Anaemia, Iron Fortified Salt Supplementation And Work Output

BY

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Introduction

I. INTRODUCTION

Malnutrition today has emerged as the major health problem of the developing world. Martorell (1985) points out that nutritional surveys have shown that small adult statures are a common feature in developing countries and this has been attributed to chronic under nutrition during the period of active growth.

Satyanarayana et al (1985) warn that growth retarded children end up as small adults. Evidence is not lacking to substantiate the relationship between malnutrition, small body size and impaired work performance and productivity. Spurr et al (1986) point out that in developing countries where large segments of the adult population constitute the labour force involved in moderate to heavy physical labour, the economic implications are obvious.

According to David and Richard (1977) "Malnutrition in a society results in a degradation of the human being which in and of itself is a social problem that cries for solution". This subjective hypothesis implies that regardless of the economic pay-off a society should do all within its power to improve the health and nutrition status of its population which is an indicator of development.

Gwatkin (1983) an economist has recently reviewed studies regarding the influence of better health on greater wealth. Normal nutrition is an important part of an individual's health and is inseparable from achievement and maintenance of positive health status. Health and nutrition together could account for five percent of economic progress of Latin American countries, according to him.

Devadas (1988) indicates that work capacity and work out put depend on the quality and quantity of their calorie and nutrient intake and the resulting nutritional status. She further notes that productivity of the labour force in developing countries is generally low. This has been attributed to their poor physique resulting from chronic malnutrition. Poor nutrition appears to restrain productivity in terms of out-put per unit of input. Wide spread malnutrition thus cripples the nation's productivity.

Lathan (1976) reports that improved nutrition can have a favourable effect on both the percapita income and quality of life.

Viteri et al (1981) states that increased food availability for the working force can result in desirable changes, in their work behaviour.

Productivity is related to life span. The economic implications of life span is largely negated by the surplus of labour commonly available in developing countries. Productivity of a work force depends on quality as wellas on nutrition that tend to lengthen life span.

Prolonged periods of malnutrition results in lethargy and sluggishness and reduces the oxygen carrying capacity resulting in a reduction in work capacity. Oxygen carrying capacity is directly related to the haemoglobin present in the blood and iron is one of the most essential nutrients which should be available for the process of haemopoiesis. As many other nutrients, iron is also lacking in most diets in developing countries, The incidence of iron deficiency anaemia is very high.

Basta (1977) point out that anaemic workers tend to be given poorer employment and so have less pay and poorer diet than healthy workers. Gatenby (1978) point out that severe anaemia in pregnant women increasing maternal morbidity and mortality involves a higher risk for the fetus.

Iron deficiency anaemia is a major health problem in developing as well as in developed countries. Finch et al (1983) point out that anaemia is more prevalent among the low income groups than among the moderate and high income group. Malnutrition contributes to high maternal mortality in developing countries. It has been computed that in a developing country, one out of every fifty women in the reproductive age dies during pregnancy; and 15-20 percent of such maternal deaths are attributed to anaemia.

Salt is a substance which is universally consumed and centrally processed. Iron fortified salt has been commercially developed by various salt procuring companies, recently. According to Vijayalakshmi et al (1986) the incidence of anaemia in rural and urban communities of India, was reduced by the introduction of salt fortified with iron.

Nadiger and Rao (1980) concludes that feeding the fortified salt for one year resulted in a significant increase in the haemoglobin value of the children. There was also a significant reduction in the prevalence of anaemia among children given the fortified salt. Pollit et al (1983) point out that there is some evidence that an acceleration of weight gain occured in anaemic children following iron supplementation therapy.

Vijayalakshmi et al (1988) point out that iron supplementation resulted in conservation of energy and increase in haemoglobin from 9.4 to 12.9 g/dl, serum iron, total iron binding capacity, packed cell volume and vital capacity. It was concluded that iron supplementation is beneficial as it increases the work output.

A solution has to be evoled for improving the nutritional status and work output of the adult population with special reference to their iron intake and hence the present study has been undertaken.

The objectives of the present study are to

1. Identify anaemic adults both men and women with suitable parameters.
2. To quantify the effect of anaemia on the physical performance of these adults.
3. Supplementation with iron fortified salt for the anaemic adults and
4. Study the impact of iron supplementation on biochemical parameters and work performance.

It is hoped that the study will throw more light and confirm the findings that iron fortified salt supplementation may be beneficial to the anaemic groups.

Review of Literature

II. REVIEW OF LITERATURE

The literature pertaining to the study on "Anaemia Iron fortified salt supplementation and work output" are reviewed under the following headings:-

I. Prevalence of Iron deficiency anaemia.

II. Anaemia and work output.

III. Studies on Iron supplementation.

IV. Factors affecting Iron absorption.

I. PREVALENCE OF IRON DEFICIENCY ANAEMIA

According to NIN report (1980) iron deficiency anaemia is an important public health problem in many developing countries. The prevalence of anaemia has been reported to range from 10 percent in adult men to 85 percent in pregnant women. Higher prevalence rates (28 to 30 percent) even among men have been observed in rural India.

Hirode (1980) and Mittal (1981) bring out the importance of iron deficiency anaemia as a major health problem, particularly among pregnant women and preschool children. Earlier studies carried out in our laboratory on poor preschool childre, showed that the prevalence of anaemia was 60 percent.

Baker and De Maeyer (1979) point out that major etiological factors of anaemia are a low intake of iron, low availability of the ingested iron and intestinal infestation such as hookworm.

Ebrahim (1975) exhort that nutritional anaemias comprise the second most common group of deficiency disorders after protein energy malnutrition. Nutritional anaemia is defined as anaemia which occurs when there is a deficiency of one or more of the essential nutrients required for the synthesis of haemoglobin and the production of erythrocytes.

WHO (1979) points out that iron deficiency prevalence was as high as 50 percent in adult menstruating women in some developing countries and over half of these had recognizable anaemia. The other extreme was seen in many developed countries where iron fortification programmes exist and where many individuals in the population voluntarily take iron supplements. In this instance, the prevalence of iron deficiency in menstruating women was as low as 10 percent. In both settings iron deficiency in the male population was, of course, much less frequent. Nevertheless, taken as a whole, the world wide prevalence of iron deficiency is exceedingly high.

Zein and Assefa (1987) found in an epidemiological survey of anaemia among Agricultural producers co-operatives

in Gondar Region, northwestern Ethiopia, the general prevalence rate of anaemia was 40.5 percent in males and 36.1 percent in females decreasing with increasing altitude.

Monitero (1985) point out that in Brazil, highest incidence of anaemia was between 6 and 24 months old children when more than half of them were anaemic. The prevalence of anaemia tended to decrease as socio economic status improved but no group was free from anaemia.

According to Rao (1974) diets of people in the lower socio economic groups in India are deficient in several essential nutrients. For this reason they suffer from protein energy malnutrition, anaemia and Vitamin A deficiency.

World Health Organisation (1974) reports that from the beginning of this century anaemia has been reported from India as a major problem among agricultural labourers, tea garden workers and especially among pregnant and lactating women. In a survey of about 4000 adult men and women it was found that 14 percent of the population studied

suffered from severe anaemia, characterized by a level of haemoglobin of less than 8.9g/100ml. The condition was most severe in pregnant women and was due to iron deficiency in nearly 85 percent of them.

Hirode (1980) report that anaemia is one of the most common complications of pregnancy. It has been estimated that between 30 and 50 percent of all pregnant women belonging to the low income groups in India have levels of haemoglobin below 10g/100ml during the third trimester of pregnancy.

Menon (1978) observed that in some parts of India as much as 10 percent of all maternal deaths are reported to be directly attributable to anaemia.

National Institute of Nutrition (1984) reports that severe anaemia with haemoglobin levels lower than 8.9g/dl is more frequently seen in severely under nourished children than in others. Severe forms of PEM are also more in children with severe or mild anaemia (8-11g/dl haemoglobin level) than in normal children with severe forms of iron deficiency also exhibit signs associated with deficiencies of calories, proteins, Vitamins and minerals.

Agarwal et al (1986) found among 100 mothers and their 109 children 3 months to 3 years old from the urban slum and rural areas of varanasi, India, prevalence of anaemia (haemoglobin value less than 12.0 and 11.0g/100ml respectively) to be 57 and 55 percent. The prevalence of anaemia among the children of anaemic mothers was 63.5 percent compared with 43.5 percent for children of normal mothers.

Gedikoglu (1979) reports that in India iron deficiency anaemia was found in all groups, especially among the children and incidence of anaemia and its severeity were greater than in developed countries. This was ascribed to socio economic factors, insufficient intake of animal protein, infectious diseases, poor hygiene, intestinal parasites and non prescription of iron during vulnerable phases of life.

According to Rao et al (1983) a haemoglobin survey in the hospital attended by urban slum population indicated that prevalence of anaemia was as high as what it was 10-15 years ago. Moderate and severe anaemia were still as high

as 30 percent and 10 percent respectively. Maternal mortality due to anaemia, however showed a reduction from 20 percent to 8 percent; probably due to better management by exchange transfusions and parenteral iron therapy.

II. ANAEMIA AND WORK OUTPUT

Nutritional anaemia is defined as the condition in which the haemoglobin content of the blood is lower than the normal as a result of a deficiency of one or more essential nutrients. Vijayalakshmi and Selvasundari (1983) point out that iron deficiency anaemia affects the physical capacity by reducing the availability of oxygen to the tissues which in turn affects cardiac output and the heart eventually leading to death in severe cases.

If young children are exposed to prolonged under nutrition their growth and development will be affected. According to NIN report (1982) body weight has been found to be one of the crucial determinants of working efficiency and work output of a person. It is therefore imperative that propernutritional care is provided to them so that from adolescence onwards, the individual can turn out the expected work load efficiently and with minimum effort.

This not only contributes to his personal economic betterment but would also greatly add to national productivity.

Satyanarayana (1977) concludes that reduced work output in a group of industrial workers was due to early malnutrition. According to Viteri, (1971) in Guatamala, that when adults known to have suffered food deprivation in childhood were provided adequate food work capacity returned to normal.

The Indian council of medical Research (1980) observed in a study that subjects who are under nourished during early life had lower work capacity status and earned lower wages, indicating the long term effects of early malnutrition.

Viteri and Torun (1974) defined physical capacity as the potential of an individual to engage in activities involved in muscle action. Such activities range from strenous exercise of short duration to mild exercise of long duration and make use of difficult mechanisms of physiological adaptation. Individual performance in acute strenous exercise leading to near exhaustion depends mostly on cardio respiratory reserve, oxygen delivery and metabolic adaptation.

WHO (1975) report points out that a reduction in haemoglobin concentration decreases the oxygen carrying capacity of the blood, which may reduce oxygen delivery to the tissues during exercise. The more severe the anaemia, the greater the reduction in near - maximum work performance.

According to Viteri and Torun (1975) when the agricultural workers received iron supplementation of 100mg/day for 6 months; both their haemoglobin concentration and their score increased in parallel fashion. The beneficial effects of iron treatment became evident within 1 month after its initiation, reached a maximum at 2 months and remained stable thereafter.

According to Viteri et al (1975) anaemia reduces the capacity to perform energy demanding task by imposing a ceiling on oxygen transport to the tissues. Gatenby (1978) point out that severe anaemia in pregnant women increases maternal morbidity and mortality and involves a higher risk for the fetus.

Edgerton and Gardner (1980) report that significantly more tea was picked when the haemoglobin concentration was increased by iron supplementation than when it was not. The degree of improvement was greater in anaemic subjects.

Lozoff et al (1980) point out that mental and physical developmental indices were significantly lower in infants of 6 to 24 months old with iron deficiency anaemia than in non-anaemic children of similar socio economic and nutritional status.

According to Gopaldas et al (1986) 30 or 40 mg of iron given daily for 60 days to under privileged school boys with initial haemoglobin 10.7 g/100ml, significantly reduced concentration of lactate in blood and improved work capacity.

Soemantri et al (1986) point out that iron treatment for 3 months resulted in increases in mean haemoglobin, haemotocrit and transferrin saturation among the Fe-deficient anaemic children. Changes in the iron status of iron deficient anaemic children were associated with significant changes in the school achievement test.

According to Vijayalakshmi et al (1986) incidance of anaemia in rural and urban communities of India was reduced by the introduction of salt fortified with iron.

Basta (1977) point out that anaemic workers tend to be given poorer employment and so have less pay and poorer diet than healthy workers. Their nutritional status ought to be improved at once, rather than wait for changes in economic and political structure.

Chitra and Edgerton (1979) point out that haemoglobin and maximal work time increased significantly within 4 days after iron treatment and continued to increase upto 16 days. Heart rates at a given exercise intensity were lower in those given iron than in control subjects who had the same haemoglobin values but had not been treated with iron.

III. STUDIES ON IRON SUPPLEMENTAION

According to Nutrition News (1986) the major cause of anaemia in our country is iron deficiency due to inadequate intake of dietary iron and its poor absorption from predominantly cereal based diets consumed by our population.

Apte (1978) observed that about 10 percent of the iron in an average Indian diet is normally absorbed. He furether points out that an intake of 20 to 30mg a day is adequate for older children and adults. The amount of iron provided by an average Indian diet of the poor income group is around 18-22 mg/day, a level that may appear to be adequate. However the high phytate and the low calcium and ascorbic acid content of poor Indian diets have now been shown to restrict the availability of iron.

Rao (1978) has shown that iron content of Indian diets is fairly adequate. The availability of the iron, however was found to be very low. It has often been stated that the iron intake of population groups in our country, computed on the basis of diet survey data represents an over estimation. Since these figures include contaminent iron present in foods as purchased. Studies undertaken during the year showed that 15 to 45 percent of iron present in cereals and pulses as purchased, constituted contaminant iron, milling of wheat on commercial mills also contributed significantly to the iron content of wheat flour, the increase ranging from 50 to 150 percent.

Nutrition Reviews (1982) warn that iron deficiency is the most common haemotologic disorder encounted world wide. Rao (1984) points out that one of the practical methods to prevent iron deficiency anaemia is to increase iron intake in the diet through fortification of a universally consumed dietary article with iron. Iron fortified salt was acceptable as a cooking salt in the place of ordinary salt. Iron fortified salt was found to reduce prevalence of anaemia significantly. Fortification of salt with iron has been accepted by the Government as a public health approach to reduce prevalence of anaemia. The doubly fortified salt remained without any colour development, when stored for 12 months or more under high humidity conditions.

Devadas (1988) states that the haemoglobin concentration and serum iron levels improved significantly after iron supplementation in all groups. The mean energy expenditure in Kcal/minute was less for all the groups studied for the various activities after the supplementation. Individuals who had a higher haemoglobin level and who were not anaemic expended relatively less energy to perform the same activity when compared to those who were anaemic. These results confirm the fact that energy expenditure is reduced with increase in haemoglobin level. Thus iron supplementation is helpful in conserving energy.

According to Gopalan (1971) the ability to perform an activity under resistance for an increased amount of time in all the groups may be attributed to iron supplementation. The energy expenditure recorded while working on the ergometer revealed that in all the groups studied, the energy expenditure was higher before iron supplementation and got reduced after supplementation.

Mohsina Kidwai (1983) reports that there is a programme of prophylaxis against nutritional anaemia among pregnant and nursing mothers and children (1-12 years), under this

programme a combined iron and folic acid tablet is administered daily for a period of 100 days to supplement the deficiency of iron and folic acid in their diet. During the sixth five year plan the target is to cover 60 million mothers and as many children.

Besides health education, nutrition education of the community, particularly mothers have been intensified through mass media channels to encourage intake of balanced diets by pregnant women and children.

In a study conducted by Vijayalakshmi and Selvasundari (1983) on adult women it was found out that haemoglobin level of anaemic subjects rose significantly after iron supplementation. The energy had been reduced after iron supplementation for performing the same activity.

NIN (1977) points out that nutrients such as iron, folic acid Vitamin B12, protein and vitamin C are necessary for blood formation and lack of these nutrients in the diet especially iron gives rise to anaemia. The normal amount of haemoglobin should be about 13-14g/dl of blood when the level goes down below 11-12g, it leads to anaemia.

Nadiger et al (1980) found that common salt is a suitable vehicle to be fortified with iron in India. It was fortified

with ferric orthophosphate (3500mg/Kg) and sodium hydrogen sulphate (5g/Kg) to provide an additional elemental iron of 1mg/g common salt consumed. After ascertaining the acceptability of the fortified salt a pilot feeding trial was conducted among residential school children in Hyderabad. Feeding on the fortified salt for 1 year resulted in a significant increase in the haemoglobin value of these children. There was also a significant reduction in the prevalence of anaemia among children given the fortified salt.

Vagheti and Ghassemi (1980) fed a group of adults with enriched bread made from flour which was supplemented with ferric ammonium citrate 498mg/100g, riboflavin 0.2mg/100g and calcium carbonate 148mg/100g. Among the women 12 to 26 years old who are enriched bread, the haemoglobin values rose significantly during the 2 month period from 10.6g to 11.92g/100ml significant increases in Hb values of older women eating enriched bread were also observed (11.38 to 12.95g/100ml).

Hallberg et al (1979) and Cook et al (1986) found that wheat flour was one of effective vehicle that could be used extensively for iron fortification at a

IV. FACTORS AFFECTING IRON ABSORPTION

Devadas (1979) point out that about 10 per cent of the iron in an average Indian diet is normally absorbed. An intake of 20 to 30 mg a day is adequate for older children and adults. The amount of iron provided by an average Indian diet of the poor income groups is about 18-22mg/day, a level that may appear to be adequate. However, the high phytate and the low calcium and ascorbic acid content of poor Indian diets have now been shown to restrict the availability of iron.

Rao, (1978) points out that the studies conducted at the National Institute of Nutrition have shown that while iron content of Indian diets is fairly adequate, the availability of this iron, however was found to be very low.

Rasmussene and Garby (1979) observed an increased iron absorption when different amounts of ferrous sulphate were added to rice based South East Asian meals. Iron fortification with simple meals composed of rice, boiled vegetables and a curry increased absorption of iron by about 0.2 to 0.3 mg/meal.

According to Disler et al (1973) and Derman et al (1977), tea has a potent inhibitory effect on the absorption of non heme iron. Disler (1975) demonstrated that iron absorption from a meal was reduced by as much as 87 per cent when tea was included. Coffee is another beverage that is often consumed with meals. Its effect on iron absorption has not been studied in detail although Derman et al (1977) observed a 37 per cent reduction when coffee was added to a meal containing maize. Because coffee is commonly consumed in countries where iron deficiency anaemia is prevalent a significant inhibitory effect on dietary iron absorption has nutritional relevance.

According to ICMR report (1975) iron absorption from types of meals based on wheat, commonly consumed in India, was found to be about 2 per cent. Iron absorption from rice based diet was found to be 5 per cent. Sorghum and Ragi constitute the staple of a sizable segment of population in South India. Mean Iron absorption from ragi was only 2.2 per cent and that from sorghum was 1.4 per cent.

The estimated dietary intake of iron to meet iron requirement of a male adult will be 32mg/day for wheat based

diets and 16mg/day for rice based diets. Diet survey data from several parts of our country indicate that 30-60 per cent of population have iron intake below these levels. Provision of an additional 15mg iron, per adults will considerably reduce the proportion of population with dietary iron intake below requirement levels. Attempts are now being made to achieve this through fortification of common salt with iron.

Bothwell et al (1979) point out that legumes and cereals supply the major part of the energy and protein requirements of people in most developing countries. Nutritional iron deficiency is common in these areas even when the dietary iron content is adequate. Studies of iron bio-availability have shown poor absorption from most cereals with the exception of highly refined wheat.

According to Cook et al (1981) legumes contain more iron than cereals but its bio-availability for human beings has not been examined carefully.

Bjorn Rasmussen et al (1973) concluded that the legumes which are major dietary components for much of the world's population, are all poor sources of bio-available iron. Mean

percentage absorption values fall towards the lower end of the range reported for cereals other than refined wheat. The pure legume meals would supply less than 20 per cent of the daily requirement of an adult male, even if eaten by iron deficient individuals. However, bio-availability could be appreciably higher in mixed meals containing factors that enhance absorption. Since the legume iron would be expected to enter the non heme common pool.

Rao and Prabhavathi (1982) point out the seed coats of many legumes have high tannin content, a factor known to inhibit iron absorption. According to Reddy et al (1982) legumes also contain appreciable quantities of phytate unlike tannin, phytate concentration is increased by dehulling because it is located in the cotyledonous fraction of the seed.

Morris and ellis (1976) reported that more than half the iron in wheat bread is present as monoferric phytate which has been shown to be soluble at neutral PH and enter the non heme iron pool in a meal.

Hallberg and Rossander (1981) observes that heme iron is well absorbed and little affected by the composition of

the diet. The absorption of non heme iron is usually much less and more difficult to predict since it varies substantially depends on the presence of a variety of substances in the diet.

Monsen et al(1978) point out that iron absorption in a complex diet is inhibited by tannins and phosphates and is enhanced by ascorbic acid and meat.

According to Jacob et al (1980) the maximum amount of iron that can be absorbed from an adequate diet by non-anaemic adults with iron deficiency is about 3.5 mg/day. A reasonable expectation for absorption by the average individual with iron depletion would be about half this figure or 2 mg/day.

Clement et al (1984) suggest that the inadequate iron absorption may occasionally be the consequence of sprue or gastric surgery, but it is usually related to the nature of the diet.

Susan and Fair weather-Tait, (1988) reported that alcohol enhances iron absorption and there appears to be a good correlation between hepatic iron levels and consumption of alcoholic beverages.

Alkashah and Seshadri (1984) point out that tea, spinach and fenu greek leaves in the meal had a tendency to reduce the ionizable iron which would be attributed to the presence of tannins and oxalates in these foods. Ascorbic acid intake obtained from analysis of cooked diets was low being around 7 mg. At such a low level of intake it is doubtful whether ascorbic acid would have any effect on the absorption of iron. Milk appears to enhance the availability of iron. The possibility of improving dietary iron absorption by appropriate meal combination using available food stuffs in the community needs to be explored. Consumption of milk along with enriched bread supplements by balwadi children may be recommended in the mean time.

Experimental Procedure

III. EXPERIMENTAL PROCEDURE

The experimental procedure pertaining to "Anaemia Iron fortified salt supplementation and work output" is detailed under the following headings:-

A. Selection of Area

B. Selection of the volunteers

C. Assessment of Nutritional status of the volunteers

D. Determination of work efficiency of subjects before supplementation

E. Supplementation with Iron fortified salt

F. Evaluation of Impact of supplementation

A. Selection of Area

The area selected for the study was Athur, a village near Karur in Trichy District. This village was chosen as there were adequate number of volunteers required for the study and good rapport was established through personal contacts with the people. The area also had workers who were undertaking stone cutting as a job.

B. Selection of the subjects

Thirty eight volunteers were selected for the present study. The volunteers were adults doing heavy work and belonging to the age group of 20-39 years. The men and women were initially screened for their haemoglobin values. Based on their haemoglobin values and in the absence of any other complication except iron deficiency they were divided into two groups. The details of the groups are as follows:

The first group consisted of 9 men and 9 women making a total of 18 volunteers having their haemoglobin value below 10 g/dl of blood and hence were considered anaemic. This group was taken as experimental group which latter received iron fortified salt supplementation.

The second group consisted of 20 volunteers of whom 10 were men and 10 were women. Their mean haemoglobin value was above 11 g/dl of blood and they were non-anaemic. This was the control group and they did not receive any supplementation.

C. Assessment of the Nutritional status of the volunteers

The nutritional status of all the 38 volunteers were assessed with the help of anthropometric measurements, biochemical changes and diet surveys adopting the following procedures indicated.

1. Anthropometric measurements

The two reliable indices for assessing the nutritional status namely height and weight were used for evaluating the volunteers. Height and weight of all the selected volunteers were measured using the procedures obtained by Jelliffe (1979).

Weight is the anthropometric measurement most in use carried out with the help of a platform beam balance (Figure 1). The subject who was in light clothing barefoot stood on the centre of the platform without touching anything else. Scale was brought to zero for each measurement and the calibration was checked at regular intervals. The weight was recorded to the nearest 0.5 Kg.

MEASUREMENT OF WEIGHT

Anthropometric rods fixed to a vertical plane were used to measure the height. The subjects after removing the shoes, stood on the flat floor by the scale with feet parallel and with heels, buttocks, shoulders and back of head touching the upright. The head was held comfortably erect. The arms were hanging at the sides in a natural manner. The head piece, which may be a metal bar or a wooden block, is gently lowered, crushing the hair, and making contact with the top of the head. Height was measured to the nearest 0.5cm.

2. Biochemical Examination

Roslyn et al (1980) reported that the collection of data during the biochemical evaluation of nutritional status may be achieved by analysis of a sample of blood, hair or urine and or biopsy of liver or bone, the most quantitative being analysis of blood and urine.

According to Park and Park (1983), haemoglobin level is a useful index of the overall status of nutrition irrespective of its significance in anaemia.

The biochemical examination was done through the analysis of blood. The blood was analysed for haemoglobin

serum iron, total iron binding capacity and packed cell volume. Haemoglobin was estimated using Cyanmethaemoglobin method of Varley (1981), details of which are given in Appendix I.

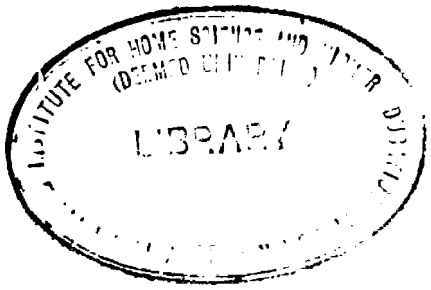
The serum iron and the total iron binding capacity were analysed using $\alpha\alpha$ Dipyridyl method of Ramsay (1957-58) details of which are given in Appendix II.

The appearance of hypochromic microcytic erythrocytes, and reduction in serum iron concentration confirm the iron deficient status (Roslyn et al, 1980).

Packed Cell volume was determined using wintrobe macro method of Henry (1986). The details of the procedure followed are given in Appendix III.

Diet survey

Swaminathan (1985) have reported that diet surveys constitute an essential part of any complete study of nutritional status of individuals or groups, providing essential information on nutrient intake levels, sources of nutrients, food habits and attitudes.



Ten adults who were co-operative, 5 men and 5 women, belonging to each group were selected randomly to conduct the 3 day weighment survey. This survey was undertaken initially before supplementation was carried out.

Initially, the raw weight of the food was taken, after which the cooked weight was also found. The volunteers were asked to consume the food and the plate waste was noted. The quantity of food left over in the vessel was weighed again. The difference between initial cooked weight and the weight after consumption gave the amount consumed by the subject. From this the plate waste was subtracted.

Thus, the quantity of food consumed by the individual was calculated. The raw ingredients consumed were computed from the weight of the cooked food. The nutrients wonsumed by the individual in daily diet was calculated using the nutritive value of Indian foods (ICMR, 1984). Individual food consumption pattern of both male and female anaemic and non-anaemic groups are given in Appendix IV.

D. Determination of work efficiency of the volunteers

Work efficiency of the volunteers were carried out separately for men and women. The efficiency to shape stones during a period of one hour was adopted for men whereas the efficiency for women were determined based on their ability to break the big pieces of stones into smaller pieces known as "Jalli" popularly. (Figure 2).

ACTIVITY DONE BY THE VOLUNTEER:

Blood pressure and pulse rate were recorded twice once initially when they came for work and after performing work for a period of 60 minutes. The Harvard step test was also carried out to evaluate the work efficiency of the subjects.

Harvard step test

Harvard step test was conducted on all the volunteers of the two groups. Harvard step is done to find out the heart recovery rate using the procedure suggested by Barry and Nelson (1968).

The subject stands before the bench and on command begins to step up the bench with one foot first and then the next. Now both his feet are on the bench and then he steps down with one foot followed by the next foot. Two steps down and two steps up denotes one count. Counting is continued till 90 counts are reached. This under normal conditions consumed a period of three minutes. The body should be erect when he steps on to the bench. There is no regulation regarding which foot the subject should put forth first.

The subject continues to exercise for three minutes unless he feels that he must stop before the specified time because of exhaustion. As soon as he stops exercising he sits down and remains seated and quiet throughout the pulse counts.

The pulse rate is felt at the carotid artery and is counted from half to one minute after exercise. The time is noted and pulse is counted for thirty seconds.

Scoring

$$\frac{\text{Number of seconds completed} \times 100}{\text{Recovery pulse} \times 5.6}$$

5.6 is a constant value.

Recording pulse rate and Blood pressure of the subjects before and after activities

Chatterjee (1980) have pointed out that the instrument was kept at the level of the heart and the cuff was tied around the upper arm pressure is raised to 200mm Hg and then gradually released. Variations of sounds are heard with a stethescope placing its chest piece on the brachial artery, a little below the cuff. The sounds are heard due to occurance of turbulance in the flow of blood through the narrowed blood vessels, when the manometric pressure just coincides with the systolic blood pressure.

Due to gaining air pressure in the cuff, the vessel is pressed and the blood flow obliterated. But while releasing the air pressure gradually, blood just begins to flow through the narrowed blood vessels and the pattern of flow is changed from stream line flow (silent) to tarbulent flow (noisy). When the pressure is further released normal stream line flow sets in and the sound is no longer heard. At this point manometric pressure coincides with the diastolic pressure so as the pressure is released, the following variations of sounds are heard. First phase - sudden appearance of a clear tapping sound. This indicates systolic pressure. It persists while the pressure falls through 15 mm Hg. Second phase - the tap sound is replaced by a murmur persisting after another 15 mm Hg. Third phase - the murmur is replaced by a clear loud gong sound lasting for the next 20mm Hg. Fourth phase - the loud sound suddenly becomes muffled and rapidlybegins to fade. This point indicated diastolic pressure. Fifth phase - absence of all sounds.

E. Supplementation with iron fortified salt

According to Nutrition News (1986) common salt constitutes one of the important ingredients in mans diet. Hence cooking salt was used as a means for supplementing. This iron fortified salt was obtained free of cost from Sundar Chemicals, Madras.

Rao et al (1980) points out that these formulas provide 1 mg elemental iron per gram salt and at the estimated intake of 15 g. salt consumed per day per head; and additional 15 mg elemental iron would be available daily. Indian diets provide 20 to 25 mg per day. This together with the fortified salt should meet the daily requirement of a normal adult men and woman. Iron fortified salt was acceptable as a cooking salt in the place of ordinary salt and the fortified salt did not have any change in taste and colour and was similar to the unfortified salt.

About 7 Kg. of salt was provided to each family and the families were instructed to use only the iron fortified salt for all cooking and as table salt. 7 Kg. of salt was distributed as per the studies made by Vijayalakshmi et al (1987), who have indicated that 6 Kg. would last for a period of approximately three months. So through iron fortified salt alone, the individual consumed 15 to 17 mg of iron per day.

F. Evaluation

At the end of 90 days of iron supplementation for the anaemic group the improvements with reference to any changes in the work efficiency of all the subjects in the two groups were evaluated, by subjecting them to the activities namely shaping stones and making "Jalli". They were also made to undertake the Harvard step test again, after supplementation.

The blood pressure and pulse rate were recorded after supplementation. The haemoglobin, serum iron, total iron binding capacity and packed cell volume were also analysed at the end of 90 days of supplementation. The improvement shown in the blood pressure, pulse rate, and the blood picture were analysed and discussed.

IV. RESULTS AND DISCUSSIONS

The results and discussion pertaining to the study on "Anaemia Iron fortified salt supplementation and work output" is dealt under the following heads:-

1. Socio economic background of the selected volunteers.
2. Assessment of the nutritional status of the volunteers.
   - (a) Heights and weights of the volunteers.
   - (b) Food and Nutrient intake.
   - (c) Biochemical picture of Iron related factors, before supplementation.

   (a) Haemoglobin (b) Serum Iron (c) Packed cell volume (d) Total Iron binding capacity.
3. Work output of the volunteers before supplementation.
4. Blood pressure and pulse rate of the volunteers before and after activity.
5. Changes in biochemical factors related to Iron after supplementation.
6. Work output of the volunteers after supplementation.
7. Results of the Hardvard step test before and after supplementation.

1. Socio economic background of the selected volunteers

On the whole 38 adult volunteers were selected for the study of whom 18 were anaemic and the rest non-anaemic in the age group of 20 to 39 years. All the volunteers belonged to low income group, their income levels was below 500 Rupees per month and were doing heavy activity. They all belonged to nuclear family and were uneducated. They spent their income only on food but still their food and nutrient intakes were not upto the mark. All of them were engaged in hard labour involving stone cutting, loading and breaking them into smaller pieces.

2. Assessment of the nutritional status of the volunteers

(a) Heights and weights of the volunteers

Table I presents the individual heights and weights of anaemic and non-anaemic women selected for the study.

TABLE - I

INDIVIDUAL HEIGHTS AND WEIGHTS OF THE ANAEMIC AND NON ANAEMIC WOMEN VOLUNTEERS

S.No.	ANAEMIC		NON ANAEMIC		't'value
	Height Cm	Weight Kg	Height Cm	Weight Kg	
1.	156	40	140	44	
2.	149	46	150	45	
3.	145	37	153	45	
4.	151	42	155	43	
5.	138	36	144	41	
6.	145	42	142	42	
7.	148	45	151	45	
8.	156	43	152	47	
9.	145	58	151	46	
10.	-	-	153	46	
Mean height	147.4± 5.02		149.1± 5.1		0.8 NS
Mean weight		43.2± 6.4		44.3± 1.8	0.4 NS

NS Not significant.

From Table I it is evident that the mean height of the anaemic was 147.4 cms as against 149.1 cms recorded by the non-anaemic women. The statistical analysis indicated that the difference in the mean height between the two groups was statistically insignificant.

The mean weight of the anaemic women was 43.2 Kg against 44.3 Kg recorded by the non-anaemic women volunteers. Both the mean weights recorded in the present study were slightly lower than the average weight of an adult woman suggested by Indian Council of Medical Research (45 Kg). Thus the groups selected were similar in socio economic as well as physical stature.

Table II presents the individual heights and weights of anaemic and non-anaemic men selected for the study.

TABLE - II

INDIVIDUAL HEIGHTS AND WEIGHTS OF THE ANAEMIC AND NON ANAEMIC MEN VOLUNTEERS

S.No.	ANAEMIC		NON ANAEMIC		't' value
	Height Cm	Weight Kg	Height Cm	Weight Kg	
1.	155	45	155	54	
2.	160	48	160	52	
3.	162	40	154	46	
4.	149	42	155	44	
5.	156	45	161	50	
6.	159	47	167	54	
7.	158	45	151	47	
8.	155	49	161	51	
9.	160	47	147	55	
10.	-	--	155	58	
Mean height	157.1± 3.8		156.6± 5.7		0.11 NS
Mean weight		45.3± 2.8		51.1± 4.4	2.32

NS Not significant.

As is evident from Table II, the mean weight recorded by the anaemic men volunteers was only 45.3 Kg against 51.1 Kg recorded by the non-anaemic men volunteers. The mean weights of these two groups are lower than the average weight suggested by ICMR for adult men.

The mean heights of the two groups were 157.1 cm and 156.6 cms respectively and the difference between the groups were not statistically significant indicating that the groups were similar in physical stature.

Table III shows the mean food intake of the anaemic and non-anaemic women volunteers compared against the ICMR recommended allowances.

TABLE - III

MEAN FOOD INTAKE OF WOMEN VOLUNTEERS

Food Items (g)	Anaemic		Non-anaemic		ICMR Recommended allowances (1984)
	Amount	Per-cent deficit (-) or surplus (+)	Amount	Per-cent deficit (-) or surplus (+)	
Cereals	490	- 15	502	- 12	575
Pulses	42	- 14	44	- 11	50
Green Leafy Vegetables	29	- 40	47	- 6	50
Other Vegetables	43	- 56	47	- 52	100
Roots & Tubers	32	- 46	50	- 15	60
Fruits	26	--	30	--	-
Milk & Milk Products	121	- 39	134	- 32	200
Fats & Oil	15	- 62	24	- 37	40
Sugar & Jaggery	20	- 50	26	- 32	40

The cereal intake of both anaemic and non-anaemic women volunteers were lower than the recommended allowances of ICMR (1984), but it was found to be much lower in the case of anaemic women. The cereal intake of anaemic and non-anaemic women volunteers were lower by 15 per cent and 12 per cent respectively than the ICMR recommended allowances.

The pulse intake of anaemic and non-anaemic women were lower by 14 per cent and 11 per cent respectively. The intake of greens and Roots and tubers by non-anaemic women volunteers were slightly lower but it was very low in the case of anaemic women. The intake of other vegetables was inadequate for both anaemic and non-anaemic women. The intake of fats and oils, milk and milk products, sugar and jaggery were very low in both the groups compared to ICMR recommended allowances.

The individual food intakes of anaemic and non-anaemic women volunteers are given in appendix IV and V respectively.

Table IV shows the mean nutrient intake of the anaemic and non-anaemic women volunteers compared against the ICMR recommended allowances.

TABLE IV

MEAN NUTRIENT INTAKE OF WOMEN VOLUNTEERS

Nutrients	Anaemic		Non-anaemic		ICMR Recommended allowances (1984)
	Amount	per-cent deficit (-) or surplus (+)	Amount	per-cent deficit (-) or surplus (+)	
Energy (K.cal)	2584	- 14	2613	- 13	3000
Protein (g)	49	+ 9	51	- 15	45
Calcium (g)	0.52	--	0.55	--	0.4-0.5
Iron (mg)	24	- 25	30	- 6	32
Retinol (mg)	418	- 44	552	- 26	750
Thiamine (mg)	1.14	- 24	1.21	- 20	1.5
Riboflavin(mg)	1.23	- 31	1.26	- 27	1.8
Vitamin C.(mg)	43	+ 9	65	+ 62	40

From table IV it is clear that the requirement of protein and vitamin C was adequately met for both anaemic and non-anaemic women volunteers. The requirements for all the rest of the nutrients were not adequately met when compared with ICMR (1984) recommended allowances for nutrients. It is note worthy that the iron intake was exceedingly low in the anamic group. The percent deficit

when compared to ICMR was found to be lower in non-anaemic than the anaemic group. The individual nutrient intake of anaemic and non-anaemic women volunteers are given in appendix VI and VII respectively.

Table V shows the mean food intake of anaemic and non-anaemic men volunteers compared against the ICMR recommended allowances.

TABLE V

MEAN FOOD INTAKE OF MEN VOLUNTEERS

Food Items in (g)	Anaemic Amount	Anaemic per-cent deficit (-) or surplus (+)	Non-anaemic Amount	Non-anaemic per-cent deficit (-) or surplus (+)	ICMR Recommended allowances (1984)
Cereals	558	- 16	587	- 12	670
Pulses	45	- 25	48	- 19	60
Greenleafy Vegetable	28	- 30	32	- 19	40
Other Vegetable	34	- 57	52	- 35	80
Roots & Tubers	44	- 45	49	- 38	80
Fruits	30	--	32	--	--
Milk & Milk Products	132	- 47	145	- 41	250
Fats & Oils	18	- 71	20	- 69	65
Sugar & Jaggery	17	- 69	24	- 56	55

From table V it is clear that the food intake of both anaemic and non-anaemic men volunteers were low as compared against ICMR recommended allowances, but very low in the case of anaemic men. The intake of milk and milk products, fats and oils were very much low and did not meet with the recommended allowances for both anaemic and non-anaemic men. It is noteworthy that the green leafy vegetable intake was lower by 30 percent and 19 percent respectively among the anaemic and non-anaemic men volunteers in the present study. The individual food intakes of anaemic and non-anaemic men volunteers are given in appendix VIII and IX.

Table VI shows the mean nutrient intake of anaemic and non-anaemic men volunteers compared against ICMR recommended allowances.

TABLE VI

MEAN NUTRIENT INTAKE OF MEN VOLUNTEERS

Nutrients	Anaemic		Non-anaemic		ICMR
	Amount	per-cent deficit (-) or surplus (+)	Amount	per-cent deficit (-) or surplus (+)	Recommended allowances (1984)
Energy (K.cal)	3298	- 15	3387	- 13	3900
Protein (g)	55	--	60	+ 10	55
Calcium (g)	0.35	--	0.5	--	0.4-0.5
Iron (mg)	20	- 16	22	- 7	24
Retinol (mg)	445	- 40	509	- 32	750
Thiamine (mg)	1.7	- 15	1.8	- 10	2
Riboflavin(mg)	1.59	- 30	1.58	- 31	2.3
Vitamin C (mg)	71	+ 80	74	+ 85	40

From the table VI it is evident that the intake of all the nutrients were inadequate when compared with ICMR recommended allowances for both anaemic and non-anaemic men volunteers except for protein, calcium and Vitamin C. But the percent deficit was lower in the case of non-anaemic when compared to anaemic group. Since the ICMR recommended allowances for nutrients for heavy workers is very high,

it was probably very difficult to meet the recommended allowances. A lower intake of green leafy vegetables reflected in a lower intake of iron in the case of the men volunteers with special reference to the anaemic group. The individual nutrient intakes of anaemic and non-anaemic men volunteers are given in appendix X and XI.

2. Biochemical pictures of Iron related factors before supplementation.

(a) Table VII presents the mean haemoglobin levels recorded by the anaemic and non-anaemic women and men volunteers at the start of study.

TABLE VII

MEAN HAEMOGLOBIN LEVELS OF MEN AND WOMEN VOLUNTEERS AT THE START OF STUDY

Group	Mean Haemoglobin level for Women in g/dl	't' value	Mean Haemoglobin level for men in g/dl	't' value
Anaemic	8.5 ± 0.69	7.8*	8.76 ±0.73	7.28*
Non-anaemic	11.6± 0.74		12.4 ± 1.44	

* Significant at 1 percent level.

As is evident from table VII, the Mean haemoglobin levels recorded by the anaemic women volunteers was only 8.5g/dl against 11.4g/dl recorded by the non-anaemic women volunteers. The mean haemoglobin level of the anaemic men was 8.7g/dl as against 12.4g/dl recorded by the non-anaemic men.

WHO suggests the cut off point as 12g/dl for men. Tara Gopaldas (1985) suggests the cut off point as 11g/dl for women.

Statistical analysis of the data indicated that the difference in the mean haemoglobin levels between the anaemic and non-anaemic women and men were statistically significant at 1 percent level. The individual Haemoglobin values are given in appendix XII and XIII.

Table VIII presents the mean packed cell volume recorded by the anaemic and non-anaemic women and men volunteers at the start of the study.

TABLE VIII

MEAN PACKED CELL VOLUME (PCV) OF MEN AND WOMEN VOLUNTEERS AT THE START OF STUDY

Groups	PCV for Women (%)	't' value	PCV for Men (%)	't' Value
Anaemic	24.2± 3.2	6.36*	23.4±2.7	9.53*
Non-anaemic	33.5± 3.2		33.7±1.9	

* Significant at 1 percent level.

From table VIII it is evident that the mean PCV of the anaemic women was 24.2 as against 33.5 recorded by the non-anaemic women.

According to O'Neal etal (1976) 38 percent PCV is an acceptable value.

In the present study anaemic men had recorded a mean PCV value of 23.4 and non-anaemic men had recorded 33.7.

Statistical analysis of the data indicated a significant difference at 1 percent level between anaemic and non-anaemic groups for PCV values in the present study. The individuals values are given in appendix XII and XIII.

Table IX presents the mean serum Iron and TIBC levels recorded by the anaemic and non-anaemic women and men volunteers at the start of the study.

TABLE IX

MEAN SERUM IRON AND TIBC OF MEN AND WOMEN VOLUNTEERS AT THE START OF STUDY

Groups	Biochemical factors	Women	't' value	Men	't' value
Anaemic	Serum Iron in mcg/dl	61±7.9	10.54*	69±4.9	10.29*
Non-anaemic	Serum Iron in mcg/dl	96±5.1		101±8.2	
Anaemic	TIBC mcg/dl	364±32.0	5.94*	396±44	6.4*
Non-anaemic	TIBC mcg/dl	291±20.4		295±29	

*Significant at 1 percent level.

From the table IX it is clear that the mean serum Iron levels of anaemic and non-anaemic women in the study were 61 mcg/dl and 96 mcg/dl respectively and the difference between the two groups were signigicant at 1 percent level.

The mean Serum Iron recorded by anaemic men was 69 mcg/dl as against 101 mcg/dl recorded by non-anaemic men volunteers. The difference between the two values were found to be statistically significant at 1 percent level.

According to the Institute of Central America and Panama nutrition programme (1972) Serum Iron levels lower than 45 µg/100ml indicate high risk, 45-89 µg/100ml indicates moderate risk and above 60µg/100ml low risk. Cornn and Cornn (1980) suggested ranges of 75-175mcg/dl for serum Iron. In the present study the Serum Iron level of both non-anaemic men and women was above the value suggested by these authors.

From table IX it is also evident that the TIBC levels recorded by the anaemic women 364 mcg/dl as against 291 mcg/dl recorded by the non-anaemic women. The mean TIBC recorded by the anaemic men was 396 mcg/dl as aginst 295 mcg/dl recorded by the non-anaemic men. Statistical analysis of the values indicated a significance at 1 percent level. The individual values are given in appendix XIV and XV.

3. Work output of the volunteers before supplementation:

Table X presents the work output with reference stone cutting by men and metal breaking by women.

TABLE X

WORK OUTPUT BY THE MEN AND WOMEN VOLUNTEERS

BEFORE SUPPLEMENTATION

Groups	Activity	Work output in 60 minutes		't' value
		Anaemic	Non-anaemic	
Women	Metal Breaking in(baskets)	4 ± 0.6	7 ± 0.8	10.7*
Men	Stone cutting (No.of stones)	29 ± 1.3	43 ± 4.4	10.41*

*Significant at 1 percent level.

From table X it is evident that the work efficiency of the non-anaemic volunteers was better when compared with anaemic volunteers.

WHO (1975) report points out that, the more severe the anaemia, the greater the reduction in near maximum work performance.

The difference in work output when statistically treated showed a significance at 1 percent level between the anaemic and non-anaemic groups of both men and women.

The individual values are given in appendix XVI.

4. Blood pressure and pulse rate of volunteers before and after activity:

Table XI highlights the blood pressure and pulse rate of men and women anaemic and non-anaemic volunteers before and after the activity namely metal breaking and stone cutting.

TABLE XI

MEAN BLOOD PRESSURE AND PULSE RATE OF MEN AND WOMEN VOLUNTEERS

Groups	Details	Women	Men
Anaemic	Blood Pressure mm/Hg	B.A-117/78 A.A-120/80	118/77 121/80
Non-anaemic	Blood Pressure	B.A.117/79 A.A.120/80	116/78 118/80
Anaemic	Pulse rate	B.A. 78 A.A-103	80 103
Non-anaemic	Pulse rate	B.A. 72 A.A. 81	72 81

B.A. Before activity

A.A. After activity.

The mean blood pressure rates before and after activity for both anaemic men and women did not show any great difference. However there was a significant difference in the pulse rate before and after activity between anaemic and non-anaemic groups of both the sexes. The increase in pulse rate was much less among the non-anaemic, indicating a better cardio vascular efficiency among the volunteers of the non-anaemic groups.

According to WHO (1983) in the wake of rapid and significant changes in life style and type of employment relative affluence, it is important to monitor changes in blood pressure and pulse rate while assessing the health status. The individual values are given in appendix XVII, XVIII, XIX and XX.

5. Changes in Biochemical factors related to Iron after supplementation:

Table XII presents the mean haemoglobin, TIBC, serum iron and PCV values of the anaemic women and men volunteers before and after Iron fortified salt supplementation.

TABLE XII

MEAN HAEMOGLOBIN PCV AND SERUM IRON AND TIBC VALUES OF THE VOLUNTEERS

Biochemical factors	Detail	Women	't'	Men	't'
Haemoglobin g/dl	B.S.	8.5 ±0.69	9.39*	8.7±0.73	9.16*
	A.S.	11.6 ±0.74		11.6±0.69	
PCV in percent	B.S.	24.2 ±3.2	7.16*	23.4±2.7	7.91*
	A.S.	32.5 ±2.1		32.8±1.76	
Serum Iron mcg/dl	B.S.	61.0 ±7.9	8.36*	69 ±4.9	9.3*
	A.S.	94.8 ±8.9		92.8±5.58	
TIBC mcg/dl	B.S.	364 ± 32.0	5.39*	396.5±44.7	5.8*
	A.S.	292 ± 24.5		295.3±29.7	

B.S. Before Supplementation

A.S. After Supplementation.

* Significant at 1 percent level.

It is noticed from table XII that the women volunteers recorded a mean haemoglobin level of 8.5g/dl and 11.6g/dl before and after supplementation respectively. In the case of men volunteers also the concentration of haemoglobin had increased from 8.7 g/dl to 11.6g/dl after supplementation

indicating the beneficial effects of supplementation. Statistical analysis of the data showed a significance at 1 percent level for the difference between the values recorded before and after supplementation.

Devadas (1988) states that the haemoglobin concentration and Serum Iron levels improved significantly after Iron supplementation in all groups.

Serum Iron levels were found to be increased after supplementation and at the same time the total Iron binding capacity was found to be decreased after supplementation in both anaemic men and women volunteers. The data are statistically significant at 1 percent level. Figure 3 & 4 shows the Haemoglobin and Serum Iron levels of anaemic women and men volunteers before and after supplementation.

6. Work output of the volunteers after supplementation:

Table XIII presents the work output with reference to stone cutting by men and metal breaking by women volunteers before and after supplementation.

COMPARISON OF MEAN HAEMOGLOBIN LEVELS OF ANAEMIC MEN AND WOMEN BEFORE AND AFTER SUPPLEMENTATION

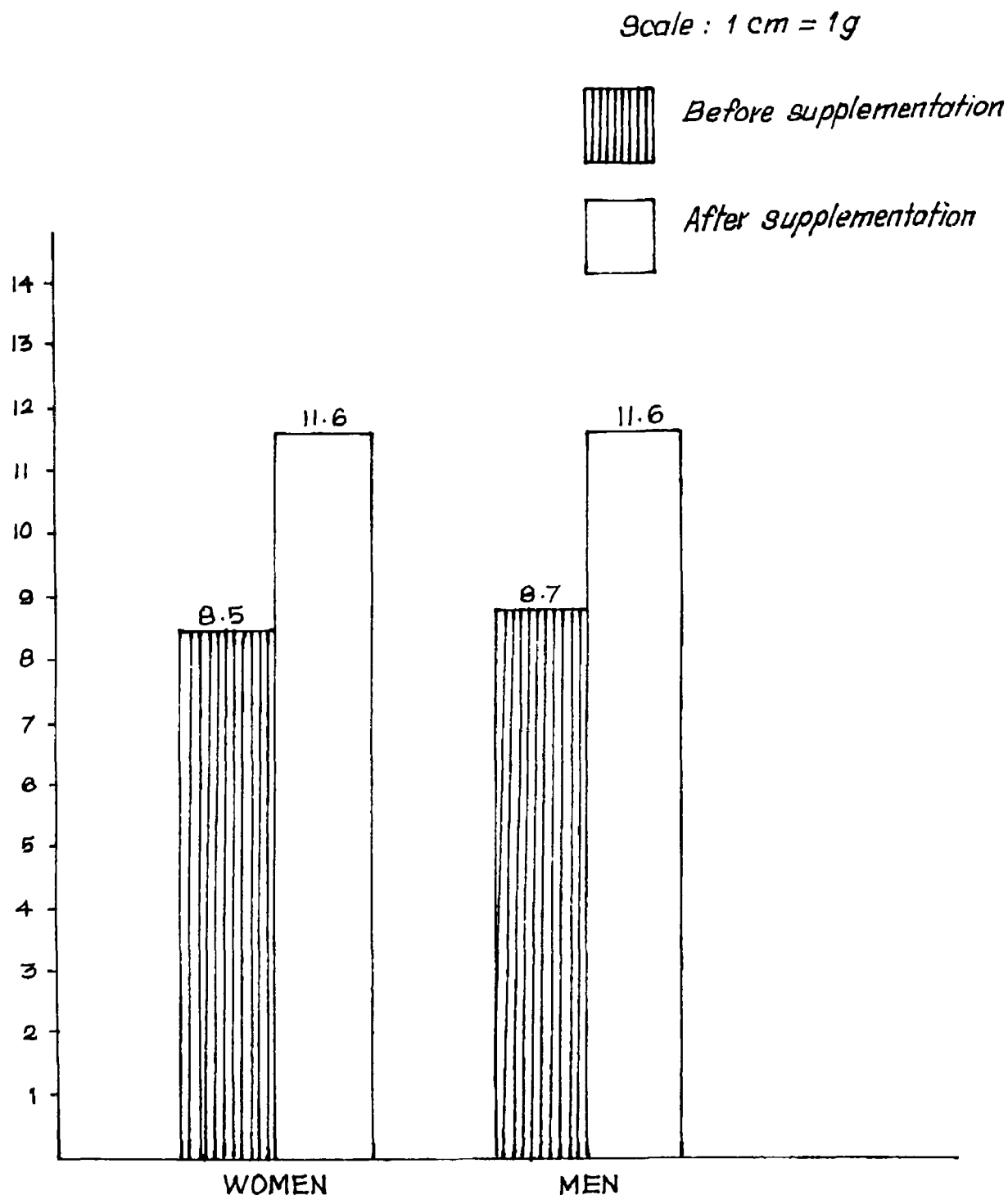


Figure : 3

COMPARISON OF SERUM IRON LEVELS OF ANAEMIC MEN AND WOMEN VOLUNTEERS BEFORE AND AFTER SUPPLEMENTATION

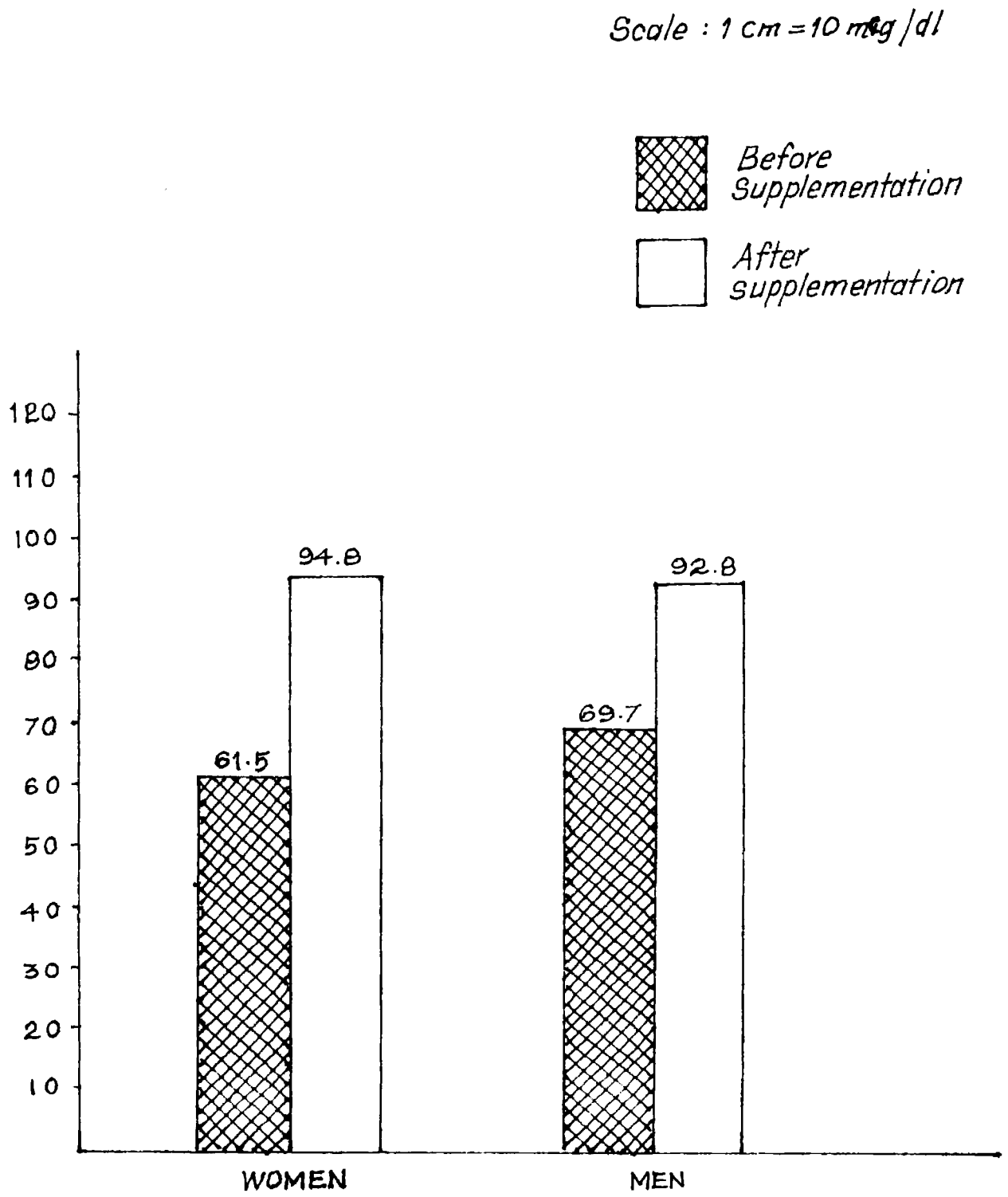


Figure: 4

TABLE XIII

WORK OUTPUT BY THE ANAEMIC MEN AND WOMEN VOLUNTEERS BEFORE AND AFTER SUPPLEMENTATION.

Groups	Activity	Work output in 60 minutes	't' value
Women	Metal breaking in (baskets)	B.S. 4 ± 0.6 A.S.5.5± 0.8	4.8*
Men	Stone cutting (No.of stones)	B.S. 29± 1.3 A.S. 34± 3.4	4.38*

* Significant at 1 percent level.

From table XIII it is evident that the work output of the anaemic volunteers both men and women increased significantly after supplementation showing the beneficial effects of supplementation.

It is in tune with the study by Edgerton and Gardner (1980) who reported that more tea was picked when the haemoglobin concentration was increased by Iron supplementation than when it was not. The difference in work output, on statistical analysis significant at 1 percent level in the present study among both men and women.

Table XVI presents the blood pressure and pulse rate of anaemic men and women volunteers before and after supplementation.

TABLE XIV

BLOOD PRESSURE AND PULSE RATE OF ANAEMIC WOMEN AND MEN VOLUNTEERS BEFORE AND AFTER SUPPLEMENTATION.

Groups	Details	Blood Pressure	Pulse Rate
Women	B.S.	B.A.117/78	78
		A.A.120/80	103
	A.S.	B.A.118/78	74
		A.A.120/80	83
Men	B.S.	B.A.118/77	80
		A.A.121/80	102
	A.S.	B.A.119/70	72
		A.A.121/81	85

B.S. Before supplementation, A.S. After supplementation.

From table XIV it is clear that while there existed no notable difference in the blood pressure before and after supplementation and activities among both anaemic men and women, the increase pulse rate decreased considerably after supplementation for performing the same task, indicating a better cardiovascular efficiency after supplementation.

7. Results of the Harvard step test before and after supplementation:

Table XV presents the recovery pulse rate at 30 seconds and cardiac efficiency of men and women volunteers before and after supplementation.

TABLE XV

RECOVERY PULSE RATE AND CARDIAC EFFICIENCY OF ANAEMIC WOMEN AND MEN VOLUNTEERS

Details	Women	't' value	Men	't' value
30 Seconds recovery pulse rate	B.S.54 ±3.23 A.S.47 ±1.90	5.6*	67±1.77 62.3±2.49	2.84**
Cardio vascular efficiency	B.S.60 ±3.6 A.S.68.8±2.96	6.0*	79±1.57 86±3.47	3.0**

** Statistically significant at 5 percent level.

* Statistically significant at 1 percent level.

From table XV it is evident that the recovery pulse rate of anaemic volunteers both men and women decreased after supplementation in Harvard step test. At the same time the cardiac efficiency increased significantly after supplementation in both men and women anaemic volunteers.

Viteri and Torum (1978) reported that in sugar cane cutters there was a direct relationship between packed cell volume or haemoglobin concentration and the score in the Harvard step test which measures cardio respiratory reserve with near maximim exercise. The individual values are given in apeendix XXi.

Summary and Conclusion

V SUMMARY AND CONCLUSION

The study on "Anaemia, iron fortified salt supplementation and work output" was carried out with the objective of finding out the relationship between anaemia and work output and the impact of iron supplementation on selected 9 anaemic men and 9 anaemic women volunteers. There were 10 non-anaemic men and 10 non-anaemic women who served as control.

The anaemic and non-anaemic volunteers were studied with reference to their socio economic anthropometric and biochemical parameters like haemoglobin, serum Iron levels, TIBC and PCV along with work output in terms of number of pieces and baskets turned out during a specified amount of time. The blood pressure and pulse rate were studied before and after activity and before and after supplementation. Harvard Step test was carried out before and after supplementation, to assess the cardio vascular efficiency and recovery pulse rate.

Anaemic volunteers received 15-17 mg of elemental iron each day for 90 days. After this period of supplementation the volunteers were studied again for the various factors mentioned above and compared with

before supplementation values. The results of the study indicated the following facts:

1. The average food intake of the non-anaemics was better than the anaemic volunteers, specially with reference to iron rich foods. However in general the intake of all foods and nutrients were below recommended allowances for both the groups.

2. The mean serum Iron levels increased from 61 to 94.8 mcg/dl and 69 to 92.8 mcg/dl in women and men respectively after supplementation. The mean haemoglobin and PCV levels also increased from 8.5 to 11.6g/dl and 8.7 to 11.6g/dl and from 24.2 to 32.5 and 23.4 to 32.8 percent in women and men respectively after supplementation. The TIBC level decreased from 364 mcg/dl to 292.4 mcg/dl and 396.5 to 295.3 mcg/dl in women and men after supplementation.

3. While the blood pressure remained by and large the same before and after supplementation and activity, the extent of increase in pulse rate was relatively less after supplementation while performing the same kind of activities, indicating probably a better cardiac and pulmonary efficiency.

4. The work output increased after supplementation suggesting that iron deficiency anaemia decreases the productivity and supplementation with iron improves working efficiency and output. This was clearly seen in the present study.

These results lead us to the conclusion that iron fortified salt supplementation is definitely beneficial to working population groups and their work output can be remarkably increased by suitable supplementation. Further studies along these lines involving other activities may be carried out to confirm the findings of the present study.

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APPENDIX - I

ESTIMATION OF HAEMOGLOBIN BY CYANMETH HAEMOGLOBIN METHOD

Estimation of Haemoglobin by this method was recommended by X International Haematology Congress and WHO Expert Committee on Nutritional Anaemia. This method measures not only Hb but also Co-Hb and methemoglobin, except sulpha-Hb, with filter type photoelectric colorimeters. The single relatively broad band of cyanmethaemoglobin in the green spectral region, has a distinct advantage. This method can be modified to determine Hb in dry blood or filter paper also.

PRINCIPLE

Hb is converted into cyanmeth Hb by the addition of KCN and ferricyanide. The colour of cyanmethhaemoglobin is read in a photoelectric colorimeter at 540 nm against a standard solution since cyanide has the maximum affinity for Hb; this method estimates the total Hb.

REAGENTS

Drabkin's Diluent solution (Cartwright 1958)

Sodium bicarbonate	- 1g
Potassium Cyanide	- 0.05g

8 Potassium Ferricyanide - 0.20g

Distilled water to make one litre.

PROCEDURE

Exactly 5ml of Drabkins solution is measured into a dry test-tube from a burette or a pipette with suction bulb. Blood 200 l is transferred (0.02ml) with the help of a haemoglobin pipette into the diluent solution. Usual care in filling and cleaning of loaded Hb pipette must be observed. The pipette is rinsed 3 times with the diluent solution, without allowing the formation of air bubbles in the solution.

The blood and the diluent are thoroughly mixed by rotating the tube.

10 minutes time is allowed for the formation of cyanmethhaemoglobin.

5ml of diluent solution is used as blank.

The readings are taken in a photoelectric colorimeter using 540 nm (green filter)

Construction of a standard curve

A std.curve can be constructed by using the standard cyanmeth Hb solutions (supplied by BDH or V.P.Chest Institute, Delhi).

Standard solution (ml)	Drabkin's diluent (ml)	Hb concn(%)
5	0	100
5	2.5	67
5	5.0	50
5	7.5	40
5	10.0	33

The concn. of the standard is mentioned on the ampoule. The corresponding blood Hb in g/100ml can be obtained by multiplying the concn. on the ampoule by the dilution factor (251).

Note

1. Drabkin's solution should be stored in amber coloured bottle. If any precipitate is formed the reagent should be discarded.

2. Since the dilution is enormous (251 times) accurate measurement of 20 l of blood is absolutely essential for reproducibility. Hb pipettes must be checked for their accuracy by weighing pure mercury upto the mark.

APPENDIX - II

ESTIMATION OF SERUM IRON BY DIPYRIDYL METHOD

Principle

Ferrous Iron gives a pink colour with $\alpha\alpha'$ dipyridyl. A solution of dipyridyl in acetic acid is added to serum followed by a reducing agent. Proteins are removed by heating in boiling water and then centrifuging.

Reagents

1. α-α' dipyridyl - 0.1%
2. Acetic acid 12% V/V
3. Sodium sulphate - 0.1m.
4. Chloroform
5. Standard solution containing 200µg.
6. Working Standard

Dilute 3ml of the solution to 100ml with water to obtain a solution containing 3mg/ml.

Procedure

Mix equal volumes of serum and 0.1m sodium sulphate and dipyridyl reagent in a glass stoppered tube which can be centrifuges. Heat in boiling water for five minutes at 300 ppm. If the supernatent is not completely clear, repeat the shaking and centrifuging. Read at 520mµ, standard in the same way.

$$\text{mg Iron/100ml} = \frac{\text{Reading of unknown} \times 300}{\text{Reading of standard}}$$

These reading are linear with concentration to atleast 500/100ml. To obtain a calibrated curve, dilute 5ml of the stock standard to 100ml with water and set up tubes containing 0.4, 0.8, 1.2, 1.6 and 2.0ml. This makes each to 2ml with water and develop the colour as described above and read against the blank. These correspond to 100, 200, 300, 400 and 500mg/100ml.

Estimation of Total Iron Binding Capacity by Dipyridyl method

Principle

Transferrin is saturated 100% by adding iron from outside in ferric form. After cheleting the iron not bound to transferrin, the transferrin iron is estimated as in the case of serum iron. Transferrin normally is saturated to only 33% by iron. Determination of transferrin solution provides a good index of Iron in nutritional status.

Reagents

1. Ferric chloride solution containing 5mg/ml in 0.005N hydrochloric acid. Prepare a stock solution containing 145mg of ferric chloride/100ml of 0.5N acid, dilute one hundred millilitre with distilled water.
2. Magnesium carbonate for light absorption.

3. Sodium sulphite 0.2%

2.52g of the anhydrous salt/100ml.

4. $\alpha\alpha$ dipyridyl: 0.2, in acetic acid, 3% chloroform

and standard solution as for the method.

Procedure

To 1ml of serum is added 2ml of ferric chloride solution, shaken well and the mixture allowed to stand for 5 mts. After allowing for 5 minutes add 400mg of magnesium carbonate (100mg for each ml of ferric chloride). Shake vigorously for 30-60 seconds. Centrifuge and pipette off 4ml of the supernatent fluid for iron determination. If the dipyridyl method is used add 1ml of each of the 0.2%mg, sulphite and 0.2% dipyridyl and proceed as described previously for determination of serum iron. This result gives total iron binding capacity. If the serum iron is determined at the same time, the percent saturation is calculated.

Calculation

X-μg amount iron present in 0.25ml of serum. This value when multiplied by 400 would give total iron binding capacity value in μg/100ml of serum. Unsaturated iron binding capacity (UIBC) = Total Iron binding capacity - Serum Iron (in μg/100ml serum)

$$\frac{\text{Reading of unknown} \times 100 \times f}{\text{Reading of standard} \times 1.33}$$

$$= \frac{\text{Reading of unknown} \times 450}{\text{Reading of standard}}$$

APPENDIX - III

ESTIMATION OF PACKED CELL VOLUME BY WINTROBE MACRO METHOD

Principle

The packed cell volume or haematocrit of blood is determined using heparinised capillary tube (75 x 1 mm) and micro haematocrit centrifuge.

Procedure

Blood from finger tip is collected in EDTA and is allowed to run about 1/2 to 3/4th length of the tube. The tube is sealed on the opposite end using sealing wax or plasticine. The tubes are then transferred to the high speed microhaematocrit. Centrifuge, and placed in groves of the centrifuge head. They are centrifuged for 5 minutes e at 11,000 rpn and read on the reader which gives the direct haematocrit value in volumes per-cent.

APPENDIX - IV

INDIVIDUAL FOOD INTAKE OF ANAEMIC

WOMEN VOLUNTEERS.

Food Items (g)	I	II	III	IV	V
Cereals	460	541	410	530	510
Pulses	37.5	52.2	39.8	42	42.5
Green Leafy Vegetables	56	15.3	26	20	32
Roots & Tubers	36	27.4	20	48	30
Other Vegetables	51	33	37	66.3	41
Fruits	22	16	25.3	33	36
Milk & Milk Products	113	104	109	160	120
Fats & Oils	14	13	19.1	16	14.8
Sugar & Jaggery	20	20	25.3	20	15.6

APPENDIX - V

INDIVIDUAL FOOD INTAKE OF NON-ANAEMIC WOMEN VOLUNTEERS

Food Items (g)	I	II	III	IV	V
Cereals	485	526	477	525	498
Pulses	32	42.3	38	52	57
Green Leafy Vegetables	15	40	59	56	65
Roots & Tubers	50	58	43	46	55.6
Other Vegetables	40	46.5	60	39	54
Fruits	28	31	35	26	30.5
Milk & Milk Products	100	180	152	126.8	115
Fats & Oils	25	20	26	26	25
Sugar & Jaggery	20	18	33	28	32

APPENDIX VI

INDIVIDUAL NUTRIENT INTAKE OF ANAEMIC WOMEN VOLUNTEERS

	Energy Kcal	Protein g	Calcium mg	Iron mg	Retinol Ug	Thia-mine mg	Ribo-flavin mg	Nia-cin mg	Vitamin C (mg)
I	2389	45.6	455.5	21.5	520.9	1.02	1.72	19.8	110
II	2856	53	310.1	25.3	317.2	0.81	0.8	12.2	35.3
III	2573	53.8	472.8	30.3	255.7	1.63	1.8	12.8	36.6
IV	2688	43.3	615.6	21	471.2	1.24	0.9	20.9	62.5
V	2418	50.4	753.7	21.1	529.2	1.01	0.92	16.9	90.4

APPENDIX VII

INDIVIDUAL NUTRIENT INTAKE OF NON ANAEMIC WOMEN VOLUNTEERS

	Energy Kcal	Protein g	Calcium mg	Iron mg	Retinol Ug	Thiamine mg	Riboflavin mg	Niacin mg	Vitamin C mg
I	2724	51	545	36	544	1.14	1.3	14.2	33
II	2827	65.6	678	29	623.5	1.69	1.07	15.7	105
III	2418	49	570	34.4	710.5	1.2	1.8	214	80
IV	2646	44.5	530.5	27	477.5	0.97	1.02	19.8	65
V	2452	48.2	470	23.8	407.75	1.08	1.12	12.8	44

APPENDIX - VIII

INDIVIDUAL FOOD INTAKE OF ANAEMIC MEN VOLUNTEERS

Food Ttems (g)	I	II	III	IV	V
Cereals	592	463.3	627	677	590
Pulses	44.5	47.8	54.7	45.5	48.6
Green Leafy Vegetables	34.6	24	21.4	14.5	67.9
Roots & Tubers	34	54.4	39	26	63.2
Other Vegetables	54.3	112	27.6	35	41.2
Fruits	39.7	39.4	29.6	29.3	25
Milk & Milk Products	133.6	170	79.2	200	146.6
Fats & Oils	18.6	20	20.6	17.36	15.6
Sugar & Jaggery	20.8	20	15	40	25

APPENDIX - IX

INDIVIDUAL FOOD INTAKE OF NON-ANAEMIC MEN VOLUNTEERS

Food Items (g)	I	II	III	IV	V
Cereals	620	590	592	495	492
Pulses	42.2	28.2	59.3	53.6	44
Green Leagy Vegetables	33.2	43.3	13.3	16.5	34.6
Roots & Tubers	15	32.6	35.2	32	53.6
Other Vegetables	22	58.3	70.7	62.4	34
Fruits	20	47	22.7	21	39.7
Milk & Milk Products	227.6	83	95.2	102.9	150
Fats & Oils	17	20	15.2	23.9	15
Sugar & Jaggery	15	30	10	11	16

APPENDIX - X

INDIVIDUAL NUTRIENT INTAKE OF ANAEMIC MEN VOLUNTEERS

	Energy Kcal	Protein g	Calcium mg	Iron mg	Retinol Ug	Thiamine mg	Riboflavin mg	Niacin mg	Vitamin C mg
I	3410	60.3	777	24.3	649.5	1.68	1.64	12.56	98.7
II	2848	57.4	681.8	21.5	488.1	1.89	1.14	22.5	73.4
III	3800	68.8	494	21.7	242	1.97	1.6	18.9	47.8
IV	3689	66.7	404.6	21	322	1.8	1.8	25.3	31.7
V	3188	49.3	485	23	845.7	1.69	1.74	20.9	12.0

APPENDIX - XI

INDIVIDUAL NUTRIENT INTAKE OF NON ANAEMIC MEN VOLUNTEERS

	Energy Kcal	Protein g	Calcium mg	Iron mg	Retinol µg	Thiamine mg	Riboflavin mg	Niacin mg	Vitamin C mg
I	3718	50.4	753.7	21.1	529.2	1.6	1.78	20.9	92.4
II	3510	60.3	77	17.8	649.5	1.68	1.64	12.5	70.7
III	3286	57.7	286.3	22.6	300.2	1.6	1.86	24.2	64
IV	3092	52.2	401	20.8	561	1.8	1.28	20.7	72.1
V	2886	54.4	275	19.8	782.7	1.9	1.4	13.6	59.5

APPENDIX - XIII

INDIVIDUAL HAEMOGLOBIN AND PACKED CELL VOLUME OF MEN VOLUNTEERS

	ANAEMIC MEN				NON-ANAEMIC MEN	
	BEFORE SUPPLEMENTATION		AFTER SUPPLEMENTATION		WITHOUT SUPPLEMENTATION	
	Hb g/dl	PCV per-cent	Hb g/dl	PCV per-cent	Hb g/dl	PCV per-cent
1.	9.4	20.8	12.8	30	10.8	36
2.	7.5	21	10.7	30.9	14.8	34
3.	9.0	21	10.6	34	10.2	32.8
4.	9.45	26.2	11.8	30.6	14.0	36.7
5.	8.5	23	11.5	37.5	11.5	34.4
6.	9.5	22.8	12.3	33.1	14.2	32.8
7.	9.5	28.0	12.0	33	12.0	36.1
8.	8.1	27	11.9	32.7	11.8	32.0
9.	7.9	21	11.0	31	12.0	30.8
10.	-	-	-	-	13	32.0

APPENDIX - XIV

INDIVIDUAL SERUM IRON AND TOTAL IRON BINDING CAPACITY OF WOMEN VOLUNTEERS.

	ANAEMIC WOMEN				NON-ANAEMIC WOMEN	
	BEFORE SUPPLEMENTATION		AFTER SUPPLEMENTATION		WITHOUT SUPPLEMENTATION	
	Serum Iron mcg/dl	TIBC mcg/dl	Serum Iron mcg/dl	TIBC mcg/dl	Serum Iron mcg/dl	TIBC mcg/dl
1.	53	338	81	321	92	306.2
2.	51	406	82	309	93	280
3.	62	380	92.5	283	94.5	272
4.	60	349	104	319	88	288
5.	72	315	104.4	292	101	288
6.	75	360	101	320	98	273
7.	53	350	106	257	103	321
8.	63	425	92	272	105	305
9.	63	360	90.5	259	97	257
10.	-	-	-	-	93	320

APPENDIX - XV

INDIVIDUAL SERUM IRON AND TOTAL IRON BINDING CAPACITY OF MEN VOLUNTEERS.

	ANAEMIC MEN				NON-ANAEMIC MEN	
	BEFORE SUPPLEMENTATION		AFTER SUPPLEMENTATION		WITHOUT SUPPLEMENTATION	
	Serum Iron mcg/dl	TIBC mcg/dl	Serum Iron mcg/dl	TIBC mcg/dl	Serum Iron mcg/dl	TIBC mcg/dl
1.	72	453	96	284	91.8	309
2.	60	394	88.5	322	93	315
3.	70	480	97.7	345	106	281.2
4.	75	404	101	267	93	290.6
5.	68	390	94	269	101	301.2
6.	75	410	98	272	104	281.6
7.	75	360	90	309	97.5	313
8.	64	363	83	330	95.6	289
9.	69	325	87.5	260	116	273
10.	-	-	-	-	114	305

APPENDIX - XVI

INDIVIDUAL WORK OUTPUT OF WOMEN AND MEN VOLUNTEERS

	ANAEMIC				NON-ANAEMIC	
	BEFORE SUPPLEMENTATION		AFTER SUPPLEMENTATION		WITHOUT SUPPLEMENTATION	
	Women (Baskets of Metal)	Men (Stones)	Women (Baskets of Metals)	Men (Stones)	Women (Baskets of Metal)	Men (Stone)
1.	4	31	6	35	6	35
2.	4	29	5.5	29	7	44
3.	5	27	7	27	5	42
4.	4	31	6	31	7	43
5.	4	28	4.5	28	7	49
6.	3.5	30	4.5	30	8	38
7.	5	29	6	29	6	45
8.	5	30	6.5	30	7.5	49
9.	3.5	30	5	30	6	40
10.	-	-	-	-	6	43

APPENDIX - XVII

BLOOD PRESSURE AND PULSE RATE OF ANAEMIC SUBJECTS - WOMEN

S.No.	BLOOD PRESSURE (mm/Hg)				PULSE RATE/Minute			
	Before supplementation		After supplementation		Before supplementation		After supplementation	
	B.A.	A.A.	B.A	A.A.	B.A.	A.A.	B.A.	A.A.
1.	120/80	121/81	117/75	119/79	76	101	72	81
2.	120/80	121/80	120/80	121/82	77	100	74	79
3.	116/76	119/80	118/29	120/80	77	101	75	83
4.	118/76	120/78	118/78	120/81	72	103	72	89
5.	116/80	120/80	115/75	118/78	81	101	71	82
6.	115/75	120/80	120/80	122/80	82	107	76	85
7.	117/76	120/81	118/78	120/81	83	109	75	81
8.	118/80	120/81	120/78	121/81	79	105	76	86
9.	115/80	118/82	120/80	122/82	78	101	76	84

APPENDIX - XVIII

BLOOD PRESSURE AND PULSE RATE OF NON ANAEMIC SUBJECTS - WOMEN

S. No.	BLOOD PRESSURE (mm/Hg)		PULSE RATE /Minute	
	B.A.	A.A.	B.A.	A.A
1.	120/80	121/81	70	80
2.	120/80	120/81	70	78
3.	120/76	121/78	72	83
4.	111/76	118/80	72	80
5.	119/78	121/80	74	83
6.	120/80	121/81	83	83
7.	110/82	112/82	72	80
8.	120/80	122/80	71	81
9.	118/78	120/80	72	81
10.	115/75	119/78	73	79

APPENDIX - XIX

INDIVIDUAL BLOOD PRESSURE AND PULSE RATE OF ANAEMIC SUBJECTS - MEN

S.No.	BLOOD PRESSURE (mm/Hg)				PULSE RATE /Minute			
	Before supplementation		After supplementation		Before supplementation		After supplementation	
	B.A.	A.A.	B.A.	A.A.	B.A.	A.A.	B.A.	A.A.
1.	115/76	120/80	120/80	122/81	80	102	72	82
2.	117/78	120/80	120/78	121/81	80	101	76	85
3.	118/79	120/81	120/80	122/81	79	103	75	84
4.	121/80	124/81	117/78	120/80	83	105	70	90
5.	115/78	118/80	115/75	120/80	80	103	73	84
6.	117/74	121/79	117/78	120/79	82	106	70	88
7.	120/77	123/80	122/80	124/82	80	102	70	80
8.	117/75	121/80	120/80	124/82	78	100	72	89
9.	121/75	124/79	120/80	121/82	78	102	73	83

APPENDIX - XX

BLOOD PRESSURE AND PULSE RATE OF NON ANAEMIC SUBJECTS - MEN

S.No.	BLOOD PRESSURE (mm⁄Hg)		PULSE RATE /Minute	
	B.A.	A.A.	B.A.	A.A.
1.	117/80	119/81	73	82
2.	110/80	110/83	72	80
3.	120/80	122/80	70	81
4.	116/75	118/78	70	80
5.	118/78	120/81	72	81
6.	115/75	118/76	70	82
7.	110/75	117/77	74	85
8.	117/80	121/81	72	80
9.	120/80	121/82	72	81
10.	115/75	118/77	71	80

APPENDIX - XXI

INDIVIDUAL 30 SECONDS RECOVERY PULSE RATE AND CARDIAC EFFICIENCY OF ANAEMIC MEN AND WOMEN VOLUNTEERS BEFORE AND AFTER SUPPLEMENTATION

	WOMEN				MEN			
	BEFORE SUPPLEMENTATION		AFTER SUPPLEMENTATION		BEFORE SUPPLEMENTATION		AFTER SUPPLEMENTATION	
S.No.	Recovery pulse rate	Cardiac efficiency	Recovery pulse rate	Cardiac efficiency	Recovery pulse rate	Cardiac efficiency	Recovery pulse rate	Cardiac efficiency
1.	52	61.8	48	66.9	69	77.6	65	82.4
2.	56	57.3	49	65.5	69	77.6	68	78.7
3.	49	65.5	47	68.3	68	78.7	65	82.4
4.	50	64.2	47	68.3	70	76.5	67	79.9
5.	56	57.3	48	66.9	68	78.7	66	81.1
6.	52	61.8	45	71.4	67	79.9	66	81.1
7.	59	54.4	49	65.5	66	81.1	63	85.03
8.	57	56.3	47	68.3	66	81.1	61	87.8
9.	52	61.8	46	69.8	64	83.7	60	89.2