Results & Discussion

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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 washout effect.

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 it was not in working condition. Once a year health check up by government physicians were done in only 3 schools. 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

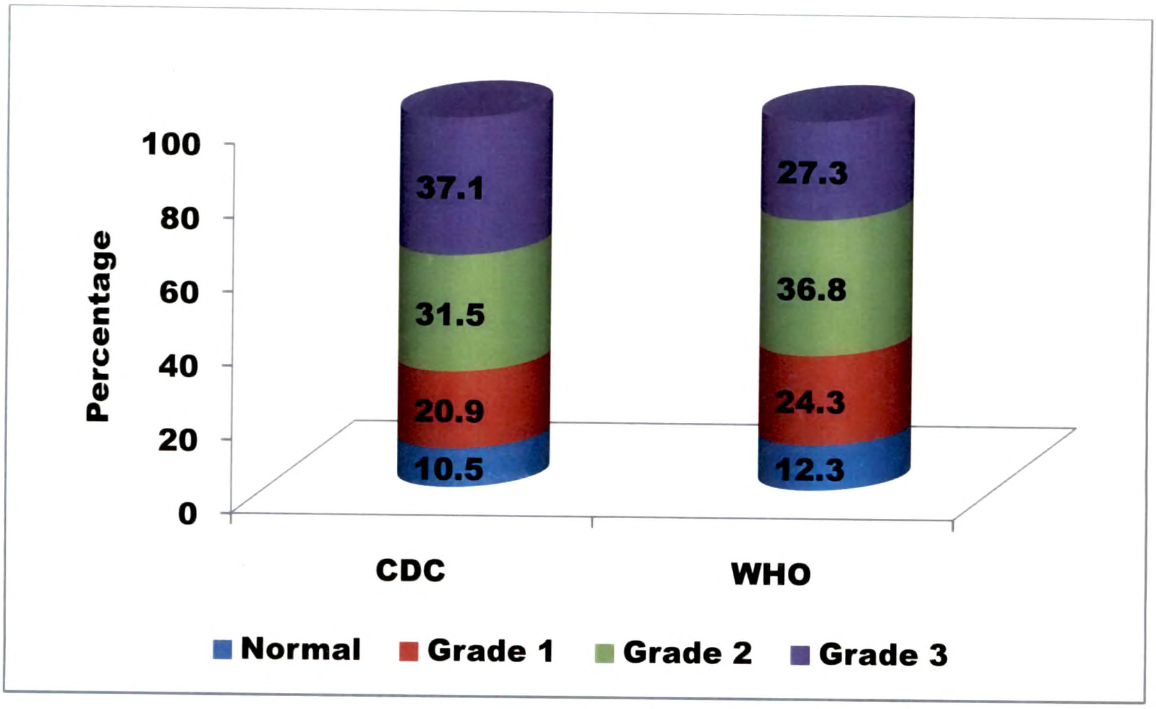


Figure 4.1.2: Prevalence of Stunting in school going children

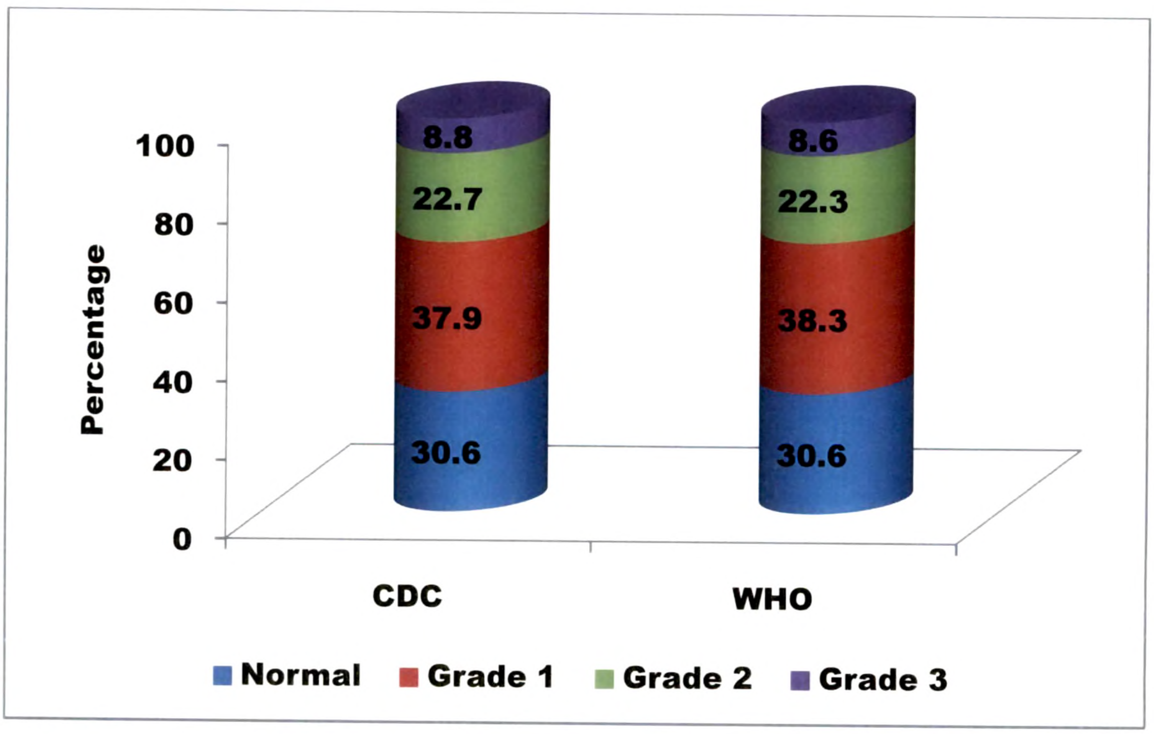


Figure 4.1.3 Prevalence of Thinness in school going children

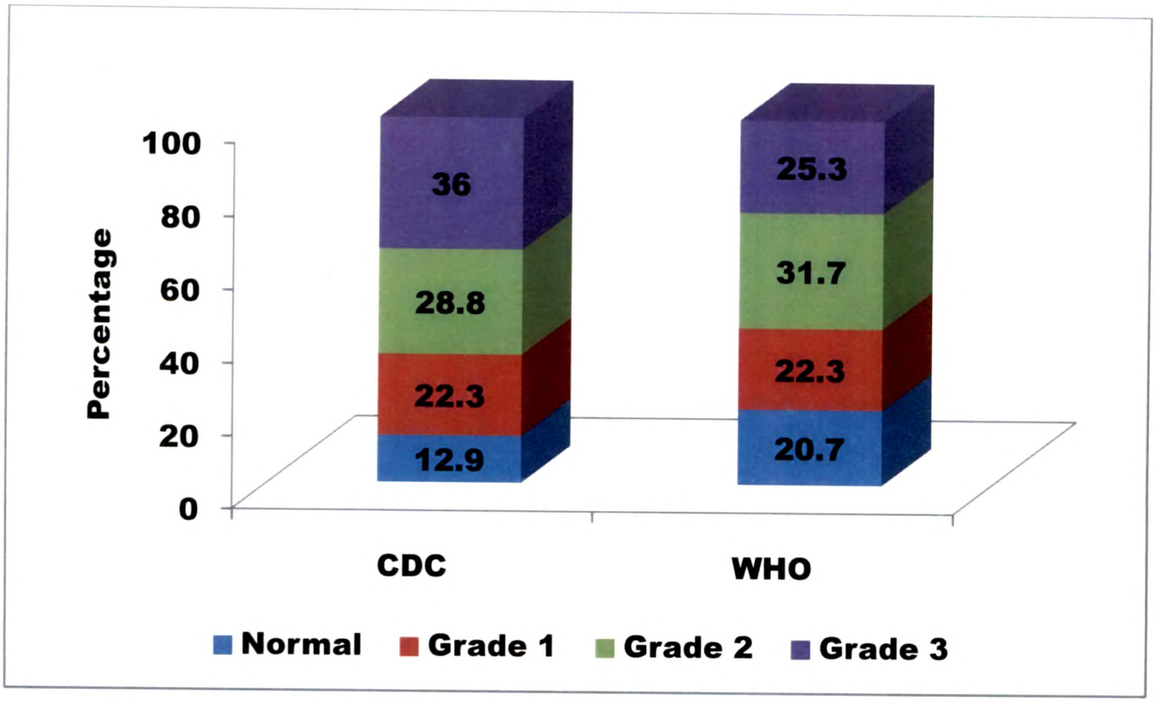


Table 4.1.10: Prevalence of malnutrition by WHO 2007 classification cross tabulated by gender

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 the age gender wise 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

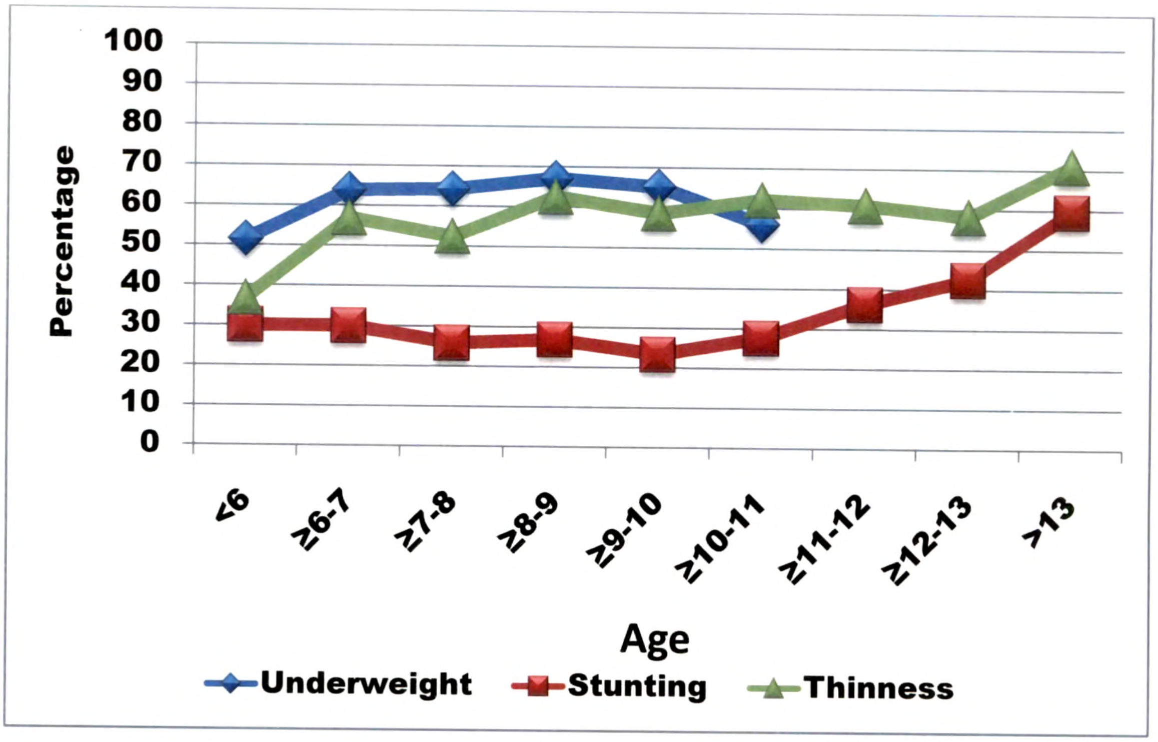
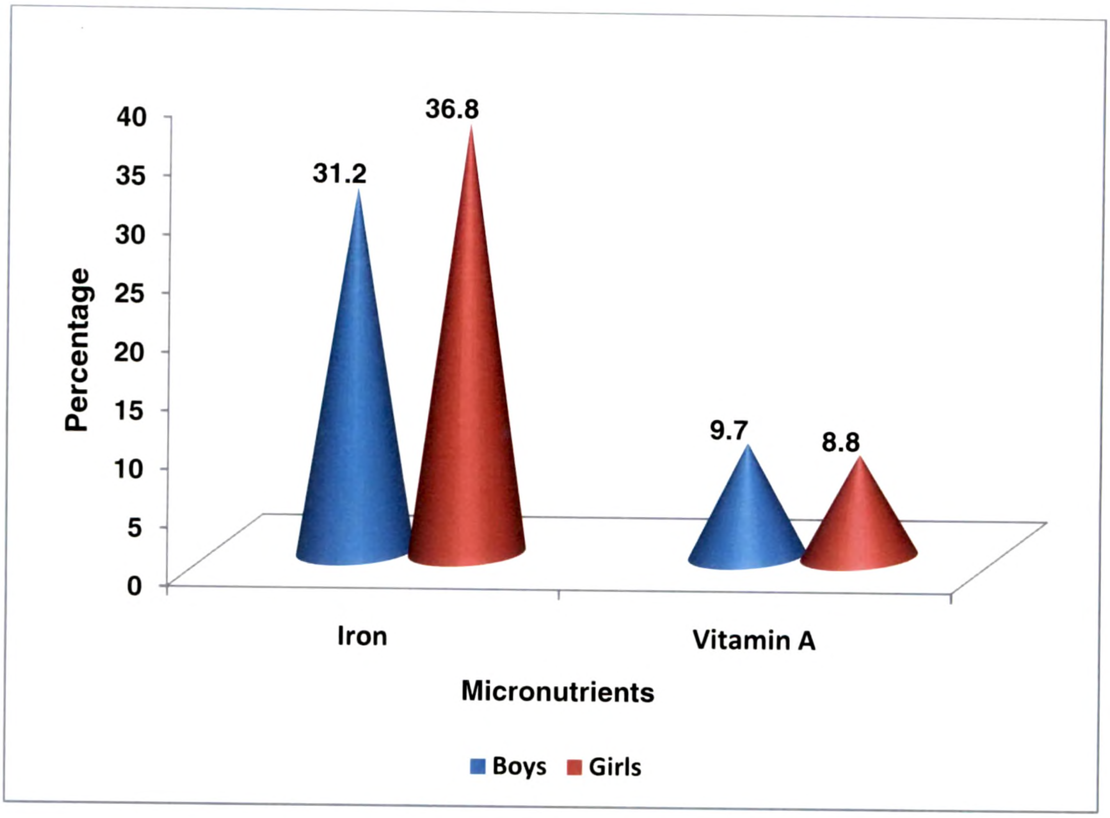


Table 4.1.13: Age wise percent prevalence of undernutrition by WHO 2007

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 2nd 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 is 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 studied 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

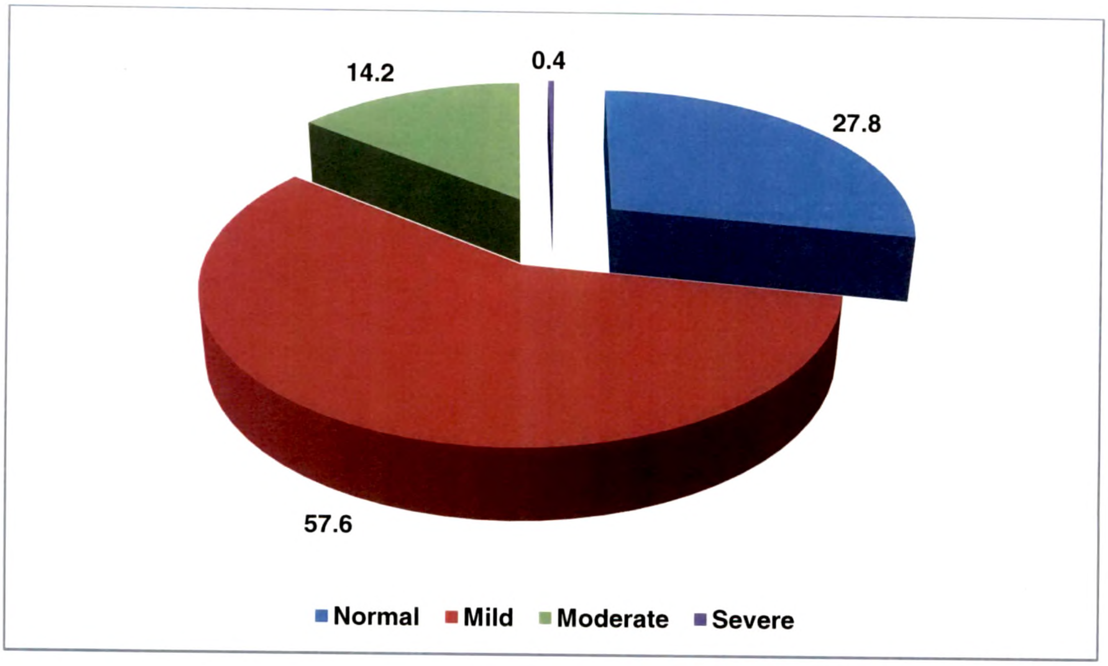


Table 4.1.26: Prevalence of Anaemia Cross Tabulated With Nutritional Status

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		0.52	0.97<RR<1.40
MDM + Lunch	**STUNTING**	1.4	0.70<RR<1.31
MDM+ Breakfast	**(<-2SD)**	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**	1.15	0.81<RR<1.58
MDM + Lunch	**(<-2SD)**	1.7	0.77<RR<1.51
MDM+ Breakfast		1.02	0.75<RR<1.34
Only MDM		0.35	0.70<RR<1.84
MDM + Lunch	**ANAEMIA**	1.12	0.77<RR<1.97
MDM+ Breakfast	**(<12g/dl)**	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 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 a 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 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 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 2^{nd} 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

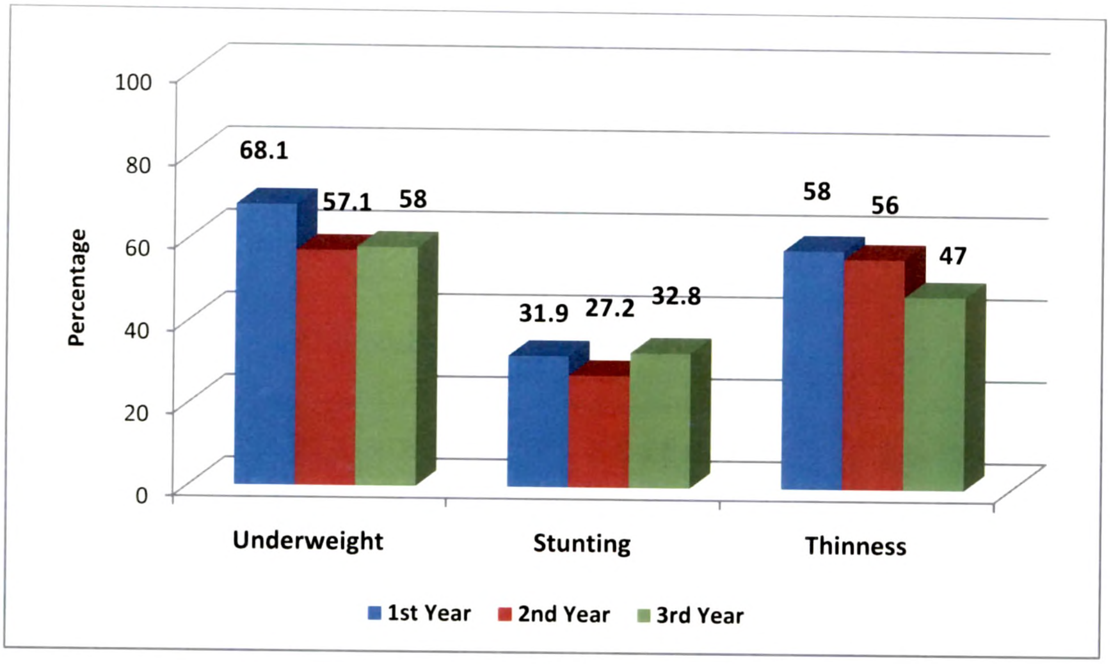


Figure 4.2.2 Trends in prevalence of severity of underweight in children

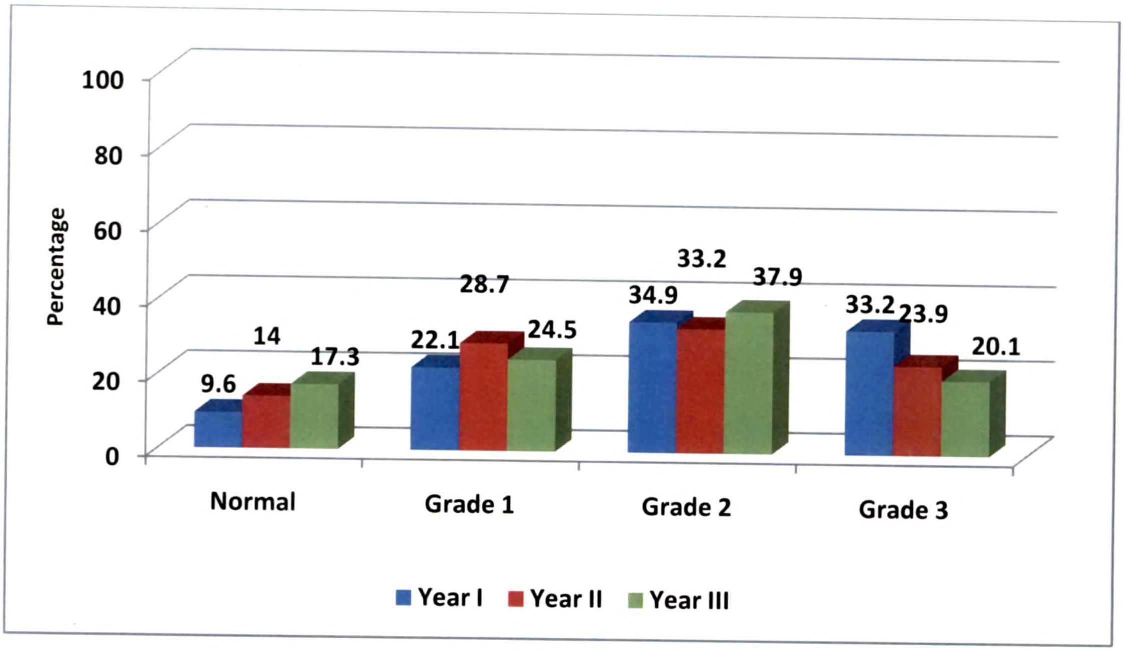


Figure 4.2.3 Trends in prevalence of severity of stunting in children

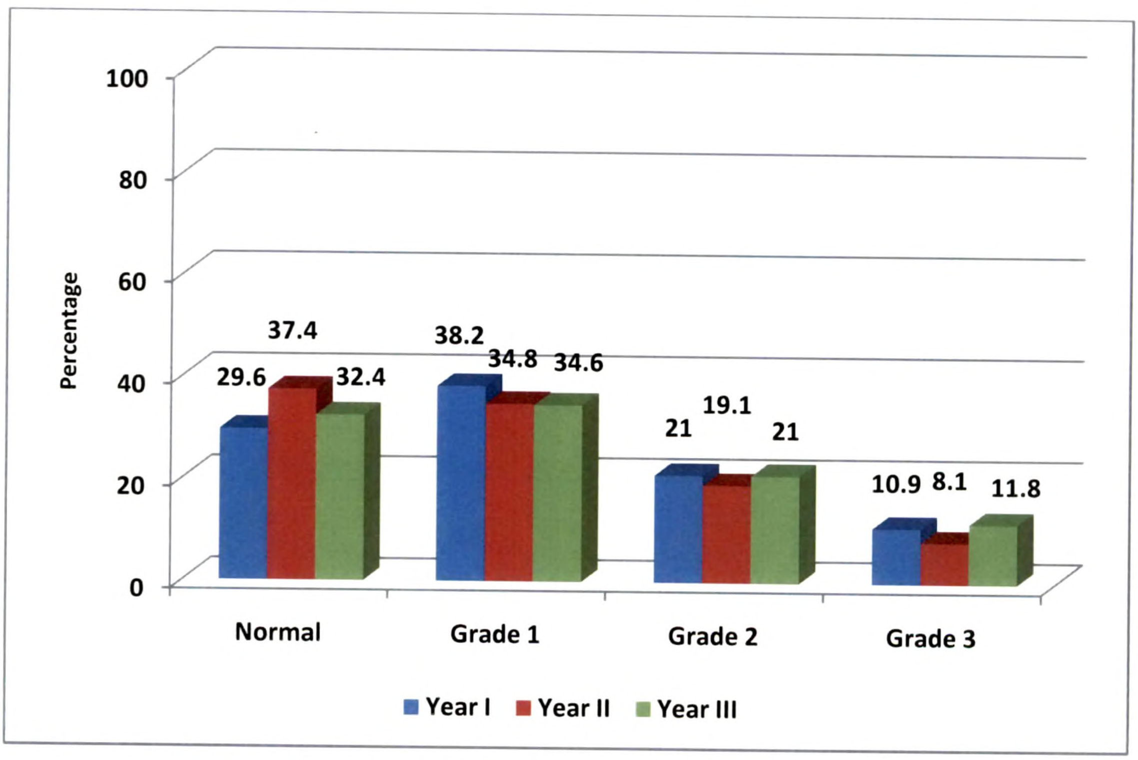
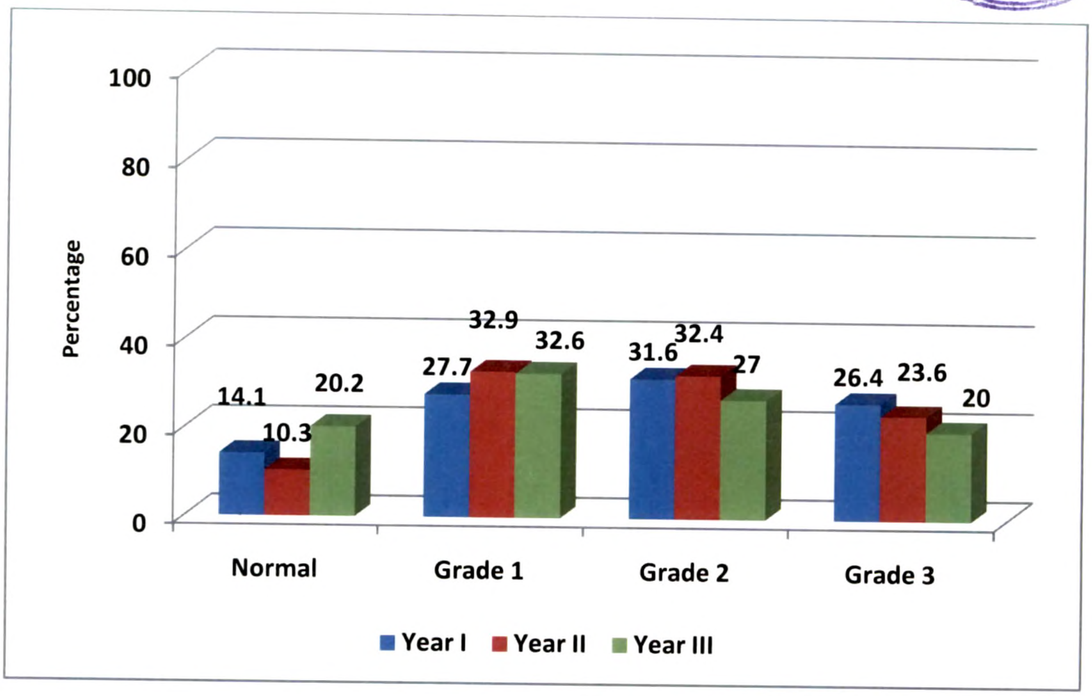


Figure 4.2.4 Trends in prevalence of severity of Thinness in children



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.

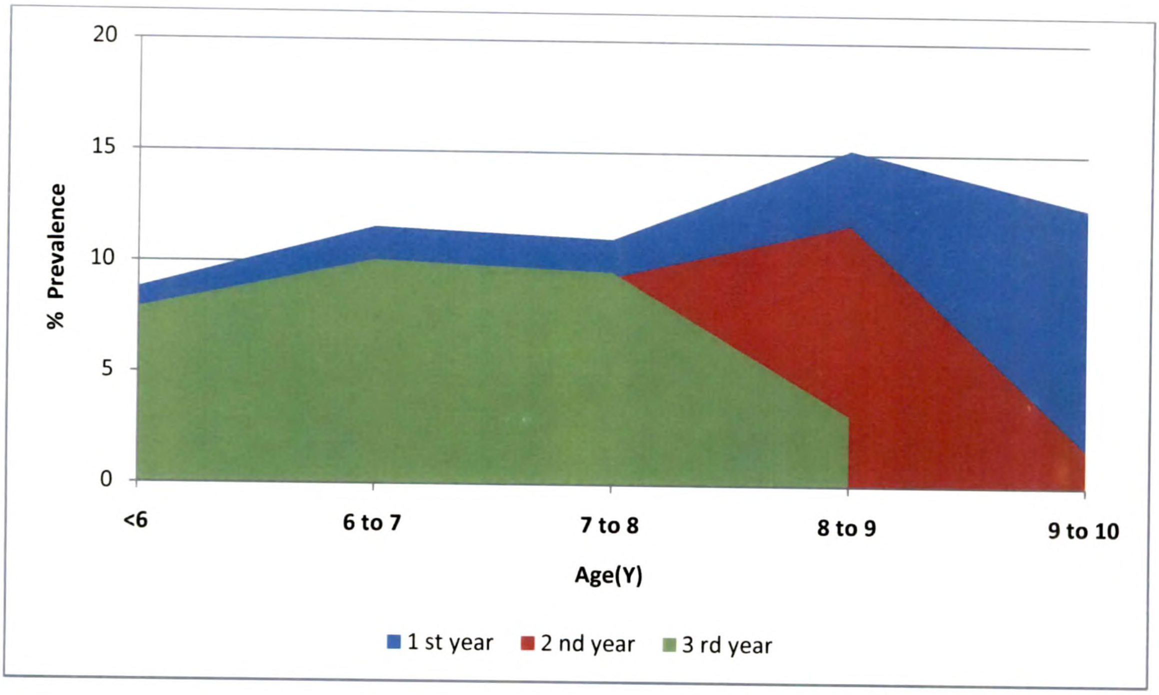
The age wise trend in the prevalence of underweight according to WHO standards is given till age of 10 years. Again maximum percent prevalence was found in the age of 8 to 10 years (**Table 4.2.11**) & (**Figure 4.2.5**). The

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

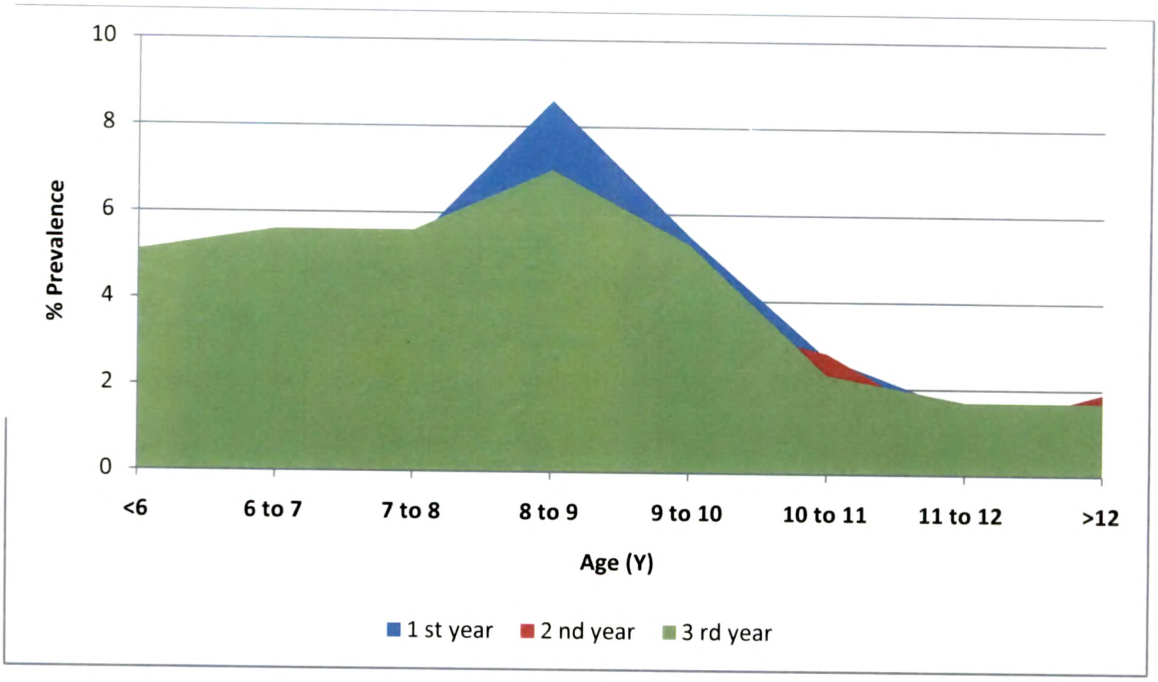


Table 4.2.13 Age wise trend in prevalence of thinness according to WHO standards

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

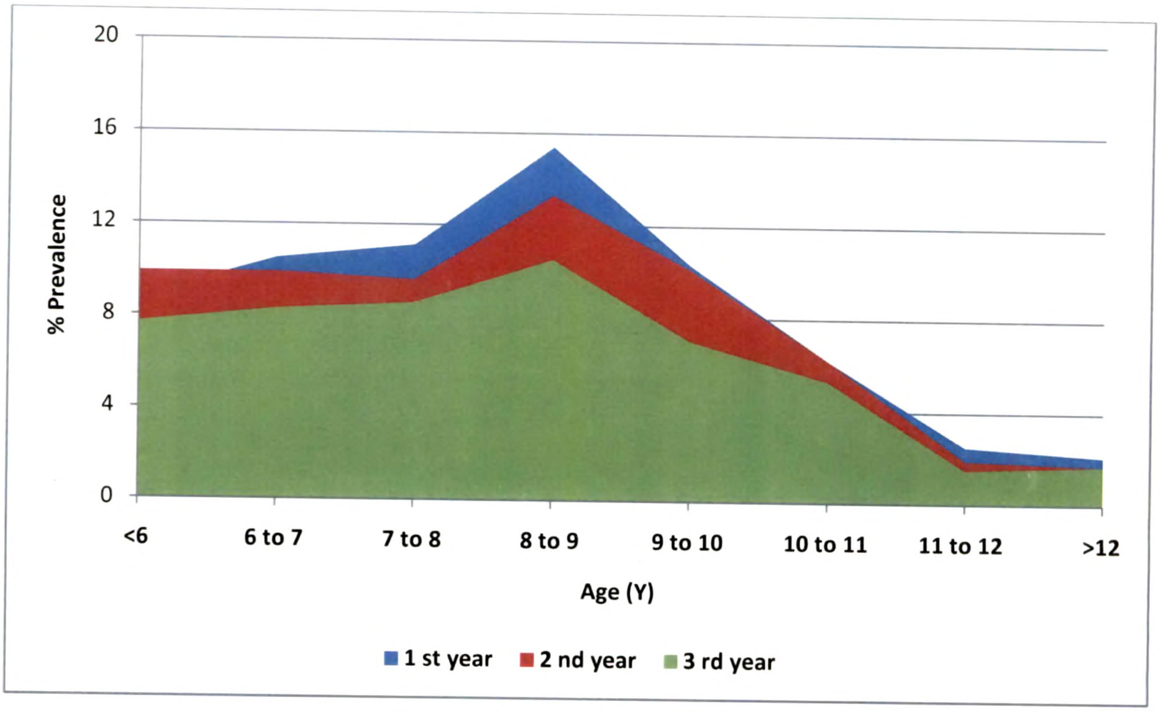


Table 4.2.14 Growth transition shift for first year represented by Weight for age

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 one year, washout effect 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, 41.5 % 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(41.5)**	**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

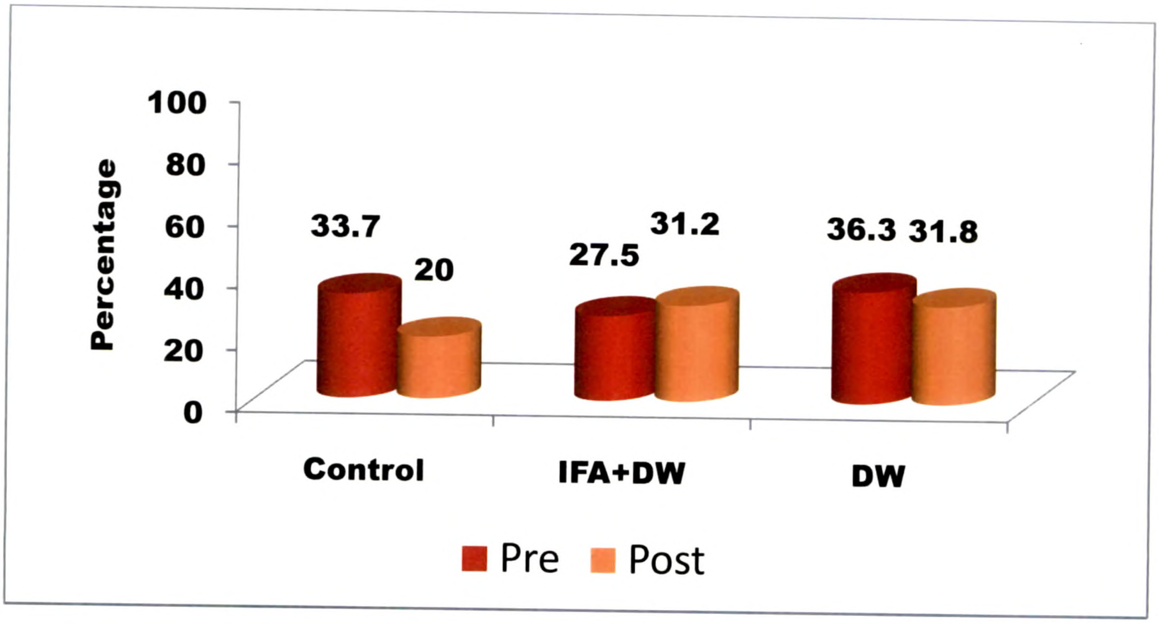


Figure 4.3.2a Percent prevalence of Stunting (<-2 SD) Z score among children as per WHO 2007 classification

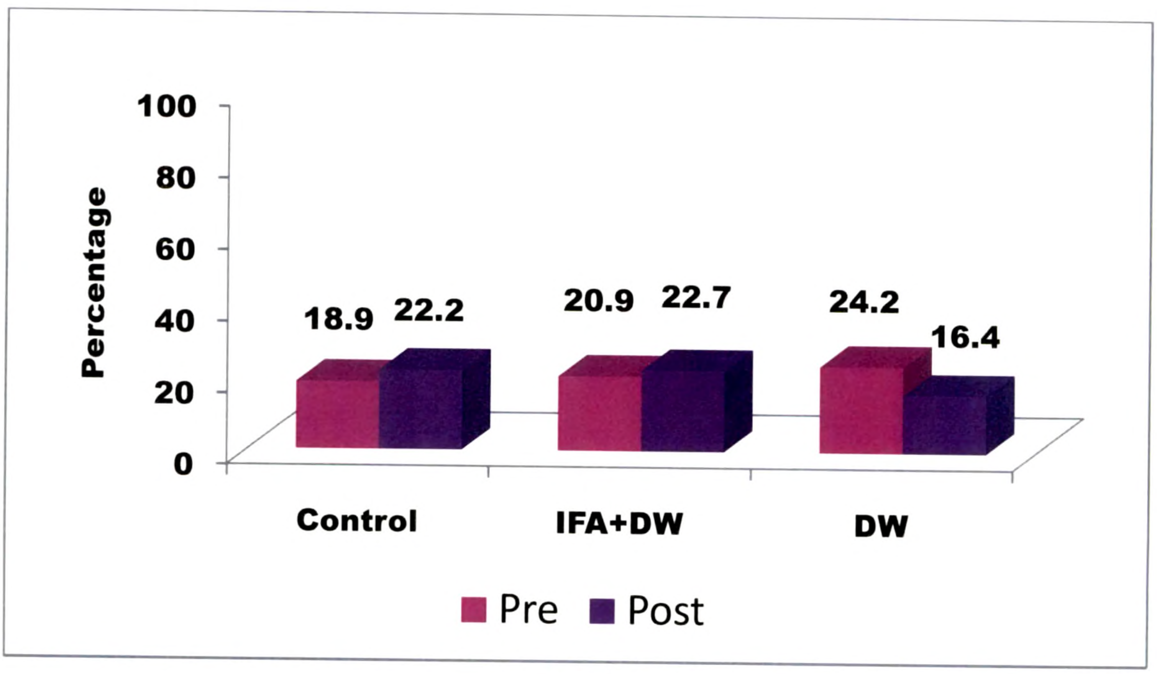
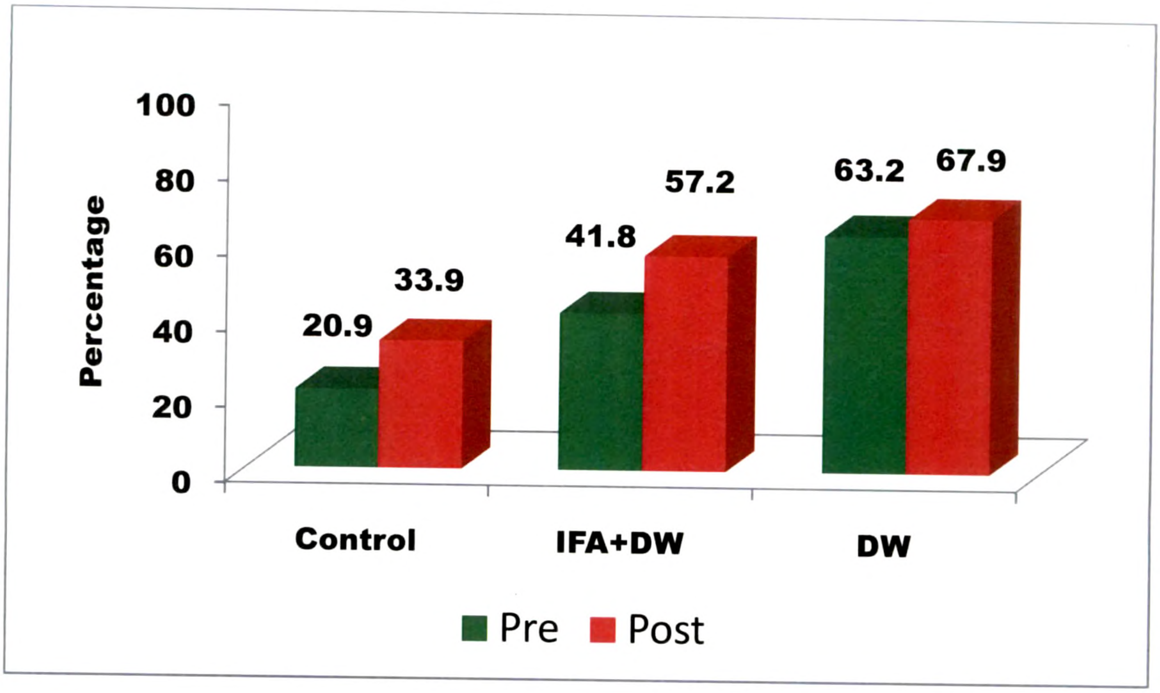


Figure 4.3.3a Percent prevalence of Thinness (<-2 SD) Z score among children as per WHO 2007 classification



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)

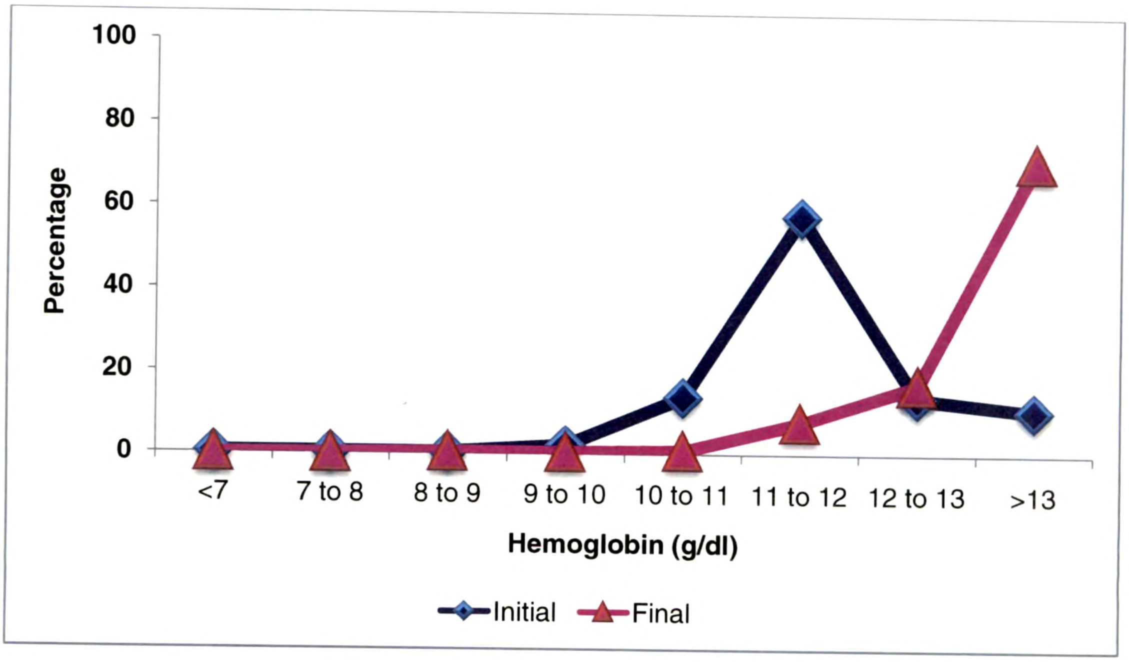
Age (Months)	Control	IFA+DW	DW	F- test
>120-132	(N=19)	(N=44)	(N=38)	
Initial	10.5±0.8	11.4±0.76	11.1±1.1	**6.5****
Final	10.2±1.5	13.5±1.0	11.0±1.4	**57.2*****
Difference	-0.24±1.3	1.9±1.2	-0.1±1.7	**27.5*****
t value	**0.78**	**10.7*****	**0.08**	
>132-144	(N=11)	(N=49)	(N=33)	
Initial	11.46±1.5	11.5±0.9	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)

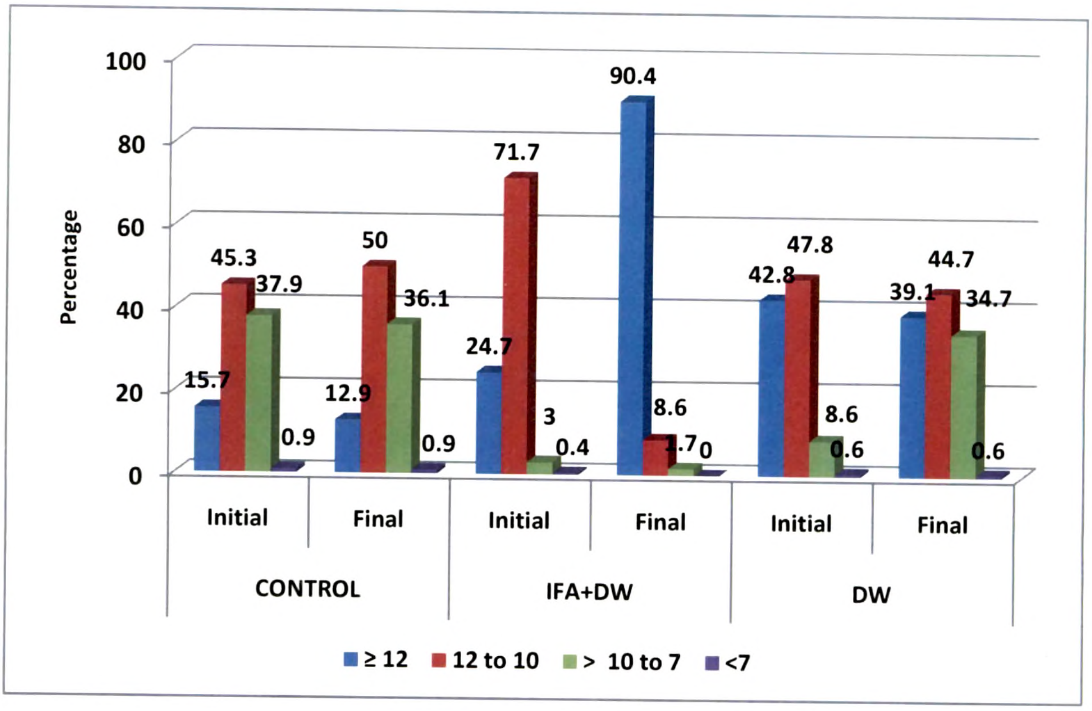


Figure 4.3.6 Impact of Intervention on the percent prevalence of Anemia among children

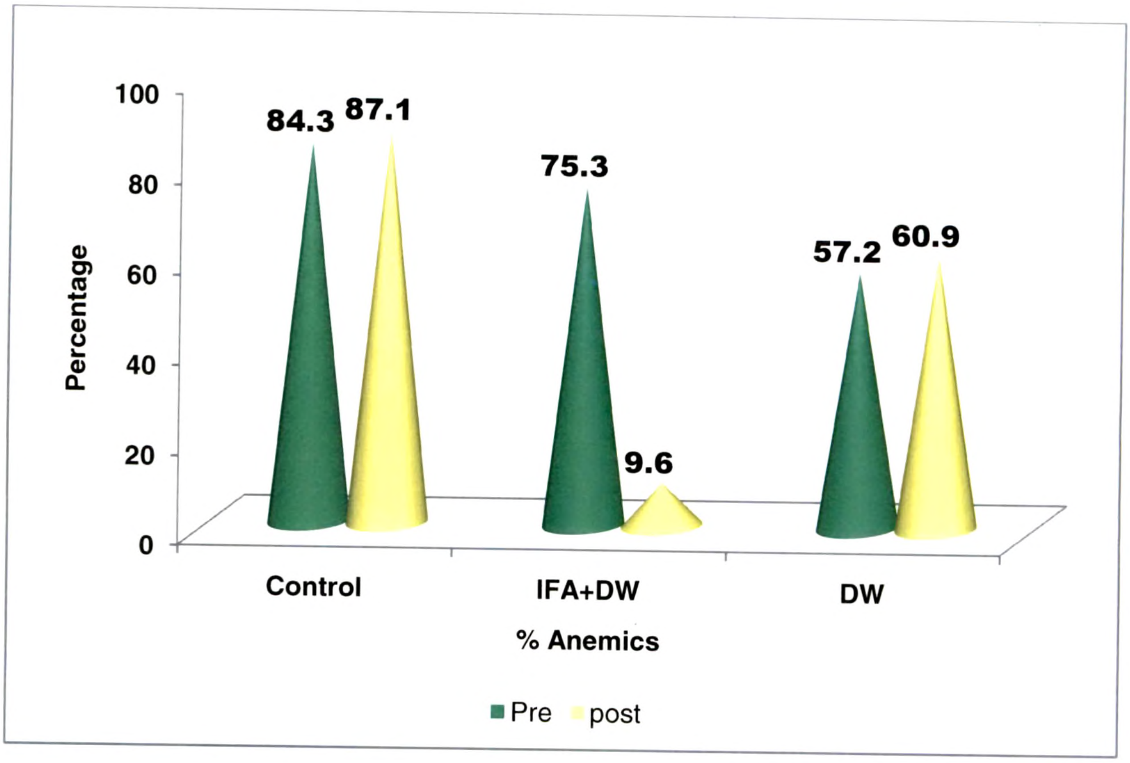


Table 4.3A.17 Impact of Weekly IFA along with Deworming and Deworming alone on prevalence of IDA among children

	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=10)	(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=21)	(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 OF WASHOUT PHASE

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 washout 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 Washout effect 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 Washout effect 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 Washout effect 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 Washout effect on Prevalence of Underweight

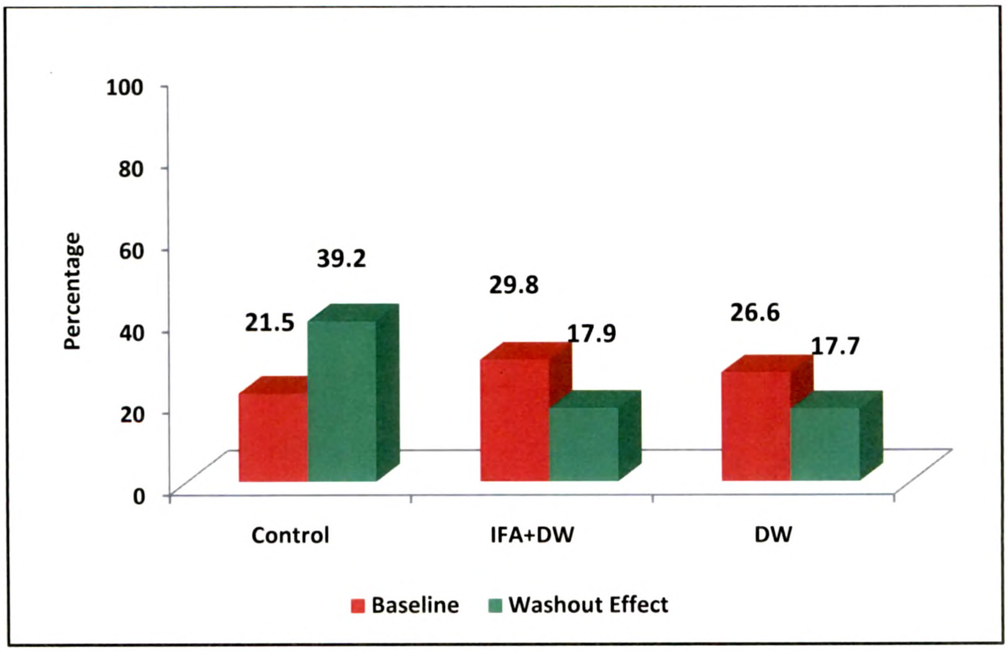


Table 4.3B.5 Prevalence of stunting (height for age < - 2 SD Z score) according to WHO 2007 standards

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 Washout effect on Prevalence of Stunting

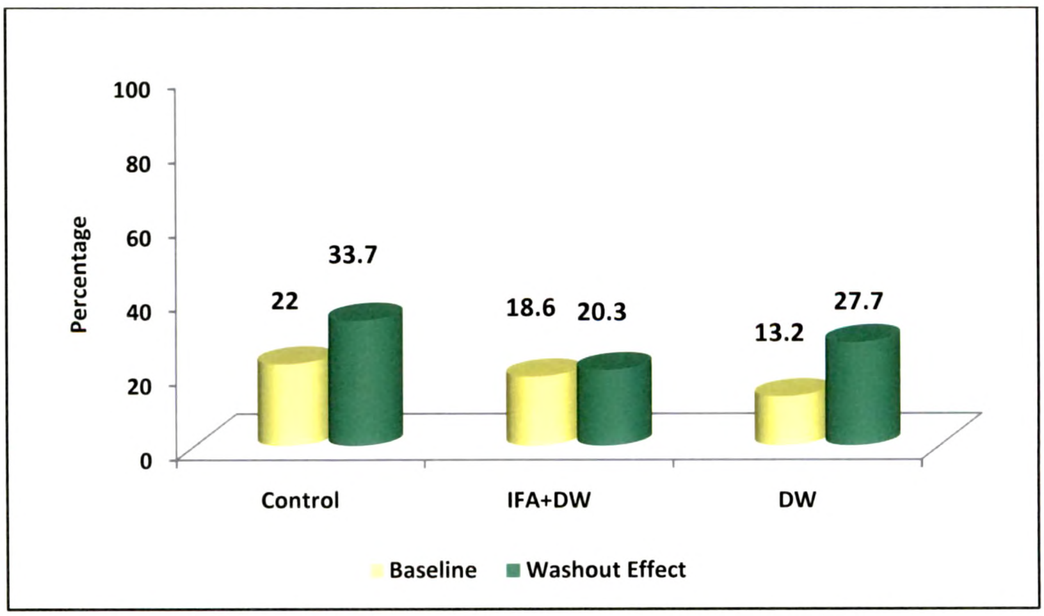


Table 4.3B.6 Prevalence of Thinness (BMI for age< -2 SD Z score) according to WHO 2007 standards

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 Washout effect on Prevalence of Thinness

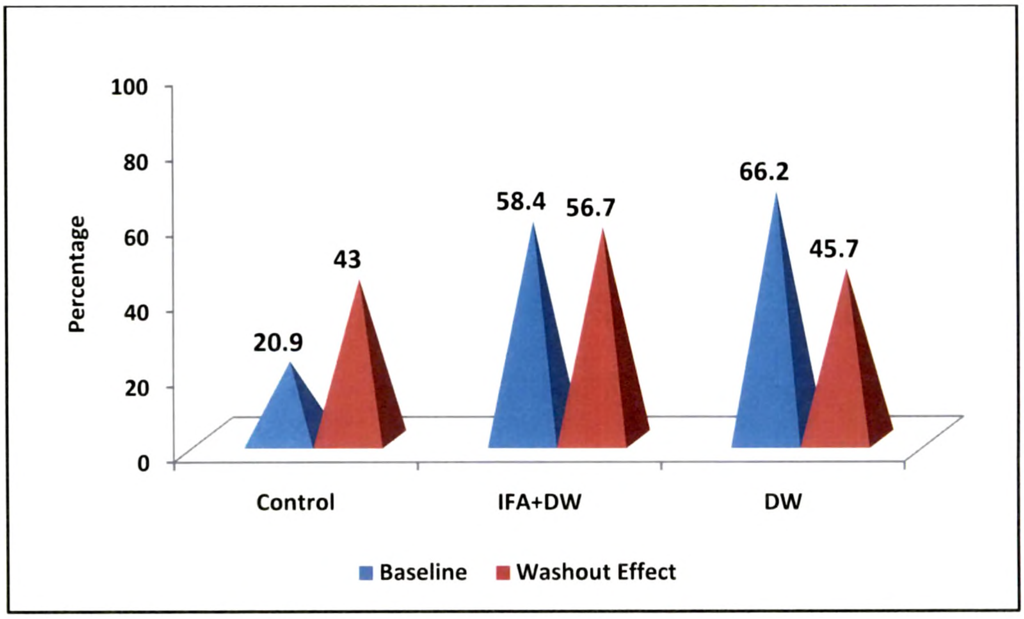


Table 4.3B.7 Impact of weekly IFA along with Deworming and Deworming alone on Hemoglobin of children (Mean ± SD)

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 washout 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 washout period

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 washout period 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.