COMPARISON OF THE CONTRIBUTION OF IRON BY AMARANTHUS FLAVUS, COLLOIDAL IRON AND IRON SALT AS DAILY SUPPLEMENTS IN A SCHOOL LUNCH PROGRAMME

By

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I. INTRODUCTION

Health is basic to human happiness and productivity and nutrition is the foundation for health (Aykroyd 1964)[1]. Good nutrition is essential not only for maintaining health but also for promoting growth of children, particularly during their early formative years of personality development.

The United Nations children's Fund (UNICEF, 1969)[2] has estimated that in the developing world today there are a billion children under 15 years of age. They constitute 40 to 45 per cent of the population in their regions. A majority of them are victims of malnutrition. Sukhatme (1968)[3] has pointed out that in India alone out of her 512 millions, 25 per cent are undernourished and well over half are malnourished. The Food and Agricultural Organisation (FAO, 1965)[4] defines undernutrition as inadequacy in the quantity of the diet, that is, in calories intake, which if continued for long periods will result in loss of body weight, retarded physical growth and development, and reduction of activity. On the other hand, malnutrition is the result of deficiency of some essential nutrients or because the total quantity of food taken by the individual is inadequate. It is a multi-deficient syndrome. Jelliffe (1969)[5] remarks that during the rapidly growing period of infancy and early childhood, the ill effects of malnutrition are more serious leading to high morbidity and mortality rates.

Malnutrition has now been recognised as one of the most widespread problems of children in developing countries. The UNICEF (1970)[6] has estimated that 32 million infants and children under five years of age suffer from severe clinical protein calorie malnutrition. The physical and mental damages caused by protein calorie malnutrition are irreversible.

The nutritional level of a community, especially, that of its highly vulnerable young children is related to numerous interacting ecological factors. It is positively correlated with the educational and economic conditions of the community, availability of foods of the right quality and the adequacy and accessibility of the health services (Gopalan, 1963)[7] and (1964)[8]. The FAO (1962)[9] has also warned that among the many factors endangering the health of poor children in India, malnutrition is probably most virulent. Customs, poverty, lack of knowledge, unavailability of suitable foods, improper feeding of infants and ignorance appear to be the causes f of malnutrition. The tragedy of malnutrition is that besides causing the prevailing high infant mortality, it also cripples and permanently damages the growing generation.

Chandra (1965)[10], Elwood (1965)[11] and Chatterjee (1967)[12] observe that anaemia is the commonest manifestation of malnutrition in India. There is a general agreement that a majority of the anaemias are of iron deficiency type (Patwardhan, 1965)[13], Jelliffe (1968)[14] explains that in many tropical countries the requirements of iron may rise because of the cumulative drain caused by continuous loss of small amounts of blood. Apte (1967)[15] has pointed out that 10-30 per cent of the world's population suffers from iron deficiency.

During the period of rapid growth an increase in red cells and haemoglobin takes place. Therefore a more liberal supply of iron is necessitated (Cooper et al, 1963)[16]. Growing children absorb larger amounts of iron than adults if the diets are adequate to keep up normal body stores of iron (Bogert, 1963)[17].

Most of the diet surveys conducted in India indicate that 94 per cent of the average families have a daily per capita dietary iron intake of 15 mg, and more, ninety per cent have intakes greater than 25 mg. However, the main defect in these figures, is that they are derived from calculations and not based on acutal analysis, The Indian Council of Medical Research (ICMR, 1964)[18] and Bransby et al 1964)[19]. Gopalan (1967)[20] has also raised the widespread occurence of iron deficiency anaemia, although the average Indian diet contains adequate amounts of iron. The main causes of iron deficiency are inadequate intake, interference with iron absorption excessive loss of iron from the body and disturbances of iron metabolism by infection or other mechanism.

Woodruff (1961)[21] and Brock (1969)[22] suggest planning for better nutrition as a remedy for malnutrition. Education and productivity, along with restriction of population increase can help to solve the problems. According to the UNICEF (1966)[23] only 28 percent of the enrolled pupils complete primary education. This high rate of drop outs creates a shortage of skilled workers and a surplus of the unskilled and unemployed. There are no better instruments of social justice than the provision of facilities for nutrition, medical care and education. Among these amenities, the school lunch serves as an effective medium for fostering democratic principles.

The importance of school lunch has been stressed by Devadas and Radharukani (1964)[24], Swaminathan (1964)[25], Anandam et al (1965)[26] Devadas et al (1965)[27], (1967)[28], (1968)[29] and (1969)[30]. Provision of well balanced meals to children during school hours will make up the deficiencies in the home diets and help children in concentrating on the lessons.

Anandam et al (1965)[26] and Nirmala et al (1968)[31] have shown green leafy vegetables to be good sources of vitamins and minerals in Indian diets. The national Institute of Nutrition has indicated that by encouraging the consumption of green leafy vegetables, which are inexpensive but rich source of provitamin A, the incidence of Vitamin A deficiency can be lowered considerably among the poor communities, (Gopalan and Vijayaraghavan, 1969)[32]. Green leafy vegetables have additional advantage of being rich in iron, carotene, folic acid and Vitamin C. They are available abundantly throughout the year, (James and Paden (1967)[33].

Only a few investigations have been carried out to elicit the sources of iron from low cost foods. This investigation aims at assessing the availability of iron supplement from a green leafy vegetable amaranthus g' flavus, in comparison with an iron salt and a colloidal iron source to school children, who were participating in the midday meal programme. The effect of the supplements on the nutritional status of the selected children was assessed through the changes in their height, weight, haemoglobin level, Red Blood Cell count and Packed Cell Volume.

II. REVIEW OF LITERATURE

The literature pertaining to the study is reviewed under the following headings.

A. The major nutritional problems prevalent in children

B. Assessment of nutritional status

C. Factors influencing iron absorption and utilisation

D. Efficacy of iron supplementation

A. The Major Nutritional Problems Prevalent in Children:

Oscar *et al* (1967)[34] states that malnutrition, particularly in young children, is a major public health problem in many areas of the world. UNICEF (1966) views that malnutrition among children in India as a major killer. Undernutrition in infancy and childhood causes inevitable damage and prevents the child from attaining its full potential as pointed by Hein *et al* (1967)[35], Lauw *et al* (1967)[36], Swaminathan (1968)[37], Berg (1968)[38] and Rao (1969)[39].

The diets consumed by a large majority of low income groups of the population in several tropical countries are deficient in various important dietary essentials such as proteins, minerals and vitamins, FAO (1962)[9], Scrimshaw and Behar (1961)[40] and Trowell *et al* (1956)[41]. The nutrition surveys conducted in several parts of India by Aykroyd (1942)[42], Gilroy (1951)[43], Mitra (1953)[44], ICMR (1961)[45], and Radhakrishna Rao (1958)[46] show the inadequacies of the diets, as well as the prevailing nutritional deficiencies among children of all stages, from infancy.

Vitamin A Deficiency:

Deficiency of vitamin A is widespread among children in the tropics and sub-tropics including Southern India, UNICEF (1963)[47] Mclaren (1964)[48], Pate (1965)[49] and Halder (1966)[50]. Narayana Rao and Joseph (1960)[51], Autret (1962)[52], Sen (1962)[53] and Aykroyd and Doughty (1964)[54] noted that protein malnutrition and vitamin A deficiency were the crucial problems harassing school children in Asia, particularly in India.

The prevalence of deficiencies of vitamin A as manifested by xerosis, nightblindness, Bitot's spots and keratomalacia has been revealed by the survey of Someswara Rao (1961)[55]. Mclaren (1960)[56] states that a deficiency of vitamin A has been and probably still is, the most important nutritional disorder affecting the eyes, resulting frequently in blindness.

Protein Calorie Malnutrition:

Jackson (1962)[57] regards protein malnutrition as the most wide spread nutritional problem in under developed countries. On a global scale two-thirds of the world's population suffer from this malady (Candau, 1963)[58].

Gopalan (1957)[59] cautions that when there is a shortage of proximate principles in the children's dietaries, their growth is retarded and some of the body functions are impaired. Enumerating the most important signs of malnutrition in young children, Jelliffe (1966)[5] emphasises low, stationary, or falling body weight due to growth failure resulting principally from lack of proteins and calories, associated with lack of other nutrients and with the cumulative effect of infection and parasitic disease.

Gopalan (1965)[60] marks three major etiological factors which contribute to protein calorie malnutrition - (a) non-availability of suitable protein due to socio-economic and agronomical factors, (b) faulty feeding habits arising from ignorance, prejudices and superstition, and (c) additional stress by way of infection and infestation.

Anaemias:

Nutritional anaemias constitute a public health problem of considerable importance in India Sood (1967)[61], Gopalan (1967)[19] and Indian Pediatrics (1969)[62]. In India anaemias result from inadequacy of the haemopoetic nutrients, iron, folic acid, Vitamin B_{12} and protein. These anaemias are particularly common in growing children and in women in their reproductive periods of life, when the requirements for the haemopoetic nutrients are increased (Chatterjee 1967)[63].

Patwardhan (1966)[64] is of like opinion that anaemia may result from dietary deficiency, poor absorption and utilization, increased losses or increased requirement such as that occuring in pregnancy.

Iron Deficiency Anaemia:

Iron deficiency represents a major public health problem. Estimated to involve several hundreds of million people in the world today, the incidence of anaemia has been reported to vary from 10% to even 50% (Sood 1967)[61].

Numerous haematological and nutrition surveys carried out in the last three decades have brought to light that different types of anaemias of varying degrees of severity are prevalent in India. The commonest kind is iron deficiency anaemia Patwardhan (1966)[64] Pandit and Someswara Rao (1960)[65]. Coelho (1962)[66] remarks that the most important cause of anaemia in children in India is insufficient protein and iron nutrition.

Anaemia can occur as a result of primary dietary deficiency of iron, incomplete absorption of iron from the gastrointestinal tract and increased losses through bleeding as noted by Foy and Kondi (1957)[67], Foy et al (1965)[68]. Severe iron deficiency during early growth may lead to a tissue depletion of iron containing iron dependent enzymes which may be associated with secondary phenomenon including absorption (Nutrition Reviews, 1969)[69].

Gopalan et al (1969)[70] reports that approximately 50 per cent of the several hundreds of pre-school children surveyed in various parts of the country have shown haemoglobin level less than 10 g. per cent. In India and other developing countries where there is high incidence of malnutrition, gastroenteritis and parasitic diseases, cases of severe anaemia with haemoglobin less than 6 gm. per cent, are frequently seen in pediatrics practices - (Dalal et al 1969)[71].

B. Assessment of Nutritional Status:

As pointed out by Scrimshaw (1962)[72] the assessment of nutritional status is necessary to define human nutritional problems and to guide the practical efforts toward their solution. The nutritional status of a population is influenced by many factors such as geography, agriculture, transportaion, education, economics, social norms, infection and parasitic diseases (Schaefer 1960)[73].

Davidson and Passmore (1963)[74] have listed the following methods for determining the nutritional status of children.

1. Anthropometric measurements
2. Biochemical investigations
3. Clinical examination
4. Diet surveys

Martin (1963)[75] emphasises the use of the above four methods in combination.

1. Anthropometric measurements:

Jelliffee (1966)[76] states that anthropometric measurements are concerned with the measurements of the variation of the physical dimension and gross composition of human body.

The body measurements commonly employed in anthropometric measurements as enumerated by Singh and Venkatachalam (1962)[77] and Martin (1963)[75] include height, weight, sitting height, length of arm, index of chest, hip and shoulders and skin fold thickness and circumference of head.

The earliest surveys of nutritional status compared recording of body weight correlated with height, age and sex (Albanese 1959)[78]. Since height and weight measurements for age provide the simplest index of nutritional status, these measurements constituted the predominant point of the physical examination (Hooks, 1967)[79].

2. Biochemical Methods:

Schaefer (1966)[80] asserts that biochemical findings are extremely valuable in assessing sub-optimal nutrition where physical symptomology cannot be recognised. Chemical methods offer the most objective means of assessing the nutritional status. Unlike clinical measurements, they are not influenced by the person making the test, as stated by Jelliffe (1966)[76], Schaefer (1960)[73] and Austall (1963)[81].

Arroyave (1960)[82] classifies the biochemical methods into the direct methods or those measuring the supply of nutrients and the indirect method which detect the biochemical changes which reflect the metabolic alterations.

Krehl and Hodges (1965)[83] point out that in general, haemoglobin level and haematocrit have been well accepted. However, the survey data accumulated for these values present little ground for controversy. Rao (1969)[59] maintains that estimation of haemoglobin and blood serves as a useful index to assess the nutritional status of a population.

3. Clinical Assessment:

Gopalan and Someswara Rao (1961)[84] remark that clinical assessment of malnutrition has gained particular importance in India due to signs of frank deficiency. Martin (1963)[75] states that physical examination of a child provides a means of obtaining an estimate of his net state of nutrition.

Plough (1962)[85] consideres clinical examination as the simplest and most basic procedure to evaluate human nutritional status.

Diet Survey:

Schaefer (1960)[73] opines that dietary studies constitute an essential part of any complete nutrition surveys but Hollingworth (1960)[86] views that nutritional stautus cannot be assessed by dietary means alone. Dietary studies help to evaluate the adequacy of the existing diet and the fundamental causes of any inadequacy (Jelliffe 1962)[87].

Diet surveys serve as important guide lines to know the existing and problems with regard to food intake of individuals andgroups and the ways and means of improving the, (Usha and Devadas 1964)[88].

Jelliffe (1966)[76] stresses that the preliminary planning of surveys mustbe done in such a way that only data that are strictly necessary will be obtained. The amount of information to be acquired is less important than its quality and relevance. The principles and practice of household food consumption surveys have been very fully covered by Hollingworth (1960)[86], Reh (1962)[89], Devadas et al (1964)[90] (1965)[91], and (1969)[92] and ICMR (1966)[93]. Difficulties in the use of food consumption tables arise from variation in techniques of food analysis, regional differences in composition of food (including moisture content and methods of preparation) and the fast that foods may be included (Asenjo 1962)[94]. Analysis of foods practicable on samples chemically preserved and brought back to the laboratory (Wilson et al 1964) [95].

C. Factors Affecting Iron Absorption:

1. Dietary Factors:

Phytic acid is a common constituent of vegetables. Dietaries which are cereal based contain large amounts of phytates which appear to interfere with the absorption of iron and thus cause iron deficiency (Conrad 1967)[96]. Iron absorption may fall below 30 per cent in diets with a high phytate content (Turnbull et al 1962)[97], Wokes and Vesey (1965)[98] and Nutrition Reviews (1967)[99].

Hussain and Patwardhan (1959)[100] found that absorption of iron was less than 7% when dietary iron intake was 22 mg. and the phytate in the diet was 40%. Apte and Venkatachalam (1962)[101] observed that the safe level of iron intake on a cereal diet 40% phytate would appear to be somewhere between 17 mg. - 21 mg./day.

In human studies absorption of iron in food was found improved by the addition of ascorbic acid Gorton and Bradley (1959)[102], Braise and Hallberg (1962)[103], Apte and Venkatachalam (1965)[104] and Bothewell et al (1964)[105].

The role of ascorbic acid in the metabolism of iron as interpreted by various workers is as follows: According to Moore and Dubache (1952)[106], it increases the absorption of iron from the gastrointestinal tract. It is essential for incorporation of iron into ferritin (Masur et al 1960)[107]. It is concerned ~~in~~ with the transport of iron across reticulo endothelial cells (Bothwell et al 1959 [108], 1964)[105].

Iron absorption may be influenced by the protein intake, and dietary protein of less than 15 to 18 per cent has been shown to result in impaired iron absorption in rats and it may also be influenced by the amino acid composition of the dietary protein, Klavin et al (1962)[109] and Reismann (1964)[110].

There are many good evidences that iron is better absorbed in the ferrous state than ferric in man as shown by Apte (1967)[111], Brown (1963)[112], Dukeworth (1968)[113], James and Paden (1967)[33]. Though the amount of iron in the body is small its formation is very important (Sherman 1965)[114].

Iron deficiency anaemia probably plays an important role in production of secondary folic acid deficiency. The defect in folate metabolism was the result of the decreased activity in liver of the iron dependent enzyme, formamine transferase (Vitalle et al 1966)[115].

2. Iron Losses:

It has been assessed that a single hook worm ingests from 0.38 ml to 0.84 ml of blood daily representing a great loss of protein and iron. Radioisotopic studies with chromium tagged red blood cell have shown that patients with heavy hookworm infestation can lose up – to 250 ml or a quarter of a litre of blood daily and upto 29 mg of iron in the gastrointestinal tract leading to direct iron deficiency anaemia (Patwardhan et al 1969)[116].

The loss of iron through sweat has been claimed to be one of the factors in development of iron deficiency in the population as stated by Foy et al (1958)[68] and Parekh (1969)[117].

Finch (1968)[118] carried out a study using Fe^{55} and Fe^{59} on the absorption of iron from the intestine in 31 normal human subjects and in 34 subjects with iron deficiency using wheat tagged with radioactive iron labelled haemoglobin. The iron absorption in normal subjects evaluated by accurate isotopic method showed a constant and marked variation between one another, which correlates with variation in their iron stores when needed.

Efficacy of Iron Supplementation:

McCurdy (1965)[119] compared the effectiveness of oral and parenteral iron therapies in patients severely deficient in iron in the form of ferrous sulphate and intravenous administration. He found no adverse reaction to orally administered iron, although one patient apparently failed to absorb iron from gastiointestinal tract and later responded to parentally administered iron.

Pritchard (1966)[120] has shown that ferrous sulphate, ferrous fumarate and ferrous gluconate in supplying 180 to 220 mg. of iron per day resulted in increase in haemoglobin concentration which was 0.25 gm/100 ml. per day.

Ferrous gluconate and other simple ferrous salts of organic radical are less concentrated sources of iron and are said to produce fewer side effects, such as gastric irritation. Chelated iron which is the latest form studied has been shown to be less toxic than ferrous sulphate . Various local side effects like skin discolouration, local inflammation, with lower gradient abdominal pain have been noted with intramuscular injection of iron oxidation complex by Goodman and Gillman (1965)[121], Chandra (1965)[10], and Sood (1967)[61]. Wilson and Ramaswamy (1965)[122] report symptoms of nausea, vomitting, excessive starvation, sneezing, pain in neck and back following parenteral iron therapy.

Basu et al (1963)[123], Carlton (1964)[124] Elhence et al (1966)[125] Murrbasins and Walterstein (1964)[126] successfully used single dose of intravenous iron dextran in meeting iron deficiency anaemia.

III. EXPERIMENTAL PROCEDURE

The aim of this study is to compare the contribution of iron by amaranthus flavus, colloidal iron and iron salt as daily supplements in a school lunch programme. The experimental procedure had the following steps:-

A. Selection of the school

B. Selection of the subjects

C. Formulation of the menu

D. Standardisation of cooking and serving procedures

E. Selection of supplements

F. Analysis of the home diet

G. Evaluation of the nutritional status.

A. Selection of School:

Sri Sarada Devi Basic School was selected because earlier nutrition studies had been carried out in that school. The staff and the authorities were familiar with the restricts. They and the children were willing to cooperate.

B. Selection of the Subjects:

The age, height, weight and haemoglobin level of all the children in the school were recorded. Search for the presence of hookworm cysts was carried out in order to select children without them. Those children who took iron tonic at home were also excluded.

Seventy two children comparable in age, sex distribution, height, weight, haemoglobin level and freedom from hookworm infestation were selected and divided into four groups of eighteen children each. A comparable group of eighteen children who were not participating in the school lunch were selcted as the control group. These five groups were designated as S_1, S_2, S_3, S_4 and C and had the diets as specified in Table I.

Table I

CODES AND DIETS OF THE SELECTED CHILDREN

Code	Number of children	Diet
S_1	18	School lunch + Amaranth Supplementation
S_2	18	School lunch + Collidal iron Supplementation
S_3	18	School lunch + Iron salt supplementation
S_4	18	School lunch (Basal Diet)
C	18	Non school lunch (Control group)

C. <u>Formulation of the Menus</u>

The menus were planned on the basis of the existing lunches. They consisted of a cereal preparation, a dhal and vegetable 'Kootu' a fruit and 'Payasam' which is a sweet preparation made out of CSM and jaggery as shown in Table II.

TABLE II

WEEKLY MENU FOR THE VARIOUS GROUPS

Days	Group S_1	Group S_2	Group S_3	Group S_4
Monday	Wheat Uppuma C.S.M. Payasam Carrot Kootu Papayya & greens	Wheat Uppuma C.S.M. Payasam Carrot kootu Papayya + iron tonic	Wheat uppuma C.S.M. Payasam Carrot Kootu Papayya + iron salt	Wheat uppuma C.S.M. Payasam Carrot kootu Papayya
Tuesday	Lime rice C.S.M. Payasam Carrot kootu Papayya + greens	Lime rice C.S.M. Payasam Carrot kootu Papayya + iron tonic	Lime rice C.S.M. Payasam Carrot kootu Papayya + iron salt	Lime rice C.S.M. Payasam Carrot kootu Papayya
Wednesday	Wheat uppuma C.S.M. Payasam Carrot kootu Papayya + greens	Wheat uppma C.S.M. Payasam Carrot kootu Papayya + iron tonic	Wheat uppuma C.S.M. Payasam Carrot kootu Papayya + iron salt	Wheat uppuma C.S.M. Payasam Carrot kootu Papayya +
Thursday	Dhal rice C.S.M. Payasam Carrot kootu Papayya + greens	Dhal rice C.S.M. Payasam Carrot kootu Papayya + iron tonic	Dhal rice C.S.M. Payasam Carrot kootu Papayya + iron salt	Dhal rice C.S.M. Payasam Carrot kootu Papayya
Friday	Wheat Uppuma C.S.M. Payasam Carrot kootu Papayya + greens	Wheat Uppuma C.S.M. Payasam Carrot Kootu Papayya + iron tonic	Wheat Uppuma C.S.M. Payasam Carrot kootu Papayya + iron salt	Wheat Uppuma C.S.M. Payasam Carrot kootu Papayya

Table III presents the cost and quantities of foods used for a lunch.

TABLE III

QUANTITIES AND COST OF FOODSTUFFS USED PER CHILD PER MEAL

Foodstuffs	Quantity (g)	Cost (ps.)
Cereals:		
Rice	75	7.5
Bulgar wheat	75	donated by CARE
Red gram dhal	20	2.3
Jaggery	10	1.1
Carrot	20	2.0
Skim milk powder	5	-
Salad oil	10	donated by CARE
C.S.M.	20	donated by CARE
Papayya	20	1.2
	Total	15.0 ps.

The cost of the ingredients was calculated on the basis of the existing prices in the super market.

Rice was given for three days and bulgar wheat on three days. The total cost comes to 49 ps. for five days. The cost of one meal per day is 10 ps. The menu was planned to meet on third requirements of the child. The nutrients supplied by the lunch in comparison with the daily allowances recommended by ICMR (1968)[127] are given in Table IV and details in appendix I.

TABLE IV

NUTRIENTS SUPPLIED BY THE LUNCH

	Calories	Protein g.	Calcium mg.	Iron mg.	Vitamin A Bcarotene	Thiamine (mg)	Ascorbic acid(mg)
Daily Allowances of nutrients	1800	33	400 to 500	15–20	1600	0.9	31
⅓ daily allowance of nutrients	600	11	133 to 166	5.7	533	0.3	10
Nutrients supplied by school lunch	565	18	154 to 165	6.9	571	0.64	58

D. Standardisation of Cooking and Serving Procedures:

The weight of the raw food for the number of children present was recorded. Then the total weights of the cooked food was recorded. In order to facilitate easy serving the amount given to each child was standardised in measuring cups.

E. Selection of Supplements:

The basal school lunch was controlled in such a way that it supplied only 7 mg. of iron per meal per child per day which is on third requirement of iron as recommended by ICMR (1968)[127]. The amount of iron provided through the supplementation is 13 mg. of iron and together this amount of iron meets the average iron requirements per child per day for children of this age group.

1. Amaranthus Flavus:

The greens chosen was amaranthus flavus, because of its year round availability, cheap sources of iron and could be easily used in the dietaries of children. No significant difference on protein, calcium, phosphorous and iron content of amaranthus on seasonal variation was noticed by Devadas et al (1969)[128]. The amaranth selected was analysed for its iron content and was found to be 25.05 mg. per 100 gm. which is approximately the same as the results given by ICMR (1968)[129]. Therefore 52 gm. of fresh amaranth was cooked and supplemented to each child with the lunch, in order to get 13 mg. of iron. Weekly analysis of the amaranthus flavus for iron content was carried out for quantitative control.

2. Iron Tonic Supplementation:

For iron tonic supplementation 'Colliron', a colloidal iron hyroxide with copper, cobalt and manganese which is a non irritant form of iron was selected. It has a pleasant flavour, easily assimilated and non constipating. The formula is given in Table V.

TABLE V

FORMULA FOR THE IRON TONIC

Composition	Amount
Colloidal iron hydroxide	5.73 g.
Copper Sulphate	6 mg.
Cobalt sulphate	3 mg.
Manganese sulphate	3 mg.
Absolute alcohol	5% - 7% v/v

The iron tonic was analysed for its iron content. It was found to contain 390 mg. of iron per 4 ml of the tonic. Four ml. of the tonic were diluted to 50 ml. with water, of which 1.7 ml were given daily for each child.

Calculation:

1 ml of the tonic contains 97.5 mg. of iron.

4 ml of the tonic contains 390.0 mg of iron.

4 ml is diluted to 50 ml.

390 mg. of iron is present in 50 ml.

∴ 13 mg of iron is present in 1.7 ml.

Tonic was made up daily with fresh water.

2. Iron salt supplementation:

For iron salt supplementation 'Fesolate' tablets of ferrous sulphate with copper and manganese was selected. The tablet was analysed to estimate its iron content, and was found to contain 61.95 mg. of elemental iron. The tablet was powdered and the quantity required to supplement 15 mg of iron was calculated, accurately weighed and packeted in butter paper. This was given along with water to the children after the lunch. The composition of the tablet is given in Table VI.

TABLE VI

COMPOSITION OF EACH TABLET

Composition	Amount
Dried ferrous sulphate I.P.	0.195 g.
Copper sulphate I.P.	2.6 mg.
Manganese sulphate B.P.C.	2.6 mg.

F. <u>Analysis of the Home Diet:</u>

Four days food weighment survey was carried out for five randomly selected children from each group. One tenth of thetotal food collected from each group for the four days was used for analysis (ICMR) (1965)[120].

<u>Protein:</u>

Protein was calculated from Nitrogen estimated by Kjeldhal method (A.O.A.C., 1960)[121].

<u>Iron:</u>

Iron was estimated by Wong's method (Hawk et al 1954)[132]

<u>Calcium:</u>

Calcium was estimated by the method of (Hawk et al 1954).[132]

<u>Ascorbic Acid:</u>

It was estimated by titrametric method. (Hawk <u>et al</u> 1954) [132].

G. Evaluation of the Nutritional Status:

The improvement in the nutritional status of the children was evaluated using the following criteria.

a. Height

b. Weight

c. Haemoglobin estimation

d. Packed cell volume

e. Red blood cell count

f. Clinical Assessment.

Height:

The height of all thechildren were recorded by means of a verticle measuring scale fixed to a wall. After removingthe shoes, the subject was made to stand on a flat floor by thescale with feet parallel and with heels, buttocks, shoulder and back of head touching the scale. The arms hanging at the sides in a natural manner (Jelliffe 1966)[76].

Weight:

Weight was recorded fortnightly for all children by means of a portable weighing Scales. Weighing should not be done after a full meal, theoritically the bladder was emptied prior to measurement. The subjects were made to stand in the centre without touching anything, bare footed with minimum clothing (Jelliffe 1966)[76].

Haemoglobin Level, Packed Cell Volume, RBC Count:

The haemoglobin level was determined fortnightly from the finger tip blood by cynamethe haemoglobin method (I CNMD 1963)[130]. Jelliffe (1960)[133] quotes that filter paper method is one of the best applicable method in field areas.

Two ml. of venous blood drawn from six children randomly selected from each group was used for these estimations. PCV was determined using wintrobe tubes I CMRD (1963)[130] and RBC count was determined by using Newbauer ruled counting chamber (Best and Taylor 1962)[134]. These estimations were done both at the beginning and end of the study.

Clinical Assessment:

Clinical assessment of the children was carried out at the beginning and end of the study period with the help of a physician using the schedule prepared by ICMR (Appendix II).

IV. RESULTS AND DISCUSSION

The results of the investigation "comparison of the contribution of iron by amaranthus, colloidal iron and iron salt as daily supplements in a school lunch programme" are presented and discussed under the following headings.

A. Nutrients intake of children.

1. Protein
2. Iron
3. Calcium
4. Ascorbic Acid

B. Nutritional status of the children.

1. Height
2. Weight
3. Haematological Indices
4. Clinical examination.

A. Nutrient intake of children:

The mean protein, iron, calcium and ascorbic acid intake of the selected children from each group obtained from the analysis of the four days pooled sample is presented in Table VII and the details in Appendix III.

1. Intake of proteins

The whole days diet in all the five groups provided 21.54 g. to 41.77 g. of protein (Figure 1.). The whole day's diet of experimental groups S_1 receiving greens, provided 41.77 g. of protein which was the highest among all the five groups. The groups S_2 receiving iron tonic with school lunch obtained 39.62 g. of protein, which was higher than the amount of protein received by the three

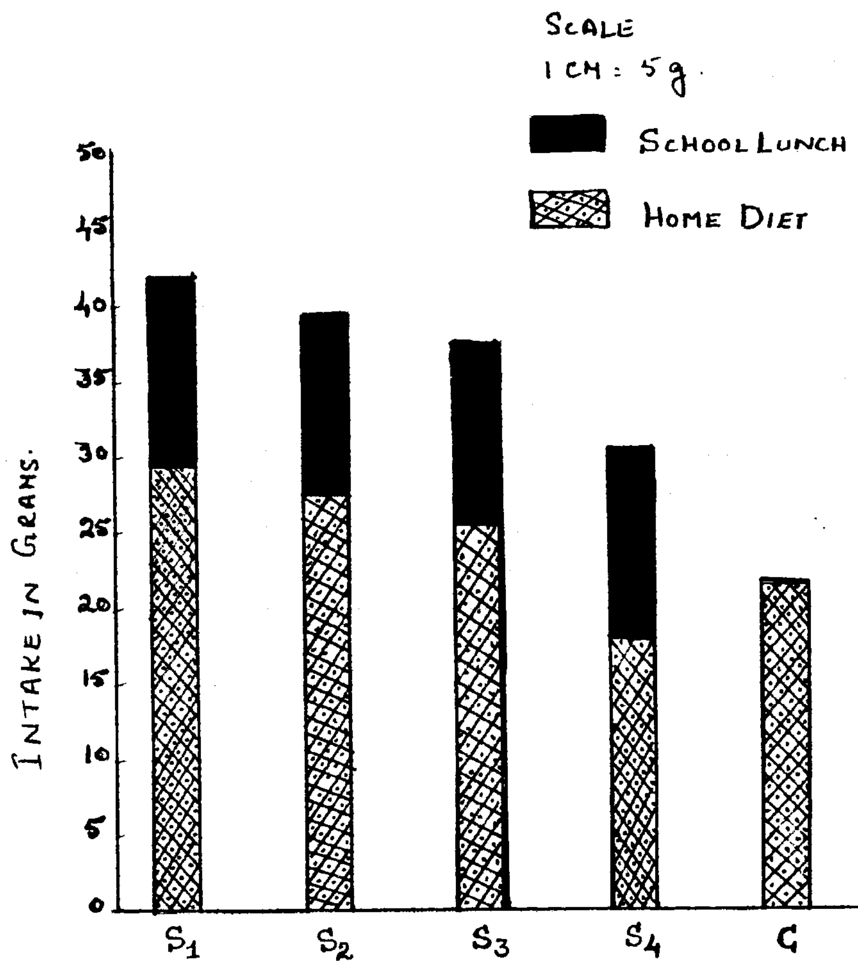
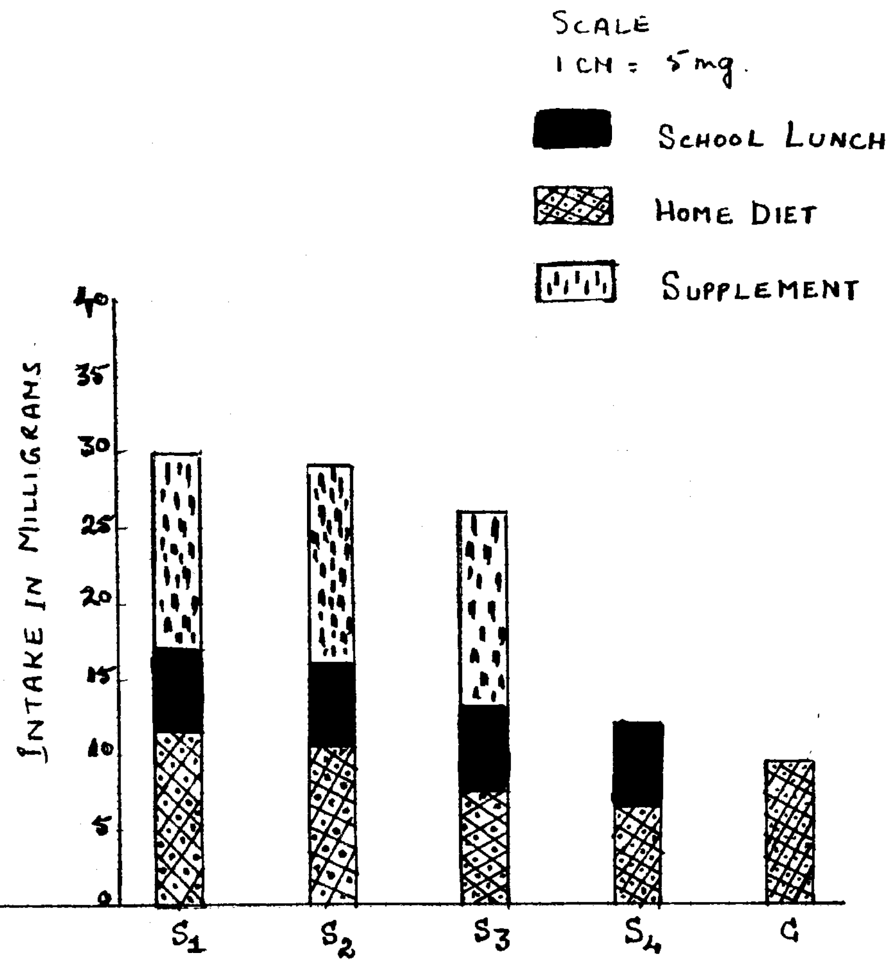


Fig. 1 GROUPS



GROUPS Fig. 2

PROTEIN AND IRON INTAKE OF CHILDREN IN FIVE GROUPS

TABLE VII

NUTRIENT INTAKE OF CHILDREN IN THE FIVE GROUPS

Code	Group	Protein (g.)			Iron (mg.)			Calcium (g.)			Vitamin C (mg.)		
		Home diet	School lunch	Whole day diet	Home diet	School lunch	Whole day diet	Home diet	School lunch	Whole day diet	Home diet	School lunch	Whole day diet
S_1	School lunch+ greens	29.60	12.17	41.77	11.30	5.5+13	29.80	0.419	0.22	0.639	6.6	9.37	15.97
S_2	School lunch+ tonic	27.45	12.17	39.32	10.54	5.5+13	29.04	0.318	0.22	0.538	5.7	9.37	15.07
S_3	School lunch+ salt	25.48	12.17	37.65	7.65	5.5+15	28.15	0.226	0.22	0.446	5.4	9.37	14.77
S_4	Basal diet	18.29	12.17	30.46	6.47	5.5	11.97	0.173	0.22	0.393	5.2	9.37	14.57
C	Non-school lunch	21.54	—	21.54	9.43	—	9.43	0.428	—	0.428	5.9	—	5.9

groups S_3, S_4 and C receiving school lunch plus salt, only basal diet and non school lunch respectively. The group C which was not participating in the school lunch received only 21.54 g. of protein which is less than the amounts received by all the other four groups S_1, S_2, S_3 and S_4 . The protein obtained from the whole day's diet by the groups S_1, S_2 and S_3 met the allowances recommended by ICMR (1968)[127] but group S_4 and C did not meet the allowance of protein. The home diets were found to contain protein which ranged from 21.54 g. to 29.60 g.

2. Intake of Iron:

The whole day's diet provided 9.43 mg to 29.80 mg of iron (Figure 2.). Group S_4 received 6.47 mg and 5.5. mg. of iron from the home diet and school lunch respectively. The children in experimental groups S_1, S_2 and S_3 received 11.30 mg, 10.54 mg, and 7.65 mg from their home diet respectively. In addition they received 5.5 mg of iron from basal diets and 13 mg of iron from the supplements. Groups S_1, S_2 and S_3 received the maximum amount of iron. The amount is comparable with the ICMR (1968)[127] recommended allowances for iron. The whole day's iron, ~~and iron~~ content of groups S_4 and C was found to be 11.97 mg and 9.43 mg. respectively which was lower than that of the ICMR recommended allowances for iron.

3. Intake of Calcium:

Home diets of children in all five groups provided calcium which ranged from 0.393 g. to 0.639 g. comparable with the recommended allowances of ICMR (1968)[127] (Figure 3.). The experimental group S_1 received greens supplements obtained the highest amount of

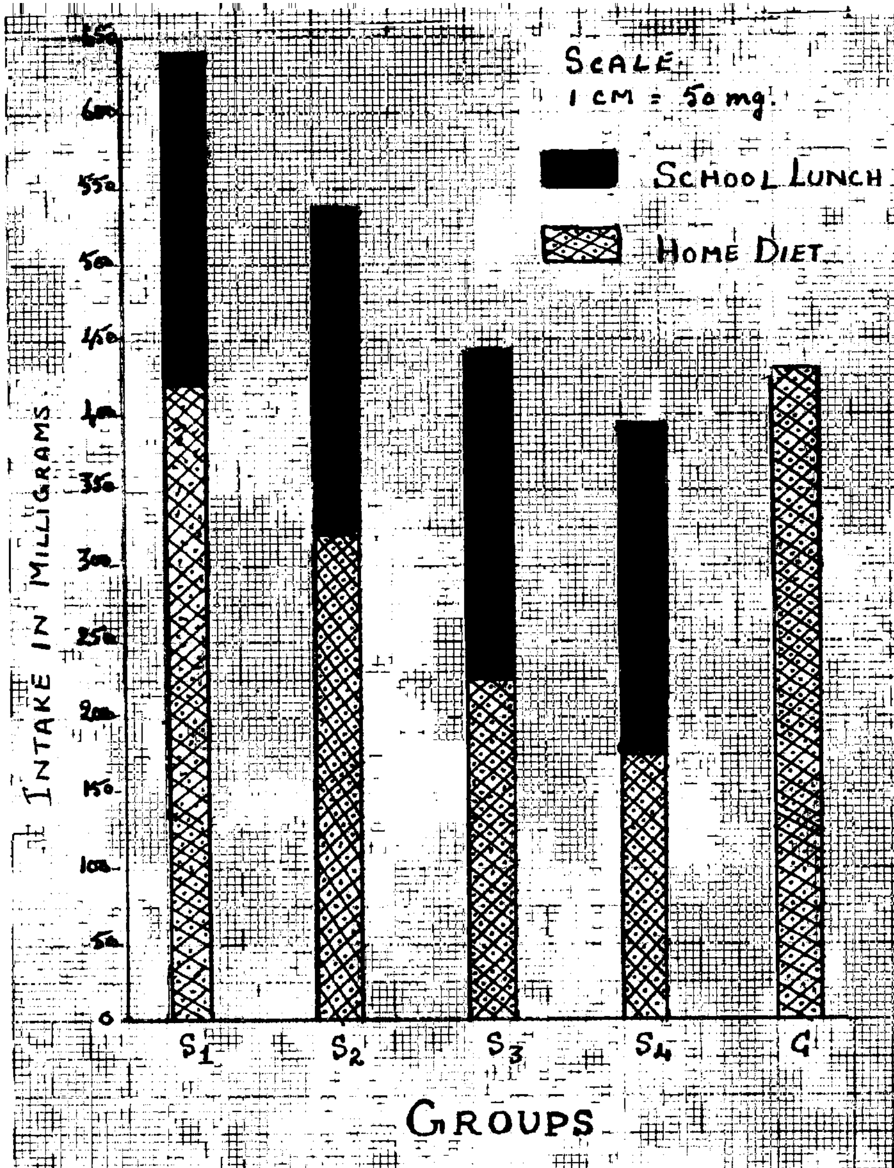


Fig. 3

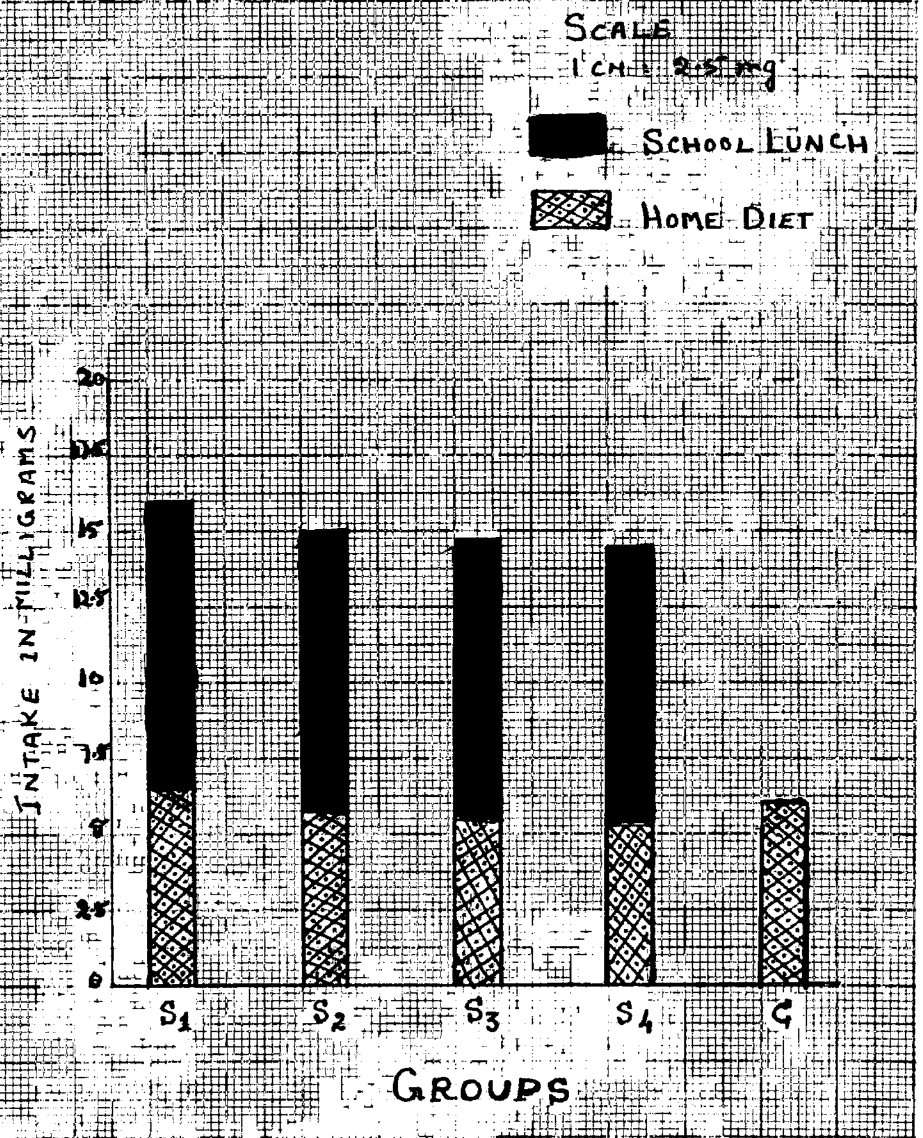


Fig. 4

CALCIUM AND ASCORBIC ACID INTAK OF CHILDREN IN FIVE GROUB calcium 0.689 g. out of which 0.22 g. was provided by the school lunch. The groups S_1, S_2, S_3 and C met the allowances for calcium recommended by the ICMR (1968)[127] except the group S_4, because the amount of calcium provided by the home diet was very low.

4. Intake of Ascorbic Acid:

The ascorbic acid provided by the home diets for all the groups ranged from 5.2 mg. to 6.6 mg. (Figure 4.). In addition the groups S_1, S_2, S_3 and S_4 received 9.57 mg of ascorbic acid from school lunch. The analysed values obtained were low which may be due to cooking losses.

Though the ascorbic acid provided by the whole day's diet does not meet the recommended allowances of ICMR (1968)[127] the groups S_1, S_2, S_3 and S_4 received a higher amounts of ascorbic acid than the group C.

B. The Nutritional Status of Children:

1. Height:

The mean height of children in the five groups is given in Table VIII, and the details of their heights are given in Appendix IV.

Increase in height was registered by children in all the groups. The highest increase in height was registered by groups S_1 and S_2 and the least by group C. Groups S_3 and S_4 registered almost similar increased in height. The 'F' values for the increase in heights for all the five groups compared is given in Table VIII. The details of statistical appraisal are given Appendix V.

TABLE VIII

MEAN FORTNIGHTLY HEIGHTS OF CHILDREN DURING THE SIX MONTHS STUDY

Group code	Particulars about lunch	1	2	3	4	5	6	7	8	9	10	11	12	Increase
S_1	School lunch + greens	112.9 ± 0.53	113.0 ± 0.64	113.1 ± 0.70	113.4 ± 0.68	113.7 ± 0.75	113.9 ± 0.66	114.2 ± 0.67	114.4 ± 0.69	114.9 ± 0.68	115.5 ± 0.69	116.0 ± 0.69	116.77 ± 0.62	3.47 ± 0.220
S_2	School lunch + Tonic	116.0 ± 0.60	116.2 ± 0.56	116.4 ± 0.56	116.5 ± 0.66	116.7 ± 0.63	117.6 ± 0.45	117.5 ± 0.56	117.4 ± 0.58	117.4 ± 0.61	118.4 ± 0.54	119.0 ± 0.57	119.44 ± 0.49	3.44 ± 0.449
S_3	School lunch + Salt	113.3 ± 0.55	113.4 ± 0.52	113.6 ± 0.56	113.7 ± 0.60	113.9 ± 0.60	114.0 ± 0.63	114.3 ± 0.43	114.6 ± 0.66	115.2 ± 0.40	115.6 ± 0.50	116.2 ± 0.50	116.5 ± 0.48	3.25 ± 0.211
S_4	Basal diet	113.8 ± 0.61	113.8 ± 0.59	114.1 ± 0.58	114.4 ± 0.44	114.7 ± 0.48	115.0 ± 0.49	115.3 ± 0.47	115.6 ± 0.48	115.8 ± 0.48	116.0 ± 0.62	116.7 ± 0.48	117.0 ± 0.17	3.26 ± 0.150
C	Non school lunch	113.8 ± 0.48	114.0 ± 0.48	114.1 ± 0.51	114.3 ± 0.45	114.6 ± 0.48	114.7 ± 0.50	115.0 ± 0.41	115.2 ± 0.52	115.5 ± 0.42	115.8 ± 0.74	115.2 ± 0.44	116.2 ± 0.44	2.40 ± 0.149

TABLE IX

'F' VALUE FOR INCREASE IN MEAN HEIGHT OF CHILDREN IN FIVE GROUPS

Code	HEIGHT IN CM. Initial	Final	Increase	'F' Test for groups	Variance ratio 'F'
S_1	112.9 ± 0.53	116.3 ± 0.62	3.47 ± 0.220	S_1 vs C	20.92**
				S_2 vs C	20.42**
S_2	116.0 ± 0.60	119.44 ± 0.49	3.44 ± 0.449	S_3 vs C	18.43**
				S_4 vs C	18.44**
S_3	113.8 ± 0.55	116.5 ± 0.48	3.25 ± 0.211	S_3 vs S_4	0.9997
				S_1 vs S_2	1.024
S_4	113.8 ± 0.61	117.0 ± 0.17	3.26 ± 0.15	S_2 vs S_3	1.133
				S_2 vs S_4	1.108
C	113.8 ± 0.48	116.2 ± 0.44	2.40 ± 0.149	S_1 vs S_4	1.1134
				S_1 vs S_3	1.135

** Significant at 0.01 level

The mean increases in height were significantly greater for all the four groups S_1, S_2, S_3 and S_4 than the group C, not participating in the school lunch. The reason for the higher increase in heights of the groups S_1, S_2, S_3 and S_4 may be due to the heigher intake of protein than the group C. The group S_1, S_2 and S_3 also received higher amounts of calcium.

2. Weight:

The mean weight of the children in all the five groups is given in Table X. The fortnightly record of weight is given in Appendix VI.

The highest increase in weight was registered by group S_1 and the lowest increase in weight was registered by group C. The 'F' values are presented in Table XI, and the statistical appraisal is given in Appendix IV.

TABLE X

MEAN FORTNIGHTLY WEIGHT OF CHILDREN DURING THE SIX MONTHS STUDY

Group code	Particulars about lunch	Body Weight in Kg. 1	2	3	4	5	6	7	8	9	10	11	12	Increase
S_1	School lunch + Greens	18.55± 1.165	19.08± 0.886	19.16± 0.949	19.26± 0.936	19.24± 0.975	19.49± 0.935	19.58± 1.042	19.70± 0.947	20.07± 0.747	20.21± 0.662	20.21± 0.713	20.67± 0.809	2.12± 0.268
S_2	School lunch + iron tonic	18.97± 0.561	19.36± 0.718	19.55± 0.711	19.61± 0.728	19.76± 0.753	19.80± 0.657	19.85± 0.795	19.95± 0.633	20.36± 0.679	20.45± 0.628	20.72± 0.755	20.80± 0.760	1.83± 0.718
S_3	School lunch + iron salt	19.23± 0.521	19.63± 0.650	19.[illegible]± 0.843	20.00± 0.795	19.96± 0.706	19.96± 0.679	19.85± 0.558	20.11± 0.658	20.26± 0.894	20.60± 0.749	20.56± 0.618	20.70± 0.712	1.47± 0.32
S_4	Basal diet	18.77± 0.844	19.50± 0.622	19.73± 0.680	19.68± 0.634	19.71± 0.626	19.80± 0.678	19.90± 0.673	19.90± 0.440	19.85± 0.875	19.77± 0.716	19.80± 0.71[illegible]	19.87± 0.504	1.2± 1.005
C	Non school lunch	18.89± 0.538	19.5± 0.611	19.59± 0.600	19.40± 0.657	19.48± 0.845	19.80± 0.713	19.78± 0.565	19.66± 0.577	19.95± 0.341	19.74± 0.583	19.69± 0.660	19.72± 0.567	0.83± 0.137

TABLE XI

'F' VALUE FOR INCREASE IN MEAN WEIGHT OF CHILDREN IN FIVE GROUPS

Code	Weight in Kilogram			'F' test for groups	Variance ratio 'F'
	Initial	Final	Increase		
S_1	18.55 ±	20.67 ±	2.12 ±	S_1 vs C	6.528**
	1.165	0.809	0.268	S_2 vs C	4.849**
S_2	18.97 ±	20.80 ±	1.83 ±	S_3 vs C	3.128**
	0.561	0.760	0.718	S_4 vs C	1.959
S_3	19.23 ±	20.70 ±	1.47 ±	S_4 vs S_1	3.286**
	0.521	0.712	0.320	S_1 vs S_3	3.412**
S_4	18.77 ±	19.97 ±	1.2 ±	S_2 vs S_3	1.967
	0.644	0.504	1.005	S_1 vs S_2	1.316
C	18.89 ±	19.72 ±	0.83 ±	S_4 vs S_3	1.584
	0.538	0.357	0.137	S_4 vs S_2	2.418

** Significant at 0.01 level

The difference between the mean increase in weights were significant at 0.01 level for the groups S_1, S_2 and S_3 over the group C. Though the increase in weight for group S_4 was higher than the group C, the increase was not statistically significant. The increase in weight registered by group S_1 was significant at 0.01 level when compared with groups S_3 and S_4.

The highest increase in weight registered by group S_1 over the other groups may be due to the higher intake of protein and calcium received by this group from the whole day's diet which includes the home diets, school lunch and the amaranthus supplement. Studies conducted on supplementary feeding by Tensil) (1945)[134], Moore (1956)[135], Edward et al (1956)[136], Subramanyan et al (1960)[137], Doraiswamy et al (1961)[138], Shurpalekar (1964)[139], Doraiswamy et al (1964)[140], Parthasarathy (1964)[141], Devadas and Radharukmani (1964)[24], Rao et al (1965)[142], Devadas et al (1966)[26], (1967)[28], (1968)[29] and (1969)[30] have shown that addition of extra nutrients in the diet increases the growth of children.

3. Haematological Indices:

Haemoglobin:

The mean increase in haemoglobin registered by the children in all the five groups is given in the Table XII. The fortnightly record of haemoglobin is given in Appendix VII.

The children in the groups S_1, S_2, S_3 and S_4 registered a a higher haemoglobin level than the group C, but the highest increase in haemoglobin was registered by the group S_1 receiving amaranthus supplement.

TABLE XII

MEAN FORTNIGHTLY HAEMOGLOBIN VALUES OF CHILDREN DURING THE SIX MONTHS STUDY

(grams per 100 ml)

Group code	Particulars about lunch	1	2	3	4	5	6	7	8	9	10	11	12	Increase
S_1	School lunch + Greens	10.31± 0.290	10.50± 0.281	10.71± 0.382	10.90± 0.139	11.00± 0.166	11.17± 0.208	11.27± 0.153	11.45± 0.153	11.60± 0.037	11.66± 0.223	11.79± 0.099	12.08± 0.187	1.72± 0.165
S_2	School lunch + Tonic	10.45± 0.456	10.59± 0.397	10.78± 0.365	10.95± 0.331	11.08± 0.672	11.18± 0.552	11.34± 0.361	11.44± 0.083	11.51± 0.183	11.57± 0.071	11.63± 0.175	12.00± 0.114	1.55± 0.126
S_3	School lunch + Salt	10.60± 0.081	10.79± 0.536	10.91± 0.236	11.08± 0.192	11.17± 0.210	11.37± 0.259	11.40± 0.156	11.50± 0.039	11.55± 0.037	11.70± 0.039	11.72± 0.068	11.96± 0.564	1.36± 0.364
S_4	Basal diet	10.32± 0.303	10.53± 0.262	10.70± 0.228	10.85m± 0.250	10.92± 0.221	11.15± 0.055	11.16± 0.338	11.28± 0.233	11.37± 0.157	11.40± 0.175	11.52± 0.182	11.60± 0.171	1.28± 0.186
C	Non school lunch	10.55± 0.186	10.71± 0.243	10.81± 0.032	10.87± 0.101	10.91± 0.146	11.11± 0.111	11.25± 0.150	11.29± 0.075	11.39± 0.038	11.45± 0.060	11.30± 0.111	11.70± 0.105	1.15± 0.356

The higher increase in haemoglobin may be due to the higher intakes of iron from the home diets, school lunch and iron supplementation. The study conducted by Keinlier and Weintraub (1968)[143] has shown that the absorption of iron itself may be relatively impaired as a result of low intake of iron previously. The higher increase in haemoglobin registered by group S_1, S_2, S_3 and S_4 may also be due to the adequate amounts of dietary protein which is necessary to increase the haemoglobin level (Latham and Stone 1967)[144]. Dietary ascorbic acid enhances iron absorption as shown by Braise and Hallberg (1962)[103], Apte and Venkatachalam (1965)[104] and Rajalakshmi et al (1967)[145] and the higher intake of ascorbic acid by the groups S_1, S_2, S_3 and S_4 may be cause for the higher increase in haemoglobin levels by these groups. Among the experimental gr-oups receiving iron supplementation from amaranthus, iron tonic (colliron) and iron salt (ferrous sulphate) the group S_1 receiving amaranthus registered the highest increase in haemoglobin and the reason for this may be as put forth by Kinaman (1966)[146] and Nutrition Review (1967)[147] that the absorption of iron, calcium and phosphorous is dependent upon relative amounts of each of these substances in the diet, and elevated level of oral iron therapy only (as in the case of iron tonic and iron salt) decreases the availability of iron due to the absence of other supporting nutrients. The beneficial effect of extra dietary calcium in iron absorption in human being has been stressed by Apte and Venkatachalam (1964)[148]. The 'F' values for the groups compared is presented in Table XIII and the details of statistical analysis of is given in Appendix V.

TABLE XIII

'F' VALUE FOR INCREASE IN MEAN HAEMOGLOBIN OF CHILDREN IN THE FIVE GROUPS

Code	Haemoglobin in g/100 ml.			Variance ratio 'F'
	Initial	Final	Increase	
S_1	10.31 ± 0.29	12.03 ± 0.187	1.72 ± 0.165	
S_2	10.45 ± 0.456	12.00 ± 0.114	1.55 ± 0.128	2.29
S_3	10.60 ± 0.081	11.96 ± 0.054	1.36 ± 0.064	
S_4	10.32 ± 0.303	11.60 ± 0.711	1.28 ± 0.186	
C	10.55 ± 0.186	11.70 ± 0.103	1.15 ± 0.055	

Insignificant

The mean increase in haemoglobin registered by group 3_1 over that of the other groups, was not statistically significant.

As the initial distribution was done on a completely randomised block design, their differences within groups is hoped to be uniform in all the experimental groups. The iron content of the whole days diet of the supplemented subject is in the range of 26.15 mg. to 29.80 mg. so even if one of the source is not utilised properly, there is a supply of more than adequate quantity per day which would make the poor quality insignificant.

Similar study based on iron supplementation was carried out last year in the same school. Most of the children selected for the present study had been receiving around 20 mg. of supplementation of iron per day for a period of six months. This would have saturated their iron stores, and ingested iron is stored and retained in the body unlike proteins and vitamins which are excreted.

Correlation Curve:

The source of iron supplementation has been ignored and the hypothesis that the increase in haemoglobin values (provided there is an adequate or above requirements supply of iron from any source) is dependent on the initial haemoglobin level i.e. iron nutritional status of the subject has been listed by the calculation of a regression equation and the calculation of a correlation coefficient. The details of statistical analysis is given in Appendix V.

Figure 5, indicates that the correlation between the increments in haemoglobin and the initial haemoglobin level was good ($r = 0.8$) and is negative in character, indicating that with higher initial haemoglobin level for the same amount of iron supplementation

CORRELATION BETWEEN INITIAL HAEMOGLOBIN LEVEL AND INCREASE IN HAEMOGLOBIN LEVEL OF CHILDREN IN IRION SUPPLEMENTATION OF 13 mg PER DAY

$\hat{Y} = 5{\cdot}020 - 0{\cdot}3347\, x_i \qquad r = 0{\cdot}4725$

SCALE

Y axis 1 CM = 1 g. PER CENT

X axis 2 cm = 1 g. PER CENT.

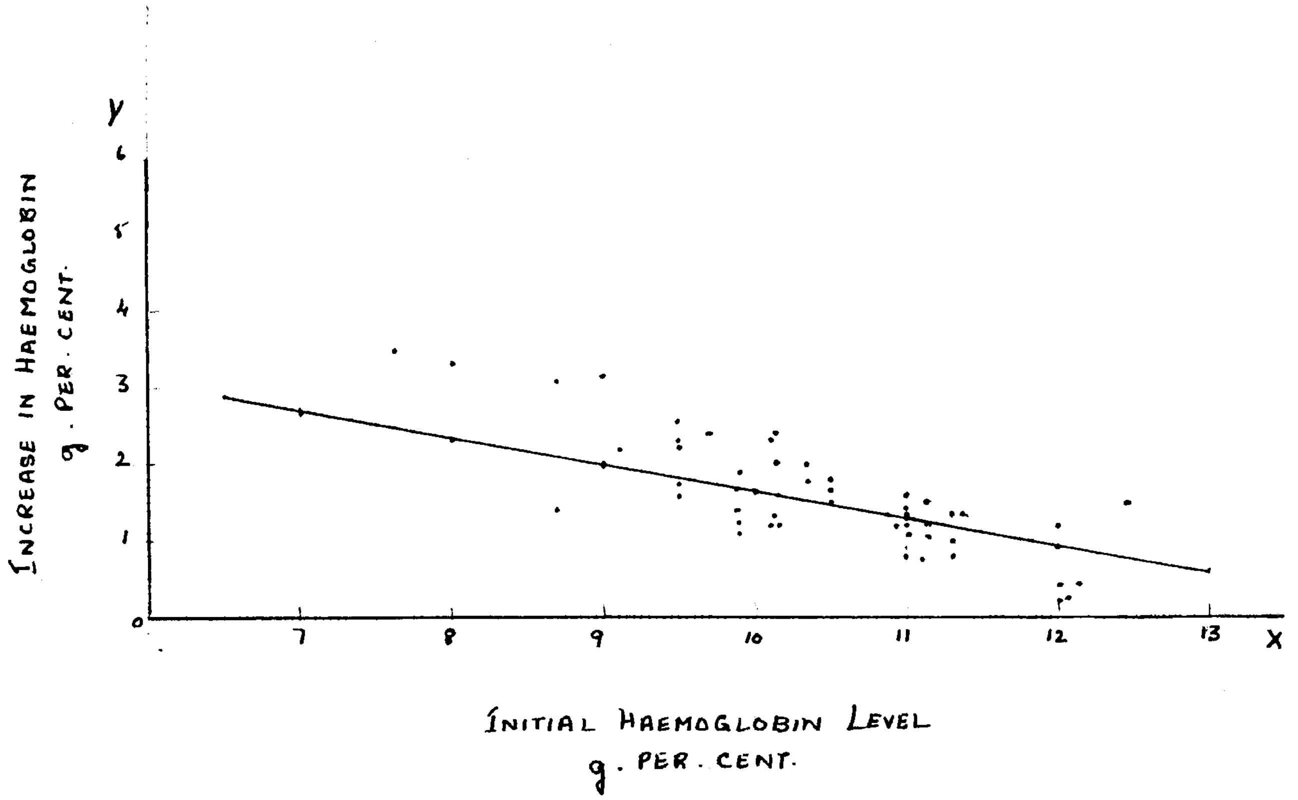


Fig. 5

increase in haemoglobin is of a smaller magnitude.

Other Red Cell Indices:

The other indices were calculated using haemoglobin level, haemotocrit and RBC to evaluate the effect of iron supplementation in the haemotological picture.

Red Blood Cell Count:

The mean increase in red blood cell count is given in the Table XIV. The initial and final red blood cell count values are given in Appendix VIII.

TABLE XIV

MEAN INITIAL AND FINAL RBC VALUES OF CHILDREN STUDIED

Code	Particulars about lunch	Initial	Final	Mean Increase
S_1	School lunch + greens	4.08±0.132	4.38±0.147	0.30±0.057
S_2	School lunch + Tonic	4.05±0.114	4.31±0.176	0.26±0.263
S_3	School lunch + Salt	3.74±0.155	3.95±0.168	0.21±0.081
S_4	Basal Diet	3.53±0.055	3.75±0.052	0.22±0.296
C.	Non school lunch	3.61±0.113	3.74±0.116	0.13±0.069

The group S_1 receiving greens showed the highest increase, in the red blood cell count while the group C registered the lowest increase in red blood cell count. The groups S_1, S_2 and S_3 registered similar increase in red blood cell count but a higher increase than the group C.

Packed Cell Volume:

The mean increase in packed cell Volume is given in Table XV. The initial and final record of packed cell volume is given in Appendix IX.

TABLE XV

MEAN INITIAL AND FINAL PCV VALUES OF CHILDREN STUDIED

Group code	Particulars about lunch	Initial	Final	Increase
S_1	School lunch + greens	34.5 ± 1.064	36.0 ± 0.856	1.5 ± 1.385
S_2	School lunch + Tonic	31.8 ± 0.876	33.7 ± 0.728	1.9 ± 1.864
S_3	School lunch + Salt	33.3 ± 1.095	34.8 ± 0.837	1.5 ± 0.898
S_4	Basal Diet	33.7 ± 2.129	34.3 ± 1.932	0.6 ± 0.943
C	Non school lunch	32.7 ± 1.683	32.7 ± 1.683	Nil

Increase in PCV values was shown by the groups S_1, S_2, S_3 and S_4 and the maximum increase was shown by group S_2. The group C did not register any change in their PCV values.

Comparison of PCV of Children with Other Standards:

Standards	PCV percentage
Present study	33.4
Beaton and McHenry (1964)[149]	38.0
Jelliffe (1966)	33.0

The P.C.V. values of the present study is 33.4 per cent which is comparable with the standard set by Jelliffe (1966).

M.C.H.C. Values:

The Mean Corpuscular Haemoglobin Concentration values of the five groups calculated using the haemoglobin levels and PCV percentage is given in Table XVI

TABLE XVI

MEAN INITAL AND FINAL M.C.H.C. VALUES OF CHILDREN STUDIED

Groups code	Particulars about lunch	Inital	Final	Increase
S_1	School lunch + Greens	30.9 ± 0.748	34.2 ± 0.620	3.3 ± 1.493
S_2	School lunch + Tonic	33.2 ± 1.571	35.3 ± 1.126	2.1 ± 2.331
S_3	School lunch + Salt	31.9 ± 1.651	36.1 ± 2.229	4.2 ± 2.501
S_4	Basal Diet	31.9 ± 1.851	36.1 ± 2.229	4.2 ± 2.501
C	Non school lunch	31.8 ± 1.347	35.5 ± 1.457	3.7 ± 2.167

The normal values for the mean corpuscular haemoglobin concentration values is 34 per cent and the range is 32 per cent to 38 per cent (Hunter et al 1968)[150]. The mean initial and final M.C.H.C. values of the children obtained in this study were 32.4 per cent and 35 per cent respectively both of which are within the normal range.

TABLE XVII

MEAN INITIAL AND FINAL M.C.H. VALUES OF CHILDREN STUDIED

Groups code	Particulars about lunch	Inital	Final	Increase
S_1	School lunch + Greens	26.1 ± 1.171	28.1 ± 0.9157	2.0 ± 1.218
S_2	School lunch + Tonic	26.1 ± 1.147	27.8 ± 1.080	1.7 ± 1.442
S_3	School lunch + Salt	27.9 ± 2.019	31.2 ± 1.669	3.3 ± 2.611
S_4	Basal Diet	29.3 ± 1.217	32.5 ± 1.585	3.2 ± 3.336
C	Non school lunch	28.7 ± 1.826	30.9 ± 3.322	2.2 ± 1.563

The initial and final mean Corpuscular haemoglobin values of this study were 27.6 mg. and 30.1 mg. respectively which are comparable with the normal values suggested by Hunter *et al* (1968)

M.C.V. Values:

The mean corpuscular volume for all five groups calculated using PCV values and RBC values is given in Table XVIII.

TABLE XVIII

MEAN INITIAL AND FINAL M.C.V. VALUES OF CHILDREN STUDIED

Groups code	Particular about lunch	Inital	Final	Increase
S_1	School lunch + Greens	84.9 ± 3.026	82.0 ± 2.733	-2.9 ± 2.498
S_2	School lunch + Tonic	78.6 ± 1.656	78.6 ± 3.026	± 7.111
S_3	School lunch + Salt	89.2 ± 3.570	88.8 ± 3.196	-0.5 ± 8.153
S_4	Basal Diet	95.3 ± 3.962	91.6 ± 5.014	-3.7 ±8.153
C	Non school lunch	94.6 ± 7.033	88.3 ± 7.065	-6.3 ± 6.928

The mean corpuscular volume obtained in this study was 86 cubic microns which is comparable to with the normal values suggested by Huner *et al* (1968).

Clinical Examination:

The scores obtained for clinical examination by individual children in all the five groups are given in Appendix X. The mean initial and final scores are given in Table XIX.

TABLE XIX

INITIAL AND FINAL SCORES FOR CLINICAL EXAMINATION

Code	Particulars of school lunch	Initial	Final	Difference
S_1	School lunch + Greens	85.5	87.8	2.3
S_2	School lunch + Tonic	83.0	85.0	2.0
S_3	School lunch + Salt	80.0	81.2	1.2 ± 1.366
S_4	Basal Diet	79.4	81.0	1.6 ± 1.429
C	Non School lunch	80.0	81.1	1.1 ± 1.283

There was an increase in the clinical scores for all the five groups. The increase was higher for groups S_1 and S_2 receiving greens and tonic, when compared to groups S_3, S_4, and C.

Incidence of Deficiency Symptoms:

Table XX presents the incidence of deficiency symptoms in the beginning and end of the study. The incidence of deficiency symptoms has decreased in all the groups but to a great extent in the groups receiving iron supplement. This may be due to the overall effect of the adequate amounts of all the nutrients received from the whole day's diet.

TABLE XX

INCIDENCE OF DEFICIENCY SYMPTOMS IN THE FIVE GROUPS

	(S_1) Number at		(S_2) Number at		(S_3) Number at		(S_4) Number at		(C) Number at	
	Beginning	End	Beginning	End	Beginning	End	Beginning	End	Beginning	End
Xerosis of conjunctiva (slight)	8	5	12	6	12	8	13	10	14	10
Discharge:										
Watery excessive lachrymation	1	nil	1	nil	1	nil	2	nil	2	1
Xerosis of cornea	5	1	8	4	10	6	13	9	12	8
Vascularisation of cornea Bitot spots	11	7	8	6	11	9	11	10	11	11
Folliculosis of cyclids (for granules)	-	-	1	-	-	-	2	-	2	1
									3	2
Angular conjuctivity	-	-	1	-	-	-	-	-	-	-
Angular stomatitis	10	4	10	6	10	5	15	6	11	8
Bleeding gunis	-	-	1	-	1	-	2	-	4	7
Caries	10	6	10	7	11	7	11	9	9	6
Skin elasticity diminished	-	-	1	-	1	-	2	-	1	-
Nasolabial seborrhoea	-	-	-	-	2	-	2	-	3	1
Odema on dependent parts	-	-	1	-	5	1	1	-	2	1
	45	23	54	29	64	36	74	44	74	40

V. SUMMARY AND CONCLUSION

The comparison of the contribution of iron by amaranthus flavus, colloidal iron and iron salt as daily supplements in a school lunch programme was studied over a period of six months. Five groups of 18 school children each, comparable in height, weight, age socio economic background and freedom from hookworm infestation and haemoglobin level were selected.

The details of grouping were as follows:-

S_1 - School lunch + amaranthus flavus

S_2 - School lunch + Colliron (Iron tonic)

S_3 - School lunch + Iron Salt

S_4 - School lunch

C - Non school lunch group

Indices such as height, weight, haemoglobin levels, red blood cell count packed cell volume, were used to evaluate the nutritional status.

The findings of the study revealed that:

1. The mean increase in height and weight were significantly greater for all the four groups S_1, S_2, S_3 and S_4 receiving school lunch than that registered by the group C, receiving home lunch only. The group highest increase was registered by the group S_1 receiving amaranth supplement followed by the group S_2 receiving iron tonic.

2. The mean increase in weights for group S_1 receiving amaranth was significantly higher at 0.01 level when compared to the group S_3 and S_4.

3. The nutrient intake as determined by the direct analysis of the whole days diet for all the groups, was highest for the group S_1 with amaranth followed by group S_2 with iron tonic. These higher nutrients were correlated with significantly higher increases in height and weight for these groups.

4. Children in all the four groups namely S_1, S_2, S_3 and S_4 receiving school lunch registered a higher increase in haemoglobin in comparison with those who were on home diet (Group C). The highest increase was registered by children in group S_1, receiving amaranth, those in group S_2 on iron tonic coming next. The increased intake of iron through the supplements had thus influenced the haemoglobin levels. Although both the groups S_1 and S_2 received the same quantity of iron through supplementation, the increase is greater in the case of amaranth perhaps due to the presence of other hemopoietic nutrients such as calcium and ascorbic acid.

5. The correlation between the increments in haemoglobin level and the initial haemoglobin level was good, ($r = 0.5$) and negative in character, indicating that with a higher initial haemoglobin level for the same amount of iron supplementation, increase in haemoglobin is of a smaller magnitude.

6. The RBC cound and PCV had increased in all the groups receiving school lunch and not in the group on home lunch.

7. The nutritional status of the children as judged by the clinical scores was higher for group S_1 and S_2 supplemented with amaranth and iron tonic respectively followed by group S_3 receiving school lunch with iron salt and S_4 on school lunch only.

From all angles this study has brought out the superior supplementing quality of amaranth as a source of iron to the school lunch. This finding deserves application in all the nutritional feeding efforts for children and other vulnerable groups in ANP and other composite programmes.

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APPENDICES

APPENDIX I

NUTRIENTS SUPPLIED BY THE WEEKLY MENU

Days	Food stuffs	Amount gms	Calories	Protein gms	Calcium gms	Iron mgms	Vit.A I.u.	Vit.B mgms	Vit.C mgms
Monday Wednesday Friday	Bulgar wheat	75	267.00	6.185	27.75	3.675	-	0.5550	-
	Redgram dhal	20	67.0	4.46	14.6	1.16	44.0	0.0900	-
	Carrot	20	10.0	0.18	16.0	0.44	630.0	0.0080	0.60
	Pappaya	20	6.0	0.12	3.4	0.10	222.0	0.0240	34.20
	Skim milk powder	5	18.0	1.90	68.5	0.007	-	0.0250	1.00
	Jaggery	10	38.0	0.04	8.0	1.14	4.66	0.0020	-
	C.S.M.	20	72.0	3.77	24.8	0.761	51.00	0.0967	0.05
	Oil	10	90.0	-	-	-	-	-	-
	Total		568.0	17.28	163.05	7.28	951.66	0.8007	35.85
Tuesday	Rice(parboiled Milled)	75	259.0	4.8	6.75	3.0	-	0.1575	-
	Red gramdhal	20	69.0	4.46	14.6	1.16	44.0	0.0900	-
	Carrot	20	10.0	0.18	16.0	0.44	630.0	0.0080	0.60
	Pappaya	20	6.0	0.12	3.4	0.10	222.0	0.0240	34.20
	Skim milk powder	5	18.0	1.90	68.5	0.007	-	0.0250	1.00
	Jaggery	10	38.0	0.04	8.0	1.14	4.66	0.0020	-
	C.S.M.	20	72.0	3.77	24.8	0.761	51.00	0.0967	0.05
	Total		560.0	15.27	142.05	6.608	951.66	0.4032	35.85
Thursday	Rice(Parboiled Milled)	75	259.0	4.8	6.75	3.0	-	0.1575	-
	Redgramdhal	20	67.0	4.46	14.6	1.6	44.0	0.0900	-
	Carrot	20	10.0	0.18	16.0	0.44	630.0	0.0080	0.60
	Pappaya	20	6.0	0.12	3.4	0.10	222.0	0.0240	34.20
	Skim milk powder	5	18.0	1.90	68.3	0.007	-	0.0250	1.00
	Jaggery	10	38.0	0.40	8.0	1.14	4.66	0.0020	-
	C.S.M.	20	72.0	3.77	24.8	0.761	51.00	0.0967	0.05
	Oil	10	90.0	-	-	-	-	-	-
	Lime	5	2.0	-	-	-	-	-	-
	Total		562.0	15.27	142.05	6.608	951.66	0.4032	37.45

APPENDIX II

SRI AVINASHILINGAM HOME SCIENCE COLLEGE
COIMBATORE.11

Schedule for Clinical Assessment

Date of Survey: Serial Number of the family :

Name: Sex: Age:

Height: Weight: Blood pressure:

Hip width (inter cristal):

I. General Appearance:

4 Good

3 Fair

2 Poor

1 Very poor

II. Eyes:

A. Xerosis of Conjunctiva:

4. Absent - glistening and moist

3. Slightly dry on exposure for ½ munute lack of lustre.

2. Conjunctiva very dry

1. Bitot spots present.

B. Pigmentation:

4. Normal colour

3. Slight discolouration

2. Moderate browning in patches

1. Severe earthy discolouration

C. Discharge:

4. Absent

3. Watery, excessive lachrymation

2. Micropurulent

1. Purulent

D. Xerosis of Cornea:

4. Absent

3. Slight dryness and diminished sensibility

2. Haziness and diminished transparency

1. Ulceration

E. Vascularisation of Cornea:

4. Absent

3. Vascularisation present

2. Severe vascularisation present

1. Severe

F. Eyelids Excoriation:

4. Absent

3. Slight Excoriation

2. Blepharitis

1. Severe

G. Folliculosis:

4. Absent

3. A few granules

2. Lids covered with extensive granules

1. Hyper trophy

H. <u>Angular Conjunctivitis:</u>

4. Absent

3. Mild

2. Moderate

1. Severe

I. <u>Night Blindness:</u>

4. Absent

3. Mild

2. Moderate

1. Severe

III. <u>Mouth:</u>

A. <u>Condition of lips:</u>

4. Normal

3. Angular stomatitis, mild

2. Angular stomatitis, moderate

1. Angular stomatitis, severe.

B. <u>Colour of Tongue:</u>

4. Normal

3. Pale but not coated

2. Red

1. Red and raw

C. <u>Surface of tongue:</u>

4. Normal

3. Fissured

2. Ulcered

1. Glazed and atropic

D. Condition of gums:

4. Normal

3. Bleeding and/or gingivities

2. Pyorrhea

1. Rettacted

E. Teeth:

4. Flourosis

3. Chalky teeth

2. Pitting of teeth

1. Mottled enabmel and discoloured teeth

F. Caries:

4. Absent

3. Slight

2. Moderate

1.

G. Tonsils Enlargement:

4. Absent

3. Slight

2. Moderate

1. Severe

IV. Hair

4. Normal

3. Loss of lustre

2. Discoloured and dry

1. Sparse and brittle

V. Skin:

A. General Appearance:

4. Normal

3. Loss of lustre

2. Dry and rough or crazy pavement

1. Hyperkeratosis, phrynoderma

B. Elasticity:

4. Normal

3. Diminished

2. Wrinkled

1. Severely wrinkled

VI. Face:

4. Normal

3. Nasolabial seborrhoea

2. Symmetrical-sub-orbital

1. Pigmentation

VII. Oedema:

4. Absent

3. Oedem on dependents parts

2. Oedema on face

1. General oedema

VIII. **Alimentary system:**

A. **Appetite:**

4. Normal

3. Anorexia mild

2. Moderate

1. Severe

Rating:

Excellent:

Very good:

Good:

Fair:

Poor:

Very Poor:

APPENDIX III

PROTEIN, IRON, CALCIUM AND ASCORBIC ACID INTAKE OF RANDOMLY SELECTED CHILDREN
(ANALYSED VALUE OF HOME DIET)

~~TABLE~~

PROTEIN INTAKE OF THE RANDOMLY SELECTED
CHILDREN IN FIVE GROUPS

S.No.	GROUPS				
	S_1	S_2	S_3	S_4	C
1.	27.96	26.65	16.00	15.16	18.80
2.	34.41	28.42	38.32	18.54	16.95
3.	29.04	28.00	28.55	16.89	28.62
4.	24.07	33.47	29.17	18.49	23.90
5.	33.60	20.72	17.40	22.37	19.52
Average	29.82	27.45	25.48	18.29	21.54

[illegible]

IRON INTAKE OF THE RANDOMLY SELECTED CHILDREN
IN FIVE GROUPS

S.No.	GROUPS				
	S_1	S_2	S_3	S_4	C
1.	11.80	9.44	4.05	6.89	11.23
2.	9.10	7.23	12.37	6.39	8.94
3.	16.10	14.40	6.20	6.72	8.78
4.	9.50	13.21	7.63	5.75	9.77
5.	10.50	8.44	8.00	6.60	8.43
Average	11.40	10.54	7.65	6.47	9.43

TABLE

CALCIUM INTAKE OF THE RANDOMLY SELECTED
CHILDREN IN FIVE GROUPS

S.No.	GROUPS				
	S_1	S_2	S_3	S_4	C
1.	0.746	0.905	0.512	0.149	0.528
2.	0.226	0.158	0.141	0.158	0.348
3.	0.116	0.146	0.125	0.210	0.567
4.	0.340	0.290	0.160	0.201	0.265
5.	0.666	0.092	0.104	0.148	0.432
Average	0.419	0.318	0.228	0.173	0.428

[illegible]

ASCORBIC ACID INTAKE OF THE RANDOMLY SELECTED CHILDREN IN FIVE GROUPS

S.No.	GROUPS				
	S_1	S_2	S_3	S_4	C
1.	6.5	4.9	5.3	4.6	7.4
2.	7.4	5.2	5.8	5.3	5.2
3.	6.4	6.6	4.9	5.1	4.3
4.	5.9	5.7	5.5	6.2	6.8
5.	6.8	6.1	5.7	4.8	5.8
Average	6.6	5.7	5.4	5.2	5.9

APPENDIX IV

FORTNIGHTLY HEIGHT RECORD OF CHILDREN IN FIVE GROUPS

HEIGHT RECORD OF GROUP S_1 (GHE MS) IN CENTIMETRES

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	138.0	138.00	139.0	139.0	139.5	139.5	140.0	140.0	140.5	140.5	141.5	141.5
2.	116.5	116.5	116.5	117.0	117.0	117.5	117.5	117.5	118.0	118.0	118.0	118.0
3.	122.0	122.0	122.5	122.5	123.0	123.0	123.5	123.5	124.0	124.5	124.5	124.5
4.	124.0	124.0	124.5	124.5	125.0	125.0	126.0	126.0	126.0	126.0	127.0	127.5
5.	121.5	121.5	121.5	122.0	122.0	122.0	122.5	122.5	123.0	124.0	124.5	125.0
6.	108.5	109.0	109.0	109.0	109.5	109.5	109.5	110.0	110.0	111.0	111.5	112.5
7.	111.5	111.5	112.0	112.0	112.5	112.5	112.5	113.0	113.5	114.0	114.5	115.0
8.	113.0	113.5	113.5	114.0	114.5	114.5	115.0	115.0	115.5	116.0	117.5	117.5
9.	119.5	119.5	119.5	119.5	120.0	120.5	120.5	120.5	120.5	122.0	122.5	122.5
10.	123.5	123.5	124.0	124.0	124.5	125.0	125.0	125.0	126.0	126.0	126.0	126.0
11.	105.0	105.0	105.0	106.0	106.0	106.5	106.5	107.0	107.0	107.0	108.0	108.0
12.	103.0	103.0	103.0	103.5	103.5	104.0	104.0	104.5	104.5	106.0	106.0	106.0
13.	100.0	100.0	101.0	101.0	101.5	102.0	102.0	103.0	103.0	103.0	103.5	104.0
14.	117.5	117.5	117.5	117.5	118.0	118.0	118.0	118.5	118.5	119.0	119.0	120.0
15.	113.0	113.0	113.0	113.0	113.5	113.5	140.0	140.0	115.0	115.5	116.0	116.0
16.	94.5	95.0	95.0	96.0	96.5	97.0	97.5	97.5	98.0	98.0	100.0	100.0
17.	97.5	97.5	97.5	97.5	98.0	98.0	98.0	99.0	99.0	99.5	101.0	102.0
18.	104.0	104.0	104.0	104.5	104.5	105.0	105.5	105.5	106.0	106.0	107.0	108.0
Average	112.9	113.0	113.1	113.4	113.7	113.9	114.2	114.4	114.9	115.3	116.0	116.33

HEIGHT RECORD OF GROUP S_2 (COLLISON TIMES) IN CENTIMETRES

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	119.0	119.0	119.5	119.5	120.0	120.0	120.5	120.5	121.0	121.0	122.01	122.0
2.	115.0	115.0	115.0	115.5	115.5	116.0	116.0	116.0	117.0	117.5	118.0	118.0
3.	119.5	119.5	119.5	120.0	120.0	120.5	121.0	121.0	121.5	121.5	122.0	122.5
4.	123.5	123.5	123.5	124.0	124.5	124.5	125.0	125.0	126.0	127.0	127.5	128.0
5.	115.5	115.5	115.5	116.0	116.5	116.5	117.5	117.5	118.0	118.0	119.0	119.0
6.	119.0	119.0	120.0	120.0	120.0	120.5	121.0	121.0	121.5	122.5	123.0	123.0
7.	105.0	105.5	105.5	105.5	105.5	106.0	106.0	106.5	106.5	107.0	107.5	108.0
8.	126.5	126.5	126.5	127.0	127.0	127.5	128.0	128.0	129.0	129.0	130.0	131.0
9.	117.5	117.5	117.5	117.5	118.0	118.0	118.0	118.5	118.5	119.0	119.0	120.5
10.	133.5	133.5	133.5	134.0	134.0	134.5	134.5	134.5	135.0	135.0	135.5	136.0
11.	117.5	117.5	118.0	118.5	118.5	119.0	119.0	119.0	120.0	120.5	121.0	121.0
12.	115.0	115.0	116.0	116.0	116.5	116.5	117.0	117.0	118.0	118.0	119.0	119.0
13.	111.0	112.0	112.0	112.5	112.5	113.0	113.0	113.0	114.0	114.0	115.0	115.0
14.	109.5	109.5	110.0	110.0	110.0	110.5	110.5	111.0	111.0	112.0	113.0	113.0
15.	107.5	107.5	107.5	108.0	108.0	108.0	108.0	108.5	109.0	111.0	111.0	111.5
16.	117.0	117.5	117.5	117.5	117.5	118.0	118.0	118.5	118.5	118.5	119.0	119.0
17.	121.5	121.5	1220.	122.0	122.5	122.5	123.0	123.0	123.0	123.5	124.0	124.0
18.	96.5	96.5	96.5	96.5	96.5	97.0	97.0	97.0	97.5	97.5	98.5	99.5
Average	116.0	116.2	116,36	116.5	116.7	117.0	117.3	117.4	117.9	118.4	119.0	119.44

HEIGHT RECORD OF GROUP S_3 (TABLET SALT) IN CENTIMETERS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	123.5	123.5	124.0	124.0	124.5	124.5	125.0	125.5	128.0	126.0	126.0	127.0
2.	125.5	125.5	126.0	12.60	126.5	126.5	127.0	127.5	127.5	128.0	128.0	128.0
3.	109.5	110.0	110.0	110.0	110.5	110.5	110.5	111.0	112.0	113.0	113.0	113.0
4.	125.5	125.5	125.5	125.5	125.5	126.0	126.0	126.0	126.5	127.5	127.5	128.0
5.	131.0	131.0	131.5	131.5	131.5	131.5	131.5	131.5	132.0	132.0	133.0	133.0
6.	101.0	101.5	101.5	101.5	101.5	101.5	102.0	120.0	102.5	103.0	104.0	104.0
7.	111.5	112.0	112.0	112.0	112.0	112.0	112.5	113.0	114.0	114.0	114.0	115.0
8.	116.0	116.0	116.0	116.0	116.5	116.5	116.5	116.5	117.0	117.5	119.0	119.0
9.	100.5	100.5	101.0	102.0	102.5	103.0	103.5	103.5	104.0	104.0	105.5	106.0
10.	109.5	110.0	110.0	110.0	110.0	110.0	110.5	111.0	111.0	111.5	112.0	113.0
11.	119.5	119.5	119.5	120.0	120.5	121.0	121.5	121.5	122.0	122.0	122.0	122.0
12.	117.5	117.5	118.0	118.0	118.0	118.0	118.5	119.0	120.0	120.0	121.0	121.0
13.	118.0	118.5	118.5	118.5	118.5	118.5	119.0	119.5	120.0	120.0	121.0	121.0
14.	106.5	106.5	106.5	106.5	106.5	107.0	107.0	107.5	108.0	108.5	109.0	109.0
15.	104.0	104.0	105.0	105.5	106.0	106.0	106.5	207.0	207.0	207.5	108.5	109.0
16.	105.0	105.0	106.0	106.0	106.5	1065	107.0	107.0	107.0	107.5	108.0	109.0
17.	103.0	103.0	103.0	103.5	103.5	103.5	104.0	104.0	104.0	104.0	106.0	106.0
18.	111.5	111.5	111.5	112.0	112.0	112.5	112.5	112.5	113.0	113.5	114.0	114.0
Average	113.25	113.4	113.6	113.7	113.9	114.0	114.3	114.6	115.2	115.6	116.2	116.5

HEIGHT RECORD OF GROUP S_4 (BASAL DIET) IN CENTIMETERS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	115.5	115.5	116.0	116.5	117.0	117.0	118.0	118.5	118.5	119.0	121.0	121.0
2.	119.0	119.0	119.0	119.0	119.0	119.5	119.5	120.5	120.5	120.5	121.0	122.0
3.	123.0	123.5	123.5	123.5	124.0	124.0	124.5	124.5	125.0	125.0	125.0	125.0
4.	127.5	127.5	128.0	128.0	128.0	128.5	129.0	129.0	130.0	130.0	130.0	130.0
5.	122.0	122.0	122.0	122.0	123.0	123.0	123.0	123.5	123.5	123.5	123.5	123.5
6.	103.5	104.0	105.0	105.0	106.0	106.0	106.5	106.5	107.0	107.0	107.5	107.5
7.	115.5	115.5	115.5	116.0	116.5	116.5	117.0	117.0	117.0	117.5	118.0	118.0
8.	117.5	117.5	117.5	118.5	118.5	119.0	119.0	119.0	119.0	120.0	121.0	121.0
9.	122.0	122.0	122.5	122.5	123.0	123.0	123.0	123.0	124.0	124.0	124.0	124.0
10.	116.5	116.5	117.0	117.0	117.5	117.5	118.0	118.0	118.0	118.0	119.5	120.0
11.	112.0	112.0	113.0	113.0	113.5	113.5	114.0	114.5	115.0	115.0	116.0	116.0
12.	121.5	121.5	121.5	121.5	122.0	122.0	122.0	122.0	122.5	122.5	122.5	123.0
13.	105.5	106.0	106.0	106.0	106.0	107.0	107.0	108.0	108.0	108.5	109.0	109.0
14.	104.5	104.5	104.5	105.0	105.0	105.5	105.5	106.0	106.0	106.0	107.5	107.5
15.	106.0	106.0	107.0	107.0	107.5	107.5	107.5	108.0	108.0	108.5	108.5	108.5
16.	95.5	96.0	96.0	97.0	97.0	98.0	98.0	98.0	98.0	98.0	100.0	100.0
17.	109.5	109.5	110.0	110.0	110.0	111.0	111.5	111.5	112.0	112.5	113.5	113.5
18.	110.5	110.5	110.5	111.0	111.0	112.0	112.5	112.5	112.5	113.0	114.0	114.0
Average	113.7	113.85	114.1	114.4	114.7	115.0	115.3	115.58	115.8	116.0	116.7	116.96

HEIGHT RECORD OF GROUP C (NON SCHOOL LUNCH) IN CENTIMETRES

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	120.5	121.0	121.0	122.0	122.0	122.0	123.0	123.0	123.5	124.0	124.0	124.0
2.	123.0	123.0	123.0	123.0	123.5	123.5	124.0	124.5	124.5	125.0	125.0	125.0
3.	120.5	120.5	120.5	120.5	121.0	121.0	121.5	121.5	122.0	122.5	123.0	123.0
4.	127.5	127.5	127.5	127.5	1280 0	128.0	128.0	129.0	129.0	129.0	130.0	130.0
5.	110.0	110.5	110.5	111.0	111.0	111.5	111.5	112.0	112.0	113.0	113.0	113.0
6.	106.5	107.0	107.0	107.0	107.5	107.5	107.5	107.5	108.0	108.0	108.5	108.5
7.	114.5	114.5	115.0	115.0	115.5	115.5	116.0	116.0	116.5	116.5	117.0	117.0
8.	117.0	117.0	117.0	117.0	117.0	117.0	117.5	117.5	117.5	118.0	118.5	118.5
9.	122.0	122.0	122.5	122.5	123.0	123.0	123.0	124.0	124.0	124.0	124.0	124.0
10.	117.5	117.5	117.5	117.5	117.5	118.0	118.0	118.0	118.5	118.5	119.0	119.0
11.	114.5	114.5	114.5	114.5	114.5	114.5	115.0	115.0	115.0	115.0	115.0	115.0
12.	108.0	108.0	108.5	108.5	109.0	109.0	109.0	110.0	110.0	111.0	112.0	112.0
13.	116.0	116.5	116.5	117.0	117.0	117.0	118.0	118.0	118.0	118.5	119.0	119.0
14.	111.5	111.5	111.5	112.0	112.0	112.5	112.5	113.0	113.0	113.5	115.0	115.0
15.	108.0	108.0	108.5	108.5	109.0	109.0	109.5	109.5	110.0	110.0	110.0	110.0
16.	106.5	106.5	106.5	107.0	107.0	107.5	107.5	107.5	108.0	108.0	108.0	108.5
17.	105.0	105.5	105.5	105.5	105.5	106.0	106.0	106.0	106.5	106.5	106.5	106.5
18.	101.5	102.0	102. 0	102.0	102.5	102.5	102.5	103.0	103.0	103.5	104.0	104.0
Average	113.8	114.0	114.1	114.3	114.58	114.7	115.0	115.2	115.5	115.8	116.2	116.2

APPENDIX V

DETAILS OF STATISTICAL ANALYSIS

APPENDIX V

ANALYSIS OF VARIANCE AND NON ORTHOGONAL COMPARISON

Any observed values is the sum of three parts:-

i) an over-all mean,

ii) a treatment deviation

iii) a random element from a normally distributed with mean and standard deviation.

The following table shows a symbolic table of data for p groups with n data in each group:

Group I	Group II	Group III
x_1	y_1	p_1
x_2	y_2	p_2
n items	n items	n items

Total number of data P_n = N

The calculation and analysis of variance are shown in the following table:

Variation due	Degrees of freedom	Sum of Squares	Mean square	Variance Ratio
Total	N - 1	(4)	-	-
Among Mean	P - 1	(5)	7	9
Within Group	N - P = (n - 1)	(6)	8	

1. Sum of all data $Sx = x_1 - y_1 \cdot P_1 = S$
2. Sum of squares $Sx^2 = x_1^2 - y_1^2 \cdot P_1^2$
3. Correction term $C = S^2/n$
4. Total sum of squares $Sx^2 - C$
5. Among mean $x_1^2 - y_1^2 \cdot P_1^2 /n - c$
6. Within mean Line 4 - Line 5
7. Among mean, mean square line $5/(P - 1)$
8. Within groups line $6/(n - P)$
9. Item 7/Item 8

The analysis of variance and non orthogonal comparison among the mean was done according to Model I.

Snedecor, G.W., Statistical Methods. Allied Pacific Private LTD, Bombay, 1961.

APPENDIX V

CALCULATION OF STANDARD ERROR

The sample standard erro is sympolised by $S\bar{x}$ and it is equal to $\frac{S}{\sqrt{n}}$ where S is standard deviation of the mean, n is the number of observations. Standard error was calculated as follows:

$$\text{Standard erro} = S\bar{x} = \frac{S}{\sqrt{n}}$$

For example:

S.No.	xi	xi^2
1.	11.0	1021.00
2.	10.91	118.81
3.	10.51	110.25
4.	11.12	123.21
5.	10.71	114.49
6.	9.71	94.09
7.	11.13	123.21
8.	9.50	90.25
9.	9.50	90.25
10.	12.74	161.29
11.	11.32	127.69
12.	7.58	57.76
13.	10.51	110.25
14.	12.04	144.00
15.	8.00	64.00
16.	8.69	75.69
17.	9.90	98.01
18.	10.71	114.49
Total	185.58	1938.74

$$S = \sqrt{\frac{\Sigma xi^2 - (\Sigma x i)^2/n}{(n-1)}}$$

where n = 18

$$\bar{x} = \frac{\Sigma x i}{n} = \frac{185.58}{18}$$

$$= 10.31$$

$$(\Sigma x i)^2 = 34439$$

$$\Sigma x i^2 = 1938.74$$

Using the above formula

$$s^2 = \frac{1938.74 - \frac{34439}{18}}{(18-1)} = \frac{1938.74 - 1913.0}{17}$$

$$s^2 = \frac{25.74}{17} = \begin{array}{r} 1.4106 \\ 1.2304 \\ \hline 0.1802 \end{array}$$

$$S = 0.0901$$

$$S\bar{x} = \begin{array}{r} 0.0901 \\ 0.6277 \\ \hline \bar{1}.4624 \end{array}$$

$$= 0.2900$$

Mean $\pm$ standard error = 10.31 $\pm$ 0.290

Based on this calculation other standard errors were calculated

Calculation of the Regression Equation and the Correlation co-efficient:

In the simple linear regression situation it is postulated that the relationship between the Y_i and X_i is of the form

$$Y_i = \alpha + B X_i + e_i$$

where the intercept α and the slope B are unknown pasemeters and e_i are random variates from an univers with u = 0 and the variance σ^2. There is in the regression content, a very important distinction between Y and X. The variate X is regarded as being measured without "error" ie. its standard deviation is zero. In fact, that Y_i need have no parent distribution in the statistical sense.

The investigator selected subjects with varions haemoglobin levels (X_i) in the experimentation and studidd their response in terms of increases in haemoglobin level (Y_i) when the same amount of iron supplementation was provided.

In contrast with the X_i, the Y_i are subject to random fluctuation e_i which are assumed to arise from an universe with zero mean.

The regression compulations are performed as follows:-

It is worth noting that (a) the number of date is the numbers of pairs X_iY_i rather than the total number of entries (b) unlike SX_i^2 or SY_i^2, SX_iY_i can have a negative sign indicating that the regression line has a negative gradient

N = 54

SX = 583.3

SX^2 = 5932.67

SY = 82.56

SY^2 = 155.2706

SXY = 841.915

$CX = (563.3)^2/54 = 5875.00$

$CY = (82.55)^2/54 = 126.5000$

$SX_1^2 = 5932.67 - 5875.00 = 57.67$

$SY_1^2 = 155.2706 - 126.5000 = 28.9706$

$CXY = (563.3)\ (82.55)/54 = 861.200$

$SX_1Y_1 = 841.915 - 861.200 = -19.3$

$mx = 10.43$

$my = 1.529$

$b = -19.3/57.67 = -0.3347 = Sx_1y_1/SX_1^2$

$a = 1.529 - (-0.3347)\ (10.43) = 5.020$

$= my - bmx.$

$Y_1 = 5.020 - 0.3347\ X_1$

Calculation of the correlation coefficient

$$= SX_1Y_1/\sqrt{(SX_1^2)\ (SY_1^2)}$$

$$= -19.3/\sqrt{(57.67)\ (28.9706)}$$

$$= -0.4725$$

The correlation co-efficient was used as a measure of the degree of association between X and Y.

WEIGHT RECORD OF GROUP S_1 (GRAMS) IN KILOGRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	28.36	29.77	29.77	30.40	29.54	30.04	30.90	30.90	31.60	31.60	31.90	32.27
2.	17.61	17.95	18.40	18.81	17.75	18.86	18.65	18.65	18.96	18.86	19.09	20.90
3.	19.98	20.00	20.22	20.90	20.90	20.90	21.36	21.36	21.81	21.81	21.81	22.72
4.	22.72	23.18	23.18	23.18	23.40	23.40	23.72	24.00	24.00	24.00	24.00	24.00
5.	23.40	23.52	23.52	23.72	24.00	24.00	24.72	24.00	25.15	25.10	25.10	25.10
6.	17.50	17.16	17.00	17.27	17.75	17.27	17.27	17.27	17.75	17.75	18.06	19.09
7.	19.77	19.45	19.43	19.25	20.00	20.00	20.00	20.90	20.90	20.90	20.90	21.36
8.	18.40	19.09	19.09	19.54	19.09	19.54	18.65	18.65	19.54	19.09	19.54	20.00
9.	19.45	20.00	20.22	20.22	20.22	20.68	20.68	20.68	21.36	21.36	21.36	21.81
10.	20.45	22.15	22.05	22.95	23.18	23.18	23.65	23.65	23.65	23.65	24.90	25.10
11.	14.09	14.54	14.54	14.54	15.00	15.45	15.00	15.45	15.90	16.36	16.00	17.00
12.	14.54	15.45	15.45	15.45	15.22	15.90	15.90	15.90	16.10	16.10	15.90	16.30
13.	14.88	15.22	15.00	15.00	15.45	15.90	15.90	15.90	15.90	16.00	16.00	16.00
14.	20.20	20.45	20.68	20.68	20.68	20.45	20.68	20.68	21.36	21.36	21.36	21.36
15.	18.20	10.09	19.09	19.25	19.09	19.09	19.54	19.54	20.00	20.00	20.00	20.00
16.	15.00	15.45	15.45	15.45	15.45	15.90	15.45	15.90	15.70	15.90	15.90	15.90
17.	14.09	15.00	15.45	15.45	15.00	15.00	15.00	15.45	15.45	15.90	15.90	16.10
18.	15.00	15.22	15.45	15.45	15.00	15.45	15.90	15.90	16.30	17.80	17.00	17.27
Average	18.55	19.08	19.16	19.26	19.24	19.49	19.58	19.70	20.07	20.21	20.21	20.67

WEIGHT RECORD OF GROUP S_2 (COLLISON TONIC) IN KILOGRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	20.56	20.68	20.68	21.36	20.90	21.36	21.81	21.81	21.81	21.81	21.81	21.81
2.	18.86	19.09	19.54	20.00	19.54	19.54	19.54	20.00	20.45	20.45	20.00	20.00
3.	19.54	20.45	20.45	20.90	20.45	20.90	20.90	20.90	21.36	21.36	21.81	21.81
4.	21.81	22.04	22.04	21.81	22.04	22.04	22.04	22.04	22.70	22.70	24.90	24.90
5.	20.22	20.22	20.45	20.22	20.90	20.45	20.00	20.00	20.45	20.45	20.90	20.90
6.	20.56	20.90	20.90	21.13	21.36	20.90	21.36	21.36	21.81	21.81	22.27	22.27
7.	15.45	15.45	15.68	15.45	15.82	15.90	16.36	16.36	16.36	16.36	16.36	16.36
8.	20.22	21.81	21.81	21.81	22.27	22.27	22.27	22.27	22.27	22.27	23.13	23.13
9.	17.50	17.73	17.73	17.85	17.85	17.85	17.85	17.85	18.63	18.63	18.63	18.63
10.	25.00	25.68	25.68	25.68	25.45	25.15	25.45	25.45	25.45	25.00	26.90	26.90
11.	21.13	23.86	23.86	23.18	24.54	23.86	24.09	24.09	24.09	24.09	24.90	25.00
12.	17.95	18.40	18.63	18.63	18.63	18.40	18.63	18.63	18.63	18.63	19.09	19.09
13.	16.25	17.16	17.27	17.27	17.27	18.18	18.18	18.18	18.63	18.63	18.63	18.63
14.	15.22	15.68	15.68	16.59	17.27	17.27	17.27	17.27	17.85	17.85	17.00	17.00
15.	16.13	15.45	16.13	16.59	16.59	16.59	16.59	16.59	17.27	17.27	17.27	17.00
16.	19.31	19.09	19.09	18.40	19.09	19.09	19.09	19.09	20.45	21.81	21.81	21.81
17.	20.45	20.22	21.81	21.13	21.60	21.81	21.81	21.81	22,70	22.70	21.23	23.18
18.	14.99	14.61	14.54	15.00	15.00	15.00	15.00	15.45	16.36	16.36	16.36	16.10
Average	18.97	19.36	19.55	19.61	19.76	19.80	19.85	19.95	20.36	20.45	20.72	20.80

WEIGHT RECORD OF GROUP S_3 (TABLET SALT) IN KILOGRAMS

(Period in Fortnight)

S.No	1	2	3	4	5	6	7	8	9	10	11	12
1.	20.90	21.36	21.86	22.72	21.81	2.181	21,81	21.81	21.81	22.47	23.13	23.60
2.	22.95	23.63	23.63	24.90	24.90	24.93	24.09	24.09	24.90	24.90	25.00	25.90
3.	17.27	17.95	18.08	18.06	17.73	17.95	18.18	18.18	18.63	18.63	18.18	18.18
4.	22.72	23.18	23.00	23.18	23.18	23.18.	23.18	23.63	23663	23.63	23.63	23.63
5.	22.95	23.52	23.15	22.72	22.59	23.18	23.63	23.63	23.18	24.09	24.09	24.09
6.	15.68	16.13	18.40	18.18	18.18	18.18	18.27	18.18	18.18	18.18	18.18	17 .27
7.	23.86	23,52	23.63	23.52	23.52	23.52	23.63	23.63	24.00	24.00	23.63	23.86
8.	20.00	20.63	20.90	20.22	21.36	20.45	20.90	20.45	20.90	21.36	21.36	21.36
9.	14.88	15.22	15.45	15.00	15.68	15.68	15.45	15.90	16.10	16.10	15.90	15.90
10.	18.86	19.88	20.00	20.22	20.22	20.00	20.00	20.22	20.22	20.22	20.22	21.36
11.	19.54	20.00	20.22	21.81	20.45	20.45	20.45	21.81	21.81	21.81	21.00	22.00
12.	18.86	20.00	20.00	20.22	20.45	19.09	19.09	21.81	21.81	21.90	21.90	21.36
13.	20.00	22.59	22.59	22.95	22.27	22.72	22.92	22.92	23.18	23.18	22.92	23.18
14.	16.81	17.16	17.27	17.16	17.27	16.81	17.27	17.27	17.27	17.27	18.18	18.18
15.	16.88	16.59	17.27	17.27	17.27	17.27	17.27	17.27	18.18	18.18	17.76	18.27
16.	15.70	16.88	17.27	17.75	17.75	17.27	17.27	17.63	17.63	18.18	18.18	18.60
17.	16.54	16.13	16.81	15.90	15.90	15.90	16.36	16.36	16.63	16.63	16.36	16.00
18.	18.74	18.75	18.63	18.63	19.09	19.09	19.09	19.09	20.22	20.22	20.45	20.00
Average	19.23	19.63	19.89	20.00	19.96	19.85	20.11	20.26	20.60	20.60	20.56	20.70

WEIGHT R CORD OF GROUP S_4 (BASAL DIET) IN KILOGRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	17.72	17.95	18.40	18.63	18.40	18.63	19.09	19.09	18,63	18.63	19.13	19.54
2.	20.22	21.70	21.81	21,36	20.68	21.36	20.96	20.68	20.90	20.90	21.20	23.18
3.	20.11	23.18	23.22	23.18	22.50	23.18	23.18	23.18	23.18	22.72	22.72	24.09
4.	25.00	26.00	25.90	24.45	25.90	25.00	25.90	25.00	25.00	25.00	25.00	25.00
5.	19.54	20.56	20.68	20.90	20.90	20.90	20.96	20.96	20.90	20.90	20.90	19.54
6.	14.64	15.90	16.00	16.00	15.45	15.45	15.90	15.45	15.90	15.90	16.25	16.36
7.	20.45	20.45	20.68	20.22	20.90	20.00	20.90	20.90	20.90	20.90	20.90	20.90
8.	17.50	17.95	18.00	18.00	18.63	18.18	18.18	18.18	17.72	17.72	18.63	19.54
9.	18.63	21.81	22.45	22.95	22.27	22.22	21.81	21.81	22.27	21.81	21.81	20.90
10.	21.47	22.04	22.04	22.00	22.72	22.95	22.95	22.95	23.18	23.36	23.18	22.00
11.	19.77	20.68	20.90	21.36	20.90	20.90	20.90	20.90	21.81	20.90	20.09	20.00
12.	20.45	18.63	18.63	19.54	19.54	19.54	19.09	19.09	19.54	19.54	19.19	19.19
13.	15.90	17.00	17.27	17.73	16.81	17.73	17.73	17.73	1.63	18.73	18.90	18.27
14.	17.00	17.00	17.00	17.00	17.27	17.27	17.27	17.27	17.73	17.27	17.00	17.90
15.	14.54	14.77	14.77	14.61	15.00	15.00	14.54	14.54	15.00	15.00	15.45	16.90
16.	17.95	18.40	18.86	18.40	18.40	18.40	18.86	18.40	18.86	17.95	18.00	18.27
17.	18.63	19.54	19,54	19.25	20.00	20.00	20.45	19.25	19.54	19.54	19.00	19.00
18.	18.40	19.09	19.09	18.63	18.40	18.40	19.[illegible]4	20,90	19.09	19.09	19.09	19.00
Average	18.77	19.59	19.73	19.88	19.71	19.80	19.90	19.90	19;.95	19.77	19.80	19.97

WEIGHT RECORD OF GROUP C (NON SCHOOL LUNCH) IN KILOGRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	22.31	24.54	25.00	26.13	25.45	24.90	25.45	25.45	25.00	25.00	25.00	24.00
2.	20.45	20.45	21.13	21.81	21.81	20.78	21.81	21.81	21.81	21.81	21.13	20.90
3.	20.45	23.13	23.18	20.90	20.90	20.45	20.45	20.45	20.45	20.45	20.90	21.36
4.	21.13	22.27	21.81	22.72	21.81	21.81	22.27	22.27	22.63	21.81	22.27	21.81
5.	19.54	20.11	20.00	19.54	20.00	20.00	20.00	20.00	20.45	20.45	20.45	20.00
6.	16.81	16.81	17.27	16.36	16.81	17.27	17.27	17.27	17.70	17.27	16.81	17.07
7.	19.54	19.63	19.54	19.09	19.09	20.00	20.45	20.45	20.90	20.00	19.54	19.09
8.	21.13	21.70	21.81	20.45	20.90	20.90	21.36	21.36	21.36	20.90	20.45	21.36
9.	22.27	22.27	22.61	22.76	22.72	23.18	22.72	22.72	22.72	21.81	22.72	22.72
10.	20.45	21.13	21.36	21.36	20.90	21.86	20.90	20.90	20;90	20.90	21.81	21.81
11.	18.40	18.18	18.63	19.09	19.09	19.09	19.54	19.54	20.45	20.45	20.00	19.09
12.	16.36	16.81	16.81	17.00	16.81	16.81	17.27	17.27	17.27	17.27	17.27	17.27
13.	20.90	20.22	20.22	20.45	21.81	20.45	21.81	21.81	22.72	22.72	21.81	21.90
14.	17.73	17.73	17.50	18.50	18.18	18.18	13.78	13.72	18.18	18.18	18.63	18.72
15.	15.80	16.38	16.36	15.90	16.13	16.36	16.81	16.81	17.27	17.27	16.36	16.90
16.	15.45	16.59	16.59	16.59	15.63	15.90	16.81	16.81	17.27	17.27	16.36	17.27
17.	16.13	17.00	17.00	16.13	16.81	16.81	16.81	15.45	15.90	15.90	16.76	16.76
18.	15.22	16.13	16.13	15.45	15.90	15.90	16.81	15.90	15.90	15.90	15.96	16.96
Average	18.89	19.50	19.59	19.40	19.48	19.50	19.78	19.66	19.95	19.74	19.68	19.72

HAEMOGLOBIN LEVEL OF GROUP S_1 (GREENS) IN GRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	11.02	11902	11.13	11.13	11.34	11.34	11.76	11.76	11.96	11.94	12.14	12.50
2.	10.91	11.02	11.02	11.34	11.34	11.34	11.60	11.60	11.80	11.80	11.97	11.34
3.	10.51	10.55	10.55	10.86	11.02	11.02	11.34	11.34	11.60	11.60	12.14	12.32
4.	11.12	11.12	11.34	11.34	11.34	11.34	11.60	11,60	11.76	11.80	11.26	12.14
5.	10.71	10.71	10.85	10.85	10.85	11.02	11.02	11.02	11.34	11.60	11.60	12.14
6.	9.71	9.96	10.55	10.55	10.55	10.55	10.22	10.72	11.02	11.02	11.76	12.14
7.	9.50	10.15	10.28	10.55	11.02	11.02	11.02	11.34	11.60	11.60	11.34	12.22
8.	11.13	11.13	11.34	11.34	11.34	11.60	11.60	11.76	11.80	11.80	12.15	12.50
9.	9.50	9.50	10.15	10.28	10.55	10.55	10.72	10.72	11.02	11.02	10.97	11.27
10.	12.74	12.76	12.76	12.80	12.80	12.96	12.96	13.02	13.02	13.13	12.86	12.86
11.	11.32	11.32	11.56	11.64	11.64	11.76	11.86	12.03	12.03	12.13	12.26	12.50
12.	7.58	8.70	8.70	8.96	9.86	9.86	9.86	10.28	10.28	10.28	10.97	11.08
13.	10.51	11.02	11.02	11.28	11.28	11.34	11.34	11.60	11.70	11.70	12.32	12.14
14.	12.04	12.08	12.26	12.34	12.34	12.60	12.60	12.86	13.02	13.02	12.96	13,40
15.	8.00	8.12	8.96	9.50	9.86	10.55	10.55	10.72	11.02	11.34	11.34	11.34
16.	8.69	8.70	8.96	9.50	9.50	9.86	9.86	10.28	10.55	10.76	10.97	11.08
17.	9.90	9.96	10.28	10.55	10.86	10.86	11.02	11.34	11.34	11.60	11.08	11.34
18.	10.71	11.31	11.34	11.34	11.56	11.56	11.56	11.76	11.76	11.80	12.14	12.34
Average	10.31	10.50	10.71	10.90	11.06	11.17	11.27	11.43	11.60	11.66	11.79	12.03

HAEMOGLOBIN LEVEL OF GROUP S_2 (COLLIREN TONIC) IN GRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	10.91	11.00	11.00	11.02	11.02	11.34	11.34	11.60	11.60	11.60	11.34	11.96
2.	11.32	11.42	11.66	11.66	11.66	11.76	11.76	12.03	12.03	12.03	12.14	12.15
3.	11.32	11.49	11.50	11.60	11.60	11.62	11.62	11.86	11.88	11.96	11.96	12.14
4.	10.31	10.41	11.02	11.34	11.34	11.34	11.34	11.60	11.60	11.60	11.96	12.34
5.	9.90	9.90	10.28	10.55	11.02	11.02	11.34	11.34	11.34	11.34	11.02	11.46
6.	9.50	9.50	9.86	9.86	10.55	10.55	10.55	10.86	11.02	11.02	11.34	11.76
7.	9.90	9.90	10.28	10.55	10.58	11.34	11.34	11.34	11.50	11.60	11.97	12.14
8.	10.96	11.00	11.60	11.60	11.64	11.64	11.86	11.88	12.02	12.02	12.14	12.34
9.	10.10	10.15	10.28	10.55	10.55	10.55	10.85	10.86	10.86	11.02	11.02	11.34
10.	11.12	11.22	11.22	11.34	11.62	11.62	11.76	11.90	12.02	12.02	12.14	12.50
11.	10.71	11.02	11.02	11.24	11.34	11.34	11.60	11.60	11.60	11.76	11.34	11.96
12.	10.10	10.15	10.28	10.55	11.02	11.02	11.34	11.34	11.34	11.60	10.97	11.34
13.	9.00	9.86	10.28	10.55	10.55	10.55	10.55	11.02	11.02	11.02	11.24	12.14
14.	8.69	8.70	9.50	9.50	9.86	9.86	10.08	1028	10.28	10.28	11.34	11.76
15.	12.13	12.27	12.32	12.32	12.45	12.60	12.60	12.76	12.76	12.76	12.34	12.50
16.	11.12	11.29	11.30	11.34	11.34	11.60	11.60	11.76	11.76	11.76	11.34	11.96
17.	10.10	10.15	10.28	10.28	10.28	10.45	10.85	10.86	10.86	10.82	11.02	11.76
18.	11.00	11.19	11.19	11.34	11.34	11.34	11.60	11.60	11.76	11.76	12.03	12.14
Average	10.45	10.59	10.78	10.95	11.08	11.18	11.34	11.44	11.51	11.57	11.63	12.00

HAEMOGLOBIN LEVEL OF GROUP S_5 (TABLET SALT) IN GRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	10.10	11.02	11.34	11.34	11.34	11.34	11.34	11.50	11.60	11.70	12.14	12.14
2.	12.00	12.18	12.18	12.26	12.26	12.40	12.40	12.56	12.58	12.76	12.36	12.36
3.	11.12	11.29	11.34	11.34	11.60	11.60	11.60	11.76	11.76	11.96	11.93	12.14
4.	11.04	11.12	11.26	11.26	11.34	11.34	11.60	11.60	11.76	11.86	11.93	11.93
5.	11.04	11.31	11.31	11.34	11.34	11.60	11.60	11.76	11.76	11.76	11.34	11.93
6.	10.10	10.15	10.28	10.55	10.88	11.02	11.02	11.02	11.26	11.34	11.93	12.50
7.	9.09	9.28	9.50	9.50	10.28	10.55	10.58	10.86	10.86	1102.	10.97	11.34
8.	9.50	9.50	9.50	10.28	10.48	10.55	10.55	10.55	10.70	11.02	10.97	11.14
9.	9.50	10.15	10.20	10.55	10.55	11.02	11.02	11.18	11.28	11.60	11.34	11.76
10.	10.91	11.02	11.02	11.34	11.34	11.34	11.60	11.60	11.60	11.76	11.97	12.14
11.	9.90	9.90	10.08	10.28	10.28	10.55	10.55	10.70	10.70	10.86	10.97	11.34
12.	10.51	11002	11.02	11.13	11.13	11.34	11.34	11.50	11.60	11.93	11.93	12.14
13.	11.34	11.34	11.45	11.60	11.80	11.60	11.76	11.76	11.76	11.80	11.93	12.14
14.	10.10	10.15	10.28	10.55	10.55	10.5	10.86	11.02	11.02	11.34	11.26	11.34
15.	11.76	11.76	12.13	12.26	12.26	12.65	12.45	12.56	12.56	12.60	12.34	12.50
16.	12.74	12.76	12.76	12.83	12.83	12.96	13.04	13.03	13.04	13.13	13.26	13526
17.	10.32	10.32	10.84	11.02	11.02	11.34	11.34	11.50	11.50	11.60	12.00	12.14
18.	9.90	9.90	9.90	10.08	10.08	10.28	10555	10.70	10.90	10.98	10.36	11.02
Average	10.60	10.79	10.90	11.08	11.17	11.31	11.40	11.50	11.55	11.70	11.72	11.96

HAEMOGLOBIN LEVEL OF GROUP S_4 (BASAL DIET) IN GRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	10.91	11.02	11.02	11.34	11.34	11.60	11.60	11.70	11.76	11.76	11.26	11.34
2.	10.31	10.55	10.86	10.86	11.02	11.02	11.34	11.34	11.34	11.34	11.76	11.34
3.	11.22	11.31	11.34	11.34	11.31	11.60	11.60	11.60	11.70	11.76	11.76	11.97
4.	10.31	10.55	10.55	10.55	10.55	11.02	11.02	11.02	11.50	11.50	11.34	11.50
5.	10.71	11.02	11.02	11.34	11.34	11.34	11.34	11.50	11.60	11.60	11.34	11.34
6.	9.60	9.38	10.28	10.28	10.28	10.55	10.55	10.55	1086	10.86	10.97	11.34
7.	10.51	10,51	10.55	10.55	10.78	10.92	11.02	11.02	11.26	11.34	10.97	11.28
8.	9.90	10.28	10.55	10.86	11.02	11.02	11.02	11.26	11.26	11.34	11.78	12.14
9.	10.10	10.28	10.55	10.55	10.55	10.86	10.86	10.86	11.02	11.02	10.97	11.02
10.	10.71	11.02	11.15	11.34	11.34	11.60	11.60	11.60	11.70	11.76	11.34	12.14
11.	10.51	10.86	10.86	11.02	11.02	11.34	11.34	11.34	11.50	11.60	11.50	11.50
12.	11.72	11.89	11.89	11.96	11.96	12.03	12.03	12.03	12.15	12.18	12.14	12.50
13.	10.50	10.50	10.86	11.02	11.02	11.34	11.34	11.34	11.50	11.50	11.44	12.14
14.	10.31	10.55	10.55	10,55	10.55	10.55	11.02	11.02	11.02	11.02	11.26	11.43
15.	12.53	12.53	12.68	12.68	12.96	12.96	13.03	13.03	13.03	13.13	13.26	13.58
16.	9.29	8.86	8.96	9.49	9.49	10.28	10.28	10.50	10.50	10.50	10.54	10.97
17.	9.09	9.28	9.50	9.50	9.86	10.09	10.28	10.28	10.28	10.54	10.19	10.26
18.	8.69	8.70	9.50	10.28	10.28	10.55	10.55	10.80	10.80	10.80	10.54	10.97
Average	10.32	10.53	10.70	10.85	10.92	11.15	11.18	11.26	11.37	11.40	11.32	11.60

HEAMOGLOBIN LEVEL OF GROUP C (NON SCHOOL LUNCH) IN GRAMS

(Period in Fortnight)

S.No.	1	2	3	4	5	6	7	8	9	10	11	12
1.	10.28	10.28	10.55	11.02	11.02	11.02	11.02	11.26	11.26	11.26	11.34	11.60
2.	10.10	10.15	10.28	10.28	10.28	10.28	10.55	10.65	10.86	10.86	10.26	10.97
3.	10.91	11.02	11.02	11.02	11002	11.34	11.34	11.34	11.50	11.50	11.34	11.34
4.	10.91	11.02	11.02	11.02	11.02	11.18	11.18	11.26	11.34	11.24	11.12	11.94
5.	10.91	11.31	11.34	11.34	11.34	11.34	11.60	11.6[illegible]	11.70	11.[illegible]	11.02	11.97
6.	10.71	10.86	10.86	11.02	11.02	11.34	11.34	11.34	11.50	11.60	11.76	11.97
7.	10.28	10.28	10.55	10.55	10.55	10.55	11.02	11.02	11.18	11.34	10.97	11.34
8.	9.50	10.15	10.28	10.28	10.28	10.55	10.55	10.60	10.76	10.76	11.02	11.34
9.	9.70	10.15	10.28	10.22	10.28	10.55	10.86	10.86	10.86	11.02	11.34	11.50
10.	10.51	10.51	10.55	10.55	10.55	11.02	11.34	11.34	11.34	11.50	11.90	11.76
11.	10.91	11.02	111.02	11.02	11.02	11.14	11.34	11.34	11.50	11.50	11.34	11.34
12.	11.33	11.60	11.60	11.86	11.86	11.94	11.94	12.03	12.03	12.03	11.98	12.14
13.	10.98	10.28	10.55	10.55	10.55	11.02	11.02	11.02	11.26	11.26	11.50	11.78
14.	10.10	10.15	10.28	10.55	10.55	11.02	11.34	11.34	11.34	11.50	11.50	11.50
15.	11.12	11.16	11.26	11.34	11.34	11.60	11.60	11.60	11.70	11.76	11.76	12.14
16.	10.51	10.86	11.02	11.02	11.13	11.13	11.34	11.34	11.50	11.60	11.34	11.97
17.	10.82	10.86	11.02	11.02	11.34	11.60	11.60	11.60	11.60	11.80	11.50	11.36
18.	10.82	10.86	11.02	11.02	11.34	11.34	11.80	11.60	11.60	11.78	11.97	12.14
Average	10.55	10.71	10.81	10.87	10.91	11.11	11.25	11.29	11.39	11.45	11.39	11.70

APPENDIX VIII

INITIAL AND FINAL VALUES OF R.B.C. COUNT

Group	S.No.	R.B.C. count in million/ c.m.m	
		Initial	Final
S_1	1.	4.32	4.73
	2.	3.57	3.85
	3.	4.01	4.19
	4.	4.06	4.52
	5.	3.98	4.36
	6.	4.52	4.67
S_2	1.	4.31	4.36
	2.	4.14	4.28
	3.	3.74	3.78
	4.	3.74	3.85
	5.	4.36	4.85
	6.	4.00	4.74
S_3	1.	3.93	4.14
	2.	3.71	3.77
	3.	3.02	3.21
	4.	3.86	4.19
	5.	4.11	4.36
	6.	3.83	4.01
S_4	1.	4.05	4.08
	2.	3.60	3.68
	3.	3.34	3.40
	4.	3.15	3.95
	5.	3.05	3.19
	6.	4.00	4.18
C	1.	3.93	3.95
	2.	3.49	3.73
	3.	3.10	3.28
	4.	3.60	3.90
	5.	3.42	3.56
	6.	2.90	3.00

APPENDIX IX

INITIAL AND FINAL VALUES OF P.C.V. COUNT

Group	S.No.	P.C.V. in percentage	
		Initial	Final
S_1	1.	34	36
	2.	34	34
	3.	31	33
	4.	34	36
	5.	35	35
	6.	39	40
S_2	1.	33	33
	2.	34	34
	3.	28	31
	4.	31	35
	5.	32	36
	6.	33	33
S_3	1.	32	34
	2.	34	36
	3.	30	32
	4.	36	38
	5.	33	35
	6.	33	34
S_4	1.	36	36
	2.	35	37
	3.	37	37
	4.	30	30
	5.	25	27
	6.	39	39
C	1.	34	34
	2.	32	32
	3.	40	40
	4.	28	28
	5.	30	30
	6.	32	32

APPENDIX X

INITIAL AND FINAL SCORE FOR CLINICAL ASSESSMENT FOR THE CHILDREN IN FIVE GROUPS

S.No.	S_1		S_2		S_3		S_4		C	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
1.	87	87	100	85	86	87	81	89	80	80
2.	85	86	85	86	87	82	81	84	78	88
3.	82	89	90	88	84	88	83	30	87	79
4.	83	86	79	83	75	84	78	86	82	87
5.	86	86	85	90	83	80	80	76	82	77
6.	82	85	82	94	83	78	80	84	83	82
7.	88	86	83	89	83	87	77	75	80	85
8.	90	90	79	80	85	79	82	82	84	85
9.	82	86	83	85	83	88	83	72	80	82
10.	85	88	84	80	77	76	78	76	80	80
11.	85	85	77	83	78	82	76	79	64	76
12.	83	88	86	88	84	88	74	79	80	79
13.	86	84	78	79	80	87	85	77	80	85
14.	87	89	84	91	79	70	78	88	85	76
15.	81	88	83	76	82	76	79	35	78	79
16.	85	94	76	89	84	86	79	85	83	85
17.	97	97	81	89	79	85	80	76	73	78
18.	87	90	91	84	81	90	80	86	78	84
Average	85.5	87.8	83	85	81.8	83	79.4	81	80	81.1