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Malnutrition among HIV- infected Children by Anthropometric Measures in Poor Outreach Area of a Developing Country and its Relationship with CD4 Counts

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Abstract

Background: Diagnosis and management of malnutrition in HIV- infected children is important as it is both a manifestation as well as an independent risk factor for death. Extent in hilly poor outreach areas of North India has been poorly studied. Aim: to study the prevalence of malnutrition among children with HIV/AIDS using WHO z- score and Indian Academy of Pediatrics (IAP) method and effect of malnutrition on immune status.

Material and Methods: Setting-Antiretroviral (ART) Centre of a teaching medical college in Uttarakhand-India. Anthropometric measurements (weight, height) and CD4 counts were taken on registration and follow up and duly recorded. Data analysis was done using SPSS -18 and WHO z-score value was calculated using WHO AntroPlus software.

Result: A total of 107 children (67 male and 40 female) were studied with mean age of 7.15years.Valid z- score could be calculated only for 46 children and it showed stunting in 69.8%(30/43), wasting in 22.4%(10/46), underweight in 58.9%(27/46). Using IAP method 75% (81/107) had PEM, 85.5% (93/107) stunting. There was no difference between male and female (P>0.05) and no relation between CD4 count and nutritional status (P>0.05). Single dose nevirapine used earlier for Prevention of Parent to Child Transmission (PPTCT) used in 10 newborns resulted in 3/10 HIV negative, 3/10 positive, 4/10 deaths at 18 months.

Conclusion: Malnutrition is rampant in children with HIV/AIDS in hilly poor Outreach areas of India. Chronic malnutrition or stunting was the most common abnormality seen in three fourth of all the children. Hence sensitizing health care workers for timely recognition and prompt remedial measures (ART, nutritional interventions) are need of the hour to reduce mortality and prevent growth failure. It also provides baseline data of efficacy of single dose nevirapine to compare efficacy of newer regimes in prevention of PPTCT.

Key Words: CD4 counts, Children, HIV, Malnutrition, Under-weight.

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1-INTRODUCTION

HIV /AIDS is responsible for 2% of under five deaths in the world (1). The first case in India was reported in 1986, since then the epidemics has spread rapidly and India is now estimated to have 2.4 million people, largest in Asia and 3rd in the world of which 3.5% are children (2, 3). Of late, national level HIV /AIDS has shown a declining trend but Uttarakhand (which is a high HIV vulnerable state based on extent of migration, poor health infrastructure and size of population) has shown a steep increase from 0% in 2007 to 0.1% in 2010 but still lower than the national average (0.3%) (4).

Under-nutrition childhood is estimated to cause 3.1 million child deaths annually through a common potentiating effect on common infections like pneumonia and diarrhea (5). Assessment of nutritional status by anthropometric measurements like weight, height has been widely used in epidemiological studies as it is easy to estimate, affordable and easy to carry out (6). Malnutrition is common in HIV infected children due to a complex interplay of recurrent infections, decreased intake due to illness, lesions like candidiasis and decreased availability due to social problems like ill or deceased caretaker and increased metabolic rate (7). The nutritional status of people living with HIV/AIDS is related to morbidity and mortality and may predict the course of HIV infection and the management of these helps in recovery and maintenance of health status (6). Malnutrition is both a manifestation as well as an independent risk factor for death in HIV as corroborated by studies in United States and Africa (8).

Uttarakhand, a state in Northern India (Figure.1), is a high HIV vulnerable state due to large migration for work, poor health infrastructure and size of population (4). It also has poor accessibility to health services due to the difficult geographic terrain. This study was conceived to study the extent of malnutrition by anthropometric measurements and determine the extent of malnutrition in children with HIV/AIDS and its relationship with CD4 counts in Kumaon region of Uttarakhand-India.

Fig.1: Uttarakhand, Northern India

2-MATERIALS AND METHODS

This is a retro prospective record based study carried out Jan 2013 to December 2013 in the Antiretroviral therapy (ART) Centre of Dr. Stm Forest Hospital in Haldwani-India and Teaching College that is a tertiary Centre in Kumaon region of Uttarakhand. The recorded data of the children (less than 15 years of age) affected with HIV/AIDS, either born in the medical college hospital or coming from peripheral areas of Uttarakhand for taking ART or follow up was obtained from the ART Centre of the hospital after completing permission and ethical formalities. The anthropometric measures of all children including height (in centimeters), weight in kilogram was taken. The CD4 count was also taken at the time of registration and every 6 monthly as per earlier protocols (9).

Children were also examined clinically for nutritional deficiencies and opportunistic infections like tuberculosis. Height and weight were obtained upon enrolment .The z- scores for weight, height, and body mass index (BMI) were computed based on childs' age and gender using the standard (10) method and references (11, 12). The WHO recommends a z-score cut-off point of <-2 standard deviation (SD) to classify low weight-for-age, to classify underweight, low height for age (stunting) and low weight for height (wasting) and a z- score of <3 SD to define severe under nutrition. A z- score of <2 SD indicates that a child height for age (HAZ), weight for age (WAZ) and weight for height (WHZ) is 2 standard deviation below the age and gender specific median for the normal population. As valid z-scores were obtained for only 46 out of 107 children wasting, stunting and under nutrition were calculated on the basis of CDC charts (13) and Indian Academy of Pediatrics (IAP) (14) method – weight for age with normal ->80%, Grade 1-70-<80, Grade II-60-<70%, Grade III-50-<60% and Grade IV-<50% of expected.

The CD4 counts of all patients were also recorded and correlated with the under nutrition and wasting and stunting. The children once found to be HIV positive were registered in the ART centre of the Medical College and kept on follow up. Highly Active Anti Retro Viral Therapy (HAART) was started on the basis of symptoms or CD4 counts as per earlier guidelines (9). The counts were repeated on follow up at 6 months.

2-1. Inclusion criteria

All children registered in ART Centre of the Teaching Medical College which is the only registered centre of National Aids Control Society (NACO), in Kumaon-India, allowing counseling, monitoring and free medications to children as per guidelines provided by NACO.

2-2. Exclusion criteria

Children who were not registered, did not come for follow up after 6 months or died were not included in the study. Children with any deformity not allowing anthropometric measurements were also excluded.

2-3. Statistical Analysis

The obtained information was checked for missing data, coded properly and entered in MS excel 2007. The data was analyzed using SPSS -18 for carrying out Chi-square test of association. WHO z- scores value was calculated using WHO AntroPlus software to determine the unde-r nutrition in the children.

3-RESULT

3-1. Baseline socio- demographic and clinical profile of patients

The total number of children infected with HIV attending ART Centre of Medical College over the one year study period was 107 either for follow up (n=44) or for taking antiretroviral therapy(n=63). All of them were infected by the parent to child transmission. Of the 107 children there were 67 (62.6%) male and 40 (37.3%) female children. Mean age of the children was 7.15 ± 3.8 years (range 2 to 15 years). Five children were found to be having comorbid conditions of either severe anemia (n=1/107), pulmonary Tuberculosis (n=3/107) or extra pulmonary Tuberculosis (n=1/107). Eight children required admission in pediatric ward out of which seven were discharged for pneumonia (n=3), tubercular pericardial effusion (n=1), pulmonary tuberculosis (n=1) and severe protein energy malnutrition with gastroenteritis in severe dehydration (n=1) and Pyrexia of Unknown Origin (n=1) with hepatosplenomegaly which on investigation was found to be HIV.

In the duration of study, 2 deaths occurred; one died in hospital with severe pneumonia in respiratory failure and another at home (case not known). Four cases were lost to follow up over the one year study period. In the same duration of study period, there were 10 newborns delivered to mothers with HIV who had received ART (nevirapine single dose as per earlier recommendations) in the Medical College Hospital. Out of these, 4 died in the first year of life (cause-septicemia on the basis of verbal autopsy), 33.33% (3/10) were positive at 18 months and 33.33 %(3/10) became negative at 18 months. These children had received single dose nevirapine as per earlier recommendations (9).

The age and gender distribution of children with HIV/AIDS is shown in (Table.1). Overall 67 male and 40 female children were studied. The mean weight and height shows an increasing trend with 2 declining peaks at 6 years and 10 years of age. Females on an average have higher mean weight and height than the male children (Table.2). Nearly three-fourth (75.70%, n=81/107) children were under weight for age as per IAP criteria (14). A much higher number of children (86.91%, n=93/107) were stunted as compared to underweight. There was no significant difference between male and female children (P>0.05). Using body mass index for age CDC percentile criteria, the 43.9 % (n=47/107) of children were found underweight, 3.7% overweight and 5.6% obese. The percentage of male underweight children was higher (46.3%) than female (0.4%) children (Table.3).

Valid z- score value could be obtained for only 46 (43%) children for calculating weight for age z- score value and weight for height/length z- score, further reduced to only 43 (40.19%) children in determining the height for age z -score value. The height-for-age z-score value which has been out of range was -6.75, -7.04 and -6.82. The proportion of stunted children was found to highest (46.51%) followed by underweight (39.13%) and wasted (13.04%) on the basis of the z-score value obtained for weight for age, height for age, and weight for height. The z- score value <-2 of the WHO reference median population separately for weight for age, height for age and weight for height has been taken as indicator for finding out the percentage of underweight, stunting and wasting, while the z- score value <-3 for the above anthropometric indices is taken as the indicator for severe underweight, stunting and wasted respectively (Table. 4). Out of the 46 children with valid WAZ score 27(58.69%) under-weight, 30 stunted and 10(21.74%) wasted children (Table.3) and out of 43 children with valid WAH score 30(69.77%) children were stunted. The following categories of under-nutrition have been given by Svedberg, so as to determine the overall frequency of under-nutrition in the studied children (Table 5).

The difference in the proportion of male and female children was statistically insignificant (P<0.05). The study also did not find any significant relationship between age of the children aged 2 to 5 years and their nutritional status (Table.6). In the present study the mean z- scores was negative implying thereby that the nutritional status of children with HIV is affected as compared to the reference population. The SD of different anthropometric parameters is above the expected range of SD values as seen in (Table.7). This may be the reason why we got valid z- scores value for only 46/107 children in the present study. More children were found to be severely under-nourished using the WHO z- score method but the IAP method detected greater number of children with mild and moderate malnutrition (Table. 8). WHO z-scores method could be applied to only 46 out of 107 children using AnthroPlus

software while IAP method has been applied to all. No association could be found between CD4 counts and nutritional status of children in this study as shown in (Table.9). For children with HIV/AIDS WAZ(weight for age z score), HAZ(height for age z- score) and weight for height z-scores curves were shifted to left as compared to the WHO reference median implying growth failure. There was no marked difference between male and female children (Figures 1-6 respectively).

Table 1: Distribution of HIV affected children according to age and gender

Age-groups (in years)	Male		Female		Total	
	Number	%	Number	%	Number	%
2-5 years	32	47.76%	14	35%	46	42.99%
6- 15 years	35	52.24%	26	65%	61	57.01%
Total	67	100.0%	40	100.0%	107	100.0%

Table 2: Age and gender wise mean weight and height of the children

Age (years)	Number	Mean weight (kg) ± SD	Mean height (cm) ± SD
2	7/107	9.71 ± 1.70	81.43 ± 19.69
3	15/107	10.6 ± 1.92	81.27 ± 7.60
4	11/107	12.82 ± 2.18	89.55 ± 8.18
5	13/107	13.31 ± 2.02	100.54 ± 7.10
6	9/107	11.78 ± 1.86	98.0 ± 9.63
7	8/107	15.25 ± 3.96	107.75 ± 8.73
8	9/107	17.45 ± 3.36	111.67 ± 9.33
9	4/107	21.5 ± 4.43	123.0 ± 6.0
10	8/107	20.63 ± 5.24	118.13 ± 15.79
11	1/107	23.0	125.0
12	7/107	24.86 ± 4.95	133.29 ± 9.95
13	6/107	31.17 ± 10.48	136.17 ± 14.20
14	8/107	31.13 ± 8.18	135.88 ± 14.36
15	1/107	45.o	169.0
Gender	Number	Mean weight (kg) ± SD	Mean height (cm) ± SD
Male	67/107	16.67 ± 7.64	105.82 ± 21.50
Female	40/107	18.45 ± 9.77	107.7 ± 24.26

Table 3: Under-weight and stunting status of the children using CDC 2000 growth standards

IAP (Weight/age)	Total children (n=107)	Male (n=67/107)	Female (n=40/107)
<=50% (very severe)	15/107(14.01%)	7/67(10.44%)	8/40(20%)
50-<60% (severe)	19/107(17.8%)	14/67(20.9%)	5/40(12.5%)
60-<70% (moderate)	30/107(28.03%)	20/67(29.9%)	10/40(25%)
70-<80% (mild)	17/107(15.9%)	11/67(16.4%)	6/40(15%)
>80% (normal)	26/107(24.2%)	15/67(22.3%)	11/40(27.5%)
Lost to follow up (LFU)	5/107 (1D+4LFU)	3/67 (1D+2LFU)	2/40 (2LFU)
Stunting	Total children (n=107)	Male (n=67/107)	Female (n=40/107)
Severe	21/107(19.6%)	12/67(17.9%)	9/40(22.5%)
Moderate	38/107(35.5%)	25/67(37.3%)	13/40(32.5%)
Mild	34/107(31.8%)	21/67(31.3%)	13/40(32.5%)
Normal	14/107(13.1%)	9/67(13.4%)	5/40(12.5%)
LFU	5/107 (1D+4LFU)	3/67 (1D+2LFU)	2/40 (2LFU)
BMI/Age	Total children (n=107)	Male (n=67/107)	Female (n=40/107)
$< 5^{th}$ percentile (underweight)	47/107(43.9%)	31/67(46.2%)	16/40(40%)
$5 < 85^{th}$ percentile (healthy weight)	50/107(46.7%)	30/67(44.8%)	20/40(50%)
$85 < 95^{th}$ percentile (overweight)	4/107(3.7%)	3/67(4.5%)	1/40(2.5%)
$\geq 95^{th}$ percentile (obese)	6/107(5.6%)	3/67(4.5%)	3/40(7.5%)

Table 4: Acute and chronic malnutrition in children with HIV/AIDS using WHO z- score method

Z- score value	Underweight	Stunting	Wasting
	Number (%) n=46	Number (%) n= 43	Number (%) n= 46
≥ 0	3 (6.52%)	3 (6.98%)	16 (34.78%)
-1 to 0	4 (8.70%)	4 (9.30%)	15 (32.61%)
-2 to -1	12 (26.09%)	6 (13.95%)	5 (10.87%)
-3 to -2	9 (19.56%)	10 (23.26%)	4 (8.70%)
< -3	18 (39.13%)	20 (46.51%)	6 (13.04%)

Table 5: Overall under-nutrition in the studied children

Variables	Number	Percentage (%)
Wasting only	4	9.30
Wasting +Underweight	4	9.30
Wasting +Underweight + Stunting	2	4.66
Stunting + Underweight	16	37.21
Stunting	12	27.92
Underweight	5	11.6
Total	43	100

Table 6: Age and gender wise comparative profile of underweight children

Gender wise	Normal weight	Moderate weight	Severe weight	P- value*
Male	12 (37.5%)	5 (15.6%)	15 (46.9%)	0.245
Female	7 (50.0%)	4 (28.6%)	3 (21.4%)	
Age wise(year)	Normal weight	Moderate weight	Severe weight	P- value*
2	4 (57.1%)	1 (14.3%)	2 (28.6%)	
3	4 (26.7%)	2 (13.3%)	9 (60.0%)	0.514
4	6 (54.5%)	2 (18.2%)	3 (27.3%)	
5	5 (38.5%)	4 (30.8%)	4 (30.8%)	

* **T**he likelihood-ratio chi-square.

Table 7: Mean z- score values for anthropometric parameters in the present study

Anthropometric parameters	Mean value	Standard deviation(SD)
WAZ (n=46)	-2.25	1.31
Length/HAZ (n=43)	-2.88	1.82
WHZ (n=46)	-0.66	1.8
WAZ in males (n=32)	-2.39	1.4
Length/HAZ in males (n=29)	-2.89	1.87
WHZ in males (n=32)	-0.8	1.68
WAZ in females (n=14)	-1.91	1.01
Length/HAZ in females (n=14)	-2.87	1.77
WHZ in females (n=14)	-0.33	2.08

Table 8: Comparison of grades of under-nutrition using z- score & IAP method

Grades of Undernutrition/underweight using weight for age criteria	WHO z score (n=46)	IAP method (n=46)
	Number (%)	Number (%)
Normal	19/46 (41.03%)	13/46 (28.26%)
Mild-moderate	9/46 (19.57%)	25/46 (54.35%)
Severe underweight	18/46 (39.13%)	8/46 (17.39%)

Table 9: Association of CD4 count with the nutritional status in children with HIV/AIDS(n=44*)

CD4 count (per microlitre of blood)	Normal weight	Moderately under-weight	Severely under-weight
>=1000/ulit (n=11) (No suppression level)	6	3 (37.5%)	2 (11.1%)
500-999/ulit (n=20) (Moderate suppression level)	6	3 (37.5%)	11 (61.1%)
< 500/ulit (13) (Severe suppression level)	6	2 (15.4%)	5 (28.5%)

*P-value= 0.35.

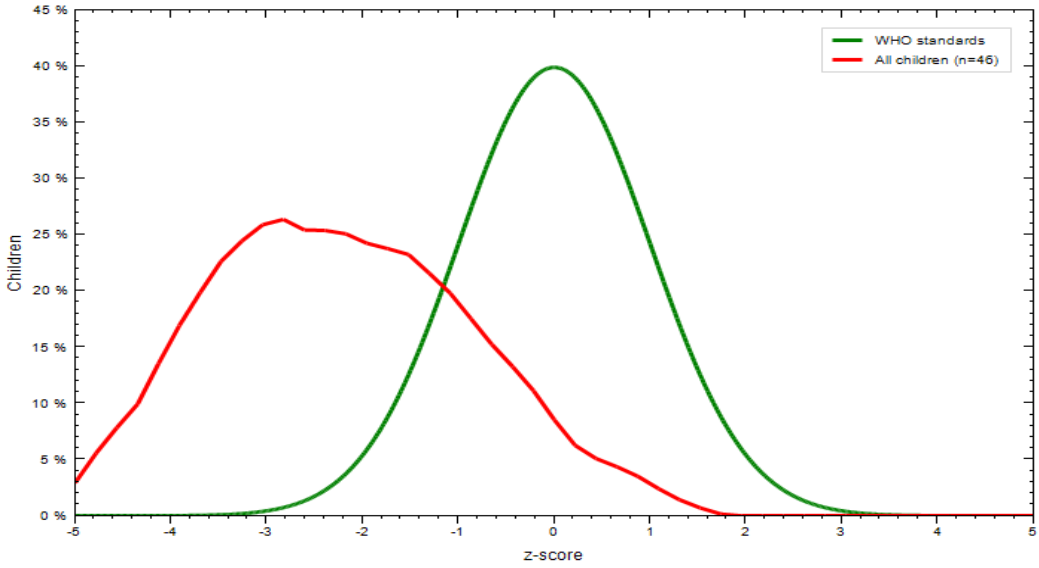

Fig.1: Comparison of WAZ z- score value in the studied children with the WHO reference WAZ z- score

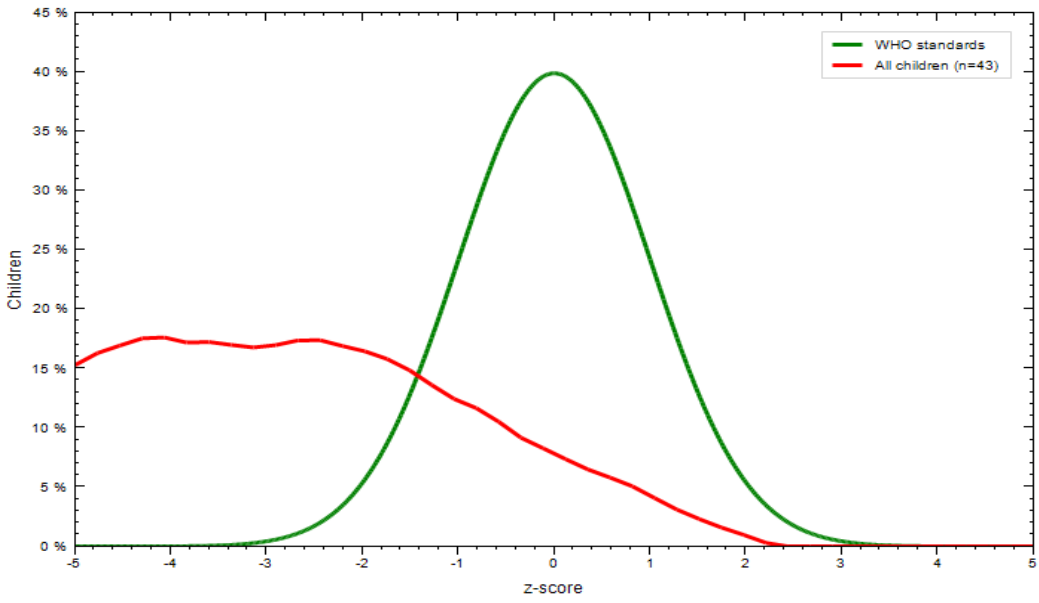

Fig.2: Comparison of HAZ z- score in the studied children with the WHO reference HAZ z- score

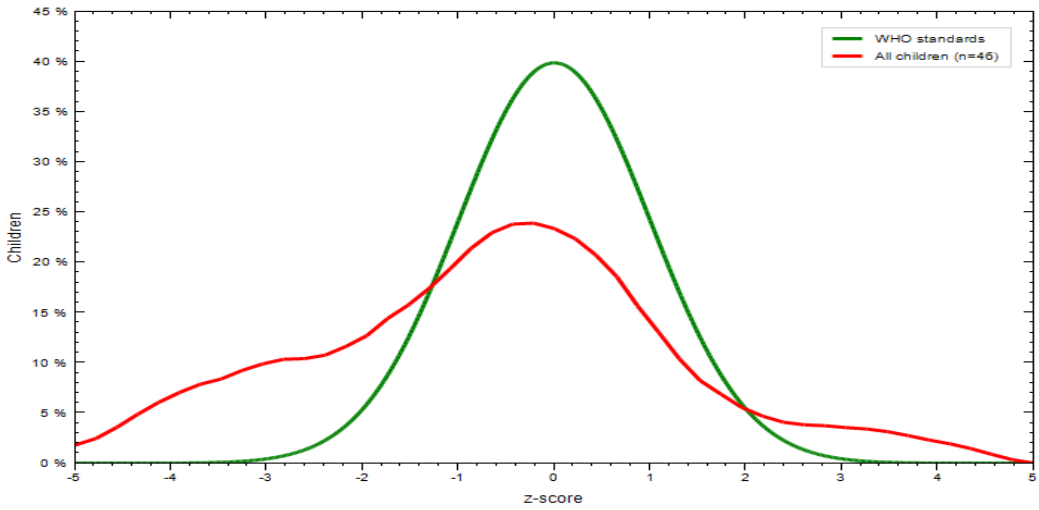

Fig.3: Comparison of weight for height z- score value with the WHO reference median population

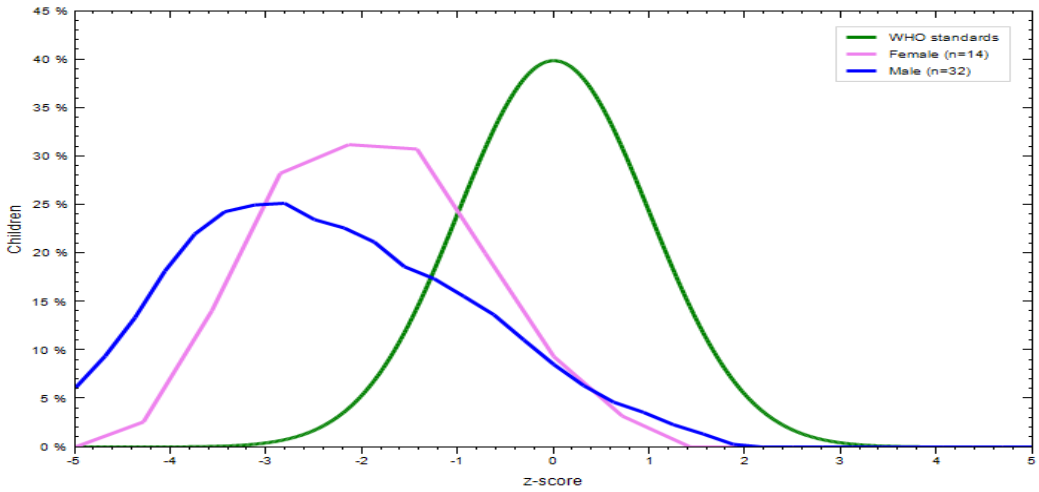

Fig.4: Weight for age z- score curve according to the gender

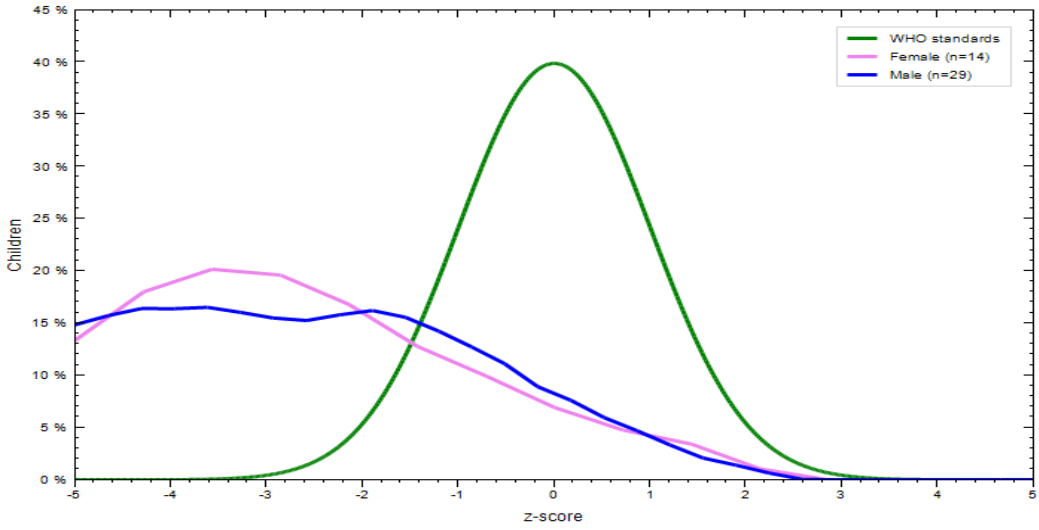

Fig.5: Height for age z- score curve according to the gender

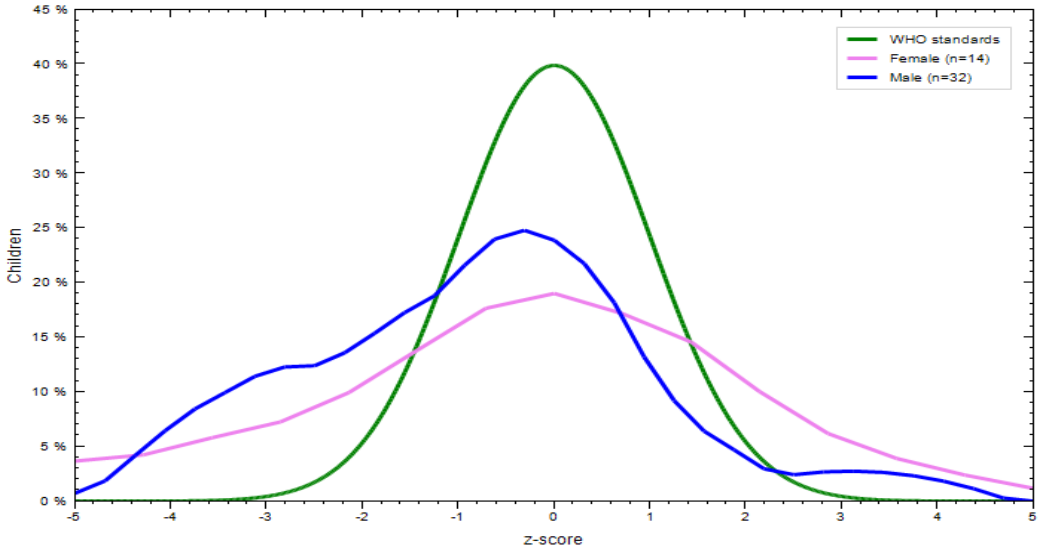

Fig6: Weight for height z- score curve according to the gender

4-DISCUSSION

Since the first case of HIV in India was documented in 1986 there was an explosive increase in the number of cases and the epidemic shifted from high risk to low risk and urban to rural areas. The transmission of late has been controlled and now this decade has shown signs of disease curtailment in the world as in India (15). This is not the case in the hilly rural state of Uttarakhand which has shown an increase in the number of reported cases (4). Whether this is due to increased awareness resulting in better reporting or due to an actual increase in the number of cases, it does serve as a wakeup call for prompt remedial measures to tackle this growing problem. The nutritional status of people with HIV/AIDS is related to morbidity and mortality and is important in maintaining health status; it may also predict the course of this illness (6). Management of malnutrition helps in recovery and maintaining health and especially in children in ensuring optimal growth (4, 12, 17). Mortality is predicted by low Weight for age z- score and low mid upper arm circumference (16). The total number of children in this study was 107 with 67 males and 40 females with a mean age of 7.15±3.8 years. The number of children in other studies ranged from 11-238 with male preponderance seen in most of the studies (18-23).The mean age was similar to a study by Ellis et al., 7.2 years (17) and ranged from 48 months to 4.5 years (21, 23). The predominant mode of transmission in this study was parent to child similar to a study from Nepal (19) and other studies from Mumbai and New Delhi (20, 21, 23) and rural south India (22). However other routes like blood transfusion, heterosexual were not seen in this study. HIV 1 is the more common infection in India as also seen in our study where all cases were HIV 1. Low prevalence of HIV 2 has however been reported from South India (26).

Of the 10 infants born to HIV positive mothers, who received single dose of Nevirapine under Prevention of Parent to Child Transmission of HIV/AIDS (PPTCT) programme, 33.33% (3/10) were HIV positive and 33.3% (3/10) were negative and 40% (4/10) died by the age of 18 months. Similar results with nevirapine were seen by Sharma (18): 55.55% positive, 44.44% negative. Other studies in India reported 38-48% transmission with median survival of 8.5

months (24). The results of single dose of nevirapine to mother and baby are not very encouraging in this study.

In this study 58.8%(63 out of 107) children were on ART as per earlier NACO guidelines (9), similar to studies from India (26) and other developing countries (17) as opposed to high prevalent areas where (6) up to 93% were ART users, with most of them receiving zidovudine. Two deaths occurred over the 1 year study period (1.8 %annual mortality) and 5 children required hospital admission (4.6%). These findings are similar to some studies in India (26) but lesser than other studies from Maharashtra (21) (14% annual mortality) and African countries (17) (8.4%mortality). The higher rate in these studies could be because these were based on children admitted in pediatric ward while our study was based on children coming to ART Centre for follow up. This study shows stunting to be the predominant anthropometric abnormality in children with HIV/AIDS found in 87% of all children with HIV/AIDS using IAP method and 69.8% using WHO z- score method (valid z- scores in 46 children). Also, 75% children were underweight by the IAP method (60% moderate to severe) and 58.9% using the WHO z- score (n=46). Wasting was seen in 22.4% of children. Only 3.7% were over-weight and 5.6 % obese. No statistically significant difference was seen between male and female children. Similar results were found in other study (Elis et al.) (17).

The percent of under-weight children (58.9%) by the WHO method is less than other studies in India Shah (20) (90% with 62% severe protein-energy malnutrition (PEM) Lodha (23) 81.3% FTT and African countries like Malawi (17) (Ellis, 88.3%), but similar to neighbouring countries like Nepal (Poudal et al. 54%) (19). Other studies, from Nigeria showed a much lower rate of malnutrition Ezeonwu (7), 22.4% and Bismarck (28) 8.4% under-weight. The rate of over-weight and obese (3.7%) is lower than studies from Africa 16.7% and 13.3% (28). Decreasent height for age (stunting) seen in 69.8% is the predominant anthropometric abnormality in this study also seen in other studies from India, [Lodha (23) HAZ z-score -2.68] and African countries (6, 28). It highlights the importance of chronic undernutrition causing growth failure in children with HIV/AIDS. WAZ, HAZ and WAH z- score curves are shifted to left as in other studies. No assosciation was seen between CD4 counts and under-nutrition in this study similar to a study from south India by Padmapriyadarsini (29) where moderate to severe undernutrition was also present in children with CD4 count above 25% unlike a study from Mumbai by Shah (22) where CD4 was low in children with failure to thrive.

5-CONCLUSION

It is sad to see that majority of the children with HIV/AIDS are under-nourished. Growth failure /stunting are widely prevalent and most common anthropometric abnormality is low height for age. CD4 counts did not show any relationship with weight yet it does warrant urgent remedial measures to decrease growth failure. Over-weight and obesity are not a major health issue in India unlike some developing countries. IAP method is easy to use, but it shows an increase in the number of malnourished children and decrease in the number of severely malnourished children. Single-dose nevirapine was not very effective in prevention of parent to child transmission as onlyningt 3/10 became negative at 18 months.

5-1. Limitations

Being a record based study no intervention could be carried out. Valid z scores could be calculated for only 46/107 children using WHO z- score method hence IAP method (weight for age) was

also used and for reference for children >5 years 2000 CDC charts were used. The lack of data on family history and socioeconomic background limits the study on etiology behind rampant malnutrition.

5-2. Recommendations

There is a need to sensitize ART workers and health care professionals regarding the ubiquitous nature of malnutrition especially stunting so that it may be timely recognized and early and timely initiation of ART and nutritional interventions coupled with regular monitoring may alleviate its burden. This is need of the hour to reduce mortality and growth failure especially now when HIV is more like other chronic infections with prolonged survival. Cd4 count alone cannot be used to decide disease status as moderate to severe under nutrition can be present at high Cd4 counts. This study also provides baseline data of efficacy of single dose nevirapine in PPTCT in Uttarakhand against which efficacy of newer more intensive regimes can be compared.

Contribution Details (to be ticked marked as applicable):

Variables	Contributor 1	Contributor 2	Contributor 3
Concepts	+	+	+
Design	+	+	+
Definition of intellectual content	+		
Literature search	+		
Clinical studies	+		
Experimental studies			
Data acquisition	+		
Data analysis		+	
Statistical analysis		+	
Manuscript preparation	+		
Manuscript editing			+
Manuscript review			+
Guarantor	+		

6-CONFLICT OF INTEREST: None.

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