International Journal of Contemporary Pediatrics
Khanna A et al. Int J Contemp Pediatr. 2026 Apr;13(4):593-599
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20260819

Original Research Article

Stunting in under-five children with chronic kidney disease: Indian synthetic growth charts are more accurate than World Health Organization growth standards

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Received: 04 February 2026
Accepted: 07 March 2026

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ABSTRACT

Background: Accurate growth monitoring is critical in pediatric chronic kidney disease (CKD), where impaired linear growth is common. The WHO multicentre growth reference study (MGRS) 2006 standards are widely used but may overestimate stunting in Indian children due to ethnogenetic and environmental differences. Indian synthetic growth charts, developed using the LMS method and based on national data, may offer a more appropriate reference. This study compared stunting prevalence in under-five children with CKD using world health organization (WHO) standards and Indian synthetic growth charts.
Methods: This cross-sectional observational study was conducted at a tertiary care centre in Pune, Maharashtra, over 18 months (January 2023-June 2024). A total of 120 term-born children aged 0-60 months with confirmed CKD were enrolled. Standardized anthropometric measurements of length/height were obtained. Length/height-for-age Z-scores were calculated using WHO AnthroPlus software and LMS values for Indian synthetic charts. Stunting was defined as a Z-score<-2 SD. CKD severity was categorized as mild, moderate, or severe based on clinical, biochemical, and imaging criteria.
Results: Across all age groups, Z-scores were consistently higher when assessed using Indian synthetic charts compared to WHO standards. The prevalence of stunting was significantly lower using synthetic charts (boys 5.9%, girls 1.9%) than WHO charts (boys 13.4%, girls 5.7%). Synthetic charts demonstrated superior discrimination of growth impairment across CKD severity, with a larger Z-score difference between mild and severe CKD (0.597 SD vs. 0.440 SD with WHO).
Conclusions: Indian synthetic growth charts provide a more accurate, population-specific assessment of growth in children with CKD. Their use reduces overdiagnosis of stunting and improves identification of clinically meaningful growth deficits, supporting their integration into routine pediatric CKD monitoring in India.

Keywords: Chronic kidney disease, Growth assessment, Reference standards, Stunting, WHO growth standards

INTRODUCTION

Growth is a key marker of the overall health and well-being of a child that captures the combined influence of nutrition, health status, and socio-economic status.[1-3] Regular follow-up of growth in paediatrics through the application of standardized growth charts allows for the early detection of growth abnormalities and enables effective intervention. It has been questioned, however, if universally standardised growth charts, particularly the WHO MGRS 2006 growth standards, can be used across populations.[4,5]

WHO MGRS 2006 growth charts were developed using children raised in optimal health environments in six countries, including India.[6] They are prescriptive standards for the way that children should be growing ideally. Indian children are likely to be in the lower percentiles on these charts while clinically healthy, with the risk of misclassification of stunting or undernutrition.[7] Overdiagnosis can lead to unnecessary investigation, incorrect nutritional advice, and parental anxiety.[8,9]

To overcome such challenges, Indian researchers have designed synthetic growth charts that are tailored to match the growth pattern demonstrated by Indian children. Synthetic growth charts use the LMS (Lambda-Mu-Sigma) method, which takes into account age-related change in the distribution of the anthropometric measures and generates smoothed centile curves.[10-12] Various studies have shown that synthetic growth charts reduce the risk of misdiagnosis and offer a more accurate estimate of the actual growth potential in Indian children.[13-16] For instance, Khadilkar et al documented that the application of WHO standards often led to overdiagnosis of undernutrition in otherwise healthy children and hence caused undue concern to caregivers and healthcare providers.[8] From their study, they emphasised the reality that synthetic charts were a better reflection of the real growth pattern of Indian children.

Mehta et al. conducted a comparative study in Pune, Maharashtra, where they demonstrated that the prevalence of stunting dropped from 14% (using WHO standards) to 6.8% (using synthetic charts), and wasting from 18.2% to 9.7% respectively.[13] They also observed that synthetic charts had a narrower BMI range, enhancing their ability to detect cases of childhood obesity more effectively.

Mondkar et al employed the composite index of anthropometric failure (CIAF) and noted a highly significant increase in the number of children classified as 'normal' from 54.1% when WHO charts were employed to 78.0% when synthetic charts were employed, exhibiting higher classification accuracy.[14]

Their results support the hypothesis that synthetic charts are better calibrated for Indian populations and thus reduce false-positive and false-negative occurrences.

Dange et al also indicated a high level of agreement between synthetic chart results and clinical assessment for growth disorders.[15]

The authors observed that the synthetic charts were more capable of correctly classifying children without a growth disorder and thus prevent misclassification.

Tresa et al also validated the findings above by demonstrating that the WHO growth charts evidenced a greater prevalence of short stature (15.03%) and severe short stature (7.51%) than synthetic charts, which evidenced rates of 7.77% and 2.38%, respectively.[16] This research validated that synthetic charts provided a more accurate and population-based measure of the growth patterns of children.

This research is grounded in a history of changing growth monitoring practices in India. From Quetelet indices of the early 20th century, Reed and Stuart's comparative statistics, and Leitch and Boyd's studies on nutrition and growth, to subsequent work by Tanner and Prader in the mid-century, India has seen an active development in growth assessment.[17-21] Indian-specific literature was preceded by studies by Agarwal et al opening a new chapter in pediatric growth monitoring.[22,23] Subsequently, Khadilkar et al created the IAP 2015 charts, including newer methods and population dynamics.[24-26] All of these cumulatively have allowed a more precise interpretation of child growth patterns in India.[27,28]

Internationally, the problems with the application of WHO growth charts have also been reported. Studies in Indonesia, Romania, and among Turkish immigrants in Germany, have documented shortcomings of WHO standards in reflecting local growth patterns accurately.[7,11,29] This supports the application of growth references specific to local populations.

Aim and objectives

Aim was to compare the prevalence of stunting among children under five years of age diagnosed with CKD using WHO MGRS 2006 standards and the Indian synthetic growth charts. Primary objective was to estimate the proportion of stunting in children with CKD using both WHO and synthetic charts.

METHODS

This cross-sectional observational study was conducted over a duration of 18 months (from January 2023 to June 2024) at the Department of Pediatrics in a tertiary care teaching hospital affiliated with a medical college in Pune, Maharashtra. The study population consisted of children aged 0-60 months with a confirmed diagnosis of CKD, as per the ‘kidney disease: Improving Global Outcomes (KDIGO) 2012 Clinical Practice Guidelines’.[30] CKD was defined based on structural and functional abnormalities of the kidney present for more than three months, as evidenced by imaging studies or estimated glomerular filtration rate (eGFR) decline.

In total, 120 children were enrolled using consecutive sampling. Eligibility criteria included children born at term (≥37 weeks gestation), with a birth weight ≥2.5 kg, and without major congenital anomalies or syndromic features.

Anthropometric assessment was conducted using calibrated and standardised equipment. Weight was measured using Zeal Pvt. Ltd. electronic weighing scales, sensitive to the nearest 10 grams, with minimal clothing and without shoes. For children aged less than 24 months, recumbent length was recorded using a Shreyas infantometer with a precision of 0.1 cm. For older children (25-60 months), standing height was measured using a Prestige wall-mounted stadiometer with the child standing upright, heels together, and the head in the Frankfurt horizontal plane. Duplicate measurements were taken in all instances, and the mean value was calculated. In addition, 10% of children taking part were randomly selected for re- measurement by another independent observer for minimization of interobserver variation.

Growth assessment was conducted using two sets of growth references: the WHO MGRS 2006 growth standards and the recently published Indian synthetic growth charts. The WHO growth standards are based on a prescriptive model of optimal child growth from six countries including India, while the Indian synthetic charts were developed using a data synthesis approach involving the Lambda-Mu-Sigma (LMS) method. The Indian synthetic references have been validated for their relevance to Indian pediatric populations.[6,8,9]

Z-scores (standard deviation scores) for anthropometric indices-length-for-age (LAZ)-were computed for each child. The WHO AnthroPlus software (Developer/Location: WHO, Geneva, Switzerland) was used to calculate Z-scores based on the WHO growth standards. For the Indian synthetic charts (Developer/Location: Pediatric Endocrinology Department, Jehangir Hospital and Bharati Vidyapeeth Deemed University Medical College, Pune, India), published LMS values were used to derive age-specific Z-scores for each anthropometric parameter.

To assess disease severity, each case was evaluated through ultrasonographic imaging and biochemical parameters. Structural anomalies were graded using the international reflux study committee guidelines for vesicoureteral reflux (VUR), the society for fetal urology (SFU) grading for hydronephrosis, and Onen grading system for posterior urethral valves (PUV).[31-33] Renal function was assessed using serum creatinine and the Schwartz formula to estimate glomerular filtration rate (eGFR) adjusted for height. Based on these findings, CKD severity was categorized as mild, moderate/severe.

Data entry was carried out in Microsoft Excel 2019 (Developer/location: Microsoft Corporation, Redmond, WA, USA), and analysis was performed using IBM SPSS Statistics for Windows, version 25.0 (Developer/Location: IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as means with standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons of mean Z-scores between WHO and synthetic charts were made using paired t tests. The difference of more than 0.5 SD was taken as clinically significant, according to earlier literature.[34] Differences in growth parameters between severity grades of CKD were also compared using one-way ANOVA.

Ethical approval for study was obtained from institutional ethics committee of Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Pune, prior to commencement. Written informed consent was obtained from parents/legal guardians of all participants after clearly explaining study's purpose, procedures and voluntary nature of participation. The Indian synthetic growth charts and Indian synthetic growth chart Z-score calculator used in this study is derived from published literature by Khadilkar et al and is freely available for academic and clinical use. As it is publicly accessible and intended for non-commercial research purposes, no special permission was required for its use.

RESULTS

Among the 120 participants, 67 were boys (55.8%) and 53 were girls (44.2%). The children were stratified into five age groups (0-6 months, 7-12 months, 13-24 months, 25-36 months, 37-60 months) for detailed analysis of anthropometric parameters.

Z-scores for length/height were consistently higher when plotted on Indian synthetic charts compared to WHO MGRS 2006 charts across all age groups. For boys, mean length-for-age Z-scores ranged from -1.69 SD (WHO) to -0.70 SD (synthetic) (Table 1), and for girls, from -1.12 SD (WHO) to -0.13 SD (synthetic) (Table 2). The most pronounced discrepancies were seen in the 0-6 month and 13-24-month age brackets, indicating that early infancy and mid-infancy are particularly sensitive windows where chart choice can influence growth interpretation.

The prevalence of stunting, defined as length/height-for-age Z-score <-2 SD, also differed significantly between the two charts. According to WHO charts, 13.4% of boys and 5.7% of girls were classified as stunted. When assessed using Indian synthetic charts, this dropped markedly to 6.0% of boys and 1.9% of girls. This discrepancy suggests a substantial overestimation of linear growth failure by WHO standards (Table 3).

A key finding was correlation of growth impairment with CKD severity. Children with severe CKD consistently exhibited more pronounced growth failure than those with mild or moderate disease. Difference in mean length-for-age Z-scores between severe and mild/moderate CKD groups-0.597 SD when assessed with synthetic charts, compared to only 0.440 SD using WHO charts (Table 4). This demonstrates superior sensitivity of synthetic charts in detecting clinically meaningful growth delays associated with disease severity.

Table 1: The distribution of age-specific Z-Scores of length/heights of boys.

Age in months (Boys)	Mean length/ height (cm)	Mean length/height Z scores on WHO MGRS charts	Mean length/height Z score on new Indian synthetic growth charts
0 to 6	59.66	-1.00	0.09
7 to 12	68.25	-1.24	-0.30
13 to 24	79.00	-0.80	-0.17
25 to 36	86.59	-1.53	-0.95
37 to 48	96.13	-0.98	-0.33
49 to 60	101.83	-1.69	-0.70

*Comparison of mean length/height (in cm) and corresponding Z-scores of boys across different age groups (in months), as calculated using 2 different growth reference standards: the WHO MGRS 2006 charts and the New Indian Synthetic Growth Charts. WHO MGRS Z-scores were generated using WHO AnthroPlus software, while the Indian Z-scores were derived using the publicly available Indian synthetic growth chart calculator by Khadilkar et al. The table highlights discrepancies in growth interpretation between the two chart systems, particularly in younger age groups, reflecting the impact of chart selection on stunting assessment. No inferential statistical test was applied in this table; values are descriptive means. Negative Z-scores indicate deviation below the median reference value for age.

Table 2: The distribution of age-specific Z-Scores of length/heights of girls.

Age in months (Girls)	Mean length/ height (cm)	Mean length/height Z-score on WHO MGRS growth charts	Mean length/height Z-score on new Indian synthetic growth charts
0-6	60.40	-0.74	0.10
7-12	68.00	-0.16	0.15
13-24	79.00	-1.12	-0.13
25-36	91.42	-0.15	0.04
37-48	96.90	-0.92	-0.40
49-60	105.15	-0.91	-0.19

*Mean length/height (in cm) of girls across various age groups (in months), along with their corresponding Z-scores calculated using two growth references: WHO MGRS 2006 growth charts and the New Indian Synthetic Growth Charts. Z-scores for the WHO charts were obtained using WHO AnthroPlus software, and those for the Indian charts were calculated using Indian Synthetic Growth Chart Z-score calculator by Khadilkar et al. This comparison illustrates the variation in growth assessment outcomes between international and national reference standards. Negative Z-scores reflect measurements below median of reference population. Values are descriptive, and no inferential statistical tests were applied in this table.

Table 3: Percentage of boys and girls with length/height-for-age<-2 SD on WHO MGRS and new Indian synthetic growth charts.

Age (in months)	Boys and girls length/height for age on WHO MGRS and new Indian synthetic growth charts			
	Percentage of children <-2SD			
	WHO MGRS charts		New Indian synthetic charts	
	% boys<-2SD	% girls<-2SD	% boys<-2SD	% girls<-2SD
0 to 6	15.8	0	0.05	0
7 to 12	12.5	0	0.13	0
13 to 24	0	14.29	0	0
25 to 36	27.3	0	0.18	0
37 to 48	0	6.67	0	6.67
49 to 60	22.2	7.69	0	0
Total	13.4%	5.66%	5.9%	1.89%

*This table shows the percentage of children, both boys and girls, with a length/height-for-age Z-score below -2 standard deviations (< -2 SD), across different age groups, as determined using WHO MGRS 2006 growth charts and the New Indian Synthetic Growth Charts. Z-scores were calculated using WHO AnthroPlus software and the Indian Synthetic Growth Chart calculator, respectively. A Z-score below -2 SD is considered indicative of stunting. The data highlight a significant reduction in the apparent prevalence of stunting when Indian references are used, reflecting the potential overestimation of stunting when using international standards for Indian children. The table includes descriptive statistics only; no inferential statistical tests were applied.

Table 4: Comparing the average length/height Z-scores across the three severity categories (Mild, moderate and severe) using both WHO MGRS and new Indian synthetic charts.

Severity of CKD	WHO MGRS charts length/height Z-scores, mean	New Indian synthetic charts length/height Z-scores, mean
Mild	-0.9560	-0.1542
Moderate	-1.3439	-0.2780
Severe	-1.5250	-0.7920

*This table presents the mean length/height-for-age Z-scores of children stratified by severity of CKD-mild, moderate, and severe-as calculated using both WHO MGRS 2006 charts and the New Indian Synthetic Growth Charts. Z-scores were computed using WHO AnthroPlus software and the Indian Synthetic Growth Chart calculator, respectively. More negative Z-scores indicate greater deviation from reference medians and reflect higher degrees of stunting. The values demonstrate a progressive decline in growth status with increasing CKD severity and a larger absolute difference in Z-scores when using the Indian synthetic charts, highlighting their greater sensitivity in detecting growth impairment. Values are descriptive means; no inferential statistical tests were applied in this table.

DISCUSSION

The findings of this study agree with earlier Indian studies that provided evidence of overestimation of malnutrition using WHO charts. Increasing prevalence of stunting and underweight have significant clinical and public health implications, including the potential for constitutionally small but healthy children to be classified as malnourished, misallocation of limited healthcare resources, and unwarranted initiation of therapeutic programs. Overdiagnosis can lead to inappropriate referral of children, causing psychological distress to parents, as well as financial cost to families.

On the other hand, Indian synthetic growth charts have shown improved performance in representing the growth of Indian children more accurately. By more closely tracking the anthropometric trends observed in the population, these charts reduce false positives in the detection of growth disorder and improve screening accuracy.[5,10] Their development through LMS modelling enables them to capture population-specific medians and variability, which is especially beneficial in low-resource settings in which infrequent revisions of growth charts are not possible.

Apart from Khadilkar et al, Mehta et al, Mondkar et al, Dange et al and Tresa et al, previous seminal literature carried out by Agarwal et al provided normative growth data on Indian children in the 1990s.[8,13-16,22,23] The previous work was a pioneering precursor to more advanced statistical modelling built in the following years. The growth charts published by Indian Academy of Paediatrics (IAP) in 2015, constructed by Khadilkar et al incorporated modern reference data and utilised LMS-based statistical analysis, thus creating a more precise tool for modern pediatric practice in India.[24,26,28]

Globally, Tanner's and Prader's contributions formed the foundation for uniform growth monitoring by means of puberty staging and longitudinal data collection, respectively.[20,21] These early models formed the foundation on which synthetic charts operate today.

One of the biggest advantages of synthetic charts is that they are inherently adaptable. The statistical model by LMS methodology facilitates easier recalibration with fewer data inputs than traditional population-based survey techniques. This is a key advantage in setting environments in which large national anthropometric surveys can be unrealistic or prohibitively expensive.

Additionally, synthetic charts can potentially be of special use in chronic childhood illnesses such as CKD, where disease-associated impairment of growth can deviate from normal norms. Our results indicate that synthetic charts better delineate differences in growth faltering observed in length-for-age scores according to disease severity. This indicates their greater discriminatory ability in identifying clinically important growth faltering.

Another advantage is their more restricted BMI percentile range, which improves their ability to detect both overnutrition and undernutrition, and thus the early diagnosis of pediatric obesity, a cause of increased worry in urban Indian communities.[13]

Despite these advantages, the present study has certain limitations. Being a single-centre study, the external validity of the findings may be constrained. The sample size, while statistically powered, may still be underpowered to detect nuanced gender-based differences or regional disparities in growth response.

However, findings provide a compelling case for extending studies to multicentric cohorts of different Indian states and socioeconomic status. Longitudinal studies would test the validity of synthetic charts for assessing growth over time and predicting future outcomes, e.g., morbidity, school readiness, or final height.

From a policy standpoint, the incorporation of synthetic growth references in national child health programs decreases the tertiary level care burden. In addition, electronic incorporation of LMS-based growth chart tools into pediatric electronic health records has the potential to make growth monitoring more effective in practice environments.

CONCLUSION

Indian synthetic growth charts provide population-specific, clinically valid, and feasible alternative to WHO MGRS 2006 standards. They have a greater potential for detection of clinically important anthropometric deficits in CKD children and fewer false positives seen with WHO charts. Application of the charts in pediatric practice across India could optimise growth monitoring, resource utilisation, and planning for interventions.

The results emphasise the significance of local references and validate the widespread use of synthetic growth charts in national health programs. They also suggest the possibility of using such charts in clinical follow-up of children with chronic diseases such as CKD, where precise growth monitoring is vital to management.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Textbook of Family Medicine. Available at: http://shop.elsevier.com/books/textbook-of-family-medicine/rakel/978-0-323-23990-5. Accessed on 26 February 2026.
2. Menardo E, Balboni G, Cubelli R. Environmental factors and teenagers' personalities: The role of personal and familial Socio-Cultural Level. Behav Brain Res. 2017;325(Pt B):181-7.
3. Iyanuoluwa OBA, Esther AOO, Adeleye AA. Primary Health Care Workers' Role in Monitoring Children's Growth and Development in Nigeria, West Africa. GJHS. 2011;3(1):30.
4. Park K. Park's Textbook of Preventive and Social Medicine-Banarsidas Bhanot. 2015.
5. Cole TJ. The development of growth references and growth charts. Ann Hum Biol. 2012;39:382-94.
6. Group WMGRS, de Onis M. WHO Child Growth Standards based on length/height, weight and age. Acta Paediatrica. 2006:450:76-85.
7. Pulungan AB, Julia M, Batubara JR, Hermanussen M. Indonesian National Synthetic Growth Charts; 2018.
8. Khadikar V, Khadilkar AV, Lohiya NN, Karguppikar MB. Extended growth charts for Indian children. J Pediat Endocrinol Metabol. 2020;34(3):357-62.
9. Levels and Trends in Child Malnutrition Child Malnutrition: Key Findings of the Geneva: World Health Organization; 2023. Available at: https://data.unicef.org/wp-content/uploads/2023/05/JME-2023-Levels-and-trends-in-child-malnutrition.pdf. Accessed on 19 January 2026.
10. Khadilkar V, Ekbote V, Gondhalekar K, Khadilkar A. Comparison of Nutritional Status of Under-Five Indian Children (NFHS 4 Data) Using WHO 2006 Charts and 2019 Indian Synthetic Charts. Indian J Endocrinol Metab. 2021;25(2):136-41.
11. Pascanu I, Pop R, Barbu CG, Dumitrescu CP, Gherlan I, Marginean O, et al. Development Of Synthetic Growth Charts For Romanian Population. Acta Endocrinol. 2016;12(3)309-18.
12. Hermanussen M, Burmeister J. Synthetic growth reference charts. Acta Paediatrica. 1999;88(8):809-14.
13. Mehta S, Oza C, Karguppikar M, Khadilkar V, Khadilkar A. Field Testing of Synthetic Growth Charts in 1-60- Month-Old Indian Children. Indian J Endocrinol Metab. 2022;26(2):180-5.
14. Mondkar SA, Khadilkar V, Jahagirdar R. Comparison of Nutritional Status of Healthy Under-Five Indian Children Using Composite Index of Anthropometric Failure on WHO 2006 versus 2019 Indian Synthetic Growth Charts. Indian J Pediatr. 2024;91(7):659-66.
15. Dange NS, Khadilkar V, Kore V. Comparison of WHO 2006 Growth Standards and Synthetic Indian References in Assessing Growth in Normal Children and Children with Growth-Related Disorders. Indian J Endocrinol Metab. 2024;28(2):220-6.
16. Tresa A, Khadilkar V, Jahagirdar R, Deshpande R, Kore V. Change in Grading of Stunting in Children aged 0- 5 years in a Tertiary Hospital in Western India by Using WHO vs. Indian References. Indian J Pediatr. 2025;93(1):48-52.
17. Rössner S. Adolphe Quetelet (1796-1874): Obes Rev. 2007;8(2):183.
18. Reed RB, Stuart HC. Patterns of growth in height and weight from birth to eighteen years of age. Pediatrics. 1959;24:904-21.
19. Jackson RL, Kelly HG. Growth charts for use in pediatric practice. J Pediatr. 194;51(27):215-29.
20. Hamill PV, Drizd TA, Johnson CL, Reed RB, Roche AF. NCHS growth curves for children birth-18 years. United States. Vital Health Stat. 1977;(165):i-iv,1-74.
21. Graitcer PL, Gentry EM. Measuring children: one reference for all. Lancet. 1981;2(8241):297-9.
22. Agarwal DK, Agarwal KN. Physical growth in Indian affluent children (birth-6 years). Indian Pediatr. 1994;31(4):377-413.
23. Agarwal DK, Agarwal KN, Upadhyay SK, Mittal R, Prakash R, Rai S. Physical and sexual growth pattern of affluent Indian children from 5 to 18 years of age. Indian Pediatr. 1992;29(10):1203-82.
24. Khadilkar V, Khadilkar A. Growth charts: A diagnostic tool. Indian J Endocrinol Metab. 2011;15(3):166-71.
25. Khadilkar VV, Khadilkar AV, Cole TJ, Sayyad MG. Crosssectional growth curves for height, weight and body mass index for affluent Indian children, 2007. Indian Pediatr. 2009;46(6):477-89.

26. Khadilkar VV, Khadilkar AV, Choudhury P, Agarwal KN, Ugra D, Shah NK. IAP growth monitoring guidelines for children from birth to 18 years. Indian Pediatr. 2007;44(3):187-97.
27. Mei Z, Ogden CL, Flegal KM, Grummer-Strawn LM. Comparison of the prevalence of shortness, underweight, and overweight among US children aged 0 to 59 months by using the CDC 2000 and the WHO 2006 growth charts. J Pediatr. 2008;153(5):622-8.
28. Parekh BJ, Khadilkar V. Pediatrician-Friendly IAP Growth Charts for Children Aged 0-18 Years. Indian Pediatr. 2020;15(11):997-8.
29. Redlefsen T, Commentz J, Meigen C, Hermanussen M. Reference values for height, weight and body mass index of German born Turkish children. Anthropol Anz. 2007;65(3):263-74.
30. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group: Chapter 1: Definition and classification of CKD. Kidney Int Supplements. 2013;3(1):19-62.
31. Lebowitz RL, Olbing H, Parkkulainen KV, Smellie JM, Tamminen-Möbius TE. International system of radiographic grading of vesicoureteric reflux. International Reflux Study in Children. Pediatr Radiol. 1985;15(2):105-9.
32. Namdev R. Radiopaedia. SFU grading system of hydronephrosis. Available at: https://radiopaedia.org/articles/sfu-grading-system-of-hydronephrosis. Accessed on 15 November 2025.
33. Fernbach SK, Maizels M, Conway JJ. Ultrasound grading of hydronephrosis: introduction to the system used by the Society for Fetal. Urology. Pediatr Radiol. 1993;23(6):478-80.
34. de Onis M. 4.1 The WHO Child Growth Standards. World Rev Nutr Diet. 2015;113:278-94.

Cite this article as: Khanna A, Jahagirdar R, Deshpande R, Khadilkar V. Stunting in under-five children with chronic kidney disease: Indian synthetic growth charts are more accurate than World Health Organization growth standards. Int J Contemp Pediatr 2026;13:593-9.