Original Article

Growth and development of children living with human immunodeficiency virus in South India a comparative study

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ABSTRACT

Background: Children living with human immunodeficiency virus (CLHIV) are physically stunted and underweight compared to normal children. **Objective:** The aim of this study was to determine the physical growth (height, weight, and body mass index [BMI]) of children infected with HIV according to age, gender, sociodemographic factors, antiretroviral therapy (ART), and health status and to compare their physical growth with two other groups, i.e., exposed uninfected children and unexposed uninfected children and to determine the extent of growth retardation and the effect of ART on the reversal of growth retardation. **Materials and Methods:** A 3-year study on growth and development of CLHIV was conducted at Action, Service, Hope Foundation, a non-governmental institution working in the field of HIV/AIDS. Three groups of children were compared - 63 CLHIV, 98 exposed uninfected children, and 70 unexposed uninfected children. Their nutritional status in terms of weight for age, height for age, BMI, sexual maturity, hemoglobin, and serum albumin were compared. **Results:** Among CLHIV, 28.1% of children were underweight with Z score of <−2, compared to 12.5% of exposed uninfected children, and 14.3% unexposed uninfected children. Height for age Z scores showed 29.8% were stunted with Z score <−2 among CLHIV, with 16.7% and 11.4% among the exposed uninfected and unexposed uninfected, respectively. Statistically significant difference was also observed in Tanner's sexual maturity with CLHIV showing slower sexual maturation. The incidence of anemia was highest among CLHIV and slightly higher in those on ART. **Conclusions:** This study shows that CLHIV are comparatively more stunted heightwise and have decreased weight for age, delayed sexual maturation, and more significant anemia when compared to exposed uninfected children and unexposed uninfected children. This physical growth retardation is not reversed completely by addition of ART.

Key words: *Anti-retroviral treatment, Children living with human immunodeficiency virus, Development, Growth, Stunted, Underweight*

Human immunodeficiency virus (HIV) positive children are a tragic consequence of the HIV epidemic because they have acquired the infection from their HIV-positive mothers during pregnancy and have not had antiretroviral treatment (ART). It is not just the medical aspects, but their entire psychosocial development and the discrimination they suffer, that adds tremendous poignancy to the tragedy. It is, therefore, important to clarify the extent of the health problems in these children in terms of growth and development, both physical and mental. HIV infection can contribute to disturbances in linear growth and weight gain in the early childhood, often apparent as early as 3 months of age [1]. Published evidence from India is scarce.

A retrospective analysis on anemia and growth failure in HIV-infected children from one study in India states that 55% of HIV positive children were underweight and 46% had stunted growth [2]. Studies from developed countries have also shown a delay in growth and development [1]. Majaliwa et al. have reported that children with perinatal HIV infection may present with clinical features of endocrine dysfunction such as growth failure and pubertal delay [3]. It is likely that provision of ART may reverse the trends of growth failure as demonstrated in one study of Thai children [4]. However, there is a dearth of similar data in the Indian setting. There is little evidence for a difference in the early growth of HIV-exposed but uninfected children compared to healthy controls. Owing to the close association of growth with immune function and clinical progression, an understanding of growth patterns may be important to ensure the provision of appropriate care to HIV-infected and HIV-exposed children. Timely growth monitoring may be used to improve the clinical course and the quality of life of these children [1].

In this prospective study, an adequate sample of children who were infected with HIV was assessed and followed up over a period of 3 years to assess their physical growth, comparing them with an age-sex matched group of children who were exposed to HIV but were not infected. A third group for comparison was children who were HIV negative. The purpose of the study was to identify possible links between HIV infection and growth.

This 3-year study was funded by the Indian Council of Medical Research and conducted at Action, Service, Hope (ASHA for AIDS) Foundation, a Non-Governmental Organization in Bengaluru that has been working in the field of HIV/AIDS since 1998.

MATERIALS AND METHODS

This was a 3-year prospective cohort study of children who were followed up at the ASHA Foundation with a nested case-control study of children living with HIV (CLHIV). This group was designated as Group 1. This group was compared to age - and sex - matched HIV-exposed uninfected children (Group 2) and HIV unexposed uninfected children (Group 3).

The total number of children enrolled for the study was 231 as demonstrated in Fig. 1 Group 1 consisted of HIV-infected children. Of these, Group 1A consisted of children who were on ART while Group 1B consisted of children who were not on ART. The ART was provided by a qualified pediatrician at ASHA Foundation as per National Guidelines. Group 2 consisted of exposed but uninfected children. Exposed, uninfected children are children with either one or both parents infected with HIV. Group 3 consisted of HIV-negative children unexposed to HIV, with both parents HIV negative. The CLHIV of Group 1 were all diagnosed HIV positive based on three positive HIV antibody tests performed on each child as per the national guidelines. The children of Group 2 and Group 3 were tested with a single HIV antibody test which was performed with consent and all these children were HIV negative. Ethical approval was obtained from the Research Advisory Board of ASHA Foundation. An informed consent form was developed and duly signed by a parent/guardian of the child, along with the investigator's and witness's signatures. Only trained research staff obtained informed consent with a necessary explanation to the parent/guardian. A well-validated questionnaire was used to assess the socioeconomic status [5]. These details included a question on prior exposure to tuberculosis.

The nutritional growth and development were assessed as follows: Height and weight were recorded using the standard height scale and digital weighing machine and were analyzed using standard growth charts for height, weight, and body mass index (BMI), for Indian boys and girls as published by the Indian Academy of Pediatrics [6]. The macro add-in devised by Dr. Khadilkar et al. in 2009 was obtained with his consent and used to determine the Z scores and percentiles. The nutritional parameters were measured at baseline and every 6 months for Group 1, at baseline and at 1 year for Group 2 and at baseline for Group 3. Sexual development was assessed using the Tanner's Sexual Maturity Rating Scale [7]. The parameters were assessed at baseline and at 1st and 2nd year for Group 1, at baseline and at 1 year for Group 2 and at baseline for Group 3.

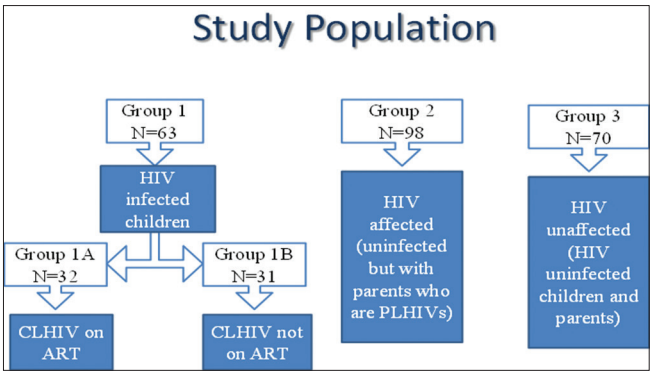

Figure 1: The distribution of the children among the three groups

Laboratory tests included estimation of hemoglobin, and total protein and serum albumin, to assess malnutrition, which can be an independent negative factor, although linked to HIV in our study children. Since anemia was a common feature of CLHIV, due to malnutrition, infection, infestation, stage of HIV/immunodeficiency, inflammation [2,8-11] and/or due to the use of zidovudine, annual hemograms were performed for CLHIV only. The other children had baseline hemoglobin estimation. The hemoglobin levels were classified using the table in the WHO manual on diagnosis and assessment of anemia [12] in children. As hypergammaglobulinemia was known to occur in CLHIV [13] which caused an increase in total protein, serum albumin was estimated to compare the groups for their nutritional status.

All details regarding inter-current infections, including respiratory and gastrointestinal, were collected at baseline and every 6 months in Group 1, at baseline and at 1 year in Group 2 and at baseline in Group 3. All data were collected on paper clinical pro forma, checked, and entered by research coordinator into the database on Microsoft Excel sheets, on an ongoing basis.

On completion of enrollment and follow-up, data were analyzed using SPSS 15.0, Microsoft Excel, and SAS 9.2. Descriptive data were summarized and compared between Groups 1, 2, and 3; and also between Group 1A, 1B, 2 and 3. All tests were two-sided, and the p value for main effect was set at 0.05 and in the case of multiple comparisons adjusted using the Bonferroni correction; and the p value for interaction was set at 0.10. Evaluation of the shape of the distribution to check for "normality" was conducted and appropriate non-parametric tests were applied when the distribution was not Gaussian. Comparison between groups was performed using the Student's t-test or ANOVA for unpaired data, paired t-test for paired data, the Fisher's exact test, or a Chi-square contingency analysis where appropriate. Stratified data analysis was performed based on baseline characteristics such as age, gender, and BMI. Microsoft Word and Excel was used to generate graphs, tables, etc. Descriptive and inferential statistical analysis was performed in this study. Results on continuous measurements were presented by mean±standard deviation, and results on categorical measurements were presented in number (%). Significance was assessed at 5% level of significance. The frequency intervals and type of data variables collected during the study period are depicted in Table 1.

RESULTS

The total number of children enrolled for the study was 231 as demonstrated in Fig. 1 Group 1 consisted of 63 HIV-infected

Table 1: The frequency intervals and type of data variables collected during the study period

Variables studied	CLHIV (n=63)		Age-sex matched HIV exposed uninfected controls (n=98)	Age-sex matched HIV unexposed uninfected controls (n=70)
	On ART (n=32)	Not on ART (n=31)		
Nutritional parameters				
Height, weight, BMI	Semiannual	Semiannual	Baseline and annual	Baseline
Tanner's sexual maturity rating scale	Baseline, second and fourth semiannual	Baseline, second and fourth semiannual	Baseline and annual	Baseline
Laboratory tests				
Total protein and albumin, hemoglobin, total lymphocyte count	Baseline	Baseline	Baseline	Baseline
HIV disease characteristics				
CD4+T cell count	Semiannual	Semiannual	X	X
Chest X-ray	Baseline and as needed	Baseline and as needed	Baseline	Baseline
WHO HIV staging; development of new OIs[a], malignancies	Semiannual	Semiannual	X	X
Clinical immune status				
All infections in past 6 months, number of respiratory infections in past 6 months, number of gastrointestinal infections in past 6 months	Semiannual	Semiannual	Baseline and annual	Baseline

OIs: Opportunistic infections, CLHIV: Children living with human immunodeficiency virus, BMI: Body mass index

children. Of these, 32 were on ART and designated as Group 1A, and 31 were not on ART (1B). Group 2 consisted of 98 exposed but uninfected children while Group 3 consisted of 70 unexposed, HIV negative children. There was no death among the children during the study period. In Group 1A, three children missed one follow-up visit out of five. In Group 1B, five children were lost to follow-up and were not included in the final analysis. Three children missed one follow-up visit. One child from Group 2 was lost to follow-up. All demographic details are summarized in Table 2.

There was no statistically significant difference between ages, gender, schooling, religion, and socioeconomic status among the three groups. Statistically significant difference was noted in prior exposure to tuberculosis, and parents alive/dead between Group 1 and Group 3. Statistically significant difference was demonstrated between Group 1 and Group 2 regarding mothers alive/dead, (33.3% vs. 7.1%) and Group 1 and Group 3 (33.3% vs. 2.9%). More number of children lost their fathers in Groups 1 and 2 when compared to Group 3 (49.2%, 41.8%, and 2.9%). This was expected as the fathers were HIV positive. As demonstrated in Table 2, Groups 1 and 2 had 62% and 59.2 % of children exposed to TB as compared to 15.7% in Group 3.

Fig. 2 and Table 3 revealed that according to weight for age Z scores, 28.1% of children were underweight (Z score <−2) among Group 1, 12.5% among Group 2, and 14.3% among Group 3. Difference between Groups 1 and 2 demonstrated statistical significance (p=0.016). The serial weight for age means Z scores for the children in Group 1 had not demonstrated a significant difference between the five measurements and the mean Z scores were −1.38, −1.32, −1.28, −1.32, and −1.32. This was confirmed by the Friedman test (p=0.405). Comparison with the baseline and second semiannual values for Group 2 revealed that Group 1 children did more poorly with no recovery in weight gain.

For height for age Z scores, 29.8% were stunted (Z score <−2) among Group 1, 16.7% among Group 2, and 11.4% among Group 3. Between Groups 1 and 3, there was statistical significance (p=0.010). There was no significant difference between CLHIV in Group 1A and Group 1B, with regard to weight for age or height for age Z scores. The serial height for age mean Z scores for the children in Group 1 revealed no significant difference between the five measurements, and the mean Z scores were −1.41, −1.41, −1.37, −1.38, and −1.42 (Friedman test p=0.365). Comparison with the baseline and second semiannual values in Group 2 again revealed no gain in height in the infected children to catch up with Group 2. BMI Z scores demonstrated no difference statistically between the three groups.

As demonstrated in Table 4, statistically significant difference was seen in Tanners Sexual Maturity Scale between Groups 1 and 3, and between Groups 1 and 2 at baseline. The Tanners Scale showed only 69.8% children with appropriate sexual maturity in Group 1, compared to 94.9% and 90% in Group 2 and 3, respectively. There was a significant difference (p<0.001) at baseline. 1 year later, 89.7% of the children in Group 1 had appropriate sexual maturity compared to 97.9% in Group 2, and the p value was no longer as significant changing from <0.001 to 0.011 during the same period.

Analysis of serum albumin demonstrated that all the three groups had normal albumin levels (Group 1 - 4.20 g/dl±0.32 vs. Group 2 - 4.24 g/dl±0.36 vs. Group 3 - 4.39 g/dl±0.17). However, the mean serum albumin was lowest in Group 1, and highest in Group 3. The difference between the Groups was significant

Table 2: Summary of demographic details of the three groups

Variable	n (%)			p value; Chi-square between Group 1 and Group 2	p value; Chi-square between Group 1 and Group 3
	Group 1 (n=63, unless otherwise noted)	Group 2 (n=98, unless otherwise noted)	Group 3 (n=70, unless otherwise noted)		
Age					
<5	1 (1.6)	10 (10.2)	1 (1.4)	χ^2=4.87; p=0.181	χ^2=1.83; p=0.609
5-10	27 (42.9)	38 (38.8)	38 (54.3)		
11-15	26 (41.3)	34 (34.7)	24 (34.3)		
>15	9 (14.3)	16 (16.3)	7 (10.0)		
Gender					
Males	34 (54)	42 (42.9)	35 (50.0)	χ^2=1.90; p=0.168	χ^2=0.209; p=0.647
Females	29 (46)	56 (57.1)	35 (50.0)		
Schooling					
Current	63 (100)	96 (98.0)	70 (100)	1.000	1.000
Discontinued	0	1 (1.0)	0	(Fisher exact test)	(Fisher exact test)
None	0	1 (1.0)	0		
Languages					
Kannada	25 (39.7)	37 (37.8)	9 (12.9)	0.397	<0.001[a]
Tamil	14 (22.2)	31 (31.6)	31 (44.3)	(Fisher exact test)	(Fisher exact test)
Telugu	20 (31.7)	23 (23.5)	8 (11.4)		
Hindi	0	0	7 (10)		
English	1 (1.6)	0	0		
Others	3 (4.8)	7 (7.1)	15 (21.4)		
Religion				p value (Group 1 and 2)	p value (Group 1 and 3)
Hindu	50 (79.4)	68 (69.4)	48 (68.6)	0.265	0.132
Muslim	0	1 (1.0)	4 (5.7)	(Fisher exact test)	(Fisher exact test)
Christian	13 (20.6)	29 (29.6)	18 (25.7)		
Locality					
Rural	20 (31.7)	27 (27.6)	0	χ^2=0.326; p=0.568	χ^2=26.20; p<0.001[a]
Urban	43 (68.3)	71 (72.4)	70 (100)		
Mother's occupation					
Dead	21 (33.3)	7 (7.1)	2 (2.9)	<0.001[a]	<0.001[a]
Housewife	17 (27.0)	33 (33.7)	30 (42.9)	(Fisher exact test)	(Fisher exact test)
Unskilled	8 (12.7)	35 (35.7)	29 (41.4)		
Skilled	13 (20.6)	20 (20.4)	9 (12.9)		
Blue collar	3 (4.8)	3 (3.1)	0		
Unknown	1 (1.6)	0	0		
Father's occupation					
Dead	31 (49.2)	41 (41.8)	2 (2.9)	0.440	<0.001[a]
Unemployed	0	4 (4.1)	0	(Fisher exact test)	(Fisher exact test)
Unskilled	11 (17.5)	17 (17.3)	37 (52.9)		
Skilled	18 (28.6)	32 (32.7)	28 (40)		
Blue collar	0	2 (2.0)	0		
Professional	2 (3.2)	1 (1.0)	0		
Others	0	0	0		
Unknown	1 (1.6)	1 (1.0)	3 (4.3)		
Average monthly income					
In a care home	1 (1.6)	0	0	0.325	0.006[a]
INR<1,000	1 (1.6)	2 (2.0)	0	(Fisher exact test)	(Fisher exact test)
INR 1,000-5,000	32 (51.8)	42 (42.9)	43 (61.4)		

(*Contd...*)

Table 2: (*Continued*)

Variable	n (%)			p value; Chi-square between Group 1 and Group 2	p value; Chi-square between Group 1 and Group 3
	Group 1 (n=63, unless otherwise noted)	Group 2 (n=98, unless otherwise noted)	Group 3 (n=70, unless otherwise noted)		
INR 5,000-10,000	19 (30.2)	42 (42.9)	27 (38.6)		
INR 10,000-25,000	6(9.5)	7 (7.1)	0		
INR 25,000-50,000	2 (3.2)	0	0		
Unknown	2 (3.2)	5 (5.1)	0		
Prior exposure to TB				p value (Group 1 and 2)	p value (Group 1 and 3)
Yes	39 (62.0)	58 (59.2)	11 (15.7)	0.614	<0.001[a]
No	23 (36.5)	35 (35.7)	59 (84.3)	(Fisher exact test)	(Fisher exact test)
Unknown	1 (1.6)	5 (5.1)	0		
Socioeconomic status	n=55 (%)	n=52 (%)	n=37 (%)	p value	p value
Upper middle class	6 (10.9)	6 (11.5)	1 (2.7)	χ^2=0.0392; p=0.981	χ^2=4.06; p=0.131
Lower middle class	38 (69.1)	35 (67.3)	23 (62.2)		
Poor	11 (20.0)	11 (21.2)	13 (35.1)		
Type of delivery	n=58 (%)	n=97 (%)	n=70(%)		
Normal	47 (81.0)	64 (66.0)	65 (92.9)	χ^2=8.15; p=0.004	χ^2=1.28; p=0.257
Forceps	0	1 (1.0)	2 (2.9)		
Cesarean	5 (8.6%)	28 (28.9)	3 (4.3)		
Unknown	6 (10.3%)	4 (4.1)	0		
Immunization summary					
Fully immunized	15 (23.8)	22 (22.4)	15 (21.4)	0.806	0.039[a]
Partially immunized	43 (68.3)	68 (69.4)	53 (75.7)	(Fisher exact test)	(Fisher exact test)
Not immunized	0	2 (2.0)	2 (2.9)		
Unknown	5 (7.9)	6 (6.1)	0		
Parents dead/alive					
Mothers dead	21 (33.3)	7 (7.1)	2 (2.9)	χ^2=18.80; p<0.001[a]	χ^2=22.00; p<0.00[a]
Mothers alive	41 (65.1)	91 (92.9)	68 (97.1)		
Unknown for both parents	1 (1.6)	0	0		
Fathers dead	31 (49.2)	41 (41.8)	2 (2.9)	χ^2=1.02; p=0.312	χ^2=39.00; p<0.00[a]
Fathers alive	31 (49.2)	57 (58.2)	68 (97.1)		

[a]**Significant difference in findings between the groups. TB: Tuberculosis**

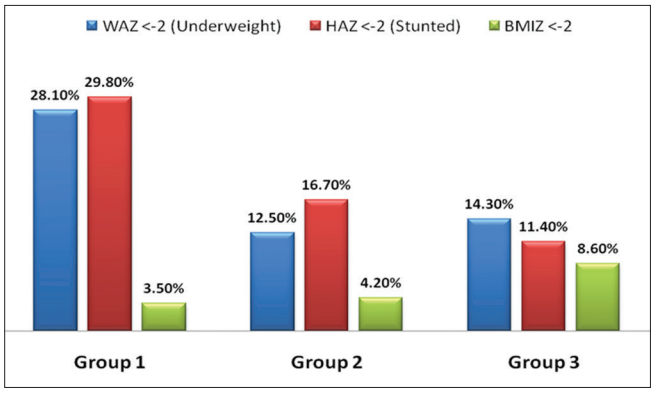

Figure 2: Anthropometric measurements showing stunted and underweight children in all three groups

(p=0.001). The difference between Group 1B (4.10±0.31) and 3 was the most significant (p≤0.001).

Anemia was highest in Group 1. On further sub-analysis, anemia was highest in Group 1A, being 38.7%; 35.8% in Group 1B, 28.8% in Group 2, and 14.3 % in Group 3. Significant difference was seen between Group 1A and Group 3 (χ^2=9.06, p=0.028) and severe anemia was highest in Group 1A. Zidovudine-based ART regimen was associated with 1.7 times more anemia. There were mixed causes for anemia in our study with macrocytic, microcytic, and normocytic anemia in equal proportion.

The incidence of infections calculated per person-year of follow-up was 92.9% in Group 1A, 109.1% in Group 1B, 93.8% in Group 2, and 137.1% in Group 3. This was lower than expected in Group 1A and 1B because the children were on prophylactic cotrimoxazole. The majority of infections which occurred in Groups 1A and 1B were severe in nature, such as herpes zoster, chickenpox, fungal infection, perianal abscess, pyoderma, and hepatitis, whereas the infections in Group 3 were mild upper respiratory infections which were counted and reported by the parents. Also for the children in Groups 1A and 1B the infections were documented by the pediatrician, whereas for children in Groups 2 and 3 it was the parents who provided the input regarding infections.

Table 3: Distribution of anthropometric measurement Z scores

Anthropometric measurements	Group 1 (n=57) (%)	Group 2 (n=96) (%)	Group 3 (n=70) (%)	p value Chi-square test between Group 1 and 2	p value Chi-square between Group 1 and 3
WAZ					
<−2 (underweight)	16 (28.1)	12 (12.5)	10 (14.3)	χ^2=5.80 p=0.016[a]	χ^2=3.67 p=0.056
>−2	41 (71.9)	84 (87.5)	60 (85.7)		
HAZ					
<−2 (stunted)	17 (29.8)	16 (16.7)	8 (11.4)	χ^2=3.66 p=0.056	χ^2=6.72 p=0.010[a]
>−2	40 (70.2)	80 (83.3)	62 (88.6)		
BMIZ					
<−2	2 (3.5)	4 (4.2)	6 (8.6)	Pierson χ^2 between groups - χ^2=2.070, p=0.355	
>−2	55 (96.5)	92 (95.8)	64 (91.4)		

[a]Significant difference in findings between the groups. BMI: Body mass index

Table 4: The tanners sexual maturity staging at baseline and at one year for the three groups

Tanners sexual maturity staging – Baseline	N=63 (%)	N=98 (%)	N=70 (%)	p value Between Group 1 & 3	p value Between Group 1 & 2
Appropriate	44 (69.8)	93 (94.9)	63 (90.0)	<0.001[a] Fisher exact test	<0.001[a] Fisher exact test
Less than appropriate	18 (28.6)	3 (3.1)	3 (4.3)		
More than appropriate	1 (1.6)	2 (2.0)	4 (5.7)		
Tanners sexual maturity staging at one year	**N=58 (%)**	**N=97 (%)**	**N (%)**	**p value**	**p value**
Appropriate	52 (89.7)	95 (97.9)	-	0.011[a] Fisher exact test	-
Less than appropriate	6 (10.3)	1 (1.0)	-		
More than appropriate	0	1 (1.0)			

[a]Significant difference in findings between the group

DISCUSSION

The data available from the Isanaka study reveal that HIV infection had long-lasting effects on both height and weight throughout infancy and childhood [1]. It was a review of 32 articles published on post natal growth in HIV-infected children both in developed (USA, Western Europe) and underdeveloped countries (Sub-Saharan Africa). This occurred in spite of access to supplemental feeding and ART in developed countries. The differences in weight for age and height for age became obvious at the same time. In our study also, a significant number of CLHIV were underweight and stunted, which did not improve over time, with or without ART. More than a quarter children in Group 1 were underweight and it was significantly more than those in Group 2. Similarly, almost double the children (28.1%) in Group 1 are underweight than in Group 3 (14.3%); however, this was not statistically significant. This could be because the numbers of children in the study were small. There was no significant difference between Group 2 and Group 3.

With regard to height for age, almost 30% of children in Group 1 were stunted, and this was significantly more than in those in Group 3. All 10 studies from less developed countries, which were mostly in Sub-Saharan Africa, reported significantly lower weight for age in CLHIV than in exposed uninfected children [1]. In the five serial measurements of height in this group also, the decrease in height for age persisted. Possible mechanisms for this concomitant occurrence include HIV-related disturbances to energy balance, gastrointestinal disturbance and malabsorption, and neuroendocrine changes [1].

Grinspoon et al. [14] reported that this deficient physical development was probably due to a number of factors such as inadequate intake, malabsorptive disorders, metabolic alterations, hypogonadism, and excessive cytokine production. The increased metabolism in CLHIV required 10% more to maintain growth in asymptomatic CLHIV and 20-30% more in symptomatic CLHIV [14]. When CLHIV show weight loss, the energy requirement may increase by further 50-100% over established requirements for otherwise healthy uninfected children [15]. Poverty and ill health prevent parents from earning and providing food and nutrition for their children and this increased nutritional need widens the gap between the nutritional needs of CLHIV and the nutrition provided by their parents.

The BMI is lower in HIV-infected children compared to those in Group 2; though, it was not statistically significant. This was similar to findings in another study which demonstrated that HIV-infected infants revealed a trend toward lower values in

BMI and that this could be evident at birth itself [16]. Physical underdevelopment in children was not just in terms of height and weight but also in sexual development especially with regard to secondary sexual characteristics. According to Isanaka et al. [1], evaluation of the effect of HIV infection on adolescent growth and development should also remain a research priority. Advances in the management of HIV meant that many perinatally infected children reached adolescence. To date, only a small number of studies have examined the effect of HIV on adolescent growth and pubertal development.

This study also revealed that CLHIV had delayed onset of sexual maturity at baseline but made up over time. Only 69.8% of the CLHIV had appropriate sexual maturity for age and this had risen to 89.7% after 1 year suggesting that sexual maturity was delayed but eventually reached for the most children. A large study for the International Maternal Pediatric and Adolescent AIDS Clinical Trials P219/219C Study and the Pediatric HIV/AIDS Cohort Study done on 2086 youth comparing CLHIV with HIV-exposed but uninfected children demonstrated that there was pubertal delay in the infected group by about 4-13 months and this pubertal delay was reduced by giving ART [17]. One study referred to children being affected psychologically because their height, weight, and secondary sexual characteristics were not as well developed as in their peer [18].

With regard to albumin levels, CLHIV not yet on ART had the lowest mean serum albumin compared to exposed children and unexposed uninfected children. The mean serum albumin level was within normal limits in all three groups. However, the highest mean was seen in Group 3 and the lowest in Group 1. On comparing Groups 1A, 1B, 2 and 3, it was found that Group 1B had the lowest level. It is probable that this was because children who were HIV positive and not on ART were not given priority to receive high-protein diet at home, like those who were known to be HIV positive and receiving ART.

Malnutrition has a multifactorial contribution. Even exposed children compared with unexposed children in Zambia [19] had lower anthropometry pointing to other socioeconomic factors in families of persons living with HIV. This was also seen in our study, in which a lower serum albumin is noted among the exposed children compared to the unexposed. Families living with HIV have multiple financial needs, poor health-seeking behavior, and increased metabolic demands due to HIV, intercurrent illness, and possibly some alterations in metabolic and endocrine function. These alterations in metabolic and endocrine function may be due to the primary infection itself or due to the medication. Reducing the viral load in these patients helps in improvement of the anthropometric indices [20]. The intense dietary counseling, drug subsidies and dry ration handouts received by those at risk help them, as the study in Tanzania shows where supply of ready-to-use foods was made available [21].

The hemoglobin levels were lowest in CLHIV on ART (Group 1A). The etiology of anemia in CLHIV was varied and included iron deficiency, anemia of inflammation, vitamin B deficiency, ART itself, a decrease in red cell precursors in bone marrow, associated hookworm infestation; and thalassemia/thalassemia trait and falciparum malaria in other regions of Asia [2,7-10]. Some of the pathophysiology was still not understood well [9]. Grinspoon et al. [14] identified certain criteria to define growth failure in CLHIV. Similar criteria are needed to establish Indian guidelines for monitoring physical growth, intellectual growth, emotional growth, and sexual maturity to identify those children who need additional counseling; micronutrients combined with earlier ART [8] and other nutritional supplements to prevent their developmental retardation.

CONCLUSION

This study shows that CLHIV are comparatively more stunted and have decreased weight for age, delayed sexual maturation, and more significant anemia when compared to exposed uninfected children and unexposed uninfected children. This physical growth retardation is not reversed completely by addition of ART.

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