



# A STATISTICAL ANALYSIS ON THE GROWTH AND DEVELOPMENT OF HIV POSITIVE CHILDREN

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## ABSTRACT

*The threat of HIV/AIDS is one of the major menace that mankind is facing today, with HIV/AIDS having made a huge global impact permeate the social, cultural and economic fabric of all nations of the world. Antiretroviral treatment (ART) reduces both mortality and morbidity of HIV infection. The current study focuses on the analysis of the growth pattern of a control group of 35 HIV infected children. Semi longitudinal data on height and weight for a period of 96 weeks of 35 HIV infected children of the age group 4 to 17 years for 96 weeks was collected. A control group of 20 children were also brought under study. Among boys 2.9% has BMI between 12–14 indicating starvation and 2.9% between 18–20 which is normal while 22.9% has BMI in the range 15–17 indicating underweight whereas among girls 8.5% has BMI between 12–14 indicating starvation and 14.3% between 18–20 which is normal while 42.9% has BMI in the range 15–17 indicating underweight. Clinical data and laboratory results show that 68.5% of them are healthy while the remaining suffers from problems like anemia, enlarged liver, bronchitis, scabies, skin fungus and TB. Z test elucidates that average BMI of the non infected children is significantly greater*

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*than that of infected children though both the groups are from the same socio-economic background. Children treated with ART shows significant improvement in their CD4 count. Analyzing the anthropometric data and clinical reports it is clear that the infection plays a crucial role in decelerating the growth the infected children. However treatment with ART gives them a better immunity than otherwise.*

**Key words:** *HIV, Human immunodeficiency virus; Acquired Immunodeficiency Syndrome; CD4; antiretroviral therapy; anthropometry; body mass index.*

## 1. Introduction

The threat of HIV/AIDS is one of the major menace that mankind is facing today, with HIV/AIDS having made a huge global impact permeating the social, cultural and economic fabric of all nations of the world. Acquired immune deficiency syndrome or acquired immunodeficiency syndrome (AIDS) is a set of symptoms and infections resulting from the damage to the human immune system. Acquired means you can get infected with it; Immune Deficiency means a weakness in the body's system that fights diseases. Syndrome means a group of health problems that make up a disease. AIDS is caused by the human immunodeficiency virus (HIV). This condition progressively reduces the effectiveness of the immune system and leaves the individual susceptible to opportunistic infections and tumors. HIV is transmitted through direct contact of a mucos membrane or the bloodstream with a bodily fluid containing HIV, such as blood, semen, vaginal fluid, preseminal fluid, and breast milk. This transmission can involve anal, vaginal or oral sex, blood transfusion, contaminated hypodermic needles, exchange between mother and baby during pregnancy, child birth, or breastfeeding, or other exposure to one of the above bodily fluids.

As the HIV infection spreads in India, increasing number of children are affected. Among the infections the most pandemic is HIV (Human Immunodeficiency Virus) infection which is the precursor of AIDS (Acquired Immunodeficiency Syndrome). This infection is fatal because once infected it is life-long causing innumerable illnesses or possibly retardation of their growth and development. Although treatment for AIDS and HIV infection can slow down the course of the disease there is currently no cure or vaccine. Antiretroviral treatment (ART) reduces both mortality and morbidity of HIV infection. Despite these advances, millions of children are born with the virus, and their well-being can be affected through biological and social factors, especially when they become orphans.

Growth patterns as determined from height, weight, and other anthropometric measurements reflect the nutritional status of a population's health when compared with other references [1]. Anthropometric measurements provide an excellent indication of the nutritional status of vulnerable groups and individuals [2]. The NHMRC now recommends that the BMI can be used as a reasonable, easily determined surrogate measure for adiposity for children over the age of 2 years [3]. BMI is calculated using weight and height measurements, then used to compare a child's weight relative to height with other children of the same age and gender, using the BMI percentile charts. The following equation can be used to determine BMI:  $BMI = \text{Weight (kg)} / \text{Height (m)}^2$ .

The absolute CD4 count is a measurement of how many functional CD4 T-cells is circulating in the blood. The lower the absolute CD4 count, the weaker the immune system. CD4 percentage represents the percentage of total lymphocytes that are CD4 cells. Typically, HIV-negative people will have a CD4 percentage of about 40 percent, while HIV-infected people's CD4 percentage can be as low as 25 percent or less. The CD4 count and CD4 percentage give a snapshot of the health of your immune system. The immune system needs CD4 cells to function properly. However HIV+children maintained on ART and good nutrition may grow up healthy comparable to normal children. Data on confirming to these facts are scarce.

In the present study we discuss in detail the use of statistical techniques in analyzing the study of HIV infected children. The objectives of the study are 1) To analyze the semi longitudinal data of weights of the children. 2) To compare the growth of the infected children with normal children.

## 2. Materials and Methods

Semi longitudinal data on the weights of the children for the past 2 years was collected as secondary data from their records. CD4 counts of these children were also taken down from each child's medical report which the home maintains and updates each time the child is taken for checkup. A control group of 20 children were brought under study. Anthropometric data of this control group were collected. Information about the children's growth before enrollment in study was retrieved from the medical records that the institution maintains. Weights and heights of each of the normal child of the control group were also measured using standardized weight and height measuring instruments. The data about age was recorded from the record maintained by the institution. A proforma was filled up by the investigator by personal interview with each child, who gives details regarding their family background, general behaviour and health conditions - like how often they fell sick etc.

### 3. Result and Discussion

The children are taken every month for their monthly check up and monitoring CD4 count. A control group of 20 children who are not infected with HIV from the same socio-economic background was brought under study. They are of the age group 5–15. These children are provided with nutritious food and healthy and hygienic conditions. The investigator has collected data on their age and the anthropometric measures (height and weight). This data is used to make a comparative study of the growth of the HIV infected children with normal children. The study is conducted on 35 children of the age group 4 to 17 years who are infected with HIV. 10 (28.6%) of the group are males and 25 (71.4%) females. 24 of them (68.6%) fall in the age group 4-9 years and 11 (31.4%) fall in the age group 10-17 years. The distribution is shown below in Table 1 and Figure 1 and the anthropometric data collected is given Table 2 and Figure 2

Table1. Data on the distribution of HIV infected children

Age (years)	Male	Female	Total
	%	%	%
4 to 10	28.57	40	68.6
10 to 17	0	31.4	31.4
Total	28.57	71.4	100

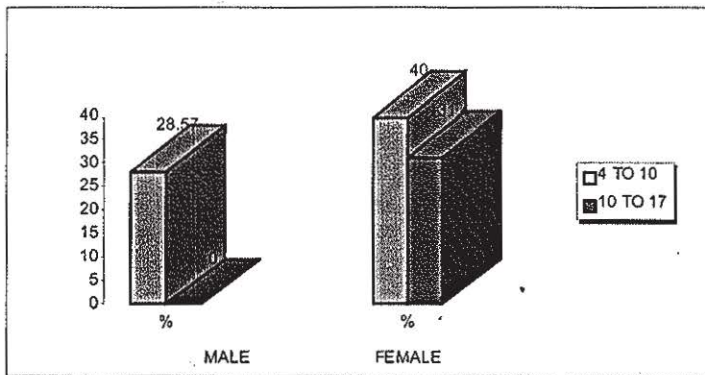
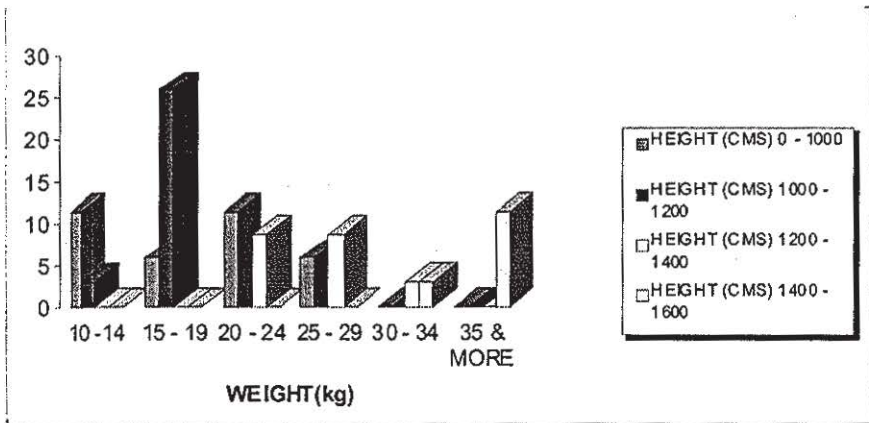


Figure1. Multiple Bar Chart Showing the Percentage of Boys and Girls

**Table 2. Distribution of height and weight of infected children**

Weight	Height (Cms)				
Kilogram	0 – 1000	1000 – 1200	1200 - 1400	1400 - 1600	TOTAL
	%	%	%	%	%
10 –15	11.4	2.9	0	0	14.3
15 –20	5.7	25.7	0	0	31.4
20 –25	11.4	2.9	8.6	0	22.9
25 –30	5.7	0	8.6	0	14.3
30 –35	0	0	2.9	2.9	5.8
35 & More	0	0	0	11.4	11.4
Total	34.2	31.5	20.1	14.3	100



**Figure 2. Multiple Bar Diagram of Percentage of Children classified based on height and weight**

BMI a useful tool to estimate a healthy body weight based on how tall a person is. It is the most widely used diagnostic tool to identify weight problem within a population including underweight, overweight and obesity. Less than 14.9 indicates starvation, from 15 to 18.4 indicates underweight, from 18.5 to 22.9 indicates normal and from 23 to 27.5 indicates overweight. For the sample under study, among boys 1 (2.9%) has BMI between 12–14 indicating starvation and 1 between 18–20 which is normal while 8 (22.9%) has BMI in the range 15–17 indicating underweight.

Among girls 3 (8.5%) has BMI between 12–14 indicating starvation and 5 (14.3%) between 18–20 which is normal while 15 (42.9%) has BMI in the range 15–17 indicating underweight.

Table 3. Distribution of BMI of boys

BMI	12–15	15–18	18–20
Age	%	%	%
4–9 years	2.9	22.9	2.9

Table 4. Distribution of BMI of girls

BMI	12–15	15–18	18–20
Age (Years)	%	%	%
4–10	2.9	34.3	2.9
10–17	5.7	8.6	11.4

The Figure 3 shows that among girls of the age group 4–10 years majority (34.3%) are underweight while among the age group 10–17 years majority are normal.

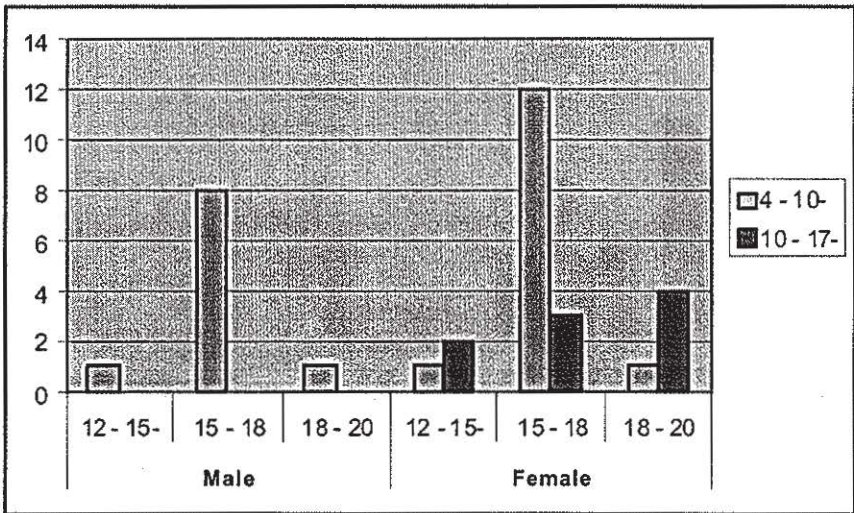


Figure 3. Multiple bar diagram of BMI corresponding to age, sex and number of children

HIV infected children often suffer many kinds of ill health. More information about their general health, whether they fall sick very often etc were collected through the proforma. The results showed that (Table 5) 68.5% are healthy whereas 31.5% suffer from various health problems. General problems which trouble them are – stomach infection/upset, enlarged liver bronchitis, anemia, skin problems etc.

Table. 5

Permanent health problems	% of children
Anaemic	2.9
Enlarged liver	5.7
Bronchitis	2.9
Scabies	8.5
Skin fungus	2.9
TB	5.7
Mosquito allergy	2.9
Healthy	68.5

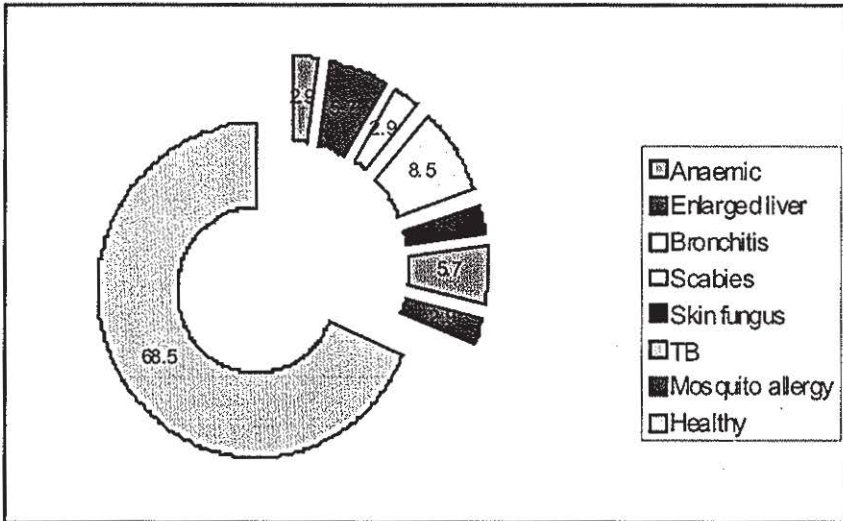


Figure 4. Dough nut explosion chart depicting various health issues of the infected children

The dough nut explosion chart (Figure 4) says that majority (68.5%) of them lead a healthy life though they are infected. This indicates the effect of proper treatment, care and healthy environment.

The semi longitudinal data on CD4 count of these children in the past 1 year is as follows.

Table 6

CD4count	% of children in I quarter	% of children in II quarter	% of children in III quarter	% of children in IV quarter
< 200	5.7	8.6	11.4	11.4
200-499	14.3	22.9	17.1	22.9
500-799	42.8	40	28.5	28.5
800 or more	37.1	28.5	37.1	37.1

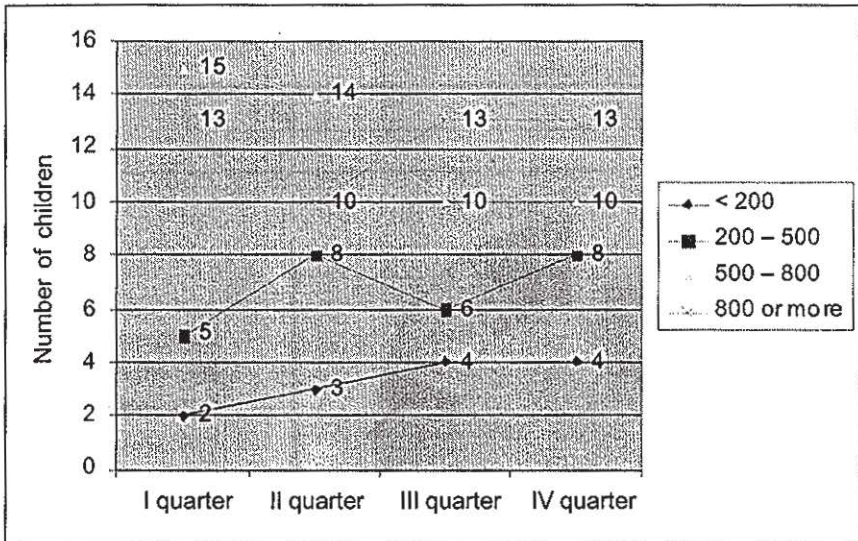


Figure 5. Line graph of the semi longitudinal data on CD4 count of the infected children treated with ART.

Line graphs showing the improvement of CD4 count of the children over an year's time. We can find a significant improvement in the number of children whose CD4 has gone above 800 which are quite promising.

The semi longitudinal data on height and weight were fitted by SPSS. The coefficient of determination,  $R^2$  is used in the context of statistical models whose main purpose is the prediction of future outcomes on the basis of other related information. It is the proportion of variability in a data set that is accounted for by the statistical model. It provides a measure of how well future outcomes are likely to be predicted by the model.



The growth curve fit or the exponential curve fit of weight by age of the whole group gave the following diagram and the analysis (Figure 6).

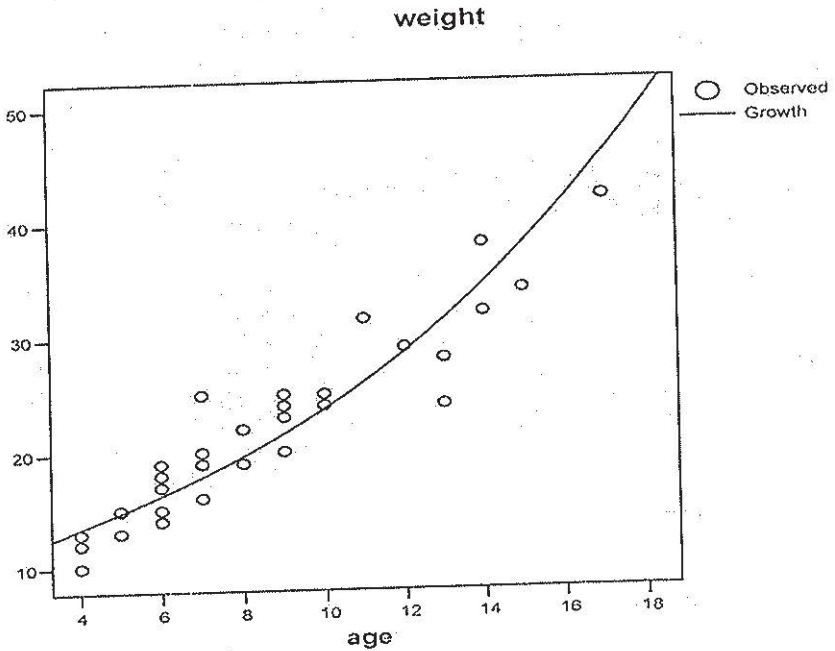


Figure 6. Exponential curve fit of weight-age

Multiple R: 0.92561

R Square: 0.85675

Standard error: 0.13423

The power curve fit of height by age of the whole group gave the following diagram and the analysis (Figure 7).

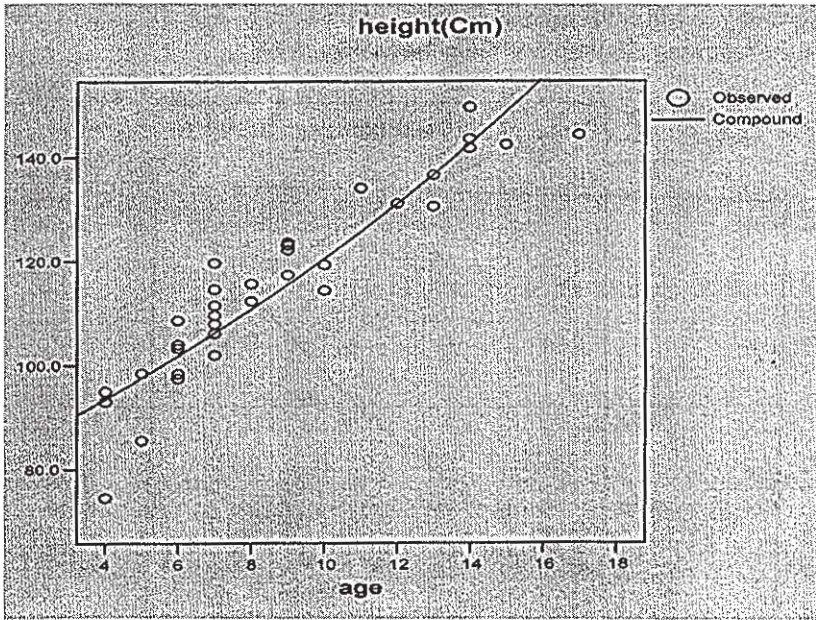


Figure 7. Power curve fit of Height-age

Multiple R: 0.93906

R Square: 0.88184

Standard error: 0.05551.

The values of  $R$  and  $R^2$  given in Figures 6 and 7 indicate that exponential curve is a good fit for weight against age and power curve is a good fit for height against age.

A small sample test for significance of difference between the average BMI of boys and girls of the same age group (4–10 years) was conducted. The hypothesis that they do not differ significantly got accepted.

Another test was to test if the average BMI of the non infected children (19.25) greater than the average BMI of the infected children (16.75). This test gave the inference that they differ significantly and the average BMI of the non infected children is significantly greater than that of infected children.

There are many studies conducted on open uncontrolled groups which gave results that agree with the current findings [1-6].

A European collaborative study [4] conclude in their study that, neither height nor weight was associated significantly with the main effects of HIV infection status at birth, but differences between infected and uninfected children increased with age. Madhivanan [5] found that diminished growth is highly prevalent in HIV-infected children. Berhane et al [6] concludes that perinatally acquired HIV infection is associated with early and progressive growth failure.

Cooper et al [7] says in his study that in HIV-infected children, the disease itself adversely affects growth in a manner that is symmetrical, with equal effects on weight and height. Growth failure is evaluated using a variety of tools including standardized growth charts, 4 incremental growth curves and Z-scores. Use of Z-scores allows an investigator to compare data from children of various ages, reducing sample size requirements for any one particular age. A Z-score of one is equivalent to a standard deviation unit. Thus, a weight-for-age Z-score of -1 signifies that a child weighs 1 standard deviation less than the mean of a population of same age and gender children. Similarly, a child of 'average' height (at the 50th percentile for height) will have a Z-score for height of 0. If the same child had an increase in her Z-score of +1.5 over 12 months it would signify that she had gained enough height relative to her peers to be 1.5 standard deviations taller than average.

## 4. Conclusion

The diagrams and graphs depict the various characteristics of the data. Among the HIV infected children a comparative study of the BMI of boys and girls say that girls average BMI of boys and girls differ significantly and girls have a healthier BMI. Also when the BMI of the different age group girls 4–10 years and 10–17 years were compared it shows girls of the age group 10–17 years is in a better health condition.

Comparison of BMI of the HIV infected and not infected children showed a significant difference, the infected children had a lesser BMI which says that infection affects normal growth. This says that how much ever care is given, the infection plays a crucial role in decelerating the growth of the infected children. The same thing is being concluded by many studies done earlier. In regression analysis the semi longitudinal data curve fit of age by weight showed exponential curve as the best fit since it had the highest R square and the least standard error. Using the same logic it is found that growth curve is the best fit for BMI for age and power curve is the best fit for height for age.

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