GROWTH DYNAMICS OF RURAL SCHOOL CHILDREN OF VADODARA

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IMPACT OF DEWORMING ALONE AND DEWORMING ALONG WITH ONCE WEEKLY IRON FOLIC ACID SUPPLEMENTATION ON GROWTH AND HAEMOGLOBIN STATUS OF RURAL SCHOOL CHILDREN

MAY 2011 **RACHANA BHOITE**

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BY

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CERTIFICATE

This is to certify that the research work embodied in the thesis has been carried out independently by Ms. Rachana Bhoite in pursuit of doctoral degree in Foods and Nutrition and represents her original work.

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Abstract

Malnutrition remains the world's most serious health problem. Prevalence of underweight among children in India is amongst the highest in the world. Childhood is a period of rapid physical and mental growth. Micronutrient deficiencies like anemia are highly prevalent in this age group and have dire consequences. To tackle the problem of macro and micronutrient deficiencies, Government of India is running the mid day meal schemes in schools. The evaluation of the scheme, running for more than a decade is also important.

Thus the study was planned with the broad objective of assessing the prevalence of malnutrition and Iron Deficiency Anaemia in the rural school children of Vadodara. The mid day meal consumption pattern was also elicited. The impact of weekly Iron Folic Acid and deworming supplements on anthropometric indices, haemoglobin status and physical work capacity was also studied. Growth monitoring was also tracked for three years.

The study was conducted in the rural petrochemical area of Vadodara. Out of 45 schools in the area, 6 schools were randomly selected from each zone. All the children from 1st to 7th standard were enrolled for the study. A total of 3170 children registered for the study. There was 28 % of absenteeism rate in rural area so the data was collected on 2282 children. Haemoglobin estimation was done on 865 children.

The prevalence of malnutrition was estimated using both the CDC 2000 and WHO 2007 standards. The prevalence of underweight was 70 % according to CDC 2000 and 64 % by WHO 2007 standards. The prevalence of stunting was 31 %. The prevalence of thinness was 60 %. MDM consumption ranged from 52.8 % - 63.6 %. Weekly consumption pattern varied from 58 % to 74 % according to likes and dislikes of children. The mean haemoglobin levels of children were 11.3 ± 1.4 g in children. It was seen that 72 % of the children were anemic of which 57.6 % were in mild category and 14.2 % in moderate category.

Phase 2 was a longitudinal study in which 3 schools were randomly selected and growth monitoring was done continuously for 2 years. A total of 465 children had 3 pair of data for consecutive 3 years. The interval between each survey was one year. The

prevalence of underweight, stunting and thinness was 64.3 %, 10.7 % and 62.7 % according to WHO 2007 classification. The mean increase in weight per year for children ranged from 2.7- 2.8 Kg. The increase in height per year ranged from 6.1 Cm – 6 cm. During the study period of two years, the underweight population contracted by 13 %.

Phase 3A was intervention research wherein impact of deworming (400 mg Albendezole) alone and deworming (400 mg Albendezole once in 6 month) with weekly IFA supplementation (60 mg Fe + 0.5 mg folic acid for 30 weeks) was seen on growth, haemoglobin status and physical work capacity of children. Before and after the intervention, height and weight, haemoglobin by cyanmet haemoglobin method and physical work capacity by step test were done.

The intervention could not make significant change on the growth profile of the children. There was a significant increase ($p<0.001$) in the mean haemoglobin levels in IFA+ DW group. Prevalence of IDA was 75 % in the IFA+ DW group, which after intervention remained only 10 %. The major shift was found in the mild category of anemia. There was 17.3 % rise in the haemoglobin level. In the DW supplemented group, haemoglobin remained unaltered. The physical work capacity, as judged by the number of steps was similar before and after intervention.

In phase 3B long term impact of the intervention was studied. No intervention was given for 6 months and sustainability of the IFA supplementation was seen. The sustainable effect of the intervention was not seen with regard to both the growth and haemoglobin status. Haemoglobin sustainability was seen in only 31 % of the children. The prevalence of IDA increased after the washout period and was found to be 90.6%, 69.1%, 91.4% in control, IFA+DW and only DW supplemented group.

The study reflects that prevalence of malnutrition is very high in the rural area. Malnutrition is coupled with high prevalence of anemia. Mid Day Meal is not consumed regularly, which should be canvassed. Behaviour Change Communication (BCC) and dietary diversification can also prove to be beneficial in long run and should be advocated. With adequate safeguard and proper monitoring, MDM can play a major role in improving the nutritional status of school children. The study reflects that growth monitoring should be a continuous process which would help in identifying growth faltering among children, who may require special attention. The study showed that long term IFA supplementation resulted in significant improvement in the haemoglobin concentration. Thus weekly IFA tablet with one deworming tablet every six month would work wonders for growing children. But the study also proved that the weekly Iron Folic Acid tablet has no sustainable effect. So the IFA supplementation should be a continuous process in schools for the children.

Introduction

“For population to be consistently healthy, it is vital that people are active participants in the health development and diseases prevention. With the future in mind, naturally the first group that strikes are children” - WHO,2005

Malnutrition remains most serious health problem and the single biggest contributor to child mortality. Malnutrition is basically cellular imbalance between the supply of nutrients and energy and the body’s demand to ensure growth, maintenance and specific body functions. Malnutrition is thus a health outcome as well as a risk factor for diseases and it can increase risk both of morbidity and mortality. Undernutrition occurs when one or more vital nutrients are not present in the quantity that is needed for the body to develop and function normally. This may be due to insufficient intake, increased loss, increased demand or a condition or diseases that decrease the body’s ability to digest and absorb nutrients from available food. Nutrient deficiencies vary in their manifestations, some leading to specific clinical signs, many affecting growth at an early stage (Mason et al, 2003). Malnutrition or undernutrition to be specific includes underweight, stunting and wasting.

Under nutrition both protein energy malnutrition and micronutrient deficiencies, directly affects many aspects of children’s development. Undernutrition reduces the capacity of all the different parts of the body to perform properly, with particularly grave consequences in young children. The relationship between underweight status and ill health, however, is complex because ill health often results in undernutrition and undernutrition increases susceptibility to disease, particularly severe disease (Tomkins A et al, 2003). The consequences of malnutrition given by Sue in 2000 can be summarized as:

- Retards mental development
- Hampers physical growth
- Decreases scholastic performance
- Reduce the work capacity
- Increase the risk of infections

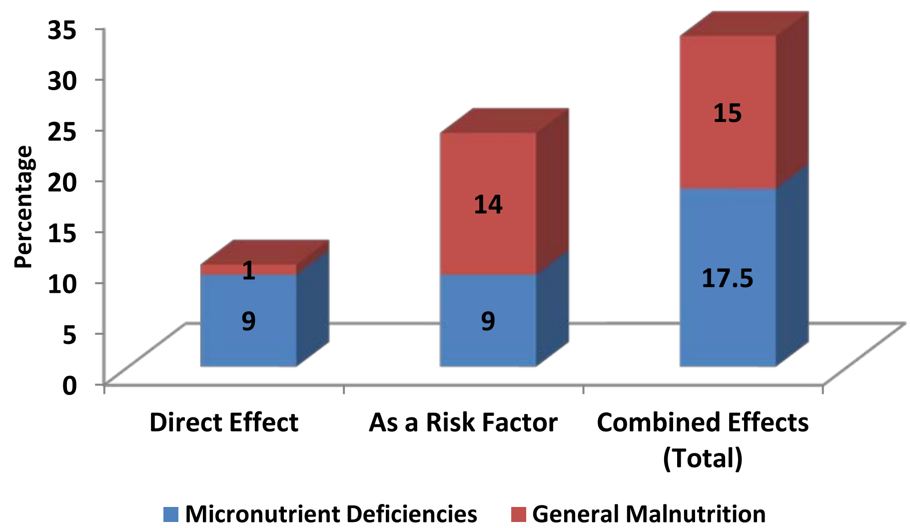
PREVALENCE OF MALNUTRITION

Malnutrition affects millions of people around the world. One third of all deaths in children in developing countries are linked to undernutrition. More than one-half of the 9.7 million child deaths worldwide are linked to under nutrition. Malnutrition alone not only kills, but also exacerbates the burden of infectious diseases (USAID 2009). World Health Organisation (2002) estimated that more than 3.7 million deaths could be attributed to underweight. Since deaths from under nutrition occur among young children, the loss of healthy life years is even more substantial. About 138 million DALYs, 9.5% of the global total, were attributed to underweight. Deficiencies in three key micronutrients – vitamin A, iron and zinc – causes an extra 750,000 to 850,000 deaths. Malnutrition has its direct effect on the diseases burden at the same time it in itself is a risk factor for various infectious diseases and thus contribute to diseases burden **(Figure 1.1).**

Malnutrition is "not so silent" emergency in India also. The global community has designated halving the prevalence of underweight children by 2015 as a key indicator of progress towards the Millennium Development Goal (MDG). Economic growth alone, though impressive will not reduce malnutrition sufficiently to meet nutrition target.

Approximately 60 million children are underweight in India. India ranks second only after Bangladesh with regards to the prevalence of underweight children in the world. India has 49 % of underweight children which contributes to 39 % of the world's underweight children. The prevalence of malnutrition in children is much higher in India than all other countries within south Asia and is higher than the averages for other regions of the world (UNICEF, 209) (**Table 1.1**). Child malnutrition is responsible for 22 percent of India's burden of disease. Given its health impact, education and productivity, persistent undernutrition is major obstacle to human development and economic growth in the country, especially among poor and the vulnerable, rural areas where the prevalence of malnutrition is highest (Michele 2005).

Figure 1.1: Estimated contribution of Malnutrition to the disease burden of developing countries



Source: Disease control priorities in Developing countries; second edition, 2006.

Table 1.1: Ranking by global share of Underweight Children & contribution of India to disease burden

Country	Prevalence of underweight children in country (%)	Share of total underweight children in the world (%)	Cumulative total (%)
India	47	39.0	39.0
Bangladesh	48	5.7	44.7
Pakistan	38	5.5	50.2
China	8	4.8	54.9
Nigeria	29	4.4	59.3
Ethiopia	47	4.2	63.5
Indonesia	28	4.2	67.7
Philippines	28	1.9	71.9
Vietnam	28	1.5	73.4

Source: UNICEF 2009

The improvement in reducing the prevalence of undernutrition in Indian children has been reserved and slower than other countries achievement. When we see such high prevalence of undernutrition, this is mainly dominant in girls, rural area, the poor people, the schedule cast and schedule tribe. The number of such affected people is increasing day by day.

There is also large inter state variation in the patterns and trends in underweight. In six states, at least one in two children are underweight namely Maharashtra, Orrisa, Bihar, Madhya Pradesh, Uttar Pradesh and Rajasthan. Gujarat (50 %) has a rural underweight prevalence that is higher than 49 % of all India rural average. Moreover, the prevalence in underweight is falling more slowly in high prevalence states. Undernutrition is concentrated in a relatively small number of districts and villages with a mere 10 % of village and district accounting for 27-28 % of all underweight children, suggesting that future efforts for combating malnutrition could be targeted to a relatively small villages and rural areas (NFHS III 2005).

Further the NFHS III data reports that Undernutrition is substantially higher in rural areas than in urban areas. Even in urban areas, however, 40 % of the children are stunted and 33 % are underweight. In rural area the prevalence of underweight is more than 60 % in India. Children belonging to schedule caste and schedule tribes or other backward classes have relatively high levels of Undernutrition. Children from schedule tribes have the poorest nutritional status.

MALNUTRITION AND ECONOMY

It has long been known that malnutrition undermines economic growth and perpetuates poverty. Yet the international community and most governments in developing countries have failed to tackle malnutrition over the past decades, even though well-tested approaches for doing so exist. The consequences of this failure to act are now evident in the world’s inadequate progress toward the Millennium Development Goals (MDGs) and toward poverty reduction more generally. Persistent malnutrition is contributing not only to widespread failure to meet the first MDG—to halve poverty and hunger—but to meet other goals in maternal and child health, HIV/AIDS, education, and gender equity. The unequivocal choice now is between continuing to fail, as the global community did for more than a decade, or to finally make nutrition central to development so that a wide range of economic and social improvements that depend on nutrition can be realized (The World Bank 2006).

The returns to investing in nutrition are very high. The Copenhagen Consensus 2010 concluded that nutrition interventions generate returns among the highest of 17 potential development investments. Investments in micronutrients were rated above those in trade liberalization, malaria, and water and sanitation. Community-based programs targeted to children are also cost-effective in preventing undernutrition.

Malnutrition slows economic growth and perpetuates poverty through three routes—direct losses in productivity from poor physical status; indirect losses from poor cognitive function and deficits in schooling; and losses owing to increased health care costs. Malnutrition's economic costs are substantial: productivity losses to individuals are estimated at more than 10 percent of lifetime earnings, and gross domestic product (GDP) lost to malnutrition runs as high as 2 to 3 percent. Improving nutrition is therefore as much—or more—of an issue of economics as one of welfare, social protection, and human rights (The World Bank, 2006).

Reducing undernutrition and micronutrient malnutrition directly reduces poverty, in the broad definition that includes human development and human capital formation. But undernutrition is also strongly linked to income poverty. The prevalence of malnutrition is often two or three times— sometimes many times—higher among the poorest income quintile than among the highest quintile. This means that improving nutrition is a proper strategy, disproportionately increasing the income-earning potential of the poor (The world bank 2006).

SCHOOL GOING CHILDREN

Childhood is a period of rapid physical and mental growth and development. Children are building up new tissues constantly and replacing the old ones. Their nutritional requirements are higher per unit of body weight than those of adults. If children do not receive the nourishment they need, undernutrition and malnutrition of one type or other will inevitably result, the type and extent depending on the type and quality of nutrients lacking in diets (Cravioto et al 1976). At present 21.8 % of the country's population consist of school going children. According to NFHS III, 90.1 % of the 6-10 years and 74.2 % of 11-14 years old children attended primary school in 2005-06. According to NNMB report, undernutrition ranges from 63 % to 73 % in 6-13 years of school children.

School provides the most effective and efficient way to reach large portion of the population, including young people, school personnel, families and community members. The life long good behavior can be formed if the habits are formed from childhood and can help children attain their maximum throughout the life. Schools have been given the mandate and responsibilities to enhance all aspects of development and malnutrition of children. School teachers are professionals in disseminating information in and out of the school community. Schools can serve as gateway to the community by providing entry points by liaisioning with children, parents and community at large (WHO report 2007).

ASSESSMENT OF MALNUTRITION THROUGH GROWTH MONITORING

Malnutrition in children can be assessed using anthropometry, biochemical indicators and clinical signs of malnutrition. The advantage of anthropometry is that body measurements are sensitive over the full spectrum of malnutrition, whereas biochemical and clinical indicators are useful only when a child is at least moderately malnourished. The best global indicator of children's well being is growth. The assessment of growth not only serves as a means of evaluating the health and nutritional status of children but also provide an excellent measure to decide future action (Mercedes de onis et al 2000).

Growth monitoring is a screening tool to diagnose nutritional chronic systemic and endocrine diseases at an early stage. It has been suggested that growth monitoring has the potential for significant impact on mortality even in absence of nutrition supplementation or education. Growth assessment is the single measurement that best defines the health and nutritional status of a child, because disturbances in health and nutrition regardless of their etiology, invariably affects child growth (Habicht et al 1974).

Experiences in India indicate that individual growth monitoring of children is both feasible and extremely useful. Monitoring the growth of a child requires taking the same measurements at regular intervals, approximately at the same time of the day, and seeing how they change. A single measurement only indicates the child's size at that moment but repeated measurements on same child gives growth trends (Lalitha et al 1998).

Undernutrition is generally characterized by comparing the weights or lengths of children at a given age to distribution of weights or lengths of generally healthy children, and calculating this relationship in terms of standard deviation scores or z-scores. Z-scores can then be categorized in terms nutritional terms as mild (-1.01 to -2.00 SD), moderate (-2.01 to -3.0 SD) or severe (<-3.0 SD) undernutrition (Laura et al 2005).

Growth is the fundamental physiological process that characterizes childhood. Secular trends in growth show the level of health of the population group. References of growth are one of the most valuable and commonly used instruments in the evaluation of the well being of individuals, groups of children and the community they live in (Juan 2008). Growth is a complex process that varies across individuals and may be influenced by multiple interacting factors. Although genetic factors such as parental height and weight form a blue print, child factors such as gender, age, early growth and overall health are also important (Maureen & Ambika 1999).

The school age period has been called the latent period of growth. The rate of growth slows down and the body changes occur very gradually. Resources however are being laid down for the growth needs to come in the adolescent period and it is some time a lull before the storm. The body type is established. Growth rates vary widely within this period. Girls usually outdistance boys by the latter part of the period.

ANEMIA

Malnutrition in children leads to other micronutrient deficiencies also. Iron deficiency anemia is one of them. One third of the world's population suffers from anemia. India continues to be one of the countries with high prevalence of iron deficiency anemia (IDA). According to NFHS III the prevalence of anemia is 70- 80 % in children. Anemia affects the oxygen carrying capacity of the cells and thereby reduces the work capacity of the children. There are various ways of tackling micronutrient deficiencies which are as follows:

- Dietary diversification
- Food fortification
- Supplementation through tablets
- Global public health & diseases control

When talking about micronutrient deficiencies, anemia is the most common and highest prevalent micronutrient deficiency diseases caused by low iron stores in the body. Iron deficiency is root cause of anemia in most of the countries. Almost half of the population suffers from it. Iron deficiency not only impairs the production of red cells on the body but affects general cell growth too.

According to the United Nations Administrative committee on coordination, sub committee on Nutrition (ACC/SCN, 2000) about 3.5 billion people worldwide are affected by iron deficiency. The fact remains that the anemia situation is much more severe in developing countries: 56 % in women and 53 % in school age children. The highest prevalence of iron deficiency anemia – 75 % - occurs in south central Asia.

Iron deficiency affects young children, adolescent and women of reproductive age- three periods of rapid growth during which the body’s iron needs are higher than normal (Behrman et al 2000). IDA is linked with depressed mental and motor development during childhood which may be irreversible. IDA during childhood also results in decreased physical activity and decreased interaction with the environment, with negative consequences on learning and school achievements. These translate into decreased adult productivity and ultimately decreased economics (Zlotkinsh et al 2004).

The most commonly used screening methods for the presence of IDA anemia in a population is the measurement of hemoglobin concentration for the presence of anemia. These measurements are relatively cheap, can be carried out under field conditions. Although other iron related tests are required for the confirmation of iron deficiency, it is reasonable to assume that a population with high anemia prevalence is likely to have a high prevalence of iron deficiency (Freire 1989).

Although anemia has been recognized as a public health problem for many years, little progress has been reported and the global prevalence of anemia remains unacceptably high. WHO and UNICEF therefore reemphasize the urgent need to combat anemia and stress the importance of recognizing its multifactorial etiology for developing effective control program. Only by recognizing the complexity of anemia, can effective strategies be established and progress be made consequently. An integrated multifactorial and multisectorial approach is required to combat these public health problem.

Strategies should be built into the primary health care system and existing programs. Furthermore, strategies should be evidence based, tailored to local condition and take into account the specific etiology. Finally to be effective and sustainable, strategies must be laid with firm political commitment. Also needed is an operational surveillance system with reliable, affordable and easy to use methods for assessing and monitoring anemia prevalence and effectiveness of interventions (WHO-UNICEF 2009).

IDENTIFYING INTERVENTIONS

In countries such as India where there are limited resources and competing demands, some point of prioritization of intervention becomes inevitable. The criteria for intervention should be:

- Those that are technically effective in substantially ameliorating a major health problem and
- Those that are financially inexpensive or cost effective relative to the outcome gains achieved.
- The first ensures that the intervention markedly reduces the burden of diseases and does not simply result in token improvement in health status. The second ensures that the intervention is good value for money (NCMH, 2005).

Looking at the above points for effective interventions, possible intervention can be giving iron folic acid tablet and deworming tablets in school setup and looking at its effect on growth, prevalence of anemia and physical work capacity of school going children. These interventions had been emphasized in Copenhagen consensus 2008 also. Intervention at school level will be more cost effective and large number of children can be covered.

IRON SUPPLEMENTATION

Keeping in mind the dire consequences of IDA, many strategies have been recommended to combat it. Each strategy has its own pros and cons. While fortification is a preventive and long-term strategy, supplementation is more of a short-term strategy. However, for iron deficiency control, supplementation with iron and Folic Acid is considered a feasible and a cost effective approach. Also, supplementation is a strategy of choice not only because it shows results in lesser time, but also the result is more pronounced.

The evidence is indisputable that iron supplements can substantially reduce IDA. A varied array of intervention exists that are designed to prevent and correct IDA. These include dietary improvements, fortification of foods with iron, iron supplementation and other public health measures, such as helminth control. All these approaches improve iron status in some context. The appropriate use of iron supplements will be an important part of anemia control program in all contexts, but supplements should be viewed as one of the several tools in the battle against IDA.

In many populations the amount of iron absorbed from the diet is not sufficient to meet many individual requirements. These also happens when physiological iron requirement are the highest. In such case iron supplementation will become a necessary component (Rebecca et al 1998).

Iron Folic Acid (IFA) supplementation is a preventive strategy for treating existing anemia. It is effective strategy until the diet of entire population changes significantly or till the time food fortification becomes very common. IFA improves behavioural & cognitive development of the children. It improves overall fitness and work capacity of the children. It also improves child survival where severe anemia is common (INACG 2004).

There are various factors which enhance or inhibit the iron bioavailability in the body. Phosphates, phytates in the diet, worm infestations negatively affects the iron absorption in the body while vitamin C, citric acid, malic acid, proteins of lower molecular weight increase the absorption of iron in body. The iron absorption in the body is a complex process. Body iron stores affect the intestinal mucosal absorption when the iron stores deplete and reduce absorption as iron store replete (Moore et al 1990). The iron absorption in the body depends on intestinal mucosal block theory, where high dose of iron given at a time, would block the subsequent dosage of iron from absorption. By reducing the dose frequency to once a week, matching the mucosal turnover of humans, iron from the tablets is absorbed (Brown, 1963). One of the study done in Nepal to study the effect of mucosal block theory, found a significant rise in hemocratic values of children who were given IFA supplementation on weekly basis as compared to daily dosage. This further supports the mucosal block theory (Shah k 2002).

DEWORMING

The infections caused by round worms, whipworms and hook worms- known as helminth infections- afflict more than 1 billion people world wide and are responsible for 150,000 deaths annually. They exacerbate iron deficiency and can thwart the physical growth and educational advancement. This anemia can further lead to malnutrition. These major interventions can reduce or eliminate helminth infections.

About half the population in South India and 50% of school children in tribal areas of Central India is infected with Ascaris lumbricoides, Trichuris trichiura and/or hookworm. In the western part of Nepal, 86.7% of the pre-school children are infected with a single geohelminth infection and 13.3% with mixed infections. Thus, worm infestation as a public health problem needs immediate attention from policy makers in India and other South Asian countries (Awasthi et al 2008).

School children are an vital high risk group for worm infestation because of fast physical growth and rapid metabolism resulting in amplified nutritional need. In a period of intense learning, helminth infections have been shown to have negative impact on cognitive tasks. Children are continuously exposed to contaminated soil and water (A. Montresor, WHO, 2002).

Anthelmintic treatment of children in developing countries has had varying success in terms of growth improvement in school children (Narthrop et al 2001). Secure evidence for the fact that worm infestation can be a determinant of iron deficiency anemia (Ball 1996).

The benefits of deworming in school are:

- Deworming children through the simple distribution of tablets has the potential to improve children’s health and educational achievement, especially for those worst affected and most disadvantaged children.
- Delivering services through schools is efficient and cost-effective. There is widespread support in schools and communities for teachers to play a role in providing services, as long as the procedures are simple, safe, and familiar.
- Providing health services in schools does not require long or complex training, nor does it add significantly to teachers’ or administrators’ workloads.
- Delivering services through schools should not require any additional infrastructure as long as the existing school system functions well.
  (Miguel and Kremer 2003).

Deworming is the best and effective way of removing worm infestation. Deworming is simple, safe, and cheap. Deworming tablets are practically not absorbed in the body. Around 99.5 % of the tablets get used up in intestinal lumen where it kills the worms. Deworming through school is simple, efficient and cost effective. No long or complex trainings are required. There is no additional burden on school teacher and no additional infrastructure is required. Albendazole is widely used as a deworming tablet as it is highly effective and easy to administer (Powlawski et al 1991).

Deworming pills are heat-stable and require no cold chain for delivery. With a shelf life of up to four years, they can be purchased in bulk to reduce costs and to ensure uninterrupted supply. In communities where infection is common all children should be offered treatment.

MID DAY MEAL

To tackle the problem of malnutrition and micronutrient deficiencies, Government of India launched the Mid Day Meal (MDM) programme. The MDM scheme which has overcome many of the teething problems that besieged it since its launch in 1995, has become an almost universal scheme, feeding primary school children all over the country. The Mid Day Meal Scheme is the largest school lunch program in the world covering 114 million children. The Mid Day Meal Scheme has been extended to upper primary classes also. This is expected to benefit an additional 25 million children, taking the total number of children covered to 139 million (Jean et al, 2003).

Each of these objectives in turn has different aspects, some more ambitious than others. To illustrate one basic contribution of mid day meal to educational advancement is to boost school enrollment. Such meal may also enhance learning achievements, in so far as “classroom hunger” undermines the ability of pupils to concentrate and perhaps even affects their learning skills. Finally a well organized school meal can have intrinsic educational value, in addition to what it contributes to the routine learning process. For instance, school meals can be used as an opportunity to impart various good habits to children such as washing hands and to educate them about the importance of clean water, good hygiene, a balanced diet and related matters (Agrawal 1987).

Similarly the nutritional objectives of mid day meals have several layers, ranging from elimination of classroom hunger to the healthy growth of school children. In many respects a mid day meal is a nutritionists dream: the children come everyday on their own and they eat what ever is given to them. This makes it possible to raise their intake of calories and proteins but also provide nutritional supplements such as iron and iodine which needs to be ingested in small doses over a period of time.

Mid day meals also provide an excellent opportunity to implement nutrition program that requires mass intervention, such as deworming (Brahmam 2003). Available experiences indicate that these interventions are highly effective. For instance, a combination of mass deworming with vitamins and iron supplementations can significantly enhance children nutrition for as little as Rs. 15 per child per year (Dreze 2001).

The nutritional impact of MDM depends both on the quality and quantity of food provided at school. There are very few studies conducted in India to see the impact of MDM on the nutritional status of school children. Some studies have noted that the amount of food provided by the school does not meet the nutritional requirement as given by Supreme Court (Jain & Shah 2005). Another concern regarding the quantity of food is that the needs of a class one child are very different from those of class five; however this has not been taken into consideration while fixing the food provided. The possibility of shortage arises because food is cooked based on attendance records of the previous day.

The quality of the meal is the main remaining challenge as far as MDM is concerned. The nutritive value of the meal needs to be monitored carefully. The net impact of a MDM on the child's health is ultimately determined by whether the meal is a supplement or a substitute for the home meal. The issue of supplement versus substitute is not easy to disentangle and require information on eating habits of children before and after the MDM. Research is also required in this aspect (Menon et al 2003).

RATIONALE

Thus school going children are an important but neglected group especially in the rural areas. Today's adolescents are tomorrow's future. Most of the programs have focused on children under 5 years. MDM (Mid Day Meal) is currently going on all over India and in Gujarat, but the evaluation has not been done in terms of its impact on nutritional status of children. The data from rural area is especially lacking as the areas are not easy to reach. We need to relook at the prevalence of malnutrition and IDA (Iron Deficiency Anemia) and identify the causative factors.

Till now IFA tablet were given only to girls that to when they come in secondary section. Further IFA supplementation was given to children of urban areas only. Looking at the almost equal prevalence of anemia in boys and girls and that too in younger age group, the study was planned to see the growth dynamics in rural school children of Vadodara and the effect of IFA supplementation and deworming tablets on growth pattern, anemia prevalence and physical work capacity of children from 4^{th} to 7^{th} Standard. The effort was to map the prevalence of malnutrition and come out with cost effective remedial techniques to tackle it.

Thus the study tries to answer the following research questions:

- What is the magnitude of the problem of malnutrition among the rural school children of Vadodara?
- What is the prevalence and severity of IDA among the rural school children?
- What is the sensitivity and specificity of clinical signs and symptoms of IDA with Hb levels when it is done with the help of pediatrician?
- What is the yearly MDM consumption pattern among the rural school children using secondary data?
- What is the growth dynamics of rural school children over a period of 3 years under standard care conditions?
- What is the efficacy of once weekly IFA supplementation along with Deworming and Deworming alone against the standard care conditions on growth, hemoglobin and physical work capacity?

The broad objective of the study was to assess the nutritional status of underprivileged school children of rural Vadodara and to see the impact of IFA supplementation and deworming on nutritional status of children. The study was divided in to 3 phases as follows

PHASE 1: FORMATIVE RESEARCH

Specific Objectives

- To assess the nutritional status of school children in terms of prevalence & severity of malnutrition
- To assess the prevalence & severity of micronutrient deficiencies in children through clinical examination
- To assess the dietary pattern of the rural school children
- To assess the utilization of mid day meal program by the children
- To map the prevalence and severity of Iron deficiency Anemia by Hb estimations

PHASE 2: LONGITUDINAL STUDY

- To monitor the school children for a period of 3 years with regards to their growth profile (Anthropometric Measurements).

PHASE 3: INTERVENTION STRATEGIES TO COMBAT IDA: RANDOM CONTROL TRIAL

Specific Objectives

- To study and compare the impact of weekly IFA supplementation (60 mg elemental Iron) for 30 weeks along with deworming dose of 400 mg Albendezole every 6 months and deworming alone (twice a year) on:
    - A) Growth parameters (Height and Weight)
    - B) Anemia Prevalence (Hemoglobin estimations)
    - C) Physical activity capacity (Step Test)
- To assess the wash out effect of the supplementation after a period of 6 months

Review of Literature

MALNUTRITION

Malnutrition at its fundamental biological level is inadequate supply of nutrients to the cell. On a biological level, nutritional deficiency disorder may be classified as primary or secondary, according to the availability of the nutrient. A primary deficiency disease is a disease that results directly from dietary lack of specific essential nutrients. A secondary deficiency disease is a disease that results from the inability of the body to use a specific nutrient properly. Such inability may result from either two general type of failure

1. Failure to absorb the nutrients from the alimentary tract into the blood
2. Failure to metabolize the nutrients normally after it has been absorbed

Undernutrition is considered to be the underlying cause of more than 50% of all childhood deaths in the world. Undernutrition diminishes the ability of all systems of the body to perform properly, with particularly grave consequences in young children. The relationship between underweight status and ill health, however, is complex because ill health often results in Undernutrition and Undernutrition increases susceptibility to disease, particularly severe disease. Numerous studies have demonstrated associations between Undernutrition and growth retardation, impaired mental development, and increased susceptibility to infectious diseases.

MALNUTRITION WORLD WIDE

More than one-half of the 9.7 million child deaths worldwide are linked to under nutrition. Malnutrition alone not only kills, but also exacerbates the burden of infectious diseases (USAID 2009). World Health Organization in 2002 estimated that more than 3.7 million deaths could be attributed to underweight. Since deaths from under nutrition occur among young children, the loss of healthy life years is even more substantial.

In developing regions, children in rural areas are more likely to be underweight than children living in cities. In part of Asia and in Latin America the relative disparity actually increased between 1990 and 2008. In eastern Asia, there was a striking increase in the rural/urban ratio from 2.1 to 4.8, indicating that in 2008 children in rural area were almost five times as likely to be underweight as children in urban areas.

All the same time, south eastern Asia, sub Saharan Africa and northern Africa have succeeded in reducing child malnutrition more rapidly in rural area and in narrowing the gap with the urban population, demonstrating that more equitable progress is indeed possible.

Across the developing world, children from the poorest household are twice as likely to be underweight as children from the richest household. The disparity is more dramatic in regions with a high prevalence of underweight children. This is the situation in southern Asia, where as many as 60 % of the children in the poorest families are underweight, compared to about 25 % in the richest households (Millennium Development Goal 2010).

MALNUTRITION IN INDIA

India ranks first with 39% of global share for underweight children with 47% of prevalence (UNICEF 2006). According to Krishnaswami 2000 and Measham and Chatterjee 1999, half of the world's undernourished population lives in India. According to World Development Indicators 2007, with 47% of low weight for age; India ranks 3rd amongst the countries with highest level of child malnutrition next to Nepal and Bangladesh.

The prevalence of under nutrition tended to increase from about 63% among 6-9 year age group to 78% in 10-13 years and then decreased to 66% in 14-17 year age group of children. Though no significant sex differences in the prevalence of under nutrition were observed in 6-9 and 10-13 year age groups, a relatively higher proportion of boys (73%) in 14-17 year age group were found to be undernourished as compared to girls (60.4%) (NNMB 2001).

A study conducted by NIN on rural adolescents revealed that 39% of the adolescents were stunted (<Median -2 S.D. of NCHS height for age) irrespective of sex. The prevalence of under nutrition (<median -2 S.D of NCHS weight for age) was higher (53.1%) in boys than in girls (39.5%). The extent of stunting was higher (42.7%) among adolescents belonging to the scheduled caste community. In the case of girls, the extent of underweight was considerably less in each age group than boys (Venkiah et al 2000). **Table 2.1** gives an overview of the prevalence of under nutrition in various parts of India. As can be seen, various studies substantiate the magnitude of the problem of undernutrition among school age group children.

Studies have shown that the rural children are more likely to be underweight than the urban children. Further, poor children are twice more likely to be underweight than the rich. However, little difference is seen in underweight prevalence of boys and girls (MICS & DHS surveys 2003-2008).

MALNUTRITION IN SCHOOL GOING CHILDREN

School age group (5-18 y) spans the period between preschool years and adult life. The number of school age children continues to rise. The total number of children out of school is decreasing from 106 million in 1990 to 69 million in 2008. The gender gap in the out of school population has also narrowed. The share of girls in this group decreased from 57 % to 53 % globally between 1999 to 2008.

Table 2.1: Prevalence of Undernutrition in various parts of India

REFERENCE	PLACE	AGE (y)	PREVALENCE (%)
Bose et al 2008	West Bengal (rural)	6-14	Underweight: 16.9 Stunting: 17.2 Thinness: 23.1
Pandaya et al 2000	Ludhiana	5-16	Wasting:52.2 Stunting:26.3
Deshmukh et al 2006	Wardha	6-14	Underweight: 53.8
Kapoor & Aneja 1992	Delhi	10-18	Stunting Girls: 35.5
Patil & Wasnik et al 2009	Maharashtra (rural)	5-12	Underweight:19 Stunting:30.3 Thinness:16.8
Anand et al 1999	Haryana (rural)	12-15	Thinness (M):43.8 (F):30.1 Stunting (M):41 (F):37.2
Chaturvedi 1996	Rajasthan (rural)	10-18	Underweight Girls: 79
Jude et al 1991	Vellore	13-18	Underweight Girls:48.8

Das & Bisai 2008	West Bengal	13-18	Undernutrition: 28.60 (M): 37.59 (F): 19.43
Rao et al 2003	Madhya Pradesh	11-19	Undernutrition: 61.7 Stunting: 51.7 Wasting: 32.8
Mukhopadhyay et al 2005	West Bengal	11-14	Undernutrtion: 36.49% (M): 41.08: (F): 30.61
Iyer et al 2005	Baroda	10-18	Underweight: 41.2

M – Male, F - Female

In 2008, there were 96 girls for every 100 boys enrolled in primary school. Poverty puts girls at a distinct disadvantage in terms of education. Girls of primary school age from the poorest 60 % of household are 3 times more likely to be out of school as those from the wealthiest household (The MGD report 2010).

India's education system is the second largest in the world after China. About 21.8% of the country's population comprises of school going children and there are still about 21 million children who are unable to attend school (IES 2007). According to NFHS-3, 90.1% of the 6-10 & 74.2% of 11-14 y old children attended primary school in 2005-06. Though the number of children of primary age group who were out of school has dropped by 33 million since 1999, still 72 million children worldwide were denied the right to education in 2007 (MDG Report 2009).

In India, according to UNICEF (2008), the prevalence of malnutrition in school going children varied across states, with Madhya Pradesh recording the highest rate (55 %) and Kerala showing the lowest prevalence of 27%.

IMPORTANCE OF NUTRITION IN THIS AGE

School going children are the future generation of any country and their nutritional needs are critical for the well being of society. In SEAR, a large number of children suffer from chronic malnutrition and anaemia, which adversely impacts their health and development (WHO 2006). The complex myriad of physiological as well as psychological changes, accompanied by rapid growth and increase in physical activity, creates special nutritional needs that are higher during adolescence than at any other time in life. Failure to consume adequate diet at this time can potentially retard physical growth, intellectual capacity and delay sexual maturation (WHO 1999). Addressing the nutrition needs of school going children could be an important step towards breaking the vicious cycle of intergenerational malnutrition, chronic diseases and poverty. Epidemiological evidence from both the developed and developing countries indicates that there is a link between foetal under-nutrition and increased risk of various chronic diseases during adulthood (ACC/SCN 2000).

School going period is considered as a nutritionally critical period of life for several reasons:

- Firstly, the dramatic increase in physical growth and development puts greater pressure on the need for nutrients. During this period, children will experience a weight gain equivalent to 65% of their weight at the beginning of the period or 40% of their final weight, and a height gain equivalent to 15% of their adult height (Brasel 1982).

- Secondly, there may be socio-cultural factors or change of lifestyle and food habits of children that can affect both nutrient intake and needs (Spear 1996).

- Thirdly, growing children have increased nutrient requirements (Scholl et al 1994, Story et al 1999).

- Fourthly, school age can be the second opportunity to catch up growth if environmental conditions, especially in terms of nutrient intake are favorable (Gopalan 1989).

- Finally, psychological changes and development of their own personality can impact on their dietary habits during a phase when they are very influence-able (WHO 2006).

School going children have typically been considered a low risk group for poor health, and often receive few healthcare resources and scant attention. However, this approach ignores the fact that many health problems later in life can be improved or avoided by adopting healthy lifestyle habits in adolescence (World Bank 2003).

Good nutrition during school age is critical to cover the deficits suffered during childhood. Dietary intake with respect to adequate availability of food in terms of quantity and quality (particularly, the mean caloric intake), ability to digest, absorb and utilize food and the social discriminations against girls can greatly affect the adequate nutrition of these children (WHO 2006).

Studies in India and Bangladesh have shown deficiencies in the intake of all nutrients, particularly iron, calcium, vitamin A and vitamin C. The reported reasons are mainly the low educational level of parents and low family income. The nutritional deprivation affects almost all growth parameters and final adult body size resulting in thinness and stunting. However, nutritional status of both boys and girls improved with age, showing that the effect of malnutrition is more pronounced at the time of peak growth. The prevalence of protein energy malnutrition (PEM) is high in most countries of the SEA region (FAO 2005)

IMPORTANCE OF NUTRITIONAL ASSESSMENT

The best global indicator of children's well being is growth. The assessment of growth not only serves as a means of evaluating the health and nutritional status of children but also provide an excellent measure to decide future action. Growth is the fundamental physiological process that characterizes childhood. Secular trends in growth show the level of health of the population group. Growth monitoring is a screening tool to diagnose nutritional chronic systemic and endocrine diseases at an early stage.

Growth monitoring has the potential for significant impact on mortality even in absence of nutrition supplementation or education. Growth trends are an essential tool in pediatric practice. Their value resides in helping to determine the degree to which physiological needs for growth and development are being met during important childhood period (Mercedes De 2009).

Nutrition monitoring helps to assess nutritional problems prevalent in the community, in terms of their nature, magnitude and distribution among the population groups as well as geographical areas. Such monitoring over a period of time gives us an opportunity to study the changes occurring over a period of time. This information is necessary to evolve policies, to formulate appropriate programs and implement the same for the prevention and effective control of nutritional deficiency disorders. It highlights the need to evaluate the ongoing nutrition programs, identify bottlenecks if any and to initiate corrective steps, wherever necessary (Brahmam 2005).

Secular changes in growth and development can be considered as the changing pattern of nutritional status of children. The best way to measure nutritional change of children is taking the anthropometric measurements of children.

Anthropometric indices

Measurements by themselves are incomplete unless they are associated with other measurement. Thus anthropometric indices are derived from combination of raw measurement (WHO 1995; Gibson 2005). Examples of anthropometric indices are weight for age, height for age, weight for height, BMI for age etc. These indices are essential for the interpretation of measurements as it is evident that a value of body weight alone has no meaning unless it is related to an individual's age or height. These indices are expressed as Z scores, percentiles or percentage of the median. Further, these indices are used to compare an individual or a group with a reference population.

1. Weight for age

Weight for age reflects the body mass relative to chronological age. The advantage of this index is that it reflects both past (chronic) and present (acute) Undernutrition. Because of its simplicity and the availability of scales in most health centers in low income countries, weight for age index is commonly used to assess the nutritional status of children. It is commonly used for monitoring growth and to assess changes in the magnitude of malnutrition over a period of time. A major limitation of using weight for age is that it reflects both weight for height and height for age. It fails to distinguish tall, thin children from those who are short with adequate weight/more weight.

Nutritional terms for weight for age

- Low weight for age: Underweight

The term "underweight" is commonly used to refer to the underlying pathological processes of low weight for age (WHO 1995). It is described as gaining insufficient weight relative to age or losing weight and is obtained as weight < 2 SD of sex specific references data relative to age.

International references/standards which provide weight for age

Many countries have collected anthropometric data and developed their local growth references for different age group. The growth references/standards are developed and reported as Z score and percentiles. The commonly used and recognized international growth standards for assessing underweight in children using weight for age as an index are:

- NCHS/WHO 1977 growth standards
- Center for Diseases control and prevention (CDC) 2000 growth charts
- WHO 2007 growth references (5-9) years
- WHO child growth standards 2006(0-71 months)

The NCHS/WHO 1977 and CDC 2000 provides age and sex specific weight for age data for children from birth to 18 years and birth to 20 years respectively (Hamill et al 1977; WHO 1983, 1995; Kuczmarski et al 2000 2002). WHO 2007 provides weight for age index for children between 5-10 years of age (de onis et al 2007; WHO 2007).

2. <u>Height for age</u>

Height for age reflects the achieved linear growth and its deficits indicate long term cumulative inadequacy of human health and nutrition. It cannot measure short term changes in malnutrition. Height for age is primarily used as a population indicator rather than for individual growth monitoring.

Nutritional condition identified for height for age

- Low height for age: Stunting or shortness

The term “stunting” is commonly used to refer to the underlying pathological processes for low height for age (WHO 1995). It is described as gaining insufficient height relative to age and is obtained as height<-2SD of the sex specific references data relative to age.

3. Weight for height

Weight for height measures the body weight relative to height and helps to identify current or acute Undernutrition. It is normally used as an indicator of current nutritional status and can be useful for screening children at risk and for measuring short term effects such as nutritional stress brought by illness. It is important to note that weight for height is not a substitute for weight for age or height for age, since each index reflects a different combination of biological processes.

Nutritional condition identified from weight for height

- Low weight for height: wasting

The term “wasting” is commonly used to refer to the underlying pathological processes of low weight for height (WHO 1995). It is described as gaining insufficient weight relative to height. It indicates current or acute malnutrition resulting from failure to gain weight or actual weight loss. Causes for wasting includes inadequate food intake, infections etc. Wasting in individual children and population group can change rapidly and shows marked seasonal patterns associated with changes in food availability or diseases prevalence, to which it is very sensitive.

4. BMI for age

Body mass index (BMI) is calculated from a person’s weight and height and is obtained as the individual’s body weight (in Kgs) divided by the square of his or her height (in meters). It is the only indicator that includes all the three measurements of weight, height and age. In recent years, it has become the most widely used diagnostic tool for screening and identifying underweight, overweight and obesity in population for both adults and children.

BMI for age overcomes the complication of weight for age index:

Weight for age, when used alone, makes the interpretation of the nutritional status assessment complicated. For example, a high weight for age may be simply because the child is overweight or it may be owing to the child being tall. Similarly, a low weight for age may be because the child is actually underweight or it may be that he is misclassified as underweight owing to his short height though he may have an appropriate weight for that short height. Therefore, weight for age alone, without taking height of the child into account, provides incomplete information regarding his/her nutritional status.

The NCHS/WHO 1977 and CDC 2000 growth references report the weight for height index, which compares the child's weight to the average weight of children of the same height. The weight for height index thus ignores the age of the child and allows the nutritional status assessment in situations when age is not known. However, this index is based on a major assumption that, on an average, children of a given height, weight the same whatever is their age. However, this assumption is not true as the weight and height relation depends on age, especially so during infancy and adolescence (Cole 1985).

International references/ standards which provide BMI for age index

The commonly used and recognized international growth reference/ standards for assessing BMI for age in children and adolescents are:

- WHO BMI for age 1995 reference (9-24) years (Must et al 1991)
- Center for diseases control and prevention (CDC) growth charts
- WHO 2007 growth reference (5-19years)
- IOTF cut off points (cole et al 2000) and thinness cut offs (cole et al 2007)
- WHO child growth standards 2006 (MGRS)

WHO BMI age reference (1995) reported BMI for age percentile for male and female adolescents 9-24 years of age (Must et al 1991; WHO 1995). The CDC 2000 references provide age and sex specific BMI for age data for children between 2-20 years (Kuczmarski et al 2000, 2002). WHO 2007 provides BMI for age data for children between 5-19 years (De onis et al 2007; WHO 2007).

Anthropometric references and standards

A growth standard defines a recommended pattern of growth that has been associated empirically with specified health outcomes and the mineralization of long term risk of diseases. The growth standard is developed using the reference data from populations that have stabilized in terms of secular increment in anthropometry and that have not been subjected to discernible external constraints on growth (dietary deficiencies, infections etc) (Butte et al 2000).

Strengths of NCHS/WHO 1977 growth standard

The NCHS/WHO 1977 growth standard was based on three national US data sets which were samples collected from non obese populations with expected heights. During this period of data collection, the US population did not show high prevalence of overweight or obesity. Therefore the data which was collected is not considered to be skewed towards high rates of overweight and obesity, which was observed in subsequent (NHANESIII) national survey of USA.

Drawbacks of NCHS/WHO 1977 growth reference

- In the current scenario, where the prevalence of overweight and obesity is rising globally, the BMI for age is recommended to be used as an index of assessing the prevalence of thinness, overweight and obesity. However, the old NCHS/WHO 1977 growth references did not report the data in terms of BMI for age index.
- Though the NCHS/WHO 1977 growth reference reported the weight for height index, but it was done so only for prepubescent children with limited heights (90-145 cm for boys and 90-137 cm for girls)

- The percentile were not developed using any sophisticated statistic method, which resulted in wiggly percentiles

Strengths of CDC 2000 growth chart

- The CDC 2000 charts were extended till the age of 20 years
- A major feature revision to the CDC 2000 growth charts was the inclusion of the BMI for age index
- The BMI for age index helped in replacing the weight for stature index which was only for prepubescent children with limited height
- The CDC 2000 growth chart used more sophisticated smoothening procedures of the LMS method for developing the percentiles. Therefore, the percentiles in the CDC 2000 were smoother non wiggly percentiles
- The NCHS/WHO 1977 growth reference suffered from a disjoint in the length for age and height for age of children between 2-3 years of age. The CDC 2000 corrected this disjunction

Drawbacks of CDC 2000 growth charts

The CDC 2000 growth charts suffer from one major limitation. The data set included two additional US national survey of NHANES II (1976-80) and III (1988-94). The data from these two surveys is skewed towards overweight and obesity. Though children > 6 years from NHANESIII have been excluded, it is still based on right skewed US population, and data was collected at a time when transition towards obesity was ongoing in US. In contrast, the NCHS/WHO 1977 growth standards were based on non obese US population with expected heights.

WHO 2007 growth reference (5-19 years)

Strengths of WHO 2007 over NCHS/WHO 1977

- In this new WHO 2007 reference the BMI for age index has been made available for school children and adolescents (5-19 years)

- This new BMI for age has replaced the weight for stature index, which suffered with prepubescent and height restriction
- State of art sophistication smoothening procedures have been used for developing the percentiles, giving smoother non wiggly percentiles
- Provides a smooth transition from WHO 2006 child growth standards (0-5 yrs) and current WHO 2007 growth reference (5-19 yrs)
- Provides a uniformly merged international reference for 0-19 years
- No disjunction between length and stature from 2-3 years seen in NCHS/WHO 1977

Strengths over CDC 2000

- As compared to the CDC, the WHO 2007 provides a wider range of percentiles

Drawbacks of the WHO 2007 growth reference

- Unlike height and BMI for age, the WHO 2007 growth reference reports weight for age index for age 5-10 years instead of 5-19 years. In developing countries, where the height measurements and BMI calculations are still in the process of gaining importance, weight measurements alone may be used for nutritional status assessment, owing to their ease in measurement. Therefore, the need for the weight for age index for 11-19 years may be deeply felt in such situations.

Comparison of different international references available

A concise Table (**Table 2.2**) comparing the international references of NCHS/WHO 1977, CDC 2000 and WHO 2007 are shown. The detailed comparison revealed that for school aged children; the WHO 2007 growth standards may be the preferred option to be used as an international reference.

MICRONUTRIENT MALNUTRITION

Micronutrient malnutrition i.e. insufficient dietary intake of nutrients such as vitamin A, iron and iodine- affects the health and survival of more than 2 billion people worldwide. Deficiency of these three micronutrients is closely linked with childhood illness and mortality (OMNI 1996). Micronutrient deficiencies are the reason for both death and disability among the South East Asian Region (SEAR) children. According to the WHO, 1 out of 3 people in developing countries are affected by vitamin and mineral deficiencies. The most important in terms of health consequences for poor people in developing countries are:

VITAMIN A: Vitamin A Deficiency (VAD) can cause night blindness and reduce the body's resistance to disease. In children VAD can also cause growth retardation. Between 100 and 140 million children are vitamin A deficient. An estimated 250,000 to 500,000 VAD children become blind every year; half of them are dying within 12 months of losing their sight (WHO 2010).

The estimated prevalence of VAD is 23.4%, suggesting that there are ~83 million VAD school-aged children in the region, of whom 10.9% (9 million, at an overall prevalence of 2.6%) have mild xerophthalmia (night blindness or Bitot's spot). Potentially blinding corneal xerophthalmia appears to be negligible at this age (Singh & West 2004).

Table 2.2 Comparison of all the growth standards

	NCHS/WHO 1977	**CDC 2000**	**WHO 2007**
Year of release	**1977-1978**	**December 2000**	**September 2007**
Data sets included	NHES II NHES III NHANES I	NHES II NHES III NHANES I NHANES II	NHES II NHES III NHANES I WHO growth standards

		NHANES III	
Period of survey	1963-1965 1966-1970 1971-1974	1963-1965 1966-1970 1971-1974 1976-1980 1988-1994	1963-1965 1966-1970 1971-1974 1997-2003
Age group used from survey to develop standard	6-11 years 12-17 years 1-18 years	6-11 years 12-17 years 2-20 years 2-<6 years	6-11 years 12-17 years 1-24 years 18-71 months
Population on which it was based	Civilian non institutionalized US population	Civilian non institutionalized US population	NHES & NHANES based on US population WHO MGRS based on 6 country population
Indices and age range for which standard is provided	Weight for age (2-18 yrs) Stature for age (2-18 yrs) Weight for stature	Weight for age (2-20 yrs) Stature for age (2-20 yrs) BMI for age (2-20 yrs)	Weight for age (5-10 yrs) Stature for age (5-19 yrs) BMI for age (5-19 yrs)
Statistical methods	Smoothed by cubic	Modified LMS	LMS model (using

used	spinning	estimation procedure (using BOX COX transformation)	BOX COX power exponential method)(BCPE)
Format in which data is available	Percentiles and Z scores	Percentiles with LMS Parameters & Z scores	Percentiles with LMS parameter

In Ethiopia a study on children aged 6-9 years, reported the prevalence of xerophthalmia as 5.8%. The serum retinol levels below 0.35 mmol/l and between 0.35 and 0.70 mmol/l was 8.4% and 51.1% of the children respectively. The liver vitamin A reserve (modified relative dose response ratio $\geq$ 0.06) was low in 41.0% of the children (Tarik et al 2001).

Major supplement programs are in place to raise vitamin A status in the region; but in South Asia, only one child in four actually receives them (Asian Development Bank 2010).

Iron: Iron deficiency is a principal cause of anemia. Two billion people i.e. over 30 % of the world's population are anemic, mainly due to iron deficiency & in developing countries this is frequently exacerbated by malaria and worm infections. The health consequences include premature birth, low birth weight, infections, and elevated risk of death. Later, physical and cognitive development is impaired, resulting in lowered school performance (WHO 2001).

Nutritional anemia due to iron and folic acid deficiency is widely prevalent among young children and adolescents. About 67.5% children under five years and 69% of adolescent girls suffer from anemia (NNMB 2001). Percentage prevalence of anemia in school age children (6-14 years) as per studies conducted during 1981 to 1996 ranges from 14% to 96% and is given in **Table 2.3**. Thus, Iron Deficiency Anemia is a public health problem among school children and is seen across the various cities of India.

Iodine: IDD affects over 740 million people, 13 percent of the world's population. Fifty million people have some degree of mental impairment caused by IDD (WHO 2009). Iodine deficiency disorders (IDD) jeopardize children's mental health and often their very lives. Serious iodine deficiency during pregnancy may result in stillbirths, abortions and congenital abnormalities such as cretinism which is a grave, irreversible form of mental

Table 2.3: Percentage of Anemic children in different parts of India

Location	% anemic children
Baroda	91
Kolkata	96
Hyderabad	60
Chennai	14
New Delhi	67
Varanasi	68

Source: Task Force Report on Micronutrients, 1996, DWCD, GOI.

retardation that affects people living in iodine-deficient areas of Africa and Asia. IDD also causes mental impairment that lowers intellectual prowess at home, at school, and at work.

Although, on an average, prevalence of total Goiter among 6-12 year old children is about 4%, it is 12.2% in Maharashtra and 9% in West Bengal which is much above the WHO cut off level of 5.0%. No State in the country is free from IDD. Around 260 districts out of 321 districts surveyed had more than 10% prevalence of IDD (Task Force Report on Micronutrients 1996)

Urinary iodine levels in children (6-12 years) indicated that 56.6% of urban children and 51.1% of rural children were biochemically iodine replete and had urinary iodine excretion (UIE) levels ≥10μg/ dl. Urban children (29.4%) and rural children (37.1%) were found to have goiter (Sen et al 2005).

Thus to summarize, high levels of malnutrition particularly among growing children are directly and indirectly associated with high morbidity and mortality. Iron deficiency in school-going children affects their learning ability and concentration power. Even mild deficiencies of micronutrients (vitamin A, iron, folic acid, zinc etc.) affect their growth, development and immunity. Malnourished children tend to have lower I.Q. and impaired cognitive ability which affects their school performance and productivity in later life.

ANEMIA

Iron status can be considered as a continuum from iron deficiency with anaemia, to iron deficiency with no anaemia, to normal iron status with varying amounts of stored iron, and finally to iron overload - which can cause organ damage when severe. Iron deficiency is the result of long-term negative iron balance. Iron stores in the form of haemosiderin and ferritin are progressively diminished and no longer meet the needs of normal iron turnover. From this critical point onward, the supply of iron to the transport protein apotransferrin is compromised. This condition results in a decrease in transferrin saturation and an increase in transferrin receptors in the circulation and on the surface of cells, including the erythron. All tissues express their need for iron in exactly the same way, i.e. by the same type of transferrin receptors on cell surfaces in proportion to actual iron need. Accordingly, a compromised supply of iron to the erythron is associated with a similarly insufficient supply of iron to all other tissues.

Functionally, the lack of mobilizable iron stores will eventually cause a detectable change in classical laboratory tests, including measurement of haemoglobin, mean corpuscular haemoglobin concentration, mean corpuscular volume, total iron-binding capacity, transferrin saturation, and zinc-erythrocyte protoporphyrin.

Iron deficiency is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythron, are noted. The more severe stages of iron deficiency are associated with anaemia. When iron-deficient erythropoiesis occurs, haemoglobin concentrations are reduced to below-optimal levels.

Nutritional anaemia is not a disease but may be considered a syndrome caused by malnutrition in its widest sense. It is a condition in which the haemoglobin content of the blood is lower than the normal due to deficiency of either a single or more essential nutrients regardless the cause of such deficiency (WHO 1995). IDA is an important public health problem in most developing countries (Soekarjo et al 2006).

Iron deficiency is impairing the mental development of 40-60 percent children in developing countries. Worldwide, $50 billion in GDP is lost annually in low-Estimates of Economic Losses from Iron Deficiency Anemia (Cognitive & Productive) as % of GDP income countries due to IDA's effect on productivity (World Bank 2009). Anemia may produce scholastic under-achievement and behavioral disturbances in school children (Pollitt et al 1976). A departmental study showed that anemia is likely to adversely affect physical work capacity and cognition in young adolescent girls undergoing pubertal development (Sen & Kanani 2006).

Adolescence is a time of increased iron requirement because of the expansion of blood volume and increase in muscle mass. During adolescence, requirement for growing boys also jumps up significantly due to muscle mass development. The deficiency gets further aggravated due to faulty food habits, lack of awareness, inadequacy of foods and poverty (Mittal 2007).

Prevalence of anemia among adolescents

Iron deficiency anemia is the most common type of nutritional anemia in the world, affecting more than two billion people globally (Stoltzfus; International Nutritional Anemia Consultative Group USA 1997).

In studies conducted by the International Center for Research on Women, country findings on adolescent anemia among both males and females anemia was found to be the widespread nutritional problem and its prevalence ranged from 32- 55% (Kurz and Johnson-Welch 1996). Also high rates of anemia have been found among children and adolescents in other developing countries, such as Indonesia, Brazil, Egypt and India varying within the range of 24%-60% (WHO 2003, Anjali 2000, Verster et al 1998, Mashauri et al 1998, Sichieri et al 1996).

Shatha et al in 2003 collected data on adolescents comprising 46% from high socio-economic area (HSEA) and 54% from low socio-economic area (LSEA) in Baghdad, Iraq. The prevalence of anemia among adolescents in HSEA was 12.9% compared to 17.6% in LSEA. Hemoglobin concentration in males was significantly correlated with age and dietary iron intake while in females it was correlated significantly with years of education of father and mother, number of pads and age at menarche.

Mine et al 2002 estimated the prevalence of IDA among a total of 1633 students (11-18 y) from different socioeconomic status in Turkey. Prevalence of IDA was 4.2 % among the urban school and 13.8 % among the shanty town school and students with low family income had a 1.75 times greater risk of IDA than those with high family income.

An assessment of nutritional status of adolescents in India revealed that almost half of the adolescents including both sexes consume inadequate iron and protein in their daily diet and the prevalence if IDA is also high (**Table 2.4**). A multi-center study carried out by ICMR in 16 districts of 10 states in year 2001 showed that the overall prevalence of anemia was 90.1%.Tiwari and Seshadri (2000) reported a similar prevalence (60.3 %) of anemia amongst Nepali School girls. In Ahmedabad, 81.8 % of school children of 6-18 years were reported to be anemic (Verma et al, 2004). A study conducted in urban and rural Vadodara on secondary school girls revealed that 75 % of them were anemic (Kotecha et al, 2002). Thus IDA is a public health problem among school age children and adolescents. It affects in deleterious effects not only on hematinic status but also had serious implications on physical growth, mental development, work capacity and school performances.

Causes of anemia

Adolescents are considered to be a nutritionally vulnerable segment of the population. A rapid growth rate combined with a marginal nutrient intake increases the risk of nutritional deficiencies in this population (World Bank Report 1993).

Adolescents are more vulnerable to develop anemia. It results from inadequate iron intake, reduced bioavailability of dietary iron, increased need for iron, chronic blood loss and parasitic infections. Iron deficiency is a major cause of anemia in all developing countries, where consumption of iron is limited because dietary sources of iron are not affordable by most families (World Bank report 2003).

TABLE 2.4 Prevalence of Anemia in India

RESEARCHER	PLACE	PREVALENCE
Agrawal et al 2003	Delhi	45%
Basu et al 2003	Chandigarh	25.4%
SWACH Foundation 2001	Haryana	82.9%

Rajaratnam et al 2000	Tamilnadu	45.2%
Anand et al 1999	Delhi	48%
Sharda et al 1999	Amritsar	70.5%
Rawat et al 1998	Meerut	35.4%
Mehta et al, 1998	Bombay	63.8%
Chaturvedi et al 1997	Rajasthan	73.7%

In spite of increased iron needs due to growth spurt, many adolescents, especially females, do not get enough iron from their diets. About 75% teenaged girls, did not meet their dietary requirements for iron, compared to only 17% of teenaged boys (CDC 1998). Dislike for certain foods like green leafy vegetables especially among school children and adolescent is another reason for poor intake of iron. Poor intake may also be associated with lack of knowledge about these foods (Kanani et al 1994). Excessive red blood cell loss due to helminthes infections (mainly hookworm and schistosomiasis and in some cases trichuriasis) also leads to iron deficiency.

Differences in test performance equivalent to a six- month delay in development can typically be attributed to heavier infections of the sort experienced by around 60 million school age children (Partnership for Child Development Report 2002). Anemia can also be exacerbated or caused by malaria infection that in turn can be increased by energy, vitamin A and zinc deficiencies. Excessive red blood cell destruction due to malaria displaces hemoglobin and prevents the transport of oxygen to the tissues (World Bank Report 2003).

The iron requirement remains higher in girls after menarche to replace menstrual losses. Adolescent girls lose about 23-54 ml of blood per day containing approximately 15.5 mg of iron during menstruation (WHO 1995). The daily requirements for absorbed iron increases from 0.5 mg/day before puberty in girls to 3.3 mg/day after puberty which has to be compensated by increased intake.

The bioavailability of dietary iron in our body is as important to iron nutrition as the amount of iron consumed. The average iron absorption varies extremely, ranging from 1-5 % for plant origin foods and 10-25 % for animal origin foods (Monsen 1998). The bioavailability of iron is low in predominantly cereal- based diets, as in India, because of their high phytate and phosphates content. Tannates present in tea are also known to inhibit the absorption of when consumed with meals (Seshadri et al 1997).

Consequences of anemia

Studies have shown that adolescents with anemia have decreased verbal learning and memory, as well as lower standardized math scores. There is evidence, though, that correcting the iron deficiency may improve learning. A study of adolescent girls with iron deficiency showed that their test scores improved after receiving iron supplements (Alton 2005).

Anemia can have a profound negative impact on psychological and physical development, behavior and learning capacity, working performance and reproductive health (De Maeyer et al WHO 1989). Low iron stores throughout childhood may contribute to a delayed age of menarche and anemia in adolescents may impair immune response (Brabin 1992). In addition, anemia in adolescence may also impair the immune response thus making them more prone to infections (Dallman 1989).

IDA also leads to loss of appetite or anorexia. With loss of appetite the dietary intake of food decreases. A study conducted on 10-18 years old adolescent girls living in three slums of Vadodara indicated that anorexia was more frequently reported among anemic girls than the non-anemic as assessed by lower appetite scores (Kanani and Poojara 2000).

Biochemical Basis of causation of signs & symptoms in Iron deficiency

1. ***Oxygen transport and cellular respiration***

   Iron is a component of several respiratory proteins and respiratory enzymes. Hence deficiency of iron in these molecules causes defective electron transport and cellular respiration. Several mitochondrial proteins within the cell including cytochromes contain iron. Several of the citric acid cycle enzymes like aconitase, succinate dehydrogenase, isocitrate dehydrogenase requires iron as the essential cofactor for the enzyme activity (Maguire J et al 1982).

2. ***Bactericidal activity and oxidant damage***

Several enzymes which are involved in bactericidal action and those involved in production and breakdown of H_2o_2 are iron containing enzymes. Catalase is such an enzyme, Myeloperoxidase in neutrophils also require iron for its optimum bactericidal activity (Tallar, Miyamoto 1948).

3. ***Porphyrin Metabolism***

Certain porphyrin metabolizing enzymes are also under the feedback control of iron. Heamsynthetase, uroporphyrinogen decarboxylases are the two examples. Thus it is clearly seen that in absence of iron even if hemoglobin levels are maintained artificially, cellular respiration in each and every cell is affected and the cells are metabolically compromised.

4. ***Pigment Metabolism***

Iron is intimately concerned with melanin metabolism. The enzymes phenylalanine hydroxylase, homogentisic oxidase requires iron for formation of homogentisic acid and melanin quinines. Hence iron deficiency can affect the formation of melanin pigments. Phenylalanine metabolism is also intimately concerned with catecholamine and thyroxine generation in the respective tissues (Mackler et al 1979).

5. ***DNA and RNA synthesis***

DNA synthesis is an extremely important step before the cell division. Infact most of these syntheses takes place during the “S” (synthesis) phase of cell division. One of the most important enzymes involved in DNA synthesis is ribonucleotide reductase. It is responsible for converting ribonucleotides to deoxy ribonucleotides. This enzyme requires iron for its optimum functioning. In the absence of iron this reaction cannot proceed satisfactorily. Xanthine oxidase, which is involved in oxidation on purines also require iron as one of the cofactors (Brittenham et al 2000).

6. Monoamine Metabolism

Catecholamine is one of the most important monoamines involved in adrenergic neurotransmission and is the glandular secretion of adrenal medulla with potent action on blood pressure, cardiac rhythm, carbohydrate and lipid metabolism. In the central and peripheral nervous system it is the harmonious function and interaction of cholinergic and adrenergic nervous system that controls our innumerable viscero vegetative functions, e.g. sleep, wakefulness, moods and so on. Iron has also been found to be an important component of neuronal monoamino oxidase. Tryptophan hydroxylase, another enzyme involved in production of serotonin also uses iron as an essential cofactor. Dopamine receptors are down regulated during iron deficiency and there is an altered Gama Amino Butyric Acid (GABA) metabolism in this condition (Beard 2001).

7. *Cytochrome P-450 and drug metabolizing enzyme*

There are a large number of drug metabolizing enzymes of this class which contains haeme iron as essential component of the enzyme. These enzymes are involved in phase I reaction in biotransformation of drugs and other xenobiotics. These enzymes are present in ample quantities in liver. Hence it is expected that iron deficiency may alter metabolism of some of the drugs. The clinical consequence of this is uncertain (Pinero et al 2000).

8. *Myelinogenesis*

Oligodendroglia in central nervous system contains large amount of iron. Studies have shown increased transferrin receptors in vascular endothelium of choroid plexuses in the brain. Knowing the essential role of oligodendroglia in myelinogenesis, it is but natural to explore the possibility that iron deficiency in experimental animals may cause abnormal myelination during immediate postpartum development phase corresponding to 4-20 month age of human infants. Biochemically oligodendroglia contains a protohaem oxygenase, which is involved in cholesterol biosynthesis and may influence myelination through this process (Taneja et al 1986).

9. *Clinical presentation of iron deficiency gastrointestinal tract*

Angular stomatitis, Glossitis, Koilonychia, sideropenic dysphagia with postcricoid oesophageal web in iron deficiency can easily be explained by the necessity of iron for cellular proliferation and differentiation. Whether iron deficiency can cause atrophic gastritis and mal absorption syndrome is a question, which is more difficult to answer. Weight of evidences seems to indicate that iron deficiency can be caused by these pathologies rather than they themselves are caused by iron deficiency except under rare circumstances. Several studies from India have shown that iron deficiency anemia which is resistant to iron therapy is caused by symptomatic celiac disease which was considered to be rare in India. One of the clinical presentations of iron deficiency with or without anemia is abnormal eating behavior or pica which can be in the form of eating clay (geophagia), ice (pagophagia) and similar things (Khosla 1984).

10. *Skin and its appendages*

Premature loss of hair, alopecia areata, greying of hair, folliculitis, acne and reduced growth of nails have been reported with iron deficiency with or without anemia. Koilonychia is one of the best known clinical features of iron deficiency (Mehta 1987).

11. *Cardiovascular physiology*

Several non invasive studies like systolic time intervals have shown myocardial dysfunction during iron deficiency without anemia as evidenced by reduced PEP / LVET ratio. This ratio was normalized within days of iron replacement before hemoglobin started to rise significantly. Similarly abnormal ST segment depression on treadmill test has been demonstrated in IDA and this test reversed on parenteral iron therapy (Mehta 1987).

12. ***Effect on cerebral function***

Poor cortical arousal, diminished attention span, reduced scholastic performance in school has been reported in iron deficiency anemia and these abnormalities partly reverse on iron replacement. Depression, disturbances of sleep rhythm and reduced mental alertness also occur in this condition. It is believed that in infants with iron deficiency not all parameters of cognitive development can be totally reversed; neither the various domains of higher cerebral function show recovery at the same rate. Hence the degree of reversal often depends on time of measurement of these parameters. It has been demonstrated that iron is concentrated in different parts of central nervous system like globus pallidus, substantia niagra, nucleus accumbens in an adult but the pattern changes in different age groups. However, most of these areas are associated with dopaminergic and GABA minergic pathways and several receptors of dopamine D1 & D2 are down regulated in IDA. Peripheral nerve conduction velocity also improves in a study following iron replacement (Burner 1996).

13. ***Renal function and drug metabolism***

The important role of P-450 cytochrome oxidase group of enzymes in drug metabolism is very well known. Thus it is but natural that some of the drug metabolism may be altered in iron deficiency. However in iron deficiency with anemia there could be several reasons for altered drug handling by the body in addition to its effect on metabolism. The absorption of drug from gastro intestinal tract may be delayed or may be incomplete. Increased cardiac output and redistribution of blood flow to various organs particularly to liver may alter the drug available to biotransformation site and may alter the volume of distribution of the drug as evidenced by prolonged half life and its correction by iron therapy on antipyrene half life. Finally the abnormal creatinine clearance due to iron deficiency may also alter the drug excretion. Hence there are theoretical reasons that every phase of drug handling i.e. absorption, distribution metabolism and excretion is likely to be altered by iron deficiency but in practice no adverse reaction or interaction due to drug administration specially caused by iron deficiency has been reported (Mehta 1984).

14. *Musculoskeletal function*

Easy fatigability and decreased work performance in iron deficiency and its improvement following iron therapy have been reported in various case control studies. This finding has enormous consequences in national economy. Studies show that anemia due to iron deficiency tends to affect fast acting muscle function (sprint function) whereas cellular deficiency of iron tends to affect endurance exercise (Dallman PR.1982).

PHYSICAL WORK CAPACITY

The key role that hemoglobin plays in transporting oxygen accounts for the diminished work capacity (DeMaeyer 1989). Workoutput, endurance and maximal work capacity are impaired in iron deficient state. Anemia represents a major threat for tissue oxygenation; hence certain tissues and organs that require much oxygen may suffer resulting in diminished capacity to perform energy consuming tasks (Bothwell et al, 1979).

Iron has a key function in oxygen transport, either as part of hemoglobin or as myoglobin. In IDA the decrease in hemoglobin reduces the availability of oxygen to the tissues, which in turn affects the cardiac output (Beaton, Corey and steel 1989). The movement of oxygen from the environment to terminal oxidases is one of the key functions of iron. Dioxygen binds to porphyrin ring iron containing molecules either as part of the prosthetic group of hemoglobin within the red blood cells or as the facilitator of oxygen diffusion in tissue myoglobin (Beard, Dawson and Pinero 1996). The very significant decrease in myoglobin and other iron containing proteins in the skeleton muscle seen in iron deficiency anemia contributes significantly to the decline in muscle aerobic capacity (Dallman 1986). Pyruvate and malate oxidase were reduced to 35 % of normal iron deficient muscle and improved to 85 % of normal in 10 days of treatment (Beard, Dawson and Pinero 1996).

The different mechanisms through which iron deficiency and anemia affects work capacity are reduced tissue oxidative capacity and reduced oxygen carrying capacity. Tissue oxidative capacity is affected across all levels of iron deficiency, whereas the oxygen carrying capacity is affected only at the most severe stages of deficiency when hemoglobin concentration is reduced. In turn these two impairments affect different aspects of physical performance. Reductions in oxygen carrying impair aerobic capacity, whereas reductions in tissue oxidative capacity impair endurance and energetic efficiency (Davies et al, 1984).

Iron deficiency anemia is found throughout the world and especially in developing countries where productivity is of prime importance. It is also known that physical work capacity in anemia subjects may be improved after iron supplementation, with a concomitant increase in circulating Hemoglobin. It has been shown that work performance can be improved almost immediately when the oxygen carrying capacity of the blood is simply increased (Gardner et al, 1977).

Oxygen saturation (SO_2) is the blood oxygen binding by hemoglobin oxygenation (HbO_2). The functional oxygen saturation for the concentration of HbO_2 concentration, HbO_2: Hb ratio, which is different from the percentage of oxyhemoglobin. Therefore, monitoring of arterial oxygen saturation (SPO_2) on pulmonary oxygenation and hemoglobin oxygen carrying capacity is estimated.

Optical method is an electrochemical method to overcome the shortcomings of the new optical measurement method. It is a continuous non-invasive oxygen measurement method which can be used in emergency wards, operating room, and recovery room and sleep studies. The principle of pulse oximeter is that detection of blood volume changes in light absorption, measurement of oxyhemoglobin (HbO_2) of total hemoglobin (Hb) the percentage obtained directly SO2. The advantages of this method can be done on the human body for non-destructive measurement, and instrumentation is simple and convenient to use, it has been a growing attention. The disadvantage is that it measures less accurately than the low electrochemical method, the extraordinary value in the low oxygen generated by the larger error. The latest pulse oximeter measurement errors can be controlled at less than 1 percent to the requirements of clinical use. Although they are not satisfactory in some respects, but its clinical benefits have been widely recognized

Hemoglobin in the blood is a major role in the delivery of oxygen, the majority of oxygen in the blood is hemoglobin (Hb) combined. 1g of hemoglobin can be combined with 1.34 ~ 1.36ml of oxygen. Healthy adults is hemoglobin 15g/100ml, 100ml of blood oxygen can combine a maximum of 20ml, 100ml of blood hemoglobin oxygen can be combined with the largest capacity of the volume of oxygen is called hemoglobin, 100ml of blood hemoglobin oxygen level in the actual combination of oxygen is called hemoglobin. Oxygen content of hemoglobin in blood oxygen capacity accounted for the percentage of hemoglobin called hemoglobin oxygen saturation. Is often said that the oxygen saturation, blood in the existence of other means (eg, dissolved) oxygen content in small, can be neglected. Blood in the vast majority of oxygen molecules in hemoglobin and red blood cell (Hb) for the reversible combination of hemoglobin molecules in each of up to 4 molecules of oxygen combine with the combination of Hb after that oxyhemoglobin (HbO2), HbO2 total blood capacity in the percentage of hemoglobin that "oxygen saturation."

For instance, if one hemoglobin molecule is carrying three oxygen molecules, the hemoglobin is carrying only 75 percent of its total capacity. In a larger blood sample, 1,000 hemoglobin molecules could carry up to 4,000 oxygen molecules. If only 3,920 oxygen molecules are transported, that equals 98 percent of total capacity. That means the blood's oxygen saturation level is 98 percent.

An accurate, easy way to measure oxygen saturation levels is through pulse oximetry. A pulse oximeter is a small clip that attaches to a patient's finger. The oximeter shines two bright lights, one red and one infrared, through the finger to measure the blood oxygen levels. It does this by analyzing the color of the arterial blood. Oxygen-rich blood is bright red. In order to tell the arterial blood apart from the surrounding tissue, the oximeter measures the change in the overall color in coordination with the beating pulse.

Oxygen saturation is an indicator of the percentage of hemoglobin saturated with oxygen at the time of the measurement. The reading, obtained through pulse oximetry, uses a light sensor containing two sources of light (red and infrared) that are absorbed by hemoglobin and transmitted through tissues to a photodetector. The amount of light transmitted through the tissue is then converted to a digital value representing the percentage of hemoglobin saturated with oxygen.

Oxygen saturation values obtained from pulse oximetry (SpO_2) are one part of a complete assessment of the patient's oxygenation status and are not a substitute for measurement of arterial partial pressure of oxygen (PaO_2,) or of ventilation (Grap 1996).

WAYS TO COMBAT ANEMIA

The three major causes of anemia (iron deficiency, malaria and helminths infections) can be addressed during contacts with vulnerable groups using a combination of key interventions, as needed. Five Key Interventions recommended are:

- Iron supplements targeted to at-risk groups
- Fortification of staple foods with iron and other micronutrients that cause anemia for the general population and iron-fortified foods targeted to at-risk groups
- Prevent and treat malaria
- Use of insecticide-treated materials and bednets
- Deworming (anthelminthics) in at-risk groups

IMPORTANCE OF INTERVENTION AT THIS PHASE

It has been known that malnutrition undermines economic growth and perpetuates poverty. Thus the three reasons for intervening to reduce malnutrition are:

- High economic returns; high impact on economic growth and poverty reduction
- The alarming shape and scale of the malnutrition problem
- The markets are failing to tackle malnutrition

The causes of malnutrition are predictable and preventable and can be addressed through affordable means. Practical measures that address the immediate causes of child under nutrition include a health, hygiene, nutrition education and promotion, fortification, micronutrient supplementation, parasite control measures (de-worming in particular); and situation-specific household food security interventions (Stephenson et al 1993).

These interventions, enacted in tandem with measures to increase the economic viability of families and communities and their capacity to access the food and basic services they need and use them effectively can lead to accelerated and sustained progress in improving child nutrition. Numerous interventions are essential if child under nutrition is to be addressed effectively and sustainably. The Initiative will directly promote interventions that are known to have immediate impact for children, can be scaled up and are currently under-championed.

The promotion of a focused set of interventions will fully and directly complement other, ongoing efforts to take the measures essential to tackle child malnutrition in the short term and to address its underlying causes (Nokes et al 1993).

There is now unequivocal evidence that workable solutions to child under nutrition exist and that they are excellent economic investments.

Purpose of Biological assessments

- Determine the magnitude, severity and distribution of iron deficiency and anemia and preferably its main causes. This information can serve as a basis for planning policies and intervention, and as a baseline against which to assess their impact

- Identify population more affected or at greater risk. This information enables national authorities to select priority area for action, especially if resources are limited
- Monitor trends in prevalence and regulate the impact of interventions. Other program indicators are also needed for monitoring program implementation
- Measure progress towards achieving the goals adopted by the international community
- Provide the basis for advocacy program for iron deficiency and anemia prevention in affected vulnerable population.

IRON FOLIC ACID SUPPLEMENTATION

Iron supplementation is the most common strategy currently used to control iron deficiency in developing countries. This is likely to remain the case until either significant improvements are made in diets for entire population or universal food fortification is achieved.

Supplementation is most often used to treat existing IDA. It should also be considered as a preventive public health measure to control iron deficiency in population at high risk of iron deficiency. Various delivery systems and modalities, under conditions of varied efficiency, reach a wide range of target groups. Small controlled studies of supplementation have been shown to be particularly successful and a few large scale supplementation programs clearly demonstrate positive biological impact. Only then will information be sufficient to introduce effective and efficient solution, if traditional approaches and practices are to continue.

It is important to differentiate between supplementation that aims at preventing anaemia by correcting iron deficiency before IDA is manifested, and therapeutic supplementation, aims at correcting established iron deficiency anaemia. Therapeutic supplementation should be part of health care delivery system. Supplementation to prevent iron deficiency without anaemia may be a community based initiative which needs innovative approaches in order to deliver timely preventive supplementation.

Several trials utilizing supplementations on a weekly or daily basis are in progress. However, the demonstrated effectiveness of weekly programs, based on self administered iron supplements under program condition is awaited before being recommended as public health measure (Ridwan et al 1996).

Supplementation is also preventive strategy to treat existing anaemia. It is the most common strategy used in developing countries to combat anaemia and is likely to be the case until the diets of the entire population change significantly or there is food fortification (UNICEF/UNU/WHO, 2001). Iron supplementation has shown positive results and, thus, remains the strategy of choice. Numerous studies have been done to observe the beneficial impact of iron supplementation as well as to come up with best possible supplementation schedule (Chwang et al1988; Brunken et al 2004; Hall et al 2002; Tee et al 1996; Berger et al 1997; Sungthong 2002 and Zavaleta et al 2000).

The iron absorption can occur at any level of the gastro intestinal tract from the stomach. However, absorption is greatest in the duodenum and progressively less in a descending gradient. Divalent ferrous iron is absorbed better than trivalent form (Moore et al 1939). Uptake of iron by intestinal mucosal cell is unidirectional and there is practically no excretion of iron into the gut. Under normal condition the body's iron content remains constant at level of 4 to 5 gms and absorption balances excretion of 0.5 to 1.5 mg per day.

The essence of mucosal block theory is that ferrous ions entering the mucosal cell stimulate the production of an acceptor protein, apoferritin. After entry into the cell the divalent ions are oxidised to the ferric state by the redox potential at the luminal border and the trivalent iron combines with apoferritin to form ferritin (Stewart 1950). At the vascular border of cell the ferritin is reduced by a different redox environment with consequent release of ferrous ions which will emerge from cell into the blood stream and after reoxidation are bound to transferring, the iron transport globulin of plasma. Thus when the needs of the body are met, further absorption of iron is curtailed by accumulation of mucosal ferritin. High dose of iron would load the mucosa with iron and block the subsequent dose from absorption. By reducing the dose frequency to once a week, matching the mucosal turnover of humans, iron from the tablet is absorbed (Brown 1963).

Chwang et al (1988) showed a significant reduction in morbidity and increased growth in children aged 8.2 – 13.5 years with supplementation of 10 mg of ferrous sulphate per kg body weight per day over 12 weeks. A mean increase of 3.5 g/dl of haemoglobin was observed in the anaemic group which was statistically significant compared to control group. Another study (Brunken et al, 2004) found a reduction of 25% in the prevalence of anaemia. Six milligram per kg body weight of iron was provided on weekly basis in six child-care centres in Brazil. The subjects were children below three years of age. Four months of supplementation were followed by five months of nutritional guidance for the maintenance of adequate iron levels and led to an average improvement of 0.1 g/l after each dose of iron sulphate in haemoglobin.

Hall et al (2002) demonstrated the effectiveness of iron supplementation channelled through school. Weekly dose of 65 mg of iron along with 0.25 mg of folic acid were administered by teachers for 10 weeks in thirty schools, covering almost 1100 students in the age group of 6 – 19 years. Haemoglobin levels rose by an average of 1.8 g/l and prevalence of anaemia fell by 8.2% both significant at $P < 0.001$. Young children (< 12 years) and girls benefitted more.

A Malaysian study (Tee et al, 1996) also yielded similar positive result with weekly iron supplementation of 60 mg or 120 mg and folic acid of 3.5 mg, for 22 weeks. Increase in haemoglobin levels was considerably higher in first 12 weeks than in the next 10 weeks regardless of dose. The mean haemoglobin increase was 2 times greater in the anemic girls during the first 12 weeks in both iron supplemented groups. Ferritin levels also increased in the group which had consumed iron tablet and folate. Thus 60 mg of iron along with 3.5 mg of folate was recommended since it had low frequency of side effects but produced similar result as that of 120 mg iron.

In Thailand study (Sungthong et al, 2002), average increase in haemoglobin in daily group (6.5 ± 6.0 g/l) was similar to weekly group (5.7 ± 6.3 g/l). However, the average increase in serum ferritin was greater in daily group compared to weekly group. Weekly group was found to have greater impact on height gain then daily group. These means that daily schedule was better in improving iron status than weekly one. The results of these studies are more or less similar to the once obtained from a research done in Peru (Zavaleta et al, 2000).

Tiwari (2000) conducted on 420 adolescent girls 10-18 year and compared the supplementation (daily vs weekly) over a period of 6 months. Deworming was also a part of study. Both daily as well as weekly schedule were effective in increasing the haemoglobin level. However none could decrease the prevalence of anemia.

There are several small iron supplementation studies that have examined its impact on growth, haemoglobin and morbidity in young children. The studies become clearer when they are classified by baseline prevalence of anemia. The studies where prevalence of anemia is greater than 80 % showed significant benefit in linear growth following the supplementation (median effect size 0.6 SD unit). An Indian study reported a negative effect in anemic children too (Bhatia & Seshadari 1992).

Similarly, none of the studies in anaemic iron replete children reported a beneficial impact of iron supplementation. On the contrary there is some suggestion that growth might be adversely affected under these circumstances (Indjradinata et al, 1994). Non significant negative effects were reported for length (-0.21 SD units) in a study by Chwang et al, 1988. The summary of few of the studies is given in the Table 2.5, Table 2.6.

Iron deficiency affects many age groups but school age is the least identified group. These groups suffer ignorance of policy makers in terms of preventive strategies to control iron deficiency anemia.

Since the target group is adolescent or to be more specific school age population schools becomes an obvious medium for such preventive strategy. It becomes important to come with feasible supplementation schedule which are not burden on teachers. Otherwise it is bound to fail eventually. Therefore weekly supplementation with elemental iron along with 0.5 mg folic acid seems to be a good strategy.

Table 2.5: Summary of IFA intervention studies in World

Researcher	**Location**	**Age**	**Sample Size**	**Iron Supplementation**	**Positive Effect**
Atukarala, 2001	Srilanka	5 -10 years	364	Oral 60mg/day, 2 months	URTI, diarrhoea
Gebresellassie, 1996	Ethiopia	5 -14 years	500	Oral 60 mg/day, 3 months	Malaria
Lawless,1994	Kenya	6-11 years	86	Oral150 mg/day, 3 months	Diarrhoea, cough, malaria
Harvey, 1989	Guinea	8-12 years	312	Oral 130 mg/day, 6 months	Malaria
Tee et al	Malaysia	5-11 years	266 girls+ 358 girls	60 & 120 mg weekly, 22 weeks	Hb and Ferritin concentration
Sen et al, 2009	India	9-13 years	161	100 mg elemental iron + 0.5 mg folic acid, one year	Digital span, maze test and visual memory
Kanani et al, 2007	India	10-18 years	210	Oral 60mg/day, 3 months	Height & Weight and hunger perception

Chwang et al, 1988	Indonesia	8 – 13 years	119	10mg/day, 12 weeks	Growth and morbidity
Latham et al, 1994	Kenya	8 years	55	80 mg/day (15 & 32 weeks)	Growth
Aguayo, 2000	Bdivia	6-12 years	64	3mg/kg body wt/week, 18 week	Hb & growth
Bhatia, 1992	India	8-13 years	165	2 mg/kg body wt for 12 weeks/day	Growth

Table 2.6: Summary of IFA intervention studies in the Department

Author / Place	Age Group	Intervention	Impact Hemoglobin Change (g/dl) and Growth
Seshadri and Gopaldas 1989, India	5-8 yrs (n=94)	20mg elem Fe + 0.1 FA for 60 days	Significant improvement in Hb 1.1 vs 0.15
	8-15 yrs (n=48)	60 mg elem Fe for 60 days	Significant improvement in Hb 2.4 vs 0.5 in control
Tiwari and Seshadri 2000, Nepal	School going adolescent girls (10-18 y) (n=1500)	Single dose 500mg mebendazole + 60mg elem iron given • Deworming+daily for 3 months • Deworming+weekly for 6 months • Only deworming or only placebo	Weekly IFA (0.33g/dl)as effective as daily (0.3 g/dl) group with regard to Hb increments, however, there was no significant reduction in prevalence of anemia
Seshadri et al 1998, Bharuch, India	Adolescent girls (10=19y) (n=1513)	Unsupervised supplementation of 100mg elem Fe+ 0.5mg Folic Acid Tablets • Daily for 100 days • Weekly for 6 months Placebo once weekly for 6 months + brochure on anemia	Weekly supplementation was not as effective as daily in terms of rise in Hb levels Weekly : 0.5 g/dl Daily : 0.3 g/dl
Kanani and Poojara 2000, India	Adolescent girls (n=203)	60 mg elem Fe+ 0.5mg folic acid for daily 3 months	Experimental group+1.73 vs. -0.08 g/dl control Increase in Hb was higher in anemic girls Significant improvement in BMI in supplemented girls compared to controls (0.0 vs -0.35 kg/m^2)

Kanani et al 1998, Vadodara, India	School girls (10-15y) (n=729)	100mg elem Fe + 0.5mg Folic Acid for 6 months	No significant impact on Hb levels after weekly supplementation (1.2 vs. 1.0g/dl in control) No difference in BMI gain between supplemented (0.68 Kg/m^2) and control group (0.49 Kg/m^2) after the intervention.
Kanani and Singh 1999, Vadodara	9-12y (n=296)	60 mg elem Fe+0.5 mg Folic acid for 3months	Significant improvement in weight (3.33 Kg vs. 1.56 Kg) and BMI as compared to controls.
Kuruvilla & Mulchandani 2010	10-19 y (n=131 boys)	100mg elem Fe 0.5mg Folic Acid and weekly for 3months	The increment seen in Hb was 0.3 g/dl
Kuruvilla & Bhatt 2010	10-19 y (n=133)	100mg elem Fe 0.5mg Folic Acid and weekly for 3months	The increment in Hb was 0.2 g/dl
Kuruvilla & Malhotra 2011	10-19 y (n=135)	100mg elem Fe, 0.5mg Folic Acid, twice weekly for 5months	A highly significant improvement was seen in Hb levels(0.4 g/dl in girls & 0.34 g/dl in boys)
Kuruvilla & Thappar 2011	10-19 y (n=96)	100mg elem Fe 0.5mg Folic Acid, twice weekly for 4months	A significant improvement was seen in Hb levels was 0.5 g/dl

DEWORMING TABLETS

Worms infect more than one third of the world's population, with the most intense infections in children and the poor. In the poorest countries, the infection is long-term and chronic, and can negatively affect all aspects of a child's development: health, nutrition, cognitive development, learning and educational access and achievement (World Bank report 2003).

Hookworm infection load can include IDA, especially in women of reproductive age and children, whose dietary iron intake is low and whose body iron stores are exhausted due to increased demand of iron for growth. Even normal levels of dietary iron intake may not be sufficient to protect from anaemia in the situation of high hookworm load (Powlawski et al 1991).

A high prevalence of intestinal parasitic infections is closely correlated with poverty and poor environmental hygiene, namely: a) lack of safe water supply, b) contamination of the environment by human excreta, c) lack of shoes, and d) poor environmental or personal hygiene. In the long run, worm infections increase susceptibility to other infections and diminish learning ability and growth in children.

Intestinal parasitic infections negatively affect the health status of a high proportion of school-age children in developing countries, giving rise to general discomfort and acute symptoms such as abdominal pain, nausea and coughing. More than two billion children globally are infected by intestinal helminthes, with 155,000 deaths reported annually. The burden of diseases caused by intestinal helminthes infection (39 million disability associated life years (DALYs) is higher than that caused by measles (34 million DALYs) or malaria (36 million DALYs). Intestinal helminthes infection affects the nutritional status of children through intestinal bleeding, malabsorption, competition for nutrients, loss of appetite and diarrhea. All of these effects are reversible after treatment. Another benefit of treatment is better digestion of the sometimes limited food available.

These symptoms are closely correlated with the “intensity of intestinal parasitic infections” (commonly called “worm burden”): the greater the worm burden, the more severe are the symptoms. In addition, hookworm infections give rise to blood loss, as the worms suck blood from the intestinal wall. This may cause iron deficiency anaemia and a decrease in work capacity and fitness.

High parasitic infestation rate (30-80%) could be one of the major cause of anaemia (Tiwari, 2000). Hook worm infestation load can induce the IDA, especially in children and adolescents, whose dietary iron is low and whose body iron stores are exhausted due to increased demand of iron for growth. Even normal levels of dietary iron intake may not be sufficient to protect from anaemia in the situation of high hook worm load (SCN News, 2007).

School-age children harbor the most intense infections with roundworm (Ascarislumbricoides), hookworm (Ancylostoma duodenale and Necator americanus) and Whipworm (Trichuris trichiuria). Therefore, treatment of this age group - which is easily accessible through the school system - achieves optimal improvements in health status and educational performance.

In Zanzibar, heavily infected school children living in high transmission areas were treated with mebendazole three times a year. The study found that a quarter of a litre of blood can be saved per child per year for as little as 1 US cents per child per year (i.e. 5 US cents per treatment including the cost of the tablet of about 3 US cents, and drug delivery, which amounts to about 2 US cents). Deworming of children can result in remarkable growth spurts. In one of the trial in Kenya, treated school-age children gained one centimeter more in height in the four months following treatment than did children who received a placebo.

In 1998, Curtale et al and in 2008, Koukounari et al reviewed the relation between parasitc infection and anaemia among Egyptian school going children (6-12 years) and Kenyan School children (aged 10-21 years) respectively. Both the studies reported that children heavily infected with parasite were also more likely to be anaemic (more than 90% in both cases) compared to uninfected children. Similarly other study was carried out by Uddin and Khanum (2008) in two different districts (Kutumbopur and Gazirchat) of Bangladesh and reported that parasitic infestation was observed among 33.82% adolescent where as in the other district the prevalence was 84.21%. Parasitic infestation was observed much higher in Gazirchat than Kutumbopur. The prevalence of anaemia was high in Kutumbopur (94.83%)

than Gazirchat (41.2%) but the correlation between anaemia and parasitic infestation was statistically insignificant.

Recent studies suggest that intestinal parasitic infections negatively affect school children's cognitive functions. A study in Jamaica showed significant improvements in the auditory short-term memory of heavily infected children after nine weeks of treatment. Single oral dose treatment with mebendazole (500 mg) or albendazole (400 mg) is very effective, safe and inexpensive. The direct benefit of chemotherapy is that the worm burden is removed, which immediately alleviates symptoms and may reduce the rate of transmission. Furthermore, WHO recommends improved sanitation and safe water supply as well as health education on the prevention of intestinal parasitic infections as important strategy.

School-age children typically have the highest intensity of worm infection of any age group. In addition, the most cost-effective way to deliver deworming pills regularly to children is through schools because schools offer a readily available, extensive and sustained infrastructure with a skilled workforce that is in close contact with the community.

Regular deworming contributes to good health and nutrition for children of school age, which in turn leads to increased enrolment and attendance, reduced class repetition, and increased educational attainment. The most disadvantaged children - such as girls and the poor - often suffer most from ill health and malnutrition, and gain the most benefit from deworming (World Bank Report 2003).

Drugs for deworming treatment are highly effective, widely available, inexpensive, easy to administer during school or general population drug campaigns and without serious side effects. One caveat is that treatment must be repeated every 6-12 months because of re-infection.

Among the interventions found to be most effective in reducing malnutrition in children micronutrient supplementation and water and sanitation interventions, deworming has been found to be particularly effective intervention for children of school age. Thus giving high priority to several of these interventions in order to attack malnutrition was emphasized by the Copenhagen Consensus panel in 2004, 2006 and again in 2008 and 2010.

MID DAY MEAL

National Programme of Nutritional Support to Primary Education, popularly known as the Mid-Day Meal Scheme involves provision of lunch free of cost to school-children on all working days. More than 12 crore (120 million) children are covered under the Mid-day Meal Scheme, which is the largest school lunch programme in the world. Allocation for this programme has been enhanced from Rs 3010 crore to Rs 4813 crore in 2008-2009. The MDM allocation has increased by 6 crore in the year 2011-2012. Last year, Rs 10,380 crore was allocated for the scheme.

A healthy MDM can help to protect children from hunger, and to provide supplementary nutrition. MDM is not enough to guarantee the right to food, but they are an important step towards it. Similarly, cooked midday meals contribute to the right to education by facilitating regular school attendance and enhancing children's learning abilities.

Objectives of MDMP are:

- To improve the nutritional and health standard of the growing children.
- To reduce drop-out rate and to increase attendance and to attract poorer children to come to the school.
- To create supplementary employment opportunities at the village level.
- To achieve social and national integration.
- To supplement state efforts towards removal of poverty.

STRENGTHS, WEAKNESS AND MILESTONES

Strengths: Merits of MDMP (NFI, 2003*)*

- Combating classroom hunger
- Promoting better learning,
- Inculcate in the pupils good dietary habits
- Promote personal hygiene
- Awareness of the importance of environmental sanitation
- Valuable means of imparting health and nutrition education to children, their parents and the community,
- Create employment opportunities,

- Improving school enrolment and attendance especially enrolment of girls and SC/ST children,
- Foster sound social behavior,
- Trigger all round development of the entire school system.

A study conducted by Amartya Sen in Birbhum West Bengal revealed that MDM has a positive role in eliminating classroom hunger to a substantial level (Pratichi Research Team 2005)

According to National Council of Educational Research & Training's latest report (2005) children covered under MDM have higher achievement level than those who were not covered under it. Situational analysis of MDMP in Rajasthan showed MDM to be contributing to gender equity and women employment. CORD study in Delhi reported that the impact of attendence was more likely on girls, who often came to school without breakfast. A study on rural area of Karnataka revealed reduced absenteeism in 64% of the schools (Naik 2005). In Madhya Pradesh 15% increase in enrollment was seen which was more marked in the case of SC and ST children (43%) (Samaj Pragati Sahyog 2005)

Weaknesses: Despite the success of the program, child hunger as a problem persists in India. According to current statistics, 42.5% of the children under 5 are underweight. "India is home to the world's largest food insecure population, with more than 200 million people who are hungry," India State Hunger Index (ISHI). Adding to that the country's poor performance is driven by its high levels of child under-nutrition and poor calorie count. A report released as part of the 2008 Global Hunger Index ranks India at 66 out of 88 countries. It says that India has more people suffering hunger - a figure above 200 million - than any other country in the world, it says. The report also stated that improving child nutrition is of utmost urgency in most Indian states (WFP, 2006).

The major problem which comes in effective implementation of MDMP is the poor enrollment and absenteeism. Although these two are major objectives of MDMP they still remain unachieved.

In Gujarat only 71% of children aged 6-17 years attend school. School attendance is somewhat higher in urban areas (74%) than in rural areas (69%). About 90% of the primary school children (6-10 years) attend school (92% of urban and 89% in rural areas). The percentage fall in children attending school drops to 74% for children age

11-14 years and 32% for 15-17 years. Gender disparity in education is quite evident in school age population 66% girls of the 6-17 years of population attend school to 75% of the boys of similar age group(NFHS-3 2005-2006).

Recent field survey of MDM initiated by the Centre for Equity Studies, New Delhi suggests that mid-day meals have made a promising start around the country. In each of the three sample areas (three districts each in Chhattisgarh, Rajasthan, and north Karnataka; mid-day meals were being served regularly in all primary schools. However, achievements of mid-day meals have been seriously compromised, if not defeated, by inadequate quality and low budgets.

There is an urgent need for better infrastructure (e.g. cooking sheds in all the schools), improved facilities (e.g. safe drinking water everywhere), closer monitoring (e.g. regular inspections), and other quality safeguards (Dreze & Goyal 2009).

An evaluation report on 112 schools of Delhi revealed that only 47% of schools were found to have distributed MDM in their school for a period of over 150 days. Teachers felt that continuation of the same item gradually make students develop dislike towards it.

An assessment of program implementation and impact reported provision of meals was sometimes interrupted because of inadequate delivery of wheat and funding. None of the schools had permanent kitchen. If MDMP is implemented in close convergence with several other development program it will ensure that all requirements of the Program are fully met in the shortest possible time frame.

Inspite of the educational development realized through Mid-day Meals program, several socio-cultural, administrative, managerial, and financial factors affected the scheme's effectiveness in Orrisa and Tamil Nadu. However, downsizing the program through appropriate organizational and operational measures is being considered (Mishra & Behera 2004).

Some other loopholes reported by Right to food review in UP in 2007 were:

- The nutritional value of the meal is far below the prescribed standard
- Meal is often not served in adequate quantity.

Most states, however, reported severe resource constraints, inadequate cooking arrangements and resentment among teachers. In recent years, the scheme has suffered from disruption in supply of foodgrains due to paucity of funds and non-reconciliation of lifting figures between states and FCI with the latter, in response, often resorting to the suspension of supply of foodgrains (Saxena 2002)

ACHIEVEMENTS AND MILESTONES

Achievements: A study conducted by National Institute of Rural Development in 2006 involved 7,200 school going children (9-12 y) at three different areas - urban, rural and slum of two representative districts- Lakhimpur Kheri and Sitapur (Uttar Pradesh) and Bharatpur and Jodhpur (Rajasthan) to assess the impact of MDM supplementation on the nutritional status of school going children (Seetharaman 2002)**.** The findings revealed that

- Children of the three areas in all the four districts spread across two States greatly varied both in respect of calorie intake and their background variables. However, within group differences were marginal and non significant in all cases except Bharatpur.
- The MDM did not make any appreciable and significant impact on improving the nutritional status of the children. One important impact was that there was a reduced dropout among the girls. The performance of Lakhimpur Kheri in reducing the dropouts among girls was significant followed by Jodhpur, Sitapur and Bharatpur.
- Educational achievement of the children was very much influenced by their nutrition, parental as well as home environmental conditions. This was clearly evident in Lakhimpur - Kheri followed by Sitapur, Jodhpur and Bharatpur.

Another similar study on impact of MDMP on educational and nutritional status of school children in Karnataka on 2,694 children (MDM: 1361; Non-MDM: 1333) from 60 schools indicated better enrolment ($p < 0.05$) and attendance ($p < 0.001$), higher retention rate with reduced dropout rate ($p < 0.001$), a marginally higher scholastic performance and marginally higher growth performance of MDM children (Laxmaiah 1999)

Milestone: For eradicating malnutrition by MDMP, one centralized model will not be either effective or efficient given the diversity and plurality in socio-economic and cultural aspects. A decentralized approach involving state and local governments would work better. This would also address greater accountability and transparency at every level of the program (Deshpande et al 2008)

Other major problems are that after the meal, 25% of the children tend to leave the schools thereby diluting the impact of the MDM in improving school attendance. Also the quality of wheat and rice grain being supplied under the MDM is not of good quality. Around 24% wastage of grains was reported mainly because of the poor quality.

There are many shortcomings in the delivery mechanism. It is true that the problems of reducing anemia and malnutrition have not been greatly impacted and the drastic mitigation of the problem observed. There are problems with Mid Day Meals as an incentive to prevent school dropouts. Despite these shortcomings all such schemes need to be expanded and intensified rather than curtailed.

GROWTH MONITORING

Growth monitoring has been defined as the regular measurement, recording and interpretation of child's growth change. The advantages of growth monitoring and promotion are:

- It allows for the early identification of children at high risk of malnutrition.
- It enhances the transfer of nutritional information by providing the educator with data concerning children's growth patterns that can be used in tailoring advice

- It assists in focusing scarce resources such as supplementary food commodities and recipients who most need them
- When combined with nutrition surveillance, it assists in evaluating the impact of other health and development activities and in identifying groups in need of special health attention

Growth monitoring is widely regarded as an essential element of primary health care. The potential of growth monitoring lies in its use as a diagnostic tool for identifying a child with nutritional or health problem, thus enabling action to be taken before the child's nutritional status is seriously jeopardized (Deheeger M, 2004).

In 1961 the use of growth charts was recommended by a joint committee of the Food and agriculture organization and WHO (WHO 1962). In 1990, Samir Basta, then Director of the UNICEF evaluation office, initiated evaluation of UNICEF supported growth monitoring activities in seven countries. This revealed low coverage, poor understanding of the causes of malnutrition and very few growth promoting actions (Pearson 1995). The survey reported that growth monitoring activities were ineffective (Shrimpton et al 2003).

In growth monitoring, height velocity remains a useful tool. However, in the assessment of height velocity, the need of accurate measurement is even more important. In the assessment of height velocity two measurements are required separately by time, ideally 1 year (Vass et al 1990). In assessing growth, accuracy is a key consideration. Longitudinal growth charts allow assessment of growth of individual children, which is a key influence on growth assessment. (Hilary et al 2005.)

The main anticipated benefits in developing countries are:

- Early intervention when growth faltering is more easily remedied
- Improved knowledge about the effect of diet and illness on growth
- Families motivated and enabled to take effective action
- Greater self reliance and self esteem
- Fewer referrals for curative care; cost saving and communities mobilized to address underlying socio economic causes of poor health

Individual measurement at a single point in time detect absolute short or tall stature but two or more measurement over a period of time are needed to detect a change in growth rate, irrespective of the starting height, hence the term is growth monitoring and not screening.

Measuring height is subject to error as a result of poor techniques, variations between instrument and observer, diurnal variation and plotting mistakes. A degree of imprecision is inevitable, because over 90 % of the variation between height measurements is the result of the fact that children are not rigid object and do not have an exact or correct height. School entry offers a good opportunity to screen the whole population. The theoretical advantages are low marginal cost when combined with other school entry screening procedure, potentially high coverage and detection of problematic causes. (Hall 1982)

Further research is needed to determine health utility gains and costs. There is a need for controlled studies to evaluate the exact role of height screening programs in improving child health and appropriate measurement strategies to adopt.

Monitoring child growth and development is a routine part of child health care in many countries. In a typical scenario, the health care worker plots heights and weights on a reference diagram, and assesses whether the growth pattern of child deviates from that of the reference population. If so, closer examination of child might be needed. An important goal is to identify diseases and condition that manifest themselves through abnormal growth (Van Buren et al, 2004).

A study done by Lipman et al shows that many children were measured with inaccurate equipment and techniques which results in inaccurate measurements. The study showed that incorrect techniques used when obtaining linear measurement is a major factor contributing to inaccuracy. In the study 70 % of the students were weighed incorrectly (Lipman et al 2004).

The oxford district growth screening program was a community based survey of heights of children at 3 and 4.5 years of age. Over the 3 years period 20338 children were screened for growth monitoring. The mean SD score for boys and girls were 0.33 and 0.35 respectively at age 3 and 0.20 and 0.26 at 4.5 years. The mean growth velocity of 2742 children measured at 3 and 4.5 years of age was same as that of the national standards, 7.14 cm/year in boys and 7.12 cm/ year in girls (Ahmed et al 1993).

A growth dynamics and weight transition study in India done by Raj et al in Ernakulam District showed the weight and height measurement taken at two point of time. A population of 25228 children was selected from schools. The paired data of 12129 children aged 5-6 years were analysed for the study. The mean interval between two survey was 2.02 ± 0.32 years. The percentage of underweight, normal weight, overweight and obese children in the first year was 38.4 %, 56.6 %, 3.7%, and 1.3 % respectively. The corresponding figures in next year were 29.9 %, 63.6 %, 4.8 % and 1.7% respectively. The study highlights that there was significant difference in trends between socio demographic groups regarding conversion of underweight status to normal weight as well as normal weight status to overweight (Raj et al, 2009).

The school age period has been called the latent period of growth. The rate of growth slows down and the body changes occur very gradually. Resources however are being laid down for the growth needs to come in the adolescent period and it is some time a lull before the storm. The body type is established. Growth rates vary widely within this period. Girls usually outdistance boys by the latter part of the period.

SUMMARY

Thus from the review we can come to the conclusion that prevalence of malnutrition among children is very high in India, especially in rural areas. We also know that school going children are the neglected group. School children are hardly thought of as at risk population. But consequences of malnutrition increases manifold in this age. Thus to reduce the prevalence of malnutrition along with iron deficiency anemia is very important. Growth monitoring is one of the most useful tool for eliciting the data on prevalence and tracking of malnutrition in rural areas.

Iron deficiency affects many age groups but school age is the least identified group. There are very few studies carried out in India for weekly IFA supplementation in school setup. Majority of the studies are done on younger children. The combined effect of IFA supplementation and deworming on growth, hemoglobin status and physical work capacity is also not studied in rural area where the chances of worm infestation are very high due to unhygienic conditions.

This group suffers ignorance at the hands of policy makers in terms of preventive strategies to control iron deficiency anemia. As made clear in the preceding paragraphs, iron deficiency has short term as well as long lasting effects which can be easily prevented by adopting supplementation as the strategy. Since the target group is school children, school becomes an obvious medium for such preventive strategy. It becomes important to come up with feasible supplementation schedule which are not burden on teachers. Therefore weekly supplementation along with deworming was tried in the study.

Methods & Materials

Malnutrition is the world's most grave health problem and the single biggest contributor to child mortality. Under nutrition is not just a state, but a process whose consequences often extend not only in later life, but also into future generations. Deficiencies of key vitamins and minerals continue to be pervasive and they overlap considerably with problem of general under nutrition. The prevalence of underweight children in India is among the highest in the world. This period is characterized by an exceptionally rapid rate of growth. School provides the most effective and efficient way to reach large portion of the population. MDM (Mid Day Meal) is currently going on all over India and in Gujarat. We need to relook at the prevalence of malnutrition and IDA (Iron Deficiency Anemia) and come out with cost effective remedial techniques to tackle it. Thus the present study was carried out in the rural government schools of Vadodara to study the growth dynamics of rural school children over a period of 3 years and to see the impact of weekly IFA tablet and deworming tablet on the growth, hemoglobin and physical work capacity of children.

MEDICAL ETHICS AND APPROVALS

The study was approved by the Institutional Medical Ethics Committee (Approval no. FCSc./FND/ME/45 dated 30/11/2009).

The following approvals were obtained for the study:

1. Permission from District Education Officer, Vadodara.
2. Permission from Principals of schools.
3. Individual consent from parents of school children for drawing blood.

PHASES OF STUDY

The study was divided into three phases

Phase 1: Formative Research on nutritional status of school going children of rural Vadodara

Phase 2: To study the growth dynamics of children by longitudinal data (three years).

Phase 3: **A** Impact evaluation of Weekly IFA tablet and deworming tablet on the growth, hemoglobin and physical work capacity of children.

Phase 3: B The long term impact of the intervention for the period of 6 months.

SAMPLE SIZE ESTIMATION

For the number of children to be included in a research study, the sample size of the study is an important consideration in designing the research. The simple formula for determining the sample size is as follows:

$$\mathbf{N=16p\ (100-p)/w^2}$$

Where,

P = estimated prevalence based on earlier study or pilot trial

W= Width of confidence interval

e.g. if the interval is 95 % the width will be 10 (±5)

Now for the following study, considering the prevalence of malnutrition to be 60 % the sample size was estimated as follows:

$N = 16 \times 60\ (100-60)/\ 10^2$

$= 384$

Thus the sample size for the study was taken keeping the prevalence rate of malnutrition in Vadodara in children (G.W. Lasker & C.G.N. Mascie Taylor, 1993).

PHASE 1: NUTRITIONAL ASSESSMENT OF THE RURAL CHILDREN

The major objective of doing the cross sectional study was to assess the magnitude of malnutrition and anemia problem among adolescent school children and to arrive at the determinants of it.

SAMPLE SELECTION

The present study was conducted in the **rural petrochemical area** of Vadodara district, Gujarat. The petrochemical area was divided into six identical zones. All the schools which gave permission to carry out the study were taken. One representative school from each zone was randomly selected. All the children from 1st to 7th standard of the school were enrolled for the study. The total number of registered children was 3170 out of which data could be collected on 2282 children. Exclusion criteria included the children who could not be contacted in 3 consecutive visits. There was almost 28 % of absenteeism in rural schools. The rate of absenteeism was high in the rural area as parents were not that proactive in sending their children to school. For some children the school was far off so they avoided coming to the school. In the rural area the problem of migration for livelihood is also there. The experimental plan for phase 1 is given in Figure 3.1

Anthropometric measurements were done in all the schools. All the children from 1st to 7th standard were assessed. The questionnaire on dietary pattern was to be administered in school itself. Children of 1st to 3rd standard were too small to accurately report their dietary pattern. So students from 4th to 7th standard were assessed. The main aim of clinical sign and symptom was to see the co-relation between invasive and non invasive method. So clinical sign and symptoms assessment was done in 3 schools in which intervention was to be done. All the children from 1st to 7th standard were assessed. For hemoglobin estimation, students from 4th to 7th standard were enrolled. Younger children of 1st to 3rd standard were not at all supportive for invasive technique so were not involved.

The following data was collected on all the children:

A) Socio-economic data (Annexure 1)

B) Anthropometric data (Height, Weight, Waist & Hip circumference)

C) Clinical signs and symptoms (Annexure 2)

D) Three day dietary pattern (Annexure 3)

E) Biochemical estimation of Hemoglobin

The Table below gives an overview of sample distribution

Table 3.1: Overview of sample distribution

Parameters	No. of Schools	Standard	Sample Size
Anthropometric measurements	6	1^{st} to 7^{th}	2282
3 Day Dietary pattern	4	4^{th} to 7^{th}	906
Clinical signs and symptoms	3	1^{st} to 7^{th}	960
Hemoglobin	4	4^{th} to 7^{th}	865

FIGURE 3.1: EXPERIMENTAL PLAN

PHASE I: FORMATIVE RESEARCH ON NUTRITIONAL STATUS OF SCHOOL GOING CHILDREN

RURAL SCHOOLS OF PETROCHEMICAL AREA

N = 48

DIVIDED INTO SIX ZONES

RANDOM SELECTION OF ONE SCHOOL FROM EACH ZONE

6 SCHOOLS

1^{ST} TO 7^{TH} STANDARD

BACKGROUND INFORMATION

ANTHROPOMETRIC PROFILE

CLINICAL EXAMINATION

DIET HISTORY

DATA COLLECTION

The tools used to elicit the data collection are given below

Table 3.2: Tools used for data collection

Indicator	Procedure
Socioeconomic status	Structured interview
Weight	Digital Bathroom Scale
Height, waist, Hip	Fiber glass tape
Dietary Pattern	Structured interview
Hemoglobin	Cyan met hemoglobin method
Clinical signs and symptoms	Structured interview

METHOD

1) **Socio- economic status**

Information on the socio- economic profile was collected using a pre-tested structured questionnaire (Appendix 1). Information regarding age, sex, religion, family members, parent's education and occupation, per capita income etc. was collected. Information on date of birth of children was verified from the school records. Some socio economic information like income, occupation of parents were also available in school records.

2) **Anthropometry**

A) Weight

Weight measurement was done for all the children using a calibrated digital weighing scale. It is portable and can be conveniently used in the field. The subject was asked to stand erect on the scale without touching anything, with no heavy clothing and footwear and looking straight ahead. The instrument was calibrated daily using 5kg sand bag.

B) Height

Height measurements of all the subjects were taken using a flexible, non- stretchable fiber glass tape. The tape was fixed vertically on a smooth wall of the school perpendicular to the ground, ensuring that the floor was smooth. The subject was asked to stand erect with the shoulder, hips and heels touching the wall and with no footwear, heels together and looking straight ahead. The head was held comfortable erect, arms hanging loosely by the sides. A thin smooth scale was held on the top of the subjects head in the center, crushing the hair at the right angles to the tape and the height of the subject was read from the lower edge of the ruler to the nearest 0.1 cms.

C) Waist to hip ratio

Waist and hip circumference were measured with the fiber glass tape. For waist circumference the subjects were made to stand facing the observer and then waist was measured at the right above the naval and the measurement with the abdomen in normal position i.e. neither it was inflated not pulled inside (Lohman 1998). For hip measurement, subject was made to stand sideways facing the observer and the maximal circumference of hip was taken (WHO 1995).

3 Dietary component

The dietary information was elicited using a structured questionnaire. Dietary pattern for 3 days (which included two working and one non working day), consumption of MDM at school were also collected. The food behavior checklist (Annexure 3) was administered for 3 days to ascertain the trend. Frequencies for consumption of breakfast, lunch, vegetables and fruits were also looked into.

4. Clinical signs and symptoms

The children were examined for clinical signs and symptoms by the pediatrician of SSG hospital. Clinical signs and symptoms were studied for micronutrient deficiencies for iron, iodine and vitamin A deficiency using the WHO criteria. Information regarding common morbidities such as worm infestation, cough, cold, fever, headache and stomach ache was obtained as a part of morbidity profile using a reference period of 15 days (WHO, 1998).

5 Biochemical parameters

- **Hemoglobin**

Two Laboratory technicians trained to draw children's blood were taken to the schools for collection of blood sample. Disposable lancets were used. On the same day, the blood samples were sent for analysis to Thyrocare Laboratories, Vadodara. Hemoglobin was estimated by Cyanmet Hemoglobin method (INACG 2004).

Principle

On treating haemoglobin with Drabkin's reagent, haemoglobin present in blood reacts with potassium ferricyanide forms methaemoglobin and this compound is reduced by potassium cyanide to form cyanmethaemoglobin a rust colored compound, which is estimated spectrophotometrically at 540 nm.

Standardization

Cyanmethaemoglobin reference standard was obtained from "Qualigens Pvt Ltd". Spectrophotometer was calibrated using this method.

Procedure

Suitable aliquot of 0.75 ml, 2.25 ml and 3.75 ml haemoglobin standard was taken in separate test tubes and the volume was made up to 5ml by Drabkin's solution. In one test tube undiluted aliquot of 5 ml was taken as top standard. These were read at 540 nm on a spectrophotometer after 30 minutes after adjusting the instrument to zero with blank solution (Drabkin's reagent). A factor for estimation of haemoglobin was calculated from the optical density obtained.

The estimation of haemoglobin was done according to the following steps:

- Any one finger of the hand was selected specifically the middle one. It was then wiped with a cotton swab dipped in ethanol and was allowed to dry.
- Then with a disposable lancet a bold prick was made.
- The first drop of blood was wiped off.
- Then a big drop of blood was allowed to form on the finger and then 20 µl of blood was pipetted using a calibrated micropipette.
- The blood sample was added to 5 ml Drabkin's reagent and mixed thoroughly.
- This solution was allowed to stand (away from sunlight) for 30 minutes before being read on a spectrophotometer at 540 nm.
- Duplicate samples were collected from each subject.

PHASE II: UNDERSTANDING GROWTH DYNAMICS THROUGH LONGITUDINAL STUDY

One of the objectives of the current study was to assess the growth pattern of school children. To achieve this objective, in addition to the cross sectional component of the study, a longitudinal component was also conducted

STUDY DESIGN

Four schools were selected and finalized for this phase of the study. The school finalized for this phase was primarily based on the cooperation from the principal and agreeability for conducting the study for the next 3 years. Thus every year the school was visited in the month of July for data collection to ensure the completion of one year**.**

STUDY SAMPLE

In the first year, all the children from 1st to 7th standard were enrolled for the study. Anthropometric measurement i.e. height and weight were recorded for all the children. In the first year, data was collected on 2282 children of which 1094 were girls and 1188 were boys. In the second year same children were followed up. Looking at the dropout rate and the pass out children of 7th standard on whom the data could not be collected, the sample size became 1555 children. In the third year, keeping the same criteria anthropometric data could be collected on 465 children; 227 boys and 238 girls.

PROCEDURE

Height was measured by wall mounted fibre glass tape with the least count of 0.5 cms. Weight measurement was taken by standardized digital bathroom scale with the least count of 0.1Kgs. Both the equipments were standardized at regular interval.

A total of 465 children had 3 pair of data for consecutive 3 years. Paired data of these children were used for studying dynamics of growth and weight trends in the study population. The reference data used to identify the BMI cutoffs as well as conversion of weight and height to Z score were taken from CDC 2000 data set and WHO 2007 data set for growth parameters in children.

Age in months was used for converting BMI, weight and height to Z score as per CDC and WHO references. The cohort was divided into various sub groups for further analysis. Z score <-2 SD for weight for age was considered underweight, Z score <-2SD for height for age was termed stunting and Z score <-2SD for BMI was termed as thinness.

PHASE III: IMPACT OF WEEKLY IRON FOLIC ACID (IFA) SUPPLEMENTATION ALONG WITH TWICE A YEAR DEWORMING TABLET ON GROWTH, HEMOGLOBIN STATUS AND PHYSICAL WORK CAPACITY OF SCHOOL CHILDREN

For this phase, the intervention study was carried out using a randomized control trial. From the six schools, 3 schools were randomly selected and allotted in any one intervention group.

SCHOOL 1: Control Group – No Intervention – Standard Care was maintained

SCHOOL 2: Once weekly IFA+ Deworming twice a year

SCHOOL 3: Only Deworming twice a year

For IFA supplementation, 60 mg elemental iron + 0.5 mg Folic acid was given in the form of tablet. The supplementation was given for 30 weeks. For deworming, 400 mg Albendezole tablet was given twice a year.

This was a supervised trial and to monitor the regular consumption of the tablets, proper compliance sheets were maintained for all the 30 weeks. If a child was absent on the day of distribution of tablets, he/she would be given it on the next day. During the three week's Diwali vacation, each child was given 3 IFA tablet in a pouch to consume every week during vacation. After the vacation, the compliance for these tablets was also seen.

The pre - post data was collected on the children after 30 week intervention period. The long term impact of the intervention was also looked in the study. After a period of six months, were no intervention was given in any group, the data was again collected for growth parameter and haemoglobin status.

The time frame for the study in a nut shell is given in Table 3.3.

Table 3.3: Time Frame of the Study

Details	Control Group	Experimental Group 1	Experimental Group 2
Pre Data	June- July 2009	June- July 2009	June- July 2009
Intervention	Standard Care	IFA+DW	DW
IFA Tablets	-	August 2009 to February 2010 30 Weeks	-
Deworming		400 mg (July 2009) & 400 mg (January 2010)	400 mg (July 2009) & 400 mg (January 2010)
Post Data	15th March 2010		
Washout Effect	September 2010		

The experimental plan for this phase is given in Figure 3.2

The following data was collected in this phase:

- Anthropometric Measurements (Height, Weight)
- Hemoglobin Estimation
- Step Test

The overview of sample size is given in Table 3.4. The number of children on whom data was collected for each of the above parameter is also given. The dropout rate for each parameter is also taken into consideration. The dropout rate for this phase of study ranged from 17 % to 40 %. This was because of high rate of absenteeism in the school. The dropout rate was high for hemoglobin estimation as it is an invasive method and as the children had given blood during pre data collection, some of them refused to give consent second time.

FIGURE 3.2: EXPERIMENTAL PLAN

PHASE III: INTERVENTION STUDY

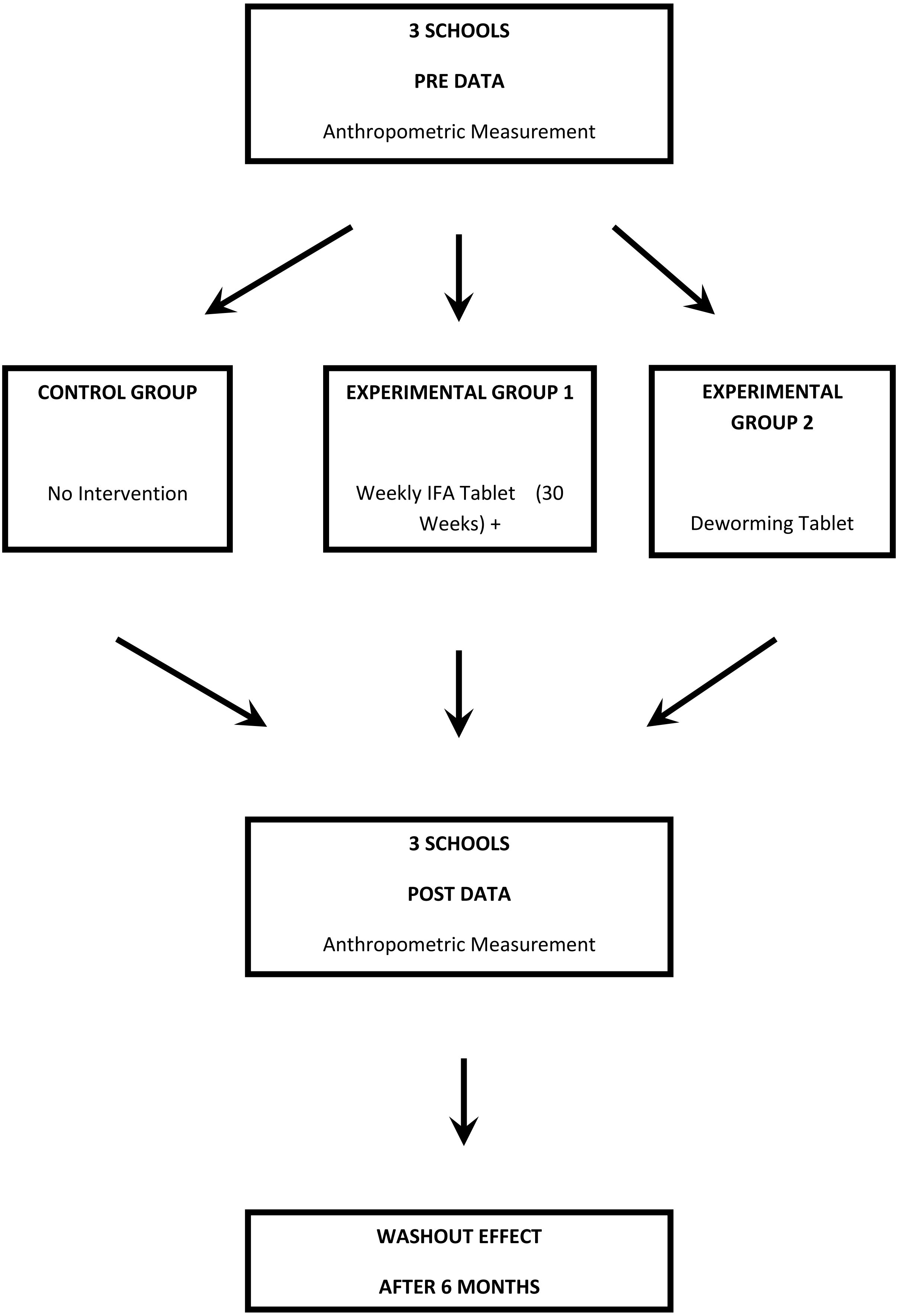


Table 3.4: Overview of Sample size for phase III

Parameters	**Control**	**IFA+DW**	**DW**
Anthropometry			
Pre	210	322	195
Post	153	215	128
Drop out	**57(27.1)**	**107(33.2)**	**67(34.3)**
Step Test			
Pre	153	273	184
Post	131	191	153
Drop out	**22(14.3)**	**82(30.0)**	**31(16.8)**
Hemoglobin			
Pre	185	331	230
Post	108	230	161
Drop out	**77(41)**	**101(30.5)**	**69(30)**

Values in parenthesis indicate percentage

DATA COLLECTION

The tools used to elicit the data collection are given below:

Table 3.5: Tools used for data collection

Indicator	**Procedure**
Weight	Digital Bathroom Scale
Height, waist, Hip	Fiber glass tape
Hemoglobin	Cyan met hemoglobin method
Step Test	Steps and Oximeter

METHODS

The methodology of data collection for anthropometry and hemoglobin estimation has been described in detail in the first phase of the study.

Step Test

An accurate way to assess fitness and physical work capacity is to complete a maximal aerobic test which records and measures the heart rate and oxygen consumption. There are many tests for assessing the aerobic capacity. One such test is the step test. Step test is based on heart rate recovery following a given work load. The pulse rate and the saturated peripheral oxygen readings were taken with the help of fingertip pulse oximeter p1. The make was ASPEN DIAGNOSTICS PVT Ltd. It is ISO 9001:2000 certified company. The oximeter gave the digital out put for saturated peripheral oxygen and pulse rate.

Step test was performed on all the children from 4^{th} to 7^{th} Standard to measure their physical work capacity. To perform this test, a 20 cm stool was designed for the children. The pulse rate per minute for each children was noted. The saturated peripheral oxygen reading was also taken. Then the children were administered the step test in which he/she had to step on the stool for 3 minutes. The numbers of steps were counted. After 3 minutes again the pulse rate and saturated peripheral oxygen reading was taken.

Principle of Pulse Oximeter

A pulse oximeter measures and displays the pulse rate and the saturation of hemoglobin in arterial blood. This saturation of hemoglobin is a measure of the average amount of oxygen bound to each hemoglobin molecule. The absorption of visible light by a hemoglobin solution varies with oxygenation. The chemical binding of the different types of hemoglobin species changes the physical properties of the hemoglobin as well. The oxygen chemically combines with hemoglobin inside the red blood cells makes up nearly all of the oxygen present in the blood (there is also a very small amount which is dissolved in the plasma).

Oxygen saturation, which is often referred to as SaO2 or SpO2, is defined as the ratio of oxyhemoglobin (HbO2) to the total concentration of hemoglobin present in the blood

$$SaO_2 = \frac{HbO_2}{(HbO_2 + Hb)}$$

Oxyhemoglobin (HbO2) and hemoglobin (Hb), have significantly different optical spectra in the wavelength range from 600nm to 1000nm, as shown in Figure 1

The P.O Pro will measure Arterial SaO2 and express it as a percentage. Under normal physiological conditions arterial blood is 97% saturated, while venous blood is 75% saturated. The difference in absorption spectra of HbO2 and Hb is used for the measurement of arterial oxygen saturation because the wavelength range between 600 nm and 1000nm is also the range for which there is least attenuation of light by body tissues (tissue and pigmentation absorb blue, green and yellow light and water absorbs the longer infra-red wavelength).

The half power spectral bandwidth of each LED is approximately 20-30nm. The LED's and photodiode chips are to be mounted on separate ceramic substrates. A small amount of clear epoxy resin will be applied over the LED's and photodiode for protection. Recessing and optically shielding the LED's and photodiode inside the sensor will minimize undesired specular light reflection from the surface of the skin and from the direct light path between the LED's and photodiode.

Oxygen saturation is divided into three ranges: normal saturation, high saturation, and hypoxic condition (low saturation level).

- High saturation (greater than 97.5%)
- Normal saturation (90 to 97.5%)
- Low saturation (less than 80%)

The normal pulse rate for humans ranges from 70 to 80 beats per minutes. The pulse oximeter is one of the most important advances in noninvasive monitoring because it provides a means of continuously and quickly assessing arterial blood oxygenation (Barker, 1987).

DATA ANALYSIS

The data was entered into Microsoft excel spreadsheet and then subjected to appropriate statistical analysis using Microsoft excel data analysis package for calculating mean and standard deviation. The entered data of excel was imported into epi info 6 package and Z scores were derived by the CDC 2000 standards for undernutrition. Z scores by WHO 2007 standards were derived by Anthro plus package of WHO. The percent consumption of Mid Day Meal by children was arrived by the number of registered children for the month. 95 % confidence interval was calculated using formulas in the excel spread sheet. In the longitudinal phase of the study, anthopometric transitions were assessed by converting the corresponding parameter to Z score through epi info and WHO anthro package and their means were compared. Paired sample test was used for comparing individual group time transition. Chi square test was used for comparing weight transition among subgroups. Significance was assigned for a p value < 0.05. Nutrition trend analysis was done keeping the track of shift in individual nutritional status in 3 years. In the intervention phase apart from the anthropometric indices, F value were calculated to check the variation between the three intervention arms, while t test was used to check the significance level of intervention before and after the study period.

Results & Discussion

The results of the study are described under 3 sections.

- Section I: Formative Research: Nutritional status of school going children of rural Vadodara.
- Section II: Longitudinal Research: To study the growth dynamics in children by longitudinal data (three years).
- Section III: Intervention Research: Impact evaluation of Weekly IFA tablet and deworming tablet on the growth, haemoglobin and physical work capacity of children and to see the long term impact.

SECTION I: FORMATIVE RESEARCH: NUTRITIONAL STATUS OF SCHOOL GOING CHILDREN OF RURAL VADODARA.

School Profile

The rural industrial area of Vadodara district was selected for the study. There were in all 45 municipal schools in this area. The whole area was divided into six zones. From each zone 1 representative school was randomly selected. Thus in all 6 schools were included for the study. The details of the schools selected are given in **Table 4.1.1.**

The school profile of the selected schools was collected from each school. The school profile included the information on number of teachers; strength of boys and girls in the school, facilities available in the school premises like play ground, audio visual room, computer room, availability of adequate rooms for the children and the functioning of Mid Day Meal. **Table 4.1.2** shows all the facilities available in the school premises.

The teacher to student ratio was on an average 1:40 in 6 schools, while boys to girls ratio was 1:0.94. Canteen facilities or sports room was not available in any school. Audio visual room was available in 3 schools where TV and DVD

Table 4.1.1: List of Schools selected from Rural Industrial belt of Vadodara

Sr. No	School	Area
1	Indira Nagar	Koyli
2	Bhathiji nagar	Chhani
3	Bajwa –3	Bajwa
4	Undera 1	Undera
5	Karodiya	Dashreth
6	Ranoli Boys	Ranoli

Table 4.1.2: Facilities available in Six school campus for the children

Sr. No	Variable	(%)
1	Teacher to student ratio	1:40
2	Boys to girls ratio	1:0.94
3	Canteen Facility	Not Available
4	Sports Room	Not Available
5	Audio Visual room	50
6	Play ground	100
7	Computer Room	66
8	School health check up	50
9	Mid Day Meal Facilities	100

player was provided. Multimedia programs for the children were played once a week over here. Playground was available in all the schools. This ground was also used to assemble children for consuming MDM. Computer room was available in 4 schools. One computer each was present in the school that too was not in working condition. Health check up was done once a year by government physician in 3 schools only. MDM facility was available in all the schools.

Children enrolled for the study

All the children from 1st to 7th standard from the 6 schools were enrolled for the study. The total number of registered children was 3170, out of which data could be collected on 2282 children. Exclusion criteria included the children who could not be contacted in 3 consecutive visits. There was almost 28 % of absenteeism in rural schools (**Table 4.1.3**).

Age Distribution of Children

The 2282 children enrolled for the study were from the age of 5 to 13 years. The age distribution of the children is shown in **Table 4.1.4**. There was almost equal representation of all the age group in the sample studied.

Socio Economic Status

The data revealed that majority (84%) of the subjects were hindus. Caste wise bifurcation showed that half of the study population was schedule caste or schedule tribe. Gender wise analysis for caste showed that the enrollment for girls was lower in schedule caste and schedule tribe as compared to general category group. The economic status revealed that the family income of 2/3rd (70%) of the children was lower than Rs. 6000 per month (**Table 4.1.5**).

Table 4.1.3: Population covered for data collection

Sr.	Name of School		Boys	Girls	Total
1	Indira Nagar	N	139	149	288
		n	110	106	216
		%	**79.13**	**71.14**	**75**
2	Bajwa –3	N	323	302	625
		N	254	241	495
		%	**78.6**	**79.8**	**79.2**
3	Undhera	N	380	356	736
		n	303	261	564
		%	**79.7**	**73.3**	**76.6**
4	Karodiya	N	229	224	453
		n	129	129	258
		%	**56.3**	**57.5**	**56.9**
5	Ranoli Boys	N	477	-	477
		N	321	-	321
		%	**67.2**	**-**	**67.2**
6	Chhani Girls	N	-	440	440
		n	-	298	298
		%	-	**67.7**	**67.7**
	Total Registered			N	3170
	Total Contacted			N	2282
				%	**71.98**

N = Total Registered

n = Total contacted

% - % contacted of the total registered

Table 4.1.4: Distribution of Children According To Age

AGE (Years)	BOYS (N= 1188)	GIRLS (N=1094)	TOTAL (N=2282)
≤ 6	122	130	252
>6-7	153	133	286
>7-8	168	132	300
>8-9	154	158	312
>9-10	143	142	285
>10-11	132	152	284
>11-12	149	123	272
>12	167	124	291

Table 4.1.5: Socio Economic Status of the Study Population

Parameters	BOYS (N= 1188)	GIRLS (N=1094)	TOTAL (N=2282)
Religion			
Hindu	1009(84.9)	913(83.4)	1922(84.2)
Muslim	179(15.1)	181(16.6)	360(15.8)
Caste			
Schedule Caste	503(42.4)	404(36.9)	907(39.7)
Schedule Tribe	124(10.4)	74(6.7)	198(8.8)
General	552(46.4)	600(54.9)	1152(50.5)
Others	9(0.8)	16(1.5)	25(1)
Income (Rs)			
2000-4000	405(34.0)	438(40)	843(36.9)
>4000-6000	552(46.5)	448(41)	1000(43.8)
>6000-8000	208(17.5)	183(16.7)	391(17.2)
>8000-10,000	23(2)	25(2.3)	48(2.1)

Values in the parenthesis indicate percentage

Anthropometric Measurements

Mean weight and height of the children were segregated according to gender i.e. boys and girls and is presented in **Table 4.1.6** and **4.1.7.** The mean weight of the girls was slightly lower than boys under 9 years of age. After 9 years reverse trend was seen. Such trend was not seen for height parameter. Height growth was more or less similar for both boys and girls. The mean height increase was higher in 6-8 years of age. The second growth spurt was found between 10-12 years, where there was mean increase of 6 cms each year. Here the height of the boys was distinctly higher as compared to the girls of the corresponding age. The weight of the girls in the age above 12 years was also higher than boys.

The BMI of the children was also calculated age wise and gender wise. **Table 4.1.8** shows that most of the subjects had a BMI between 13-15 Kg/m^2. A catch up growth was depicted in the case of girls after 9 years of age while similar trend was not seen for boys. This trend was seen because the weight of girls was increasing after 9 years of age while height growth was almost similar in both the genders. BMI also crossed 15 Kg/m^2 in case of girls above 15 years of age unlike boys of the same age group

Prevalence of Malnutrition

Based on the anthropometric measurements obtained for the children, the prevalence of malnutrition was calculated using CDC 2000 standards and the WHO 2007 standards. Prevalence of malnutrition was estimated by the Z scores derived as the output result.

The prevalence of malnutrition in the study subjects is shown in **Table 4.1.9.** The comparison was done between CDC standards and new WHO 2007 Standards. The number of children included for weight for age i.e. prevalence of underweight was only 1430 as only children less than 10 years of age were included. This is because in WHO 2007 weight for age reference data are not

Table 4.1.6: Mean Weights Of The Children Cross Tabulated By Age And Sex

AGE GROUPS (Years)	WEIGHT OF THE SUBJECTS (KG) MEAN±SD		
	BOYS (N=1188)	GIRLS (N=1094)	TOTAL (N=2282)
≤ 6	122 15.11±2.16	130 14.33±2.0	252 14.7±2.11
>6-7	153 15.99±1.95	133 15.72±2.40	286 15.87±2.17
>7-8	168 18.36±5.35	132 17.3±2.93	300 17.89±4.48
>8-9	154 19.77±2.94	158 19.46±8.7	312 19.61±6.56
>9-10	143 21.7±3.63	142 22.9±13.68	285 22.3±100
>10-11	132 23.56±3.48	152 23.9±4.34	284 23.7±3.97
>11-12	149 25.8±5.5	123 26.60±5.21	272 26.20±5.42
>12	167 29.97±6.8	124 31.33±7.36	291 30.55±7.10

Table 4.1.7: Mean Heights Of The Children Cross Tabulated By Age And Sex

AGE GROUPS (Years)	HEIGHT OF THE SUBJECTS (Cms) MEAN±SD		
	BOYS (N=1188)	GIRLS (N=1094)	TOTAL (N=2282)
≤ 6	122 106.6±6.14	130 105.0±5.8	252 105.81±6.01
>6-7	153 111.3±5.9	133 110.49±6.43	286 110.92±6.15
>7-8	168 116.38±10.43	132 116.40±7.13	300 116.39±9.11
>8-9	154 122.83±7.95	158 120.2±6.45	312 121.5±7.35
>9-10	143 127.4±6.52	142 126.9±6.75	285 127.19±6.64
>10-11	132 131.59±6.6	152 132.3±7.03	284 131.9±6.87
>11-12	149 135.6±7.7	123 136.7±7.46	272 136.14±7.64
>12	167 142.8±9.6	124 141.7±8.8	291 142.35±9.31

TABLE 4.1.8: Mean BMI of the Subjects Cross Tabulated By Age And Sex

AGE GROUPS (YEARS)	BMI OF THE SUBJECTS (Wt Kg/Ht m²) MEAN±SD		
	BOYS (N=1188)	GIRLS (N=1094)	TOTAL (N=2282)
≤ 6	13.26 ±1.36	13.0±1.3	13.1 ± 1.3
>6-7	12.9 ± 1.04	12.8 ±1.28	12.87±1.15
>7-8	13.1 ± 2.9	12.7 ± 1.2	12.9 ±2.4
>8-9	13.0 ±1.36	12.8 ±1.5	13.3 ±5.6
>9-10	13.28 ± 1.28	14.2 ± 1.1	13.7 ±1.0
>10-11	13.6 ± 1.6	13.6 ± 1.6	13.6 ± 1.64
>11-12	13.9 ±1.9	14.1 ± 1.8	14.02 ± 1.85
>12	14.5 ± 2.0	15.4 ± 2.4	14.9 ± 2.28

Table 4.1.9: Prevalence of Malnutrition by CDC and WHO 2007 criteria

Parameter	N	CDC 2000		WHO 2007	
		N (%)	95 % CI	N (%)	95 % CI
Wt/age Z<-2SD	1430	1001 (69.7)	66.8-72.5	917 (64.1)	61.5-66.6
Ht/age Z<-2SD	2282	720 (31.5)	28.0 – 34.9	704 (30.9)	29-32.8
BMI/age Z<-2SD	2282	1484(65.0)	62.6 – 67.4	1285 (56.9)	54.8-58.9

Values in the parenthesis indicate percentage

available beyond the age of 10 years as this indicator does not distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as having excess weight, when in fact they are just fine. The graphical representation of prevalence of underweight by both the standards is given in **Figure 4.1.1**

The prevalence of underweight was 70 % according to CDC 2000 standard while it was 64 % by WHO 2007 standard. There was no variation in the prevalence of stunting (height for age) by both the standards. The prevalence was 31.5 % and 30.9 % for CDC 2000 and WHO 2007 respectively **(Figure 4.1.2)**. Thinness (BMI for age) in the study population was very high (60 %) using both the classifications. Based on 95 % CI limits, the true prevalence for underweight and thinness was between 54.6-72.5 % indicating that malnutrition is very high among rural school children **(Figure 4.1.3)**. The prevalence of stunting ranged from 28-34.9 % signifying that nearly 1/3 rd of the rural school children had long standing chronic malnutrition.

Gender wise difference in the prevalence of Undernutrition was also looked into. **Table 4.1.10** shows the results as per the WHO 2007 classification. The prevalence of underweight (64%) was similar for both gender i.e. boys and girls with narrow confidence limits of 60.5- 67.5 When gender wise differences were looked into, it was observed that stunting was more in girls than boys (32.4 % vs. 30.8%), whereas thinness was more in boys than girls (71% vs. 64%).

Table 4.1.11 depicts the percent prevalence of severity of malnutrition. It can be seen from the table that only 10 to 12 % of the children fell into normal category as far as weight for age was concerned. One third i.e. 30 % of the children were normal and not stunted. There was much variation in the normal category for BMIZ by both the standards. By CDC standard, 12.9 % of children were in normal category while by WHO 2007 classification 20.7 % of the children fell into normal category. The prevalence of severe underweight children was 37 % by CDC standards while it was 27 % by WHO 2007 standards. Severe stunting was seen in almost 9 % of the children while

Figure 4.1.1: Prevalence of Underweight in school going children

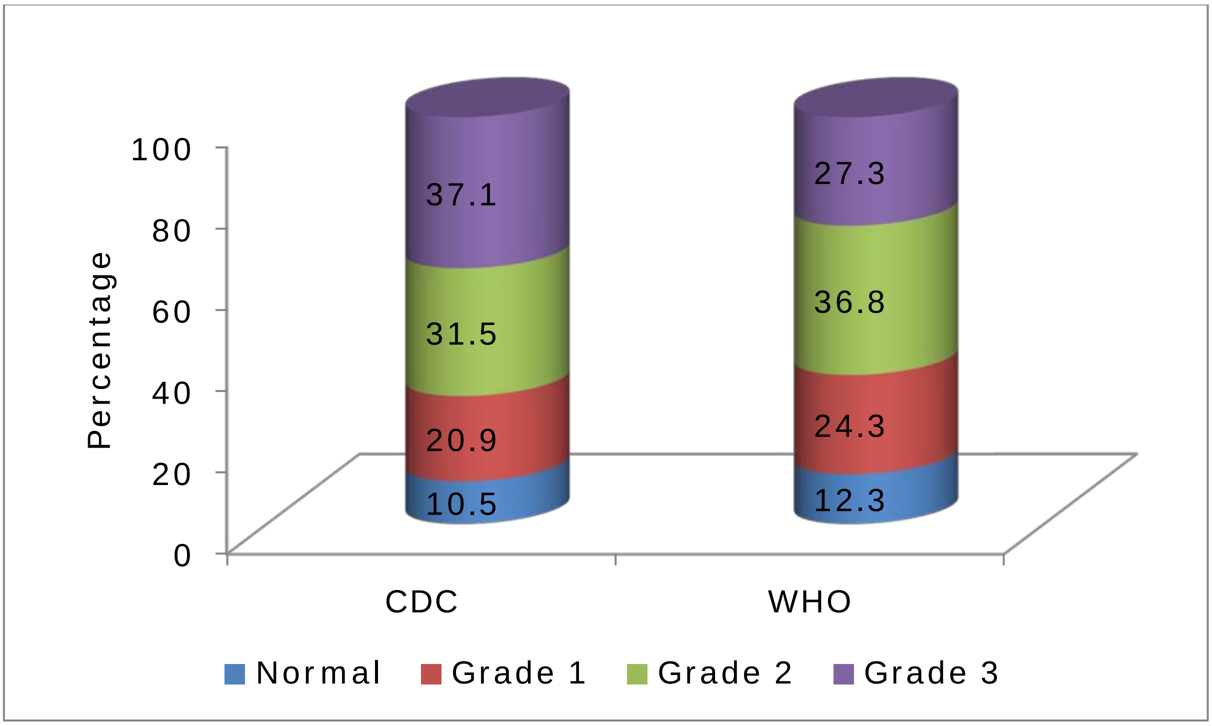


Figure 4.1.2: Prevalence of Stunting in school going children

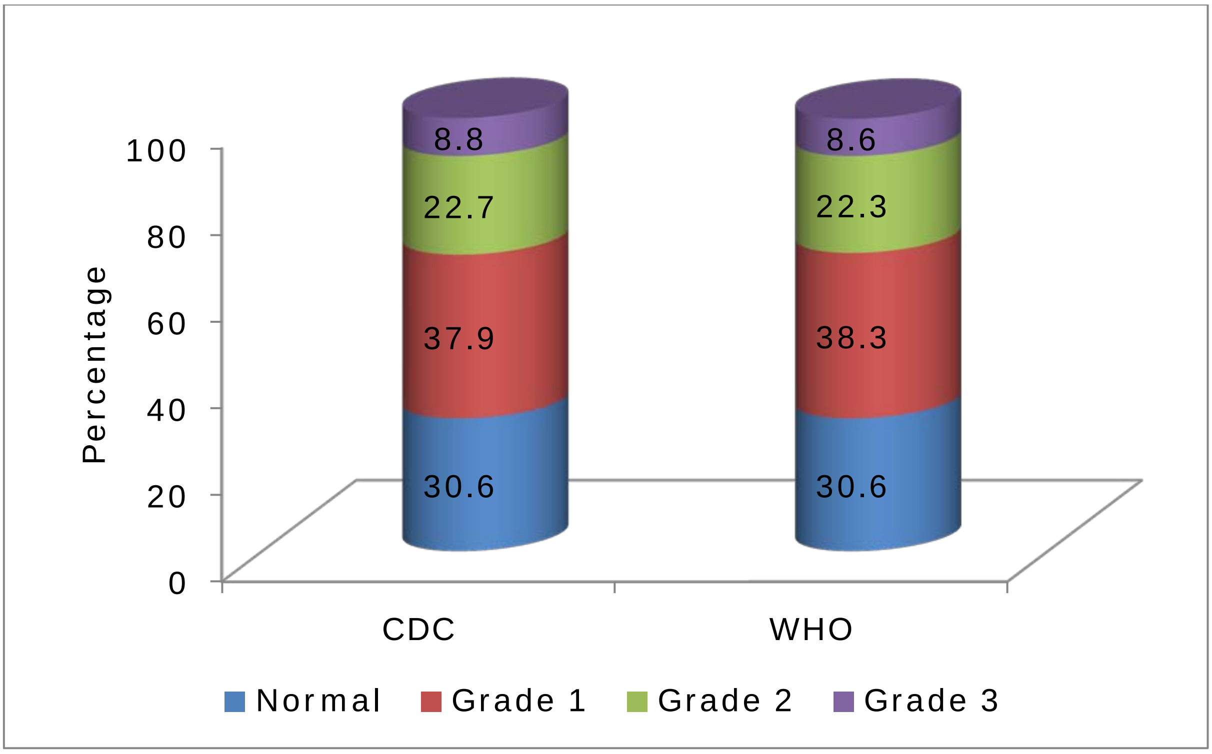


Figure 4.1.3 Prevalence of Thinness in school going children

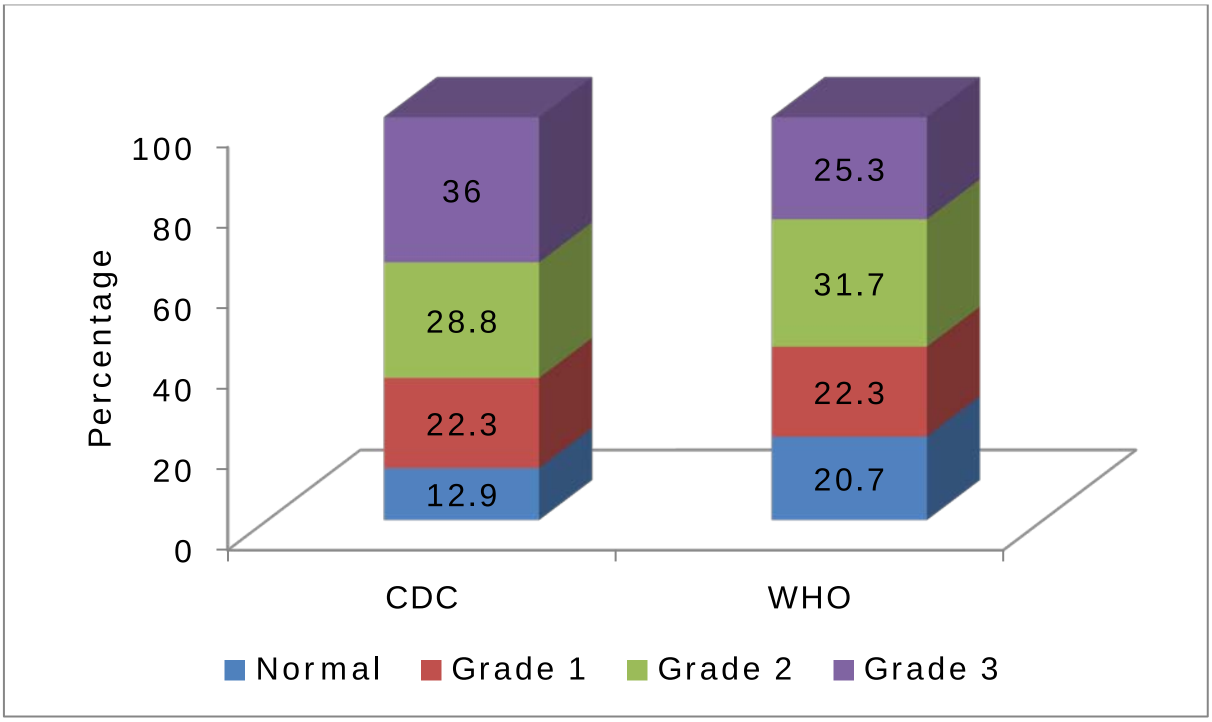


Table 4.1.10: Prevalence of malnutrition by WHO 2007 classification cross tabulated by gender

Parameter	Male		Female		Total	
	N (%)	**95 % CI**	**N (%)**	**95 % CI**	**N (%)**	**95 % CI**
Wt/age Z<-2SD	738 (64)	60.9-67.5	692 (64.2)	60.5-67.8	1430 (64.1)	61.5-66.6
Ht/age Z<-2SD	1185 (29.8)	27.1-32.4	1093 (32.1)	29.3-34.9	2278 (30.9)	29-32.8
BMI/age Z<-2SD	1169 (61.1)	58.2-63.9	1090 (52.4)	49.4-55.4	2259 (56.9)	54.8-58.9

Values in the parenthesis indicate percentage

Table 4.1.11: Percent prevalence of severity of malnutrition for anthropometric Indices

	Weight for age		Height for age		BMI for age	
	CDC	**WHO**	**CDC**	**WHO**	**CDC**	**WHO**
Normal	10.5	12.3	30.6	30.6	12.9	20.7
Grade 1	20.9	24.3	37.9	38.3	22.3	22.2
Grade 2	31.5	36.8	22.7	22.3	28.8	31.7
Grade 3	37.1	27.3	8.8	8.6	36	25.2

prevalence of severe thinness was 36 % according to CDC standards and it was lower (25 %) by WHO 2007 standards.

Table 4.1.12 shows the gender wise prevalence of malnutrition by both the classification. By WHO 2007 classification the prevalence of Undernutrition was similar in both girls and boys while there was difference of almost 3 % by CDC standards. The prevalence of underweight seemed to be higher in boys as compared to the girls. The prevalence of stunting was similar in girls and boys. The prevalence of thinness was more in boys as compared to girls by both the standards. Overall after comparison it can be seen that CDC standards over estimates the prevalence of all the indices i.e. underweight, stunting and thinness. The comparison of BMI for age and gender as per the WHO 2007 standards is shown in **Figure 4.1.4.**

Age wise prevalence of undernutrition scenario was also looked in **Table 4.1.13.** It can be seen from the emerging trends that prevalence was slightly low in children less than 6 years of age but then it peaks up and remains high throughout the childhood.

Clinical signs and symptoms

The data on prevalence of micronutrient deficiencies related to iron, iodine and vitamin A could be elicited from 960 children. The prevalence of deficiencies was assessed through clinical signs and symptoms. The symptoms for micronutrients were listed and a government recognised paediatrician was deputed to assess the children. The signs and symptoms for iron deficiency were swollen tongue, brittle nails, pale skin, angular stomatitis, fatigue and pallor. The symptoms for Vitamin A deficiency were conjunctival xerosis, Bitot spot, corneal ulceration, xeropthalmic fundus, night blindness, corneal xerosis, corneal scar and eye infection. Iodine deficiency was assessed by the varying degree of goitre prevalence **(Figure 4.1.5)**.

Table 4.1.12: Gender wise percent prevalence of Malnutrition by CDC 2000 and WHO 2007 criteria

Nutritional Status	Boys	Girls	Total
WAZ			
CDC	70.2	67.1	68.6
WHO	64	64.2	64.1
HAZ			
CDC	30.6	32.4	31.5
WHO	29.8	32.1	30.9
BMIZ			
CDC	69.5	60.1	64.8
WHO	61.1	52.4	56.9

Figure 4.1.4 Age wise trend in the prevalence of malnutrition in the children as per WHO standards

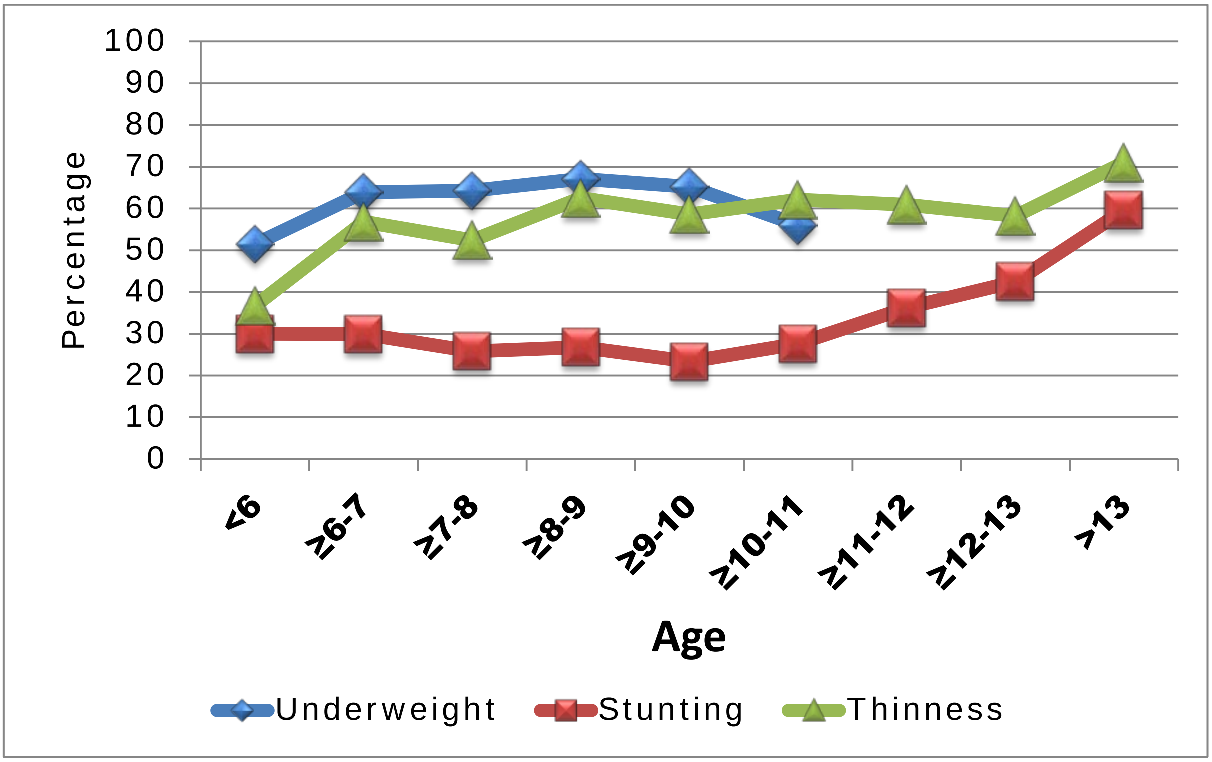
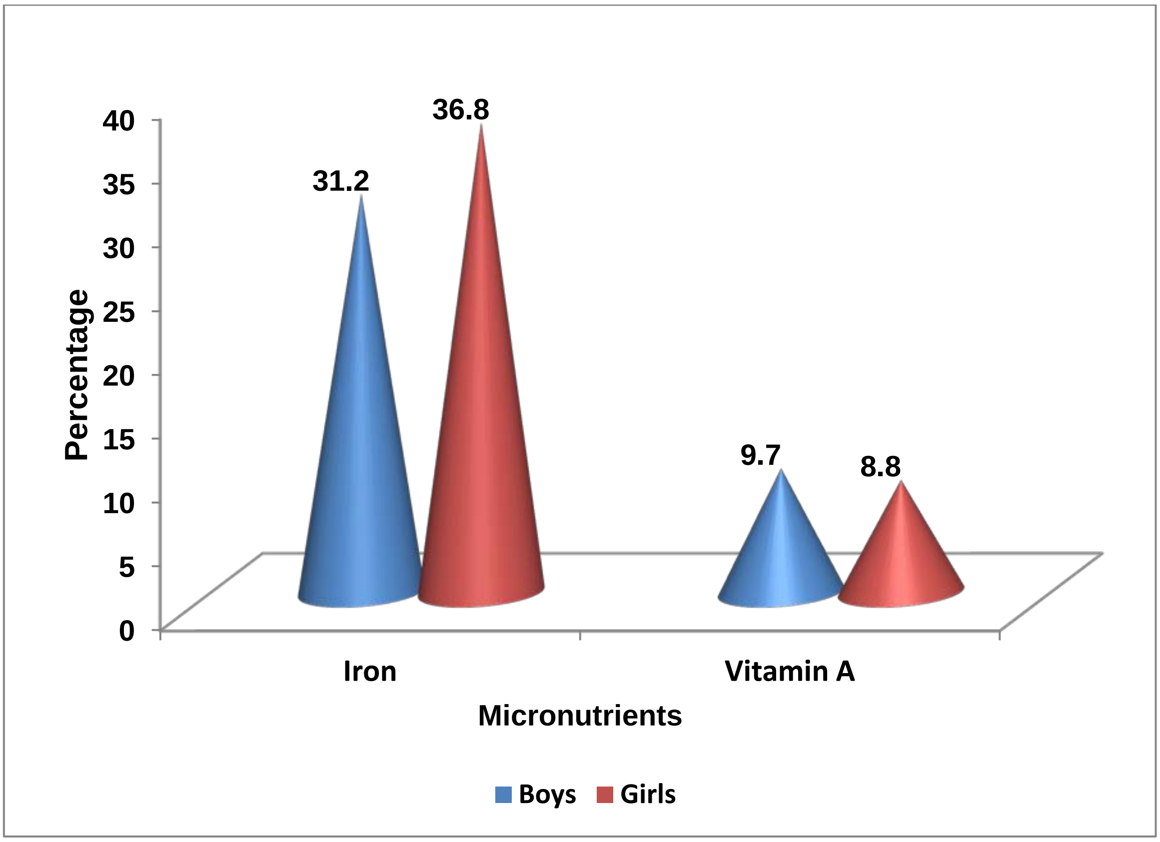


Table 4.1.13: Age wise percent prevalence of undernutrition by WHO 2007

Age (Y)	Weight for age	Height for age	BMI for age
< 6	51.5	30	36.7
≥ 6-7	63.9	29.9	56.8
≥ 7-8	64.3	25.8	52.4
≥ 8-9	67.1	26.8	62.5
≥ 9-10	65.2	23.3	58.6
≥ 10-11	56	27.6	62.1
≥ 11-12	NA	36.2	60.9
≥ 12-13	NA	42.5	58.2
> 13	NA	59.6	71

Figure 4.1.5 Prevalence of clinical signs and symptoms of micronutrient deficiencies



Iron deficiency was visible in 33.5 % of the subjects, Vitamin A deficiency was evident in 8.12 % of the children **(Table 4.1.14)**. The signs for iron deficiency were pale tongue, brittle nails, pale skin, angular stomatitis, fatigue and pallor. Pallor symptoms were most evident (78.3%). Those who were identified for vitamin A deficiency had predominantly (60 %) conjunctival xerosis. Only two children showed mild symptoms of goitre.

Table 4.1.15 depicts the prevalence of signs and symptoms for iron deficiency. It could be seen that pallor signs were very evident in most of the school children. Pallor signs were seen in 78 % of the children. It was seen that almost all girls (96 %) had pallor symptoms. Pale skin colour was identified as 2^{nd} symptom for iron deficiency. Pale skin was apparent in 17 % of the children. The symptom was more common in girls as compared to boys. Other symptoms which followed the list were fatigue (12 %), angular stomatitis (4 %), swollen tongue and brittle nails. Only one symptom was seen in 63 % of the children while combination of two or three symptom was evident in 36 % of the children. Four or more than four symptoms were not manifested in any child (**Table 4.1.16**).

As far as prevalence of various signs and symptoms of vitamin A deficiency was concerned, conjunctival xerosis was most prevalent. It was present in almost 60 % of the children. Bitot spot was detected in 4 children while night blindness was apparent in five subjects. There were complains of eye infection by 8 % of the children. The prevalence of symptoms of vitamin A deficiency was similar for boys and girls (**Table 4.1.17**). None of the children had more than 4 or more signs of Vitamin A deficiency and one sign predominantly of conjuctival Xerosis was prevalent in 60.25 % of children (**Table 4.1.18**).

Only two children showed mild symptoms of goitre. All the children who were identified for various micronutrient deficiencies in school check up by the paediatrician were referred to the government hospital for further check up and medicinal care.

Table 4.1.14: Percent prevalence of clinical signs of micro nutrient deficiencies among children

Deficiencies	Girls N = 474	Boys N = 486	Total N= 960
Iron Deficiency	148 (31.2)	174 (35.8)	322 (33.5)
Vit A Deficiency	46 (9.7)	32 (6.6)	78 (8.12)
Iodine Deficiency	-	2 (0.4)	2 (0.2)

Values in the parenthesis indicate percentage

Table 4.1.15: Percent prevalence of various signs of Iron Deficiencies among children

Signs	Boys	Girls	Total
Swollen/red tongue	4 (2.3)	2 (1.35)	6 (1.86)
Brittle nails	2 (1.14)	-	2 (0.62)
Pale skin colour	23 (13.2)	33 (22.3)	56 (17.4)
Angular Stomatitis	9 (5.2)	5 (3.4)	14 (4.3)
Fatigue	23 (13.2)	15 (10.1)	38 (11.8)
Pallor	110 (63.2)	142 (95.9)	252 (78.3)

Values in the parenthesis indicate percentage

Table 4.1.16: Percent prevalence of combination of various signs of Iron Deficiency among children

No. of signs	Boys	Girls	Total
Only one	102 (58.6)	101 (68.2)	203 (63.04)
Two-three	72 (41.4)	45 (30.4)	117 (36.3)
4 or more than 4	-	-	-

Values in the parenthesis indicate percentage

Table 4.1.17: Percent prevalence of various signs of Vitamin A Deficiency among children

Signs	Boys	Girls	Total
Conjuctival Xerosis	19 (59.4)	28 (60.8)	47 (60.25)
Bidot Spot	2 (6.25)	2 (4.34)	4 (5.12)
Corneal Ulceration	-	-	-
Xeropthalmic fundus	-	-	-
Night blindness	5 (15.6)	-	5 (6.4)
Corneal Xerosis	-	2 (4.3)	2 (2.56)
Corneal scar	-	-	-
Eye Infection	3 (9.4)	4 (8.7)	7 (8.9)

Values in the parenthesis indicate percentage

Table 4.1.18: Combination of various signs of Vitamin A deficiency among children

No. of signs	Boys	Girls	Total
Only one	45	26	71
Two-three	2	2	4
4 or more than 4	-	-	-

Dietary pattern

Two working days and one Sunday was included for eliciting information on dietary pattern related to morning meals, mid day meal and consumption of fruits and vegetable. Morning breakfast, including snacks was consumed by just 22 % of the children. It was seen that morning breakfast habit was being compromised by the children for the facility of Mid Day Meal available in the school. Mid Day Meal consumption in the school was also sporadic. It was not mandatory for the children to have the MDM in the school. Those who wanted to have, used to eat, while rest of them went home in the recess or kept playing all the time. Regular consumption of MDM was also not observed. Nearly 9 % of the children did not consume the MDM at all. The fruits and vegetable consumption was poor (**Table 4.1.19**). Due to the increasing cost of fruits, fruit consumption was as less as 14 % while consumption of green leafy vegetable was reported to be only 32%.

Mid Day Meal Consumption Pattern

The data of Mid Day Meal (MDM) consumption was used to elicit weekly, monthly and standard wise data for the children. The comparison was made from the registered number of children in each school and also in each class. **Table 4.1.20** shows the overall consumption pattern of Mid Day Meal of all the 4 schools. The actual children present in the school as against that of registered one ranged from 60 % to 75 %. Mid day meal consumption was 52.8 % in one school which was lowest while the maximum percent was 63.6 %.

The number of the children registered according to standard was also noted. The number of children present in the school did not vary much as per standard and was in the narrow range of 78 % to 84 %. The maximum number of children remained present in 3rd, 4th and 5th standard to avail the benefit of mid day meal. The consumption was lower in 1st and 2nd standard as the children were very small and new to the school setup. At the same time

Table 4.1.19: Dietary Pattern of children of school going children

Variable	Boys N=481	Girls N=425	Total N=906
Breakfast	619(98)	574(98.9)	1193(98.5)
Only Tea	485(78.3)	454(79.0)	939(77.5)
Tea+ Snack	134(21.7)	120(21)	254(22.5)
Mid Morning	268(42.4)	279(48.0)	547(45.1)
MDM			
Regular	178(37.0)	151(35.5)	329(36.3)
Partial	273(56.7)	224(52.7)	497(54.8)
None	30 (6.3)	50(11.8)	80(8.9)
Fruits	97(15.3)	82(14.1)	179(14.7)
Vegetable	184(29.1)	203(35)	387(31.9)

Values in the parenthesis indicate percentage

Table 4.1.20: Average consumption of Mid Day Meal for the School

School	Registered	Present		95 % CI	Consumed		95 % CI
	N	N	%		N	%	
1	288	206	71.5	65.3-77.7	173	60.0	52.6-67.4
2	625	450	72	67.8-76.2	398	63.6	58.8-68.4
3	736	552	75	71.4-78.6	291	52.8	47-58.6
4	453	270	59.6	53.7-65.5	263	58.2	52.2-64.2

they had their own likes and dislikes. The consumption seemed to be increasing in 3rd (62.8 %) and 4th (69%) standard (**Table 4.1.21**).

Again a down ward trend was seen from 5th standard because of two possible reason. One is that at this age they start getting minimal pocket money and they eat from the outside hawker. The second reason being that the older children prefer going home during recess time and did not avail the mid day meal benefit.

The monthly consumption pattern of mid day meal was also derived. The **Table 4.1.22)** shows that consumption ranged from 53 % to 66 %. The consumption was lower in initial months of academic session within the range of 53 % to 57 %. After august the percent consumption went up and was maximum during December (66.6%) followed by January (61.7%). Thus during the winter season the mid day meal consumption increased.

Weekly menu was followed by the school authorities for which the guidelines are given by the government. On Monday *Dal Rice*, Tuesday *puri bhaji*, Wednesday *Khidi shak*, Thursday *Phada ni Khidhi*, Friday *Dal dhokli* and Saturday *Shukdi* was served to the children. It was a cyclic menu and the menu was not changed unless there was shortage of some ration.

Table 4.1.23 shows the weekly consumption pattern of school children. The consumption pattern ranged from 58 % to 74 %. The consumption trend was more or less similar varying in very narrow range of 57 % to 58 %. During the week as per the convenience of the cook and the availability of the ration, dal-bhat, puri bhaji or spicy rice was being prepared. Green leafy vegetables were not added to any of the recipe. The Saturday consumption was the highest i.e. 73.5 %. This variation may be because of personal likes and dislikes of the children and the recipe cooked on the particular day. On Saturday, mostly in all schools *shukdi* (a sweet made of wheat flour and jaggery) was being served. It is ready to eat food item and is sweet in taste so children like it

Table 4.1.21: Standard wise consumption of MDM by school children

Std	Registered	Present		95 % CI	Consumed		95 % CI
	N	N	%		N	%	
1st	90 ± 4	71 ± 3	78.8	61.5-80.5	52 ± 4	57.7	44-71.4
2nd	87 ± 3	68 ± 4	78	58-78	48 ± 3	55.1	40.8-69.3
3rd	113 ± 7	89 ± 3	78.7	83.2-94.5	71 ± 6	62.8	51.4-74.2
4th	122 ± 6	103 ± 5	84.4	77.3-91.5	85 ± 4	69	59-79
5th	79 ± 6	64 ± 6	81	71.2-90.8	44 ± 5	55.7	40.7-70.7
6th	60 ± 4	46 ± 4	76.6	64.2-89	29 ± 6	48.3	30-56.8
7th	60 ± 3	46 ± 3	76.6	64.2-89	30 ± 3	50	32.8-68.2

Table 4.1.22: Month wise consumption pattern of MDM by school children

Month	Registered	Present		95 % CI	Consumed		95 % CI
		N	%		N	%	
June	79 ± 1	63 ± 4	79.7	69.5-89.8	42 ± 3	53.1	37.7-68.5
July	83 ± 2	69 ± 5	83.1	74.0-92.1	44 ± 4	53.0	37.9-68.0
August	85 ± 1	68 ± 2	80	70.3-89.7	49 ± 3	57.6	43.4-71.7
Sept	88 ± 4	71 ± 5	80.6	71.2-89.9	50 ± 3	56.8	42.7-70.8
October	90 ± 3	69 ± 4	76.6	66.4-86.7	51 ± 5	56.6	42.7-70.4
November	90 ± 4	70 ± 2	77.7	67.7-87.6	52 ± 2	57.7	44-71.4
December	90 ± 3	73 ± 6	81.1	71.9-90.2	60 ± 3	66.6	54.4-78.7
January	89 ± 5	73 ± 3	82.0	73.0-90.9	55 ± 3	61.7	48.5-74.8
February	89 ± 2	70 ± 4	78.6	68.8-88.4	54 ± 6	60.6	47.3-73.9
March	89 ± 5	72 ± 4	80.8	71.5-90.0	55 ± 2	61.7	48.5-74.8

Table 4.1.23: Weekly consumption pattern for Mid Day Meal by school children

Days	Registered	Present		95 % CI	Consumed		95 % CI
	N	N	%		N	%	
Monday	87 ± 2	69 ± 2	79.3	69.5-89.0	51 ± 2	58.6	44.8-72.3
Tuesday	87 ± 1	70 ± 2	80.4	69.5-89.0	51 ± 3	58.6	44.8-72.3
Wednesday	87 ± 4	69 ± 4	79.3	70.9-89.8	51 ± 2	58.6	44.8-72.3
Thursday	87 ± 3	69 ± 3	79.3	70.0-89.8	50 ± 4	57.4	43.4-71.3
Friday	87 ± 2	70 ± 2	80.4	44.8-72.3	52 ± 1	59.7	46.1-73.3
Saturday	87 ± 1	70 ± 3	80.4	44.8-72.3	64 ± 3	73.5	62.4-84.5

most. The other reason was that such items were not prepared at their home as they cannot afford it, so they like this change in their diet.

The other salient observation of the study was that it was not made compulsory for the children to have food in the school. The serving size of the Mid Day Meal also varied from child to child. It depended on the size of plates or the tiffin boxes which the children brought from home. If the children had not brought any tiffin then he was not given food.

Haemoglobin status

The haemoglobin levels could be ascertained from 865 children studying from 4 th to 7th standard. The mean haemoglobin levels of the children were almost similar in both the genders being 11.4 $\pm$ 1.18 g/dl and 11.1 $\pm$ 1.20 g/dl in boys and girls respectively **(Table 4.1.24)**. The mean haemoglobin levels did not differ in all the age group, except that in higher age group it was low in girls. It was seen that 72 % of the subjects were anemic of which 57.6 % were in mild category and 14.2 % in moderate category (**Table 4.1.25**)**.** The pictorial representation of prevalence of anemia is given in **Figure 4.1.6.**

Table 4.1.26 gives the prevalence of anaemia based on the nutritional status of the children. It was observed that nearly 75% of the underweight and thin children were anemic and the prevalence increased with the increase in the severity. However the prevalence of anemia in stunted children was found to be much lower i.e. 33 %. The mean haemoglobin levels of the children were also cross tabulated with the existing nutritional status (**Table 4.1.27**). Though the overall prevalence of anemia was lower among stunted children, the mean Hb was lower for severely stunted children than the moderate or mildly stunted children.

The disparity in prevalence of anemia with regard to consumption of mid day meal was also studied. The mean Hb of regular consumers of MDM was

Table 4.1.24: Mean haemoglobin levels of the subjects cross tabulated by age and sex

AGE GROUPS (Years)	HAEMOGLOBIN LEVELS OF THE SUBJECTS (g/dl) MEAN±SD		
	TOTAL (N=865)	**BOYS (N=442)**	**GIRLS (N=423)**
	30	20	10
>7	11.5±1.08	11.4±1.05	11.6±1.17
	132	69	63
>7-8	11.30±1.2	11.4±1.28	11.18±1.24
	192	97	95
>8-9	11.2±1.35	11.3±1.24	11.14±1.45
	169	84	85
>9-10	11.2±1.03	11.2±1.02	11.1±1.04
	150	77	73
>10-11	11.3±1.1	11.4±1.12	11.1±1.26
	84	39	45
>11-12	11.3±1.18	11.5±0.9	11.0±1.3
	67	45	22
>12	11.2±1.38	11.4±1.2	10.6±1.54
Total	**11.2±1.2**	**11.3± 1.1**	**11.0±1.2**

Table 4.1.25: Prevalence of Anaemia among Subjects Cross Tabulated By Age

Age Group (Years)	N	PERCENT PREVALENCE OF ANAEMIA			
		≥12 g/dl	10-11.99 g/dl	7-9.99 g/dl	<7 g/dl
<7	30	10 (33.3)	17 (56.6)	3(10)	-
>7-8	137	39(28.5)	73(53.3)	25(18.2)	-
>8-9	214	61(28.5)	112(52.3)	40(18.7)	1(0.5)
>9-10	176	40(22.7)	119(67.6)	17(9.7)	-
>10-11	155	53(34.2)	83(53.5)	19(12.2)	1(0.6)
>11-12	85	22(25.9)	53(62.3)	9(10.5)	1(0.5)
>12	67	16(23.9)	41(61.2)	10(14.9)	-
Total	**865**	**241(27.8)**	**498(57.6)**	**123(14.2)**	**3(0.4)**

Values in the parenthesis indicate percentage

Figure 4.1.6 Prevalence of Anemia in the children

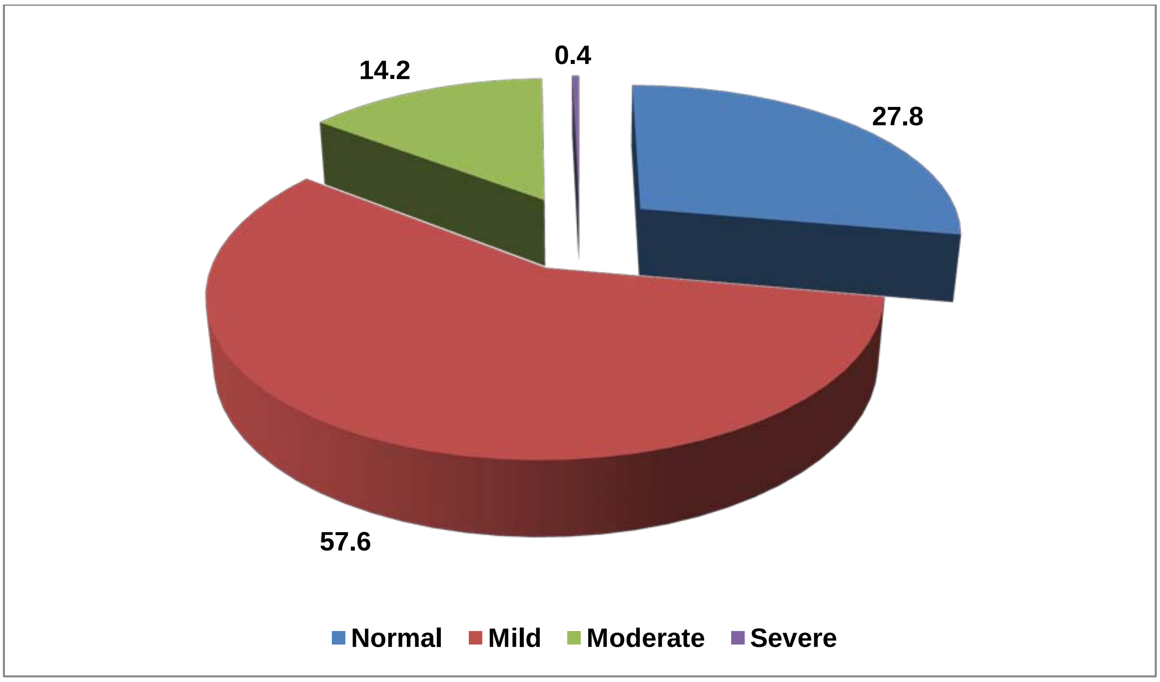


Table 4.1.26: Prevalence of Anaemia Cross Tabulated With Nutritional Status

NUTRITIONAL GRADE (Z SCORE)	PERCENT ANAEMIC SUBJECTS		
	BOYS N=317	GIRLS N=307	TOTAL N=624
WEIGHT FOR AGE			
NORMAL+ MILD	80 (24.9)	78 (25.1)	158 (25.3)
MODERATE	99 (30.9)	103 (32.9)	202 (32.4)
SEVERE	138 (43.6)	126 (40.7)	264 (42.3)
HEIGHT FOR AGE			
NORMAL +MILD	221 (69.4)	200 (64.8)	421 (67.5)
MODERATE	76 (23.9)	84 (26.7)	160 (25.6)
SEVERE	20 (5.9)	23 (7.16)	43 (6.9)
BMI			
NORMAL+MILD	83 (25.9)	83 (26.7)	166 (26.3)
MODERATE	99 (30.9)	100 (32.2)	199 (31.9)
SEVERE	135 (42.3)	124 (40.0)	259 (41.5)

Figures in the parenthesis indicate percentage

Table 4.1.27: Mean haemoglobin levels cross tabulated with nutritional status of subjects

NUTRITIONAL GRADE (Z SCORE)	N	HAEMOGLOBIN LEVELS (g/dl) MEAN ± SD
WEIGHT FOR AGE		
NORMAL AND MILD	224	11.2 ± 1.18
MODERATE	282	11.1 ± 1.38
SEVERE	359	11.2 ± 1.21
HEIGHT FOR AGE		
NORMAL AND MILD	601	11.27 ± 1.26
MODERATE	215	11.2 ` ± 1.2
SEVERE	49	10.7 ± 1.3
BMI FOR AGE		
NORMAL AND MILD	225	11.2 ± 1.2
MODERATE	273	11.1 ± 1.36
SEVERE	367	11.1 ± 1.2

11.30 ± 1.22, while that for partial consumption and no consumption was 11.06±1.2 and 11.0 ± 1.1 respectively. Regular consumption of MDM did not have any influence on overall prevalence of anemia but a stepwise increase in the prevalence of moderate anemia was seen as the degree of compliance decreased. It was 11.4% for regular mid day meal consumption, 15.3% for partial consumption and 18.6% for non consumption of Mid Day Meal (**Table 4.1.28**).

An effort was made to see the influence of dietary variables on the outcome like stunting, underweight, thinness and anemia using relative risk ratio method. The result showed that regular MDM along with lunch or/and breakfast may improve the outcome in terms of 3 anthropometric indices and iron deficiency anemia. The relative risk (RR) ratio indicated that non compliance or only MDM had no impact on the nutritional outcome. But nutritional status of the children was influenced by having MDM regularly along with breakfast or lunch **(Table 4.1.29).**

A positive correlation was seen when hemoglobin values were correlated with clinical signs and symptoms of iron deficiency (χ^2 53.94, $p<0.001$). The sensitivity for the correlation was 64 % while specificity was 44 % **(Table 4.1.30).**

Discussion

Once a child crosses the age of five, they are considered more or less safe from nutritional disorders. But little attention is paid to the quality of life (FAO, 2004). School age children are hardly thought of as “at risk” population but this period is a unique intervention point in the life cycle (World Bank, 2003). Malnutrition is common among school children and is usually coupled with iron deficiency anemia (WHO-UNICEF, 2004). Asia has the largest number of malnourished children in the world. Looking at the scenario, Government of India started with the Mid Day Meal Program.

Table 4.1.28: Prevalence of anemia cross tabulated by consumption of MDM

Severity of Anemia	Regular Consumption N=116	Partial consumption N=326	No consumption N= 43
≥12 g/dl	51(30.7)	87(26.6)	15(34.9)
10-11.99 g/dl	96(57.8)	187(57.3)	20(46.5)
7-9.99 g/dl	19(11.4)	50(15.3)	8(18.6)
<7 g/dl	-	2(0.6)	-

Figures in the parenthesis indicate percentage

Table 4.1.29: Relative risk calculations of MDM consumption on anthropometric Indices

VARIABLE	OUTCOME	RR	RANGE
Only MDM	**STUNTING (<-2SD)**	0.52	0.97<RR<1.40
MDM + Lunch		1.4	0.70<RR<1.31
MDM+ Breakfast		0.8	0.58<RR<1.46
Only MDM	**UNDERWEIGHT (<-2SD)**	0.91	0.77<RR<1.43
MDM + Lunch		1.7	0.98<RR<1.84
MDM+ Breakfast		0.7	0.87<RR<1.28
Only MDM	**THINNESS (<-2SD)**	1.15	0.81<RR<1.58
MDM + Lunch		1.7	0.77<RR<1.51
MDM+ Breakfast		1.02	0.75<RR<1.34
Only MDM	**ANAEMIA (<12g/dl)**	0.35	0.70<RR<1.84
MDM + Lunch		1.12	0.77<RR<1.97
MDM+ Breakfast		1.2	0.86<RR<1.23

Table 4.1.30: Chi square between Clinical signs and symptoms and haemoglobin

		Anaemia	
		Present	Absent
	Present	167	38
Iron Deficiency	Absent	75	92

The MDM scheme is the largest school lunch program in the world covering millions of children with the major objective of improving the nutritional status of children (Nutrition support, 1995). Over the years, despite MDM program is in place, it has not made a major dent on the nutritional status of the children. In order to improve the nutritional status of children, the MDM is being strengthened from time to time. Therefore there is the need to see the impact of ongoing MDM program especially in rural setup (Sethi, 2008).

Growth curves are essential tool in pediatric practice. They help in determining the degree to which physiological needs for growth and development are being met during the important childhood period (De onis, 2009). In the present study, the nutritional status of the children was assessed using CDC 2000 and WHO 2007 growth standards. The divergence in the number of children assessed by CDC standard and WHO 2007 standard was seen because in WHO 2007 weight for age reference data are not available beyond the age of 10 years as this indicator does not distinguish between height and body mass in an age period where many children are experiencing the pubertal growth spurt and may appear as having excess weight, when in fact they are just fine (De onis, 2007).

The study also revealed a high prevalence of malnutrition despite the MDM program running since decades. Around 70 % of the children were underweight and prevalence of stunting was 32 %. Further all forms of severity were witnessed indicating poor nutritional status among the adolescent children studied. As per the WHO standards 64 % of the children were underweight. Comparing the observation on the prevalence of underweight children by both the standards, it was found that WHO 2007 underestimated the prevalence. Similar trend persisted for both stunting (height for age) and thinness (BMI for age). The results depict that overall WHO 2007 underestimates the prevalence of malnutrition. The difference is more evident for the prevalence of thinness (BMI for age Z score). When looked in detail higher variation was seen in prevalence of severe degree of thinness.

Similar results were shown in a study conducted on growth and nutritional status of school age children (6-14 years) of tea garden worker in Assam by Medhi et al in the year 2007. Their study indicated a high prevalence of malnutrition among tea garden school age children and malnutrition was both chronic and recent in nature. Prevalence of wasting, stunting and underweight was 21.2%, 47.4% and 51.7% respectively among the children in the age group of 6-8 years. Prevalence of stunting and thinness was 53.6% and 53.9% respectively among the children in the age group of 9-14 years age group.

A study conducted on nutritional status and level of intelligence of school children 7-10 years in Karnataka by Suvarna & Itagi in the year 2009 revealed that there was no significant difference seen in the mean weight (19.5 kg Vs. 20.5 kg) and height (121.6 cm Vs. 123.3 cm) of boys and girls. The nutritional status was positively correlated with age of children.

Another study conducted in West Bengal by Bose et al in the year 2008 on school going children revealed that overall prevalence of undernutrition was 35.3%. It was observed that undernutrition was more common among early adolescents (11-14 years) than late adolescents (15-18 years). There was a consistent increasing trend in mean BMI with age among both sexes. The prevalence of undernutrition was higher in boys (41.8%) as compared to girls (25.2%).

Studies conducted in different states in India on school going adolescent children reveal faulty dietary practice, inadequate consumption of foods and inadequate intake of fruits and vegetables which can adversely influence growth and development, cognitive performance and increase susceptibility to infections making them prone to under nutrition and micronutrient deficiency mainly iron deficiency anaemia (Sen, 2006). The dietary data reveal that vegetable consumption was as low as 32 % while the fruit consumption was only 14 % in the subjects.

MDM seeks to provide for each school child roughly one third of the daily nutrient requirement in the form of hot fresh cooked meal. It should provide cereals and vegetables to support their dietary intake. But in the present study MDM was not consumed regularly by the children. The reason behind low contribution of MDMP in improving nutritional status of children could be due to the fact that school meal became a substitute rather than supplement for the home meal in poor households. Besides, the mid-day meal supplies only one third of the dietary requirements, and that too for 200-250 days in a year. These observations are in line with other studies (Samson, 2003).

In the present study nutritional status of school children was obtained were MDMP was running. The high prevalence of malnutrition i.e. Undernutrition (68 %), stunting (31 %) and thinness (60 %) was evident through the first phase of the study. Thus it was not difficult to come to an agreement that though MDMP started in 1995, it has failed to bring about required change in the nutritional status of school children. Since MDMP started in 1995 there have been lots of changes in the program to suit to the situation and meet the nutritional demands of the beneficiaries i.e. the children (Bose 2008).

A study conducted by National Institute of Rural Development in 2006 involved 7,200 school going children (9-12 y) at three different areas - urban, rural and slum of two representative districts- Lakhimpur Kheri and Sitapur (Uttar Pradesh) and Bharatpur and Jodhpur (Rajasthan) to assess the impact of MDM supplementation on the nutritional status of school going children (Seetharam, 2002). The MDM did not make any appreciable and significant impact on improving the nutritional status of the children. One important impact was that there was a reduced dropout among the girls

Another similar study on impact of MDMP on educational and nutritional status of school children in Karnataka on 2,694 children (MDM: 1361; Non-MDM: 1333) from 60 schools indicated better enrolment ($p < 0.05$) and attendance ($p < 0.001$), higher retention rate with reduced dropout rate ($p < 0.001$) a marginally higher scholastic performance and marginally higher growth performance of MDM children (Laxmaiah, 1999). A study conducted by Amartya Sen in Birbhum West Bengal revealed that MDM had a positive role in eliminating classroom hunger to a substantial level (Sen 2005).

In Gujarat only 71% of children aged 6-17 years attend school. School attendance is somewhat higher in urban areas (74%) than in rural areas (69%). About 90% of the primary school children (6-10 years) attend school (92% of urban and 89% in rural areas). The percentage fall in children attending school drops to 74% for children age 11-14 years and 32% for 15-17 years. Gender disparity in education is quite evident in school age population 66% girls of the 6-17 years of population attend school to 75% of the boys of similar age group (NFHS III, 2005).

The major problem which comes in effective implementation of MDMP is the poor enrollment and absenteeism. Although these two are major objectives of MDMP they still remain unachieved. In the present study also 30 % of absenteeism was observed in the rural school.

The study data revealed that MDM consumption is limited to only 52-60 % of the children which is further supported by a recent field survey of MDM initiated by the Centre for Equity Studies, New Delhi in the year 2007. This study suggests that mid-day meals have made a promising start around the country. In each of the three sample areas (three districts each in Chhattisgarh, Rajasthan, and north Karnataka); mid-day meals were being served regularly in all primary schools. However, **achievements of mid-day meals have been seriously compromised, if not defeated, by inadequate quality and low budgets.**

The monthly consumption pattern was also discrete and the weekly pattern showed the consumption from 58 % to 74 %. An evaluation report on 112 schools of Delhi revealed that only 47% of schools were found to have distributed MDM in their school for a period of over 150 days. Teachers felt that continuation of the same item gradually make students develop dislike towards it.

In the present study 73 % of the children were anaemic. Since majority of the children were in mild and moderate category of iron deficiency, concrete efforts should be made to curtail the prevalence otherwise it may worsen in severity. It was seen that percent anaemic children increased as the severity of underweight increased. Only 25 % of the mild underweight children were anaemic as against 42 % of anemia in severely underweight category. In a study by Patel et al in 2009 on urban school children of Gujarat the prevalence of anemia was found to be 63%.

An assessment of nutritional status of adolescents in India revealed that almost half of the adolescents in both the gender consume inadequate iron and proteins in their diet. A multi-centric study carried out by ICMR 1985-86 in 16 districts from 11 states showed overall prevalence of anemia to be 90.1%

A survey conducted in 1992 by Awate et al in 3 primary schools in a rural area of India's southwest Maharashtra State, assessed the prevalence of nutritional deficiency disorders among children of 5-15 years of age in which one of the most common problem seen was anemia which was 32.47%.

Another study conducted on primary school children of Delhi by Sethi et al in 2003 revealed that the overall prevalence of anemia was 66.4%. The prevalence of mild, moderate and severe form of anemia was found to be 33.3%, 32.6% and 0.5% respectively. The mean hemoglobin level in girls and boys was 10.7g/dl and 10.9 g/dl respectively. The study revealed a higher prevalence of anemia in girls as compared to boys (70.5% Vs. 61.9%).

We found a significant correlation between clinical signs and symptoms of anemia and haemoglobin status was found. This could be because the prevalence of anemia was very high and the clinical examination was done by paediatrician. Strobach et al in 1988 noted a statistically significant correlation between haemoglobin concentration and pallor, colour tint of eye lid, nail bed colour. Results from their study support the contention that the presence and degree of anemia can be estimated clinically by careful physical examination.

Other study in Nepal also confirmed that pallor is useful to detect severe anemia, but is insensitive to detect mild anemia. At descending haemoglobin cut-off, sensitivity of clinical pallor increased greatly while specificity decreased slightly. The sensitivity of clinical pallor to detect mild anemia was ≤ 23 %. Haemoglobin <70 g/L is the most commonly used definition of severe anemia. At this cut-off, the sensitivity was ≥ 61 %. The specificity at this cut-off remained relatively high ≥ 84 % (Rebecca, 1999). In our study sensitivity was 64 % while specificity was 44 %. This observation calls for regular checkups by a paediatrician in a school system to identify anaemic children. This will help in reducing the prevalence of severe form of Iron deficiency anemia.

All the above indicators reflect that prevalence of malnutrition is very high in the rural areas despite the ongoing school meal program. The malnutrition is coupled with high prevalence of anemia. Since severe anemia was seen in very less percent of children, dietary diversification should be canvassed. We feel that simple messages like regular consumption of MDM along with food at home should be advocated. Parents and teachers should be made aware that without meals at home like breakfast, lunch and dinner the effort of providing MDM will be futile. There is a need to strengthen the present school meal program along with monitoring at ground level. Regular clinical examinations by government physicians in all schools may help to prevent the worsening of the problem and to take corrective action.

PHASE II: LONGITUDINAL PHASE: THE GROWTH DYNAMICS IN CHILDREN

The study was conducted in the rural industrial area of Vadodara, Gujarat. Out of the 45 government primary schools in the area, four schools were randomly selected. In the first year, all the children from 1st to 7th standard were enrolled for the study. Anthropometric measurements i.e. height and weight were recorded for all the children. In the first year data was collected on 2282 children of which 1094 were girls and 1188 were boys. In the second year same children were followed up. After looking at the dropout rate and the passed out children of 7th standard on whom the data could not be collected, the sample size became 1555 children. In the third year, keeping the same criteria and considering the dropout rate, anthropometric data could be collected on 465 children of which 227 were boys and 238 were girls. These schools were different from the intervention target group.

A total of 465 children had 3 pair of data for consecutive 3 years. Paired data of these children were used for studying dynamics of growth and weight trends in the study population. The reference data used to identify the BMI cutoffs as well as conversion of weight and height to Z score were taken from WHO 2007 data set for growth parameters in children.

Number of children enrolled for the phase

Overall 465 school children were covered for the longitudinal study. These included 238 girls and 227 boys. The age wise distribution of number of children in 3 consecutive years was also seen. There was equal representation of boys and girls in all age except at two instances i.e. in first year there was less representation of girls greater than 12 years. Similarly for boys in 3rd year there was no representation for less than 6 years of age **(Table 4.2.1)**.

Table 4.2.1: Age wise distribution of boys and girls

Age (Y)	Girls (N=238)			Boys (N=227)		
	1st Year	2nd Year	3rd Year	1st Year	2nd Year	3rd Year
< 6	31(13.0)	7(2.9)	4(1.6)	30(13.2)	2(0.8)	-
6-7	32(13.4)	28(11.7)	3(1.2)	40(17.6)	28(12.3)	2(0.8)
7-8	39(16.3)	32(13.4)	28(11.7)	43(18.9)	40(17.6)	28(12.3)
8-9	60(25.2)	39(16.3)	32(13.4)	44(19.3)	43(18.9)	40(17.6)
9-10	46(19.3)	58(24.3)	39(16.3)	30(13.2)	44(19.3)	43(18.9)
10-11	22(9.2)	45(18.9)	58(24.3)	23(10.1)	30(13.2)	44(19.3)
11-12	4(1.6)	22(9.2)	45(18.9)	11(4.8)	23(10.1)	30(13.2)
>12	2(0.8)	7(2.9)	29(12.1)	6(2.6)	17(7.4)	40(17.6)

Values in parenthesis indicate percentages

Changes in height, weight and BMI over a period of 3 years

As the age increased, the increase in mean height and weight of both girls and boys was seen. The mean height and weight for a particular age remained more or less same for all the three years. Girls had lower height as compared to boys in younger age i.e. less than 8 years but till they reached 12 years the mean height of both the genders were comparable **(Table 4.2.2)**. The weight gain **(Table 4.2.3)** was similar for boys and girls. There was a slight increase in BMI with advancing age. The BMI was in the range of 12.5 to 14.5 for the age of 6-12 years **(Table 4.2.4).**

The mean increase in the height of children was extracted from the analysis. The increase of height per year ranged from 6.1 cm to 5 cm. In the first year the mean increase was 6.1 cm while in the 2nd year the increase was 5 cm. The age wise bifurcation of mean increase in height depicts that at the age of 6-7 years the increase was 6.9 cm per year. At 7-8 years the increase ranged from 5.9 to 5.1 cm per year and it was lowest at 9-10 years where mean increase was only 4.5 cm. The trend was similar for both boys and girls. The mean height gain per year was more for boys as compared to girls in both the years. **(Table 4.2.5)**

The mean increase in weight per year for children ranged from 2.8-2.7 kg. The weight increase was almost similar in both boys and girls. In fact in the first year, at the age of 12 years, the weight gain was more in girls as compared to boys. The standard deviation in the weight was higher at all the ages as great variation was seen in weights of children of same age and sex. This is because there are a number of factors influencing weight gain in children. Even small event of illness or infection or fasting would immediately affect the weight parameters **(Table 4.2.6).**

Table 4.2.2: Mean change in height over a period of 3 years cross tabulated by age and gender (Mean ± SD, Cms)

Age (Y)	**Girls (N=238)**			**Boys (N=227)**		
	1st Year	2nd Year	3rd Year	1st Year	2nd Year	3rd Year
< 6	104.4±5.0	118.0±14.4	128.1±7.4	105.2±5.7	109.5±0.7	-
6-7	108.6±5.5	107.6±19.0	109.3±5.7	110.0±5.6	111.9±6.2	115±2.8
7-8	117.2±8.0	115.1±5.6	115.5±5.4	116.9±7.3	116.8±6.5	117.5±6.3
8-9	119.8±7.3	123.2±8.5	118.5±6.0	121.4±5.8	123.5±7.4	123.6±7.5
9-10	124.5±6.8	126.6±7.3	126.9±9.3	126.8±8.1	127.2±6.7	126.9±7.6
10-11	129.9±6.7	132.0±7.8	130.9±8.7	130.1±6.3	132.2±8.6	130.7±6.8
11-12	131.5±4.7	136.1±7.4	135.7±9.1	130.1±8.8	136.1±6.1	135.6±10.9
>12	129.6±0.7	137.2±5.7	140.3±7.9	135.3±9.1	137.5±7.4	140.4±8.7

Table 4.2.3: Mean change in weight over a period of 3 years cross tabulated by age and gender (Mean ± SD, Kg)

Age (Y)	**Girls (N=238)**			**Boys (N=227)**		
	1st Year	2nd Year	3rd Year	1st Year	2nd Year	3rd Year
< 6	14.1±1.5	14.7±4.9	14.9±4.4	14.5±1.9	15.4±1.0	
6-7	15.2±1.4	15.8±1.6	15.1±1.9	15.2±2.9	16.3±2.1	16.5±0.7
7-8	17.5±4.8	17.2±2.1	17.2±2	17.6±2.4	17.7±2.3	18.4±2.8
8-9	17.5±3.9	20.2±4.6	18.9±2.2	16.9±7.5	20.3±2.8	20.6±3.0
9-10	20.0±4.4	21.0±4.2	22.5±6.1	20.0±4.5	21.8±3.2	22.2±3.6
10-11	21.7±3.9	23.7±5.2	24.3±5.3	22.9±3.6	24.2±4.8	24.9±5.6
11-12	18.7±7.0	26.3±3.6	27.7±6.9	23.6±5.6	25.6±2.7	27.2±7
>12	23.2±0.9	27.0±5.9	28.9±6.5	24.4±4.1	26.3±2.9	29.4±5.4

Table 4.2.4: Mean change in BMI over a period of 3 years cross tabulated by age and gender (Mean ± SD)

Age (Y)	**Girls (N=238)**			**Boys (N=227)**		
	1st Year	2nd Year	3rd Year	1st Year	2nd Year	3rd Year
< 6	13.0±1.3	12.2±0.5	13.5±1.2	13.1±1.0	12.8±0.7	
6-7	12.9±1.0	12.8±0.7	12.6±1.0	12.8±1.2	13.0±0.9	12.5±0.5
7-8	12.8±1.7	12.9±0.9	12.9±0.8	12.8±0.9	12.9±0.8	13.3±1.5
8-9	12.6±3.5	13.2±1.5	13.4±1.0	12.6±2.4	13.2±0.8	13.0±0.9
9-10	12.9±2.4	13.0±1.7	13.7±2.1	12.4±2.5	13.4±1.1	13.7±1.0
10-11	13.5±1.4	13.4±1.9	14.0±2.1	12.9±2.2	13.8±1.7	14.4±2.1
11-12	12.7±3.3	14.1±1.2	14.8±2.3	14.1±3.8	13.8±0.8	14.5±2.3
>12	13.2±0.7	13.9±0.8	14.8±1.6	13.8±0.6	14.2±2.9	14.5±2.1

Table 4.2.5: Mean increase in height over a period of 3 years

(Mean ± SD, Cms)

Age (Y)	1st Year		2nd Year	
	Boys	Girls	Boys	Girls
< 6	6.9±1.8	6.1±2.1	5.3±1.9	4.6±2.1
6-7	6.9±3.5	5.7±2.0	6.7±6.4	4.2±2.2
7-8	5.9±2.9	6.1±1.8	4.2±2.2	4.2±2.3
8-9	5.1±3.6	6.4±1.4	4.5±2.6	4.7±2.7
9-10	4.6±2.4	7.1±3.6	4.6±4.0	4.6±2.8
10-11	6.0±4.4	4.2±2.6	6.1±1.8	4.8±3.0
11-12	8.4±9.2	4.3±3.7	3.9±4.3	4.1±3.1
>12	3.8±1.8	5.5±2.9	4.7±1.6	6.4±1.5

Table 4.2.6: Mean increase in Weight of the children over a period of 3 years (Mean ± SD, Kg)

Age (Y)	1st Year		2nd Year	
	Boys	**Girls**	**Boys**	**Girls**
< 6	1.7±1.4	1.4±1.6	2.1±1.4	1.5±1.6
6-7	2.2±1.6	2.0±1.3	2.4±2.5	1.8±1.6
7-8	2.6±1.7	2.5±1.6	2.1±1.7	2.3±2.7
8-9	3.1±4.3	3.2±5.9	3.1±4.0	3.4±3.6
9-10	4.2±5.3	3.6±3.6	3.0±4.4	4.0±4.5
10-11	3.8±3.0	3.3±2.2	2.7±2.3	4.0±2.8
11-12	3.6±5.4	5.4±5.5	5.4±4.9	2.5±2.0
>12	2.4±2.0	2.8±0.3	5.1±5.0	3.9±2.5

Prevalence of Malnutrition

Prevalence of malnutrition was assessed by WHO 2007 standards. The malnutrition indices taken into consideration were underweight, stunting and thinness.

According to WHO 2007 standards, **Table 4.2.7** shows that the prevalence of underweight decreased to 30.9 % in the third year from 60 % in the first year. The improvement was seen more in girls where the prevalence came down from 61.7 % to 30 % as compared to boys where the prevalence came down from 57 % to 31 %.

According to WHO 2007 standard, the prevalence of stunting remained 32 % in the 3 years with CI limits of 25 – 40 (**Table 4.2.8**). As per WHO 2007 classification as shown in **Table 4.2.9**, there was a gradual decrease in the prevalence of thinness in consecutive years. In the first year the prevalence was 58 % [52.0-64.0] which decreased to 56 % [50.0-62.2] and further came down to 47 % [40.3-53.7]. The decreasing trend was not similar for boys and girls. For girls the prevalence came down from 55 % to 41.5 % while for boys the prevalence came down to 52.8 % from 61.2 %. The comparative prevalence of all the three years is shown graphically in **Figure 4.2.1**.

The emerging trends in overall malnutrition scenario according to WHO 2007 is given in the **Table 4.2.10**. The comparison has been made for 3 years based on severity of malnutrition. As can be seen graphically in **Figure 4.2.2, 4.2.3, 4.2.4** over a period of 3 years the percentage of children in normal category for all the three indices had increased along with the drop in severe malnutrition except for stunting. Despite this trend, a high prevalence of 20 % for severe thinness and underweight along with 11.8 % of severe stunting was observed.

The percent prevalence of underweight children in the normal category increased from 9.6 % in the first year to 14 % in the second year to 17.3 % in

Table 4.2.7 Trends in prevalence of underweight (< - 2SD) over a period of 3 years according to WHO 2007 Standard

Years	Boys (N=227)		Girls (N=238)		Total (N=465)	
	%	95% CI	%	95% CI	%	95% CI
I	130 (57.2)	48.5-65.9	147 (61.7)	53.7-69.7	277 (59.5)	53.6-65.4
II	91 (40.0)	29.7-50.3	100 (42.0)	32.1-51.9	191 (41.0)	33.9-48.9
III	71 (31.2)	20.2-42.2	73 (30.6)	19.8-41.4	144 (13.9)	23.2-38.6

Values in parenthesis indicate percentages

Table 4.2.8 Trends in prevalence of stunting (< -2 SD) over a period of 3 years according to WHO 2007 Standard

Years	Boys (N=227)		Girls (N=238)		Total (N=465)	
	%	95% CI	%	95% CI	%	95% CI
I	66 (29.0)	17.8-40.2	83 (34.8)	24.3-45.3	149 (32.0)	24.4-39.6
II	62 (27.3)	16.0-38.6	65 (27.3)	16.2-38.4	127 (27.3)	19.4-35.2
III	70 (30.8)	19.8-41.8	83 (34.8)	24.3-45.3	153 (32.9)	25.3-40.5

Values in parenthesis indicate percentages

Table 4.2.9 Trends in prevalence of thinness over a period of 3 years according to WHO 2007 Standard

Years	Boys (N=227)		Girls (N=238)		Total (N=465)	
	%	95% CI	%	95% CI	%	95% CI
I	139 (61.2)	52.9-69.5	131 (55.0)	46.3-63.7	270 (58.0)	52.0-64.0
II	139 (69.2)	52.9-69.5	122 (51.2)	42.1-60.3	261 (56.1)	50.0-62.2
III	120 (52.8)	43.7-61.9	99 (41.5)	31.6-51.4	219 (47.0)	40.3-53.7

Values in parenthesis indicate percentages

Figure 4.2.1 Trend in prevalence of Malnutrition over 3 years according to WHO Classification

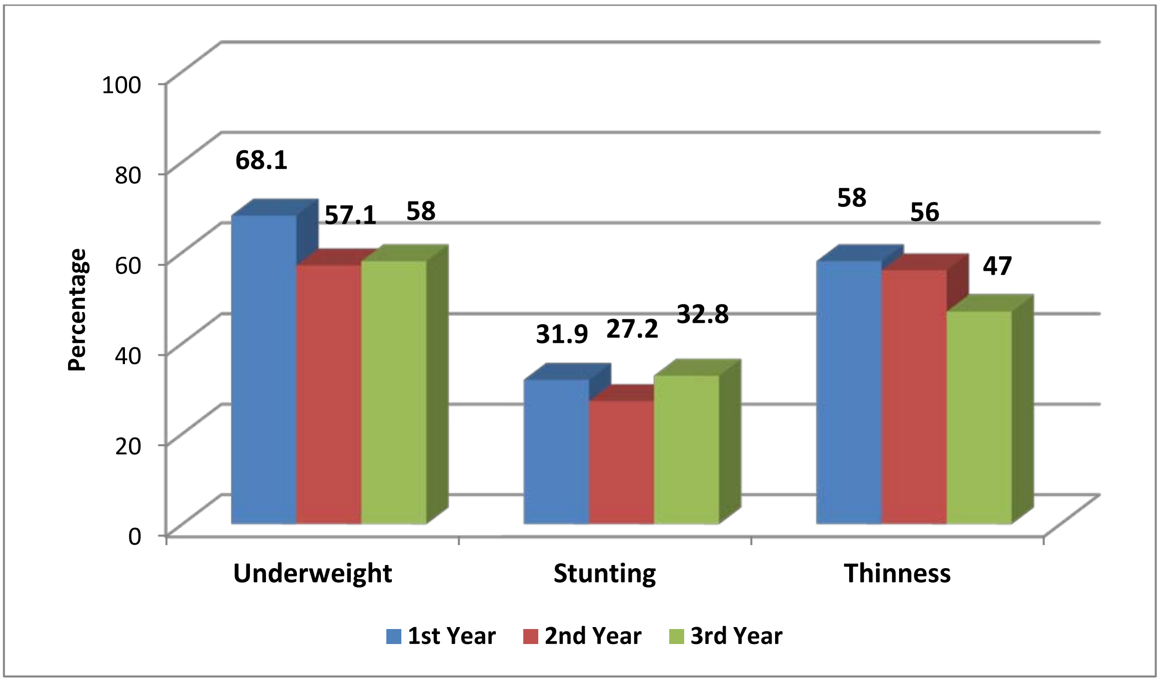


Table 4.2.10 Overall Malnutrition Scenario according to WHO 2007 Standards

Category	Year I		Year II		Year III	
	N (%)	95 % CI	N (%)	95 % CI	N (%)	95 % CI
UNDERWEIGHT						
Normal	39 (9.6)	0.5-17.1	47 (14)	1.3-18.9	43 (17.3)	0.4-18.1
Grade 1	90 (22.1)	11.0-27.6	96 (28.7)	12.3-28.9	61 (24.5)	4.5-21.7
Grade 2	142 (34.9)	22.8-38.2	111 (33.2)	15.7-31.9	94 (37.9)	11.9-28.5
Grade 3	135 (33.2)	21.2-36.8	80 (23.9)	8.8-25.6	50 (20.1)	2.0-19.4
STUNTING						
Normal	138 (29.6)	21.8-37.3	174 (37.4)	30.1-44.7	151 (32.4)	24.8-40.0
Grade 1	178 (38.2)	30.9-45.5	162 (34.8)	27.3-42.3	161 (34.6)	27.1-42.1
Grade 2	98 (21.0)	12.8-29.2	89 (19.1)	10.8-27.4	98 (21.0)	12.8-29.2
Grade 3	51 (10.9)	2.2-19.6	38 (8.1)	0.8-17.0	55 (11.8)	3.1-20.5
THINNESS						
Normal	66 (14.1)	5.5-22.7	48 (10.3)	1.5-19.1	94 (20.2)	11.9-28.5
Grade 1	129 (27.7)	19.8-35.6	153 (32.9)	25.3-40.5	152 (32.6)	25.0-40.2
Grade 2	147 (31.6)	23.9-39.3	151 (32.4)	24.8-40.8	126 (27.0)	19.1-34.9
Grade 3	123 (26.4)	18.5-34.3	110 (23.6)	15.5-31.7	93 (20)	11.7-28.3

Values in parenthesis indicate percentages

Figure 4.2.2 Trends in prevalence of severity of underweight in children

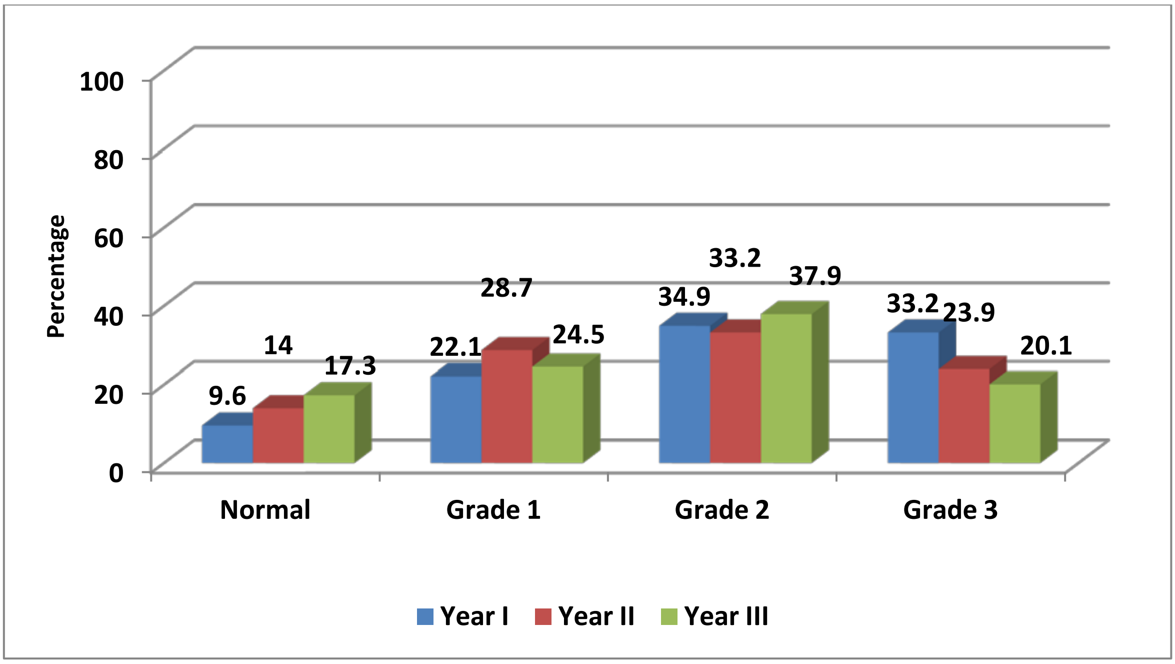


Figure 4.2.3 Trends in prevalence of severity of stunting in children

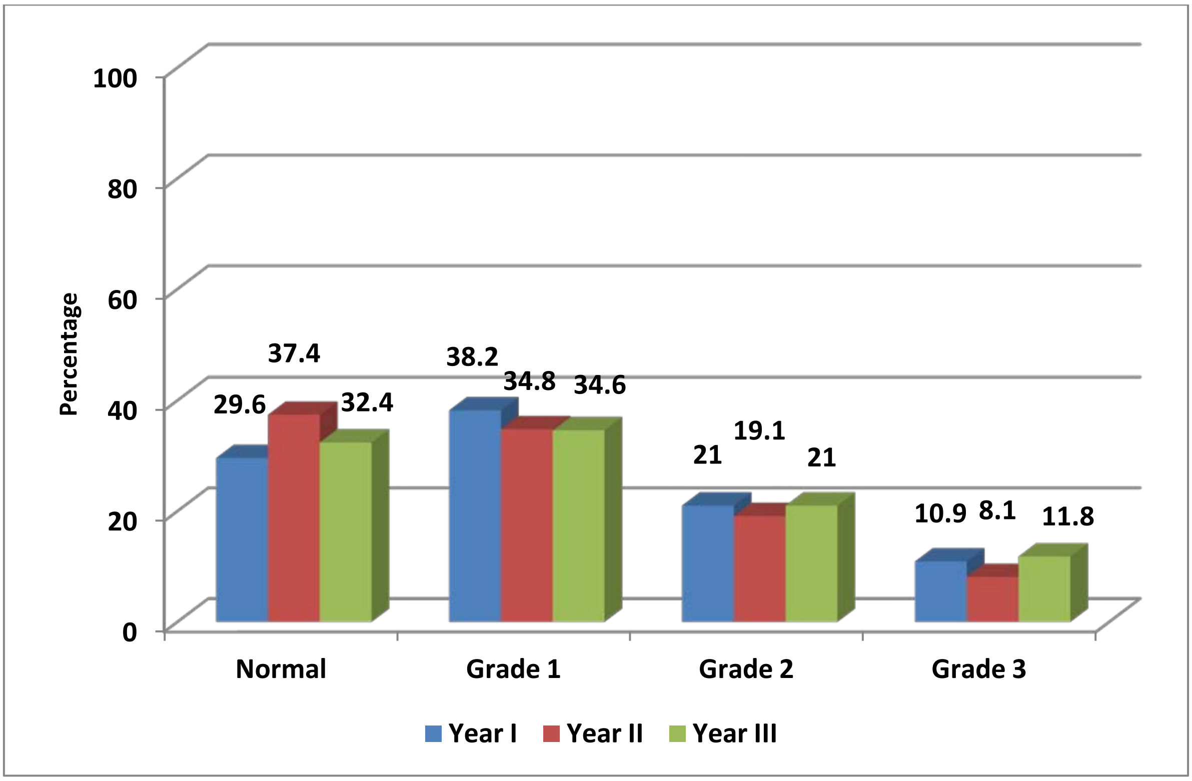
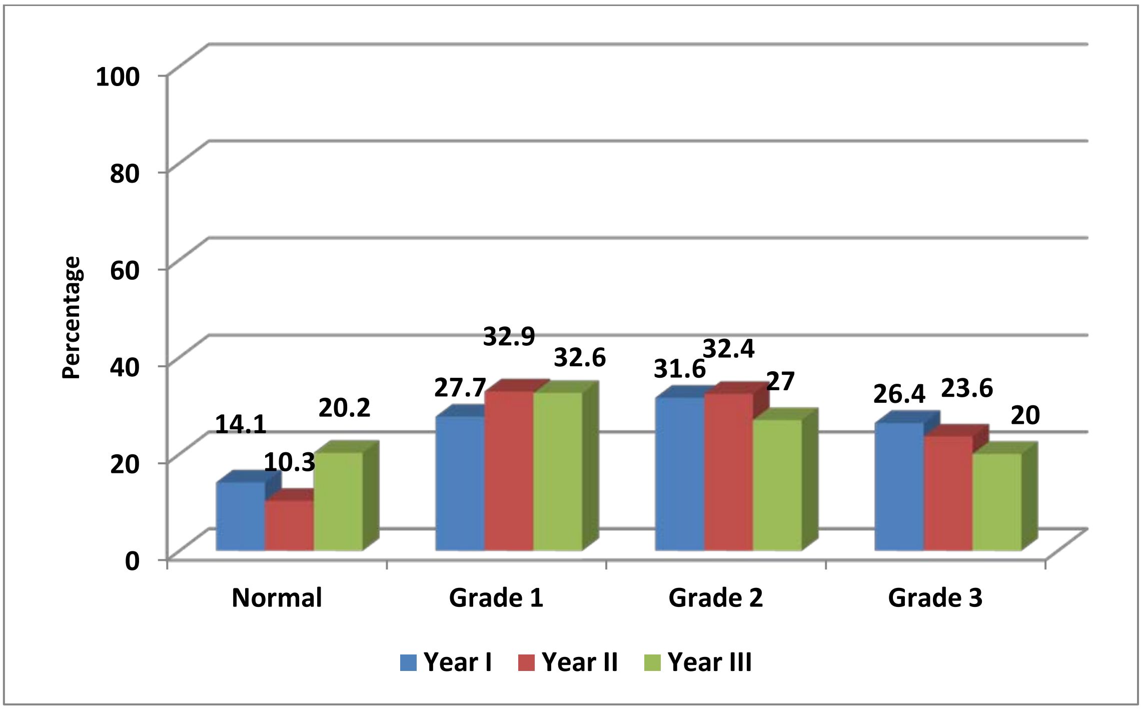


Figure 4.2.4 Trends in prevalence of severity of Thinness in children



the third year. Same downward trend was found for severe degree of underweight. The severe degree of underweight children reduced to 20 % in the third year with the shift in the grade 2. Grade 2 degree of malnutrition increased from 33.2 % in the second year to 38 % in the third year.

There was no major shift found in the prevalence of stunting as it represents chronic malnutrition prevalence. It will take a long time to change this scenario. A minor decrease in the prevalence of normal children was registered because of which proportionate increase in the prevalence of children in severe category, which came up to 11.8 % from 10.9 %. The prevalence was same in grade 1 and grade 2 degree of malnutrition.

An encouraging trend was seen in the prevalence of BMI in the course of 3 years. The percent prevalence of children in the normal category increased from 14.1 % in the first year to 20.2 % in the third year. Number of children in grade 1 remained more or less same. The major shift was seen in children in grade 2 and 3. The prevalence of grade 2 came down from 31.6 % to 27 % in the two year span. Adding to the beneficial trend, severe malnutrition also decreased from 26 % in the first year to 20 % in the third year.

Age wise prevalence of Malnutrition

Age plays a very important role when the growth of children is taken into consideration. Each phase of age has its own unique characteristics of growth. Keeping this point in mind the three year trend analysis of prevalence of malnutrition was done age wise. The analysis was done by WHO 2007 standards.

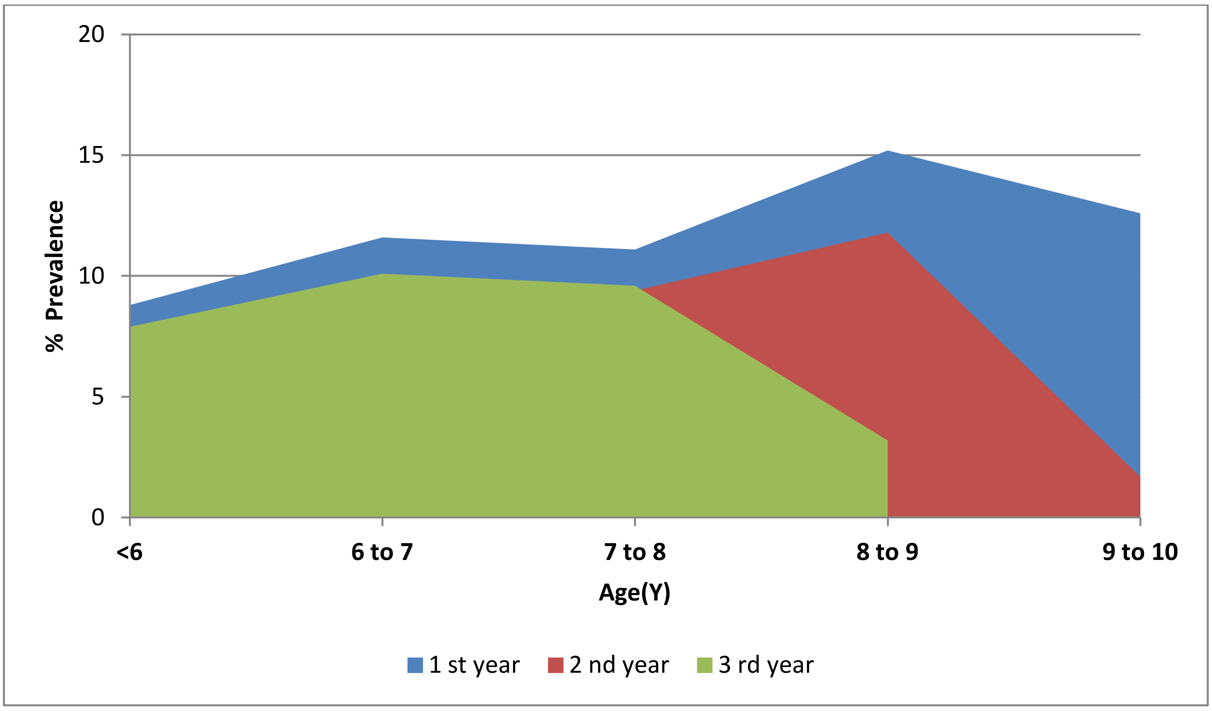
The age wise trend in the prevalence of underweight according to WHO standards is given till age of 10 years. Again maximum percent prevalence was found in the age of 8 to 10 years (**Table 4.2.11**) & (**Figure 4.2.5**). The

Table 4.2.11 Age wise trend in prevalence of underweight according to WHO standards

Age (Y)	Year I (N=465)		Year II (N=465)		Year III (N=465)	
	N (%)	**95 % CI**	**N (%)**	**95 % CI**	**N (%)**	**95 % CI**
< 6	41 (8.8)	0.0-17.6	4 (0.8)	-8.1-9.7	37 (7.9)	-1.0-16.8
6-7	54 (11.6)	2.9-20.3	46 (9.9)	1.1-18.7	47 (10.1)	1.3-18.9
7-8	52 (11.1)	2.4-19.8	44 (9.4)	0.6-18.2	45 (9.6)	0.8-18.4
8-9	71 (15.2)	6.7-23.7	55 (11.8)	3.1-20.5	15 (3.2)	-5.9-12.3
9-10	59 (12.6)	4.0-21.2	8 (1.7)	-7.4-10.8	-	-

Values in parenthesis indicate percentages

Figure 4.2.5 Age wise trend of prevalence of underweight according to WHO 2007 standards



maximum prevalence of stunting was found in the age group of 7 to 10 years (**Table 4.2.12**) & (**Figure 4.2.6**). A bell shaped curve was generated when the prevalence of thinness was plotted age wise. The prevalence of thinness was also highest in the age group of 7-10 years (**Table 4.2.13**) & (**Figure 4.2.7**).

The comparative analysis of 3 years according to age suggests that the major growth dynamics is taking place at the age of 7-10 years. Thus regular growth monitoring of children is necessary at this age to identify growth faltering.

Growth transition trend analysis

The individual tracking data for weight in the first year depict that 50.5 % remained in the same grade of malnutrition. There was a negative shift found in 6.8 % of the children while rest 41% showed positive trend. In the second year 69 % could maintain their health status while negative trend was seen in 11.4 % of school children. Only 18.9 % of the children in the second year showed an improvement in their weight according to their age (**Table 4.2.14 & Table 4.2.15**).

When the height gain was tracked according to age the trend analysis showed the following scenario. In the first year, 72% of children were in the same grade of malnutrition as in the first year. Good height gain was seen in 22 % of the children because of which they moved to better grade. Negative trend was seen in 5 % of the study population. In the second year 21.5 % of the children showed a negative trend while improvement was seen in only 9 % of the population. 69.4 % of the children could maintain their health status (**Table 4.2.16 & Table 4.2.17**).

As far as growth transition shift in the BMI status is concerned, in the first year 53.7 % of the children could maintain their health status. Though 23 % of the children showed a positive trend by shifting in the better grade of malnutrition, there was 21.5 % of population which shifted to negative grades. In the

Table 4.2.12 Age wise trend in prevalence of stunting according to WHO standards

Age (Y)	Year I (N=465)		Year II (N=465)		Year III (N=465)	
	N (%)	95 % CI	N (%)	95 % CI	N (%)	95 % CI
< 6	20 (4.3)	-4.8-13.4	18 (3.8)	-5.2-12.8	18 (3.8)	-5.2-12.8
6-7	26 (5.6)	-3.4-14.6	20 (4.3)	-4.8-13.4	22 (4.7)	-4.3-13.7
7-8	19 (4)	-5.0-13.0	15 (3.2)	-5.9-12.3	24 (5.1)	-3.9-14.1
8-9	30 (6.4)	-2.5-15.3	24 (5.1)	-3.9-14.2	32 (6.8)	-2.1-15.7
9-10	25 (5.3)	-3.7-14.3	19 (4.0)	-5.0-13.0	28 (6.0)	-3.0-15.0
10-11	14 (3)	-6.1-12.1	14 (3.0)	-6.1-12.1	13 (2.7)	-6.3-11.7
11-12	7 (1.5)	-7.7-10.7	8 (1.7)	-7.4-10.8	8 (1.7)	-7.4-10.8
>12	8 (1.7)	-7.4-10.8	9 (1.9)	-7.2-11.0	8 (1.7)	-7.4-10.8

Values in parenthesis indicate percentages

Figure 4.2.6 Age wise trend of prevalence of stunting according to WHO 2007 standards

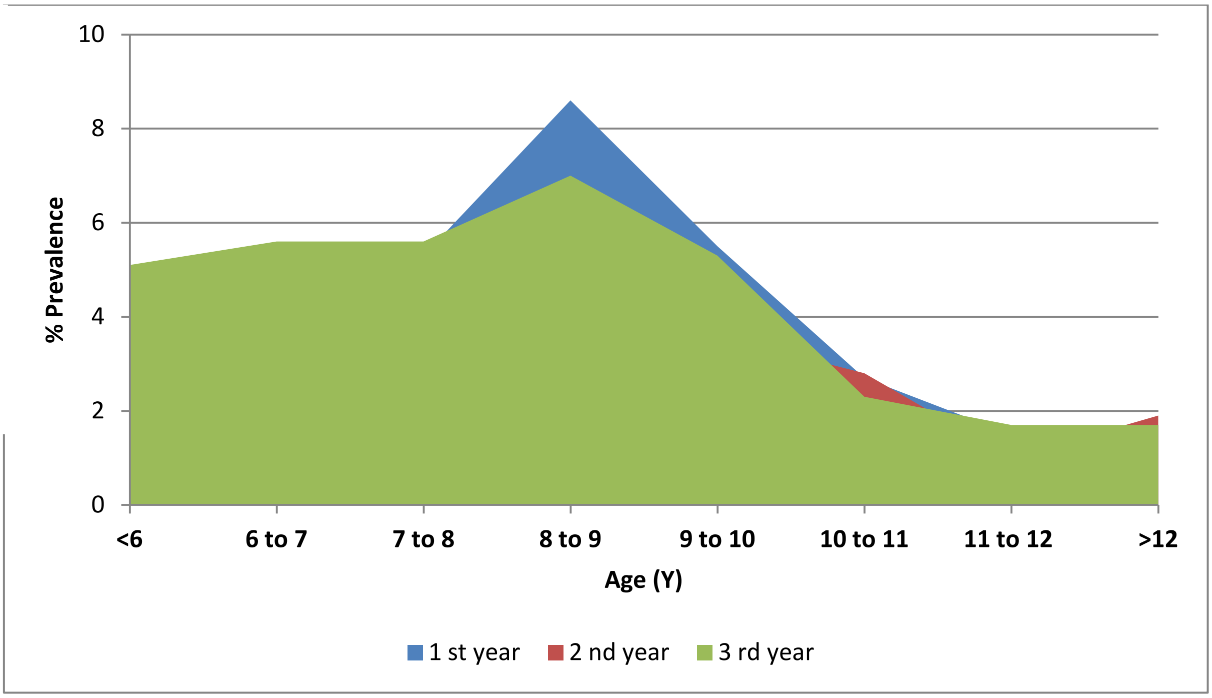


Table 4.2.13 Age wise trend in prevalence of thinness according to WHO standards

Age (Y)	Year I (N=465)		Year II (N=465)		Year III (N=465)	
	N (%)	95 % CI	N (%)	95 % CI	N (%)	95 % CI
< 6	27 (5.8)	-3.2-14.8	29 (6.2)	-2.8-15.2	32 (6.8)	-2.1-15.7
6-7	40 (8.6)	-0.3-17.5	36 (7.7)	-1.2-16.6	35 (7.5)	-1.4-16.4
7-8	45 (9.6)	0.8-18.4	42 (9.0)	0.2-17.8	37 (7.9)	-1.0-16.8
8-9	65 (13.9)	5.3-22.5	60 (12.9)	4.2-21.6	45 (9.6)	0.8-18.4
9-10	44 (9.4)	0.6-18.2	46 (9.9)	1.1-18.7	32 (6.8)	-2.1-15.7
10-11	27 (5.8)	-3.2-14.8	29 (6.2)	-2.8-15.2	23 (4.9)	-4.1-13.9
11-12	12 (2.50	-6.5-11.5	10 (2.1)	-7.0-11.2	7 (1.5)	-7.7-10.7
>12	10 (2.1)	-7.0-11.2	9 (1.9)	-7.2-11.0	8 (1.7)	-7.4-10.8

Values in parenthesis indicate percentages

Figure 4.2.7 Age wise trend in prevalence of thinness according to WHO 2007 standards

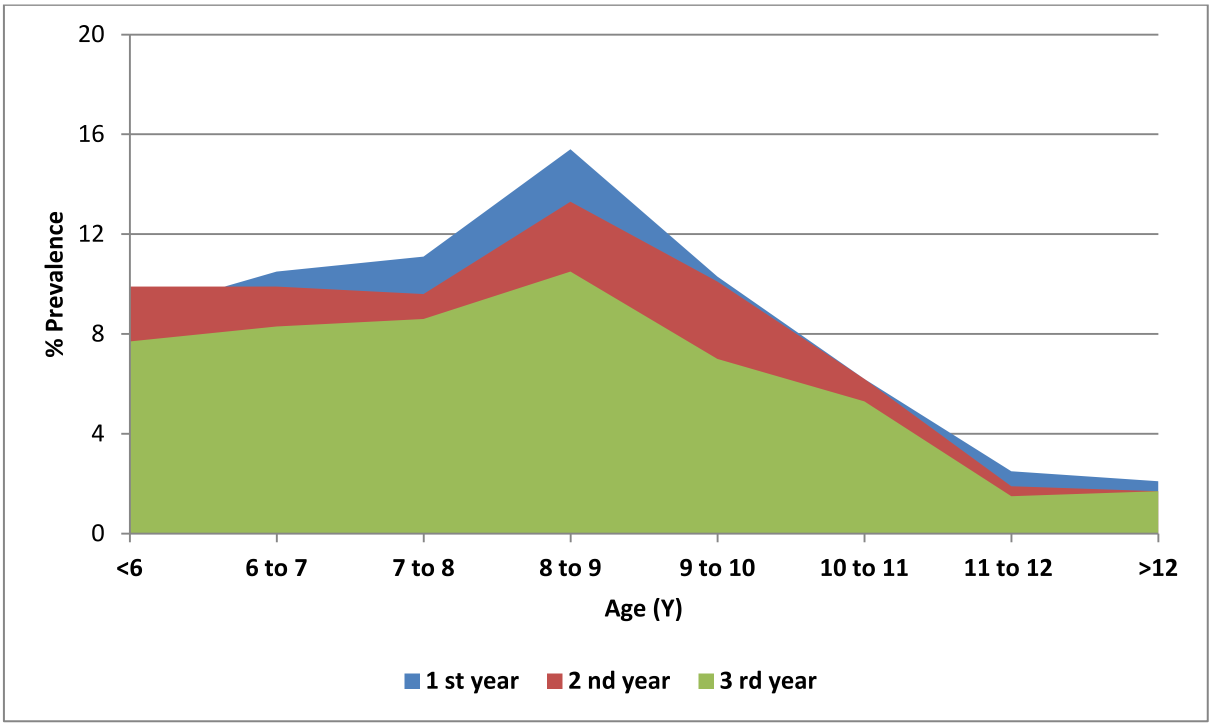


Table 4.2.14 Growth transition shift for first year represented by Weight for age

1st year Status	2nd Year Status			
	Normal	**Grade 1**	**Grade 2**	**Grade 3**
Normal **N=39**	26 (66.6)	9 (23)	-	4 (10.2)
Grade 1 **N=85**	10 (11.7)	61 (71.7)	13 (15.2)	1 (1.1)
Grade 2 **N=130**	36 (27.7)	70 (53.8)	12 (9.2)	5 (3.8)
Grade 3 **N=211**	10 (4.7)	16 (7.6)	49 (23.2)	136 (64.4)

Values in parenthesis indicate percentages

Table 4.2.15 Growth transition shift for second year represented by Weight for age

2nd year Status	3rd Year Status			
	Normal	**Grade 1**	**Grade 2**	**Grade 3**
Normal N=50	41 (82)	5 (10)	3 (6)	1 (2)
Grade 1 N=115	19 (16.5)	74 (64.3)	19 (16.5)	3 (2.6)
Grade 2 N=140	2 (1.4)	31 (22.1)	85 (60.7)	22 (15.7)
Grade 3 N=159	5 (3.1)	5 (3.1)	26 (16.3)	123 (77.3)

Values in parenthesis indicate percentages

Table 4.2.16 Growth transition shift for first year represented by height for age

1st year Status	2nd Year Status			
	Normal	**Grade 1**	**Grade 2**	**Grade 3**
Normal N=130	118 (90)	8 (6.1)	1 (0.7)	3 (2.3)
Grade 1 N=174	45 (25.8)	120 (68.9)	7 (4.0)	2 (1.1)
Grade 2 N=106	6 (5.6)	30 (28.3)	66 (62.2)	3 (2.8)
Grade 3 N=55	3 (5.4)	1 (1.8)	18 (32.7)	33 (60)

Values in parenthesis indicate percentages

Table 4.2.17 Growth transition shift for second year represented by height for age

2nd year Status	3rd Year Status			
	Normal	**Grade 1**	**Grade 2**	**Grade 3**
Normal N = 171	124 (72.5)	40 (23.4)	7 (4)	-
Grade 1 N = 159	20 (12.6)	102 (64.1)	36 (22.6)	1 (0.6)
Grade 2 N = 94	2 (2.1)	12 (12.7)	64 (68)	16 (17)
Grade 3 N = 41	2 (4.9)	2 (4.9)	4 (9.7)	33 (80.4)

Values in parenthesis indicate percentages

second year, the overall scenario was that 51.6 % of children could maintain their status Quo while 36.5 % of the children showed a positive trend. But at the same time 11.8 % of the children showed negative trend in the second year too (**Table 4.2.18 & Table 4.2.19**).

Discussion

The best global indicator of children's well being is growth. The assessment of growth not only serves as a means of evaluating the health and nutritional status of children but also provide an excellent measure to decide future action. Growth is the fundamental physiological process that characterizes childhood. Secular trends in growth show the level of health of the population group. Growth monitoring is a screening tool to diagnose nutritional chronic systemic and endocrine diseases at an early stage. Growth monitoring has the potential for significant impact on mortality even in absence of nutrition supplementation or education. Growth trends are an essential tool in paediatric practice. Their value resides in helping to determine the degree to which physiological needs for growth and development are being met during important childhood period (Mercedes De 2009). These growth trends can be obtained by systematic anthropometric measurements over a long period of time at regular interval.

Nutrition monitoring helps to assess nutritional problems prevalent in the community, in terms of their nature, magnitude and distribution among the population groups as well as geographical areas. Such monitoring over a period of time gives us an opportunity to study the changes occurring over a period of time. This information is necessary to evolve policies, to formulate appropriate programmes and implement the same for the prevention and effective control of nutritional deficiency disorders. It highlights the need to evaluate the ongoing nutrition programmes, identify bottlenecks if any and to initiate corrective steps, wherever necessary (Brahmam 2005).

Table 4.2.18 Growth transition shift for first year represented by BMI for age

1st year Status	2nd Year Status			
	Normal	**Grade 1**	**Grade 2**	**Grade 3**
Normal N = 54	27 (50)	12 (22.2)	13 (24)	2 (3.7)
Grade 1 N = 98	8 (8.1)	56 (57.1)	30 (30.6)	4 (4)
Grade 2 N = 124	3 (2.4)	32 (25.8)	50 (40.3)	39 (31.4)
Grade 3 N = 182	8 (4.4)	20 (10.9)	37 (20.3)	117 (64.2)

Values in parenthesis indicate percentages

Table 4.2.19 Growth transition shift for second year represented by BMI for age

2nd year Status	3rd Year Status			
	Normal	**Grade 1**	**Grade 2**	**Grade 3**
Normal **N = 46**	39 (84.8)	4 (8.7)	-	3 (6.5)
Grade 1 **N = 122**	36 (29.5)	62 (50.8)	15 (12.3)	9 (7.3)
Grade 2 **N = 135**	9 (6.6)	54 (40)	48 (35.5)	24 (17.7)
Grade 3 **N = 162**	5 (3)	17 (10.5)	49 (30.2)	91 (56.1)

Values in parenthesis indicate percentages

Secular changes in growth and development can be considered as the changing pattern of nutritional status of children. Developing countries which have many changes in socio economic conditions reveal various growth trends. The dynamics of growth transition demonstrated by the cohort appears to be heterogeneous in nature. The positive shift in weight appears to be more when compared to that seen in height. This is evident by the decreasing trend in prevalence of underweight in consecutive three years, while similar trend was not seen in prevalence of stunting which was unchanged in three years. The mean increase in height in the study population was 6.1 cm and weight increase was 2.7 Kg per year. Similar findings were also observed in the longitudinal study done by Deghree et al in 2004 which was carried out in Persian children were mean increase in height was 7.2 cm at the age of 12 years while it was 5.6 at 18 years of age.

There was almost similar trend of height and weight increase at all ages in school children. Thus we can say gender divide in weight status is diminishing with time. Similar time trend of diminishing weight divide between the gender was reported in many studies of vidal et al in 1999. It is important to note that secular trend in height demonstrated during childhood could extend into adulthood too. (Cole 2003)

Studies conducted during past century in Australia, Canada, Japan and U.S.(Meredith et al 1976) indicate that the magnitude of secular increase in the mean height rose with advancing age from childhood to mid adolescences. In our study also the increasing trend of the increase in mean height with increased age is very evident. The trend was seen in both boys and girls. The mean increase in height was 6.02 cm per year which was less than that found in the study owing to the fact that the countries were developed countries where mean height growth will be definitely higher than that in rural India where prevalence of malnutrition is very high.

It is evident that there is a shift in weight as well as BMI status across both the gender. A notable difference between the two transitions is that the shift in BMI of boys appears less impressive as compared to girls. This is despite the fact that boys too had significant shift in underweight Z score. The reason for this disparity could be attributed to the fact that boys are growing more symmetrically and the change in BMI is less due to significant gain in height status that accompanies their weight shifts.

During the study period of two years, the underweight and thinness in school going children contracted by 11.5 % & 16.4 % respectively. In the same period, the normal population had grown by nearly 6 %. A decline in the underweight population along with rapid growth of normal population in the cohort suggests that the study population is going through accelerated phase of nutrition transition. This encouraging shift in the malnutrition prevalence was visible across the entire spectrum of weight distribution. Such trends were observed by Raj et al in 2009. The study indicated that the conversion of underweight to normal weight status occurs more in girls as compared to boys. These findings suggest that the favourable decline of underweight burden has socio economic and gender gradients.

On a broader perspective positive shifts were seen in growth of children but the trend analysis gave a better idea about the shifts in the nutritional status of the growing children.

Tracking of the cohort over a period of 3 years showed positive improvements in the underweight and thinness variables but the children scored poorly in stunting status. This was a matter of concern. In the study, 5 % of the children had shifted to severe category. This calls for multipronged approach to tackle the situation. Growth monitoring and health tracking can go a long way in reversing the trend.

The beneficial conversion of underweight and thin children to normal category can be attributed to the increasing efforts of the government to improve the health status of school going children. One of the efforts by the government is the MDMP which has given good results though the progress is slow. Thus proper strengthening of MDM program can change the scenario of malnutrition in school children. Thus the present study reflects that growth monitoring should be a continuous process which would help in identifying growth faltering among children; who may require special attention. At the same time the ongoing MDMP of the government should be strengthened and sustained to improve the nutritional status of rural school children.

PHASE III (A): INTERVENTION RESEARCH: IMPACT OF WEEKLY IFA SUPPLEMENTATION ALONG WITH DEWORMING AND DEWORMING ALONE ON SCHOOL GOING CHILDREN

The impact of weekly IFA supplementation (60 mg elemental iron + 0.5 mg folic acid) for 30 weeks along with twice a year deworming tablet (Albendezole 400 mg) and only Deworming tablet was seen on growth, physical work capacity and haemoglobin status of school children. For the study three schools were randomly selected and the interventions were randomly assigned to them. One was a control group in which standard care condition were maintained, second was the experimental group which received IFA supplementation for 30 weeks and deworming tablet twice a year. The third group received deworming tablet twice a week. After the intervention period of 30 weeks, long term impact was seen after 6 months. For six months no intervention was given and the sustainability of the intervention was looked into. The children from 4^{th} to 7^{th} standard were enrolled for the study.

Children enrolled for the study

Table 4.3A.1 shows the number of children enrolled for the study. At baseline, for anthropometry in the control group 210 children were available while for post data only 153 children were available. In the school where Iron folic acid and deworming was given, 322 children were initially registered for the study while post data could be collected on 215 children. In the third school where only deworming was given, pre data was collected on 195 children and post data could be collected on 128 children. Thus the attrition rate in control school was 27.1 % for anthropometry, 14.5 % for step test while 41 % for haemoglobin test. In the school with IFA+DW intervention, attrition was 33.2 %, 30 % &30.5 % for anthropometry, step test and haemoglobin respectively. In the deworming supplemented group, the attrition was 34.3 % for anthropometry, 16.8 % for step test and 30 % for haemoglobin estimations. During three consecutive visits, the post step test and haemoglobin estimations could be done on nearly 70 % of the children.

Table 4.3A.1 Number of children enrolled for the intervention study (n, %)

Parameters	Control	IFA+DW	DW
Anthropometry			
Pre	210	322	195
Post	153	215	128
Drop out	**57(27.1)**	**107(33.2)**	**67(34.3)**
Step Test			
Pre	153	273	184
Post	131	191	153
Drop out	**22(14.5)**	**82(30.0)**	**31(16.8)**
Hemoglobin			
Pre	185	331	230
Post	108	230	161
Drop out	**77(41)**	**101(30.5)**	**69(30)**

Values in parenthesis indicate percentage

Impact of intervention on Anthropometric indices

Height: As height gain is a continuous process, there was a significant increase in the height of the children in all the three groups. The increase was highest in the group supplemented with DW alone. The difference between the three groups was highly significant $p < 0.001$. The increase in height was similar in both boys and girls. There was increase in height of children in the control group which was comparable to the increase in the height of children of IFA+ DW group (**Table 4.3A.2**).

The age distribution in mean height gain is shown in **Table 4.3A.3a & Table 4.3A.3b** which shows that there was significant increase in height at all the age group but the height gain was maximum in the age of 9-11 years. The height gain was found to be higher in IFA+DW group and DW group as compared to the control group.

Weight: The impact of IFA+DW and DW alone on weight gain of children is shown in **Table 4.3A.4**. Surprisingly, the control group showed the maximum weight gain (3.7 Kgs) as compared to IFA+DW supplemented group (1.4 Kg) and DW group (2.4 Kg). One of the reasons for the weight gain in the control group could be the significant lower initial weight in the control group as compared to the two experimental groups. The second reason could be due to the differences in age. In control group maximum children were in the age group of 8-9 years where as in IFA+DW group the maximum children were in 9-10 years who had shown a drop in the mean weight. Despite these facts as can be seen from the **Table 4.3A.5a & Table 4.3A. 5b** at each age, in control group higher weight gain was observed as compared to the two experimental groups.

Table 4.3A.2 Impact of weekly IFA along with Deworming and Deworming alone on height gain of the children (Mean ± SD, Cm)

Variable	Control	IFA+DW	DW	F- test
Boys	(N=67)	(N=128)	(N=65)	
Initial	131.3±9.0	134.4±10.6	133.5±9.6	**2.13**
Final	133.9±9.3	137.8±10.3	138.0±9.9	**3.7***
Difference	2.6±1.3	3.6±2.2	5.1±3.3	**19.5*****
t value	**16.6*****	**15.2*****	**6.9*****	
Girls	(N=86)	(N=87)	(N=63)	
Initial	131.6±9.3	133.7±9.2	134.6±8.9	**2.21**
Final	134.4±9.3	137.6±9.4	139.6±9.2	**6.04****
Difference	2.9±1.4	3.9±1.9	5.2±1.6	**30.8*****
t value	**16.3*****	**17.7*****	**16.4*****	
Total	(N=153)	(N=215)	(N=128)	
Initial	131.4±9.1	134.1±10.0	133.8±9.0	**3.8***
Final	134.2±9.3	137.9±10.2	139.0±9.5	**9.6*****
Difference	2.8±1.36	3.9±2.1	5.2±2.6	**47.6*****
t value	**24.9*****	**26.0*****	**22.1*****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.3a Impact of weekly IFA along with Deworming & Deworming alone on height of children cross tabulated by age (Mean ± SD, Cm)

Age (Months)	Control	IFA+DW	DW	F- test
84-96	(N=5)	(N=7)	(N=5)	
Initial	122.4±2.5	119.5±4.9	118.6±4.7	**1.07**
Final	129.9±2.5	125.0±7.5	122.3±4.9	**0.38**
Difference	2.5±0.9	5.5±4.6	3.7±0.9	**1.43**
t value	**5.97****	**3.1****	**9.10*****	
>96-108	(N=49)	(N=28)	(N=18)	
Initial	127.5±8.3	124.1±5.6	125.1±6.0	**2.11**
Final	130.3±8.5	127.6±6.0	129.9±6.5	**1.16**
Difference	2.8±1.0	3.5±2.0	4.8±2.1	**10.2*****
t value	**19.1*****	**9.1*****	**9.6*****	
>108-120	(N=28)	(N=48)	(N=27)	
Initial	126.1±6.7	128.5±5.2	130.0±5.8	**3.09**
Final	129.0±6.8	132.0±5.2	134.9±6.2	**6.7****
Difference	2.9±1.6	3.5±0.8	4.9±1.2	**20.1*****
t value	**9.2*****	**27.5*****	**20.0*****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.3b Impact of weekly IFA along with Deworming & Deworming alone on height of children cross tabulated by age (Mean ± SD, Cm)

Age (Months)	Control	IFA+DW	DW	F- test
>120-132	(N=33)	(N=41)	(N=27)	
Initial	134.7±8.1	131.6±5.9	135.1±4.7	**3.12***
Final	137.2±8.9	135.0±6.4	140.0±5.4	**3.9***
Difference	2.6±1.3	3.4±1.2	4.9±1.4	**22.4*****
t value	**11.5*****	**18.3*****	**17.1*****	
>132-144	(N=24)	(N=43)	(N=20)	
Initial	137.1±6.2	139.6±5.9	136.4±5.9	**2.4**
Final	139.8±6.6	143.5±6.3	142.7±7.0	**2.45**
Difference	2.7±1.7	3.9±2.2	6.3±4.6	**8.9*****
t value	**7.8*****	**11.5*****	**6.05*****	
>144	(N=14)	(N=48)	(N=31)	
Initial	141.9±6.2	145.0±8.5	141.7±8.9	**1.65**
Final	144.5±5.9	148.7±8.5	147.0±8.9	**1.4**
Difference	2.7±1.6	3.7±2.7	5.2±2.8	**5.3****
t value	**6.08*****	**9.42*****	**10.2*****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.4 Impact of weekly IFA along with Deworming and Deworming alone on weight gain of children (Mean ± SD, Kg)

Variable	Control	IFA+DW	DW	F- test
Boys	(N=67)	(N=128)	(N=65)	
Initial	23.4±4.7	26.5±7.2	24.6±5.4	**5.78****
Final	26.9±5.6	27.7±8.0	26.4±5.3	**0.7**
Difference	3.5±2.5	1.2±2.5	2.1±2.6	**17.2*****
t value	**11.1*****	**4.8*****	**3.8*****	
Girls	(N=86)	(N=87)	(N=63)	
Initial	23.9±5.0	26.5±5.9	25.0±5.8	**4.8****
Final	27.8±5.7	28.0±7.1	27.6±7.1	**0.05**
Difference	4.0±1.8	1.5±2.8	2.6±3.3	**16.7*****
t value	**19.8*****	**3.38*****	**6.34*****	
Total	(N=153)	(N=215)	(N=128)	
Initial	23.7±4.8	26.5±6.7	24.6±5.4	**11.1*****
Final	27.4±5.7	27.9±7.6	27.1±6.2	**0.6**
Difference	3.7±2.1	1.4±2.6	2.4±3.0	**16.5****
t value	**21.1*****	**7.5*****	**9.08*****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.5a Impact of weekly IFA along with Deworming and Deworming alone on weight of children cross tabulated by age (Mean ± SD, Kg)

Age (Months)	Control	IFA+DW	DW	F- test
84-96	(N=5)	(N=7)	(N=5)	
Initial	20.5±1.1	18.5±2.5	18.0±1.4	**2.28**
Final	23.1±2.4	21.1±3.7	19.1±1.4	**2.32**
Difference	2.6±1.8	2.6±3.3	1.2±0.5	**0.60**
t value	**3.25***	**2.05***	**5.26****	
>96-108	(N=49)	(N=28)	(N=18)	
Initial	22.1±4.7	21.4±3.6	20.5±2.7	**0.92**
Final	25.1±5.5	22.0±3.0	22.3±3.0	**5.12****
Difference	3.1±2.1	0.5±1.6	1.8±1.3	**15.7*****
t value	**9.96*****	**1.81***	**5.5*****	
>108-120	(N=28)	(N=48)	(N=27)	
Initial	21.1±3.0	24.0±3.0	22.9±3.4	**6.5****
Final	24.4±3.8	23.7±3.8	24.7±4.5	**0.58**
Difference	3.3±1.3	-0.2±1.7	2.3±1.5	**24.2*****
t value	**13.5*****	**0.94**	**2.8*****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.5b Impact of weekly IFA along with Deworming and Deworming alone on weight of children cross tabulated by age (Mean ± SD, Kg)

Age (Months)	**Control**	**IFA+DW**	**DW**	**F- test**
>120-132	(N=33)	(N=41)	(N=27)	
Initial	25.5±4.8	25.3±4.6	24.7±2.9	**0.20**
Final	29.3±5.1	25.8±4.9	27.5±5.6	**4.2***
Difference	3.9±1.5	0.5±2.0	2.7±3.6	**19.0*****
t value	**14.6*****	**1.5***	**3.9*****	
>132-144	(N=24)	(N=43)	(N=20)	
Initial	25.8±2.8	28.3±4.7	24.7±4.3	**5.8****
Final	29.8±3.4	30.7±5.3	27.8±4.5	**2.5**
Difference	4.0±1.3	2.4±2.2	3.1±2.8	**4.2***
t value	**14.9*****	**7.2*****	**4.9*****	
>144	(N=14)	(N=48)	(N=31)	
Initial	28.0±6.3	32.6±8.6	29.5±6.6	**2.7**
Final	34.2±5.5	35.6±8.8	32.1±6.8	**1.88**
Difference	6.2±3.3	3.0±3.1	2.6±3.0	**6.4****
t value	**5.8*****	**6.6*****	**4.8*****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

BMI: The data on BMI of children before and after intervention is given in **Table 4.3A.6**. As there was higher weight gain in the control group as compared to the two experimental groups. BMI remained unaltered in the experimental group. However in the control group, a significant increase in BMI (1.6, $P<0.001$) was seen in both boys and girls. The data analysis of BMI based on age also showed similar trend (**Table 4.3A.7a & Table 4.3A. 7b**).

Thus the intervention could not make significant change in the height and weight of the children because of which BMI status also remained unaltered. There was an increase in height and weight of children, but as compared to the control group it was not significant and the slight increase cannot be attributed to the intervention.

Impact of intervention on the prevalence of malnutrition

The impact of intervention on the prevalence of malnutrition using the 3 anthropometric indices is given in **Table 4.3A.8 to Table 4.3A.11.** The results have been listed below.

- The prevalence of underweight (WAZ <-2 SD) as adjudged by WHO 2007 standards showed that there was a decrease in the prevalence of underweight in the control and DW supplemented group and an increase was seen in the IFA+DW group. The decrease observed in the control group was 13.7 % and 4.5 % in the DW supplemented group. In the IFA+DW group a 3.7 % increase in the prevalence was seen which was higher in girls (7.4 %) as compared to boys (1.8 %) (**Figure 4.3A.1**).
- The prevalence of stunting had increased in control group and IFA+DW supplemented group and decreased in the DW supplemented group. A 3.2% and 1.5 % increase in the prevalence of stunting was seen in control & IFA+DW group respectively. On the contrary a fall of 7.8 % was observed in the DW group (**Figure 4.3A.2**).
- Like underweight, the prevalence of thinness reduced by 33.9 % in the control group, increased by 15.3 % in the IFA+DW and 4.6 % in DW. The rise in the prevalence of thinness in IFA+DW supplemented group was significant ($P<0.001$) (**Figure 4.3A.3**).

Table 4.3A.6 Impact of weekly IFA along with Deworming and Deworming alone on BMI of children (Mean ± SD)

Variable	Control	IFA+DW	DW	F- test
Boys	(N=67)	(N=128)	(N=65)	
Initial	13.3±2.1	14.5±2.0	13.7±1.6	**8.6*** **
Final	14.8±1.4	14.3±2.1	13.7±1.0	**6.6** **
Difference	1.6±2.0	0.2±1.8	0.06±1.3	**30.9*** **
t value	**6.25*** **	**1.5**	**0.24**	
Girls	(N=86)	(N=87)	(N=63)	
Initial	13.7±1.5	14.7±2.0	13.6±1.7	**9.3*** **
Final	15.3±1.9	14.6±2.4	13.9±2.2	**6.12** **
Difference	1.6±1.0	0.07±2.1	0.39±1.4	**24*** **
t value	**14.1*** **	**0.31**	**2.03** **	
Total	(N=153)	(N=215)	(N=128)	
Initial	13.5±1.8	14.5±2.0	13.6±1.6	**17.2*** **
Final	15.1±1.7	14.4±2.2	13.9±1.7	**13.5*** **
Difference	1.6±1.5	0.1±1.68	0.2±1.4	**32.0*** **
t value	**12.6*** **	**1.1**	**1.8**	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.7a Impact of weekly IFA along with Deworming and Deworming alone on BMI of children cross tabulated by age (Mean ± SD)

Age (Months)	**Control**	**IFA+DW**	**DW**	**F- test**
84-96	(N=5)	(N=7)	(N=5)	
Initial	13.6±0.4	12.9±1.2	12.8±0.73	**1.27**
Final	14.8±0.9	13.4±1.2	12.7±0.3	**4.9***
Difference	1.1±1.1	0.4±1.1	0.03±0.49	**1.5**
t value	**2.24***	**1.1**	**0.14**	
>96-108	(N=49)	(N=28)	(N=18)	
Initial	13.1±2.4	13.9±1.6	13.1±0.9	**1.29**
Final	14.6±2.0	13.5±1.4	13.1±1.0	**5.8****
Difference	1.5±2.3	-0.25±1.0	0.1±0.6	**9.5*****
t value	**4.45*****	**1.24**	**0.77**	
>108-120	(N=28)	(N=48)	(N=27)	
Initial	13.2±1.1	14.5±1.4	13.5±1.3	**9.25*****
Final	14.6±1.5	13.5±1.4	13.6±1.5	**5.12****
Difference	1.4±0.8	0.9±1.0	0.12±1.53	**37.2*****
t value	**8.8*****	**6.25*****	**0.4**	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.7b Impact of weekly IFA along with Deworming and Deworming alone on BMI of children cross tabulated by age (Mean ± SD)

Age (Months)	Control	IFA+DW	DW	F- test
>120-132	(N=33)	(N=41)	(N=27)	
Initial	13.9±1.5	14.5±1.9	13.6±1.2	**3.01**
Final	15.5±1.6	14.1±2.3	13.9±2.1	**5.08****
Difference	1.6±0.8	0.3±1.9	0.3±1.5	**14.08*****
t value	**11.4*****	**1.09**	**1.28**	
>132-144	(N=24)	(N=43)	(N=20)	
Initial	13.7±0.7	14.5±2.0	13.2±1.5	**4.46***
Final	15.2±0.9	14.6±1.8	13.5±1.2	**6.4****
Difference	1.5±0.6	0.2±1.0	0.4±1.3	**13.5*****
t value	**12.7*****	**1.2**	**1.2**	
>144	(N=14)	(N=48)	(N=31)	
Initial	13.8±2.2	15.3±2.3	14.5±2.2	**2.3**
Final	16.4±1.5	15.9±2.7	14.7±1.8	**3.4***
Difference	2.5±1.6	0.6±2.0	0.1±1.6	**8.05*****
t value	**5.7*****	**2.04***	**0.54**	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.8 Impact of Weekly IFA along with Deworming and Deworming alone on the prevalence of underweight (weight/Age Z score) according to WHO 2007 classification (n, %)

Variable	Control	IFA+DW	DW
Boys	N=37	N=53	N=25
Initial	13(35.1)	15(28.3)	9(36)
Final	7(18.9)	16(30.1)	8(32)
Difference	6(16.2)	1(1.8)	1(4)
Girls	N=43	N=27	N=19
Initial	14(32.5)	7(25.9)	7(36.8)
Final	9(20.9)	9(33.3)	6(31.5)
Difference	5(11.6)	2(7.4)	1(5.2)
Total	N=80	N=80	N=44
Initial	27(33.7)	22(27.5)	16(36.3)
Final	16(20)	25(31.2)	14(31.8)
Difference	11(13.7)	3(3.7)	2(4.5)

Values in parenthesis indicate percentages

Table 4.3A.9 Impact of Weekly IFA along with Deworming and Deworming alone on the prevalence of stunting (Height/Age Z score) according to WHO 2007 classification (n, %)

Variable	Control	IFA+DW	DW
Boys	N=67	N=128	N=65
Initial	9(13.4)	24(18.7)	15(23.0)
Final	11(16.4)	29(22.6)	10(15.3)
Difference	2(2.9)	5(3.9)	5(7.6)
Girls	N=86	N=87	N=63
Initial	20(23.2)	21(24.1)	16(25.3)
Final	23(26.7)	20(22.9)	11(17.4)
Difference	3(3.4)	1(1.1)	5(7.9)
Total	N=153	N=215	N=128
Initial	29(18.9)	45(20.9)	31(24.2)
Final	34(22.2)	49(22.7)	21(16.4)
Difference	5(3.2)	4(1.8)	10(7.8)

Values in parenthesis indicate percentages

Table 4.3A.10 Impact of Weekly IFA along with Deworming and Deworming alone on the prevalence of thinness (BMI/Age Z score) according to WHO 2007 classification (n, %)

Variable	Control	IFA+DW	DW
Boys	N=67	N=128	N=65
Initial	38(56.7)	62(48.4)	43(66.1)
Final	14(20.8)	79(61.7)	47(72.3)
Difference	24(35.8)	17(13.2)	4(6.1)
Girls	N=86	N=87	N=63
Initial	46(53.4)	28(32.1)	38(60.3)
Final	18(20.9)	44(50.5)	40(63.4)
Difference	28(32.5)	16(18.3)	2(3.2)
Total	N=153	N=215	N=128
Initial	84(54.9)	90(41.8)	81(63.2)
Final	32(20.9)	123(57.2)	87(67.9)
Difference	52(33.9)	33(15.3)	6(4.6)

Values in parenthesis indicate percentages

Table 4.3A.11 Impact of Weekly IFA along with Deworming and Deworming alone on the prevalence of malnutrition by WHO 2007 standards

Z Scores	**Control**		**IFA+DW**		**DW**	
	Initial	Final	Initial	Final	Initial	Final
	Weight for age					
≥ -2SD	53	64	58	55	28	30
< -2SD	27	16	22	25	16	14
Chi square	3.8*		0.2		0.20	
	Height for age					
≥ -2SD	124	119	170	166	97	107
< -2SD	29	34	45	49	31	21
Chi square	0.5		0.22		2.4	
	BMI for age					
≥ -2SD	69	121	125	83	47	41
< -2SD	84	32	90	132	81	87
Chi square	3.7***		16.4***		0.62	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Figure 4.3.1a Percent prevalence of Underweight (<-2 SD) Z score among children as per WHO 2007 classification

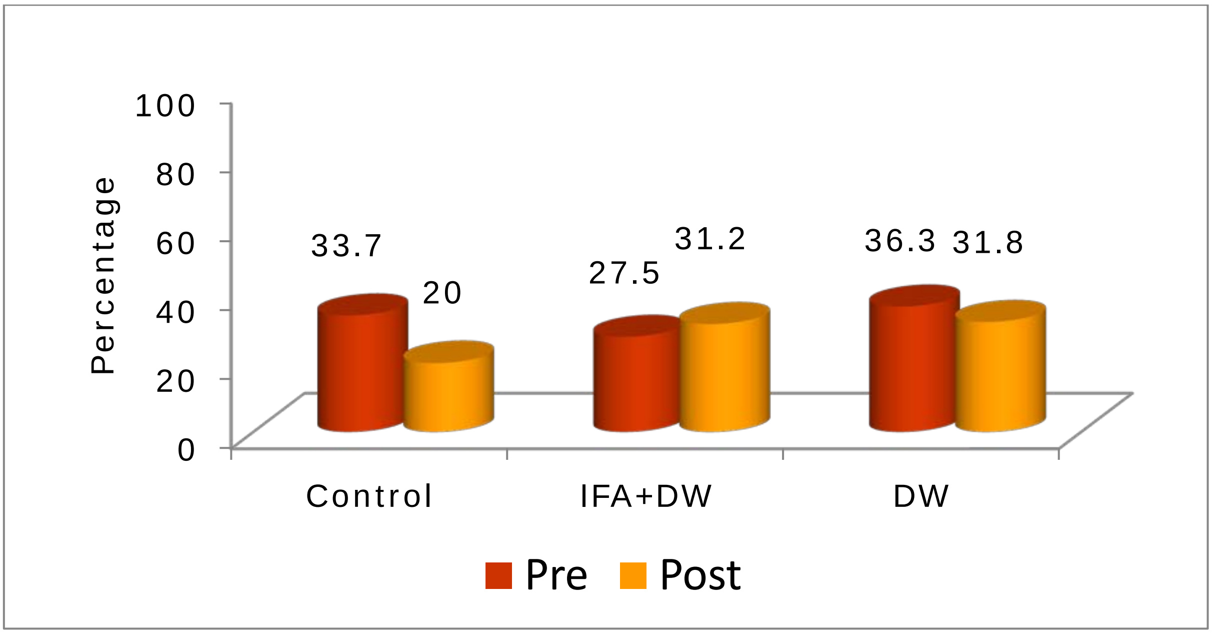


Figure 4.3.2a Percent prevalence of Stunting (<-2 SD) Z score among children as per WHO 2007 classification

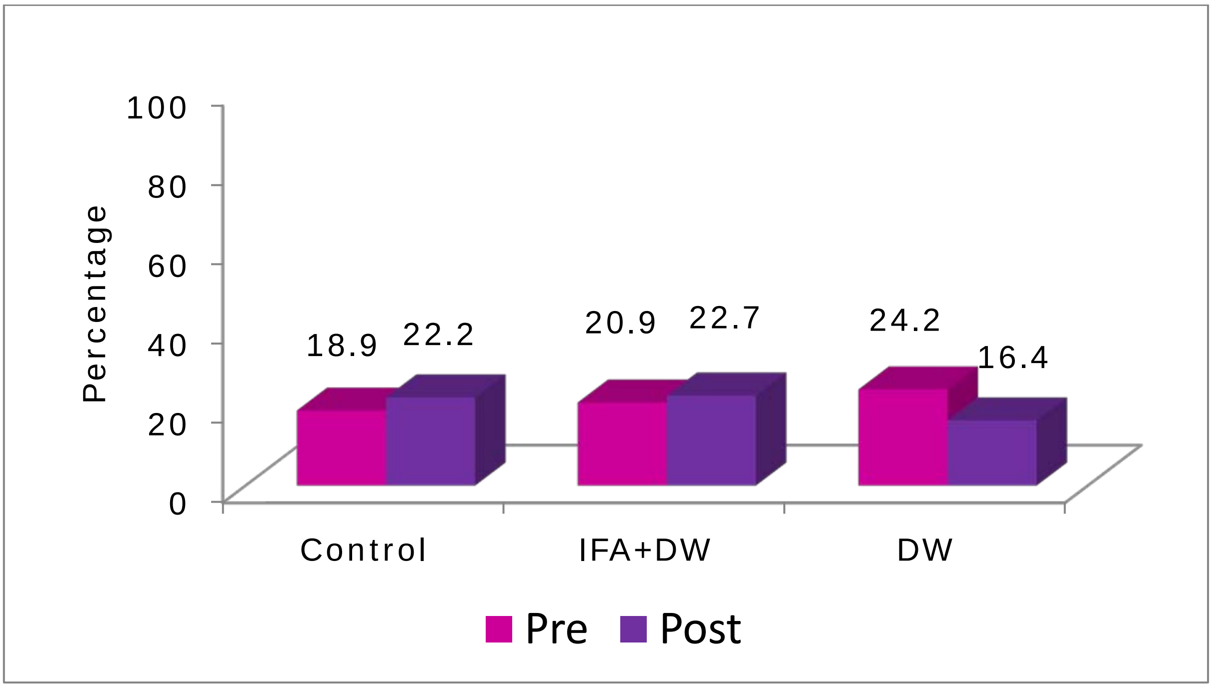
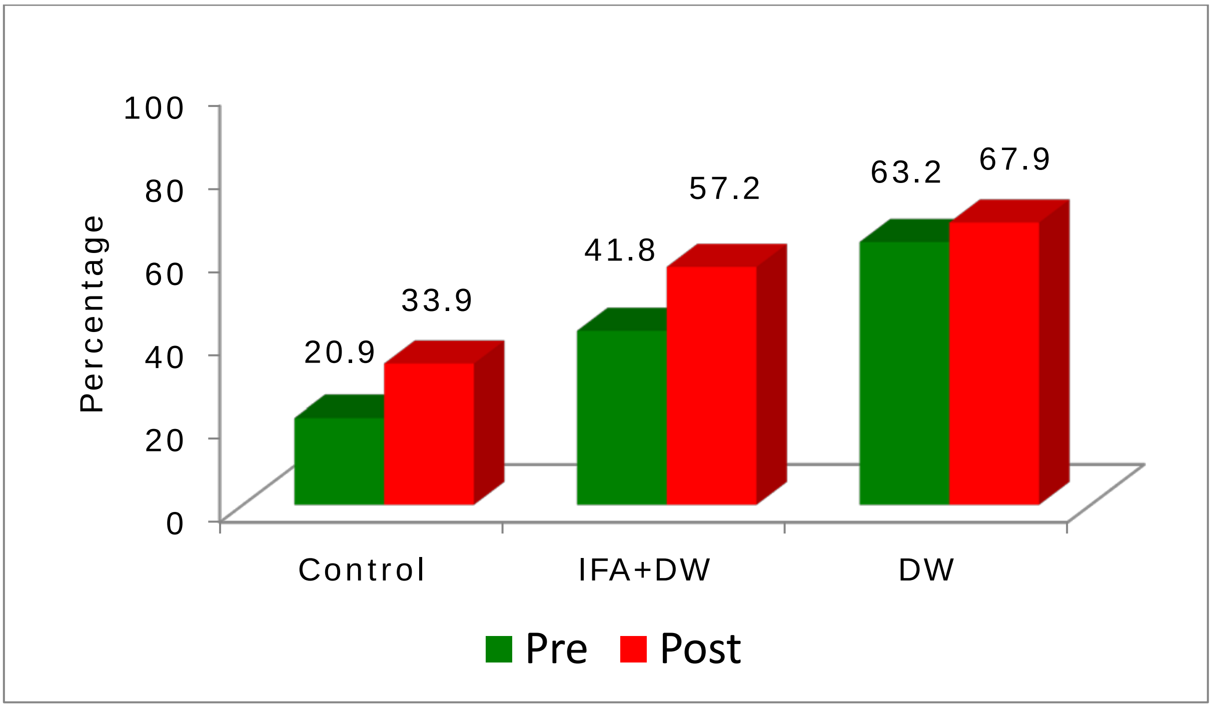


Figure 4.3.3a Percent prevalence of Thinness (<-2 SD) Z score among children as per WHO 2007 classification



Impact of intervention on the haemoglobin status of children

The mean haemoglobin levels of the children before and after the intervention period is given in **Table 4.3A.12.** There was a significant change in the mean haemoglobin levels before and after the intervention. In the IFA+ DW supplemented group, there was a mean increase of 1.9gm/dl and the difference was statistically significant. The increase was slightly higher in boys as compared to girls (2.0 g/dl Vs. 1.8 g/dl). In the control group there was no change with regard to the haemoglobin levels.

When the data was segregated according to the gradation of haemoglobin, it was seen that in IFA + DW supplemented group, the improvement in the Hb levels were higher with lower Hb levels **(Table 4.3A.13).** The increase in the normal category was only 0.4 ± 0.9 gm/dl as compared to 0.6 ± 1.0 in the mild category. In the DW group, children who were moderately anemic had shown a significant improvement in the Hb levels (0.5 g/dl). In the control group, non anemic children maintained their status.

The impact of intervention on the haemoglobin was studied in relation to age **(Table 4.3A.14a & Table 4.3A.14b).** It was observed that across all ages IFA+DW supplementation helped to significantly improve the Hb levels. Such observations were not seen in the other 2 groups.

The frequency distribution table for haemoglobin status depicts that IFA tablets were effective in reducing the prevalence of anemia in the school children. Before intervention in the IFA+ DW group 75 % of the children were anaemic, which after intervention was only 10 %. The major shift was found in the mild category of anemia. The intervention was successful in bringing down the prevalence of mild anemia from 58 % to 8 %. The prevalence of severe anemia was only 0.4 % before the intervention. After the intervention none of the children was severely anaemic. In the moderate category a shift of 14 % was seen from 16 % to 2 % (**Table 4.3A.15**) & (**Figure 4.3A.4**).

Table 4.3A.12 Impact of weekly IFA along with Deworming and Deworming alone on the hemoglobin of children (Mean ± SD, g/dl)

Variable	Control	IFA+DW	DW	F- test
Boys	(N=55)	(N=120)	(N=78)	
Initial	10.92±1.36	11.6±0.78	11.6±1.2	**8.5*** **
Final	10.75±1.89	13.7±1.1	11.5±1.5	**97.3*** **
Difference	0.17±2.2	2.0±1.2	0.05±1.6	**56.9*** **
t value	**0.57**	**17.6*** **	**0.29**	
Girls	(N=53)	(N=110)	(N=83)	
Initial	10.0±1.4	11.4±1.0	11.2±1.2	**23.4** **
Final	10.1±1.1	13.3±1.3	11.3±1.3	**28.4*** **
Difference	0.04±1.3	1.8±1.3	0.12±1.4	**50.6*** **
t value	**0.25**	**10.9** **	**0.80**	
Total	(N=108)	(N=230)	(N=161)	
Initial	10.5±1.4	11.5±0.93	11.3±1.1	**2.9*** **
Final	10.4±1.6	13.5±1.2	11.4±1.3	**2.1*** **
Difference	-0.06±1.8	1.9±1.3	0.04±1.5	**10.7*** **
t value	**0.36**	**3.2*** **	**0.33**	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.13 Impact of weekly IFA along with Deworming and Deworming alone on the hemoglobin level of children based on gradation of Hb levels (Mean ± SD, g/dl)

Hb (g/dl)	Control	IFA+DW	DW	F- test
≥ 12	(N=17)	(N=57)	(N=69)	
Initial	12.7±0.6	12.6±0.5	12.4±0.5	**3.3***
Final	13.5±1.2	13.2±0.3	12.7±0.6	**7.0*****
Difference	2.6±1.7	0.4±0.9	0.9±1.2	**7.3*****
t value	**0.45**	**5.0****	**4.2****	
12 - ≤10	(N=49)	(N=165)	(N=77)	
Initial	10.9±0.6	11.2±0.4	10.9±0.5	**15.3*****
Final	10.6±0.6	11.5±0.4	11.0±0.5	**11.06*****
Difference	-0.2±1.4	0.6±1.0	0.1±1.2	**1.18**
t value	**0.25**	**2.48****	**1.02***	
10-7	(N=42)	(N=8)	(N=15)	
Initial	9.18±0.71	9.08±0.67	8.95±0.86	**0.5**
Final	9.08±0.64	9.8±0.5	9.15±0.6	**0.46**
Difference	-0.8±1.45	0.78±0.6	0.5±1.4	**5.0****
t value	**1.0**	**4.32*****	**3.1****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.14a Impact of weekly IFA along with Deworming and Deworming alone on hemoglobin of children cross tabulated by age (Mean ± SD, g/dl)

Age (Months)	Control	IFA+DW	DW	F- test
84-96	(N=3)	(N=8)	(N=4)	
Initial	10.16±0.3	11.2±1.0	12.6±1.3	**5.25***
Final	11.7±0.9	13.2±0.9	13.0±1.2	**3.1**
Difference	1.5±1.2	1.3±0.8	0.4±0.8	**5.6***
t value	**2.14**	**7.6*****	**0.8**	
>96-108	(N=42)	(N=31)	(N=16)	
Initial	10.7±1.5	11.7±0.6	12.0±1.0	**9.3*****
Final	10.8±1.5	13.05±1.1	11.9±1.7	**20.3*****
Difference	0.12±2.0	1.3±1.2	0.09±1.6	**4.9****
t value	**0.37**	**5.8*****	**0.22**	
>108-120	(N=24)	(N=46)	(N=34)	
Initial	9.9±1.3	11.6±1.0	11.4±1.1	**20.4*****
Final	9.7±1.5	13.06±1.0	11.4±1.3	**54.9*****
Difference	-0.1±1.5	1.4±1.3	0.02±1.5	**14.4*****
t value	**0.57**	**7.1*****	**0.11**	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.14b Impact of weekly IFA along with Deworming and Deworming alone on hemoglobin of children cross tabulated by age (Mean ± SD, g/dl)

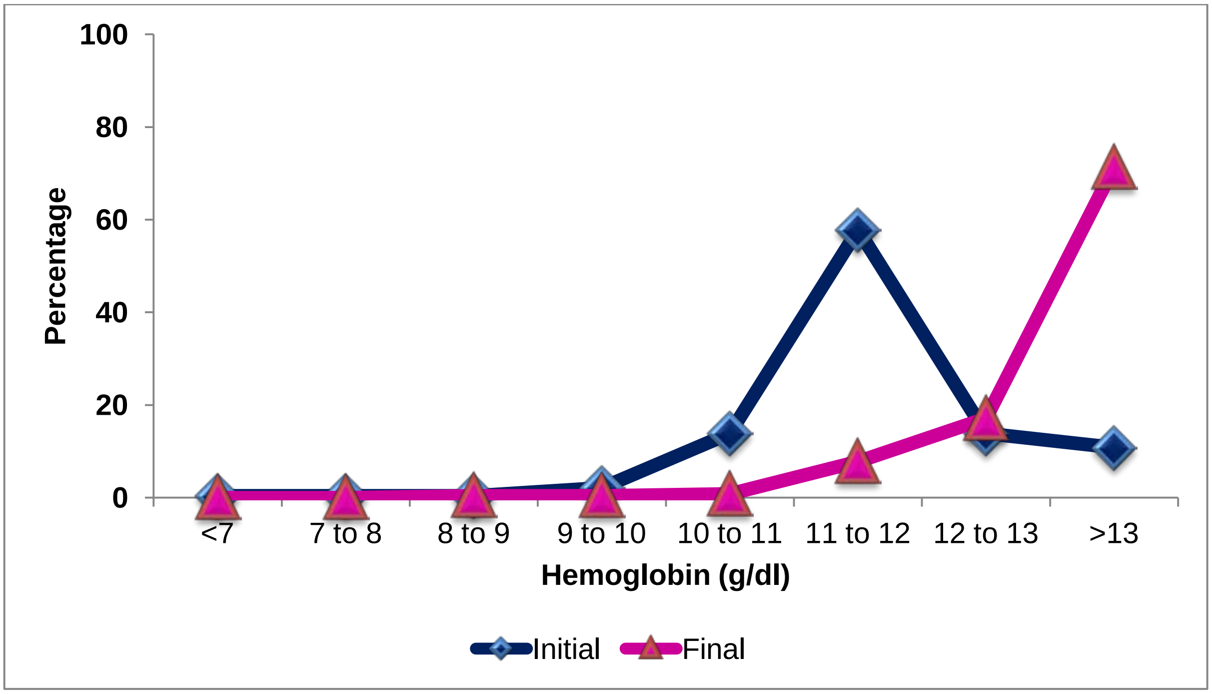
Age (Months)	**Control**	**IFA+DW**	**DW**	**F- test**
>120-132	(N=19)	(N=44)	(N=38)	
Initial	10.5±0.8	11.4±0.76	11.1±1.1	**6.5****
Final	10.2±1.5	13.5±1.0	11.0±1.4	**57.2*****
Difference	-0.24±1.3	1.9±1.2	-0.1±1.7	**27.5*****
t value	**0.78**	**10.7*****	**0.08**	
>132-144	(N=11)	(N=49)	(N=33)	
Initial	11.46±1.5	11.5±0.9	11.28±1.52	**0.53**
Final	10.8±1.9	13.7±1.0	11.5±1.1	**43.5*****
Difference	-0.6±2.4	2.1±1.0	0.2±1.7	**24.2*****
t value	**0.89**	**13.9*****	**0.86**	
>144	(N=9)	(N=52)	(N=36)	
Initial	10.0±1.6	11.3±1.1	11.25±1.22	**4.7***
Final	9.9±1.1	13.9±1.5	11.19±1.3	**52.4*****
Difference	-0.07±1.4	2.5±1.2	0.02±1.3	**49.4*****
t value	**0.16**	**14.6*****	**0.01**	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.15 Frequency distribution of hemoglobin levels of the children (n, %)

Hb (g/dl)	Control (N=108)				IFA+DW (N=230)				DW (N=161)			
	Initial	95 % CI	Final	95 % CI	Initial	95 % CI	Final	95 % CI	Initial	95 % CI	Final	95 % CI
<7	1 (0.9)	-18- 19.8	1 (0.9)	-18- 19.8	1 (0.4)	-12.2-13	-		1 (0.6)	-14.8-16	-	
7-8	4 (3.7)	-15.2-22.6	3 (2.7)	-16-21.4	1 (0.4)	-12.2-13	-		1 (0.6)	-14.8-16	1 (0.6)	-14.8-16
8-9	7 (6.4)	-12.1-24.9	11 (10.1)	8.1-28.3	1 (0.4)	-12.2-13	1 (0.4)	-12.2-13	4 (2.4)	-12.9-17.7	9 (5.5)	-9.7-20.7
9-10	30 (27.7)	11.4-44	25 (23.1)	6.2-40	5 (2.1)	-10.7-14.9	1 (0.4)	-12.2-13	9 (5.5)	-9.7-20.7	16 (9.9)	-5-24.8
10-11	26 (24)	7.2-40.8	35 (32.4)	16.6-48.2	32 (13.9)	1.7-26.1	2 (0.8)	-11.8-13.4	28 (17.3)	3-31.6	31 (19.2)	5.1-33.3
11-12	23 (21.2)	4.2-38.2	19 (17.5)	0.1-34.9	133 (57.8)	49.2-66.4	18 (7.8)	-4.8-20.4	49 (30.4)	17.3-43.5	41 (25.4)	11.8-39
12-13	11 (10.1)	-8.1-28.3	6 (5.5)	-13.1-24.1	32 (13.9)	1.7-26.1	44 (19.1)	7.2-31	54 (33.5)	20.7-46.3	43 (26.7)	13-40.2
>13	6 (5.5)	-13.1-24.1	8 (7.4)	-11.1-25.9	25 (10.8)	-1.6-23.2	164 (71.3)	64.2-78.4	15 (9.3)	-5.7-24.3	20 (12.4)	-2.3-27.1

Figure 4.3.4a Frequency Distribution of Hemoglobin levels of children in IFA+ DW intervention Group



The shift in the haemoglobin status of the deworming supplemented group was also looked into. In this group, initially the prevalence of anemia was 56. 8%. After the intervention the prevalence remained at 60 %. Thus there was no major effect of deworming alone on the prevalence of anemia. In both the mild and moderate category the prevalence remained same.

In the control group there was no change in terms of Hb status or prevalence of anemia. In the pre data the prevalence of anemia was 83.9 % which was 87 % after the intervention period maintained by conditions. No major shift was recorded in mild, moderate or severe category of anemia.

Mean Haemoglobin levels based on Anaemic Status

The **Table 4.3A.16** shows that in the IFA+DW intervention group, the intervention was more effective in increasing the initial Hb levels in the children who were initially anaemic as compared to the children who were initially non anaemic $p<0.01$. In the DW supplemented group, there was significant increase ($p<0.01$) in the Hb levels of initially anaemic children, while in non anaemic school children a small decrease in the Hb levels were registered, where Hb levels came down from 12.5 ± 0.5 to 11.9 ± 1.2. In the control group, no change was observed. A small drop in the Hb levels was registered in the initially non anaemic children and the Hb levels came down from 12.7 ± 0.6 to 11.3 ± 1.7. Thus deworming helped to improve the Hb levels of anemic children (**Figure 4.3A.5)**.

Thus overall if we see, IFA+DW supplementation was highly effective in decreasing the prevalence of anemia $p<0.001$. Deworming supplementation was less effective, but when compared to the control group, deworming had positive effect (**Figure 4.3A.6**). Thus the synergic effect of IFA+DW was very effective (**Table 4.3A.17**). When the effect of intervention was seen based on the change

Table 4.3A.16 Impact of Weekly IFA along with Deworming and Deworming alone on haemoglobin status of children (Mean ± SD)

	Control		**IFA+DW**		**DW**	
	Initially Anemic (N=91)	Initially non Anemic (N= 17)	Initially Anemic (N=173)	Initially non Anemic (N=57)	Initially Anemic (N=92)	Initially non Anemic (N=69)
Initial	10.0±1.1	12.7±0.6	11.1±0.7	12.6±0.5	10.5±1.0	12.5±0.5
Final	10.3±1.5	11.3±1.7	13.4±1.3	13.6±1.1	11.0±1.3	11.9±1.2
Difference	0.22±1.6	-1.3 ±2.0	2.3 ±1.2	0.9±1.0	0.4±1.5	0.5±1.2
Paired t value	**1.29**	**2.4***	**23.8*****	**6.9****	**2.7****	**3.6****

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Figure 4.3A.5 Impact of Weekly IFA along with Deworming and deworming alone base on severity of Anemia (g/dl)

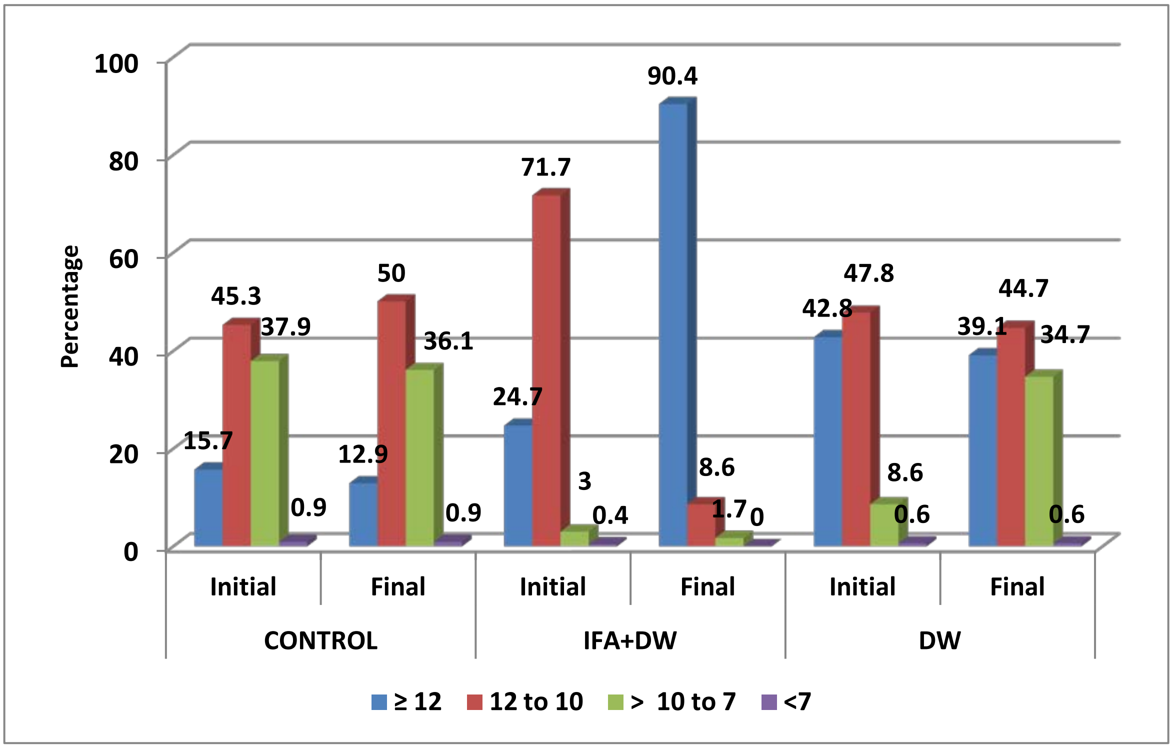


Figure 4.3.6 Impact of Intervention on the percent prevalence of Anemia among children

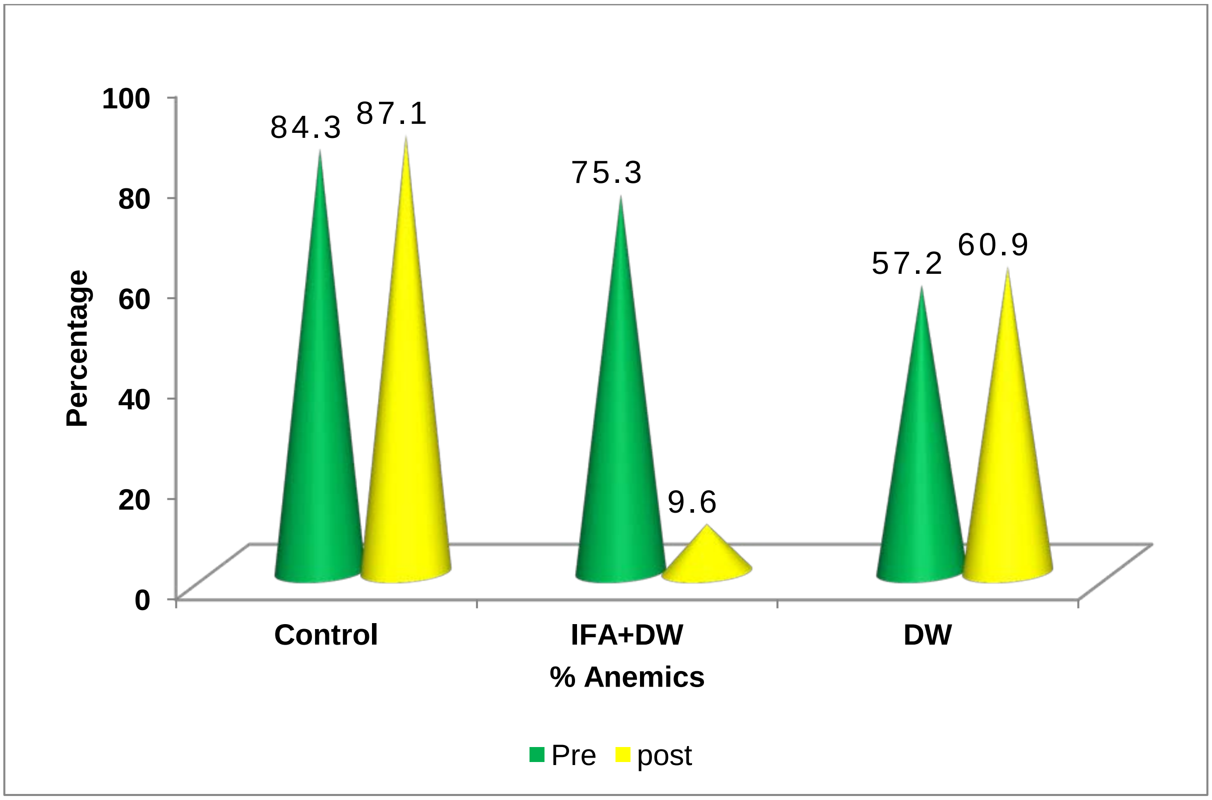


Table 4.3A.17 Impact of Weekly IFA along with Deworming and Deworming alone on prevalence of IDA among children

	Control (N=108)		**IFA+DW (N=230)**		**DW (N=161)**	
	Anemic	**Normal**	**Anemic**	**Normal**	**Anemic**	**Normal**
Initial	91(84.25)	17 (15.75)	173 (75.2)	57 (24.8)	92 (57.1)	69 (42.9)
Final	94(87.0)	14 (13)	22 (9.5)	208 (90.5)	98 (60.8)	63 (39.2)
Chi square	**0.34**		**97.2******		**0.46**	

***Significance at $p<0.001$

in the severity of Hb levels, there was significant change $p<0.01$ in both the intervention group as compared to the control group (**Table 4.3A.18**).

The shift in the Hb levels was studied in all the three groups. In the IFA+DW intervention group, 80.4 % of the children showed a positive shift in the Hb status. Around 17 % of the children could just maintain their initial Hb levels while negative shift was observed in 2.6 % of the subjects (**Table 4.3A.19**). In the DW supplemented group, 31 % of the children showed the positive trend while negative trend was registered in 37 % of the children. 1/3rd of the children could maintain their Hb status with the supplementation of DW tablets (**Table 4.3A.20**). In the control group, 34 % showed a positive trend while only 26.8 % of the children could maintain their status. Negative shift were seen in 40 % of the children (**Table 4.3A.21**).

Impact of intervention on physical work capacity of the children

Physical work capacity was obtained by step test. Oximeter was used to get saturated peripheral oxygen ($SP0_2$) and beats per minute (BPM) before and after the step test. The normal value for $SP0_2$ is > 97. The normal resting beats per minutes for children is 70 BPM.

The SPO_2 values remained unaltered after the intervention period. None of the subjects had abnormal SPO_2 values (**Table 4.3A.22**). The data on beats per minutes before and after the step test is given in **Table 4.3A.23**. There was no change in beats per minute values of children after the intervention period.

The number of steps undertaken by the children in 3 minutes is given in **Table 4.3A.24**. Improvements in the number of steps were seen only in the two experimental group. The average increase in the number of steps was 4 & 7 for IFA+DW group and only DW group respectively. In the IFA+DW group the

Table 4.3A.18 Impact of Weekly IFA along with Deworming and Deworming alone on severity of Hemoglobin level of children (n, %)

Hb (g/dl)	Control (N=108)		IFA+DW (N=230)		DW (N=161)	
	Initial	Final	Initial	Final	Initial	Final
≥ 12	17(15.7)	14(12.9)	57(24.7)	208(90.4)	69(42.8)	63(39.1)
12-10	49(45.3)	54(50)	165(71.7)	20(8.6)	77(47.8)	72(44.7)
10-7	41(37.9)	39(36.1)	7(3.0)	4(1.7)	14(8.6)	56(34.7)
<7	1(0.9)	1(0.9)	1(0.4)	-	1(0.6)	1(0.6)
Chi Square	**0.58**		**20.1.5*****		**23.10*****	

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.19 Shift in hemoglobin levels of the children in control group

Initial Hb level (g/dl)	Final Hb Level (g/dl)								
	<7	7-8	>8-9	>9-10	>10-11	>11-12	>12-13	>13	Total
<7	1								1
7-8		1	1	1	1				4
>8-9			3	1	1		1	1	7
>9-10			5	11	8	4	1	1	30
>10-11		1	1	7	8	7	2		26
>11-12		1		3	11	4	1	3	23
>12-13				1	3	3	1	3	11
>13			1	1	3	1			6
Total	1	3	11	25	35	19	6	8	108

Table 4.3A.20 Shift in the hemoglobin levels of children in IFA+DW group

Initial Hb level (g/dl)	Final Hb Level (g/dl)								
	<7	7-8	>8-9	>9-10	>10-11	>11-12	>12-13	>13	Total
<7			1						1
7-8						1			1
>8-9					1				1
>9-10				1			2	2	5
>10-11						6	7	19	32
>11-12					1	8	26	98	133
>12-13						3	7	22	32
>13							2	23	25
Total			1	1	2	18	44	164	230

Table 4.3A.21 Shift in Hemoglobin levels of the children in DW group

Initial Hb level (g/dl)	Final Hb Level (g/dl)								
	<7	7-8	>8-9	>9-10	>10-11	>11-12	>12-13	>13	Total
<7							1		1
7-8									1
>8-9				3	1				4
>9-10			1			6	2		9
>10-11			2	4	7	8	6	1	28
>11-12		1	4	6	11	14	9	4	49
>12-13			1	2	9	9	23	10	54
>13				1	3	4	2	5	15
Total		1	9	16	31	41	43	20	161

Table 4.3A.22 Impact of intervention on saturated peripheral oxygen to judge physical work capacity of children (Mean ± SD)

Variable	**Initial**	**Final**	**Difference**	**t- test**
Control Group (N=131)				
Baseline	97.51±1.2	98.0±1.0	0.03±0.9	**0.4**
Post Data	98.3±0.9	98.0±1.09	0.3±1.0	**0.72**
Difference	0.80±1.6	0.45±1.7	0.3±1.6	**0.3**
IFA+DW (N=191)				
Baseline	97.4±3.1	97.6±1.7	0.2±3.5	**0.8**
Post Data	97.4±1.0	97.4±1.1	0.04±1.3	**0.1**
Difference	0.1±3.2	0.2±2.0	0.2±3.8	**0.2**
DW (N=153)				
Baseline	97.6±1.0	97.4±1.02	o.12±0.9	**1.6**
Post Data	96.9±4.7	96.6±6.0	0.3±5.14	**0.7**
Difference	0.63±4.8	0.8±6.0	0.17±5.2	**0.4**

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.23 Impact of weekly IFA along with Deworming and Deworming alone on Physical work capacity of children (Mean ± SD) (beats per minute)

Variable	Initial	Final
Control Group (N=131)		
Baseline	93.4±19.1	132.0±22.7
Post Data	106.5±22.6	122.0±32.3
Difference	13.0±29.9	10.0±35.6
t value	1.2	0.8
IFA+DW (N=191)		
Baseline	92.8±21.1	125.6±24.8
Post Data	91.8±23.5	125.1±32.8
Difference	1.08±29.6	0.43±39.4
t value	0.3	0.2
DW (N=153)		
Baseline	90.8±19.5	128.2±21.6
Post Data	93.16±23.8	110.0±29.1
Difference	2.3±2.9	16.9±36.1
t value	0.5	1.5

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3A.24 Impact of intervention on the physical work capacity by children (Mean ± SD) (number of steps in 3 minutes)

Variable	Control	IFA+DW	DW
Boys	(N=60)	(N=95)	(N=72)
Initial	31.2±3	33.4±6	31±9.1
Final	36.4±6.4	39.1±6.7	37.4±6.9
Difference	4.9±3.2	7.1±1	6.7±3.9
t value	**1.32**	**4.03****	**3.2**
Girls	(N=71)	(N=96)	(N=81)
Initial	33.1±4.1	32±5.3	28.6±5
Final	35±4	35.4±5.4	34.1±5.7
Difference	2±1	3.9±5	6.4±3.1
t value	**1.29**	**3.1**	**4.2***
Total	(N=131)	(N=191)	(N=153)
Initial	32.5±3.9	33.2±5.6	29.7±7.3
Final	35±2.3	37.0±6.4	35.6±6.5
Difference	2.8±4.2	4±6.2	7.1±4.2
t value	**2.1**	**3.7***	**4.9****

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

increase in the physical work capacity was significantly higher for boys than girls (7 Vs. 4) where as it was similar in both girls and boys in the DW group with girls showing significant improvement than boys ($p<0.05$). The data was segregated gender wise to see the impact of intervention on gender wise physical work capacity. Overall picture depicts that boys had better physical work capacity as compared to girls, as the number of steps done by the boys were more than that of girls. In the control group, there was no difference found in the physical work capacity. The difference as depicted by the t test was not significant. The results were similar for both the genders. Though there was increase in the number of steps in the post data, the increase can be attributed to the maturation effect i.e. the children had earlier experience of the step test.

When the physical work capacity was studied in relation to anemia status, it was observed that number of steps taken by the non anemic subject were higher then the anemic counterparts though the difference was non significant **(Table 4.3A.25)**.

Table 4.3A.25: Impact of weekly IFA along with Deworming and Deworming alone on physical work capacity (number of steps) of children based on Anemia Status (Mean ± SD)

	Control (N= 131)		IFA+DW (N= 191)		DW (N=153)	
	Anemic	**Non Anemic**	**Anemic**	**Non Anemic**	**Anemic**	**Non Anemic**
Initial	31.2±4	32.4±4.8	31.0±5	33.1±6	29.4±5.0	30.1±7.2
Final	34.2±2.1	35.9±4.2	32.0±4.8	37.2±6.5	33.2±2.0	36.1 ± 6.3
t test	2.4	3.7	1.7	3.9	3.8	4.2

PHASE III (B): SUSTAINABILITY OF THE EFFECT OF INTERVENTION ON GROWTH AND HAEMOGLOBIN LEVELS OF SCHOOL CHILDREN AFTER 6 MONTHS

After the post data was collected for the intervention period, standard care conditions were maintained in all the three groups. Thus the follow up was extended to further 6 months without the intervention. The results of this phase deals with the data on sustainability effect of the IFA+DW and only DW on the growth and Haemoglobin status.

At the end of the standard care period, sample size was 86 children in control group, 118 children in the IFA+DW supplemented group and 83 children in the deworming supplemented group. In the control group there were 50 girls and 36 boys; in the IFA+DW supplemented group there were 48 girls and 70 boys while in the deworming group there were 38 girls and 45 boys.

As linear growth is a natural phenomena at the end of the 6 month a slight increase in the mean height was seen which was significant only in case of IFA+DW group and control group. In the control group mean increase in the height was significant only for girls. In the DW group, the children maintained their height status **(Table 4.3B.1)**.

With regards to weight, it is important to note that weight gain was higher in the two experimental group whereas the mean weight was slightly lower in the control group **(Table 4.3B.2)**. With the increase in height and weight the BMI of the children in the experimental group showed an upward trend and was higher, whereas in the control group a drop in BMI was seen (15 Vs 14.4). The drop in BMI was seen in both boys and girls **(Table 4.3B.3)**.

Prevalence of malnutrition

The change in the prevalence of malnutrition was looked into after the washout period. The prevalence was again looked into by WHO 2007 standards.

Table 4.3B.1 Long term impact of weekly IFA along with Deworming and Deworming alone on height change of children (Mean ± SD, cms)

Variable	Control	IFA+DW	DW
Boys	(N=36)	(N=70)	(N=45)
Baseline	132.3±8.6	133.6±8.5	136.4±10.0
Washout Effect	134.2±9.5	135.7±8.4	136.6±11.3
t value	-	6.1***	0.4
Girls	(N=50)	(N=48)	(N=38)
Baseline	132.7±9.8	133.8±8.5	137.6±7.6
Washout Effect	134.9±10.6	135.1±8.2	137.2±7.7
t value	**4.4****	**6.7***	**0.9**
Total	(N=86)	(N=118)	(N=83)
Baseline	132.5±9.3	133.7±8.4	136.9±9.0
Washout Effect	134.6±10.3	135.4±8.3	136.9±9.8
t value	5.5***	8.0***	0.1

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3B.2 Long term impact of weekly IFA along with Deworming and Deworming alone on weight change of children (Mean ± SD, Kg)

Variable	Control	IFA+DW	DW
Boys	(N=36)	(N=70)	(N=45)
Baseline	26.1±4.4	25.2±5.6	25.7±5.4
Washout Effect	25.9±5.2	26.2±5.7	26.8±6.3
t value	0.4	-	
Girls	(N=50)	(N=48)	(N=38)
Baseline	27.2±6.1	25.1±5.2	26.8±6.8
Washout Effect	26.9±6.7	26.1±4.9	28.4±7.7
t value	**0.6**	**-**	**4.9****
Total	(N=86)	(N=118)	(N=83)
Baseline	26.7±5.5	25.2±5.4	26.1±6.1
Washout Effect	26.5±5.5	26.2±5.4	27.4±7.0
t value	0.7	-	1.7*

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3B.3 Long term impact of weekly IFA along with Deworming and Deworming on BMI of children (Mean ± SD)

Variable	Control	IFA+DW	DW
Boys	(N=36)	(N=70)	(N=45)
Baseline	14.8±1.0	14.0±1.6	13.6±1.0
Washout Effect	14.2±1.2	14.1±1.6	14.2±1.3
t value	3.3	-	-
Girls	(N=50)	(N=48)	(N=38)
Baseline	15.3±2.0	13.9±1.8	13.9±2.3
Washout Effect	14.6±2.2	14.2±1.4	14.9±2.9
t value	**3.7*** **	**-**	**6.2** **
Total	(N=86)	(N=118)	(N=83)
Baseline	15.0±1.7	13.9±1.7	13.7±1.7
Washout Effect	14.4±1.8	14.1±1.5	14.5±2.2
t value	4.9***	-	7.3***

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

The change in the prevalence of underweight according to WHO 2007 is shown in **Table 4.3B.4 & Figure 4.3B.1**. As in WHO 2007 standard the Z score for children less than 10 years are not obtained, the data analysis shown in the table is for children greater than 10 years of age. For these particular age children it shows that IFA+DW supplementation could sustain the growth of the children. The overall prevalence of underweight which was 29.8 % in post data went further down to 17.9 %. The trend was similar for both boys and girls. In the deworming supplemented group too, the intervention was sustainable and the prevalence reduced from 26.6 % to 17.7 %. The gender wise bifurcation suggests that trend was better in girls as compared to boys. In the control group, there was increase in the prevalence of underweight from 21.5 % in post data to 39.2 % in the washout period. The worsening trend was seen more in boys than girls.

The data on stunting is depicted in **Table 4.3B.5 & Figure 4.3B.2**. After six months of washout effect, the prevalence of stunting increased in all the 3 groups. The increase in the prevalence of stunting was 11.7 % in control group, 2.3 % in IFA+DW supplemented group and 14.5 % in DW supplemented group. The prevalence of thinness after the washout period was also seen. In line with the observations of underweight, thinness also showed a similar trend. The reduction in the prevalence of thinness in both the experimental group was 1.7 % in the IFA+DW supplemented group and 20.5 % in the DW supplemented group. However in the control group, a rise of 22.1 % in the prevalence of thinness was seen **(Table 4.3B.6 & Figure 4.3B.3)**.

Impact on haemoglobin status

The sustainable effect of the intervention was seen on the mean haemoglobin status of the children (**Table 4.3B.7**). Both the interventions i.e. IFA+DW and only DW could not sustain their effect for 6 months period. In the IFA+DW supplemented group, there was a significant drop ($p<0.01$) in the

Table 4.3B.4 Prevalence of Underweight (weight for age < -2 SD Z score) according to WHO 2007 standards

Variable	Control	IFA+DW	DW
Boys	N=23	N=45	N=25
Baseline	4(17.4)	14(31.1)	7(28)
Washout Effect	5(21.7)	9(20)	7(28)
Girls	N=28	N=22	N=20
Baseline	7(25)	6(27.2)	5(25)
Washout Effect	4(14.2)	3(13.6)	1(5)
Total	N=51	N=67	N=45
Baseline	11(21.5)	20(29.8)	12(26.6)
Washout Effect	20(39.2)	12(17.9)	8(17.7)

Values in parenthesis indicate percentages

Figure 4.3B.1 Long term impact on Prevalence of Underweight

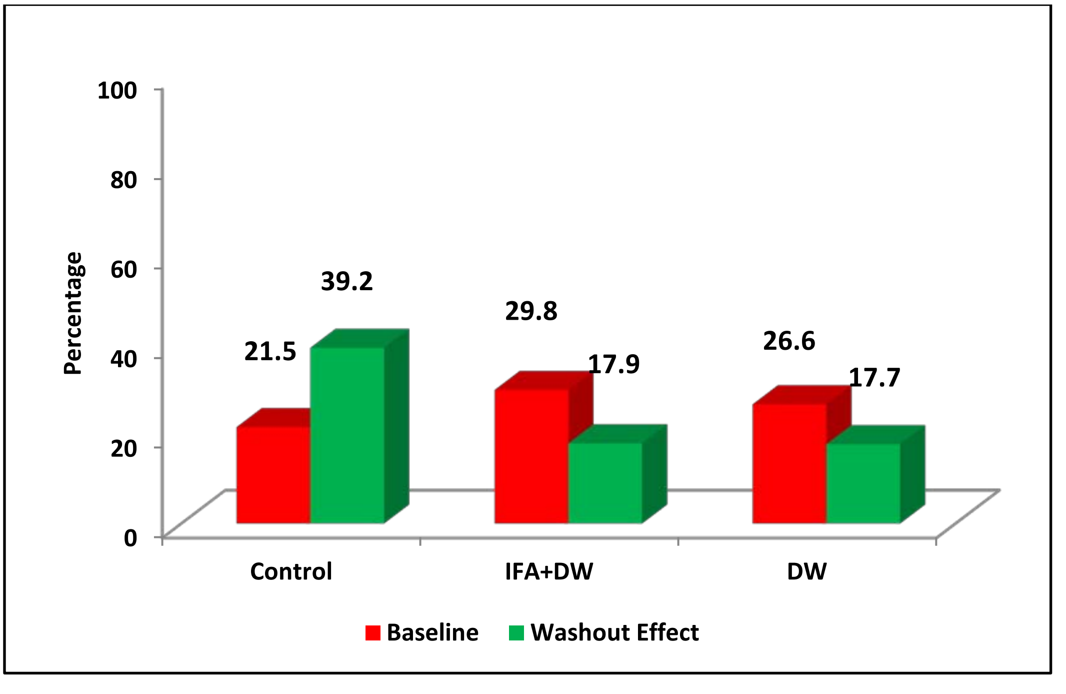


Table 4.3B.5 Prevalence of stunting (height for age < - 2 SD Z score) according to WHO 2007 standards

Variable	Control	IFA+DW	DW
Boys	N=36	N=70	N= 45
Baseline	4(11.1)	11(15.7)	6(13.3)
Washout Effect	8(22.2)	8(11.4)	12(26.6)
Girls	N=50	N=48	N=38
Baseline	15(30)	11(22.9)	5(13.1)
Washout Effect	21(42)	16(33.3)	11(28.9)
Total	N=86	N=118	N=83
Baseline	19(22.0)	22(18.6)	11(13.2)
Washout Effect	29(33.7)	24(20.3)	23(27.7)

Values in parenthesis indicate percentages

Figure 4.3B.2 Long term impact on Prevalence of Stunting

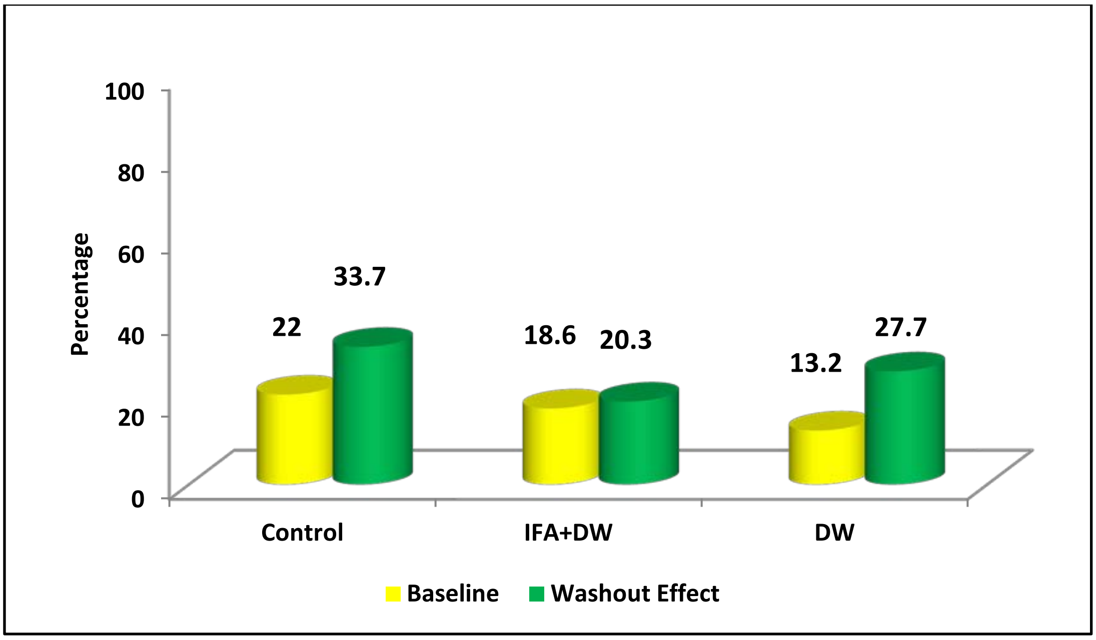


Table 4.3B.6 Prevalence of Thinness (BMI for age< -2 SD Z score) according to WHO 2007 standards

Variable	Control	IFA+DW	DW
Boys	N=36	N=70	N=45
Baseline	6(16.6)	42(60)	33(73.3)
Washout Effect	17(47.2)	40(57.1)	23(51.1)
Girls	N=50	N=48	N=38
Baseline	12(24)	28(58.3)	24(63.1)
Washout Effect	20(40)	27(56.2)	15(39.4)
Total	N=86	N=118	N=83
Baseline	18(20.9)	69(58.4)	55(66.2)
Washout Effect	37(43.0)	67(56.7)	38(45.7)

Values in parenthesis indicate percentages

Figure 4.3B.3 Long term impact on Prevalence of Thinness

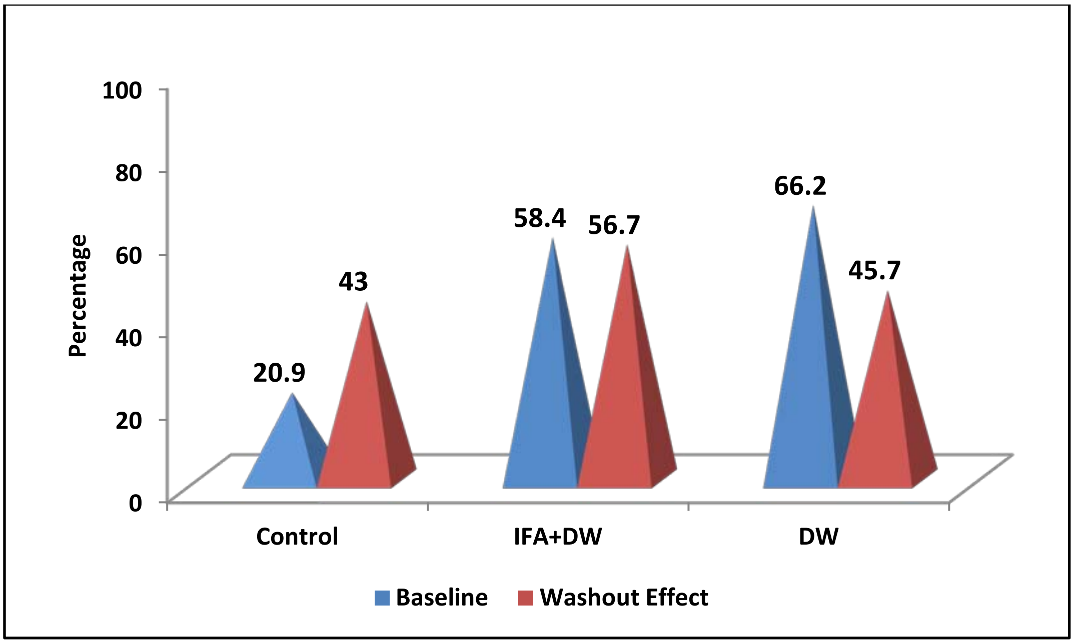


Table 4.3B.7 Impact of weekly IFA along with Deworming and Deworming alone on Hemoglobin of children (Mean ± SD)

Variable	Control	IFA+DW	DW
Boys	(N=47)	(N=57)	(N=49)
Baseline	10.7±1.8	13.4±1.2	11.2±1.6
Washout Effect	10.5±1.4	10.8±1.3	9.8±1.7
t value	2.8	13.0***	12.8***
Girls	(N=48)	(N=53)	(N=55)
Baseline	10.0±1.2	12.9±1.0	11.3±1.2
Washout Effect	10.0±1.1	11.0±1.4	9.8±1.4
t value	2.9	8.0***	14.0***
Total	(N=95)	(N=110)	(N=104)
Baseline	10.4±1.6	13.1±1.1	11.3±1.4
Washout Effect	10.2±1.3	10.9±1.3	9.3±1.5
t test	-	14.4***	19.0***

*Significant at $p<0.05$; ** significance at $p<0.01$; ***Significance at $p<0.001$

mean Hb levels after 6 months. In the DW group similar results were obtained. The drop after 6 months was more pronounced in the DW group as compared to the IFA supplemented group. The significant fall in the mean Hb levels was similar in both the genders.

The washout effect was also looked into as per the severity of anemia. The **Table 4.3B.8** shows that in the IFA+DW supplemented group, a striking trend was noticed. The significant decrease in the mean Hb levels was registered in the non anaemic group as compared to the anaemic group. The subjects in the moderate category of anemia could maintain their Hb levels as compared to children in the mild category. In the deworming group non significant decrease in the mean Hb levels was registered in all the children irrespective of severity of anemia.

The frequency distribution table for haemoglobin levels in the pre and post period shows that there was a negative shift found in the haemoglobin levels in both the intervention group as compared to the control group. In the IFA+DW supplemented group, 86.3 % of children who were in normal category after the intervention came down to 31 % in the washout period. The shift was seen from normal to mild and moderate category of anemia. About 42 % of the children were in the mild category after the washout period as compared to only 13 % in the post intervention phase. None of the children were in moderate or severe category of anemia in the post intervention phase which saw a rise of 27 % in the washout period. In the deworming supplemented group too negative trend was observed but was less severe as compared to the IFA+DW supplemented group. In this group the % of normal children came down to 8.6 % in the washout period as compared to 33.6 % in the post intervention phase. In this group more adverse trend was seen and 56 % of the children came into moderate category, while there were only 15 % in this category in the post intervention phase. About 2 % of the children showed a shift in the severe category in the washout period (**Table 4.3B.9**).

Table 4.3B.8 Impact of weekly IFA along with Deworming and Deworming alone on hemoglobin levels based on severity of anemia (Mean ± SD)

Variable (g/dl)	Control	IFA+DW	DW
>12			
Baseline	13.3±1.2	13.4±1.0	12.9±0.7
Washout Effect	12.5±0.7	12.4±0.7	12.8±0.4
t value	2.1	5.1***	1.7
12-10			
Baseline	10.6±0.6	11.6±0.4	11.0±0.5
Washout Effect	10.6±0.5	10.9±0.5	10.8±0.8
t value	0.7	3.7***	1.9
>10-7			
Baseline	9.0±0.6	9.0±1.7	9.1±0.6
Washout Effect	8.9±0.6	9.2±0.7	8.7±0.8
t value	2.0	1.2	1.9

*Significant at p<0.05; ** significance at p<0.01; ***Significance at p<0.001

Table 4.3B.9 Frequency distribution of hemoglobin levels of the children after the standard care

Hb (g/dl)	Control (N=108)		IFA+DW (N=230)		DW (N=161)	
	Baseline	**Washout**	**Baseline**	**Washout**	**Baseline**	**Washout**
<7	1 (1)	-	-	-	-	2(1.9)
7-8	3(3.1)	3(3.1)	-	2(1.8)	1(0.9)	10(9.6)
8-9	10(10.5)	10(10.5)	-	5(4.5)	6(3.6)	21(20.1)
9-10	21(22.1)	23(24.2)	-	23(20.9)	12(11.5)	26(25)
10-11	31(32.6)	29(30.5)	1(0.9)	21(19)	23(22.1)	21(20.1)
11-12	16(16.8)	18(18.9)	14(12.7)	25(22.7)	27(25.9)	15(14.4)
>12	13(13.6)	9(9.4)	95(86.3)	34(30.9)	35(33.6)	9(8.6)

Values in parenthesis indicate percentage

The chi square analysis (**Table 4.3B.10**) of all the three phases together shows that in the control group there was not much difference in the prevalence of anaemic children throughout the study period. The highly significant χ^2 value (9.8, p<0.001) in the IFA+DW supplemented group suggest that the intervention was very effective in improving the Hb levels of the anaemic children, but the effect was not sustainable and again a negative shift was evident. In the deworming supplemented group, the χ^2 value (7.2) was significant (p<0.001), as the prevalence of anemia had gone up.

Discussion

Malnutrition continues to be a major public health problem throughout the developing world. Diets in population are frequently deficient in macronutrients (Protein, Carbohydrates and fats) leading to protein energy malnutrition and micronutrient deficiencies. Iron supplementation remains an important strategy for the prevention and treatment of iron deficiency anemia.
The fact that the haemoglobin concentration increased in the iron folic acid supplemented group suggested that folic acid supplement stimulated the synthesis of haemoglobin, thereby resulting in the utilization of existing iron stores. The findings thus emphasize the importance of supplementation of both iron and folic acid together. Similar results were obtained in a long term study done on adolescent girls by Tee et al in 1999. The study showed that the long term (i.e. 30 weeks) weekly supplementation to the school going children with iron and folic acid resulted in significant improvement in their iron nutrition and haemoglobin concentration. The positive change included a slow and progressive increase in iron reserves in iron folic acid supplemented group, regardless of initial iron status.

There was increase in non anaemic children from 24 % before intervention to 81 % after the IFA + DW intervention. The consistent increase in the haemoglobin level can be attributed to the mucosal block theory by Fair-weather. The theory suggests that mucosal iron absorption in the body depends on the body stores of iron. It leads to increase in absorption when

Table 4.3B.10 Impact of weekly IFA along with Deworming and Deworming alone and the standard care on the hemoglobin levels of the children

	Baseline	Washout	Baseline	Washout	Baseline	Washout
Anemic	82	86	15	76	69	95
Non Anemic	13	9	95	34	35	9
Chi Square	1.6		9.8 ***		7.2***	

the iron stores deplete and reduces absorption as iron store replete. The fact that the rise in haemoglobin to the response of iron folic acid supplementation was highest in the anaemic group as compared to non anaemic group further gives justification to the obtained results.

The theory also suggests that high dose of iron would load the mucosa with iron and block the subsequent dose of iron from absorption. By reducing the dose frequency to once a week, matching the mucosal turnover of humans, iron from the subsequent tablets is absorbed. In our study also small dose of 60 mg elemental iron and 0.5 mg folic acid for longer duration i.e. 30 weeks was very effective. Iron can interface with the absorption of other nutrients and in excess can generate free radicals that impair cellular functions and suppress enzymatic activity. Keeping this in mind and looking at the beneficial effect which IFA supplementation brought in the children, weekly IFA supplementation would prove to be very beneficial (Lora 2006).

A study done by Siddique et al in 2004 on school children proved that once weekly iron supplementation is as effective as daily supplementation. Moreover weekly iron supplementation is cost effective and has practically no side effect. Improving iron and folate nutrition and preventing iron deficiency anemia in growing school children has a direct benefit on the well being of these population. Cost effectiveness of an intervention has become a principal tool to evaluate the health intervention and guiding health policy in both developed and developing countries (Jamison et al 2006). **The cost of weekly IFA tablets along with twice a year deworming tablet in only 2.4 Rs per year for a child.** No extra training is required for this reason or extra infrastructure needed. Thus the intervention effectively reduces the diseases burden, it is cost effective and is policy marker and has policy implication. Thus it would be more cost effective than periodic screening and selective therapy (Demaeyer Sachdev et al, 2006, 1989).

The strength of our study was that distribution was easily integrated into existing health service and was made freely available to all children. The presence of control group helped us to establish the prevalence of anemia and iron deficiency based on the proportion of children who responded to the intervention.

The intervention has not shown positive result on the growth of the children. This result is supported by the meta analysis done by Sachdev et al in 2005, Which shows that effect of IFA supplementation on children's growth are not significant.

Rassamee Sungthong et al suggested that weekly supplementation of ferrous sulphate (300 mg/tablet) for 16 weeks did not have positive influence on weight for age and height for age of children. Another possible reason for the lack of an effect of IFA on linear growth in our study could be the coexistence of other macronutrient deficiencies. For the linear growth macronutrients are equally important along with micronutrient. Studies have shown that 30 mg Fe/ daily supplemented for 14 weeks lead to increase in appetite of children and lead to growth. But in rural areas, the poor children don't have liberty to have ample of food. This may have lead to the negative trend in the nutritional status of the children. Similar results where iron supplements did not affect the growth of the school children were seen in the study done by Bui Dai et al in 1999.

Results from trials of iron supplementation overall have not found significant growth effects, even in anaemic children, though some studies have shown an adverse effect, especially in iron replete children. Dietary iron may inhibit the absorption of other essential growth promoting nutrients such as Zinc. Iron supplements may lead to increase in morbidity and consequently to reduce dietary intakes, poor nutrient absorption and negative energy balance (Oppenheimer, 2001).

A meta analysis of RCTs examining iron interventions in children aged <18 years found that in the 21 iron supplemented RCTs identified, no significant effect on growth was reported. The overall size effect was 0.09 (95 % CI: -0.07, 0.24) for height and 0.13 (95 % CI: -0.05, 0.30) for weight and negligible differences in height gain (0.007 Cm)and weight gain (0.012 Kg) were found between the treatment and the control group (Ramakrishan, 2004).

The study focused on deworming along with IFA supplementation because data suggests that worm loads peak during these years- typically around five to six years for round worms and whipworms and in adolescence for hookworms. Though being a rural area, no effort was taken by the government to provide antihelmnethic tablets. Thus one group received only deworming tablet while other group received both.

Hotez et al in 2006 summarized that treatment of worm infestation reduces the burden of anemia and improves physical fitness too. Similar results have been evident in our study where the prevalence of anemia reduced from 78 % before intervention to 36 % after the intervention. The physical activity or work capacity also increased which is evident by the step test.

Alderman et al in 2006 found that deworming tablet had positive effect on weight gain of school children. This was evident in the study where the prevalence of malnutrition was much lower in the deworming supplemented group as compared to IFA+DW supplemented group. Though much of improvement in the haemoglobin levels were not seen in the deworming supplemented group, in one of the study done by Roche et al, improvements in haemoglobin levels were not detected until at least 10 months after antihelmenthic treatment. It had previously been concluded that iron supplementation can lead to rapid improvement in haemoglobin levels, the effect of deworming may appear up to 15 to 20 months after treatment.

School based deworming programmes can favourably influence the anemia status of children. The regular deworming of school children should therefore be given serious consideration as an approach to anemia control.

Supplementation is mandated in case of a specific deficiency when other approaches are too slow. But at the same time micronutrient deficiencies alone cannot improve growth and decrease malnutrition. In this case diet based strategies which also provide macronutrients along with micronutrients are inevitable. Even if the children utilize the mid day meal scheme properly the macronutrient needs can be fulfilled. Thus as malnutrition has many causes, only multiple and synergistic interventions embedded in true multisectoral programs can be effective (Bhargava 2001)

Iron compounds used for supplementation or fortification will only be partially available for absorption. Once dissolved, same factors influence this iron which affects the iron from food. In the body, regulation of iron absorption is maintained through intestine. Decreasing body iron stores trigger increased iron absorption and increasing iron store trigger decreased iron absorption. For a given diet this regulation of iron absorption, however can only balance losses up to a certain critical point and beyond that iron deficiency will develop. The three main factors that affect iron balance are absorption (intake and bioavailability) of iron, losses and stored amount. In states of increased iron requirement or decreased bioavailability the regulatory capacity to prevent iron deficiency is limited (Hallberg 1995).

In setting where there are not convenient food vehicle for fortification and the prevalence of Iron deficiency anemia is very high, supplementation is a cost effective option. But most of the analysis may have overestimated the health gains from iron deficiency control because effectiveness estimates of iron supplementation were based on data steaming from mainly small trials. There remains a significant gap between the efficiency and the effectiveness of program at controlling iron deficiency. In this study also the sustainable effect of iron supplementation has not been found effective (Baltussen 2004).

The supplementation time in the study was for 30 weeks, which can be regarded as long term weekly supplementation and could be complementary to other preventive measures and is conceptualized as a surrogate for targeted fortification. But still after long term iron supplementation, iron status could not be sustained. The possible reason for this may be that diet is very deficient in iron. Viteri et al in their study showed that weekly supplementation of iron and folic acid for 7 months were proven effective in controlling mild to moderate iron deficiency and anemia. But how long the improvements in iron status can be achieved by weekly supplementation if the tablets are stopped is still unknown. The unacceptable result of iron sustainability is hard to interpret but similar results were obtained in the study where the plasma feritin level went low after the supplementations were stopped. **The following mechanism may be implicated 1) diminished food iron absorption during and after the supplementation 2) Increased iron losses following increment in iron stores, most probably in "labile iron pool"** (Viteri et al, 1999).

One of the issues still to be resolved is sustainability of improved iron status, as a period of negative iron balance tends to occur because absorption is down regulated, thus benefits of supplementation are likely to be temporary if diets are low in iron. Thus role of iron supplementation as a treatment of existing anemia or as a preventive measure to reduce the risk of acquiring it is still a question (Jose 2002).

The interaction between iron and infection has been also in debate. As this is a rural area the chances of infections could also be high. Infections must be having negative effect on the iron stores. Thus we can see that sustainable effect of IFA tablets was not positive on growth and haemoglobin levels. Thus IFA supplementation should be a continuous process in the school setup. Along with supplementation, behaviour change communication is very important so that the children consume diet rich in iron which have more sustainable effect as far as iron pool in the body is concerned. If both the strategies are implemented together, in long run it will result in remarkable improvement in the iron status of children.

Compliance with taking the tablet was very good. Side effects were minimal in the long term and no case stopped taking the supplements. This suggests that the level of supplementation were safe and that the regimen used did not cause poor adherence or rejections. Thus we suggest that weekly supplementation of 60 mg elemental iron + 0.5 mg folic acid along with deworming be given to the school children to improve their iron and folic acid reserves and thus prevent iron deficiency and folic acid deficiency in areas with a moderate to high prevalence of iron deficiency anemia. The synergic effect of IFA along with deworming has shown excellent results in improvement of haemoglobin status of the children. Deworming is as such very important in rural areas where unhygienic conditions are maintained in and around the houses.

Summary & Conclusions

Malnutrition means non optimal status of the individual with reference to one or number of nutrients. It is well established that nutritional status is a major determinant of the health and well being among children. Developing countries like India, accounts for about 40 % of the undernourished children in the world and it is largely due to the result of dietary inadequacy. Nutrient deficiencies vary in their manifestations, some leading to specific clinical signs, many affecting growth at an early stage. Thus assessment of nutritional status plays a vital role.

Iron Folic Acid (IFA) supplementation is a preventive strategy for treating existing anemia. It is effective strategy until the diet of entire population changes significantly or till the time food fortification becomes very common. IFA improves behavioural & cognitive development of the children. It improves overall fitness and work capacity of the children. It also improves child survival where severe anemia is common. Therefore the objective of the study was to assess the nutritional status of underprivileged school children of rural Vadodara and to see the impact of IFA Supplementation and deworming on the nutritional status of children. The study was divided into 3 phases.

PHASE 1: FORMATIVE RESEARCH

The study was conducted in the rural petrochemical area of Vadodara district, Gujarat. The petrochemical area was divided into six identical zones. All the schools which gave permission to carry out the study were taken. One representative school from each zone was randomly selected. All the children from 1st to 7th standard of the school were enrolled for the study. The total number of registered children was 3170 out of which data could be collected on 2282 children. Socio economic data of the children was collected using a pre tested semi-structured questionnaire. The anthropometric measurements like weight, height, waist and hip circumference measurements were studied in relation to age and gender. Clinical signs and symptoms, three day dietary pattern were collected using a pretested questionnaire. Biochemical estimation of haemoglobin by cyanmet haemoglobin method was collected on all the children.

The major findings of this phase of the study are given below:

Socio Economic Status

- The data revealed that majority (84%) of the subjects were Hindus. Caste bifurcation showed that half of the study population was schedule caste or schedule tribe.
- Gender wise analysis for caste showed that the enrolment for girls was lower in schedule caste and schedule tribe as compared to general category group.
- The economic status revealed that the family income of 2/3 rd (70%) of the subjects was lower than Rs. 6000 per month.

Anthropometric Indices and prevalence of malnutrition

- The mean weight of the girls was slightly lower than boys under 9 years of age. After 9 years reverse trend was seen. Such trend was not seen for height parameter. Height growth was more or less similar for both boys and girls.
- The prevalence of Undernutrition was seen by both CDC 2000 and WHO 2007 classification.
- The prevalence of underweight was 70 % according to CDC 2000 standards and 64 % by WHO 2007 standard.
- Prevalence of stunting was more or less same by both the standards. It was 31 %.
- Thinness in the study population was 60 % using both the classification.
- Prevalence of severe underweight, stunting and thinness was 27.3 %, 8.6 % and 25.2 % respectively by WHO standards.
- Prevalence of undernutrition was lower in children less than 6 years of age but then it peaked up and remained high throughout the childhood.

Clinical signs and symptoms

- Assessment of deficiencies of clinical signs and symptoms of Iron, iodine & vitamin A were elicited from 960 children.
- The symptoms for micronutrients were listed and a government recognised paediatrician was deputed to assess the children.
- Iron deficiency was visible in 35.5 % of the children and vitamin A deficiency in 8.12 % children. Only two children showed mild symptoms of goitre.

Dietary Intake

- Two working days and one Sunday was included for eliciting information on dietary pattern related to morning meals, mid day meal & consumption of vegetables and fruits.
- Morning snacks were consumed by just 22 % of the subjects. About 9 % of the children did not consume the MDM at all.
- It was not made compulsory for the children to have food in the school. The serving size of the Mid Day Meal also varied from child to child.
- The serving size depended on the size of plates or the Tiffin boxes which the children brought from home. If the children had not got any tiffin then he was not given food.
- Mid Day Meal consumption ranged from 52.8 % to 63.6 % in schools.
- The monthly consumption of MDM was maximum in December (66.6 %) and January (61.7%).
- The MDM consumption was highest in standard 3rd (62.8 %) and 4th (69 %).

Haemoglobin status and prevalence of anemia

- Haemoglobin levels could be ascertained from 865 children studying from 4th to 7th standard.
- The mean haemoglobin levels of the children were almost similar in both the genders being 11.4 ± 1.8 gm/dl and 11.1±1.2 gm/dl in boys and girls respectively.
- It was seen that 72% of the children were anemic of which 57.6 % were in mild category and 14.2 % in moderate category.

- Nearly 75 % of underweight and thin children were anemic. Prevalence of anemia in stunted children was found to be 33 %
- A positive correlation was seen when haemoglobin values were correlated with clinical signs and symptoms of iron deficiency (χ^2 53.9, $p<0.001$). The sensitivity for the correlation was 64 % while specificity was 44 %.

PHASE 2: LONGITUDINAL STUDY: GROWTH MONITORING FOR 3 YEARS

The study was conducted in the rural industrial area of Vadodara, Gujarat. Out of the 45 government primary schools in the area, four schools were randomly selected. In the first year, all the children from 1st to 7th standard were enrolled for the study. Anthropometric measurements i.e. height and weight were recorded for all the children. In the first year data was collected on 2282 children of which 1094 were girls and 1188 were boys. In the second year same children were followed up. Looking at the dropout rate and the passed out children of 7th standard on whom the data could not be collected, the sample size became 1555 children. In the third year, keeping the same criteria, anthropometric data could be collected on 465 children of which 227 were boys and 238 were girls.

A total of 465 children had 3 pair of data for consecutive 3 years. Paired data of these children were used for studying dynamics of growth and weight trends in the study population. The reference data used to identify the BMI cutoffs as well as conversion of weight and height to Z score were taken from CDC 2000 data set and WHO 2007 data set for growth parameters in children.

The major findings of this phase of the study are given below:

Change in mean Height & weight over a period of three years

- As the age increased the increase in mean height and weight of boys and girls were studied for 3 years. The increase of height per year ranged from

6.1 cm to 5 cm. The mean increase in weight per year for children ranged from 2.8-2.7 kg. The weight increase was almost similar in both girls and boys.

Change in prevalence of malnutrition over a period of three years

- According to WHO 2007 standards, the prevalence of underweight decreased to 30.9 % in the third year from 60 % in the first year.
- The prevalence of stunting remained 32 % in the 3 years at 95 % CI limits of 25 – 40.
- As per WHO 2007 classification, there was a gradual decrease in the prevalence of thinness in consecutive years. In the first year the prevalence was 58 % [52.0-64.0] which decreased to 56 % [50.0-62.2] and further came down to 47 % [40.3-53.7].

Growth transition trend analysis

- Tracking data of children for Undernutrition showed that negative growth was seen in 10.8 % of children which remained constant in the third year.
- As far as stunting was concerned, in the first year positive shift were seen in 22 % of children while negative shifts were evident in 5 % of children. Negative shift in second year increased to 21 % which calls for attention and intervention.
- With regards to thinness, 22 % showed positive trend in the first year while almost similar i.e. 21 % showed negative trend. The negative trend in second year reduced to 12 % while positive trend was evident in 28 % of children.

PHASE 3: INTERVENTION RESEARCH: A RANDOMIZED CONTROL TRIAL

The impact of weekly IFA supplementation (60 mg elemental Iron + 0.5 mg folic acid) for 30 weeks along with twice a year deworming tablet (Albendezole 400 mg) and only Deworming tablet was seen on growth, physical work capacity and haemoglobin status of school children. Here three schools were randomly selected and the interventions were randomly assigned to them. One was a control group in which standard care condition were maintained, one experimental group which received IFA supplementation for 30 weeks and deworming tablet twice a year. The third group received deworming tablet twice a week. After the intervention of one year, washout effect was seen for 6 months. For six months no intervention was given and the sustainability of the intervention was looked into. The children from 4th to 7th standard were enrolled for the study.

The major findings of this phase of the study are given below:

Anthropometric Indices and prevalence of malnutrition

- There was a significant increase in the height of the children in all the three groups. The increase was highest in the group supplemented with IFA+ DW. The height gain was highest in the age of 9-11 years.
- Weight gain was more in the control group as compared to the intervention group. In between the two intervention group too, the weight gain was more in the group supplemented with DW as compared to the IFA+DW supplemented group. Thus the supplementation failed to show its impact on the weight parameter of the school children.
- In the IFA+DW supplemented group, there was 5 % increase in the prevalence of underweight while 3 % drop was seen in the DW group. In the control group 16 % reduction in the prevalence of underweight was seen. The rise in prevalence of underweight was more in girls as compared to boys.
- The prevalence of stunting was more or less similar before and after intervention in the IFA+DW group. In the DW group, the prevalence of stunting came down by 7 % while in the control group prevalence dropped by 4.5 %.
- There was increase in the prevalence of thinness in both the experimental groups. In the IFA+DW group, there was 14 % increase in the prevalence of thinness and 4 % in the DW group.
- Thus IFA intervention with deworming did not support growth in rural school children.

Haemoglobin Status and Prevalence of Anemia

- There was a significant change in the mean haemoglobin levels before and after the intervention.
- In the IFA+ DW supplemented group, there was mean increase of 1.9 gm/dl increase and the difference was statistically significant. The increase was more in boys as compared to girls. In the deworming group non significant rise in the mean haemoglobin levels were registered.
- It was seen that in IFA supplemented group, the improvement in the Hb levels were more in severe anaemic group as compared to less severe category. The increase in the normal category was only 0.4 ± 0.9 gm/dl as compared to 0.6 ± 1.0 in category of mild category. The highest increase was seen in the moderate anemic group which was 0.7 ± 0.6 gm/dl.
- In the group supplemented with IFA+DW it was seen that as the age increases the difference between the initial and the final Hb level increased. That shows that the utilization of IFA increased in the body as the age increased due to increased demand by the body.
- Before intervention in the IFA+ DW group, 75 % of the children were anemic, which after intervention was only 10 %. The intervention was successful in bringing down the prevalence of mild anemia from 58 % to 8 %.
- There was no major effect of deworming alone on reducing the prevalence of anemia. In both the mild and moderate category the prevalence remained same.
- Positive change in the haemoglobin levels were observed in the experimental group as compared to the control. The IFA+ DW intervention was highly significant $p<0.001$ in improving the Hb status of initially anaemic group. There was improvement in the Deworming supplemented group too ($P<0.01$). Such changes were not seen in control group.

Physical work capacity

- The physical work capacity as judged by the SPO_2 values, was not influenced by any of the intervention strategy.
- In the group supplemented with IFA+DW tablet, there was statistically significant increase ($p<0.05$) in the number of steps taken by the children. When the gender wise difference was looked into, it was seen that the number of steps were significantly higher for boys than girls. Thus the IFA +

DW could increase the physical work capacity of the boys in a more pronounced manner.

- A non significant improvement in the work capacity of the children was also seen as compared to the control group.

Washout effect

- After the washout period, a significant fall in the overall Hb levels was seen in both the intervention group.
- Sustainability was seen in only 31 % of the children. The prevalence of IDA increased after the washout period and was found to be 90.6%, 69.1%, 91.4% in control, IFA+DW and only DW supplemented group.

Conclusion

We can conclude that nutritional status of rural school children is compromised which is evident by the high prevalence of malnutrition. This condition is prevalent even though the Mid Day Meal (MDM) program is being run by government of India. The main reason behind this is that the consumption of MDM is a big question mark in this region. Children are not consuming the MDM regularly.

A healthy MDM can help to protect children from hunger, and to provide supplementary nutrition. MDM is not enough to guarantee the right to food, but they are an important step towards it. Similarly, cooked midday meals contribute to the right to education by facilitating regular school attendance and enhancing children's learning abilities.

There are serious problem relating to the infrastructure and logistics of mid day meals. Shortage of utensils is a common problem. There is similar issue with the lunch plates. Children are expected to bring plates or bowls from home. Some parents however are reluctant to let children take plates or bowls away from home, for fear of losing them.

The morning breakfast of the children is being compromised as parents feel that MDM is available in the school. Even in the rural area, the consumption of cheap fried snacks is very high. The consumption of fruits and vegetables at home is very low. Even in the MDM, vegetables are not added and the meal does not provide adequate micronutrients to the children.

From the intervention study we can conclude that the weekly supplementation of 60 mg elemental iron along with 0.5 mg of folic acid was beneficial to reduce the prevalence of anemia and improve the mean haemoglobin status of the children. The supplementation was more beneficial to severely anemic and children in the moderate category of anemia. The rise in haemoglobin status was more in them as compared to children in the mild and normal category of anemia. The sustainable effect of the supplementation was again a big question mark. The intervention could not sustain its effect when the supplements were not provided for 6 months. This proves that the supplements should be provided at a regular interval to the school children and should not be stopped. The intervention was not much effective in improving the malnutrition scenario for which inputs of macronutrients are also very vital. This can be done through regular consumption of MDM in the school premises and increasing the food intake at home too.

The growth monitoring phase emphasise the importance of routine growth monitoring in the school set up too. This will help us to detect the children who are experiencing constant growth faltering and necessary steps can be taken there and then. The study also focuses on importance of routine medical checkups for school children even in rural setup. Further referral could be advised if the need be.

Based on our study, we propose the following recommendations. The components which need to be addressed are:

Component	**Recommendation**
Behaviour Change Communication (BCC)	Simple BCC messages can be designed and should be imparted to the school children to bring about long term changes.

Medical Checkups	Quality medical checkups should be made regular in the rural schools
MDM	• The recipes which provide adequate micronutrients should be incorporated in the menu. • Children's likes and dislikes should be taken into consideration. • Plates and bowls should be provided by the school authorities itself. • MDM should be made compulsory for all the school children and the school authorities should be strict about it. • Monitoring system needs to be overhauled. Close supervision and regular inspections are essential to achieve higher quality standards
Iron Folic Acid (IFA) Supplementation	• Weekly IFA supplementation along with deworming can be given to the school children of 4^{th} to 7^{th} class in the rural setup. • Macronutrient intake of the children should also be increased along with micronutrient supplements for the improvement in the growth status of the children.
Growth Monitoring	• It should be a regular practice in the school and the growth should be plotted on the chart as done in the anganwadis to reflect the trend in the growth.

Overall parents and teachers should be made aware of the grave situation of malnutrition. We feel once weekly IFA tablet supplementation along with deworming and regular MDM consumption may go a long way to arrest the growing trend of malnutrition among rural school children.

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ANNEXURE 1

Id: □□□□

GENERAL INFORMATION

1. Name of the school: code: □

2. Name of the student:

3. Standard: code: □

4. Section:

5. Roll no:

6. Medium:

7. Residential address:

8. Age:

9. Date of birth:

10. Sex:

    1. Male
    2. Female

11. Religion:

    1. Hindu
    2. Muslim
    3. Christian

4. Others

12. Name of father: ____

13. Name of mother: _______________________________________

14. Education:

1. Father:(specify) ______________________
    a. Illiterate
    b. < 7^{th} standard
    c. 7-9^{th} standard
    d. 10-12 standard
    e. Other (specify)

2. Mother: (specify) ______________________

    a. Illiterate

    b. <7^{th} standard

    c. 7-9^{th} standard

    d. 10-12^{th} standard

    e. other (specify)

15. Occupation:

1. Father :(specify) ______________________

    a. Industrial worker
    b. Service
    c. Business
    d. Driver
    e. Agriculture
    f. Others(specify)

2. Mother: (specify) ______________________

    a. Industrial worker

b. Business
c. Agriculture
d. Housewife
e. Service
f. others (specify)

16. Type of family:

a. Joint
b. Nuclear
c. Extended

17. Total number of family members: ______________________

18. Income:

1. Total family income:
2. Per capita income:

ANTHOPOMETRIC MEASUREMENTS

1. Height: _________________________ Cms
2. Weight: _________________________ Kgs
3. **B**ody **M**ass **I**ndex (BMI): __________ kgs/m^2
4. Waist: __________________________ Cm
5. Hip: ___________________________ Cm
6. **W**aist **H**ip **R**atio (WHR): ____________

ANNEXURE 2

Clinical Examination Profile

Name of the School: ____

Name of the Student: ____

Class: ____________ Division: _______________ Roll No: _________________

Iron Deficiency Symptoms

Swollen and red tongue	☐	Angular Stomatitis	☐
Brittle Nails	☐	Fatigue	☐
Pale skin colour	☐	Pallor	☐

Vitamin A Deficiency Symptoms

Conjunctival Xerosis	☐	Night blindness	☐
Bidot's Spot	☐	Corneal Xerosis	☐
Corneal ulceration	☐	Corneal scar	☐
Xeropthalmic fundus	☐	Eye Infection	☐

Iodine deficiency Symptoms

Goiter Grade I A	☐	Goiter grade I B	☐
Goiter grade II	☐	Goiter grade III	☐
Goiter grade IV	☐		

Doctor's Comment on other morbidity:

____

____

ANNEXURE 3

DIETARY PATTERN

Name: ____

Std: _______ **Division:** _____ **Roll No:** _____

Sr. No	Food & life style pattern	Day:___	Day:____	Day:___
1.	**Breakfast:** Milk, Tea, Milk/Cereal, Cereal/Veg, Milk/Cereal/Veg etc.			
2.	**Mid morning:** Cereal, Cereal/Veg, Cereal/Pulse/Milk product, etc.			
3.	**Vegetables:** GLV'S, other veg, Yellow and Orange veg, Roots & Tubers			
4.	**Fruits:** Other Fruits, citrus fruits, yellow &orange fruits			
5.	**Mid day meal consumption**: Full, partial, None			
6.	**Pocket money:** yes/ no How much			
7.	**Biscuits:** Plain, Cream, Wafer, Cookies.			
8.	**Confectionaries:** Hard candies, Toffees, Chewing gum, Cadbury.			
9.	**Fried foods**: Samosa, Dabeli, Vadapav, etc.			
10.	**Fast foods:** Fryms, wafers, kurkure, chips			
11.	**Cold drinks:** Coke, Thumsup, Fanta, Limca, etc			
12.	**Local fruits:** Wood apple, Guava, Bor, etc.			

13.	**Water intake**			
14. a)	**Physical activity:** Mode of transport to/ from school			
b)	PA during recess			
c)	PA during evening time/ at home			
d)	PT class			
15.	**TV watching:** yes/ no Duration			