GROWTH ASSESSMENT AND GROWTH DISORDERS

GROWTH PARAMETERS TO BE MONITORED

- **Birth-2 years:**
  - Weight, length & head circumference at birth, immunization contacts at 6, 10, 14 weeks, 9 months, 15 months & 18 months
  - An additional visit at 6 months desirable
- **2-8 years:**
  - Height & weight 6 monthly.
  - Calculate BMI & record SMR staging in a child beyond 6 years annually
- **9-18 years:**
  - Annual assessment of height, weight, BMI & SMR
  - Growth can also be assessed at times the child is brought for any other reason to the physician

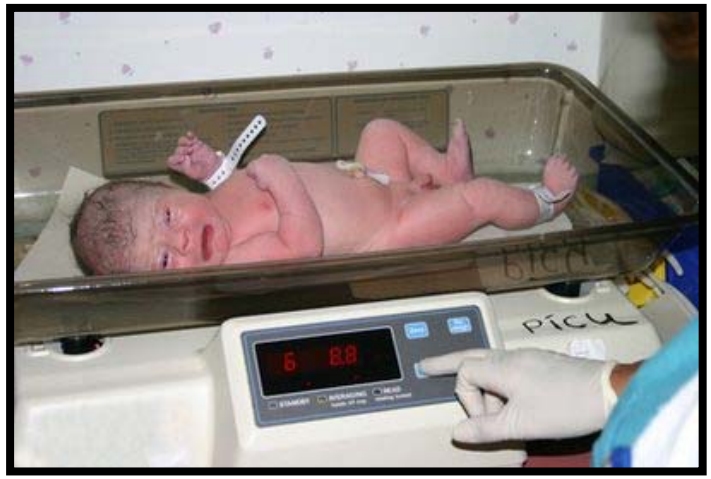
SIGNIFICANCE OF GROWTH MONITORING

- Monitor the growth of an individual and detect growth abnormalities
- Monitor nutritional status
- Track the effects of medical or nutritional interventions

HOW TO MEASURE WEIGHT?

Weighing scales:

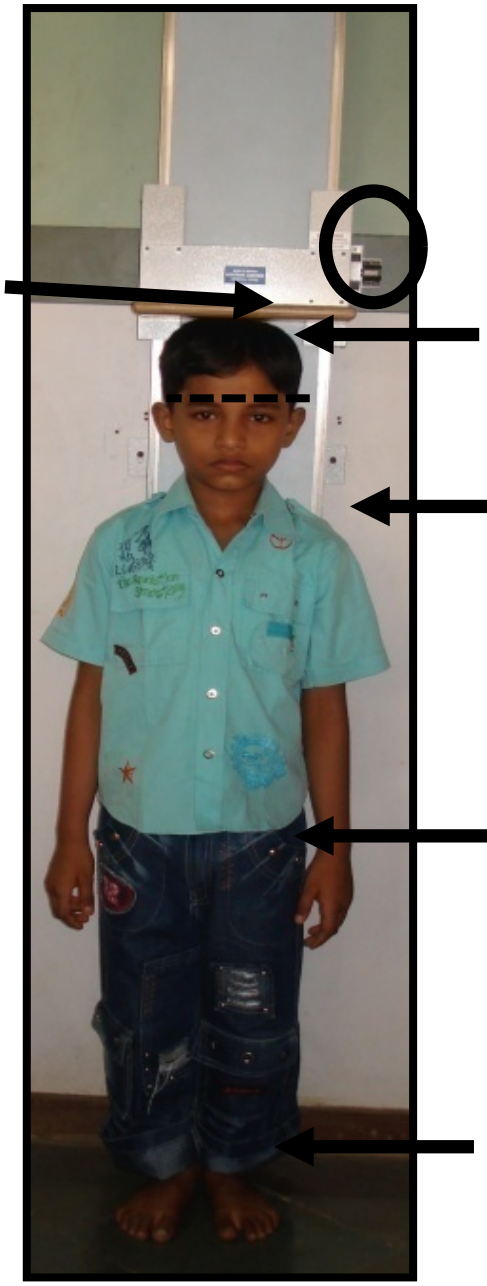
- Lever/Electronic
- Spring balance (less accurate)
- Minimum unit 100gm



Technique

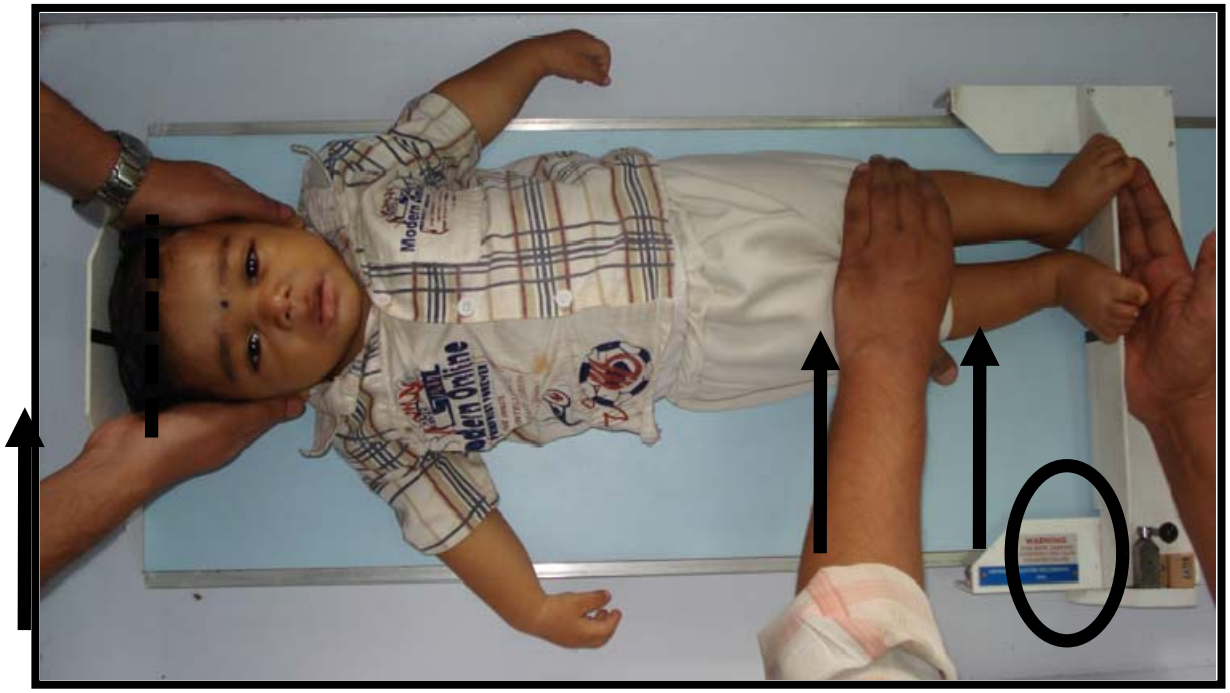
- In nude or minimal clothing
- Weighing scale checked for zero error
- Center the infant on the scale tray
- Weigh infant to the nearest 10 gm and older child to nearest 100 gm.

MEASUREMENT OF LENGTH



- After 2-3 years of age, height should be measured by stadiometer.
- Child should stand erect, with occiput, shoulders, buttocks, and heels touching the vertical bar. Look straight (Frankfort's plane parallel to floor)
- Horizontal bar is lowered to the vertex of the child and take reading

MEASUREMENT OF LENGTH

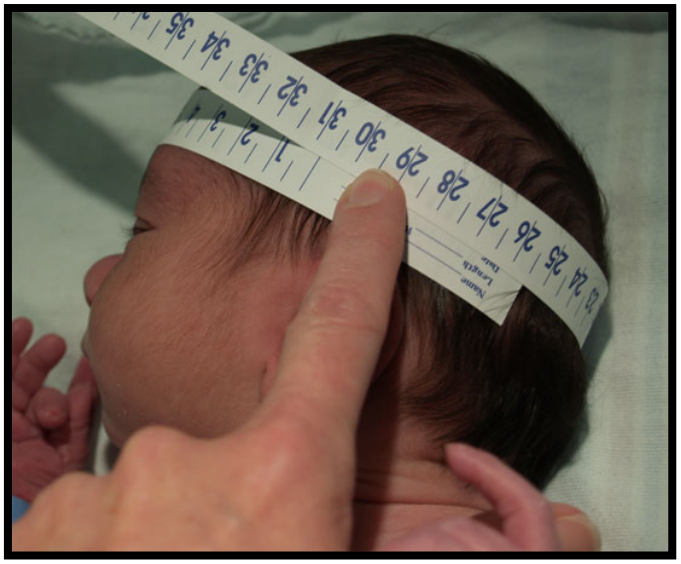


Length of children < 2-3y are measured by infantometer.

MEASUREMENT OF HEAD CIRCUMFERENCE (HC)

- HC should be measured using non-stretchable tapes (e.g.. Steel)

- Measure across most prominent points of superior orbital ridge (anterior) and external occipital protuberance (posterior)



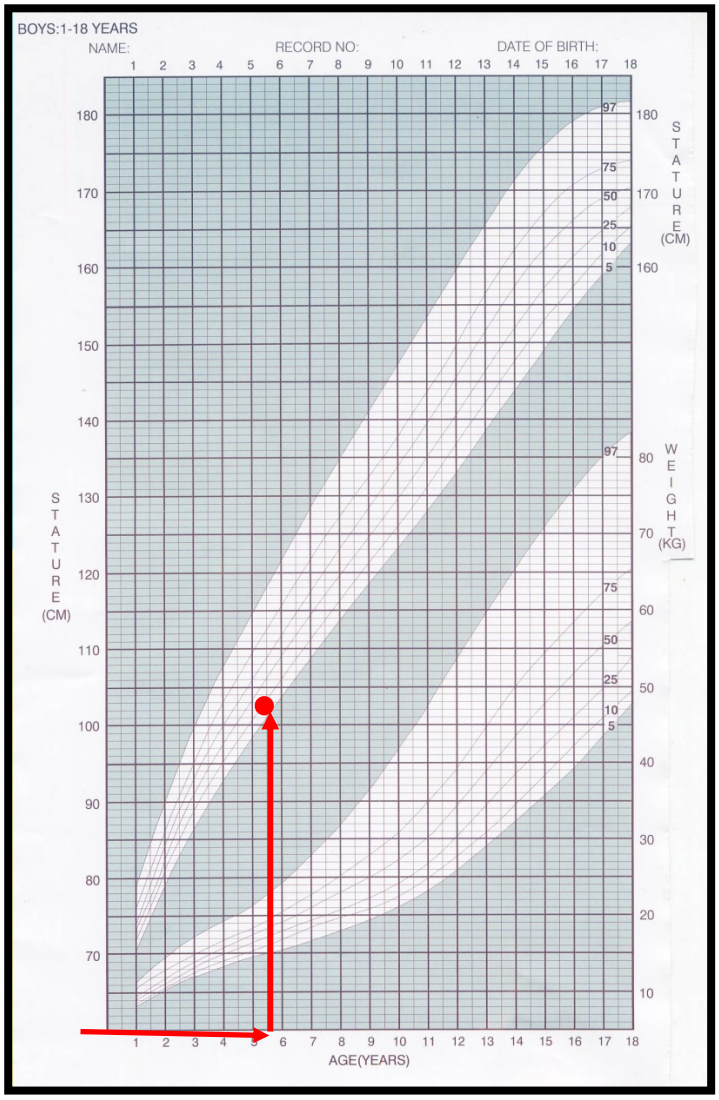
Should not be measured within 24 hrs. after birth to avoid spurious values due to moulding

MEASUREMENT OF ARM SPAN

Distance between the tips of middle fingers when the arms are out stretched parallel to the floor.

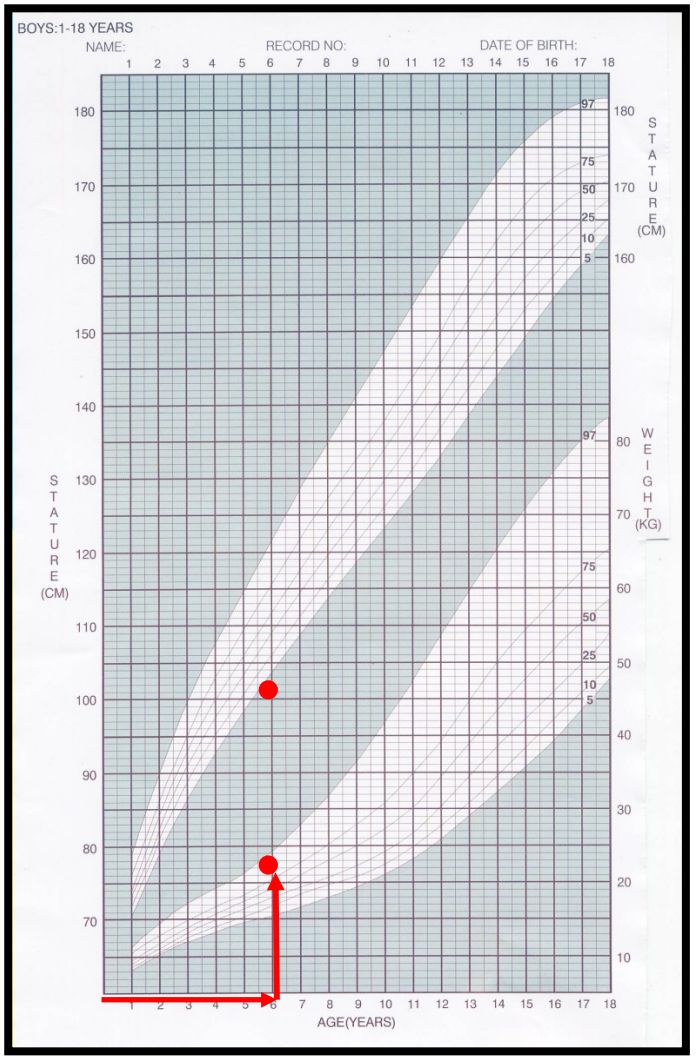
PLOTTING HEIGHT ON A GROWTH CHART

- 6 years old boy
- Height: 102 cm
- Draw an imaginary line along the X-axis till the age (6y) of the child
- Then extend the imaginary line along the Y-axis till the height (102 cm) of the child
- Mark the point



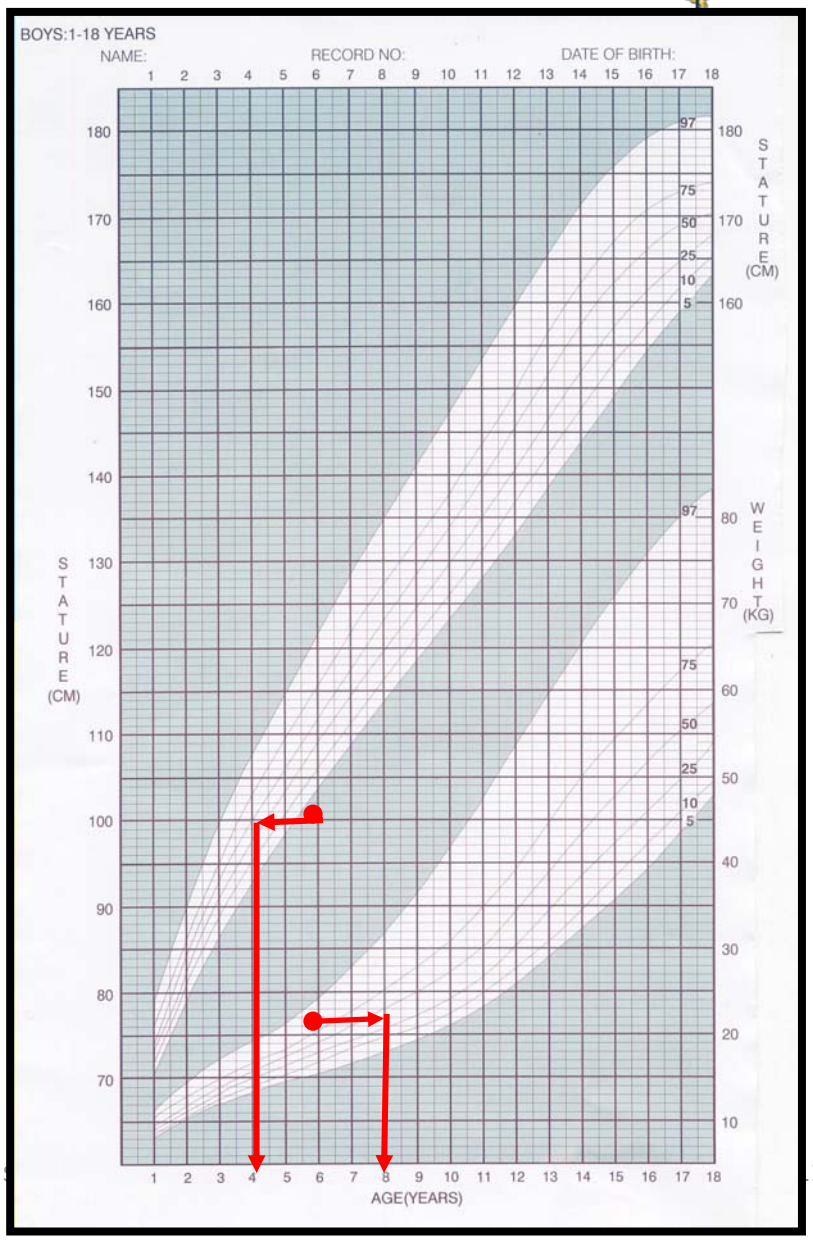
PLOTTING WEIGHT ON A GROWTH CHART

- 6 years old boy.
- Weight: 22 kg.
- Draw an imaginary line along the X-axis till the age (6y) of the child.
- Then extend the imaginary line along the Y-axis till the weight (22 kg) of the child.
- Mark the point.



CALCULATION OF HEIGHT AGE AND WEIGHT AGE

A 6 years old boy
Height: 102 cm
Weight: 22 kg
Ht age: 4 years
Wt. Age: 8 years

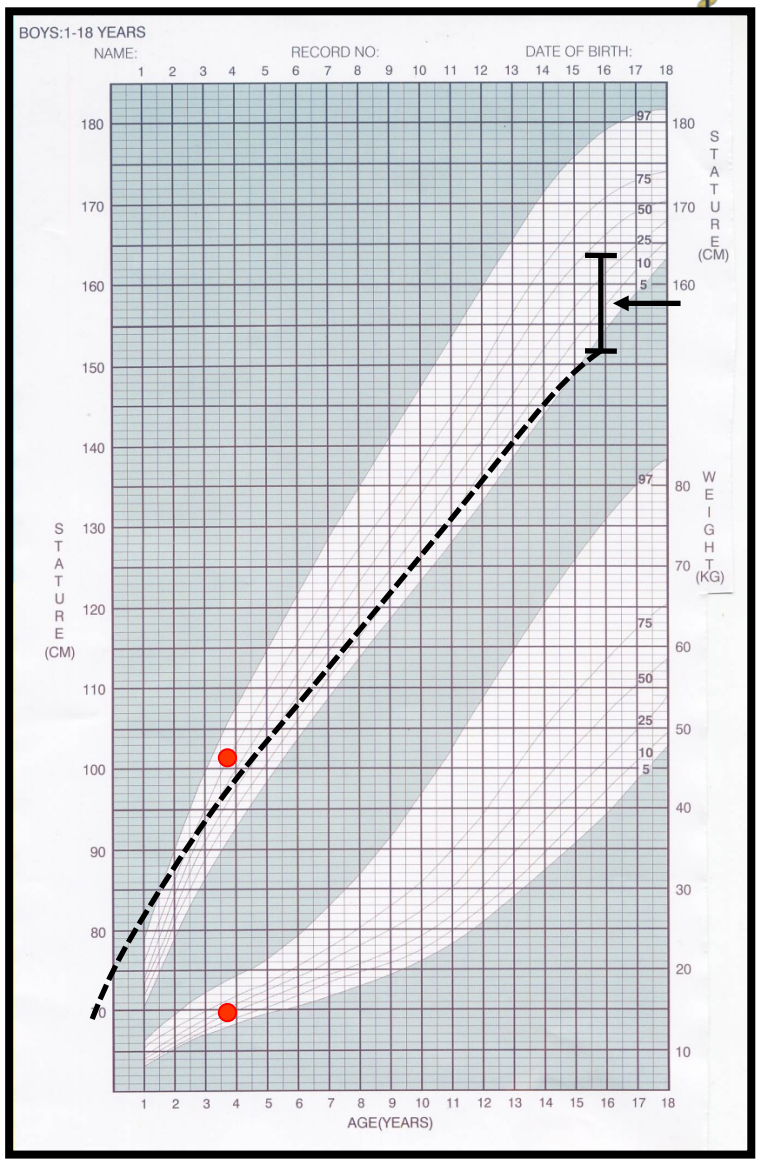


MEAN PARENTAL HEIGHT

- For boys mean parental height: (MH+FH+13)/2
- For girls mean parental height: (MH+FH-13)/2
- Target range: MPH± 6 cm
- Height of a boy: 103 cm
- Father's height: 160 cm
- Mother's height: 147 cm
- Mean parental height(boy): (MH+FH+13)/2: 160 cm
- Target range: 160 ± 6cm (154-166 cm)

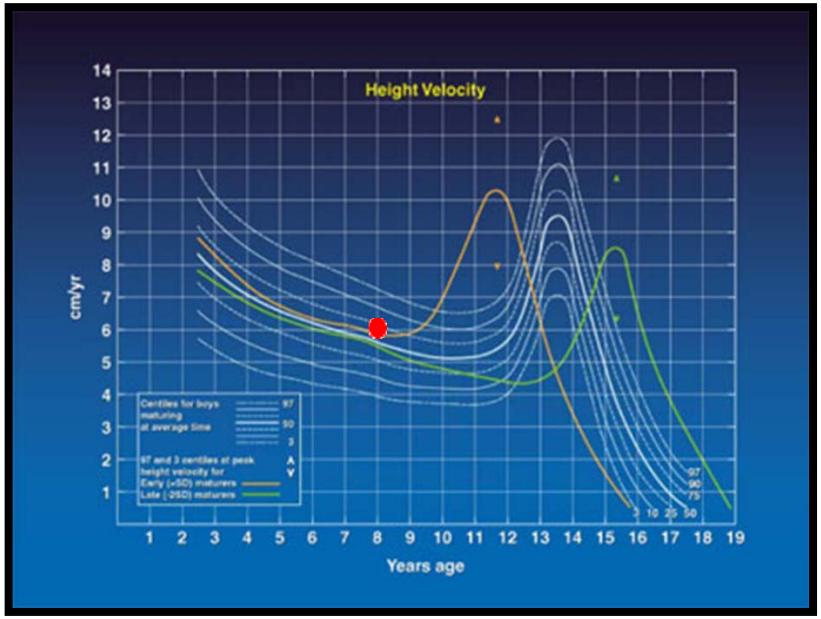
PLOT MPH AND TARGET RANGE ON GROWTH CHART

- Extend 6 cm above and below from MPH point: Target range
- Extend an imaginary line backwards from the lower end of the target range till reaches the patient's height
- If a short child's height is above this line then child is familial short stature and if below then child is pathological short stature



HEIGHT VELOCITY

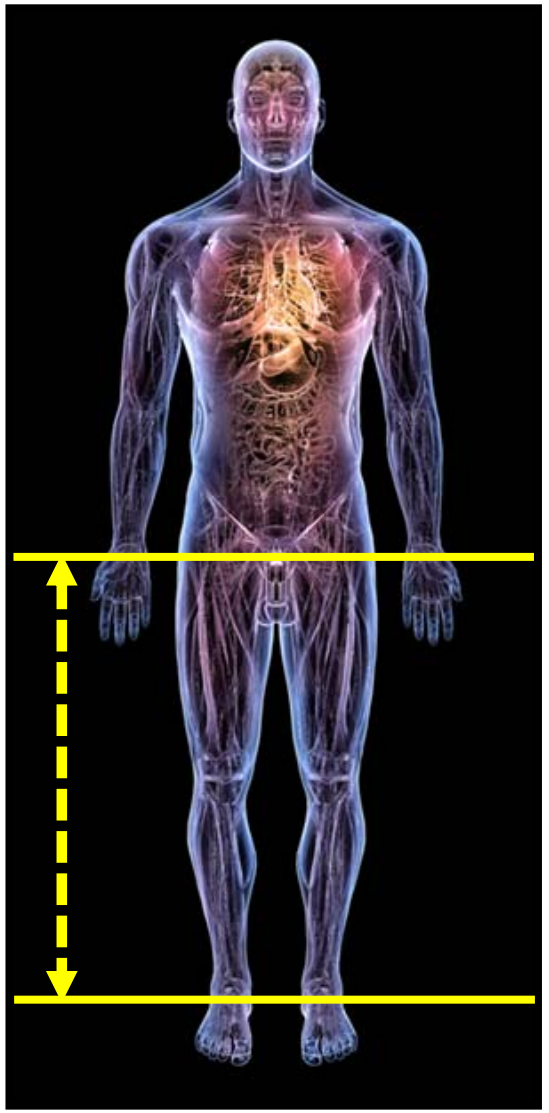
- A boy grows from 119 to 122 cm from 9 to 9.5y
- Grown 3 cm in 1/2 year
- Growth velocity: 6cm/y
- 75th and 90th percentiles
- Height velocity < 25th centile is abnormal



- Usually normal in variants of growth like CDGP and FSS
- Decreased in pathological causes of short stature

BODY PROPORTIONS

- Upper segment: Lower segment ratio
- Measure lower segment from top of symphysis pubis to floor
- Subtract lower segment from height to get upper segment.



DISPROPORTIONATE SHORT STATURE

Short limbs (Increased US/LS)

- Achondroplasia
- Hypochondroplasia
- Chondrodysplasia punctata
- Mesomelic dysplasia
- Acrodysostosis

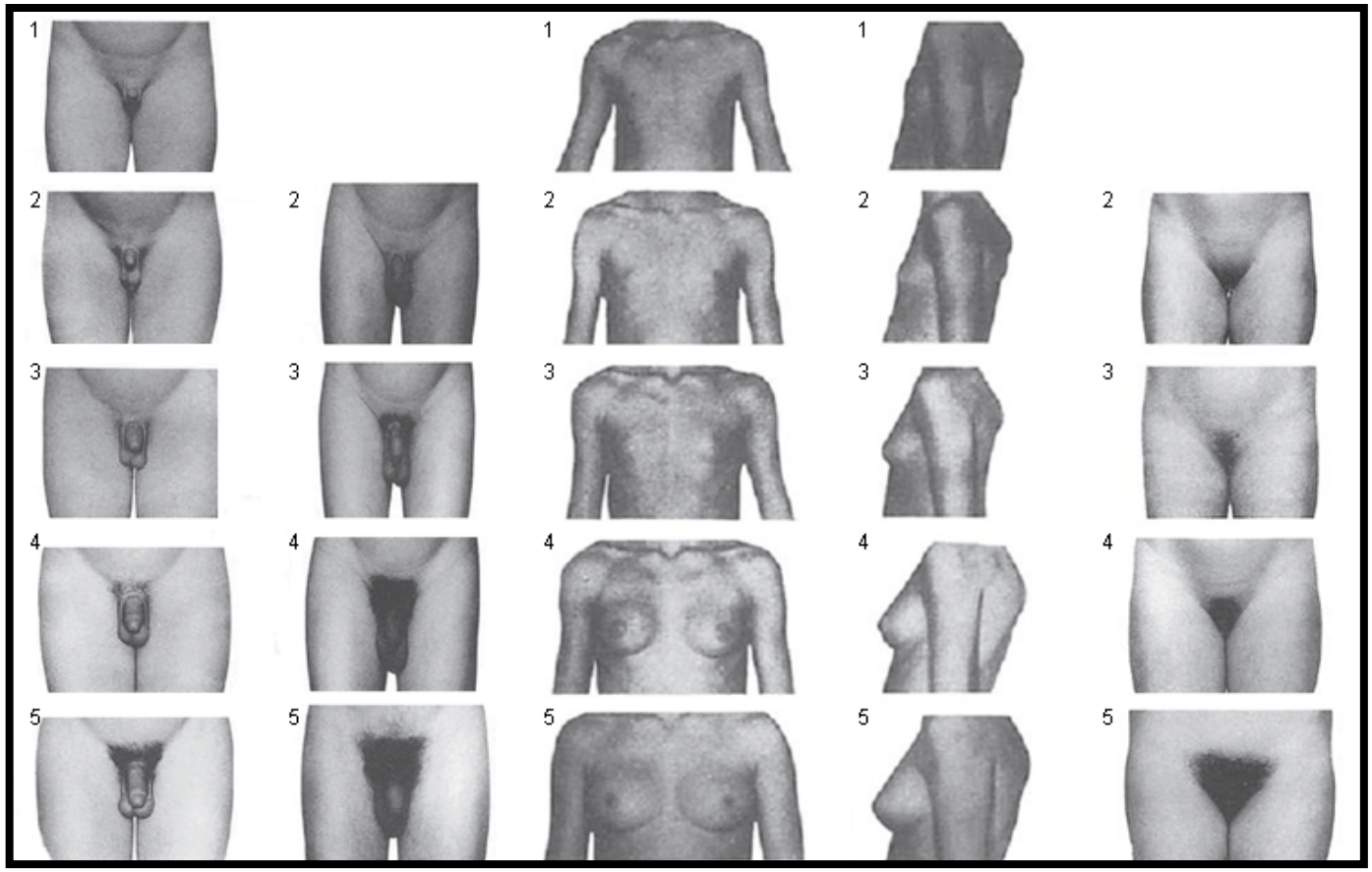
Short trunk (Decreased US/LS)

- Spondyloepiphyseal dysplasia
- Spondylometaphyseal dysplasia
- Mucopolysachcharidoses
- Mucolipidoses

Skeletal survey should be done to rule out skeletal dysplasia in patients with disproportionate short stature

PUBERTAL ASSESSMENT
(TANNER'S SEXUAL MATURITY RATING)

Genital and Pubic hair staging in boys Breast and pubic hair staging in girls



IMPLICATIONS OF PUBERTAL ASSESSMENT IN SHORT STATURE

Normal

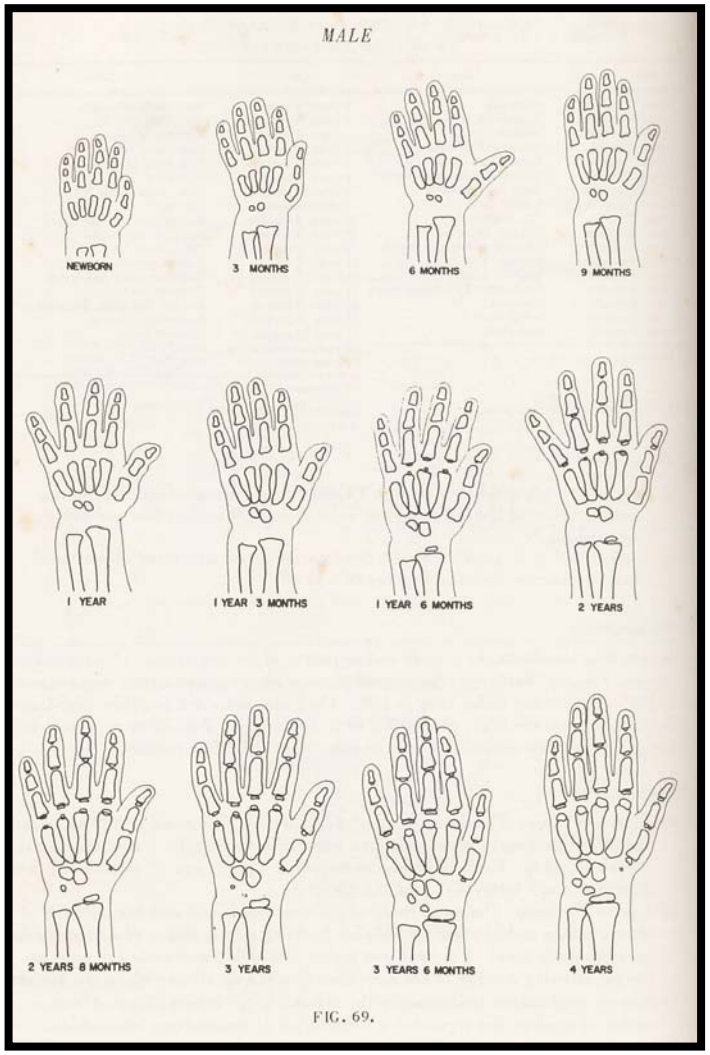
- Familial short stature
- Skeletal dysplasia

Delayed

- CDGP
- Endocrine causes
- Chronic diseases

BONE AGE (BA) ESTIMATION

- Tanner and Whitehouse or Gruelich-Pyle method.
- X-ray of non dominant hand-AP view.
- Compared with the standard of the same sex and nearest age.
- It is next compared with adjacent standard, both older and younger to get the closest match.



WHAT DOES BONE AGE TELL?

- Skeletal maturity and correlates closely with SMR
- Speaks for remaining growth potential and helps in adult height prediction
- Bone age delay of more than 2 SD i.e. about 2 years is significant
- Delayed in most causes of short stature except few conditions like FSS

SHORT STATURE: DEFINITION

- Height less than 3rd percentile of the normal for age, or more than 2 SDs below the mean height for that age, sex and reference population.
- Height velocity less than 25th percentile for age, sex and reference population.

CAUSES OF SHORT STATURE *"IS NICE"*

I- Idiopathic (Most common, constitutional delay, familial short stature)

- Intrauterine (IUGR, TORCH, Fetal alcohol)

S- Skeletal causes (dysplasia, osteogenesis imperfecta)

- Spinal defects (scoliosis, kyphosis)

N- Nutritional (under nutrition)

- Nurturing (deprivation)

I- Iatrogenic (steroids, radiation)

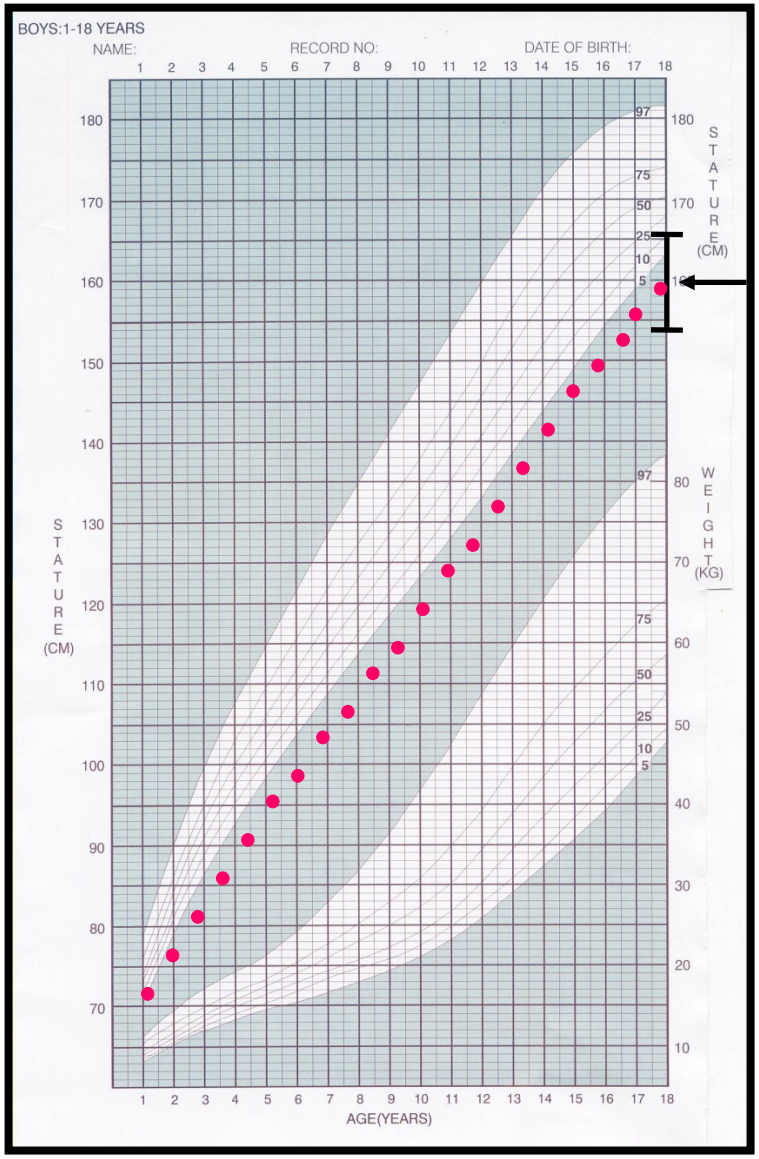
C- Chronic disease

- Chromosomal (Turner, Down's)

E- Endocrine (GH deficiency, hypothyroidism)

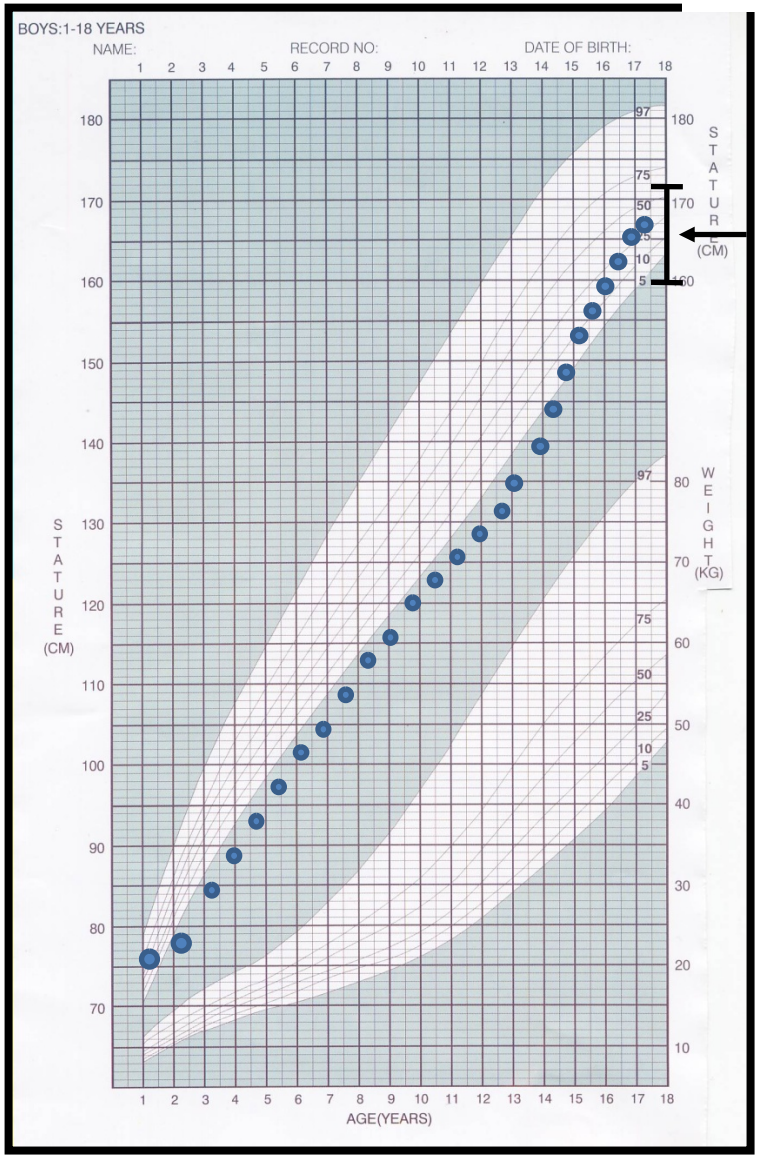
FAMILIAL SHORT STATURE

- MPH < 3rd percentile for reference population
- Normal tempo of puberty
- Normal height velocity
- CA=BA>HA
- Final height is < 3rd centile for reference population but within target range



CONSTITUTIONAL DELAY IN GROWTH AND PUBERTY

- Normal MPH
- Family h/o delayed puberty
- BA=HA<CA
- Normal height velocity
- Delayed puberty
- Normal final height



CLASSIFICATION OF CAUSES OF SHORT STATURE

Intrinsic shortness	Delayed Growth	Attenuated Growth
BA=CA>HA	BA=HA<CA HV ~ Normal	BA=HA<CA HV: Subnormal
• Familial short stature • Syndromic short stature • Skeletal Dysplasia's	• CDGP • Mild-Moderate chronic illness • Mild-Moderate malnutrition	• Endocrinopathies GH deficiency Hypothyroidism Cushing syndrome • Severe chronic illness • Severe malnutrition

HISTORY AND EXAMINATION

POINTERS FROM HISTORY	ASSOCIATED DISEASES
• Birth size (length, weight, head circumference) and gestational age • Birth history (breech delivery, asphyxia, jaundice, hypoglycaemia) • Parental height • Tempo of puberty in parents • Family history • Previous growth information • Social environment	• To identify small for gestational age (symmetric vs asymmetric) • Associated with pituitary dysfunction • To assess genetic potential to grow • To look for family h/o delayed puberty • To look for a genetic cause • May provide clues about the aetiology • To look for emotional deprivation

POINTERS FROM HISTORY	ASSOCIATED DISEASES
• Cardiac: dyspnoea, anasarca, cyanosis Pulmonary: chronic cough, dyspnoea • Intestinal: abdominal distension, diarrhoea • Renal: polyuria, vomiting, fatigue • Neurological: headache, vomiting, focal neurological deficits • Previous surgeries: intestinal resection	• Cardiac failure, cyanotic heart disease • Cystic fibrosis, bronchial asthma, TB • Malabsorption syndromes like Celiac disease • Chronic kidney disease, RTA • Neurotuberculosis, sellar or perisellar tumours, brain tumours treated with RT • Short bowel syndrome

CLINICAL POINTERS	ASSOCIATED DISEASES
• Underweight	• Malnutrition, malabsorption syndromes, hypocortisolism, metabolic disorders.
• Obesity	• SGA hypothyroidism, Cushing's syndrome, IGF-1 deficiency.
• Microcephaly	• Pseudohypoparathyroidism
• Macrocephaly	• Birth asphyxia, symmetric SGA, syndromes
• Short trunk or short limbs dysmorphic features.	• Hydrocephalus, achondroplasia, storage disorders
• Frontal bossing, mid-facial hypoplasia	• Skeletal dysplasia ,Primary growth disorders (syndromes) IGF-1 deficiency

CLINICAL POINTERS	ASSOCIATED DISEASES
• Round facies, facial plethora, virillization	• Cushing's syndrome
• Pharyngeal examination	• Look for adenotonsillar hypertrophy
• Bradycardia, dry skin, goitre	• Hypothyroidism
• Hypertension	• Kidney disease, Cushing's syndrome
• Hepatosplenomegaly	• Hepatic, haematological or metabolic disorder
• Pubertal stage	• Early, normal or late puberty
• Micropenis	• Hypogonadism, hypopituitarism
• Fundoscopy, visual field defect	• Central nervous system pathology
• Signs of neglect or abuse	• Emotional deprivation

WHEN TO EVALUATE?

- Severe short stature (height SDS <-3 SD).
- Severe growth deceleration (height velocity SDS <-2 SD over 12 months).
- Height <-2 SD and height velocity <-1.0 SD over 12 months.
- Height <-1.5 SD and height velocity <-1.5 SD over 2 years.
- Risk factors for GHD.

INVESTIGATIONS : STEP 1

- CBC, ESR
- RFT/LFT
- Chest X-ray
- X-ray Left hand-AP
- Serum electrolytes
- Serum calcium, phosphorous, alkaline phosphatase
- Urine analysis including urine pH
- Stool for parasites, fat globules and occult blood

INVESTIGATIONS: STEP 2

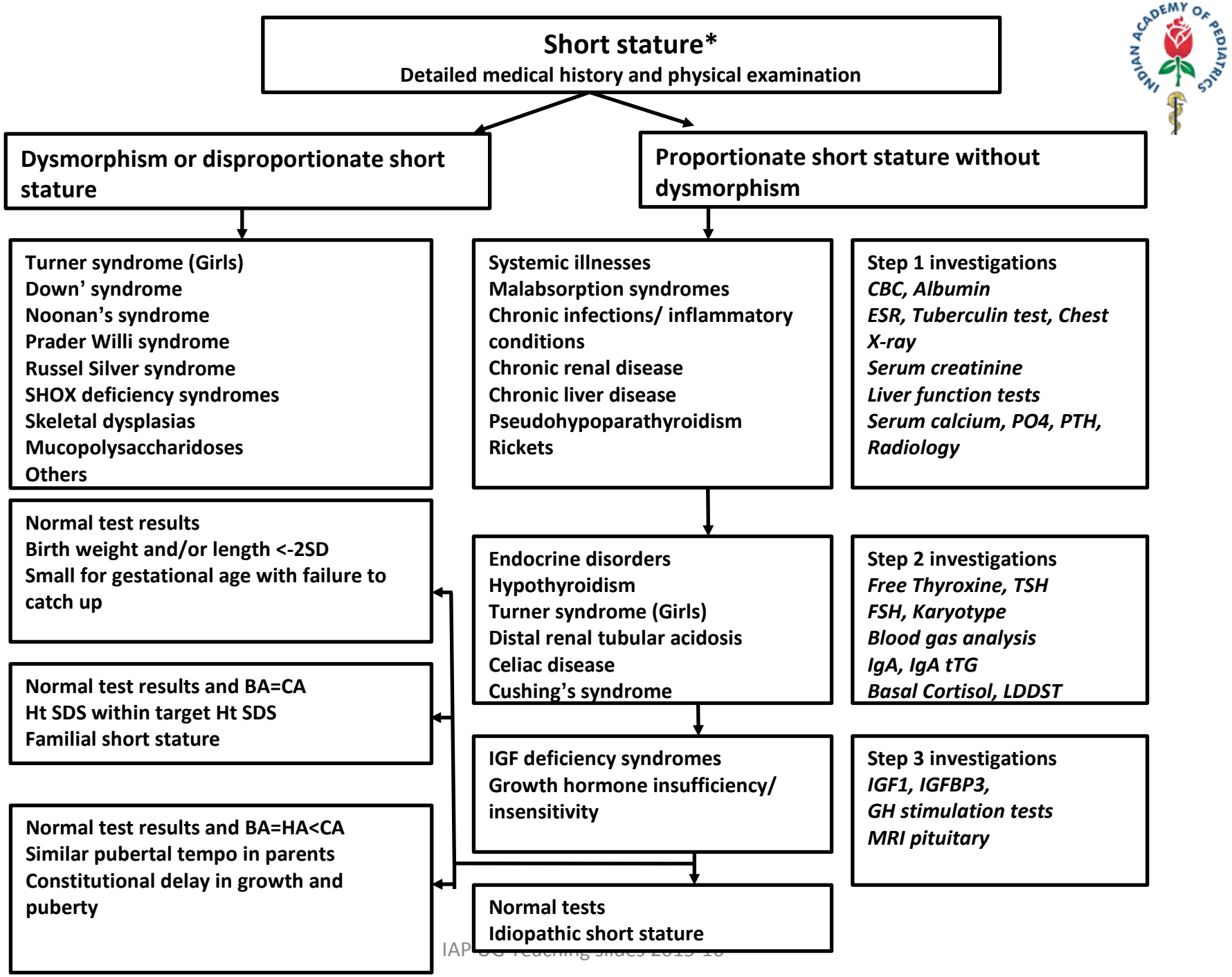
- FT4/TSH
- FSH and Karyotyping (in girls)
- Arterial blood gas
- IgA tTG
- LDDST (only if clinical suspicion)

INVESTIGATIONS: STEP 3
TO RULE OUT GROWTH HORMONE RELATED DISORDERS

- IGF-1 and IGFBP3
- Growth hormone stimulation tests
- MRI pituitary

CLINICAL EVALUATION OF SHORT STATURE

- Anthropometrics: Ht, Wt., HC, Arm span, U/L segment ratio
- Dysmorphic features
- Nutritional status
- Thyroid gland
- Tanner staging for puberty development
- Neurological exam
    - visual acuity and visual fields, nystagmus
    - signs of hydrocephalus, focal signs


Short stature*
Detailed medical history and physical examination
Dysmorphism or disproportionate short stature
Proportionate short stature without dysmorphism
Turner syndrome (Girls)
Down' syndrome
Noonan's syndrome
Prader Willi syndrome
Russel Silver syndrome
SHOX deficiency syndromes
Skeletal dysplasias
Mucopolysaccharidoses
Others
Systemic illnesses
Malabsorption syndromes
Chronic infections/ inflammatory conditions
Chronic renal disease
Chronic liver disease
Pseudohypoparathyroidism
Rickets
Step 1 investigations
CBC, Albumin
ESR, Tuberculin test, Chest X-ray
Serum creatinine
Liver function tests
Serum calcium, PO4, PTH, Radiology
Normal test results
Birth weight and/or length <-2SD
Small for gestational age with failure to catch up
Endocrine disorders
Hypothyroidism
Turner syndrome (Girls)
Distal renal tubular acidosis
Celiac disease
Cushing's syndrome
Step 2 investigations
Free Thyroxine, TSH
FSH, Karyotype
Blood gas analysis
IgA, IgA tTG
Basal Cortisol, LDDST
Normal test results and BA=CA
Ht SDS within target Ht SDS
Familial short stature
IGF deficiency syndromes
Growth hormone insufficiency/ insensitivity
Step 3 investigations
IGF1, IGFBP3,
GH stimulation tests
MRI pituitary
Normal test results and BA=HA<CA
Similar pubertal tempo in parents
Constitutional delay in growth and puberty
Normal tests
Idiopathic short stature

MANAGEMENT

Systemic diseases: Disease directed therapy

- Thalassemia Major: Pre Blood Transfusion Hb: 9-10.5 g/dl
- Malnutrition: Nutrional rehabilitation
- Nutritional rickets: Vitamin D
- Distal RTA: Shohl's solution
- Celiac disease: Gluten free diet
- Psychosocial dwarfism: Good social environment.

MANAGEMENT

Endocrine disorders

- Primary hypothyroidism: Thyroxine
- Endogenous Cushing syndrome: Tumorectomy
- Panhypopituitarism: GH, Thyroxine, sex steroids, Glucocorticoid

INDICATIONS FOR GH THERAPY

Indication	Dose of GHmg/kg/wk
Growth hormone deficiency	0.18-0.3
Chronic kidney disease	0.35
Turner syndrome	0.375
SGA children with failure to catch up growth	0.47
Idiopathic short stature	0.48
Prader Willi syndrome	0.24
Noonan syndrome	0.46
SHOX gene haploinsufficiency	0.35

TALL STATURE

- Height more than 97th percentile of the normal for age, or more than 2 SDs above the mean height for that age, sex and reference population

- Most often constitutional

CAUSES OF TALL STATURE IN CHILDHOOD

Postnatal overgrowth

- Familial (constitutional) tall stature
- Exogenous obesity
- Hypogonadism
- Excess GH secretion
- Marfan syndrome
- Fragile X syndrome
- Homocystinuria
- Klinefelter syndrome
- XYY

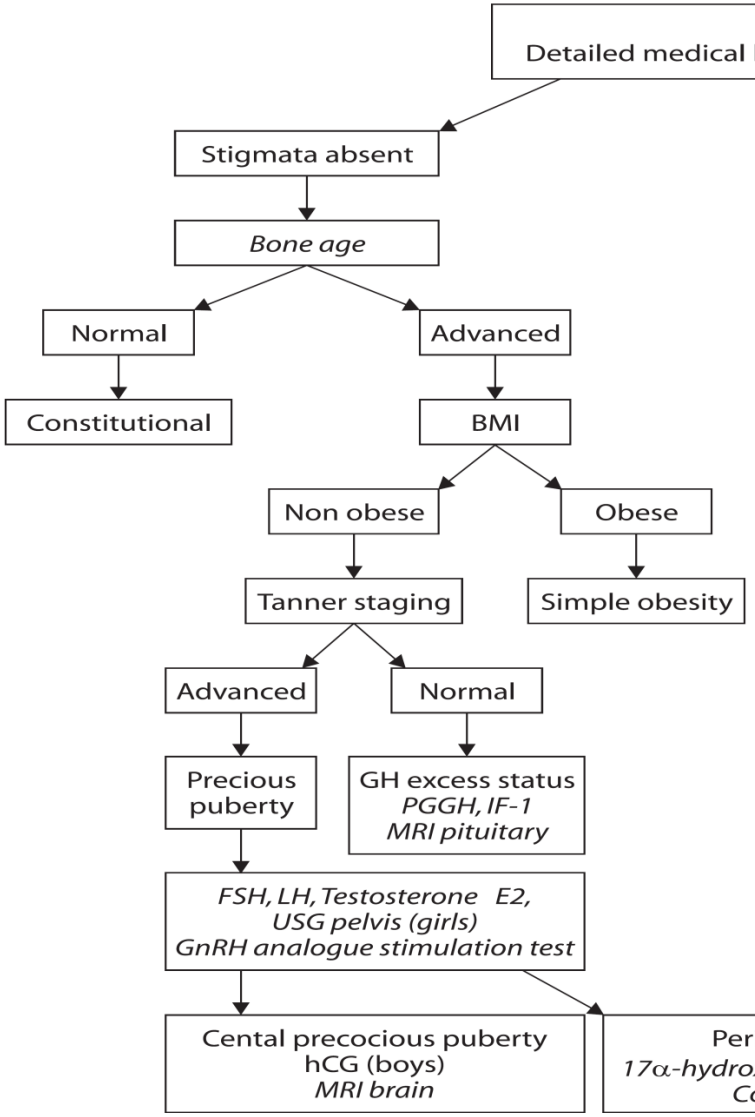
Foetal overgrowth

- Maternal diabetes mellitus
- Cerebral gigantism
- Beckwith-Wiedemann syndrome

Childhood tall stature with adult short stature

- Hyperthyroidism
- Precocious puberty

APPROACH TO CHILD WITH TALL STATURE



Macroglossia, anterior abdominal wall defect, pre- and postnatal overgrowth advanced bone age, hypoglycemia	Beck with – Wiedmann syndrome *(Glucose, insulin, renal USG)*
Facial flushing, frontal boss, prominent, narrow jaw, long, narrow face and head, excessive physical growth, advanced bone age	Sotos syndrome *(NSD-1 gene analysis)*
Sparse facial, body, or sexual hair; high pitched voice; female pattern fat distribution, increased arm span, eunuchoid proportions	Klinefelter's syndrome *(FSH, LH, Testosterone karyotyping)*
Ghent nosology criteria*	Marfan's syndrome *(Fibrillin-1 gene analysis)*
Superior dislocation of lens, mental retardation	Homocystinuria *(serum homocystine, methionine)*

MANAGEMENT OF TALL STATURE

- Reassurance of the family and the patient in constitutional tall stature. May be oestrogen if expected final height > 3SD
- Hypogonadism: Sex steroid
- Gigantism: excision of pituitary adenoma, somatostatin analogues, pegvisomant or radiotherapy
- CAH: glucocorticoids and mineralocorticoid replacement
- Central precocious puberty: GnRH analogues

THANK YOU