENT PARAMETER VALUES TO THE NEW BORN'S BIRTH WEIGHT

Parameters	Third Trimester Mean	Comparision	Correlation
Weight gain (kg) (X_1) S.D	4.14 ± 0.79	BW Vs X_1	0.41894
Abdominal girth, cm (X_2) S.D	7.51 ± 1.89	BW Vs X_2	0.37635
Fundal height, cm (X_3) S.D	6.88 ± 1.64	BW Vs X_3	0.18534
Haemoglobin, g% (X_4) S.D	8.89 ± 1.56	BW Vs X_4	0.28386
Total serum proteins, g% (X_5) S.D	6.25 ± 0.78	BW Vs X_5	0.29458
Serum albumin, g% (X_6) S.D	3.66 ± 0.81	BW Vs X_6	0.29816

* Birth weight 2.7kg

Correlation computation of the parameter values reveal that there is a positive correlation between the parameters and the birth weight. This is in line with the findings of various researches that the fundal height and abdoxminal girth are highly correlated with birth weight (Gopalan, 1986). Thus the birth weight of the new born is an indication of the maternal helath and nutritional status.

C. Effect of Supplementation

1. Anthropometric profile of the control and supplemented groups during the third trimester

The details of the weight gain, abdominal girth and fundal height of the 'control' and 'supplemented' groups during the third trimester are shown in Table XI and Figure 5.

TABLE XI

ANTHROPOMETRIC PROFILE OF THE CONTROL AND SUPPLEMENTED GROUPS

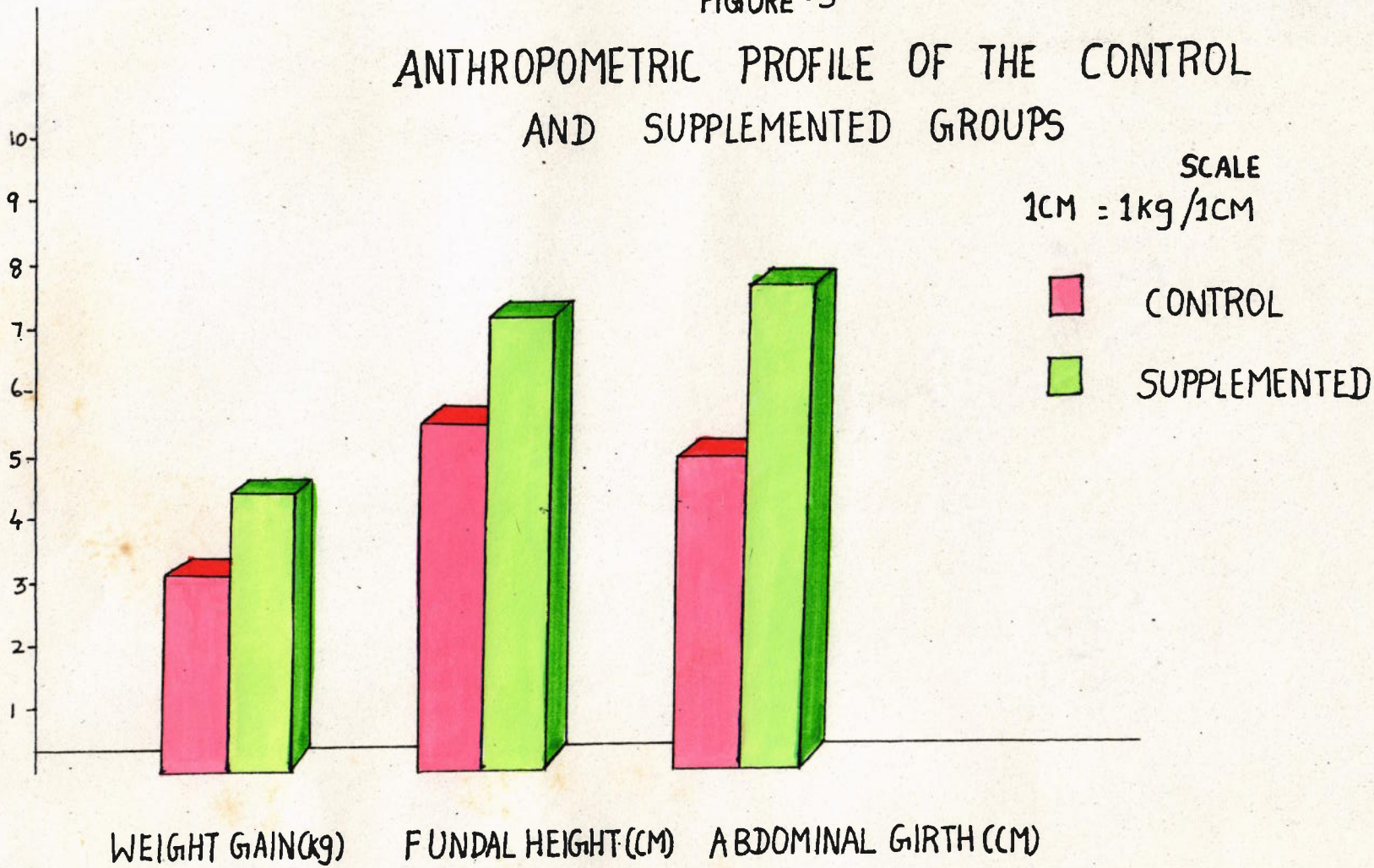
Parameters		Control group n=25	Supplemented n=25	't' value
Weight gain (kg)	mean	3.05	4.39	
	S.D	± 0.4022	± 8393	7.187 **
Fundal height (cm)	mean	5.31	7.18	
	S.D	± 1.29	± 1.38	4.96 **
Abdominal girth	mean	5.02	7.27	
	S.D	± 1.32	± 1.14	6.44 **

** Significant at one per cent level.

The mean weight gain observed at term for the supplemented group was 4.39 kg as compared to 3.05 kg for the control group. As revealed by the statistical appraisal, the weight gain of the supplementary group during the third trimester is significant at one per cent level. The expectant

FIGURE -5

ANTHROPOMETRIC PROFILE OF THE CONTROL AND SUPPLEMENTED GROUPS



mothers who received the supplementary mix had shown a better picture compared to the control group both in fundal height as well as abdominal girth values.

Weight gain is a common parameter used for the assessment of foetal growth and maternal health. Several studies have shown that the weight gain pattern after supplementation is more pronounced in women who are undernourished (Dawn and Mitra, 1990).

Longitudinal studies of National Institute of Nutrition, Hyderabad indicate that the abdominal girth and fundal height increase by about eight centimeters during the third trimester. In this study, the supplemented group had gained seven centimeters in comparision to the control group which had gained only 4.8 centimeters. Obviously the control group had a deficit of approximately 33 per cent. The monthly increments of weight gain (kg), for the control and supplemented groups are shown in Figure 6.

2. Haemoglobin and blood protein picture of 'control' and 'supplemented' group

The haemoglobin and blood protein profile of the 'control' and 'supplemented' groups are given in Table XII and Figure 7.

FIGURE - 6

THE MONTHLY INCREMENTS OF WEIGHT GAIN FOR THE CONTROL AND SUPPLEMENTED GROUPS

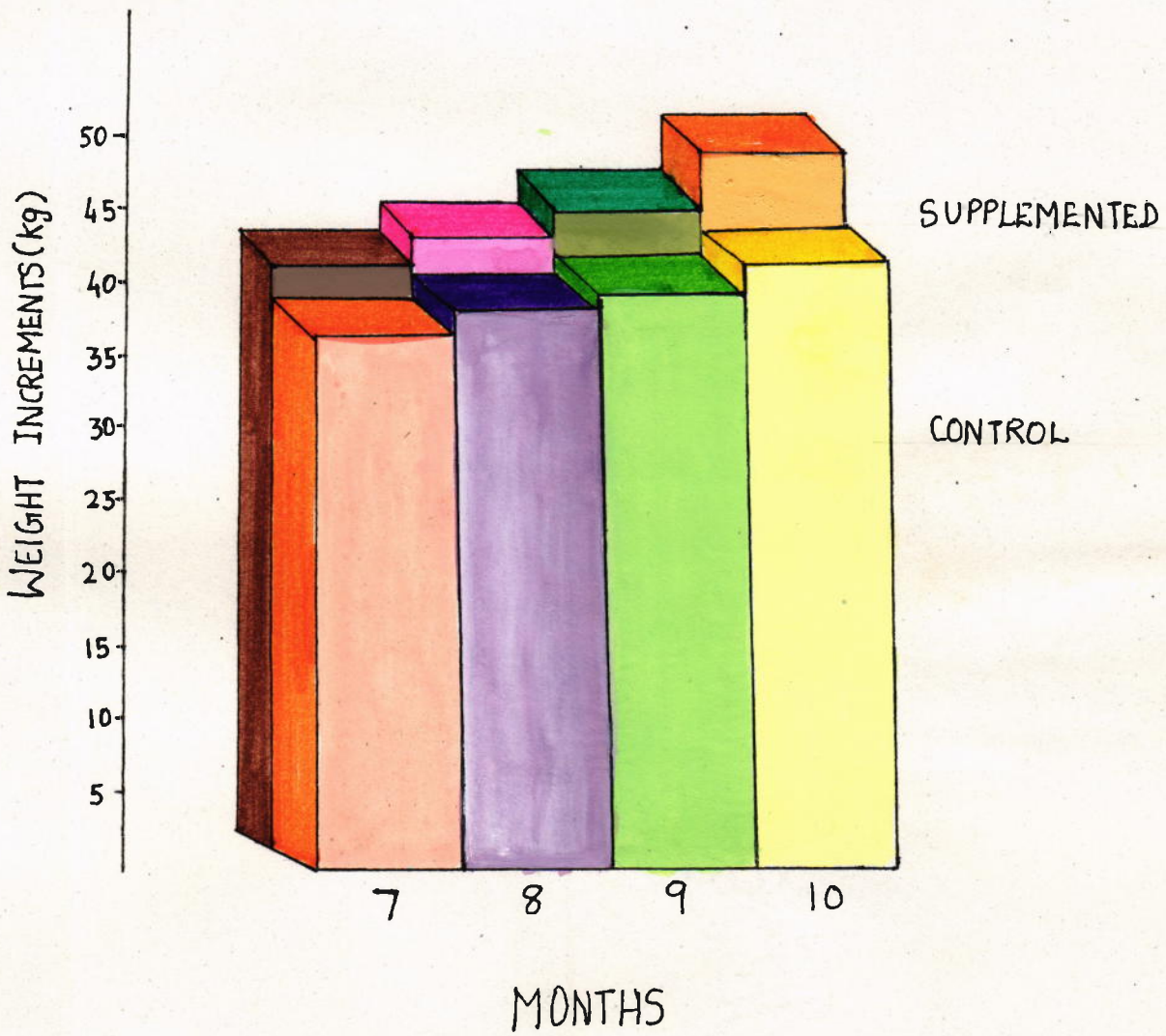


TABLE XII

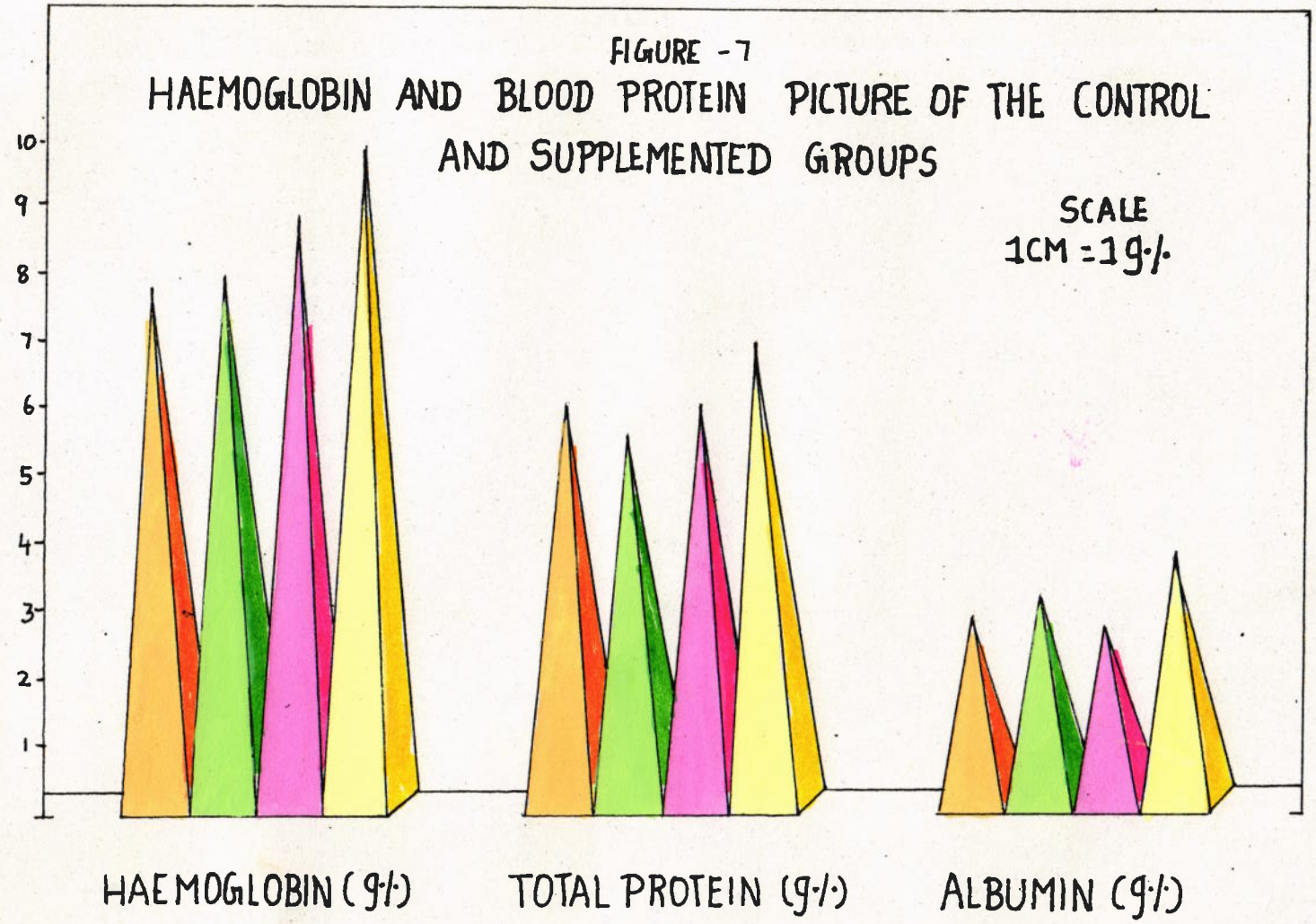
HAEMOGLOBIN AND BLOOD PROTEIN PROFILE OF THE 'CONTROL' AND 'SUPPLEMENTED' GROUPS

Parameters	control		supplemented		't' value
	Commencement of the study n=25	End of the study n=25	Before supplementation n=25	After supplementation n=25	
Haemoglobin (g%) mean	7.7	8.3	7.8	9.3	
S.D	± 0.61	±1.28	±0.6	±1.32	2.89 **
Total protein (g%) mean	5.7	5.9	5.8	6.5	
S.D	± 0.47	±0.41	±0.45	±0.46	4.54 **
Albumin (g%) mean	2.9	3.1	2.9	3.8	
S.D	± 0.34	±0.27	±0.34	±0.53	5.95 **

** Significant at one per cent level

FIGURE -7

HAEMOGLOBIN AND BLOOD PROTEIN PICTURE OF THE CONTROL AND SUPPLEMENTED GROUPS



The mean haemoglobin values of the supplemented group had improved from 8.3 g per cent to 9.3 g per cent at term. This value is lower than accepted normal value of 11.0 g per cent recommended by WHO (Demaeyer, 1989).

As compared to the control group, the supplemented group had gained more total blood proteins and albumin. Albumin is the index of protein nutrition and hence the effect of the supplementary mix is seen in the elevation of the albumin level in the supplementary group.

3. Comparision of birth weight of the newborn to the placental weight and placental diameter of the control and supplemented groups

Comparision of birth weight of the new born to the placental weight and placental diameter of the control and supplemented groups are shown in Table XIII and Figure 8.

TABLE XIII

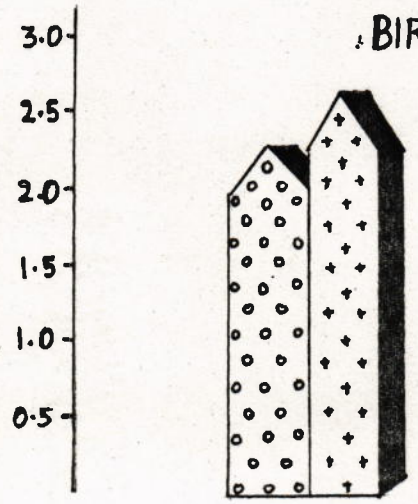
COMPARISION OF BIRTH WEIGHT OF THE NEWBORN TO THE PLACENTAL WEIGHT AND PLACENTAL DIAMETER OF THE CONTROL AND SUPPLEMENTARY GROUPS

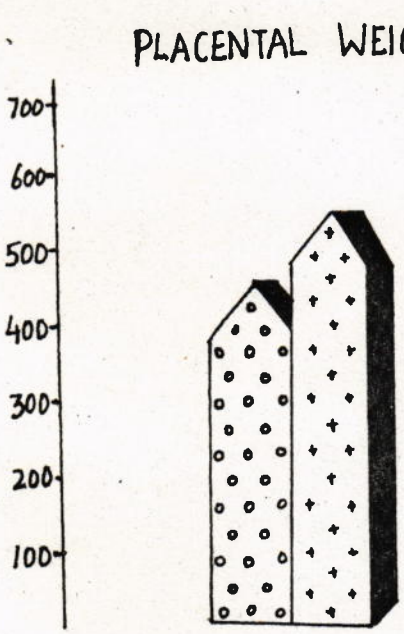
Parameters	Control n=25	Supplemented n=25	't' value
Birth weight (kg)			
mean	2.29	2.58	
S.D	± 0.21	± 0.32	3.95 **
Placental weight			
mean	410.74	541.15	
S.D	± 104.98	± 138.38	3.83 **
Placental Diameter			
mean	13.69	15.72	
S.D	± 0.86	± 2.34	4.03 **

** Significant at one per cent level.

The average birth weight of the infants born to the supplemented group was significantly higher (2.58 ± 0.32 kg) than the control group (2.29 ± 0.21 kg). The difference though small is statistically significant. The birth weight of infants born to the South Indian mothers of low socio economic group had been found to be between 2700 and 2800 g for the past four decades (Srikantia, 1989). In a study of pregnant women receiving supplementary nutrition of 300 Kcals and 16 g protein in the last trimester of pregnancy in an urban Integrated Child Development Service showed significantly higher weight gain as compared to the

COMPARISION OF BIRTH WEIGHT OF THE NEW BORN TO THE PLACENTAL WEIGHT AND DIAMETER OF THE CONTROL AND SUPPLEMENTED GROUPS





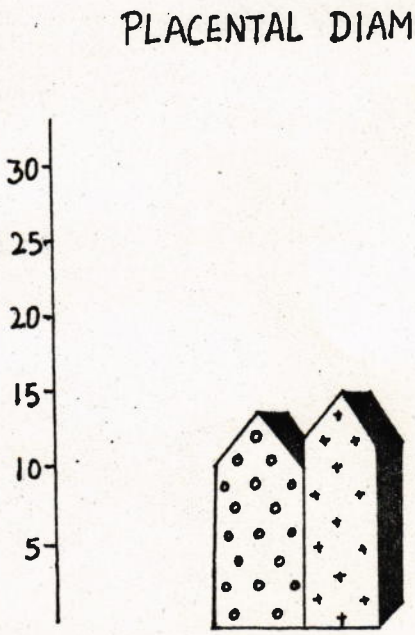


FIGURE - 8

similar group of unsupplemented women (Shakuntala et al, 1983). Adequate antenatal care combined with effective food supplementation would show substantial improvement in pregnancy outcome in undernourished communities (Gopalan, 1989).

The placental weight and diameter of the supplemented group were higher than those of the control group. Statistical analysis between the values registered by the control and supplementary groups revealed that the difference was significant at one per cent level.

Available data indicates that the reduced placental weight and circumference in foetal malnutrition can be raised by improving the maternal nutrition (Achari et al, 1988).