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Original research article

Children with Down syndrome's chromosomal profile, growth, and levels of vitamin D: Prospective descriptive study

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Abstract

Background and Objectives: The occurrence of Down syndrome and chromosomal nondysjunction is more prevalent in the progeny of mothers who conceive at an advanced age. The primary objectives of the study were to investigate the prevalence of Vitamin D deficiency through the evaluation of 25(OH) Vitamin D levels in children diagnosed with Down syndrome.

Material and Methods: This study employed a prospective descriptive design. The research was carried out at the Department of Pediatrics, Gayatri Vidya Parishad Institute of Health Care and Medical Technology, Visakhapatnam, Andhra Pradesh, which is a medical center providing specialized care in India. The study spanned from May 2022 to April 2023. A total of 50 children who were thought to have Down syndrome were subjected to examinations.

Results: A total of 50 youngsters who were thought to have Down syndrome were subjected to interviews. Two individuals exhibited a cytogenetic profile consistent with Down syndrome; nevertheless, they expressed a lack of willingness to undergo additional diagnostic procedures. Three individuals exhibited clinical characteristics consistent with Down syndrome, however, they declined to provide a blood sample for subsequent diagnostic testing and verification. The cytogenetic study of the youngster, consisting of 50 samples, did not reveal any evidence of Down syndrome. The analysis comprised a total of 50 children, consisting of 40 boys and 10 girls. The following table and graph provide an overview of the demographic composition of the children in terms of age and gender.

Conclusion: Children with Down syndrome had a prevalence of 25 (OH) Vitamin D deficiency of 26.8%. Deficiencies in 25 (OH) Vitamin D had no appreciable effect on these children's height, bone age, or other biochemical indicators.

Keywords: Children, down syndrome's chromosomal profile, growth, vitamin D

Introduction

Down syndrome is the prevailing genetic etiology of mild to moderate cognitive impairment and concomitant medical complications, affecting approximately 1 in 800 live births across diverse racial and socioeconomic backgrounds [1]. The incidence of Down syndrome and chromosomal nondysjunction is higher in the progeny of women who conceive at an advanced maternal age. In contemporary society, there is a prevailing emphasis on education, job, career advancement, and the imperative of achieving financial stability prior to embarking on parenthood. Consequently, the trend of delaying childbirth has gained widespread acceptance and is increasingly seen as the standard practice. Therefore, it is probable that the prevalence of Down syndrome will rise [2-4].

There has been a notable improvement in the survival rates of children diagnosed with Down syndrome. An increasing number of parents are currently seeking care for their children. Therefore, it is crucial that we proactively anticipate a rise in the prevalence of children diagnosed with Down syndrome and their attendance at our medical facilities. Our objective should be to enhance individuals' quality of life and facilitate their attainment of their utmost capabilities [5]. Children diagnosed with Down syndrome exhibit a comparatively reduced stature in relation to their typically developing counterparts. The typical height for individuals across various age groups tends to fall within the 2nd percentile range when considering the general population. The etiology of growth retardation remains mostly unknown for the majority of cases. Several conditions that can result in inadequate growth, such as congenital heart disease, sleep-related upper airway obstruction, coeliac disease, thyroid hormone deficiency, deficiency of insulin-like growth factor 1, and nutritional inadequacy caused by feeding problems, are observed with higher frequency among individuals with the syndrome [6-8].

Individuals with Down syndrome in adulthood have an increased susceptibility to developing osteoporosis. The insufficiency of vitamin D has been identified as a causative factor for impaired growth and the development of osteoporosis. Limited data exists regarding the assessment of Vitamin D

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levels in pediatric individuals diagnosed with Down syndrome and its potential impact on growth outcomes. Our objective was to investigate whether these children had diminished amounts of Vitamin D, which could potentially lead to delayed growth. The rationale behind our investigation is that rectifying Vitamin D deficiency is a pretty straightforward process. Remarkably, there exists only a solitary study worldwide that has examined the Vitamin D status in children diagnosed with Down syndrome. The study was conducted on a cohort of 21 children in Spain approximately 16 years ago. The findings of the study indicated that none of the children exhibited low levels of Vitamin D metabolites. Therefore, it is evident that further investigation is necessary in this particular field in order to arrive at a definitive conclusion [7-9].

The primary objectives of the study were to investigate the prevalence of Vitamin D deficiency through the evaluation of 25(OH) Vitamin D levels in children diagnosed with Down syndrome.

Materials and Methods

This study employed a prospective descriptive design. The research was carried out at the Department of Pediatrics, Gayatri Vidya Parishad Institute of Health Care and Medical Technology, Visakhapatnam, Andhra Pradesh, which is a medical center providing specialized care in India. The study spanned from May 2022 to April 2023. A total of 50 children who were thought to have Down syndrome were subjected to examinations.

Inclusion criteria

- Children aged 5 months to 16 years with clinical suspicion of Down syndrome.
- Enrolled cytogenetically confirmed individuals in the study.

Exclusion criteria

- Children older than 16 years.
- Cytogenetic testing on children was not performed.

Results

A total of 50 youngsters who were under suspicion of having Down syndrome were subjected to interviews. A total of six individuals were removed from the study. Among these, two individuals exhibited a cytogenetic profile consistent with Down syndrome; however, they declined to undergo any more diagnostic testing. Three individuals exhibited clinical manifestations consistent with Down syndrome; however, they declined to undergo blood testing to confirm the diagnosis. The cytogenetic study of the sixth child did not reveal the presence of Down syndrome. In the analysis, a total of 50 children were included, comprising 40 boys and 10 girls. The following table and graph provide an overview of the distribution of children based on age and sex.

All participants in the study underwent cytogenetic analysis to confirm the presence of Down syndrome. The table provided below presents the frequencies of various cytogenetic abnormalities. Given that there has been no previous examination of the correlation between cytogenetic anomalies and the social quotient, we conducted a separate analysis to investigate this relationship.

Table 1: Cytogenetic profile of study children

Sr. No	Cytogenetic analysis	Frequency	%
1.	Trisomy 21	45	90.0
2.	Translocation	4	8.0
3.	Mosaic	1	2.0
	Total	50	100

The cytogenetic data were analyzed in conjunction with other pertinent parts of our investigation. Given the limited sample size, the statistical significance of the findings remains uncertain. The cases of trisomy 21, 90%, the cases of translocations 8%, and 2% of the cases of mosaics out of 100%. Among the cohort of three individuals diagnosed with acute lymphoblastic leukemia, two exhibited trisomy, while the remaining patient presented with translocation.

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Weight vs. Age

Table 2: Age and weight as indicated by the IAP growth chart

Age	IAP weight Centiles		Total
	<25	>=25	
Age in < 3	25	02	27
Years >=3	15	08	23
Total	40	10	50

As a result of AIP, children with Down syndrome seem to gain weight as they get older. Age of < 3 has 27 in total number and of years >=3 are 23 in number found out of 50.

25(OH) Vitamin D levels

In an editorial published in the journal Indian Pediatrics, Petti for (year) highlighted the challenges associated with comparing study findings and making comparisons between different communities and demographics due to the utilization of diverse classifications for vitamin D deficiency. The author proposed that the definition of vitamin D deficiency should be established as having 25(OH) D readings below 10 ng/mL. There was a higher prevalence of 25-hydroxyvitamin D deficits in children under the age of three. This phenomenon can likely be attributed to a decreased level of solar exposure among individuals within this particular age demographic.

Table 3: 25(OH) Vitamin D levels and a child's sex

	Sex		Total
	Boy	Girl	
25 (OH) Vitamin D < 10 ng/ml	10	01	11
> = 10 ng/ml	30	09	39
Total	40	10	50

In this particular study, there were a total of 40 male participants and 10 female participants.

Table 4: Clinical evaluation and Echocardiogram results are correlated

	Cardiac clinical examination		Total
	Abnormal	Normal	
Echo Abnormal	14	06	22
Cardiogram Normal	00	30	30
Total	14	36	50

A group of 06 children, who had no clinical issues, were discovered to possess echocardiographic anomalies and 30 with the Cardiogram Normal.

Discussion

This study aims to investigate the prevalence of Vitamin D deficiency in children diagnosed with Down syndrome by evaluating their 25(OH) Vitamin D levels. Evaluate the impact of Vitamin D insufficiency on stature, skeletal maturation, and additional biochemically measurable indicators in this cohort of children. This study aims to evaluate the phenotypic and cytogenetic characteristics of children diagnosed with Down syndrome, as well as the prevalence of often related deformities, deficits, and diseases. A critical assessment of their social intelligence. The study included a cohort of 50 individuals with cytogenetically confirmed Down syndrome. Growth monitoring serves as a screening tool for the early detection of dietary deficiencies, chronic systemic conditions, and endocrine disorders in young individuals. Regrettably, the availability of growth charts specifically designed for Indian children diagnosed with Down syndrome is currently lacking. The height and weight measurements for each child were recorded and plotted on both the IAP growth charts and the growth charts specifically designed by Cronk for Children with Down syndrome. The head circumference of children under the age of three was graphed using the IAP chart [10-12].

The Kappa coefficient was computed to assess the level of agreement between the classifications of height for age based on the two charts. Consequently, there was a lack of consensus between the two charts. It is commonly observed that children diagnosed with Down syndrome often exhibit a tendency towards being overweight. In our study, a significant majority of the youngsters, accounting for at least three quarters of the sample, exhibited measurements below the 50th percentile, regardless of the specific growth chart employed. The observed Kappa coefficient, which measures the agreement between the two charts, was determined to be 0.325. Therefore, a lack of consensus was observed between the two charts in this case as well. The measurement of head circumference was recorded and graphed using the

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International Association for Pediatricians (IAP) growth charts specifically designed for children under the age of three. A total of 86% of the individuals exhibited microcephaly. This aligns with the research conducted by Sachdev (2015), in which all participants had head circumference measurements below the 10th percentile [11-15].

The youngsters were divided into two groups based on their age. There was no statistically significant difference observed in the height measurements of the children belonging to the two distinct age groups. No significant disparities were observed among the various age groups when used the Cronk charts for weight plotting. However, when using the IAP chart, it was observed that 90% of children under the age of three were situated below the 25th percentile, in contrast to 56% of children aged three and above. The observed results exhibited statistical significance. Therefore, it can be observed that children diagnosed with Down syndrome exhibit a tendency to experience weight gain as they progress in age. Styles et al. conducted a study that revealed a significant prevalence of overweight and obesity, with a special emphasis on the adolescent and adult populations [16-18].

In an editorial published in Indian Pediatrics, Pettifor proposed a suggested threshold of 10 ng/ml as a means to establish the definition of vitamin D deficiency. Within the scope of our investigation, it was shown that 26.8% of the juvenile participants had 25 (OH) Vitamin D levels that fell below the threshold of 10 ng/ml. Regrettably, there exists a dearth of scholarly material pertaining to the incidence of Vitamin D deficiency within the broader population of India. According to the study conducted by Tiwari et al., the prevalence of hypovitaminosis in specific slums of Delhi was determined to be 83% among children aged 9 months to 30 months. However, in contrast to the aforementioned slums, the incidence rate in other slums was under 2%. According to Harinarayan *et al*. (year), the criteria for defining Vitamin D deficiency was established as a serum concentration of less than 20 ng/ml. The authors conducted a study in several communities in Andhra Pradesh and reported a prevalence rate of Vitamin D deficiency in children ranging from 63% to 82%. Hypovitaminosis D was observed in 36% of children by Marwaha *et al*. The incidence of vitamin D deficiency is higher among children under the age of three. This phenomenon can likely be attributed to a decreased level of solar exposure among this particular age demographic [17-20].

There was no statistically significant difference observed in the parameters between the groups with vitamin D levels below 10 ng/ml and those over that threshold. The findings from a study including 21 infants with Down syndrome in Cantabria, Spain were published by a single research team. The mean values of the three Vitamin D metabolites shown similarity to those of a group of individuals of the same age, both during the winter and summer seasons. None of the children diagnosed with Down syndrome exhibited results that fell below the established normal range, either in terms of Vitamin D metabolites or other parameters related to calcium metabolism. It has been hypothesized that these youngsters do not necessitate Vitamin D supplementation if they receive adequate exposure to sunlight. Additionally, our study demonstrates that there is no correlation between Vitamin D insufficiency and development delay [21-23].

Bone age refers to the mean age at which children typically attain a specific level of skeletal maturation. It is indicative of the typical age range observed in youngsters that are developing normally. In the present investigation, a total of 50 youngsters had radiographic examinations of the left hand and wrist. The radiologist conducted a comparison between the bones depicted in the X-ray and the Greulich and Pyle standard. The assessment of bone age was conducted, and an examination was performed to identify any manifestations of rickets. There was no statistically significant disparity observed in the bone age between the groups with 25(OH) vitamin D levels below and above 10 ng/ml. One X-ray had characteristics suggestive of rickets. The 25(OH) vitamin D level of this child was measured to be 21.5, and it was found to be within the normal range for serum calcium, phosphorus, and vitamin D levels. In contrast, no radiological characteristics indicative of rickets were observed [24-26].

Children diagnosed with Down syndrome have distinct phenotypic characteristics. The prevalence of the observed phenomenon in our investigation was as follows: In their retrospective research, Kava et al. observed that 83.9% of the subjects had mongoloid slant, 66.9% displayed ear abnormalities, 56.9% had epicanthic folds, 50.9% exhibited a flat facial profile, 33.2% showed a simian crease, 36.1% had clinodactyly, and 46.2% displayed the sandle sign. A total of 52 children had echocardiograms, resulting in the identification of heart abnormalities in 22 of these individuals. The data given by Bhatia et al. exhibited similarities to the present findings. Kava et al. (year) did a retrospective analysis with a cohort of 524 patients over a period of 7.5 years. Ninety-six instances were clinically diagnosed with congenital cardiac disease. The heart defect's nature was determined through the utilization of color Doppler examination and/or 2D-echocardiography in a total of 58 patients. The prevailing cardiac anomalies observed in this study encompassed ventricular septal defect, tetralogy of Fallot, and atrial septal defect [27-29].

The study conducted by Bhatia et al. aimed to analyze the efficacy of echocardiography as a diagnostic tool for evaluating the prevalence and characteristics of heart abnormalities in pediatric patients diagnosed with Down syndrome. A total of fifty instances with Down syndrome, which were confirmed through chromosomal analysis, were examined in this study. The most prevalent aberration observed was

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endocardial cushion defect, with ventricular septal defect being the subsequent most frequently occurring anomaly. In order to assess the potential impact of thyroid abnormalities on growth, a comprehensive evaluation was conducted on all the children, which included the administration of thyroid function tests (TFTs) and the measurement of thyroid stimulating hormone levels. This observation aligns with the existing body of literature, which demonstrates a considerable range in the prevalence of hypothyroidism, ranging from 3% to 54%, contingent upon the specific definition employed [30-32].
This suggests that via the implementation of early developmental tests and intervention, it is possible to enhance the social quotient of older children as well. An alternative rationale posits that the administrative structure of the VSMS is more aligned with the needs and developmental stages of older children as opposed to younger ones. Among the children with translocation, none exhibited a social quotient below 50. In contrast, 39% of those with Trisomy and 50% of those with Mosaics displayed a poor social quotient. The observed results did not reach statistical significance. The modified Kuppuswamy score was employed for the evaluation of the socioeconomic level of the household. The construct comprises three key elements, namely family income, education, and occupation. The predominant demographic group among the parents surveyed in our study consisted of individuals from the upper middle class, with the subsequent largest representation being from the upper lower class. There was no statistically significant disparity observed in the 25(OH) Vitamin D levels across various socioeconomic status (SES) groups. This finding contradicts the results of Marwaha et al.'s study, which examined vitamin D deficiency in normal Indian children and found that children from lower socioeconomic backgrounds had a higher prevalence of vitamin D deficiency compared to children from higher socioeconomic backgrounds [31-34].

Conclusions

It was discovered that 26.8% of children diagnosed with Down syndrome had insufficient levels of 25-hydroxyvitamin D. For the purpose of study, the two lower socioeconomic groups and the two upper socioeconomic groups were combined. Therefore, the lower socioeconomic groups, whereas the upper socioeconomic group of children. Children hailing from households of lower socioeconomic status exhibit delayed arrival for medical intervention. According to the findings of the study, deficiencies in 25-hydroxyvitamin D did not have a statistically significant impact on the children's height, bone age, or any of the other biochemical indicators.

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Conflict of Interest: None.

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