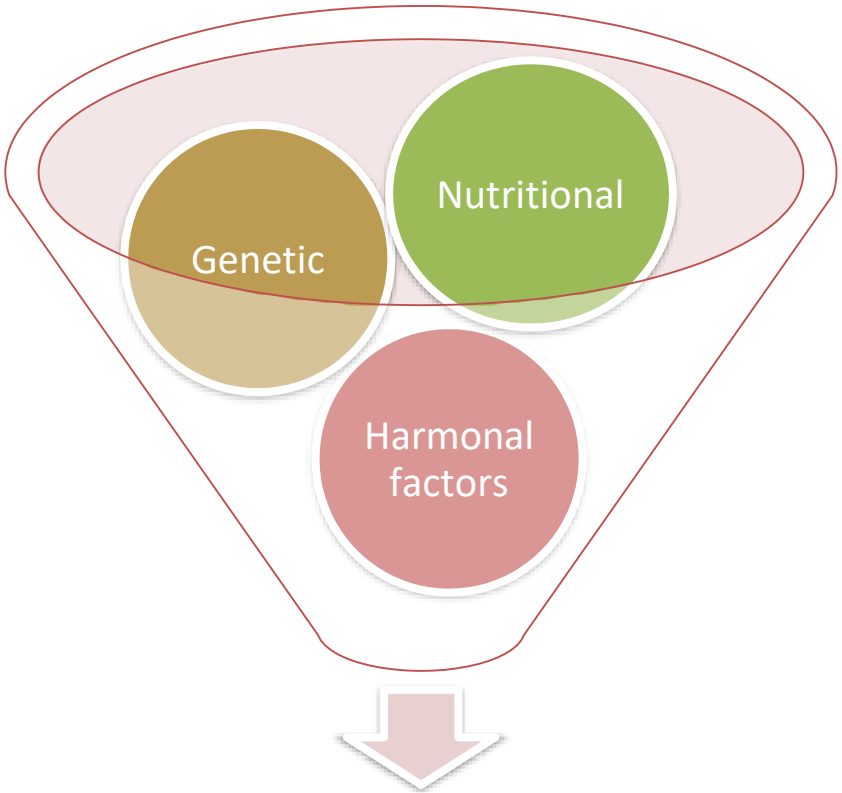
Short stature

- Normal growth physiology
- Growth monitoring and growth charts
- When to evaluate/refer
- Short stature vs growth failure
- Major phenotypes
- How to evaluate
- Management
- Points to ponder

Normal growth

- Oxygen
- Absence of toxins
- Healthy physical environment
- Healthy Psychoscocial environment



Age	*Growth velocity per year*
Birth to 12 months	23 to 27 cm (9.06 to 10.63 in)
12 months to 1 year	10 to 14 cm (3.94 to 5.51 in)
2 to 3 years	8 cm (3.15 in)
3 to 5 years	7 cm (2.76 in)
5 years to puberty	5 to 6 cm (1.97 to 2.36 in)
Puberty	Girls: 8 to 12 cm (3.15 to 4.72 in)
	Boys: 10 to 14 cm (3.94 to 5.51 in)

Changes with development

FOETAL GROWTH

- Uterine function, size, maternal nutrition
- Insulin, IGF, IGFBPs

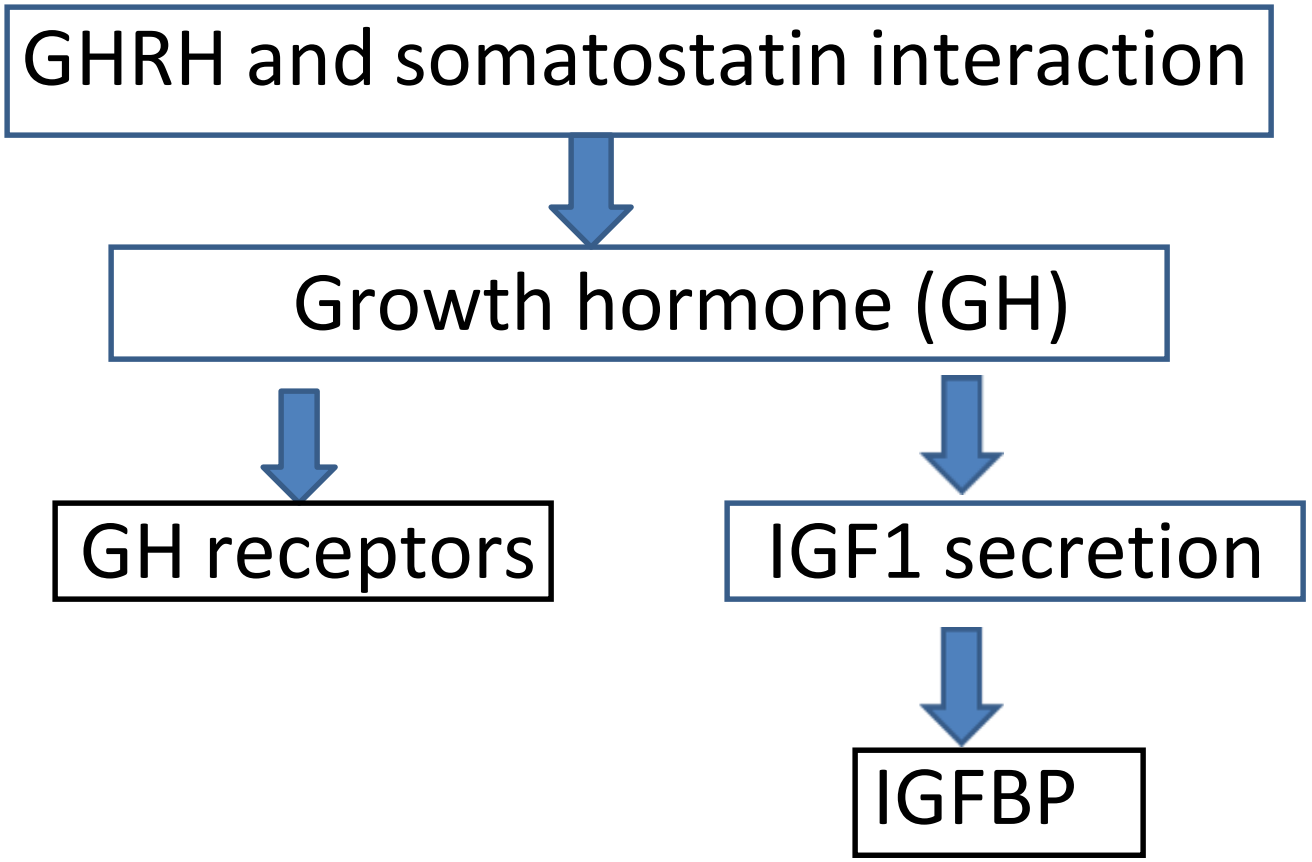
POST NATAL GROWTH

- GH, thyroid hormone
- Nutrition, insulin

PUBERTAL GROWTH

- Sex steroids, GH, thyroid hormone
- Nutrition

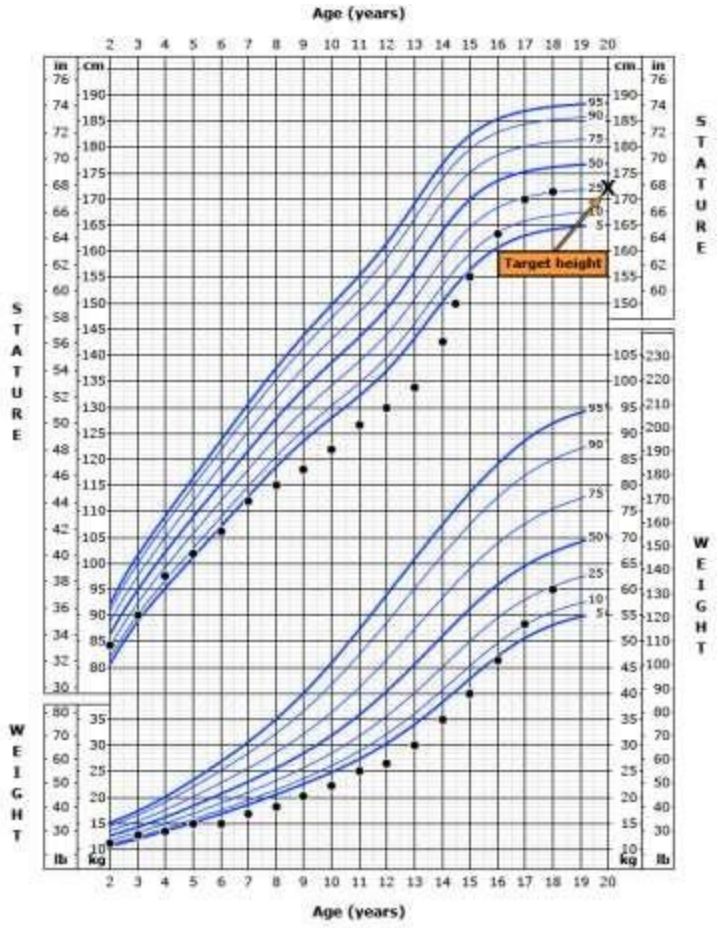
Physiology of growth hormone



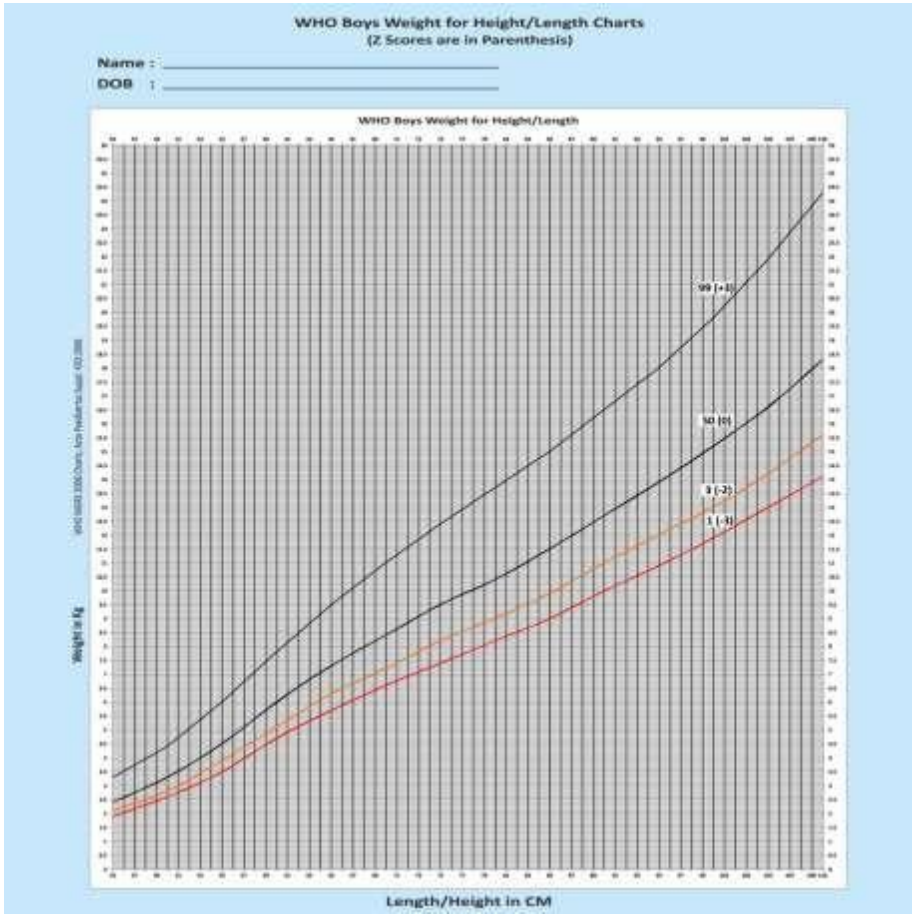
Growth monitoring

- Absolute height
- Growth velocity
- Weight for height ratio
- Target height
- Body proportion (US:LS ratio)
- Pubertal assessment

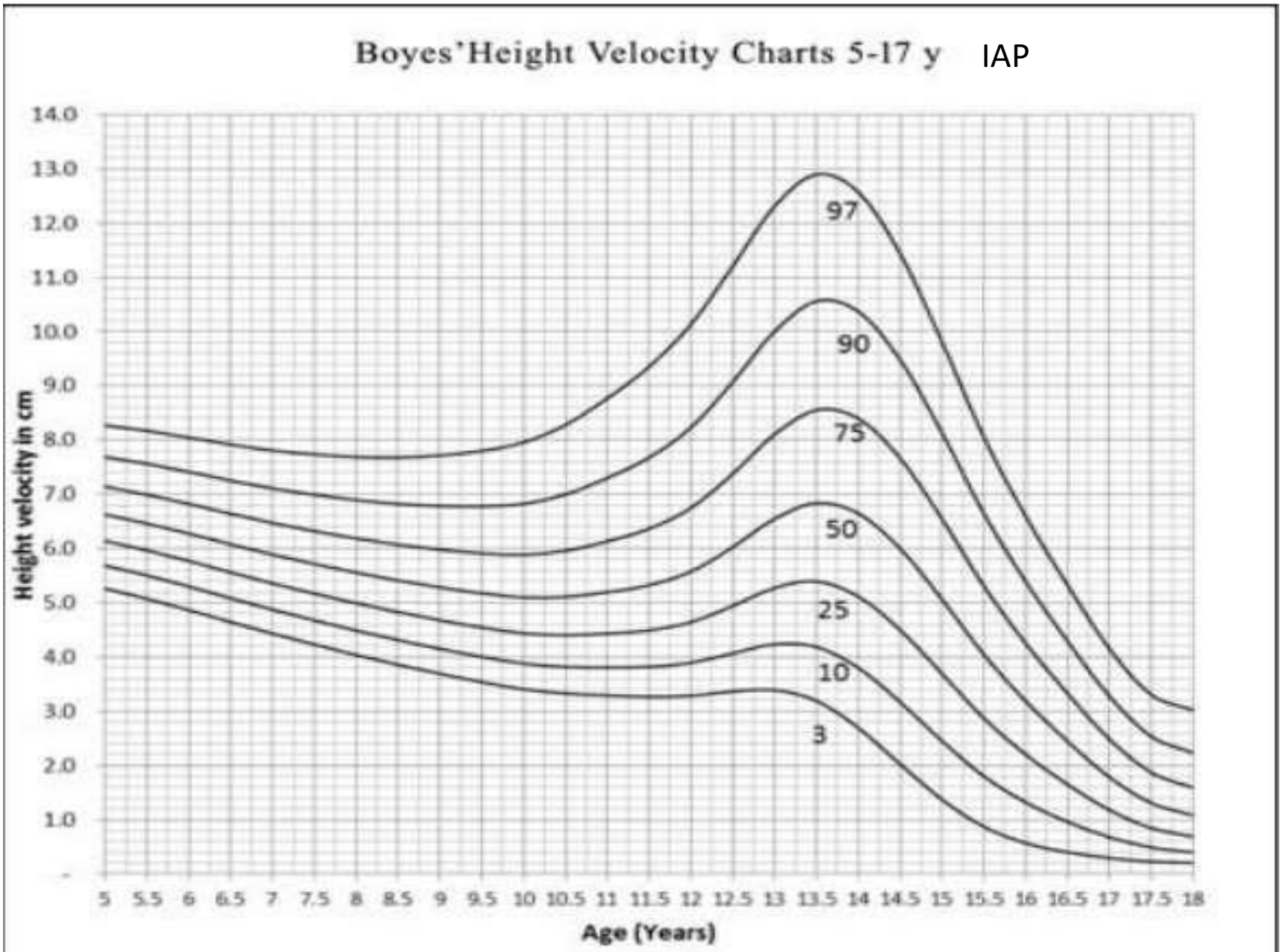
Growth charts



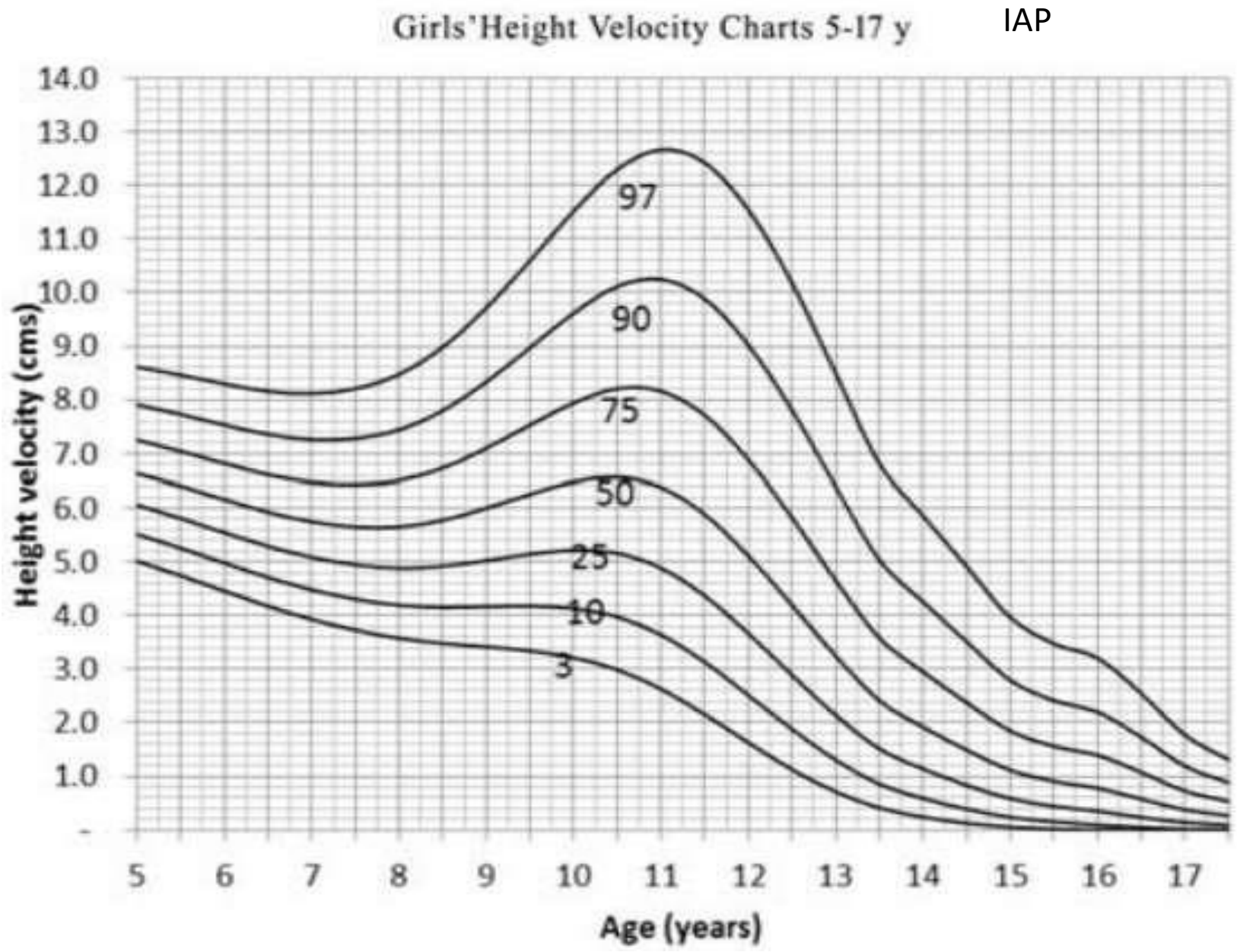
Weight for age and height for age



Weight for height/ length


Boyes'Height Velocity Charts 5-17 y
IAP
Height velocity in cm
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
-
97
90
75
50
25
10
3
5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10 10.5 11 11.5 12 12.5 13 13.5 14 14.5 15 15.5 16 16.5 17 17.5 18
Age (Years)

IAP


Girls'Height Velocity Charts 5-17 y
Height velocity (cms)
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
-
97
90
75
50
25
10
3
5
6
7
8
9
10
11
12
13
14
15
16
17
Age (years)

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 m
- Height <-1.5 SD and height velocity <-1.5 SD over 2 years.
- Risk factors for growth hormone defciency

Short stature vs growth failure

- Short stature -height that is two standard deviations below the mean height for age and sex (less than the 3rd percentile)

- Growth failure -pathologic state of abnormally low growth rate over time
- -may manifest as height deceleration across two major percentile lines on the growth chart.

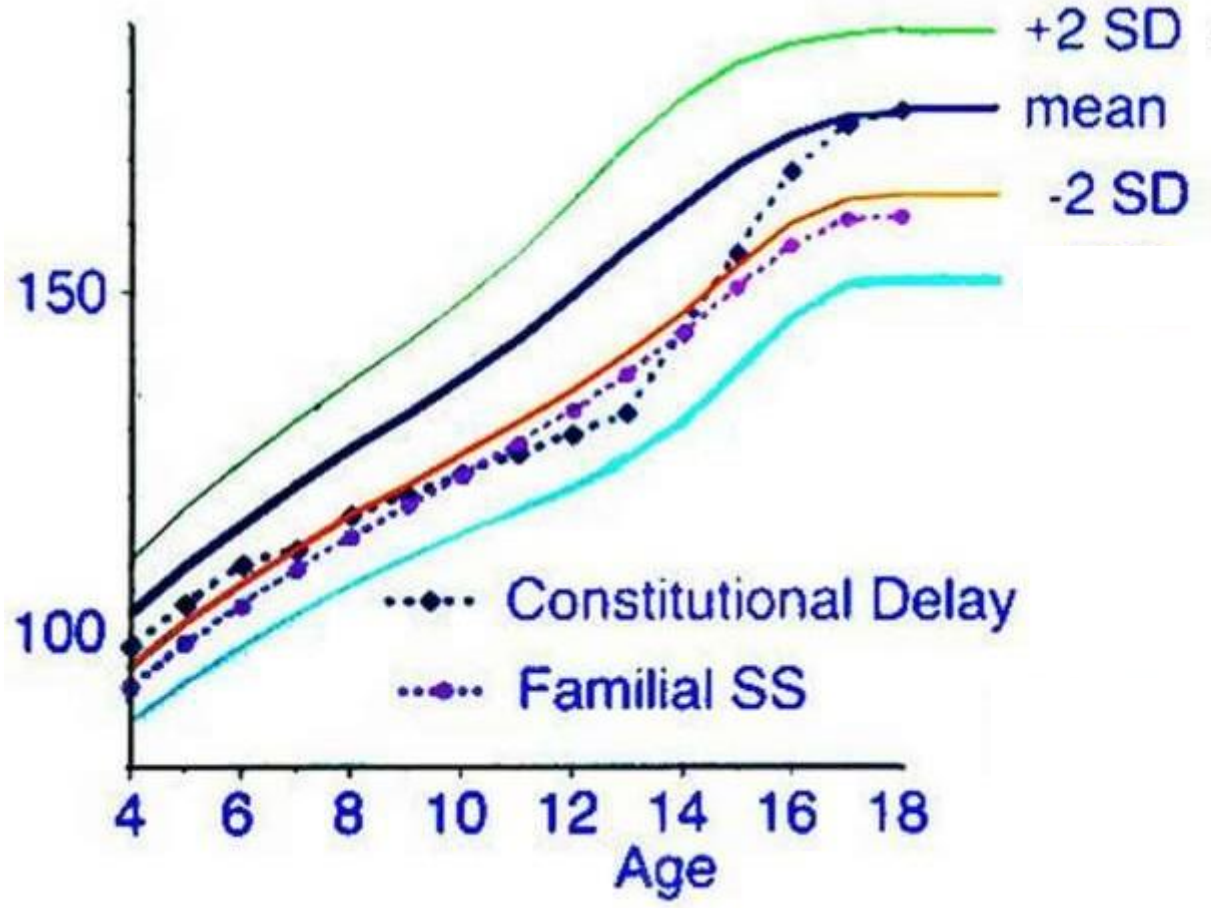
- Short stature may be normal, but growth failure is always abnormal

MAJOR CLASSES OR PHENOTYPES

1. Normal growth variants

Age	FSS	CGD
Sex	-	Commoner in boys
Birth Height	Less	Normal
Family History	History of short stature -positive	Delayed puberty especially in father
Growth Velocity	Growth Velocity normal	Growth Velocity normal for bone age.
Bone Age	Normal	Slight delay/BA = HA
Final adult height	short	Normal

Management: Explain and reassure


+2 SD
mean
-2 SD
150
100
Constitutional Delay
Familial SS
4
6
8
10
12
14
16
18
Age

2. Proportionate short stature

Increased weight for height

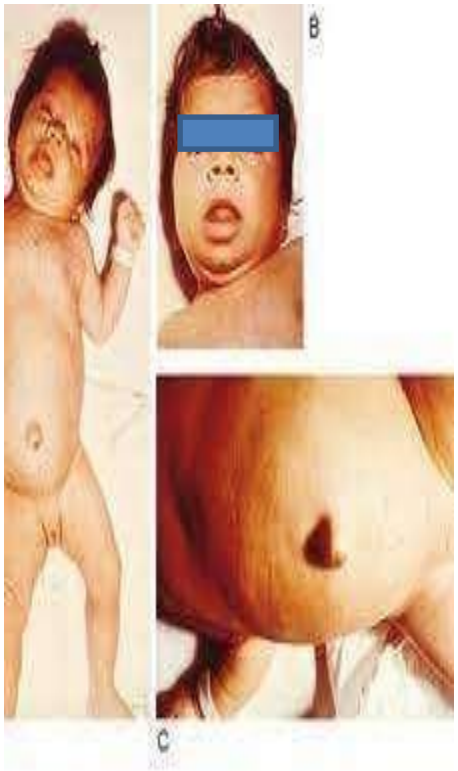
BA<<CA

- Hypothyroidism: asymptomatic or
  -dry skin, constipation, goiter, mental retardation, learning deficits
- GH deficiency: doll facies, high pitched voice, micropenis, marbled abdomen fat
  -congenital/ acquired
- Glucocorticoid excess: central obesity, hypertension
  -endogenous/ iatrogenic

Decreased weight for height

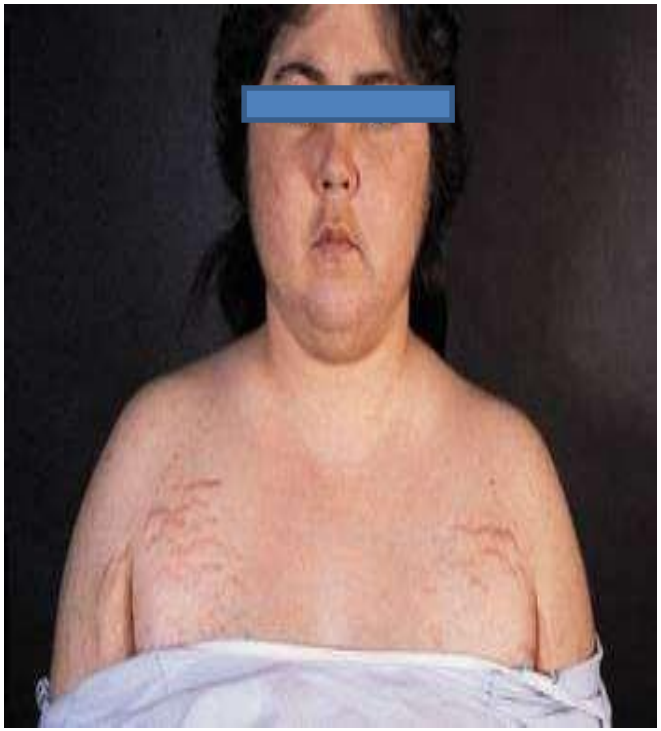
BA<CA

- Malnutrition- protein/calorie/calcium/vitamin D
- Systemic disease
  - Can be missed/ not overt in all
    GI- malabsorption, IBD
    Renal- RTA, DI
    Psychosocial
  - Usually symptomatic
    Pulmonary- cystic fibrosis, bronchiectasis
    CVS- Congenital heart disease
    Others



Congenital hypothyroidism

Growth hormone deficiency



Cushing syndrome

3. Disproportionate/ dysmorphic short stature

Disproportionate

- BA=CA
- **Skeletal dysplasia**

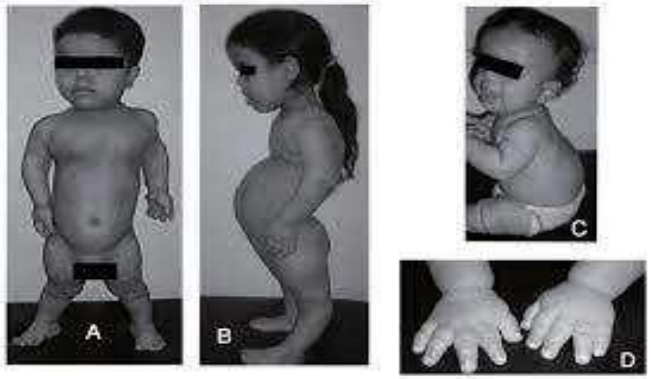
-Short limbs: achondroplasia

-Short trunk:spondylodysplasia

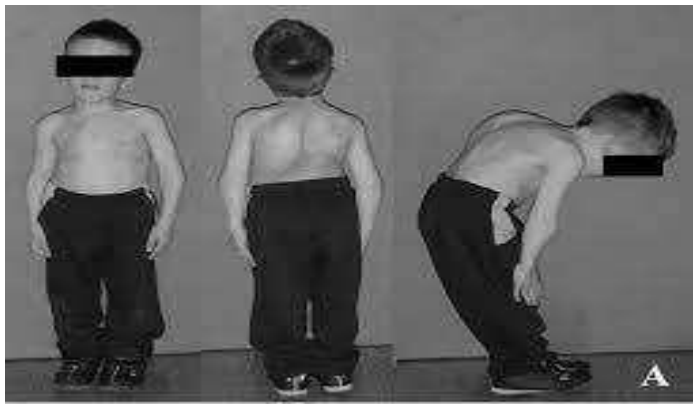
- **Mucopolysaccharidoses**

Clinical syndromes

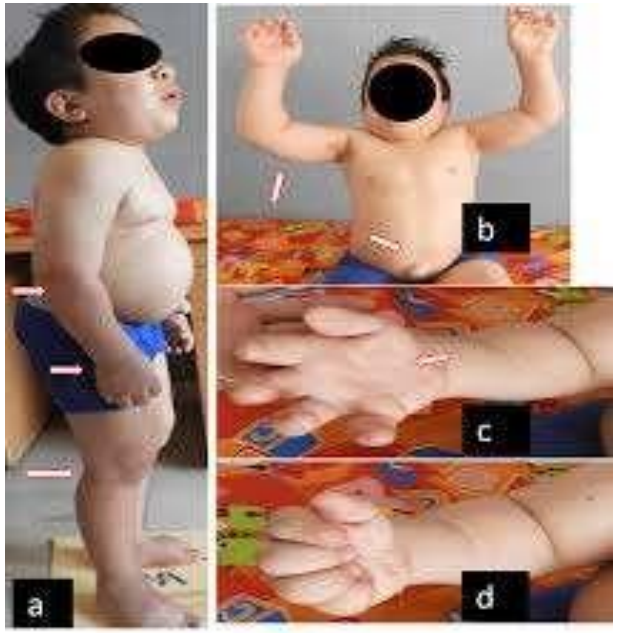
- Bone age minimal delay
- Chromosomal : Turners syndrome, Down, Prader Willi syndrome etc



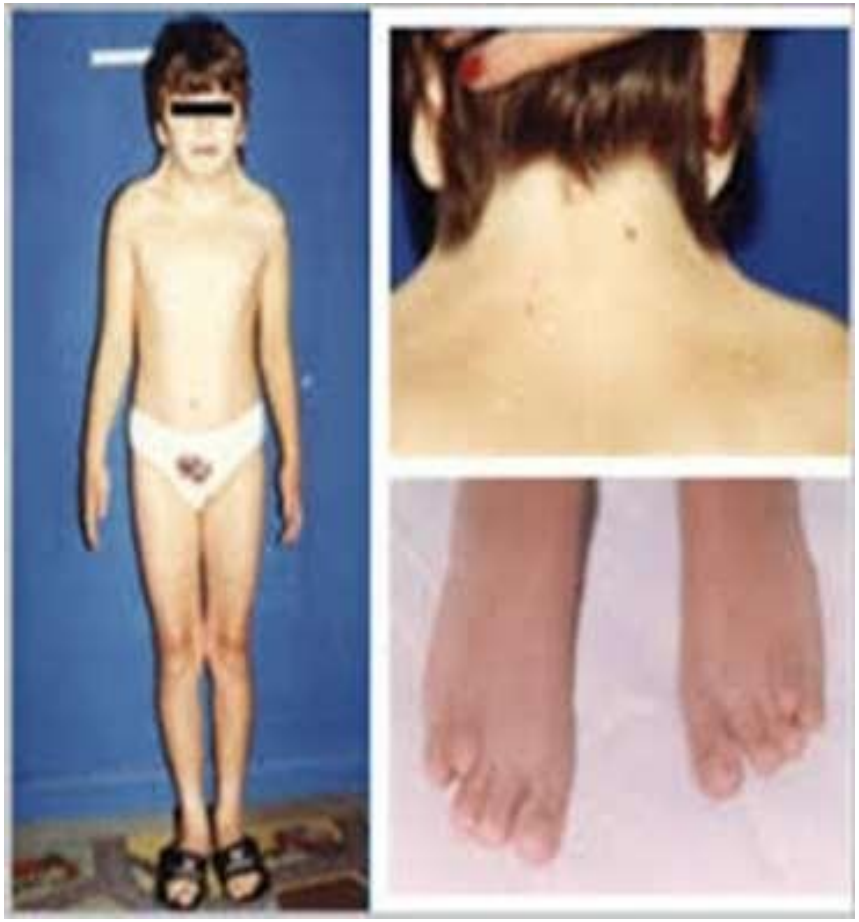
Achondroplasia



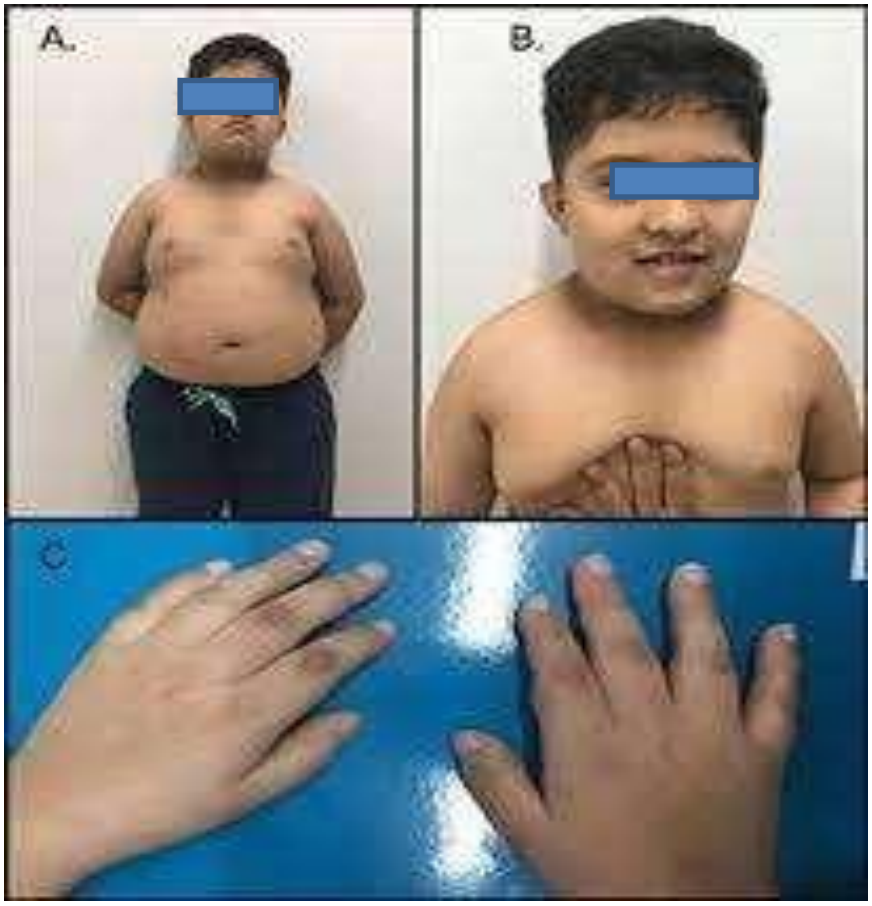
Spondylodysplasia



Mucopolysachcharidoses



Turner syndrome



Prader Willi syndrome

HOW TO EVALUATE

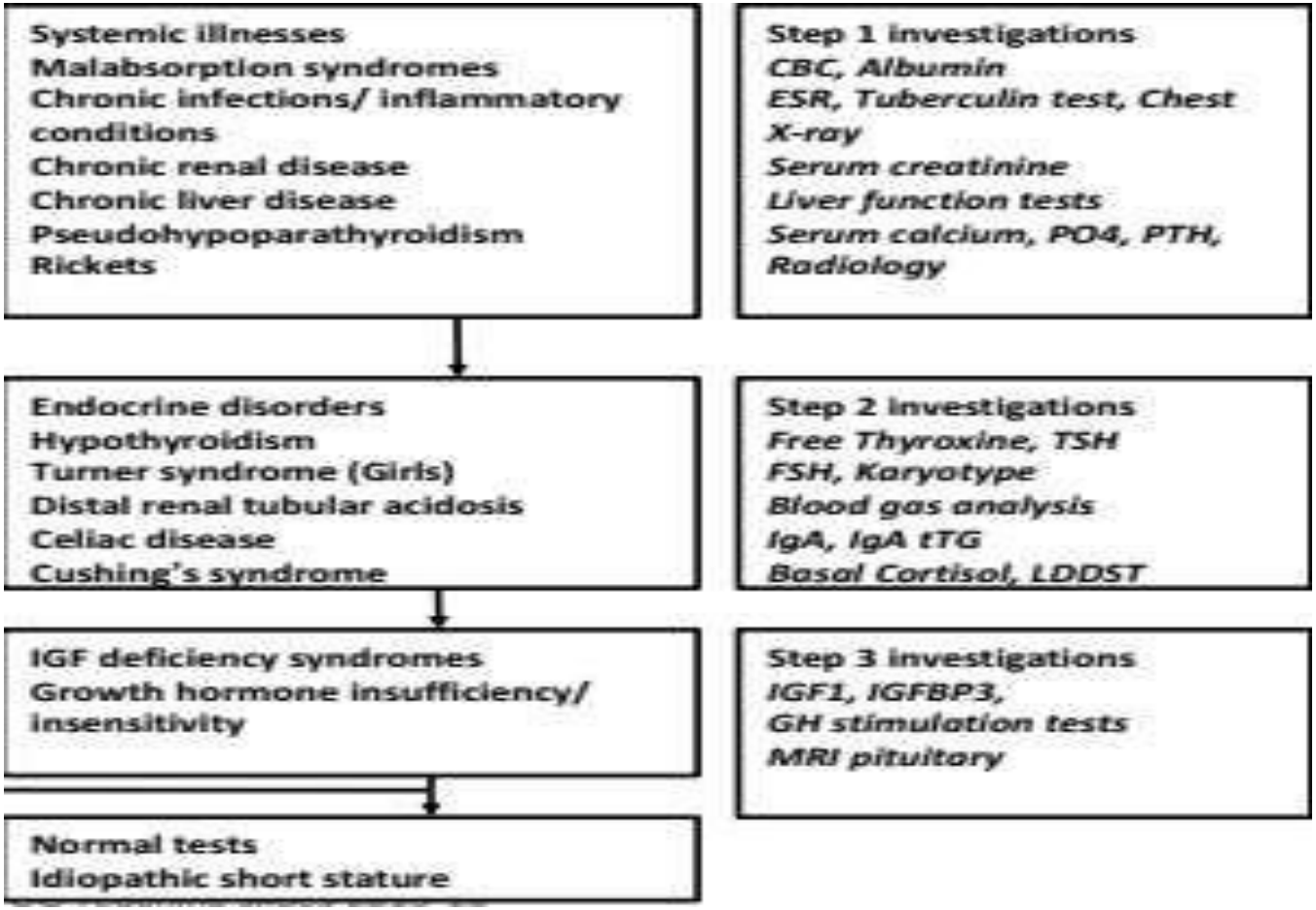
Clinical pointers

- Growth parameters
- Dysmorphic features
- Nutritional status
- Thyroid gland
- Tanner staging for puberty development
- Neurological exam

- visual acuity and visual fields, nystagmus
- signs of hydrocephalus, focal signs

- Signs of any other systemic disease

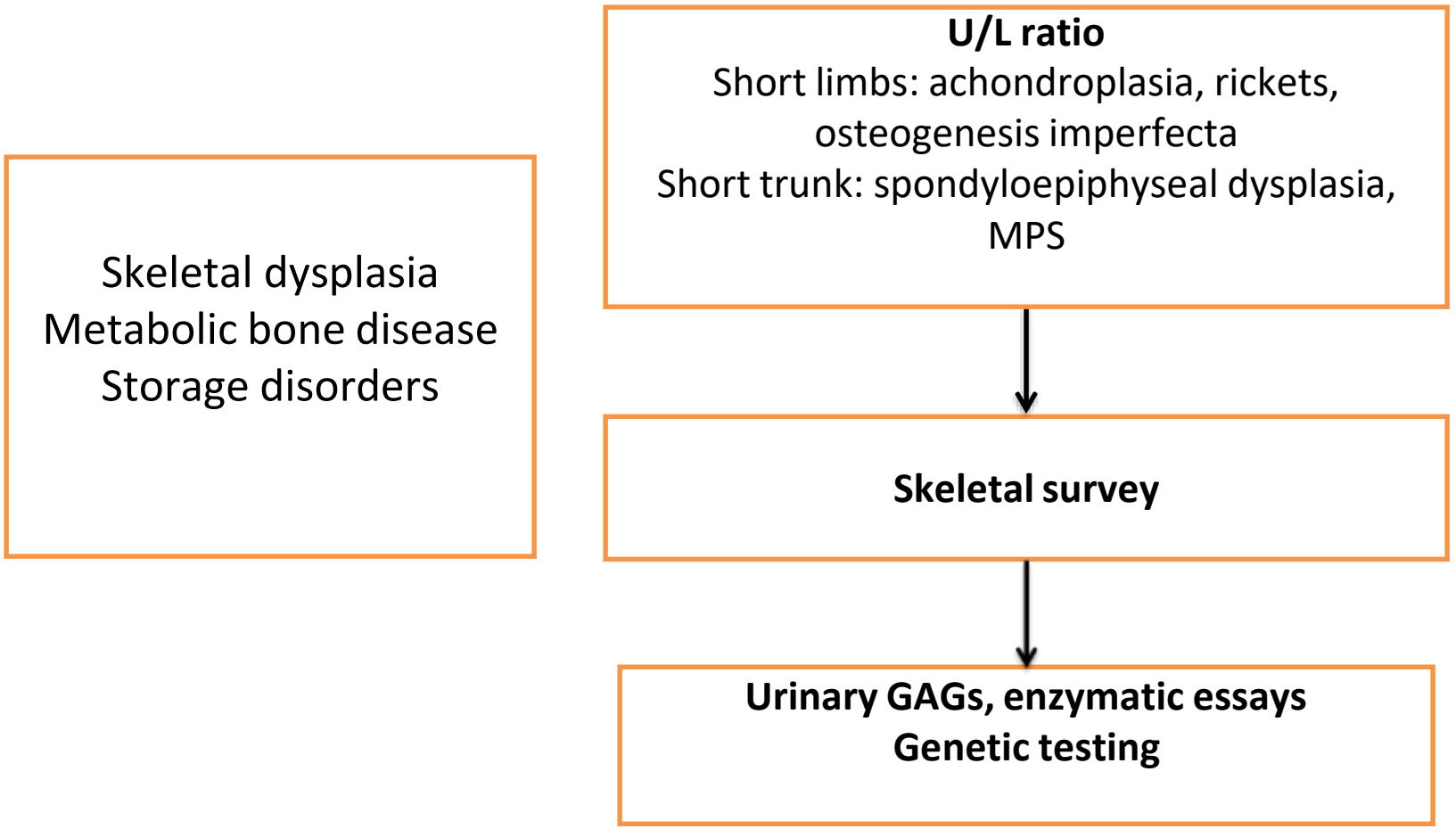
Proportionate short stature approach



Evaluation in GH-IGF1 axis

- GH stimulation test
  -Priming with sex steroids in boys > 11 years and girls > 10 years and not in established puberty
  -peak concentration< 10 ng/ml in response to 2 stimulation tests(arginine, insulin, clonidine, glucagon)
  -< 18 ng/ml to combined arginine- GHRH
- IGF-1 levels
- IGFBP-3 levels
- Hypothalamic-pituitary MRI scan in patients with GH deficiency

Disproportionate short stature



When to refer to geneticist

- Disproportionate short stature
- Dysmorphism
- Congenital anomalies
- Developmental delay

Management

- Identifying underlying cause
- Specific disease treatment

Malnutrition: Nutritional rehabilitation

Nutritional rickets: Vitamin D

Distal RTA: Shohl's solution

Celiac disease: Gluten free diet

Psychosocial dwarfism: Good social environment

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

GH therapy indication and dosage

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

Recombinant GH (somatotropin)

- SC route(site rotated daily to avoid lipoatrophy)
- Adverse effects

-injection site reactions

-hypersensitivity to the diluent

-Hypothyroidism

-Others- edema, arthralgia, myalgia, carpal tunnel syndrome, paraesthesias, and hyperglycemia

Points to ponder !

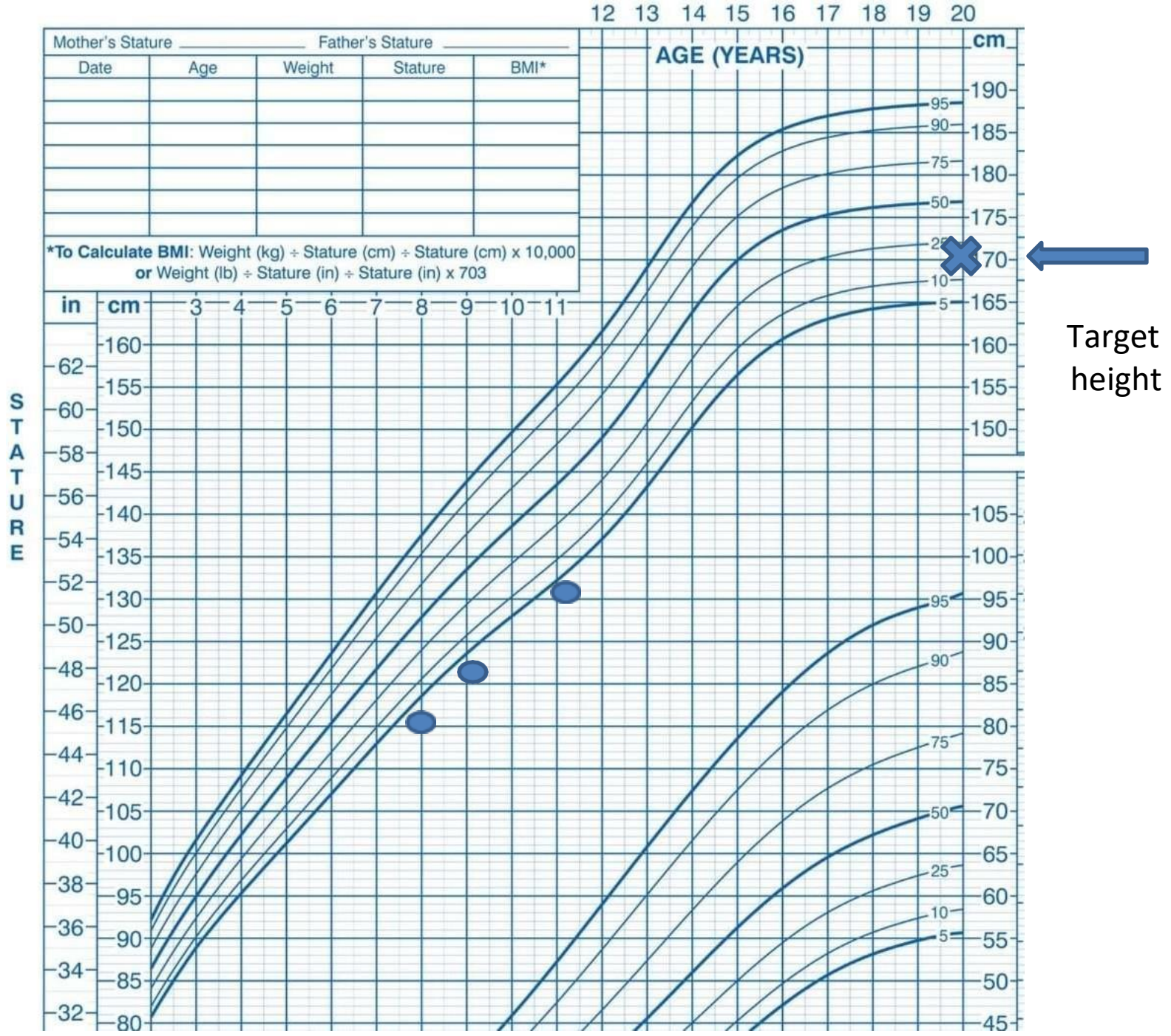
- Deceleration of linear growth in well child/obese child- endocrine causes
- Deceleration of linear growth in thin child- systemic causes
- Deceleration of linear growth at adolescence- hypogonadism

- Short child with dymorphism/ disproportionate stature- genetic causes
- Short child with normal growth velocity- normal variants

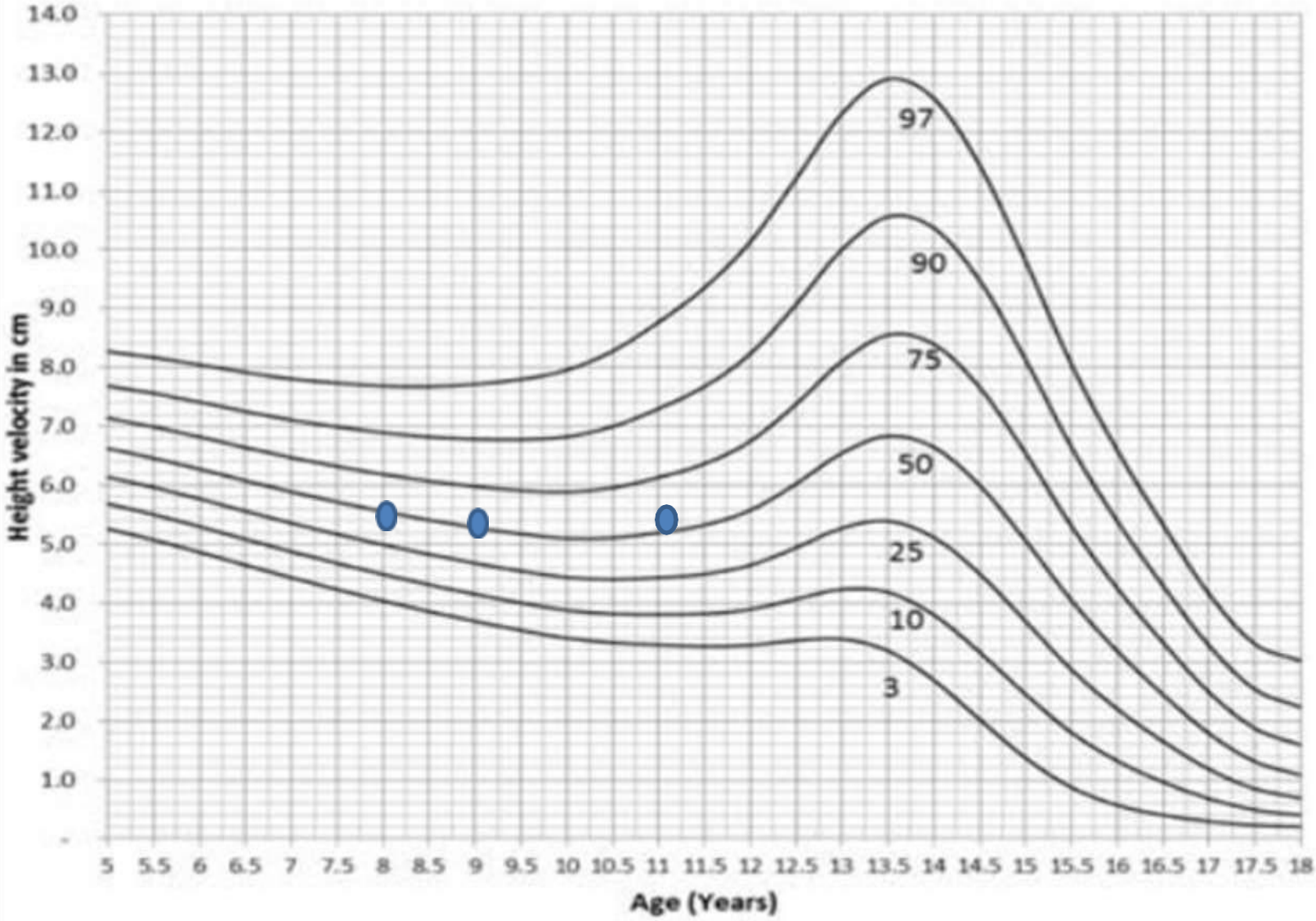
Case snippet

- A 11 year old boy is brought with concerns of being puny for his age. He is otherwise active, good at school.

- Mothers height is 150 cm and fathers is 180 cm


Mother's Stature
Father's Stature
Date
Age
Weight
Stature
BMI*
*To Calculate BMI: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703
AGE (YEARS)
STATURE
in
cm
Target height

Boyes' Height Velocity Charts 5-17 y

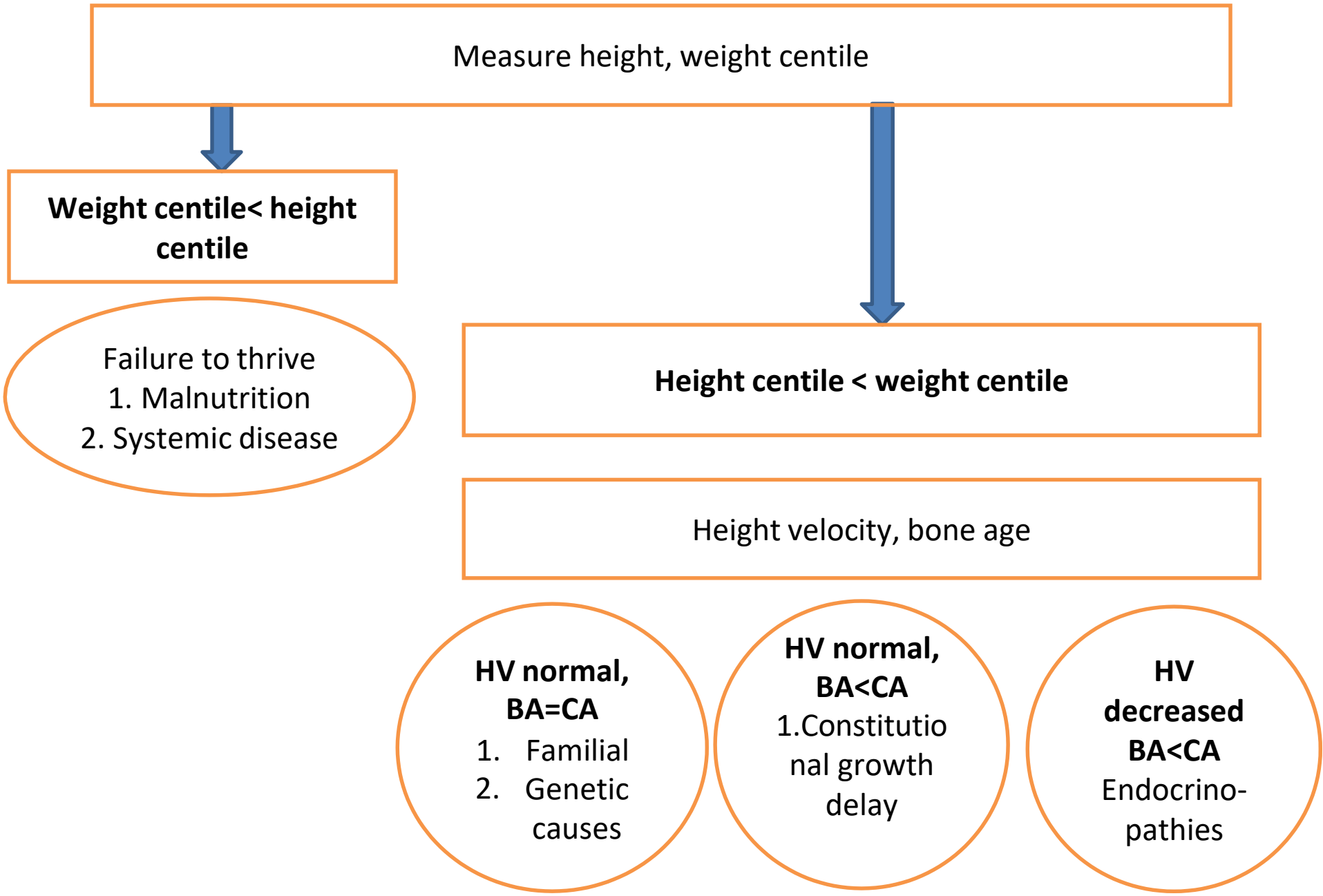


- Weight is on the 10 th centile
- Height is below 3 rd centile
- Height velocity is on 50 th centile
- Systemic examination is normal
- SMR staging is pre pubertal

- He is ABNORMAL

- On re questioning, father admits he too was called short for his age in high school

- Diagnosis : constitutional growth delay


Measure height, weight centile
Weight centile< height centile
Failure to thrive
1. Malnutrition
2. Systemic disease
Height centile < weight centile
Height velocity, bone age
HV normal, BA=CA
1. Familial
2. Genetic causes
HV normal, BA<CA
1.Constitutional growth delay
HV decreased BA<CA
Endocrino-pathies