ANAEMIA AND ATHELETIC PERFORMANCE

By

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INTRODUCTION

INTRODUCTION

The population of India for the year 1983 is 684 millions (Manorama, 1983). With such a massive ever growing population it should be possible to make a head way in all fields, on par with other developed nations. But malnutrition and ill health seem to be the debilitating factors in meeting the various demands of our population. Therefore importance should be given to proper human development which is our greatest resource.

Both work capacity and work output are influenced by nutrient intake and the resulting nutritional status of those who perform work. Childhood malnutrition may also affect the future capacity of individual for work. Sathyanarayana, et al., (1978), believe that productivity among workers in developing countries is low as a consequence of chronic malnutrition.

Poor nutrition may cripple a nations productivity by more subtle long range mechanisms, (LIFE, 1972). Sadasivam and John (1979) explain that malnutrition leads to a wastage of human resources and reduction of these losses would increase the social effectiveness of the population and contribute to economic development.

One vital area of the atheletic programmes that has remained neglected in our country is the nutrition of the athletes. This relates to the nutritional standards which affect the capacity and performance of athletes, (Guzman et al., 1972). Sound nutrition and a sensible programme of physical activity are two chief requirements for health (Bogert et al., 1973 and Krishnaswamy, 1982).

The reasons for the decline in performance are multifaceted and deeprooted. Nutrition definitely plays a role in the satisfactory performance of athletes. Vellegas and Vellendria (1972). Andersen and Barkue (1970) studiedthe relationship between variation in the haemoglobin concentration and the ability to carryout muscular exercise by measurement of quantitative changes in cardio vascular respiratory fuction. Davies et al., (1972) calculated that anemia will adversely affect the muscular endurance capacity of an individual in aerobic type activities.

Iron to life is a metal more precious than gold (Squibb, 1970). Iron deficiency is an important public health problem in many developing countries and is the commonest cause of anaemia in India and all over the world (Nutrition Reviews, 1980).

Sjolin (1981) warns that the incidence of iron deficiency anemia in developing countries is often ~~ect~~ extremly high compared with that in industrialised part of the world. According to Sjolin (1981) it has been estimated that there are a total of 260 million anaemic women in the developing world alone. The overall proportion of anaemic women is highest in Asia.

WHO (1975) points out that anaemia causes a great deal of ill health sapping energy and productiveness in many countries and causing tragedies in child birth. Thus it is obvious that urgent steps are needed to prevent and control anaemia among our population in general and our women specially.

Gopalan (1975) explains that to perform energy demanding tasks, blood must be able to transport oxygen at a rate and level required by the effort, which in turn depends upon the circulating levels of haemoglobin.

There is adequate evidence in the literature to show that a decrease in haemoglobin concentration leads to a reduction in the oxygen delivery to the tissues during work or exercise WHO (1975). This in turn reduces the maximal work capacity both in man and in experimental animals, when measured using standardised laboratory tests.

The more severe the anaemia the greater the reduction in maximum work performance. Physical incapacity supervenes when tissues oxygen demands cannot be met Bengoa (1974).

The most effective way of dealing with a population where the diet is difficult to manipulate according to Finch _et al_., (1974) is by the use of medicinal iron involving treatment with iron salts. Layrisee (1970) appreciates the therapeutic administration of ferrous sulphate since it substantially raises the haemoglobin level within a few weeks. Supplementation with iron is the only feasible approach where there is a large deficit to be made up in a relatively short span of time. Iron supplementation is an effective way of combating anaemia and increasing the work output of population groups.

Having these points in mind the present study was designed with the following aims:

1. To find out the relationship between nutrition and atheletic performance with special reference to iron deficiency among adolescent girls, and
2. To supplement the anaemic volunteers with ferrous sulphate tablets and evaluate the impact of supplementation.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

The literature pertaining to the study on 'Anaemia and atheletic performance' is reviewed under the following headings:

1. Population as a resource and its utilization
2. Nutritional status of our population in general
3. Prevalence of anaemia
4. Anaemia and atheletic performance
5. Need for iron supplementation

and 6. Studies conducted on iron supplementation

1. Population as a resource and its utilization

The population of India for the year 1983 is 684 millions (Year Book of India 1983 and Manorama 1983). It is the World's Second highest population. With such a massive ever growing population it should be possible to make a head way in all fields. On the other hand population explosion is the main contributory factor to undernutrition and malnutrition as per Devadas (1979). The process of national development requires the utilisation of all the resources - human and material - to maximum advantage. The human inputs are the people. They are the active participants who create and conserve capital mobilise natural resources and build the social, economic and political infrastructure which is essential for national development. It is the human resource, still largely untapped which constitute man's real hope for the future, Farris (1966).

As per Sai (1972) every country depends on its working groups for its economic development and it is almost axiomatic that a hungry nation cannot achieve its full potential.

There is a close relationship between a well fed labour force and a high rate of productivity, (LIFE, 1972). Widespread malnutrition has been citied to reduce productivity by Berg (1973) particularly in the developing countries where the use of heavy physical labour is common.

Sadasivam and John (1979) opined that malnutrition leads to a wastage of human resources and reduction of this loss would increase the social effectiveness of the population and contribute to economic development. They also found out that a well fed worker contributes nearly five times more to production than a malnourished worker.

According to FAO (1976) a well fed worker will be efficient, have more earnings, less illness and absenteeism and thereby raise both their economy and future health and in turn improve the nation's economy.

Though there is population explosion in our country, the contribution to national economy is very meagre because of poor nutritional status of our people.

2. Nutritional status of our population in general

A recent United Nations Study in India (UNICEF, 1975) indicated that two out of every five persons are undernourished. Consequently under nutrition is widespread and nearly half of India's children under five years are anaemic; millions who are weaned from breast feeding face blindness from Vitamin A deficiency and millions of mothers are emaciated, anaemic and/or victims of tuberculosis.

According to Devadas (1979) vulnerable groups, particularly children, expectant and nursing mothers are the worst sufferers of malnutrition which results in high morbidity and mortality.

Bengoa (1974) investigated that about 5% of the deaths from malnutrition among children under 1 year of age were due to Kwashiorkor, 26% due to nutritional marasmus and 70% due to other forms of protein calorie malnutrition.

Latest report of the National Monitoring Bureau also show that in nearly 85% of children under 5 years of age weight/age is less than 80% of the normal values observed in wellnourished Indian children not subject to socio economic constraints, Gopalan (1983).

Malnutrition is one of the major public health problems faced by the country today. As per Aleta (1976) a malnourished person is less productive because of impaired intellectual capacity and stunted physical growth.

Many developing countries are faced with the problem of how and where to break the vicious circle of undernutrition, low work efficiency - low productivity and lack of suitable food. According to Viteri and Torum (1974) and Dam (1978) severe forms of malnutrition and specific vitamin and mineral deficiencies impair work capacity and performance.

3. Prevalence of anaemia

Anaemia per se should be regarded as a symptom of an underlying disorder, not a disease according to Burton (1978). It is a condition in which the total quantity of haemoglobin is less than the normal.

Gopalan (1975) has stated that anaemia of nutritional origin has a global distribution and constitutes one of the major public health problems throughout the world. Alfin - Slater (1980) opines that inspite of the fact that knowledge is incomplete iron deficiency and iron deficiency anemia are considered by many to be a major health problem, problems in need of immediate action.

Clinically iron deficiency anemia is found chiefly in infants, young children and women but rarely in men, Wilson *et al* (1971). According to Robinson (1977) iron deficiency anaemias are widely prevalent throughout the world. Incidence in the various countries ranges about 5 to 15% in males, 10 to 50% in women and 15 to 92% in children.

The maximum estimates of prevalence of anaemia ranges from 20% in industrialised countries to 60% in developing nations. The population groups particularly at risk of acquiring iron deficits are preschool children, pregnant women, old individuals and adolescents (Swaminathan 1974 and Chandra 1976).

Iron deficiency and iron deficiency anaemia have been shown to be prevalent in the United States in children and adolescents as well as in pregnant and lactating women, particularly among those in low income groups. (Food and Nutrition Notes and Reviews, 1974). The prevalance of anaemia has been reported to range from 10% in adult women to 85% in pregnant women, Nutrition Reviews (1980).

According to ICMR (1978) 47% of the pregnant women and 50% of the preschool children are suffering from this syndrome. Studies carried out in the National Institute of Nutrition showed that anaemia is also very much a disease of the children. In a fairly large sample, nearly 63% of children below 3 years of age and about 45% of children between 3 and 5 years were found to suffer from anaemia, Gopalan (1983).

Aung-Than-Battu et al (1972) have stated that iron deficiency is associated with a high proportion of anaemias in women, in pregnant 32 to 34% and 26 to 51% of the non pregnant women. In developed countries the prevalence of anaemia ranges from 7 to 20% in nonpregnant women and upto 35% in pregnant women. Assuming conservatively that 10% of the non-pregnant women and 30% of the pregnant women are anaemic, this would make an additional 31 million bringing the world total (outside China) of anaemic women between 15 and 49 years of age to 291 million, (Food and Nutrition Bulletin 1979 and SwasthHind 1980).

Surveys throughout the world have shown a prevalence of iron deficiency anaemia in menstruating women varying from 10 to 50% prevalence of adolescent anaemia, WHO (1972).

Adolescent females are considered a nutritionally vulnerable segment of the population. A rapid growth rate combined with marginal nutritional intakes increases the risk of nutritional deficiencies in this population. A high incidence of iron deficiency anaemia has been noted in Black and in white teenage girls, Liebman et al (1983).

Nutritional iron deficiency anaemia is more prevalent among young women, than is generally supposed and is bound to interfere with health, preparation for pregnancy and work efficiency, Vijayalakshmi et al (1983).

4. Anaemia and atheletic performance

The ability of the muscles to work can be limited by failure of any one of these following processes: the ability of the heart to pump blood, inadequate oxygen carrying capacity of the blood, or failure of the peripheral circulation to supply enough blood to the working muscle. Anaemia is one condition in which oxygen transport is limited. Low blood haemoglobin levels in anaemic patients and the sharp drop in haemoglobin occasioned by blood donation in healthy women reduce blood buffering power and capacity to transfer oxygen and have a detrimental effect on work performance, (Anderson, 1970).

Anderson and Barkue (1970) studied and confirmed the direct relationship between variation in the blood haemoglobin concentration and the ability to carry out muscular exercise by measurement of quantitative changes in cardiovascular respiratory function. Davies et al (1973) have concluded that anaemia will adversely affect the muscular endurance capacity of an individual in aerobic type of activities. The same conclusion is supported by Stewart (1972) that athlets especially those in endurance activities which stress aerobic capacity would appear to have their ability compromised if anemic.

Basta (1977) has stated that iron defieiency anaemia affects the physical capacity by reducing the availability of oxygen to the tissues, which inturn affects cardiac output and heartrate eventually leading to death in severe cases.

A study conducted among the road construction workers in Java has showed that moderate to severe anaemia (haemoglobin level below 11.1 gm./blood, haemotocrit of 33% and below), present in about 20% of the anaemic sample, was closely associated with poor physical performance.

In another study concerned with clearing of weeds the anaemic workers cleared an area about 20% less than the non anaemic workers, Basta (1977).

According to Finch et al (1974), in anaemia maximum work performance will be reduced proportionate to the fall in haemoglobin. Although not fatal, anaemia result in reduced work efficiency, lethargy, sluggishness, increased susceptibility to infection and low birth weight of the new born, LIFE (1972).

Disabilities associated with iron deficiency are presently ill defined, but there is evidence that capacity for physical work may be reduced, (Food and Nutrition Notes and Reviews, 1974).

The more severe the anaemia the greater the reduction in near maximum work performance. WHO (1975) reports that physical incapacity supervenes when tissue oxygen demands cannot be met. Devadas (1977) reported that apart from causing a large number of deaths among pregnant women, anaemia debilitates the farm and industrial workers, affects their working capacity and reduces their work output. Subjects suffering from anaemia are more prone to develop infectious diseases.

The work output depends upon physical efficiency and anaemia is one of the diseases that can impair physical work capacity (Gopalan, 1975). A number of studies have demonstrated that subjects suffering from severe degrees of anaemia have impaired work capacity. Studies on agricultural labourers have shown that using an acute severe exercise which measure cardiopulmonary reserves, differences in maximal physical efficiency can be demonstrated, even when the anaemia is of a mild or moderate degree.

Kerrigan et al (1975) has pointed out that anaemic women tea pickers from ceylon exhibited a decreased physical work capacity when measured in the laboratory.

A physically fit individual, as compared to the poorly conditioned man, can perform a given grade of physical activity more efficiently, can attain a greater maximal ventilation and greater maximal oxygen uptake with displacement of his physiological equilibrium and has better recuperative powers after exhausting exercise (pulse rate) Margen (1971).

5. Need for iron supplementation

Improvement of nutritional status is one of the factors improving conditions of work and as a result increasing capacity for work, FAO (1976). Iron deficiency can be completely prevented through an iron supplementation programme, Lakhan pal (1976).

Iron deficiency is the most frequent nutritional problem across the world. It has been estimated that 20 to 60% of individuals in different countries have a subclinical or clinical evidence of iron depletion. Most patients with iron deficiency respond quickly and adequately to oral administration of iron in its elemental or colloidal form or as one of its salts, the most frequently used being ferrous sulphate, (Nutrition Reviews, 1976).

According to Finch et al (1974), Iron fortification of food is a second approach which may be particularly useful in the areas where dietary iron is low and reasonably available. The distribution of iron medication through health centres might be considered the initial step in improving iron nutrition.

Once anaemia has developed, dietary iron alone cannot cure the condition. The cheapest and probably the best preparation of oral iron is ferrous sulphate. Medicinal iron is best absorbed from an empty stomach, De Silva and Baptist (1969).

According to WHO (1975) medicinal iron may be given to special population groups such as pregnant or young children to prevent anaemia.

ICMR (1974) and Narasinga Rao (1975) have stated that fortification of common salt with iron compounds may be a practical public health measure in combating the widespread iron deficiency anaemia in our population.

The enrichment of foods with iron is a potential method for preventing anaemia, Burgess (1976). Updyke (1973) reported that most endurance athletes take large daily dosages of iron hopefully to increase haemoglobin levels and a world class distance runner, Jim Ryun, althrough advocating a rather routine diet, does consume iron tablet.

Buzina et al (1982) reported a study on 665 adolescents of 16-19 years whihh indicated that if the nutritional status is adequate, short - for age adolescents also perform physical work capacity tests and vital capacity tests in comparision with their taller peers. They also found that physical work capacity, increased with improved nutritional status.

6. Studies conducted on iron supplementation

The world bank study in Indonesia has shown that even moderate anaemia does affect productivity. Treatment of anaemia for a period of 60 days led to an increase in productivity of 15% for rubber tappers and 25% for weeders, Latham (1976).

Elwood (1973) found in a randomized trial that an iron supplement (120 mg./day) led to an increase in maximal work capacity eventhough there was no change in haemoglobin levels.

Studies on the supplem ntation of fortified common salt among children living in residential schools have shown that levels of haemoglobin had gone up significantly in the group which had received the fortified salt, while there was no such increase in children who had received the unfortified salt ICMR (1976).

Viteri and Torum (1974) reported that the work intensity and leisure activity were higher in the nutritionally supplemented agricultural workers than in their non-supplemented counterparts.

Nutrition Society of India (1973) has reported that the improvement of nutrition among workers has been associated with increased efficiency and greater work output.

Gardner et al (1975) conducted a study in Venezuela on 29 adult iron deficient women subjects with haemoglobin level 4.0 to 12.0 g./100 ml. Haemoglobin level for the iron treated groups after 83 days improved from 7.7 to 12.4 g./100 ml. for women.

Vijayalakshmi et al (1983) have stated that the haemoglobin level of anaemic subjects rose significantly after iron supplementation. The exertion on the heart as shown through blood pressure and pulse rate had reduced after supplementation.

METHODOLOGY

III EXPERIMENTAL PROCEDURE

The experimental procedure pertaining to the study on "Anaemia and atheletic performance" is dealt with under the following heads -

1. Selection of the venue
2. Selection of the volunteers
3. Assessing the nutritional status of the volunteers
   a) Conducting the food weighment survey
   b) Recording heights and weights of the volunteers
   c) Haemoglobin estimation
4. Recording pulse rate and blood pressure
5. Quantifying the atheletic performance of volunteers
6. Supplementation with iron tablets
7. Evaluating the atheletic performance after supplementation

1. Selection of the venue

The venue selected for the present study was the college campus itself. The college has over thousand undergraduate students and it was easy for the investigator to locate the volunteers of similar age group and socio economic background from these students.

2. Selection of the volunteers

It was decided to choose two sets of adolescent girls in the age group of 13-19 years one set of vòlunteers being anaemic and the second set being non-anaemic.

Accordingly 20 volunteers who were anaemic (experimental) and 16 volunteers who were non-anaemic (control) were chosen for the study, whether they were anaemic or non-anaemic was based on the haemoglobin estimation.

3. <u>Assessing the nutritional status of the volunteers</u>

a. <u>Conducting the food weighment survey</u>

Food weighment survey is supposed to be most accurate among the various methods of diet surveys and hence it was proposed to conduct food weighment survey on a sub-sample of 10 volunteers from experimental group and 10 volunteers from the control group.

All the raw food items were weighed before cooking. Then the total cooked weight of the food was recorded. After this the volunteers were requested to consume the food. As soon as the eating was over, the quantity of food left unconsumed was weighed and this was substracted from the total cooked weight of the food. From the above data, the quantity of cooked food consumed by the individual was obtained. The raw ingredients used were computed from the cooked food consumed by the individual. From this figure, the nutrients available from the daily diet was calculated using the "Nutritive value of Indian foods" by Gopalan <u>et al</u> (1982).

b) Recording the heights and weights of the volunteers

Heights and weights were recorded for all the volunteers belonging to both the experimental and control group.

The height was measured using a fibre glass tape fixed to the wall. The volunteers were made to stand erect and upright on a firm level floor barefooted, against the tape with the arms hanging freely at the sides. A wooden scale was placed gently on the head, perpendicular to the wall and the height was measured from the tape nearest to 0.1 cm.

The weights were measured with the help of an Avery balance. Before weighing, the balance was checked for its accuracy with the help of standard weights. The weighing scale could read nearest to 50 grams.

c. Haemoglobin estimation

Biochemical estimations are accurate means of assessing the nutritional status of the population groups.

A finger prick was made and 0.02 ml. of blood was collected with the help of a micro pipette. The blood was blown out into a filter paper and stored after labelling. The concentration of haemoglobin was most reliably measured after accurate dilution of the blood sample in a solution that converts haemoglobin to cyanmet - haemoglobin which is then quantified colorimetrically using the method of Crossby et al (1954). The procedure followed is given in Appendix I. The values thus arrived at were compared with those suggested by National Institute of Nutrition (1977) and all those below the 11 g./100 ml. were termed anaemic.

4. Recording the pulse rate and blood pressure

The pulse rate and blood pressure were recorded before and after th different activities.

The pulse rate was recorded for the various atheletic activities before and after the supplementation to see the effects of the atheletic performance.

For recording the blood pressure the subjects were made to sit in a comfortable position and the blood pressure was recorded using a sphygmomanometer by auscultatory method. The linen cuff is tied round the extremity in such a way that the rubber bag is placed across the artery running in the limb. The linen cuff is snugly tied round the limb by taking atleast two and half circles round it, and the metal hook at the tail is tucked in, to fix the cuff in position. The cuff as it covers the rubber bag does not allow its free expansion when air is pumped in it under pressure. As the bag is tied round the limb, the pressure is transmitted to the limb and indirectly to the underlying artery. When the pressure transmitted to the artery is equal to or a little more than the blood pressure, the flow is reinstated. The reinstation of the blood flew is studied by the palpatory and ausculatory methods.

The Ausculatory Method

After tying the cuff in position, the site where a segment of the artery comes very superficial is examined. The exact site of the vessel is located and if necessary marked with a pencil or chalk. The pressure in the cuff is raised beyond the expected systolic level and the chest piece of a stethescope is placed on the vessel. Now the pressure is slowly reduced while the sounds produced in the vessel are heard through the stethoscope.

While the pressure in the cuff is more than the blood pressure there is no flow of blood through the vessel and no sound is produced. As the cuff pressure reduces and becomes equal or just less than the systolic pressure the blood is able to force its way through the obliterated segment of the vessel during each systole and a sound is produced. Each sound synchronizes with the systole of the heart. This occurs when a jet of blood is able to cross the obtained segment first time as the cuff pressure is reduced. The level in the manometer at which this first abrupt sound breaks the silence is taken as the systolic blood pressure.

As stated above the second phase begins when the sound acquired a murmurish quality and it continues during the fall of next 15 mm. of Hg pressure. At the beginning of the fourth phase the sound suddenly changes in quality. It is muffled suddenly. This phase continues for a fall of about 5 mm. Hg. pressure. The level of mercury in the manometer at the time the sound gets suddenly muffled is taken as the diastolic pressure. At the end of the fourth phase the sound may slowly or suddenly disappear.

Thus the first occurence of the sound is taken as the criterion of the systolic blood pressure and the sudden muffling of the sound at the end of the third phase or its disapperance is taken as the criterion of the diastolic blood pressure.

The blood pressure was recorded for all the atheletic activities before and after supplementation with ferrous sulphate tablets containing 60 mg. of iron given one each a day.

5. Quantifying the atheletic performance of the volunteers

The following atheletic activities were performed by the volunteers in both the experimental and the control groups:

1. Jumping
2. Skipping
3. Running

and 4. Climbing

Jumping

The volunteers were asked to jump 50 times and the time taken by the individual to jump was recorded. The pulse and the blood pressure were also recorded before and after the activity.

Skipping

The volunteers were made to skip for 100 times and the time taken by the individual to skip was recorded. The pulse and blood pressure were also recorded before and after skipping.

Running

The volunteers were asked to run a distance of 100 meters and the time taken by the individual to run this distance of 100 meters was noted. The pulse and blood pressure were recorded before and after running.

Climbing

The volunteers were asked to climb the stairs from down to the 3rd floor in a specific building inside the college campus and the time taken by the individual to climb was noted. The pulse and blood pressure were recorded before and after the activity.

6. Supplementation with iron tablets

All the anaemic volunteers were supplemented with elemental iron of 60 mg. of ferrous sulphate (one tablet a day) for a period of ninety days. The non-anaemic volunteers were given a placebo tablet to avoid the feeling of one group being supplemented and the other group not-being supplemented. The investigator distributed the tablets everyday after lunch break.

7. Evaluating the impact of supplementation

The haemoglobin levels were estimated after the iron supplementation and was compared with the initial values. The differences in the atheletic performance by way of the time taken and difference in pulse rate and blood pressure were recorded and compared with the values obtained before supplementation.

RESULTS AND DISCUSSION

IV RESULTS AND DISCUSSION

The results and discussions pertaining to the study on "Anaemia and atheletic performance" are presented under the following heads:

1. Mean food and nutrient intake of the volunteers
2. Mean height and weight of the volunteers
3. Mean haemoglobin levels of the volunteers
4. Mean pulse rate and blood pressure of the volunteers
5. Time taken for atheletic activities

and 6. Impact of the iron supplementation of the volunteers.

1. Mean food and Nutrient intake of the volunteers

Table I and II present the mean food and Nutrient intake of the volunteers at the start of the study. The individual food and nutrient intake of the volunteers are given in Appendix - II.

TABLE I

MEAN FOOD INTAKE OF THE VOLUNTEERS IN GRAM

Group	Cereals	Pulses	Green leafy vegetables	Other vegetables	Roots and tubers	Fruits	Milk	Oils and fats	Sugar	Nuts
Anaemic	247	65	27	54	70	50	283	24	17	20
Non-Anaemic	189	122	42	28	81	50	384	25	18	20
RDA* (1981)	410	40	100	40	50	-	100	20	20	-

* Recommended dietary allowance

The mean food intake of the anaemic volunteers revealed that their intake was inadequate with respect to cereals, green leafy vegetables, fats and oils, sugar and jaggery and nuts. The gross low intake of green leafy vegetables might have resulted in anaemia in these volunteers. Anaemia may also be due to the fact that iron rich cereals and fruits were missing in their diet. The mean food intake of the non-anaemic volunteers revealed that their food intake was inadequate with respect to cereals, green leafy vegetables, other vegetables fats and sugar, However their intake of green leafy vegetables was almost double when compared to that of the anaemic volunteers. This probably is reflected in better haemoglobin levels among the non-anaemic volunteers.

TABLE II

MEAN NUTRIENT INTAKE OF THE VOLUNTEERS

Group	Protein (g.)	Energy (KCals)	Calcium (mg.)	Iron (mg.)	Retinol (µg)	Thiamine (mg.)	Riboflavin (mg.)	Asocrbic acid (mg.)
Anaemic	44	1691	682	26	880	2.0	1.4	48
Non-Anaemic	49	1839	807	32	2191	2.0	2.2	83
ADA* (1981)	44	2200	500-600	35	750	1.1	1.3	40

* Recommended dietary allowance

The nutrient intake of the anaemic volunteers was inadequate with reference to energy and iron when compared with the recommended dietary allowances. The nutrient intake of the non-anaemic volunteers was above the recommended dietary allowance with reference to all the nutrients except energy and the marginal level of iron. However, when compared with the anaemic subjects, the iron intake of the non-anaemic subjects was far better and also the intake of ascorbic acid was double the recommended allowance, which has got an enhancing effect on the absorption of iron. This gross low intake of iron might have resulted in anaemia in the anaemic volunteers.

2. <u>Mean height and weight of the volunteers</u>

Table III presents the mean heights and weights of the volunteers involved in the present study. The individual values are given in Appendix - III.

TABLE III

MEAN HEIGHT AND WEIGHT OF THE VOLUNTEERS

Group	Number	Height in cm.	't' Value	Weight in kg.	't' value
Anaemic	20	153		44	
			0.557 NS		0.755 NS
Non-Anaemic	16	154		45	

NS - Not significant

As is evident from Table III the mean height of the anaemic group and the non-anaemic group were only slightly different. Statistical analysis of the data revealed that the difference was statistically insignificant. Similarly the mean weight recorded by the anaemic group was 44 kg. against 45 kg. recorded by the non-anaemic group. Statistical analysis of the data revealed that the difference was statistically insignificant. It was considered essential to choose volunteers in such a manner that their heights and weights were statistically insignificant, so that these factors do not affect the atheletic performance of the volunteers.

3. Mean haemoglobin levels of the volunteers

Table IV presents the mean haemoglobin levels of the anaemic and non-anaemic student volunteers participating in the present study. Appendix IV gives the individual values.

TABLE IV

MEAN HAEMOGLOBIN LEVELS OF THE VOLUNTEERS AT THE START OF THE STUDY

Groups	Number	Mean Haemoglobin levels g/100 ml.	't' value
Anaemic	20	9.4	
			4.010*
Non-Anaemic	16	12.6	

* Significant at 1 percent level

According to National Institute of Nutrition (1977) haemoglobin levels below 11 g./100 ml. is supposed to be indicative of anaemia among female adults who are not expecting. For the present study, values suggested by NIN were considered as standard and the volunteers grouped accordingly. There were 20 volunteers who were anaemic and 16 volunteers who were non-anaemic according to the values suggested by NIN (1977). The anaemic group registered a mean value of 9.4 g./100 ml., against 12.6 g./100 ml. recorded by the non-anaemic group.

4. Mean pulse rate and blood pressure of the volunteers

Table V presents the mean pulse rate and blood pressure of both the anaemic and non-anaemic volunteers before and after running. The individual values are given in Appendix V-A and V-B.

TABLE V

MEAN PULSE RATE AND BLOOD PRESSURE OF THE VOLUNTEERS BEFORE AND AFTER RUNNING

Details	Anaemic		Non-Anaemic	
	Before running	After running	Before running	After running
Pulse rate/ minute	75	94	73	79
Blood Pressure	117/78	140/86	120/80	133/81

The pulse rate at resting stage for anaemic volunteers was 75 against 73 among the non-anaemic volunteers. The pulse rate of these volunteers after atheletic performance namely running was 94 for anaemic volunteers against only 79 for non-anaemic volunteers. Basta (1977) has stated that iron deficiency anaemia affects the physical capacity by reducing the availability of oxygen to the tissues, which

In turn affects cardiac output and heartrate. The anaemic subjects showed a blood pressure value of 117/78 as against 120/80 for non-anaemic subjects before running. After running the anaemic subjects showed an increased blood pressure level of 140/86 as against 135/81 for non-anaemic subjects. It is note worthy that while there was an increase in pulse rate and blood pressure in both the groups, the rate of increase was more among the anaemics.

Table VI presents the mean pulse rate and blood pressure of both the anaemic and non-anaemic volunteers before and after skipping and the individual values are indicated in Appendix VI-A and VI-B.

TABLE VI

MEAN PULSE RATE AND BLOOD PRESSURE OF THE VOLUNTEERS BEFORE AND AFTER SKIPPING

Details	Anaemic		Non-anaemic	
	Before skipping	After skipping	Before skipping	After skipping
Pulse rate/minute	74	92	73	84
Blood pressure	117/78	142/85	119/80	135/81

The mean pulse rate at resting stage for anaemic volunteers was 74 against 73 among non-anaemic volunteers. The pulse rate of the volunteers after skipping was 92 and 84 respectively. The mean blood pressure at resting stage for anaemic volunteers was 117/78 against 119/80 of the non anaemic. The blood pressure of the volunteers after skipping was 142/85 and 135/81 respectively. It appears that the rate of increase in pulse rate and blood pressure for a given activity is more among anaemic volunteers than among non-anaemic volunteers.

Table VII gives the mean pulse and blood pressure of both anaemic and non-anaemic volunteers before and after jumping. Appendix VII-A and VI-B presents the individual values for the subjects.

TABLE VII

MEAN PULSE RATE AND BLOOD PRESSURE OF THE VOLUNTEERS BEFORE AND AFTER JUMPING

Details	Anaemic		Non-Anaemic	
	Before jumping	After jumping	Before jumping	After jumping
Pulse rate/minute	75	90	72	80
Blood pressure	117/77	133/81	119/80	131/81

The mean resting pulse rate remained at 75 for anaemic and 72 for non-anaemic. The mean resting blood pressure remained at 117/77 for anaemic and 119/80 for non-anaemic. The pulse rate however increased spontaneously to 90 and 80 and the blood pressure to 133/81 and 131/81 for anaemic and non-anaemic volunteers after jumping 50 times. Though there was an increase in both the groups, it is obvious that the anaemic group had registered a higher rate of increase than their non-anaemic counterparts.

Table VIII highlights the mean pulse rate and blood pressure of both the anaemic and non-anaemic volunteers before and after climbing the stairs. The individual values are given in Appendix - VIII-A and VIII-B.

TABLE VIII

MEAN PULSE RATE AND BLOOD PRESSURE OF THE VOLUNTEERS BEFORE AND AFTER CLIMING STAIRS

Details	Anaemic		Non-Anaemic	
	Before climbing	After climbing	Before climbing	After climbing
Pulse rate/minute	76	92	73	79
Blood pressure	112/75	142/81	119/80	131/81

The resting mean pulse rate of the anaemic and non-anaemic volunteers was 76 and 73 respectively. The resting mean blood pressure level of the anaemic and non-anaemic volunteers was 112/75 and 119/80 respectively. The values after climbing the stairs, were increased to 92 and 79 for pulse and 142/81 and 131/81 for blood pressure respectively. While there is an increase in the pulse rate and blood pressure which is expected after any activity among both the groups the rate of increase was much more among the anaemic volunteers than among the non-anaemic volunteers. These results on the various atheletic activities indicate that the performance of individuals who are anaemic require a higher effort than that required for performing the same activity by a non-anaemic person.

5. Time taken for atheletic activities

Table IX gives the mean time taken to perform the various atheletic activities by the anaemic and non-anaemic student volunteers. The individual values are presented in Appendix-IX-A, B, C and D.

TABLE IX

MEAN TIME TAKEN FOR VARIOUS ATHELETIC ACTIVITIES

Activity	Number	Time taken in seconds		't' value
		Anaemic	Non-Anaemic	
Running	20	26	23	2.365*
Skipping	20	108	74	4.23*
Jumping	20	24	23	1.78 NS
Climbing stairs	20	32	24	4.115*

* Significant at 1 percent level

NS - Not significant

As is evident from Table IX all the four activities namely running, skipping, climbing stairs and jumping were carried out at a faster rate by the non-anaemic volunteers than their anaemic counterparts. However the difference in the time taken was greater for skipping and climbing than running and jumping. The difference in the time taken to perform specific activities was significant at 1 percent level with reference to running, skipping and climbing and not significant for jumping. The non-anaemic group seems to be at an advantage in performing the atheletic activities than the anaemic volunteers.

6. Impact of iron supplementation on volunteers

Table X highlights the impact of iron supplementation on the anaemic volunteers, with respect to haemoglobin levels, the individual values are given in Appendix-X.

TABLE X

MEAN HAEMOGLOBIN LEVELS BEFORE AND AFTER SUPPLEMENTATION

Group	Number	Mean level g/100 ml.	
		Before supplementation	After supplementation
Anaemic	20	9.4	11.7

The mean haemoglobin levels of the anaemic volunteers was 9.4 g./100 ml. at the start of the study, before supplementation. After supplementation with iron tablets for a period of threemonths (90 days) the mean haemoglobin level came upto 11.7 g. which was remarkable. Continuation of the supplementation for some more time could have improved the values further. These results are similar to the findings reported by Gardene et al (1975) who have stated that the haemoglobin level for the iron treated groups after 83 days improved from 7.7 to 12.4 g./100 ml. in adult women. Figure A shows the mean haemoglobin values before and after supplementation in comparision with the non-anaemic subjects.

MEAN HAEMOGLOBIN LEVELS

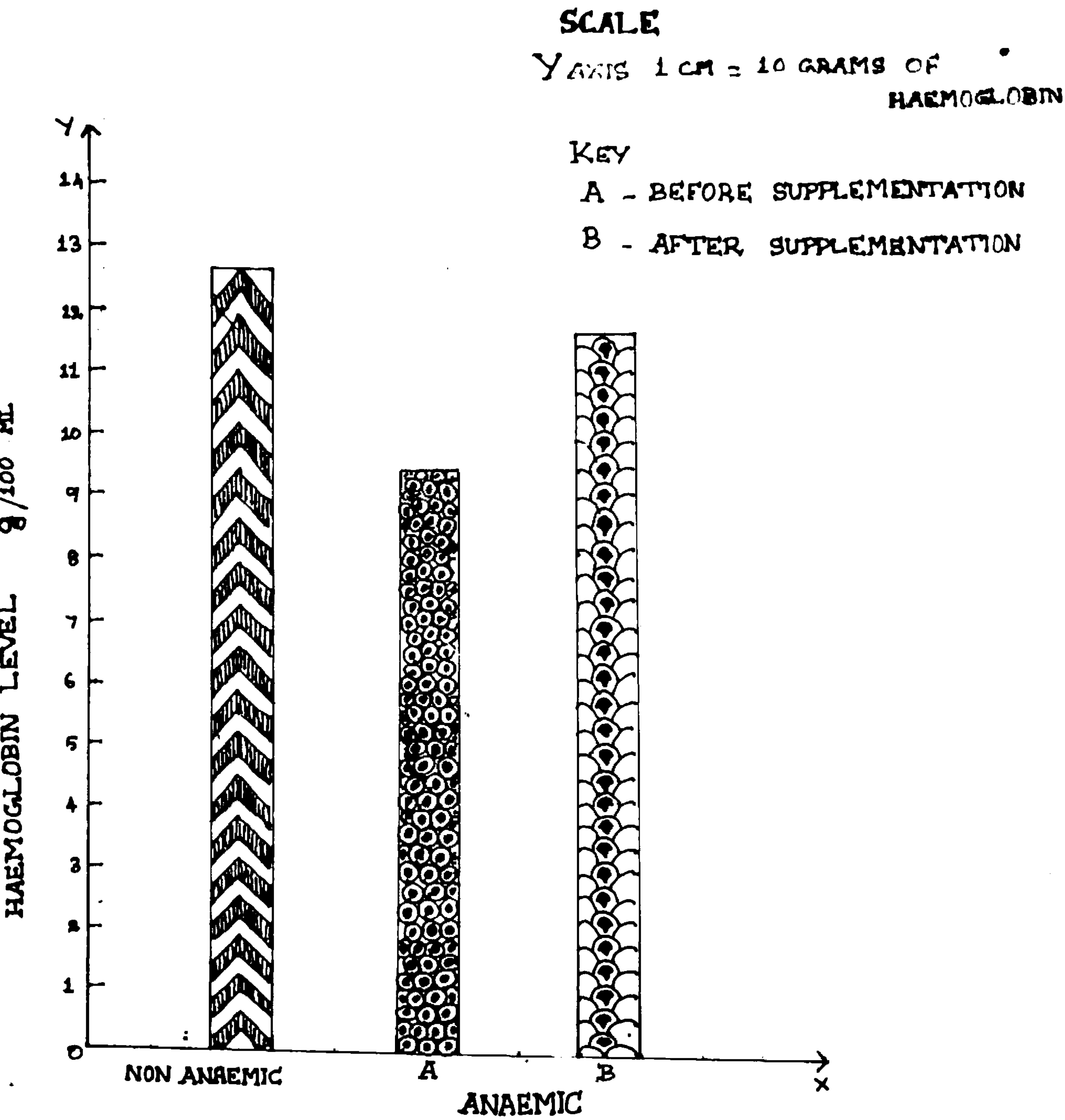


Table XI explains the pulse rate and blood pressure before and after activity and before and after supplementation. The individual values are given in Appendix-XI.

TABLE XI

MEAN PULSE RATE AND BLOOD PRESSURE OF THE ANAEMIC VOLUNTEERS BEFORE AND AFTER SUPPLEMENTATION FOR RUNNING

Details	Number	Before running	After running
<u>Pulse Rate</u>			
Before supplementation	20	75	94
After supplementation	20	72	81
<u>Blood Pressure</u>			
Before supplementation	20	117/78	140/86
After supplementation	20	119/79	132/81

The mean pulse rate and blood pressure for the anaemic subjects before supplementation at rest was 75 and 117/78 respectively. After running, the pulse rate and blood pressure increased dramatically to a level of 94 and 140/86 respectively. However after supplementation, the volunteers recorded a pulse rate and blood pressure level of 72 and 119/79 at rest, which increased to 81, 132/81 respectively, after the completion of running. This decrease in the rate of increase of pulse rate and blood pressure after running was probably due to the supplementation of ferrous sulphate for a period of 3 months. Similar observations have been made by Vijayalakshmi *et al* (1983).

Table XII explains the pulse rate and blood pressure before and after activity and before and after supplementation. The individual values are given in Appendix-XII.

TABLE XII

MEAN PULSE RATE AND BLOOD PRESSURE OF THE ANAEMIC VOLUNTEERS FOR SKIPPING BEFORE AND AFTER SUPPLEMENTATION

Details	Number	Before skipping	After skipping
Pulse Rate			
Before supplementation	20	74	92
After supplementation	20	73	81
Blood pressure			
Before supplementation	20	117/78	142/85
After supplementation	20	120/80	135/82

The mean pulse rate and blood pressure of the volunteers at rest before supplementation was 74 and 117/78 and after supplementation 73 and 120/80 respectively. After skipping there was a sudden increase in the level to 92 and 142/85 before supplementation and 81, 135/82 after supplementation. As observed in the activities like running the rate of increase in blood pressure and pulse rate had decreased after iron supplementation.

Table XIII highlights the pulse rate and blood pressure before and after jumping and before and after supplementation. The individual values are given in Appendix XIII.

TABLE XIII

MEAN PULSE RATE AND BLOOD PRESSURE OF THE ANAEMIC VOLUNTEERS FOR JUMPING BEFORE AND AFTER SUPPLEMENTATION

Details	Number	Before jumping	After jumping
Pulse Rate			
Before supplementation	20	75	90
After supplementation	20	72	80
Blood pressure			
Before supplementation	20	117/77	133/81
After supplementation	20	119/80	130/80

The mean pulse rate and blood pressure at rest before supplementation was 75 and 117/77 respectively. But after umping there was an increase in pulse rate and blood pressure to 90 and 133/81 which was remarkable. The mean pulse rate and blood pressure of the volunteers at rest after supplementation was 72 and 119/80, and after jumping the pulse and blood pressure rate increased to a value of 30 and 130/80 respectively. Though there is an increase in both the values the decrease in pulse and blood pressure after jumping was remarkable after supplementation with ferrous sulphate for a period of 90 days.

Table XIV brings forth the pulse rate and blood pressure before and after climbing and before and after supplementation. The individual values are given in Appendix-XIV.

TABLE XIV

MEAN PULSE RATE AND BLOOD PRESSURE OF THE ANAEMIC VOLUNTEERS FOR CLIMBING STAIRS BEFORE AND AFTER SUPPLEMENTATION

Details	Number	Before climbing	After climbing
Pulse rate			
Before supplementation	20	76	92
After supplementation	20	73	81
Blood pressure			
Before supplementation	20	112/75	142/81
After supplementation	20	119/79	129/80

The mean pulse rate and blood pressure of the volunteers at rest before supplementation was 76 and 112/75, and after supplementation was 73 and 119/79 respectively. After climbing the stairs the pulse rate and blood pressure was 92 and 142/81 before supplementation and 81, 129/80 respectively. The decrease in both the levels after supplementation with ferrous sulphate for a period of 3 months was thus obvious.

Table XV gives the mean time taken to perform the various atheletic activities by the anaemic volunteers before and after supplementation. The individual values are given inAppendix-XV.

TABLE XV

MEAN TIME TAKEN FOR VARIOUS ATHELETIC ACTIVITIES BEFORE AND AFTER SUPPLEMENTATION

Group	Activities	Time taken in seconds		't' value
		Before supplementation	After supplementation	
Anaemic	Running	26	24	2.932*
	Skipping	108	61	5.112*
	Jumping	24	21	2.838*
	Climbing stairs	32	27	6.303*

* Significant at 1 percent level

MEAN TIMETAKEN FOR VARIOUS ATHELETIC ACTIVITIES BEFORE AND AFTER SUPPLEMENTATION

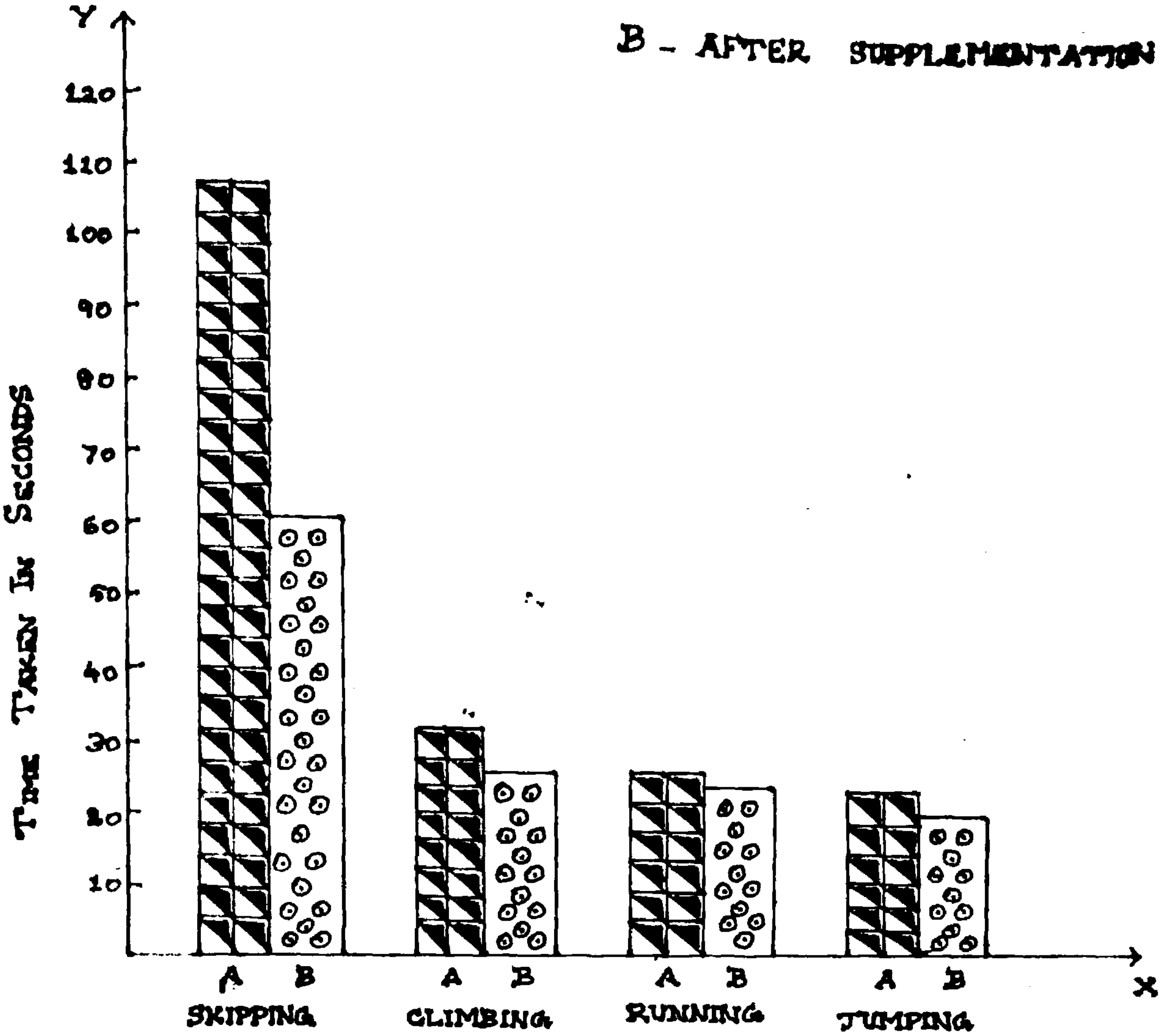
SCALE

Y AXIS 1 CM = 10 SECONDS

KEY

A - BEFORE SUPPLEMENTATION

B - AFTER SUPPLEMENTATION



As is evident from the Table XV all the four activities namely running, skipping, climbing stairs and jumping were carried out by the anaemic volunteers at a faster rate after supplementation than before supplementation. There was a significant decrease in the time taken by the individuals for skipping and climbing than running and jumping after supplementation with iron tablets. Thus it appears that iron supplementation is highly beneficial for anaemic volunteers who can perform an atheletic activity at a remarkably shorter time after supplementing their diets with iron. The differences in time to perform an activity before and after supplementation was statistically significant at 1 percent level in case of all the activities. Figure B shows the time taken for various activities before and after supplementation.

SUMMARY AND CONCLUSION

V SUMMARY AND CONCLUSION

The study on "Anaemia and atheletic performance" was carried out with the objective of finding the relationship between anaemia and atheletic performance and the impact of iron supplementation on selected anaemic adolescent volunteers. Non-anaemic adolescent volunteers in the similar age group were also studied for purposes of comparision.

The anemic and non-anaemic volunteers were studied with reference to their food and nutrient intake, haemoglobin levels, performance interms of time taken to run a distance of 100 meters, to skip for 100 times, to jump for 50 times, to climb a specific number of steps and pulse and blood pressure rates before and after these activities. The values achieved by the anaemic volunteers were compared with the non-anaemic volunteers.

Each of the anaemic volunteers were fed 60 mg. of elemental iron everyday for 90 days. After this period of supplementation the volunteers were studied agains for the various factors mentioned above, and compared with before supplementation values. The results of the study indicated the following facts.

1. The mean food intake of both the anaemic and non-anaemic volunteers was below the recommended allowances with reference to cereals and green leafy vegetables which is the richest and cheap source of iron. However the intake of green leafy vegetables of the non-anaemic group was double when compared with the anaemic volunteers. The other nutrients like protein, calcium, retinol, thiamine, riboflavin, ascorbic acid were above the recommended allowance in both the groups.

2. The mean haemoglobin levels increased from 9.4 to 11.7 g/100 ml. after supplementation for all the anaemic volunteers.

3. The extent of increase in pulse rate and blood pressure were relatively less after supplementation with iron while performing the same activities, indicating a better cardiac and pulmonary efficiency.

4. The atheletic performance was completed at a faster rate after supplementation suggesting that iron deficiency anaemia decreases the atheletic performance by causing easy fatigue, and supplementation with iron improves the performance.

Thus the present study lead us to the conclusion that atheletic performance can be improved in adolescents suffering from anaemia by a suitable iron supplementation programme.

LIST OF REFERENCES

BIBILIOGRAPHY

Aleta, I.R. 1976 .. "Nutrition As an entry point to community development". Phillipine Journal of Nutrition, Vol.29, pp.1.

Alfin - Slater, R.B., Kritehevsky, D. 1980 .. "Nutrition and the adult - Micro Nutrition". Plenum Press, N.Y. London, pp.312.

Anderson, H.T. and Barkue, H. 1970 .. "Iron deficiency and muscular performance". Scandinavian Journal of Clinical Laboratory Investigations, Vol.14, pp.37.

Aung-Than-Battu, Thein - Than, Khin - Kyi - Nyunt 1972 .. "Iron deficiency in Burmese population groups". American Journal of Clinical Nutrition, Vol.25, No.2, pp.210-215.

Basta, S.S. 1977 .. "Iron deficiency and labour productivity". Foods and Nutrition, Food and Agricultural Organisation, Vol.3, No.4, pp.12-18.

Bengoa, J.M. 1974 .. "The problem of malnutrition". WHO Chronicle, Vol.28, pp.3.

Berg, A.D. 1973 .. "Malnutrition and Development". The Nutrition Factor its role in National Development, The Brookings Institution, MassaChsetts Avenue, Washington, pp.9-13.

Buzina, R. Grgic, Z. 1982 .. "Nutritional Status and Physical Working Capacity". Human Nutrition: Human Nutrition: Clinical Nutrition, Vol.36, pp.6.

Bogert, J.C. Briggs, G.M., Colloway, H.D. 1973 .. "Nutrition and Physical Fitness". 19th Edition, W.B. Saunders Co., Philadelphia, pp.28-30.

Burgess, H.J.L., Burgess, A.P. 1976 .. "Malnutrition in the Western Pacific Region", WHO Chronicle, Vol.30, No.2, pp.64-66.

Burton, T.B. 1976 .. "Nutrition and the anemias". Human Nutrition, 3rd edition, TATA Mc Graw-Hill Publishing Company, pp.392-393.

Chandra, R.K. 1976 .. "Iron and Immuno Competence". Nutrition Reviews, Vol.34, No.5, pp.129-132.

Dam, B.V. 1978 .. "Vitamin and Sports". British Journal of Sports Medicine, 12, p.74.

Davies, C.T.M., Chukweameka, A.C., 1973 .. "Aerobic power and responses to exercise in African males aged 17-40 years". Clinical Science, 44, pp.5-55.

Devadas, R.P. 1977 .. "Nutrition problems in Rural India". Kurukshetra, July, pp.12-13.

Devadas, R.P. 1977 .. "Nutrition problems in Rural India". Journal of Home Science, Vol.15, pp.22.

Devadas, R.P. 1979 .. "Strategies to overcome Malnutrition in India". Home Science and the Nation, published by the University of Madras, pp.42-60.

DE Silva, C.C., Baptist, N.G., 1969 .. "Tropical Nutritional disorders of infants and children". Charles C. Thomas Publishers U.S.A., pp.191.

Elwood, P.C. 1973 .. "Evaluation of the clinical importance of anemia". American Journal of Clincail Nutrition, Vol.26, No.9, pp.958-964.

FAO 1976 .. "Seminar on Food and Work". Second International Meeting, Tashkent - USSR, September 1974, pp.71.

FAO 1976 .. "Food and working efficiency". The feeding of workers in developing countries, pp.12-14.

Farris, D.K. 1966 .. "Adequate nutrition an indispensable base for economic development". UN Report pp.12-31.

Finch, C.A., Cook, J.D., Monsen, E.R., Sood, S.K. .. "The problem of nutritional iron deficiency". Indian Journal of Nutrition and Dietetics, Vo.2, No.5, pp.296-299.

Foods and Nutrition Notes and Reviews 1974 .. "Iron deficiency and its control in the U.S. population". Australian department of Health, Vol.31, No.5, pp.122.

Gopalan, C. 1975 .. Anaemia As a public health problem". Nutrition, Publications of the National Institute of Nutrition, Vol.9, No.2, pp.2-11.

Gopalan, C. 1973 .. "Collected publications of Dr. C. Gopalan". 1943-1973, National Institute of Nutrition pp.105.

Guzman, F.E., Domingues, S.R. Santos, V.E. 1975 .. "Filipine athletes their literary intake andtotal energy expenditure". Phillipine Journal of Nutrition, Vol.XXV, No.4, pp.225-235.

Gopalan, C. 1983 .. "Journal of the Madras Univeraity". Vol.46, pp.75-86.

Gardner, W., Haggie, V., Edgerton, V.R. 1975 .. "Cardio Respiratory, hematological physical performance responses of anaemic subjects to iron" American Journal of Clinical Nutrition, Vol.28, pp.982 - 985.

ICMR 1974 .. "Nutrition" Annual report of the director general, Indian Council of Medical Research, pp.60-61.

ICMR 1976 .. "Nutrition" Annual report of the director general, Indian Council of Medical Research, pp.68.

ICMR 1978 .. "Nutritional anaemia". ICMR Bulletin, Vol.8, pp.4-6.

Kerrigan, K.A., Barnard, R.J. 1975 .. "Papers in free communication Sessions". Xth International Congress on Nutrition, pp.597.

Krishnaswamy, K. 1982 .. "Diet for middle age". Indian Council of Medical Research, Vol.16, No.1, pp.2.

Layrisse, M. 1970 .. "Effects of interaction of various foods on iron absorption". American Journal of Clinical Nutrition Vol.21, pp.1175-1183

Latham, M.C. 1976 .. "Nutritional problems in the labour force and their relation to Economic development". Nutrition and Agricultural Development, Plenum Press, pp.77-85.

Lakhanpal, R.K. 1976 .. Iron deficiency anemia", Journal of Indian dietetic association, vol.4, No.1, pp.27-39.

Liebman, M. 1983 .. "The Iron Status of Black and White female adolescents from eight Southern States". American Journal ofClinical Nutrition, Vol.38, No.1, pp.109.

League for International Food Education L.I.F.E. 1972 .. "Nutrition and Productivity Their relationship in developing countries". pp.1-6.

Manorama Year Book 1983 .. "A Handy encyclopaedia". pp.263.

Margen, S. 1971 .. "Progress in Human Nutrition" The Avi Publishing Company, Vol.1. pp.119.

Nutrition Reviews 1976 .. "Intestinal malabsorption of Iron". Nutrition Reviews, Vol.34, No.9, pp.270-272.

Nutrition Reviews 1980 .. "Iron fortified salt to combat anaemia". Vol.38, No.9, pp.308.

Nutrition Society of India 1973 .. "Malnutrition and its impact on National development". Proceedings of the Nutrition Society of India, No.13, pp.4.

NIN 1977 .. "Anaemia a major problem". Nutrition, Publications of the National Institute of Nutrition, Vol.2, No.4, pp.15-17.

Robinson, H.C. 1977 .. "Anemias". Normal and Therapeutic Nutrition, Macmillan Publishing Co., INC. 15th edition, pp.571.

Sai, F.T. 1972 .. "Nutrition as a priority in national development". Nutrition a priority in African development. The Dag Mammarekjold Foundation, pp.138-143.

Sadasivam, D.B. 1979 .. "Industrial Nutrition". Regional workshop on planning Diet for health, pp.85-86.

Swaminathan, M.S. 1974 .. "Food Production Technology and achievements of social goals". Seminar on Social and economic aspects of Nutrition, proceedings of the Nutritional Society of India, No.17, pp.14.

Swasth Hind .. "Nutritional anaemia".
1980 Vol.24, No.10, pp.287.

Stewart, G. .. "Observations on the haemotology
1972 and the iron and protein intake of Australisan Olympic athletes", Medical Journal of Australia, Vol.21, pp.1339-1343.

Sjolin, S. .. "Anaemia in adolescence".
1981 Nutrition Reviews, Vol.39, No.2, pp.96-99.

Sathyanarayana, K; .. "Nutrition, physical work
Naidu, A.N.; capacity and work output".
Rao, B.S.N. Indian Journal of Medical Research, 68 (Supple.) pp.38-93.

Sauberlich, H.E., .. "Laboratory tests for the
Dowdy, R.P. assessment of Nutritional Status".
Skala, J.H. CRC Press INC, pp.114.
1976

UNICEF NEWS .. "Fighting Child Malnutrition
1975 Part I". United Nations Children's Fund, New York, pp.83, 3, 11.

UNO .. "Nutritional anaemia" Food and
1979 Nutrition Bulletin, Vol.1, No.4, pp.48-49.

Viteri, F.E., Torum, B. 1974 .. "Anaemia and physical work capacity". Clinics in Haematology, Vol.3, pp.609.

Vellegas, M., Vellendria 1972 .. "Dietary patterns, Food habits and preferencesof Filipino atheletes of theSixth Asian Games 1970". Phillipine Journal of Nutrition, Vol.XXV, No.4, pp.237-244.

Vijayalakshmi, P. 1983 .. "Relationship between iron deficiency anaemia and energy expenditure of young adult women". The Indian Journal of Nutrition and Dietetics, Vol.20, No.4, pp.117.

Wilson, D.E., Fisher, H.K., Fuqua, E.M. 1971 .. "Principles of Nutrition". 2nd edition, Wiley Eastern Private Limited, New Delhi, pp.156.

WHO 1972 .. "Nutritional Anaemias". Report of a World Health Organisation Group of experts, Geneva, Technical Report Series No.503, p.1

WHO 1975 .. "Control of nutritional anaemia special reference to iron deficiency". Technical report Series 580, pp.1-5.

APPENDICES

APPENDIX - I

ESTIMATION OF HAEMOGLOBIN BY CYANMETHAEMOGLOBIN METHOD

The haemoglobin is treated with a reagent containing potassium ferricyanide, potassium dihydrogen phosphate. The ferricyanide forms methaemoglobin which is converted to cyanmethaemoglobin by the cyanide.

REAGENTS

1. Drapkin's diluent solution

Sodium bicarbonate	1 gm.
Potassium cyanide	0.05 g.
Potassium ferricyanide	0.2 g.
Distilled water	1 litre

This solution is preserved in a dark bottle and preferably under cold storage. Its preparation and handling should be done with great care. This solution should not be used after it forms a precipitate at the bottom of the storage bottle.

PROCEDURE

1. Exactly 5 ml. of thedrapkin's diluent is measured into a dry test tube from a burette (or) a pipette with suction bulb.

2. Exactly 0.02 ml. of blood is measured from a Standard haemoglobin pipette into a diluent solution.

Usual care in filling and cleaning of loaded haemoglobin pipette must be observed.

3. The pipette is rinsed three times with the diluent solution without allowing the formation of air bubbles in the solution.

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

5. Ten minutes time is allowed for the formation of cyanmethaemoglobin.

6. 5 ml. of diluent solution is used as blank.

7. The readings are taken in a photo electric colorimeter at 540 mμ.

Caliberation procedure

1. Total blood iron is determined by Wong's method which would give absolute amount of haemoglobin.

2. Exactly 0.02 ml. of this known blood sample is measured into 5.0, 7.5, 10.0, 12.5 and 15.0 ml. of diluent solution. These are now equivalent to blood samples containing respectively 100, 67, 50, 40 and 30 per cent of the original haemoglobin concentration.

3. The intensity of the color is read using a green filter at 540 mμ against a blank at zero density.

DETERMINATION OF IRON AND HAEMOGLOBIN -WONG'S METHOD TO STANDARDISE THE HAEMOGLOBIN VALUES

Principle

The iron is detached from the haemoglobin molecules by treatment with concentrated sulphuric acid in the presence of potassium per-sulfate without heating. After removal of the proteins by tungstic acid, the iron in the filterate is determined colorimetrically. From the total iron content, the haemoglobin content is readily obtained, since the haemoglobin content is 0.34 percent of iron and only 1 to 2 percent or less of the total blood iron is non haemoglobin iron.

Reagents

1. 10% sodium tungstate
2. Saturated potassium persulphide solution
3. Potassium cyanide
4. Standard iron solution
5. Working standard

Procedure

With an Ostwald (or) micropipette, accurately transfer 0.5 ml. of well mixed oxalated whole blood into a 50 ml. volumetric flask. Add 2 ml, of saturated potassium persulphate solution. Mix and dilute to about 25 ml. with water. Add 2 ml. of 10 percent sodium tungstate solution. Mix and cool to room temperature under the tap, and dilute to volume with water. Stopper and mix by inversion filter through a dry, paper, collecting the filterate in a dry flask. Prepare a standard in a second 50 ml. volumetric flask by addition of 2 ml. of concentrated sulphuric acid, 2 ml. of saturated potassium persulphate and 2.5 ml. of standard iron solution containing 0.1 mg. of ferric iron per ml. Cool to room temperature, dilute with water to the mark and mix. Prepare a blank similar to the standard but omitting the standard iron solution.

Measure 20 ml. of unknown filterate, standard and blank if, necessary into separate tubues. To each add 0.5 ml. of saturated persulphate solution followed by 2 ml. of 3N potassium thiocyanide solution. Mix by inversion and read within the next thirty minutes, setting the colorimeter to zero density with the blank at 480 mμ .

Calculation

$$\frac{\text{Density of unknown}}{\text{Density of standard}} \times 0.25 \times \frac{100}{0.5} \times \frac{1}{3.4}$$

= Grams of haemoglobin per 100 ml. of blood.

APPENDIX II

FOOD INTAKE FOR NON ANAEMIC SUBJECTS

Name of the Food Stuffs	SUBJECTS									
	1	2	3	4	5	6	7	8	9	10
(gms.)										
Cereals	175	150	125	175	250	200	220	200	220	175
Pulses	120	130	80	120	120	140	145	120	130	110
Green Leafy Vegetables	35	60	30	50	20	30	60	40	60	30
Other Vegetables	25	25	0	50	25	50	50	25	25	0
Roots and Tubers	100	70	45	120	70	70	70	70	70	120
Fruits	50	50	50	50	50	50	50	50	50	50
Milk	320	425	470	620	375	220	270	400	220	520
Oils and Fats	25	25	25	25	25	25	25	25	25	25
Sugar	20	10	20	20	10	20	20	20	20	20
Nuts	20	20	20	20	20	20	20	20	20	20

FOOD INTAKE FOR ANAEMIC SUBJECTS

NAME OF THE FOOD STUFFS (gms.)	SUBJECTS 1	2	3	4	5	6	7	8	9	10
Cereals	225	225	250	225	250	250	275	250	275	250
Pulses	50	70	75	70	80	65	100	65	35	35
Greenleafy Vegetables	30	20	20	30	30	30	30	30	20	30
Other Vegetables	55	50	55	55	50	55	55	55	55	55
Root s andTubers	70	70	70	70	70	70	70	70	70	70
Fruits	50	50	50	50	50	50	50	50	50	50
Milk	375	270	270	350	150	220	270	250	420	250
Oils and Fats	25	20	25	25	20	25	25	25	25	25
Sugar	20	20	20	20	20	20	20	20	0	10
Nuts	20	20	20	20	20	20	20	20	20	20

NUTRIENT INTAKE FOR ANAEMIC SUBJECTS

NUTRIENTS	SUBJECTS 1	2	3	4	5	6	7	8	9	10
Protein (gm.)	37.3	46.8	36.3	47.5	44.7	44.3	54.9	44.9	46.6	38.1
Energy (KCals)	1625	1556	1648	1748	1589	1710	1906	1729	1776	1627
Calcium (mg.)	518	774	712	821	583	604	743	634	830	598
Iron (mg.)	24	24.8	26.7	28.6	23.1	26.8	28.4	26.7	26.1	25
Retinol (μg)	910	849	910	821	825	867	962	384	944	837
Thiamine (mg.)	1.75	1.06	1.85	1.15	1.23	1.25	1.32	1.26	1.97	1.72
Riboflavin (mg.)	0.76	0.87	1.41	1.96	1.22	1.57	2.74	1.34	1.01	0.69
Vitamin C (mg.)	46	49	47	49	44	46	48	47	58	46

NUTRIENT INTAKE FOR NON-ANAEMIC SUBJECTS

NUTRIENTS	SUBJECTS 1	2	3	4	5	6	7	8	9	10
Protein (gm.)	50.4	56.2	41.2	62	55.9	53.8	57.7	54.1	53.1	55
Energy (KCals)	1771	1734	1462	2024	1983	1867	1899	1901	1869	1883
Calcium (mg.)	758	992	888	1244	760	660	805	830	760	1015
Iron (mg.)	29.9	36.3	23.2	35.8	26.3	32.8	39.1	31.3	38.4	29.2
Retinol (μg)	1843	3191	1590	3143	1019	1525	3176	1620	3158	1652
Thiamine (mg.)	1.35	1.54	1.95	2.02	2.08	2.24	2.26	1.31	2.05	1.49
Riboflavin (mg.)	2.57	2.08	284	2.58	1.52	1.78	1.79	1.76	1.96	2.64
Vitamin C (mg.)	73	67	68	114	60	65	79	102	97	102

APPENDIX - III

INDIVIDUAL HEIGHT AND WEIGHT OF THE VOLUNTEERS

Anaemic			Non-Anaemic		
No.	Height in cm.	Weight in Kg.	No.	Height in cm.	Weight in Kg.
1.	160	43	1.	134	40
2.	163	45	2.	158	52
3.	132	25	3.	152	52
4.	143	38	4.	153	42
5.	156	40	5.	152	42
6.	153	43	6.	142	35
7.	164	42	7.	153	44
8.	162	47	8.	136	40
9.	165	53	9.	156	48
10.	158	42	10.	160	44
11.	152	46	11.	158	46
12.	148	48	12.	158	50
13.	148	48	13.	153	45
14.	156	46	14.	158	46
15.	153	41	15.	161	47
16.	161	50	16.	156	42
17.	154	44			
18.	153	41			
19.	165	58			
20.	154	40			

APPENDIX IV

INDIVIDUAL HAEMOGLOBIN VALUES OF THE VOLUNTEERS AT THE START OF THE STUDY

Anaemic group		Non-Anaemic group	
Number	Haemoglobin g/100 ml.	Number	Haemoglobin g/100 ml.
1.	8.2	1.	11.0
2.	10.0	2.	11.6
3.	9.8	3.	11.2
4.	9.0	4.	14.2
5.	9.8	5.	12.0
6.	9.6	6.	13.0
7.	9.4	7.	14.4
8.	10.0	8.	12.8
9.	10.0	9.	13.8
10.	9.4	10.	13.5
11.	9.8	11.	13.2
12.	9.0	12.	14.3
13.	9.2	13.	12.2
14.	10.0	14.	11.2
15.	9.6	15.	11.6
16.	8.4	16.	12.0
17.	9.8		
18.	9.4		
19.	9.8		
20.	8.0		

APPENDIX V-A

INDIVIDUAL PULSE RATE IN VOLUNTEERS AT THE START OF THE STUDY FOR RUNNING

Anaemic			Non-Anaemic		
Number	Before activity	After activity	Number	Before activity	After activity
1.	74	88	1.	72	78
2.	76	82	2.	73	82
3.	73	96	3.	72	77
4.	74	86	4.	72	78
5.	76	102	5.	73	79
6.	75	90	6.	73	79
7.	75	92	7.	74	80
8.	76	96	8.	72	79
9.	80	96	9.	73	81
10.	79	92	10.	72	76
11.	73	91	11.	72	78
12.	72	94	12.	73	80
13.	80	98	13.	73	82
14.	73	89	14.	73	81
15.	76	82	15.	72	80
16.	72	80	16.	73	77
17.	74	86			
18.	73	88			
19.	72	80			
20.	74	86			

APPENDIX V-B

INDIVIDUAL BLOOD PRESSURE IN VOLUNTEERS AT THE START OF THE STUDY FOR RUNNING

Anaemic			Non-Anaemic		
No.	Before activity	After activity	No.	Before activity	After activity
1.	108/76	139/82	1.	120/80	132/82
2.	117/73	146/80	2.	120/80	140/81
3.	118/79	139/83	3.	119/80	138/81
4.	119/80	142/80	4.	120/80	184/81
5.	113/74	142/80	5.	119/80	132/81
6.	103/76	140/81	6.	120/80	130/80
7.	116/78	140/84	7.	120/80	131/81
8.	109/75	143/82	8.	120/80	134/81
9.	118/80	138/88	9.	120/80	131/82
10.	115/78	138/86	10.	119/80	131/80
11.	113/78	140/81	11.	119/80	136/82
12.	118/80	130/80	12.	120/80	132/82
13.	120/80	144/81	13.	119/80	131/81
14.	117/79	139/80	14.	119/80	132/82
15.	120/82	138/84	15.	119/80	133/82
16.	120/80	142/83	16.	120/80	130/80
17.	120/78	140/81			
18.	119/80	138/80			
19.	120/79	140/82			
20.	119/79	142/81			

APPENDIX VI-A

INDIVIDUAL PULSE RATE IN VOLUNTEERS AT THE START OF THE STUDY FOR SKIPPING

Anaemic			Non-Anaemic		
No.	Before activity	After activity	No.	Before activity	After activity
1.	72	89	1.	73	84
2.	73	104	2.	72	86
3.	73	80	3.	73	84
4.	79	104	4.	74	90
5.	78	100	5.	73	84
6.	75	86	6.	74	86
7.	73	99	7.	72	90
8.	76	98	8.	73	80
9.	75	98	9.	72	80
10.	74	92	10.	73	82
11.	73	96	11.	74	83
12.	76	100	12.	72	86
13.	74	87	13.	73	82
14.	73	80	14.	75	88
15.	72	79	15.	73	86
16.	72	86	16.	73	82
17.	74	81			
18.	76	105			
19.	75	90			
20.	72	84			

APPENDIX VI-B

INDIVIDUAL BLOOD PRESSURE IN VOLUNTEERS AT THE START OF THE STUDY FOR JUMPING

Anaemic			Non-Anaemic		
No.	Before activity	After activity	No.	Before activity	After activity
1.	114/73	142/82	1.	120/80	135/81
2.	116/80	141/84	2.	119/80	138/82
3.	118/79	142/81	3.	118/80	132/81
4.	120/80	143/84	4.	119/80	139/82
5.	120/80	146/86	5.	120/80	135/81
6.	116/79	140/83	6.	119/80	134/81
7.	118/78	142/84	7.	119/79	139/83
8.	115/77	139/83	8.	119/80	135/82
9.	120/79	140/83	9.	120/80	132/81
10.	119/78	144/82	10.	119/80	134/81
11.	116/79	148/83	11.	119/80	135/82
12.	118/77	136/70	12.	120/80	132/81
13.	114/76	150/82	13.	118/79	137/82
14.	118/79	143/89	14.	120/80	139/82
15.	113/76	140/86	15.	120/80	139/82
16.	120/78	140/89	16.	119/79	140/82
17.	119/78	138/82			
18.	120/80	144/88			
19.	120/76	136/82			
20.	116/80	148/88			

APPENDIX - VII-A

INDIVIDUAL PULSE RATE IN VOLUNTEERS AT THE START OF THE STUDY FOR JUMPING

Anaemic			Non-Anaemic		
No.	Before activity	After activity	No.	Before activity	After activity
1.	78	99	1.	72	80
2.	72	78	2.	71	81
3.	73	79	3.	72	79
4.	75	84	4.	74	80
5.	73	86	5.	72	83
6.	74	88	6.	72	80
7.	78	95	7.	72	80
8.	73	81	8.	72	78
9.	76	92	9.	72	78
10.	75	84	10.	73	80
11.	78	101	11.	72	79
12.	74	94	12.	73	81
13.	78	102	13.	70	78
14.	73	98	14.	73	80
15.	72	79	15.	72	81
16.	75	100	16.	73	80
17.	76	86			
18.	73	85			
19.	74	83			
20.	73	100			

APPENDIX VII-B

INDIVIDUAL BLOOD PRESSURE IN VOLUNTEERS AT THE START OF THE STUDY FOR JUMPING

Anaemic			Non-Anaemic		
No.	Before activity	After activity	No.	Before activity	After activity
1.	118/72	140/81	1.	119/80	130/80
2.	120/79	136/80	2.	119/79	132/80
3.	118/76	139/81	3.	120/80	130/80
4.	119/79	139/81	4.	119/80	131/80
5.	116/74	148/81	5.	120/80	132/81
6.	109/78	136/80	6.	120/80	130/81
7.	113/72	140/79	7.	120/80	130/81
8.	119/78	140/81	8.	119/80	132/81
9.	116/78	138/80	9.	120/79	131/80
10.	117/79	142/81	10.	119/79	131/81
11.	119/77	146/82	11.	119/80	131/81
12.	120/80	138/80	12.	120/80	130/81
13.	109/76	136/80	13.	119/79	132/81
14.	109/78	139/81	14.	120/80	130/80
15.	119/80	132/80	15.	119/79	132/80
16.	120/78	140/80	16.	120/80	130/80
17.	118/76	139/81			
18.	115/78	140/80			
19.	119/80	142/82			
20.	118/79	142/83			

INDIVIDUAL PULSE RATE IN VOLUNTEERS AT THE START OF THE STUDY FOR CLIMBING STAIRS

Anaemic			Non-Anaemic		
No.	Before activity	After activity	No.	Before activity	After activity
1.	80	100	1.	72	82
2.	72	79	2.	73	80
3.	73	86	3.	72	79
4.	72	98	4.	72	78
5.	76	100	5.	74	82
6.	76	98	6.	72	79
7.	77	83	7.	72	76
8.	73	80	8.	73	78
9.	75	100	9.	72	76
10.	82	100	10.	73	80
11.	78	98	11.	72	79
12.	76	100	12.	72	80
13.	80	93	13.	73	80
14.	74	83	14.	73	80
15.	76	100	15.	73	82
16.	80	86	16.	73	79
17.	73	81			
18.	75	81			
19.	74	100			
20.	76	96			

APPENDIX VIII-B

INDIVIDUAL BLOOD PRESSURE IN VOLUNTEERS AT THE START OF THE STUDY FOR CLIMBING STAIRS

Anaemic			Non-Anaemic		
S.No.	Before activity	After activity	No.	Before activity	After activity
1.	108/75	140/78	1.	120/80	131/81
2.	114/73	148/81	2.	119/80	131/80
3.	119/75	152/	3.	119/80	132/80
4.	108/78	140/78	4.	120/80	131/81
5.	108/70	140/81	5.	120/80	131/81
6.	104/74	134/79	6.	120/80	133/82
7.	120/78	146/80	7.	119/80	131/82
8.	119/76	140/81	8.	120/80	130/80
9.	112/72	140/78	9.	119/80	130/80
10.	110/78	138/82	10.	120/80	131/80
11.	110/80	140/81	11.	119/80	131/80
12.	114/74	139/78	12.	119/80	130/80
13.	119/78	148/81	13.	118/79	130/81
14.	118/74	143/78	14.	119/80	132/81
15.	109/76	142/80	15.	118/79	132/80
16.	116/74	138/78	16.	120/80	133/81
17.	108/76	147/82			
18.	119/80	132/81			
19.	108/72	138/78			
20.	116/74	146/80			

APPENDIX - IX-A

INDIVIDUAL TIME TAKEN FOR VARIOUS ATHELETIC ACTIVITIES IN THE VOLUNTEERS AT THE START OF THE STUDY

100 Meters Running

No.	Anaemic Time taken in seconds	No.	Non-Anaemic Time taken in seconds
1.	30	1.	25
2.	24	2.	26
3.	24	3.	22
4.	35	4.	24
5.	30	5.	20
6.	25	6.	25
7.	27	7.	23
8.	30	8.	29
9.	25	9.	21
10.	34	10.	18
11.	25	11.	23
12.	28	12.	25
13.	25	13.	20
14.	25	14.	23
15.	30	15.	22
16.	25	16.	27
17.	27		
18.	25		
19.	27		
20.	25		

APPENDIX IX-B

INDIVIDUAL TIME TAKEN FOR VARIOUS ATHELETIC ACTIVITIES IN THE VOLUNTEERS AT THE START OF THE STUDY

Skipping for 100 times

Anaemic Number	Anaemic Time taken in secs.	Non-anaemic Number	Non-anaemic Time taken in secs.
1.	130	1.	90
2.	84	2.	56
3.	87	3.	40
4.	91	4.	92
5.	103	5.	95
6.	127	6.	90
7.	105	7.	88
8.	135	8.	50
9.	130	9.	62
10.	115	10.	79
11.	130	11.	90
12.	145	12.	83
13.	180	13.	86
14.	45	14.	51
15.	45	15.	77
16.	105	16.	70
17.	180		
18.	55		
19.	112		
20.	60		

APPENDIX IX-C

INDIVIDUAL TIME TAKEN FOR VARIOUS ATHELETIC ACTIVITIES IN THE VOLUNTEERS AT THE START OF THE STUDY

J U M P I N G

S.No.	Anaemic Time taken in seconds	No.	Non-Anaemic Time taken in Seconds
1.	25	1.	26
2.	25	2.	30
3.	26	3.	17
4.	25	4.	30
5.	22	5.	30
6.	25	6.	27
7.	25	7.	23
8.	25	8.	22
9.	25	9.	25
10.	22	10.	25
11.	26	11.	27
12.	29	12.	22
13.	22	13.	17
14.	26	14.	30
15.	22	15.	26
16.	25	16.	28
17.	22		
18.	25		
19.	26		
20.	24		

APPENDIX IX-D

INDIVIDUAL TIME TAKEN FOR VARIOUS ATHELETIC ACTIVITIES IN THE VOLUNTEERS AT THE START OF THE STUDY

CLIMBING STAIRS

No.	Anaemic Time taken in Seconds	No.	Non-Anaemic Time taken in Seconds
1.	35	1.	31
2.	35	2.	31
3.	27	3.	31
4.	33	4.	21
5.	26	5.	23
6.	35	6.	19
7.	38	7.	24
8.	25	8.	22
9.	20	9.	22
10.	60	10.	21
11.	45	11.	22
12.	25	12.	24
13.	31	13.	23
14.	40	14.	27
15.	21	15.	22
16.	35	16.	27
17.	34		
18.	33		
19.	25		
20.	31		

APPENDIX X

INDIVIDUAL HAEMOGLOBIN VALUES AFTER SUPPLEMENTATION

Number		Haemoglobin g/100 ml.
1.	..	11.4
2.	..	12.3
3.	..	11.4
4.	..	11.4
5.	..	12.3
6.	..	10.8
7.	..	11.7
8.	..	12.0
9.	..	12.2
10.	..	11.8
11.	..	12.1
12.	..	12.0
13.	..	11.4
14.	..	10.8
15.	..	11.0
16.	..	12.0
17.	..	12.3
18.	..	12.0
19.	..	11.4
20.	..	12.2

APPENDIX XI

INDIVIDUAL PULSE RATE AND BLOOD PRESSURE IN VOLUNTEERS PERFORMING RUNNING AFTER SUPPLEMENTATION

Pulse Rate			Blood Pressue		
No.	Before activity	After activity	No.	Before activity	After activity
1.	72	83	1.	119/79	132/81
2.	72	84	2.	119/80	136/81
3.	72	80	3.	120/79	132/81
4.	73	82	4.	119/80	133/81
5.	73	84	5.	118/79	132/81
6.	72	81	6.	117/79	133/81
7.	73	82	7.	120/80	131/81
8.	72	80	8.	119/80	135/81
9.	73	82	9.	119/79	132/81
10.	73	84	10.	118/79	136/81
11.	73	82	11.	119/80	136/81
12.	72	79	12.	119/79	133/81
13.	73	81	13.	120/80	129/81
14.	72	82	14.	119/79	132/81
15.	72	81	15.	120/80	129/81
16.	72	78	16.	119/79	130/81
17.	72	81	17.	120/79	130/81
18.	72	82	18.	119/79	130/81
19.	72	80	19.	120/80	131/81
20.	73	80	20.	119/80	133/81

APPENDIX XII

INDIVIDUAL PULSE RATE AND BLOOD PRESSURE IN VOLUNTEERS PERFORMING SKIPPING AFTER SUPPLEMENTATION

Pulse Rate			Blood Pressure		
No.	Before activity	After activity	No.	Before activity	After activity
1.	72	84	1.	119/80	136/82
2.	73	84	2.	120/80	138/82
3.	72	82	3.	120/80	135/82
4.	73	81	4.	120/78	134/81
5.	73	85	5.	120/79	136/81
6.	73	87	6.	119/80	138/82
7.	73	84	7.	120/79	135/81
8.	73	82	8.	120/80	138/82
9.	72	83	9.	119/80	136/82
10.	72	86	10.	120/80	136/82
11.	73	82	11.	119/79	136/81
12.	72	85	12.	120/79	132/81
13.	73	86	13.	120/79	136/82
14.	72	83	14.	120/80	132/82
15.	73	84	15.	120/79	132/81
16.	72	81	16.	120/30	134/82
17.	72	86	17.	119/79	132/82
18.	73	84	18.	120/80	134/82
19.	73	86	19.	119/80	132/82
20.	72	83	20.	120/79	134/81

APPENDIX XIII

INDIVIDUAL PULSE RATE AND BLOOD PRESSURE IN VOLUNTEERS PERFORMING JUMPING AFTER SUPPLEMENTATION

Pulse rate			Blood Pressure		
No.	Before activity	After activity	No.	Before activity	After activity
1.	72	81	1.	119/80	128/80
2.	72	78	2.	120/79	130/80
3.	73	77	3.	118/79	128/80
4.	73	81	4.	119/79	130/80
5.	72	80	5.	120/80	128/80
6.	73	80	6.	119/79	126/80
7.	72	82	7.	120/80	132/80
8.	73	78	8.	119/79	128/80
9.	72	81	9.	118/79	132/80
10.	73	80	10.	117/79	129/80
11.	72	78	11.	119/80	128/80
12.	73	82	12.	120/80	128/80
13.	73	84	13.	119/79	128/80
14.	72	81	14.	120/80	130/80
15.	72	78	15.	119/80	130/80
16.	72	79	16.	120/79	132/80
17.	73	81	17.	117/80	130/80
18.	73	81	18.	119/80	134/80
19.	72	81	19.	119/80	132/80
20.	72	80	20.	120/79	130/80

APPENDIX XIV

INDIVIDUAL PULSE RATE AND BLOOD PRESSURE IN VOLUNTEERS PERFORMING CLIMBING AFTER SUPPLEMENTATION

Pulse Rate			Blood Pressure		
No.	Before activity	After activity	No.	Before activity	After activity
1.	73	80	1.	116/77	128/80
2.	72	78	2.	119/78	131/80
3.	73	80	3.	119/78	130/80
4.	72	82	4.	119/80	132/80
5.	72	80	5.	120/80	128/80
6.	73	79	6.	119/80	128/80
7.	73	81	7.	119/79	130/80
8.	72	80	8.	119/80	130/80
9.	72	80	9.	120/80	128/80
10.	73	82	10.	119/79	132/80
11.	73	81	11.	119/80	130/80
12.	72	80	12.	120/80	128/80
13.	73	81	13.	119/80	129/80
14.	72	80	14.	120/80	128/80
15.73	73	81	15.	120/80	130/80
16.	72	83	16.	119/80	129/80
17.	73	81	17.	119/79	128/80
18.	72	80	18.	120/80	129/80
19.	73	81	19.	119/80	128/80
20.	72	80	20.	120/79	128/80

APPENDIX XV

INDIVIDUAL TIME TAKEN FOR VARIOUS ATHELETIC ACTIVITIES IN VOLUNTEERS AFTER SUPPLEMENTATION

	RUNNING	SKIPPING	JUMPING	CLIMBING
No.	Time taken (Seconds)	Time taken (Seconds)	Time taken (Seconds)	Time taken (Seconds)
1.	24	60	23	32
2.	22	48	23	30
3.	22	50	22	25
4.	26	45	23	29
5.	23	70	20	22
6.	22	78	23	30
7.	25	82	22	32
8.	22	53	20	24
9.24	24	52	21	19
10.	26	62	21	35
11.	24	58	20	25
12.	25	63	19	23
13.	26	98	24	26
14.	26	43	21	25
15.	23	54	20	19
16.	20	40	18	30
17.	25	65	23	28
18.	25	80	21	26
19.	22	52	21	28
20.	24	60	20	28