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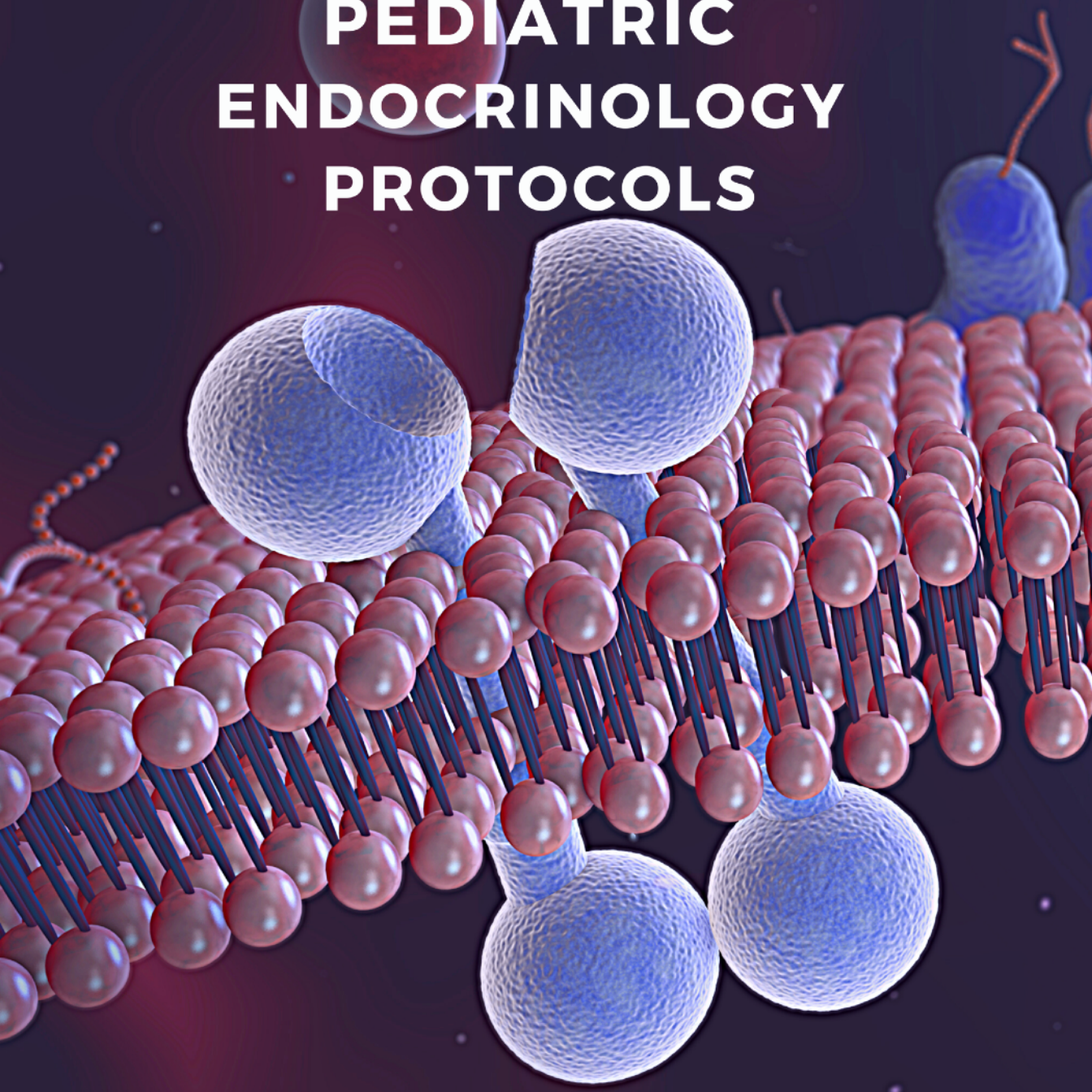

ANURAG BAJPAI

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PEDIATRIC ENDOCRINOLOGY PROTOCOLS

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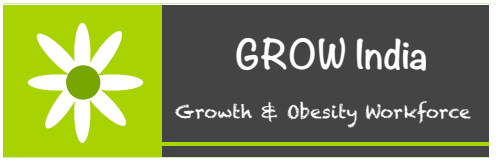
II Edition



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Preface

The advances in Pediatric Endocrinology have resulted in significant improvement in the quality of care of children with hormonal disorders. A lack of practical resources has, however, been a key impediment to evidence based pediatric endocrinology practice. The first edition of Pediatric Endocrinology Protocols, published in 2014, aimed to fulfill the void and was widely appreciated for its clarity and succinctness.

GROW Society (Growth & Obesity Workforce), established in 2013 to spread awareness about Pediatric Endocrinology, has worked extensively for physician awareness by formulating six modules, publishing four books, and developing three point-of-care mobile applications. GROW Society modules have been attended by over 5000 pediatricians. The difficulties of onsite programs led to the development of MedEClasses. This innovative E-Learning portal uses a combination of videos, animations, didactic text, and real-life cases to provide knowledge about pediatric endocrinology. The MedEClasses online courses in Pediatric Endocrinology have been widely subscribed to globally.

This book represents a significant update on the previous edition with the inclusion of the latest guidelines and state-of-the-art management pathways. Each chapter is divided into sections on pointers and criteria, etiology, assessment, approach, and management. The book is supplemented by animated videos that can be accessed by scanning the QR code provided in all chapters. The book would help Pediatricians, Pediatric trainees, Pediatric Endocrinologists, and Endocrinologists.

This work would not have been possible without the help of dynamic, colleagues Drs Manoj Agarwal, Vibha Yadav, and Dhvani Raithatha. Dr. Yuthika's valuable suggestions have gone a long way in bringing the book into its shape. Thanks to Hariom, Aditya, and Nikhil for making this project seamless and enjoyable.

Happy learning,

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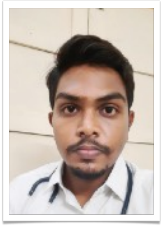

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SECTION I GROWTH DISORDERS
Chapter 1 Growth Assessment

Manoj Agarwal, Sonal Shah, Anurag Bajpai

INDICATIONS

At birth

- Head circumference.
- Penile length- To identify micropenis, a clue to multiple pituitary hormone deficiency.
- Length and weight.

On follow-up

- Height, weight. Body mass index and sexual maturity rating from six years of age.
- At each immunization visit (6, 10, and 14 weeks) and six months of age.
- Six monthly from 1-8 years and annually after that.

Table 1.1- IAP recommendations for growth monitoring

Age	Frequency	Parameters
Birth	-	Weight, Length, head circumference, penile length
6 week- 3 year	6, 10, 14 wk, 6 mo; 6 monthly	Weight, length, head circumference
3-8 year	6 monthly	Weight, height; Body mass index, puberty from 6 yr
8-18 year	Annually	Weight, height, body mass index, pubertal stage

LINEAR ASSESSMENT

Length

- Indications- Till 2 years of age or below 90 cm.
- Greater than height by 1 cm.
- Assess using infantometer till the first decimal point.
- Two observers, one fixing the head and the second extending the lower limbs.

Height

- Measure using a stadiometer.
- Head in the Frankfurt plane (line joining outer canthus and external auditory meatus).
- Occiput, shoulder blades, buttocks, and heel firmly touching the stand.
- Errors- Failure to remove footwear, over-pressing the headrest, incorrect positioning.

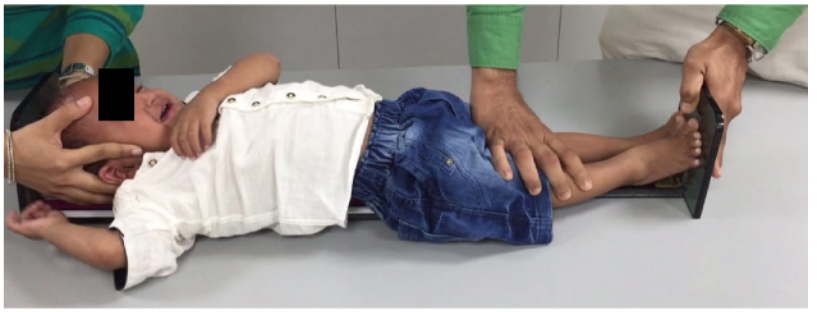

Figure 1.1- Length measurement

- Evening length 0.8 cm lower that morning (decreased tone of spinal muscles).
- Surrogate- Knee length in spinal deformity, upper arm length with contractures.

Parental height

- Target height
- Average the mean height of the parents
- Add 6.5 cm for boys and subtract 6.5 cm for girls.
- Range- Mid parental height ± 8 cm (1.5 standard deviation score).

BODY PROPORTION

Upper to lower segment ratio

- Upper segment- Top of the head till the pubic symphysis.
- Lower segment- Pubic symphysis to legs.
- Measured the height of a child sitting on a stool.
- Sitting height- Deduct the size of the stool from the height of the seated child.
- Lower segment- Total height – Sitting height.
- Normal- 1.7 :1 at birth decreases annually by 0.07 to reach 1:1 by 10 years.
- Decreased (Advanced)- Spondyloepiphyseal dysplasia, precocious puberty.
- Increased (Delayed)- Achondroplasia, hypothyroidism.

Arm span

- Distance between the tip of the middle phalanges of outstretched arms.
- Less than height till 12 years of age in boys and 14 years in girls.
- Adult arm span greater than height (5.3 cm in men and 1.2 cm in women).
- Increased- Klinefelter syndrome, Marfan syndrome.
- Decreased- Achondroplasia.

Rhizomelic index

- Marker of forearm shortening.

- Ratio of
    - Shoulder elbow length (mid shoulder to distal humerus)
    - Elbow metacarpal length (tip of the elbow to the third metacarpal).
- Levels below 0.98 suggest rhizomelia (forearm shortening).

Brachymetacarpia

- Short fourth metacarpal.
- Place a scale against the knuckles of a clenched fist.
- Greater than 2 mm- Turner syndrome, Pseudohypoparathyroidism, SHOX defects.

GROWTH INDICES

Percentile

- The ranking is when a group is arranged in ascending order for a given parameter.
- Not a useful marker of severity (difficult to quantify beyond the first percentile).

Standard deviation score (SDS)

- An objective measure of the deviation of height from the median value.

SDS = Observed value - expected value/ SD

- Higher SDS levels indicate a higher chance of pathological disorders.

Table 1.2- Comparison of SDS and the percentile score

SDS	-3	-2.25	-2	-1	0	1	2	3
Percentile	0.1	1	2.5	16	50	66	97.5	99.9

GROWTH CHART

Advantages

- Pictorial.
- Easy to plot.
- Easy to interpret and follow up.

Ideal chart

- Recent (within 10 years).
- Developed from the local population.
- Designed to overcome confounders affecting growth (nutrition and disease).

Types

Growth Standard (WHO)

- Population living in ideal conditions.
- Difficult to prepare.
- Information about how children should grow.

Growth reference (CDC, IAP 2015)

- Representative of each section of the population.
- Information about how children are growing.

Table 1.3- Comparison of growth reference and standard

Feature	Reference	Standard
Population	General	Ideal
Design	Cross sectional	Longitudional
Measure	Actual growth	Ideal growth
Value	Lower	Higher

- CDC 2000 growth charts- NCHS data of middle-class unselected American children.
- WHO growth standards
    - Six countries- Longitudinal (till 24 months), Cross-sectional (2-5 years).
    - Standard- Singleton, normal birth weight, breastfed with no maternal smoking.
    - Limitations- Small sample size.
    - Over-estimates growth failure and underestimate obesity in resource-poor setting.
- Indian Academy of Pediatrics (IAP) 2015 charts
    - Nine studies of 33,000 subjects across India aged five to eighteen years of age.
    - Pediatrician-friendly growth charts (0-18 years)
        - Direct information about mid-parental height.
        - BMI category based on height and weight.

Growth velocity charts

- Levels above 25 percentiles are normal.
- Lower than 25 percentiles are a matter of concern.

Table 1.4- Growth velocity norms

Age	Normal growth	Abnormal
1-2 year	10 cm/year	< 7 cm/year
3-4 years	7 cm/year	< 6 cm/year
5-6 years	6 cm/year	< 5 cm/year
6 years-puberty	5 cm/year	< 4 cm/year

Disease-specific charts

- Turner syndrome, Down's syndrome, and achondroplasia.
- Identify causes of growth failure other than the primary disorder.

APPLICATION

Precautions

- Confirm date of birth and calculate decimal age.
- Use only a dot to mark the child's growth, not a large arrow.

Stepwise evaluation

- Assess absolute status- Percentile.
- Evaluated the parental effect
    - Plot mid-parental height at the age of 18 years.
    - Draw a line 8 cm above and below the dot marking the target height range.
    - The area between these lines is the growth chart for the family.
    - Values within the chart suggest normal growth.
- Assess the relative impact on height and weight
    - Height age- The age at which the current height is the fiftieth percentile.
    - Weight age- The age at which the current weight is the fiftieth percentile.
    - Draw a line from the height to where it meets the 50 percentile line.
    - Draw a perpendicular line from this point to obtain height and weight age.

Interpretation

- Short stature- Lower weight age suggests nutritional etiology.
- Obesity- Height age less than chronological age suggests the endocrine cause.

Further reading

1. IAP Growth Monitoring Guidelines for Children from Birth to 18 Years. http://medind.nic.in/ibv/t07/i3/ibvt07i3p187.pdf
2. Bajpai A. Agarwal N. Growth chart assessment. Bajpai A, Ed. Basic Pediatric Endocrinology, Kanpur, Edition 2019. Pp 40-45.

Growth Assessment

Growth chart

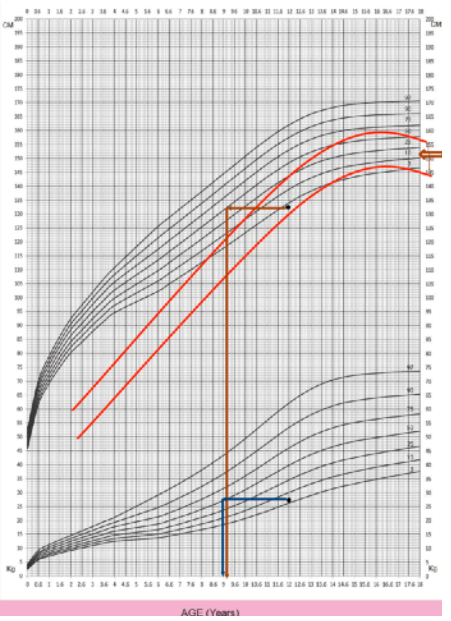

Figure 1.2- A 12-year-old girl with short stature (height 132 cm; weight 28 kg). She is short for the population (height below the third percentile) but normal for the family, suggesting familial short stature. Height and weight age are equally affected at nine years.

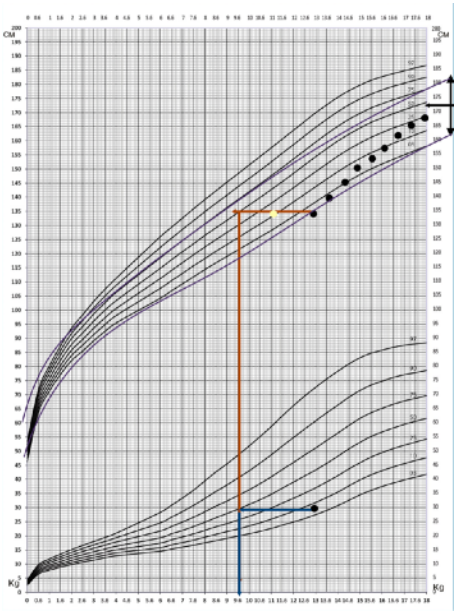

Figure 1.3- Thirteen-year-old boy with short stature diagnosed with GHD given low peak GH. He was short for the population and family but normal for bone age, indicating constitutional delay. He showed normal growth on follow-up without GH treatment.

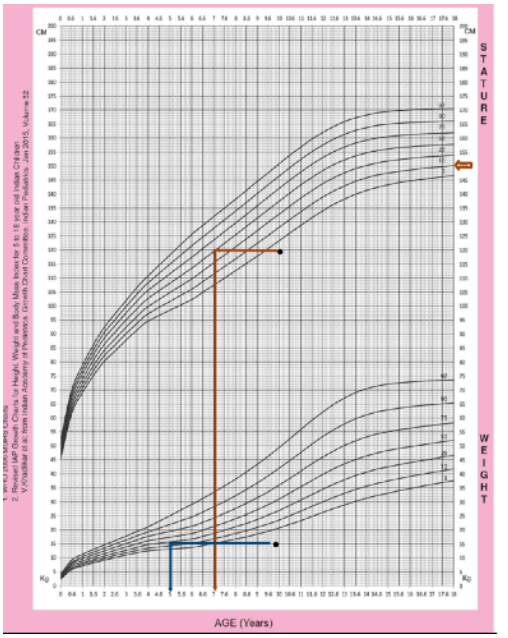

Figure 1.4- A 10-year-old girl was diagnosed with GHD in view of low IGF-1 and GH levels. She had no response to growth hormones. The growth chart indicated nutritional patterns. IgA levels were low, with a biopsy confirming celiac disease.

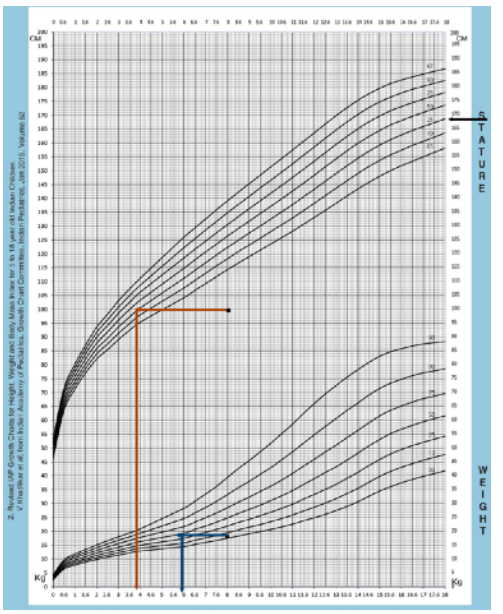

Figure 1.5- Eight-year-old boy with short stature was diagnosed with celiac disease in view of high TTG (32 IU/L) without endoscopic biopsy. He had no response to a gluten-free diet. The growth chart showed greater height involvement than weight, indicating an endocrine pattern. GH test showed complete growth hormone deficiency.

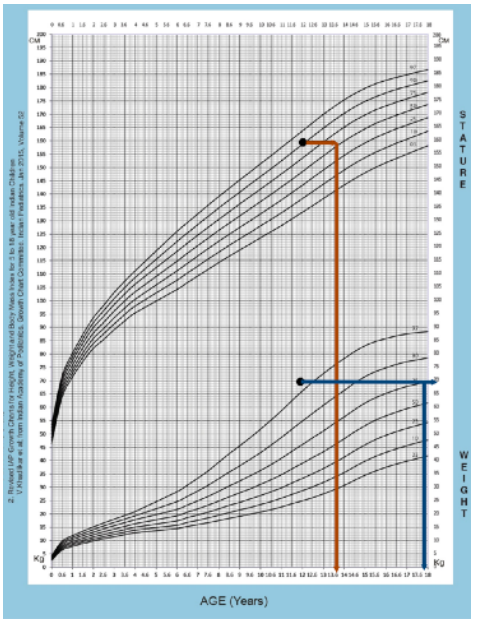

Figure 1.6- A 12-year-old boy with obesity diagnosed with hypothyroidism in view of elevated TSH (6.2 mU/L). The growth chart suggested the endocrine pattern (increased height age). TPO was negative and thyroid functions normalized with weight loss.

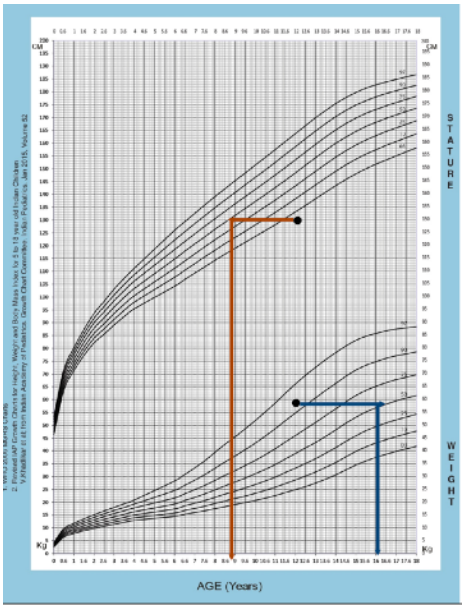

Figure 1.7- A 11.5 year--old boy was diagnosed with exogenous obesity in view of normal screening tests. He had persistent weight gain, plethora, and myopathy. The growth chart showed an endocrine pattern with compromised height. Workup was suggestive of Cushing syndrome.