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Growth Chart of Indian Girls with Down Syndrome from Birth to Three Years-A Pilot Study

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Abstract

Objective: The objective of the study is to develop a specialized growth chart for girls with Down Syndrome (DS) which will help the children from birth to three years to monitor the growth pattern.

Methods: Data were collected from 60 children between ages from birth to three years with DS girls and 60 normal children. The growth charts cover the time period from birth until three years of age at various intervals (0, 3, 6, 9, 12, 24 and 36 months). Data was collected from four states (Tamil Nadu, Rajasthan, Madhya Pradesh and West Bengal) in India in view to cover entire geographical area. Each child contributed only one single set of data for each age group. The study was conducted over a period of three years from January 2014 to March 2017 at Indira Child Care, Chennai and Down Syndrome Society of Tamil Nadu, Chennai.

Results: The 25th, 50th and 90th percentile of both normal and Down syndrome children (girls) was compared to find the statistical difference. The statistical findings suggest that there is a significant difference in the height, weight and head circumference of the children between the normal and DS group among the various time periods. The significant difference noted in the height, weight and head circumference of the children between the normal and DS group among the time period is ($p< 0.01$).

Conclusion: There are growth charts available for normal children in India, both for boys and girls which help to monitor their growth. There is a need to monitor the growth for children with Down's Syndrome using specific and specialised growth charts as growth retardation is common in these children. This pilot study will help to develop the specific growth chart for Indian Down's Syndrome children.

Keywords: Down syndrome; Chromosomal abnormalities; Congenital aneuploidy

Introduction

Down syndrome is one of the most leading causes of intellectual disability and millions of these children face various health issues including learning and memory, Congenital Heart Diseases (CHD), Alzheimer's Diseases (AD), leukemia, cancers and Hirschprung Disease (HD) [1]. The incidence of trisomy is influenced by maternal age and differs in population [2]. With high complex variability, the incidence of Down syndrome being 1:800, which means approximately 32,000 babies with Down syndrome are born every year (the birth rate of India is 25.6 million births) [3].

Down syndrome is the most commonly identified chromosomal abnormality in live-born infants and the most recognized congenital aneuploidy associated with delayed physical and mental development [4].

Short stature is one of the important cardinal features of Down syndrome [5]. Stature growth is a well-known sign of health during childhood [6]. The idea of plotting a child's body measurements on a chart to illustrate their pattern of growth is generally attributed to Count Philibert de Montbeillard, who plotted his son's height every six months from birth to age 18 years, and George Buffon) then published the chart in his Natural History, thus producing the first height growth curve [7]. Growth curve is a powerful graphical tool, as it displays both the size of the child at a series of ages, and at the same time their growth rate or growth velocity over time, based on the slope of the curve [8].

Specific growth references have also been developed for children with various disorders known to interfere with growth, such as Turner and Down Syndrome (DS) [9]. Since growth assessment depends on the growth pattern characteristic for these conditions, disorder specific charts are desirable [10].

Till date no growth charts are available for the children with Down syndrome in India. A pilot study on Indian children for boys is only available [11]. The potential benefits of growth charts is to monitor growth, to identify any difference in the pattern of growth, to assess the measures by supporting growth thus providing encouragement to parents and to intervene individual children and finally comparing with that of the normal population. Therefore, the aim of the present study is to provide a growth chart for girls aged 0–36 months, with Down syndrome specific for Indian children. It is essential to establish new growth references for children with DS in India, whereby a strict selection on their health status will be applied. Only with such references health care professionals can monitor growth of individual children with Down syndrome optimally, and can identify growth retarding co-morbidities at an early stage

Methods

The study is based on data from 60 girls with DS between ages from birth to three years and 60 normal girls. All children participated in this study regardless of complicating disease such as congenital heart defect and hypothyroidism.

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The data used for creation of the growth charts were age at examination, height in cm, weight in kg, and head circumference in cm. The growth charts cover the time period from birth to three years of at the various periodic intervals of 0, 3, 6, 9, 12, 24 and 36 months. Each child contributed only one single set of data for each age group. The data represent and unselected, therefore presumably unbiased sample of children with DS in India.

Measurements were taken by trained personnel and second person assisted in alignment and immobilization of the child during the measurements. Length was measured to the nearest millimeter using the recumbent length board infant measuring table. The weight was assessed by a sensitive balance scale to the nearest gram. Head circumference was measured by millimeter by a non-stretchable plastic tape taking maximum occipital frontal diameter. All the measuring instruments used in this study were calibrated as per international standards. The recorded measurements for weight, length and head circumference represent a combination of cross-sectional and longitudinal data.

Data for weight and height were transformed into logarithms before the statistical analysis in order to obtain normal distributions. The percentile growth was calculated at 5^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th} and 95^{th} and for representation only 25^{th}, 50^{th} and 90^{th} was considered. All growth charts are based on means and standard deviations using the weighted regression fitness system. For statistical comparison Repeated measures ANOVA is used. The software SPSS v 16.0 is used for analysis purpose.

Results

The 25^{th}, 50^{th} and 90^{th} percentile of both normal and Down syndrome children (girls) was compared. The statistical findings suggest that there is a significant difference in the height, weight and head circumference of the children between the normal and DS group among the various time periods. The significant difference noted in the height, weight and head circumference of the children between the normal and DS group among the time period is ($p< 0.01$).

The Figures 1, 3 and 5 represents the height, weight and head circumference of normal children.

The Figures 2, 4 and 6 represents the height, weight and head circumference of Down syndrome children.

Discussion

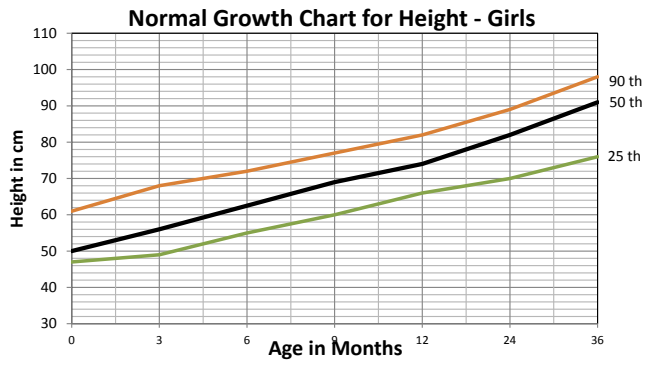

Figure 1: Height for age percentile curves for normal girls from birth to 36 months. Age is reported in months.

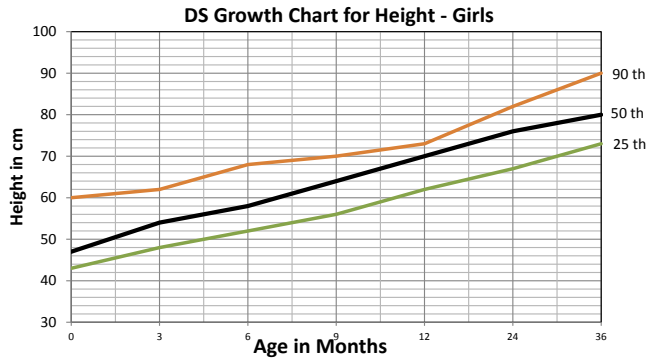

Figure 2: Height for age percentile curves for Down Syndrome Girls from birth to 36 months. Age is reported in months.

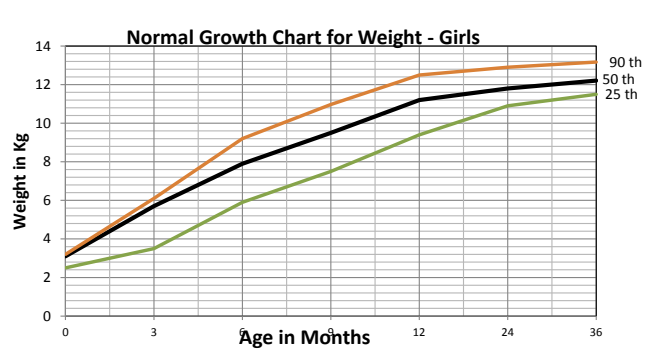

Figure 3: Weight for age percentile curves for normal girls from birth to 36 months. Age is reported in months.

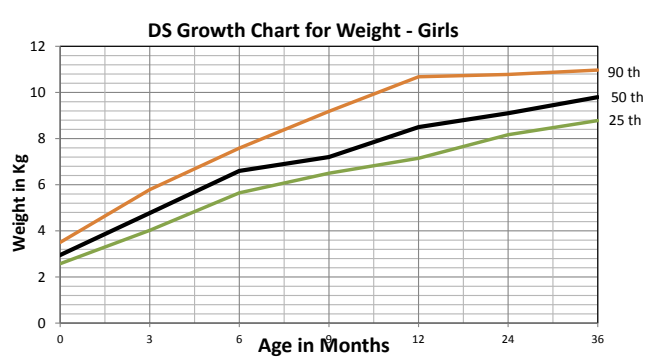

Figure 4: Weight for age percentile curves for Down Syndrome Girls from birth to 36 months. Age is reported in months.

Growth chart which show the overall health status of the children is one of the important tools used in routine practice. There are normal growth charts both boys and girls, specific to Indian children available and widely used. In this current pilot study as a continuation of growth chart development for boys with DS, we have now developed length/height, weight and head circumference growth charts specific for Indian children-girls with DS aged 0-3 years. We have compared the mean height of children with DS with the mean height of normal population. As the result it is seen that birth length of children with DS was -0.3 SD (Standard Deviation) when compared of the mean of the normal children. On comparing the difference at the age of 3 it was -1.4 SD. Restriction of growth is seen which mostly be a possible of

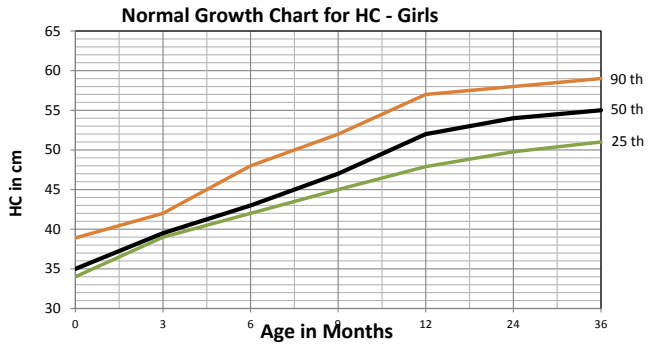

Figure 5: Head Circumference for age percentile curves for normal girls from birth to 36 months. Age is reported in months.

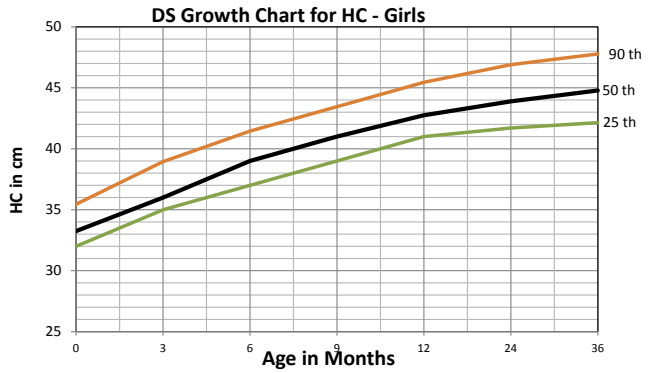

Figure 6: Head Circumference for age percentile curves for Down Syndrome Girls from birth to 36 months. Age is reported in months.

genetic reasons [12]. The trisomy 21, fetal parts have almost has normal symmetrical of growth. But after birth the growth velocity is reduced which is seen in the DS children [13]. As growth hormone does not play a role, newborn's size and growth are a result of the intrauterine environment. Children below two years exhibit catch-up or catch-down growth until they reach their genetically determined growth curve based on mid-parental height. By two years of age, growth hormone plays a predominant role [14]. During these 2 years of age they should track along a percentile and difference in variation should be within two large bands on the growth chart. Growth is affected by the onset of puberty and sex hormones become the predominant factor in growth during the teenage. Thus the children with short stature mostly have normal variants such as familial short stature, constitutional delay of growth and puberty. Few children when investigated the reason for short stature was found to be a pathologic cause. As growth becomes Growth Hormone (GH) regulated from about age 6 months one could speculate that GH deficiency occurs in DS children [15]. This is also supported by bone measurements at 11-14 weeks of gestation showing short femur lengths in fetuses with trisomy 21 [16].

In this study the mean birth weight of the DS girls is -0.5 SD, which is lower than the normal girls. Length restriction and feeding difficulties may explain these lighter weights of infants with DS in this developmental stage. The mean weight of infants with DS is affected by feeding difficulties associated to hypotonia, chronically open mouth and oral motor dysfunction due to lack of nutrition intake [17]. Evidence indicates that embryologic and fetal growth is regulated by interactions between genes, environmental and nutritional components, fetal and placental hormones, and growth factors. The birth weight correlates with fetal plasma levels of insulin like growth factor although both insulin like growth factors I and II increase gradually during fetal development up to birth [18].

The head circumference of the girls with DS mean was found to be -0.4 SD at birth and -2.0 SD at age 3 which is lower than the normal girls. Considering the mental health associated with DS the growth of the head is of real interest. Head circumference measurement during infancy and childhood is one of several useful indices of a child's medical, physical, and developmental status. There is a close correlation between head circumference growth and brain development in the last weeks of gestation and in the first two years of life is no longer disputed [19]. During this growth spurt there exists an increased vulnerability by unfavorable environmental conditions, such as malnutrition and psychosocial deprivation [20].

The study was conducted with an available small population which is less in number. With this number it is not possible to develop a standardized growth chart for the Indian population. The future plans on this development of growth chart will involve children in large number thus statistically viable to develop a standard growth chart with reference to racial and reference to ethnicity as India has a divergent population. This will help us to provide a standard growth chart for India specific Down syndrome children.

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Declarations

The authors confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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