*Original Research Article*

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# Effect of HAART on the Anthropometric Parameters and CD4 counts in HIV/AIDS Affected Children

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**Abstract**

*Background:* Role of Highly Active Retro Viral Therapy (HAART) in improving the nutritional status and immunity in poorly accessible areas of developing countries has been inadequately documented.This study aims to assess the effect of HAART on weight, height and CD4 counts of Human Immune Deficiency Virus (HIV) infected children and analyze factors associated with the effect. *Methods:* Anthropometric measurements and CD4 counts were taken on registration and follow up and duly recorded. *Results:* 107 children were studied for one year out of these 63 received ART on the basis of CD4 counts or symptoms. The mean weight improved from 16.67±7.64kg to 19.63±9.15kg in boys and from 18.45±9.77kg to 21.7±10.89kg in girls. The mean height increased from 105.82±21.5cm to 108.75±23.18cm in boys and from 107.7cm to 108.58±24.54cm in girls. The percentage of underweight, stunted and wasted children decreased after the start of HAART from 58.7% to 32.6%, 69.8% to 60.5% and 21.7% to 11.4% respectively. Weight for age and weight for height z scores improved significantly while height for age showed a small increase. No effect on CD4 countswas seen. *Conclusions:* HAART has a positive effect on growthin HIV1 infected children irrespective of nutritional supplementation. The change is more significant in severe forms of malnutrition. We strongly recommend viral load estimation for better monitoring and prompt and universal initiation of HAART in children with HIV infection to prevent growth failure.

**Keywords**: Malnutrition; Children with HIV/AIDS; HAART; CD4 Count.

## Introduction

Globally the AIDS epidemic has slowed down and the number of new patients has declined or stabilized. Adult HIV prevalence in India too has declined to 0.31% in 2009 against 0.36% in 2006. Estimated number of people with HIV/AIDS in India is 2.40 million in 2009 against 2.44 million in 2008 out of which 3.5-4.4% is children less than 15 years [1]. Nutritional disorders may decide the course of HIV infection and timely management of these conditions may help in recovery and maintenance of health status [2,3].

Uttarakhand is a small hilly state with 80% of population scattered through small rural hamlets which are economically poor and geographically difficult to access due to hilly terrain and frequent natural disasters. Unlike the trend of HIV/AIDs internationally as well as in high prevalence areas of India, where new cases and prevalence are showing a decline, in low prevalence state of Uttarakhand. However, adult HIV prevalence has increased in the last few years from 0% in 2007 to 0.1% in 2010 [3,4].

With the increasing number of children surviving into adulthood and taking long term HAART its response on nutritional status needs greater importance. Malnutrition is rampant in Indian children with HIV/AIDS as seen in studies from Uttarakhand [5] and South India [6]. Malnutrition is an independent risk factor for death [7]. Role of HAART alone in alleviation of malnutritionis not well documented. This study was conceived with an aim to study the baseline profile of these children. To determine the effect of HAART on the under

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nutrition and anthropometric measurements in the children and to ascertain the effect of HAART on the CD4 count of the children.

## Materials and Methods

This is a retro prospective record based study carried out for a duration of 1 year (Jan 2013 to December 2013) in the ART Centre of 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 HAART 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 [8]. 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 BMI were computed based on child's age and gender using the standard [9] method and references [10,11]. The WHO recommends a cut off z score of <2 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 indicates that a child's height for age (HAZ), weight for age (WAZ) and weight for height (WHZ) is 2 SD below the age and gender specific median for the normal population.Valid z scores were obtained for only 46 out of 107 children. The CD4 counts of all patients were also recorded and correlated with under nutrition, 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. HAART was started on the basis of symptoms or CD4 counts as per prevalent guidelines [8]. The counts and anthropometric measurements were repeated on follow up 6 monthly.

### *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 score value was calculated using WHO Antroplus software to determine the Under nutrition in the children.

## Results

The total number of children infected with HIV attending ART Centre during the study period was 107 out of which 63 children on HAART were studied. All of them were infected by the parent to child transmission and all of them were found to be infected by HIV1. Of the 107 children there were 67 male and 40 female children. Mean age of the children was 7.15±3.8 years (range 2 to 15 years). 4 cases were lost to follow up over the one year study period one each at 2yr, 5yr, 8yr and 10 yrs. An 8 year old child died due to severe pneumonia in respiratory failure during the study period and another died at home due to unknown cause. The HAART regime given to the children is shown in Table 1.

The change in under nutrition, wasting and stunting after use of HAART is depicted in Table 2.

**Table 1:** HAART regime given to children (n=63)

| HAART Regime | Number of children receiving HAART |
|---|---|
| Abacavir+ Nevarapine (ABC+NVP) | 6 |
| Stamivudine (SLE) | 3 |
| Stamivudine/Abacavir (SLE/ABC) | 1 |
| Stamivudine/Zidovudine (SLE/ZLN) | 1 |
| Stamivudine/Abacavir +3TC+Efavirenz+ Zidovudine (SLE/ABC+3TC+EFV+ZLN) | 1 |
| Tenofovir | 2 |
| Zidovudine (ZLN) | 45 |
| Lost to follow up (LFU) | 4 |

The comparison of mean weight and height of children before and after HAART with WHO reference is shown in Figure 1-4. The percentage of underweight, stunted and wasted children has decreased after the start of ART from 58.7% to 32.6%, 69.8% to 60.5% and 21.7% to 11.4% respectively.There is a marked reduction in underweight, wasting and a minimal improvement in stunting. There is also a greater improvement in more severe forms of underweight, wasting and stunting as compared to milder forms.

In the present study the valid z score values could be calculated only for 46 children aged 2 to 5 years.

As per WHO the WHZ parameter is not used in children 5-14 years of age because of puberty changes hence to assess wasting BMI/age is used. But in the present study the valid z score could not be obtained for children beyond 5 years. Hence, both WHZ and BMI/age is used in the children 2-5 years of age. After the start of HAART, the children were gaining weight as shown by increased percentage of 56.8% in the BMI/age category of > +1SD and 22.7% in > +2SD category. BMI/age helps us identify not only a decrease in thinness but also appreciate an increase in overweight from 19.6% to 56.8% and obesity from 10.9% to 22.7% with the institution of HAART (Table 3).

Mean WAZ (weight for age) z score HAZ (height for age) z scoreand WHZ (weight for height) z scoreincreased after institution of HAART (Table 4). The mean weight and height of all children has shown an increasing trend with institution of HAART (Table 5).

CD4 count was available for only 44 children before HAART was initiated and for 35 children after the start of HAART out of the 46 children had valid z score values. Median CD4 count in terms of median±inter-quartile range before HAART was 790±504cells/µl (Range 179 to 1895) and after HAART was 586±383 cells/µl(range 207-1280). (Table 6)

The Z score value of different anthropometric parameters represent the deviation from the median value of the WHO reference population. After HAART, the mean Z score value of different anthropometric parameters decreased clearly indicating a decrease in variation from normal (Table 7).

**Table 2:** Comparison of under nutrition in the children before and after the HAART using WHO z score

| Children | Before HAART | | After HAART | |
|---|---|---|---|---|
| | Number | % (95% C.I) | Number | % (95% C.I) |
| Underweight(n=46) | 27 | 58.7% (95% C.I is 43.4% to 74%) | 15 | 32.6% (95% C.I is 18% to 47.2%) |
| Severe underweight(n=46) | 18 | 39.1% (95% C.I is 23.9% to 54%) | 10 | 21.7% (95% C.I is 8.7% to 34%) |
| Stunted(n=43) | 30 | 69.8% (95% C.I is 54.9% to 84%) | 26 | 60.5% (95% C.I is 44.7% to 76%) |
| Severe stunted(n=43) | 20 | 46.5% (95% C.I is 30.4% to 62%) | 14 | 32.6% (95% C.I is 17.4% to 47%) |
| Wasted(n=46) | 10 | 21.7% (95% C.I is 8.7% to 34%) | 5 | 11.4% (95% C.I is 0.8% to 21.9%) |
| Severe wasted(n=46) | 6 | 13% (95% C.I is 2.2% to 23.9%) | 1 | 2.3% (95% C.I is 0% to 7.8%) |

**Table 3:** Anthropometric profile of children before and after HAART

| Anthropometric parameters | Before HAART (n=46) | | After HA ART (n=46) | |
|---|---|---|---|---|
| | Number | % | Number | % |
| WAZ (<-2SD) (underweight) | 27 | 58.7% | 15 | 32.6% |
| HAZ (<-2SD) (Stunted) | 30 | 69.8% | 26 | 60.5% |
| WHZ (<-2SD) ( wasted) | 10 | 21.7% | 5 | 11.4% |
| BMI/age | Number | % | Number | % |
| Thinness (<-2SD) | 10 | 21.7% | 2 | 4.5% |
| Severe Thinness (<-3SD) | 3 | 6.5% | 1 | 2.3% |
| Overweight (>+1SD) | 9 | 19.6% | 25 | 56.8% |
| Obesity (>+2SD) | 5 | 10.9% | 10 | 22.7% |

**Table 4:** Mean Z score value of different anthropometric parameters before and after HAART

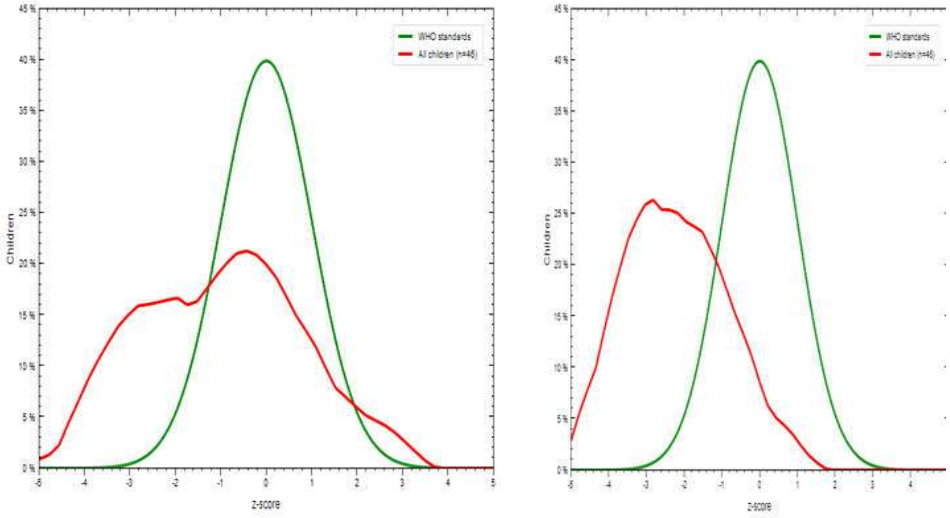
| Anthropometric parameters | Before HAART (n=46) | | | After HAART (n=46) | | |
|---|---|---|---|---|---|---|
| | Number | Mean value | SD | Number | Mean value | SD |
| WAZ | n=46 | -2.25 | 1.31 | n=46 | -1.0 | 1.67 |
| Length/HAZ | n=43 | -2.88 | 1.82 | n=43 | -2.34 | 1.95 |
| WHZ | n=46 | -0.66 | 1.8 | n=44 | 0.61 | 1.72 |
| WAZ in males | n=32 | -2.39 | 1.4 | n=32 | -1.29 | 1.67 |
| Length/HAZ in males | n=29 | -2.89 | 1.87 | n=29 | -2.31 | 2.05 |
| WHZ in males | n=32 | -0.8 | 1.68 | n=31 | 0.41 | 1.64 |
| WAZ in females | n=14 | -1.91 | 1.01 | n=14 | -0.32 | 1.52 |
| Length/HAZ in females | n=14 | -2.87 | 1.77 | n=14 | -2.41 | 1.8 |
| WHZ in females | n=14 | 0.33 | 2.08 | n=13 | 1.09 | 1.89 |

**Table 5:** Effect of ART on the weight of children and CD4 count

| CD4 count (per microlitre of blood) | Normal weight | | Moderate underweight | | Severe underweight children | |
|---|---|---|---|---|---|---|
| | Before HAART * | After HAART# | Before HAART* | After HAART# | Before HAART* | After HAART# |
| >=1000/ulit (No suppression level) | 6 (33.3%) | 3 (11.1%) | 3 (37.5%) | 1 (50%) | 2 (11.1%) | 0 (%) |
| 500-999/ulit (Moderate suppression level) | 6 (33.3%) | 13 (48.1%) | 3 (37.5%) | 0 (%) | 11 (61.1%) | 4 (66.6%) |
| < 500/ulit (Severe suppression level) | 6 (33.3%) | 11 (40.7%) | 2 (25%) | 1 (50%) | 5 (27.8%) | 2(33.3%) |

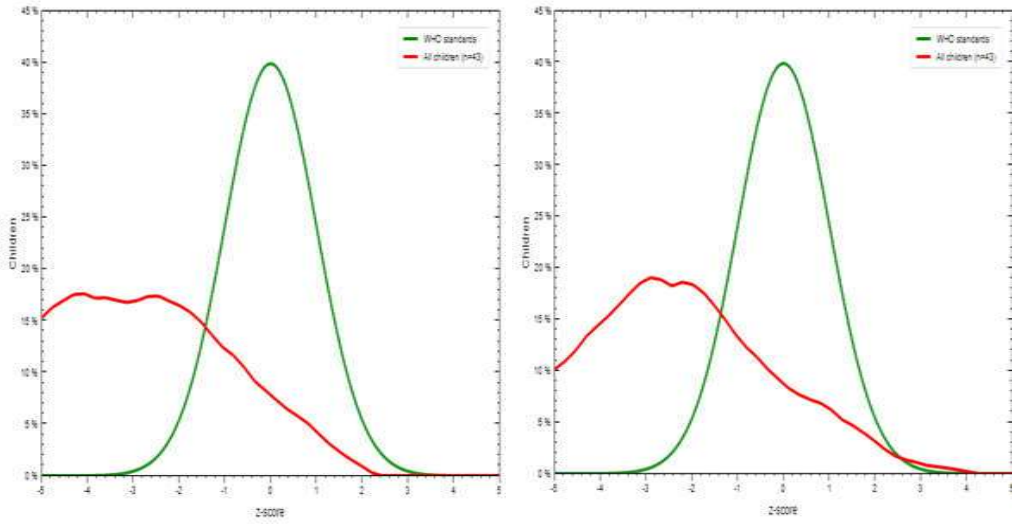
*BeforeHAART (n=44), # After HAART( n=35)

On using HAART the WAZ, HAZ, WHZ curves were shifting towards right side depicting positive improvement in all growth parameter with HAART. There was no significant difference between male and female children (Fig. 4-12).



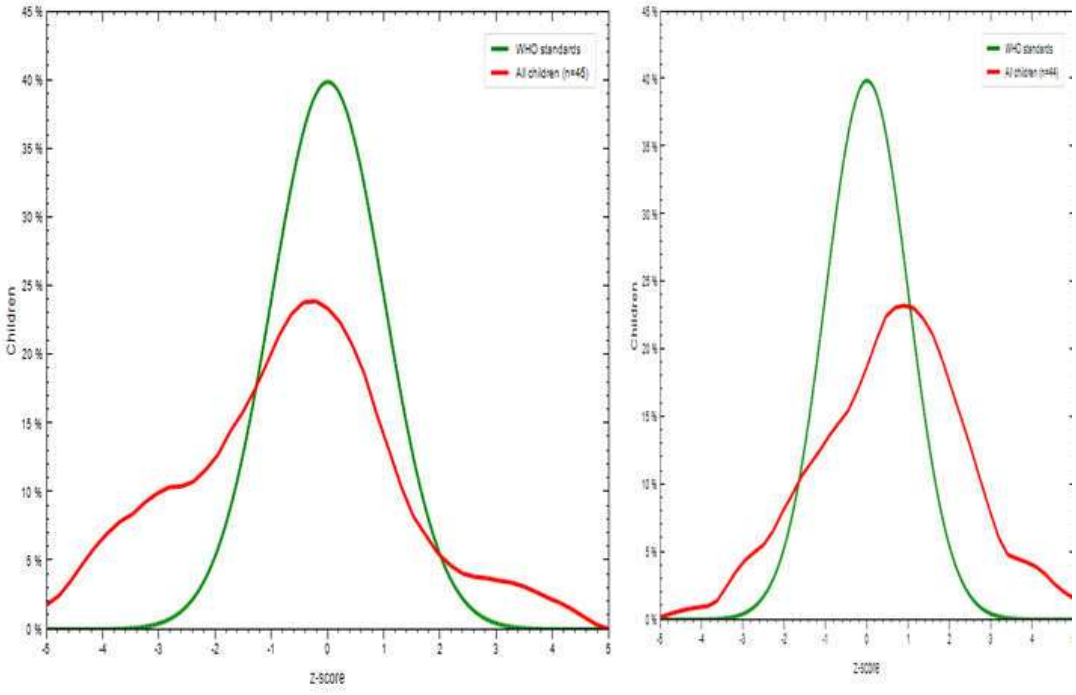

Before HAART After HAART

**Fig. 1:** Comparison of WAZ z score value in the studied children with the WHO reference WAZ z score value*(original)*




Before HAART After HAART

**Fig. 2:** HAZ z score value comparison in the studied children w ith the WHO reference HAZ *(original)*




**Before ART** **After ART**

**Fig. 3:** Comparison of weight for height z score value with the WHO reference median population*(original)*

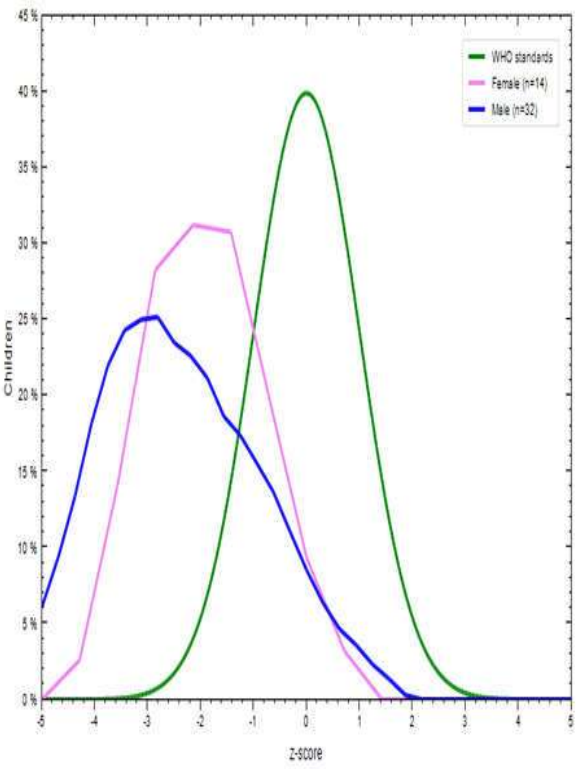



**Fig. 4:** Weight for age z score curve according to sex (Before ART)*(original)*

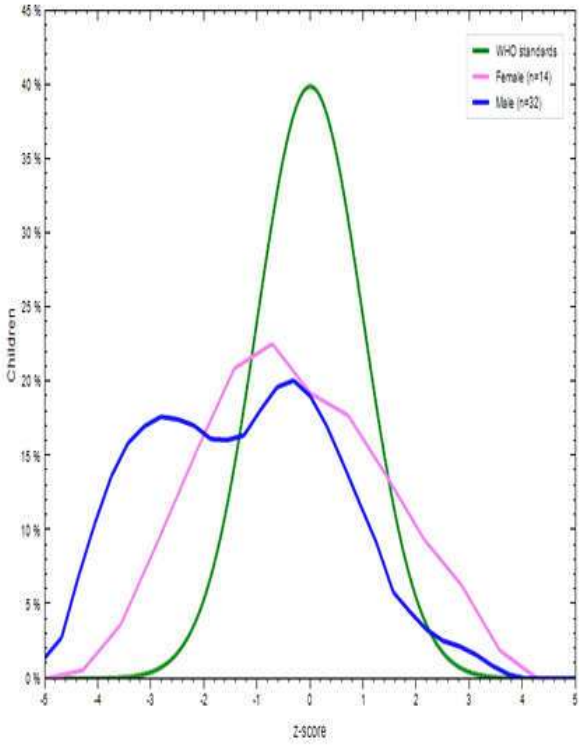



**Fig. 5:** Weight for age z score curve according to sex (After ART) *(original)*

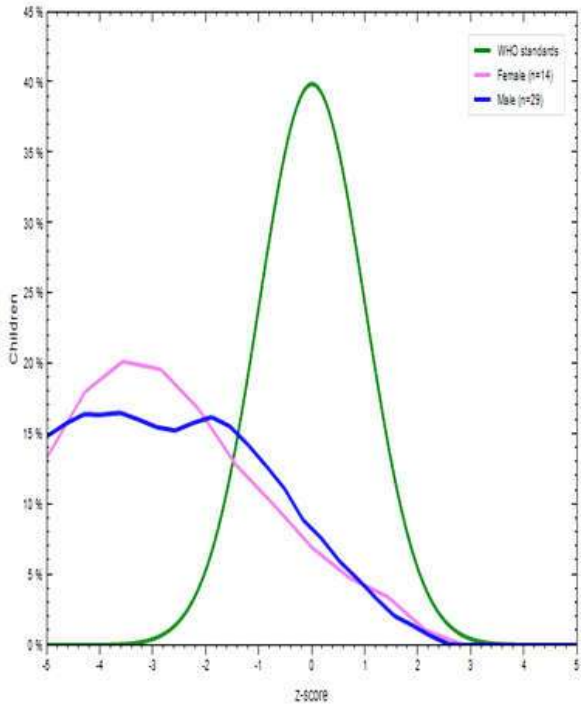



**Fig. 6:** Height for age z score curve according to sex (Before ART) *(original)*

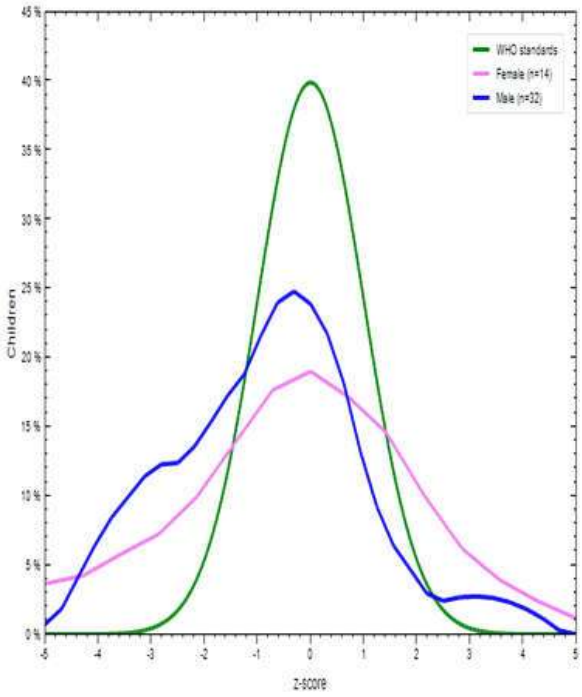



**Fig. 8:** Weight for height z score curve according to sex (Before ART)*(original)*

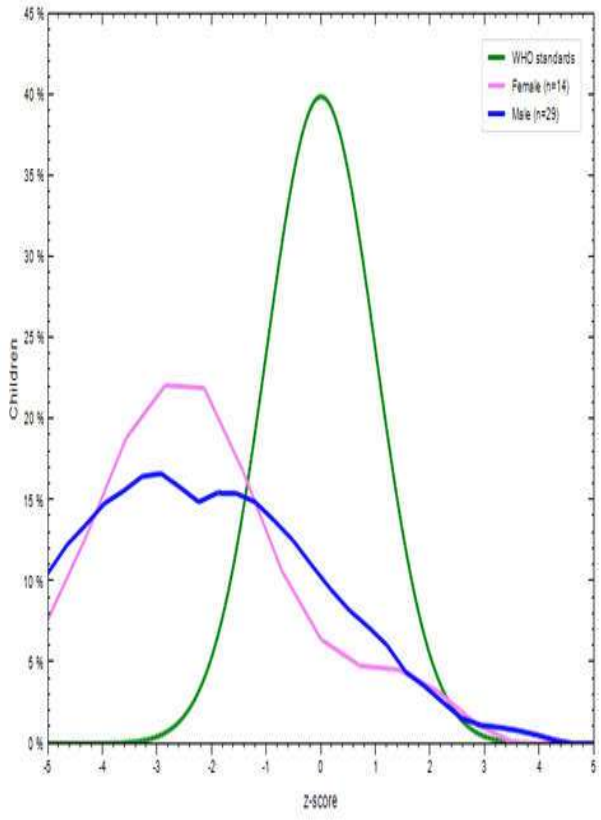



**Fig. 7:** Height for age z score curve according to sex (After ART) *(original)*

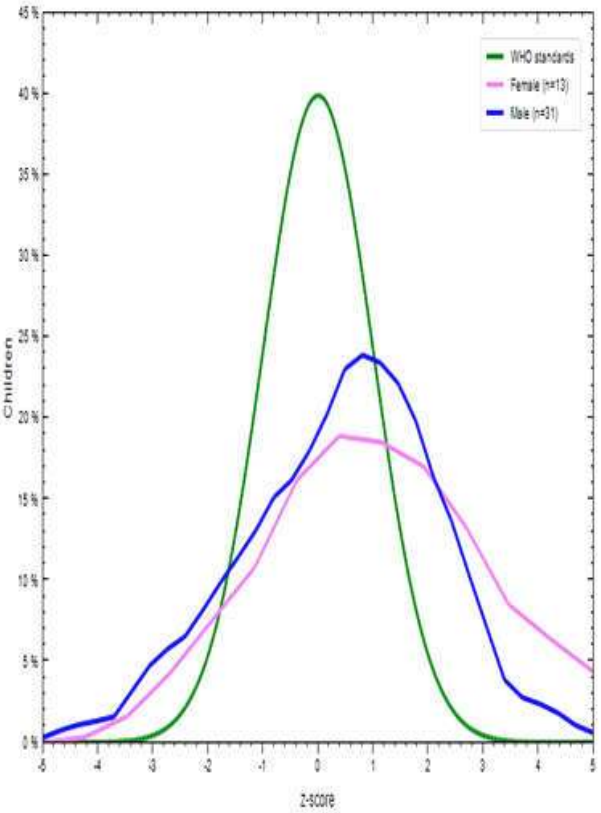



**Fig. 9:** Weight for height z score curve according to sex (After ART) *(original)*

## Discussion

Malnutrition accelerates the progression of HIV/AIDS and chances of acquiring other opportunistic infections by lowering immunity and also causes growth failure i.e short stature or stunting with its permanent psychological and functional consequences [12]. Role of HAART alone in alleviation of malnutrition (measured by anthropometric measurements like weight, height) is not well documented as developed countries follow enteral or parenteral support along with HAART and some studies show contradictory findings [13].

In the present study we found that height and weight of children infected with HIV1 improved after HAART.There was a marked reduction in underweight (WAZ z score -2.25 to -1.0), wasting (WHZ z score -0.66 to +0.61) and stunting (HAZ z score -2.88 to -2.34) and the effect is more marked in children with severe forms of malnutrition as seen by a greater reduction in severe underweight (31.9% to 21.7%), severe wasting (13% to 2.3%) and severe stunting (46.5% to 32.6%). There is also a more marked improvement in weight than height as indicated by a greater reduction in wasting than stunting. We found that height did improve on follow up though not as significantly as weight. This is understandable as in all chronic infections height and weight do not accelerate simultaneously. An increase in weight is followed by an increase in height. Similar results have been seen in Indian studies [14,15,16], resource poor African countries [17] and developed countries with easy accessibility to HAART like USA [18,19].The difference in the increase is probably due to the different durations of follow up. Our study has a short follow up of 1 year while other studies have 6 months to 6 years. Buchacz et al. [20] found a per year gain of 0.13z score in height and 0.05 z score in weight on protease inhibitor based HAART. Why HAART improves the nutritional status can be due to the energy used for immunologically fighting the virus being better utilized for growth after institution of HAART along with lesser number of opportunistic infections and decreased gut infections hence decreased malabsorption.

The change in nutritional status in the present study was not affected by CD4 counts as also seen by Miller TZ et al. [19] in contrast to other studies from India [14,15] and Nepal [21] who found HAART to have a simultaneous effect on CD4 counts and WAZ z scores. Other studies [22,23] found that the children on HAART who were viral responders had significant increases in height and weight while the non-responders did not .We could not do viral load estimation due to economic constraints but CD4 counts did not correlate to nutritional status and did not show short term response to HAART.

We have not studied changes in fat distribution though the percentage of overweight and obese children increased. Adult HIV patients receiving protease inhibitor therapy have described a metabolic syndrome with peripheral insulin resistance, hyperlipidemia, lipodystrophy, truncal obesity. They have not been widely described in children (39% lipodystrophy seen by Guillen et al. [18] but a longer and larger study would be needed to rule it out.

We have not used control of similar children due to ethical reasons but compared the growth parameters before and after HAART. Longer duration studies are needed to conclusively study the effect of HAART on CD4 counts.

## Conclusion

This study strongly supports the institution of HAART at the earliest to all children with HIV/AIDS for its positive effect on nutritional status which in turn is responsible for the growth and immunity of children and lower morbidity and mortality. We also recommend viral load estimation rather than CD4 counts for assessing response to HAART and immunological status as CD4 counts did not show a good correlation in this study. This study also serves to alert health workers to the importance of routine monitoring of nutritional status by anthropometry so that not only malnutrition but also potential metabolic problems which may arise ina small subset of children with HAART suggested by an increase in obese and overweight children may be timely diagnosed and remedial measures may be instituted at the earliest.

## References

1. National AIDS Control Organisation, Ministry of Health and Family Welfare Government of India. NACO press release on HIV estimates 2009.Available at http://naco.gov.in/NACO/.
2. Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE. Global, regional and national causes of child mortality:an updated systematic analysis for 2010 with time trends since 2000. Lancet 2012;379:2151-61.
3. Pandey A, Sahu D,Bakkali T, Reddy DCS, Venkatesh S, Kant S et al. Estimate of HIV prevalence and

number of people living with HIV in India 2008-2009. BMJ Open. 2012;2:e000926. doi:10.1136/bmjopen-2012-0009.

4. Kumar R, Sharma SK. Trends of Communicable and Non-Communicable Morbidities in Uttarakhand state:a systemic review. Indian J Community health 2013;25(2):178-87.
5. Rakholia R, Bano M, Rawat V. Malnutrition among HIV- infected Children by Anthropometric Measures in Poor Outreach Area of a Developing Country and its Relationship with CD4 Counts. Int J Pediatr 2016; 4(4):1643-54.
6. Padmapriyadarsini C, Pooranagangadevi N, Chandrasekaran K, Subramanyan S, Thiruvalluvan C, Bhavani PK et al. Prevalence of underweight and wasting among children infected with Human Immunodeficiency Virus in South India. Int J Pediatr 2009:83;7627.
7. Arpadi S. Growth Failure in HIV infected children. J Acquir Immune DeficSyndr 2000;25 Suppl 1:S37-42.
8. National Pediatric and Family HIV Resource Centre(NPHRC). The health Resources and services Administration (HRSA) and the National Institute of Health(NIH). Guidelines for the use of Antiretroviral agents in Pediatric HIV infection. November 2003. Available at:http://AIDSinfo.nih.gov.
9. Lohman T, Roche AF, Martorell R. Anthropometric standardization reference manual.Champaign, IL: Human Kinetics Books; 1988.
10. World Health Organization. Physical status: the use and interpretation of Anthropometry –report of a WHO expert Committee. Geneva; 1995. (WHO Technical Report Series, 854). Available at http://www.who.int/child growth/publications/physical_status/en/.
11. World Health Organization. Multicentre Growth References Study Group.WHO Child Growth Standards based on length/height, weight and age. ActaPaediatrSuppl 2006;450:76-85.
12. Gillepsie S, Kadiyal S. HIV/AIDS and food nutrition security-From Evidence to action. LSHTM Research Online 2005;24(4):352-357.
13. Nachman SA, Sharon A, Lindsey JC, Moye J, Stanley KE, Johnson GM, Krogstad PA, Andrew A. Growth of Human Immunodeficiency Virus-Infected Children Receiving Highly Active Antiretroviral Therapy. Pediatric Infect Dis Journal. 2005;24(4):352-57.
14. Banerjee T,Pensi T,Banerjee D,Grover G. Impact of HAART on survival,weight gain and resting expenditure in HIV 1infected children in India.Annals Trop Peds.2010;30(1):27-37.
15. Savakar S, Kachrul S.Effect of institution of HAART in correlation with various anthropometric indices in paediatric HIV patients.Medical Journal March 2014; 1(3):110-114.
16. Lodha R,Upadhyay A,Kapor V,Kabra SF.Indian J Pediatr. 2006;73(3):201-204.
17. Ellis J, MolyneuxEM.Experience of anti retroviral treatment for HIV –infected children in Malawi:the 1st 12 months.Annals Trop Pediatr.2013;261-267.
18. Guillen S,Ramos JT,Resino R,Bellon JM,Munoz MA. Impact on Weight and Height with the Use of HAART in HIV Infected Children.PediatricInfec Dis Journal. 2007;26(4):334-338.
19. Miller TL, Mawn BE, Orav EJ, WilkD, WeinbergGA, Nicchitta J et al.The Effect of Protease Inhibitor Therapy on Growth and Body Composition in Human Immunodeficiency Virus Type 1-Infected Children. Pediatrics.2001;107:e77.
20. BuhaczK,Cervia JS, Lindsay JC, Hughes MD, Seageiii GR, Dankner WM, Oleske JM.Impact of protease inhibitor –containing antiretroviral therapies on height and weight growth in HIV infected children. ediatrics; 2001:108(4) for Pediatric AIDS Clinical Trial Group 219 study team.
21. Poudal P, Pokharal R, Chittangia M, Chaudhary S. Profile of HIV infected children:A hospital based study at Eastern Nepal, Asian Pac Trop Dis; 4(3):169-75.
22. Verweel G, Van Rossum AN, Hartwig HJ, de GrootR. Treatment with highly active antiretroviral therapy in human immunodeficiency virus type1-infected children is associated with a sustained effect on growth. Pediatrics. 2002;109(2):E25.
23. N Kumarswamy, Venkatesh KK, Devaleenol B, Poongulali S, Mothi SN, Solomon S. Safety and Effectiveness of generic HAART in NIV infected children in South India. Journal of Trop Pediatr. 2008; 55(3):155-59.