# Growth and Growth Disorders in Children

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# Outline

- Normal Growth and puberty
- Causes of short stature
- Approach to a short child

# Growth

- Growth in childhood: is a complex and dynamic biological processes, is tightly controlled and regulated.

Short stature: height below 3rd percentile (depending on what chart you use it could be < 5th percentile)

Tall stature: > 95th percentile

Normal (full-term) birth weight: 2.4 kg - 4.2 kg (SGA: TORCH inf., eclampsia)

HC when born: 34 cm at 6 mon: 43 cm at 1 year: 49 cm

Baby should reach double their birth weight at 4 mon and triple by 1 yr

A newborn starts at 50 cm. They should reach double their height at 4 yrs old. Half of that growth (25 cm) should be completed in the 1st year of life.

Premies catch up: weight: by 2 yrs
height: by 3-4 yrs
HC: b/t 1-2 yrs
developmentally: by 2 years

# Growth Parameters

- Weight for age
- Height (length) for age
- Weight for length
- Body mass index for age
- Head circumference for age

# Stadiometer

height

↓

can

stand

length - measured laying down

# Measuring Table

## 2 to 20 years: Boys
## Stature-for-age and Weight-for-age percentiles

NAME _____

RECORD # _____

Mother's Stature _____ Father's Stature _____

| Date | Age | Weight | Stature | BMI* |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
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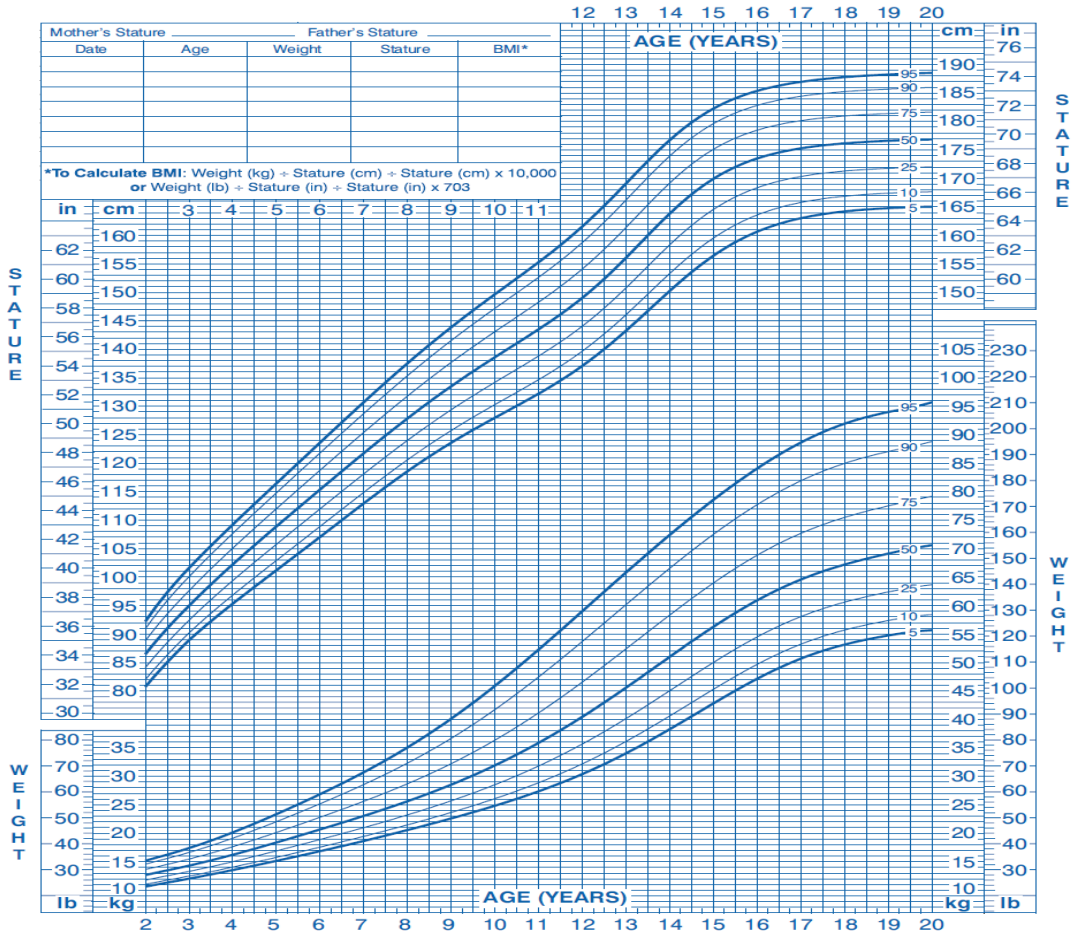
*To Calculate BMI: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703




Published May 30, 2000 (modified 11/21/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts

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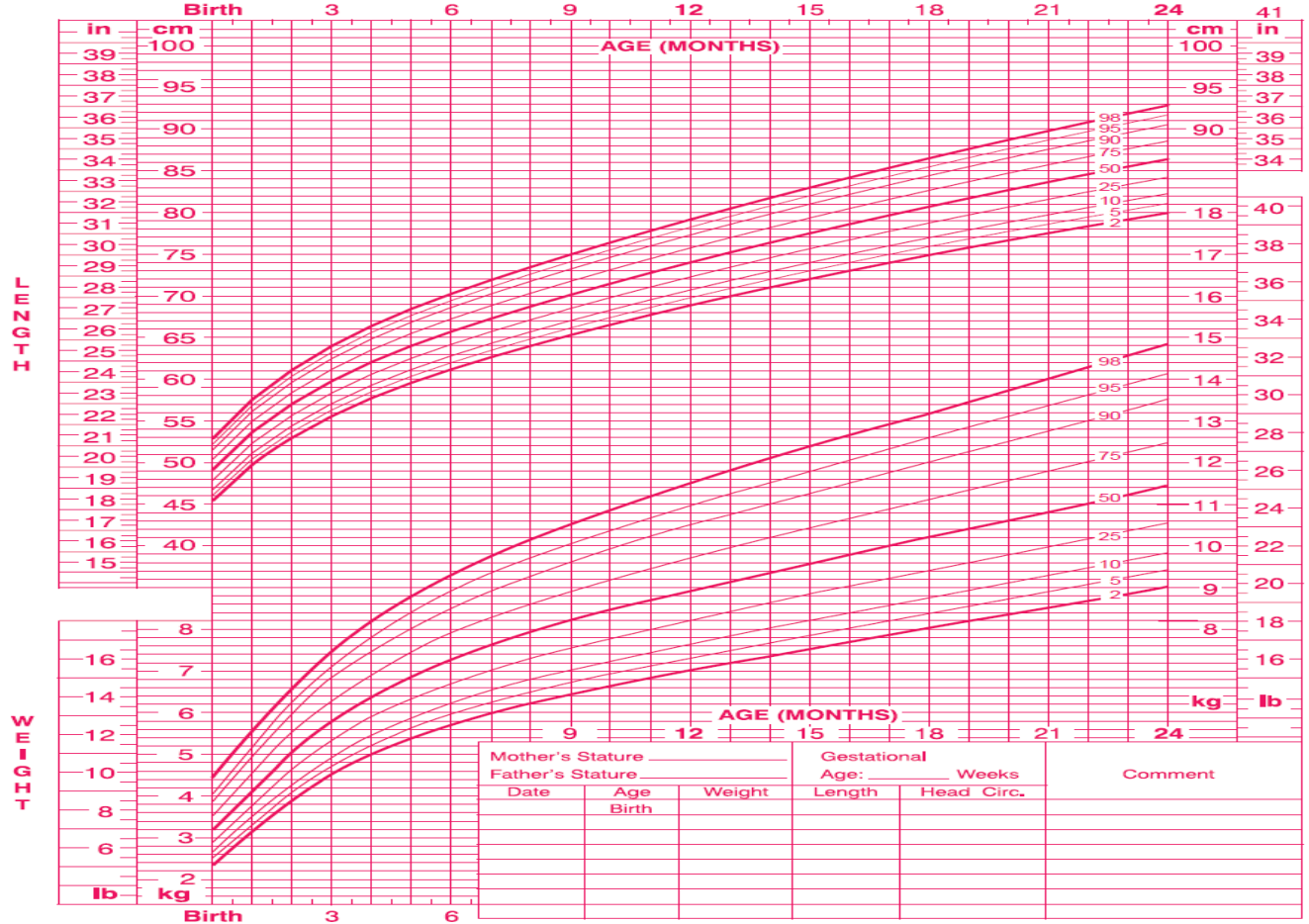
# Birth to 24 months: Girls
## Length-for-age and Weight-for-age percentiles

NAME _____

RECORD # _____




| Mother's Stature _____ | | | Gestational Age: _____ Weeks | | |
|---|---|---|---|---|---|
| Father's Stature _____ | | | | | |
| Date | Age | Weight | Length | Head Circ. | Comment |
| | Birth | | | | |
| | | | | | |
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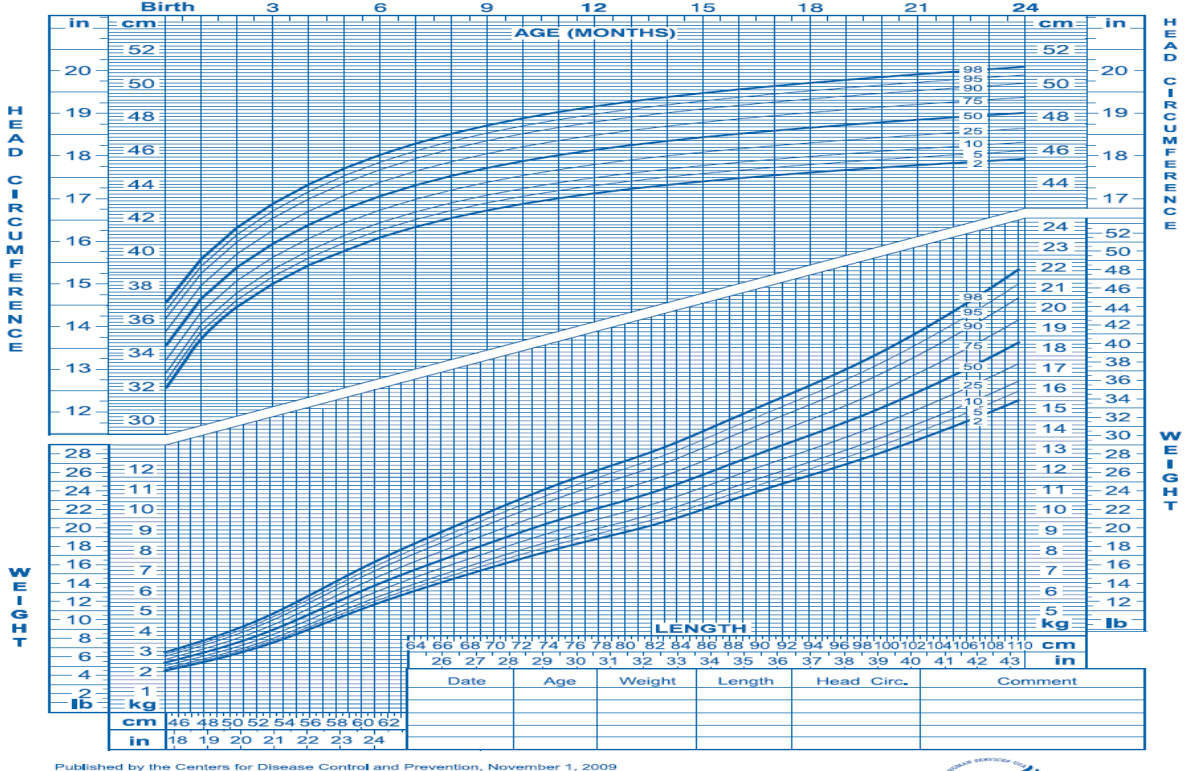
Published by the Centers for Disease Control and Prevention, November 1, 2009
SOURCE: WHO Child Growth Standards (http://www.who.int/childgrowth/en)

# Birth to 24 months: Boys
## Head circumference-for-age and Weight-for-length percentiles

NAME _____

RECORD # _____



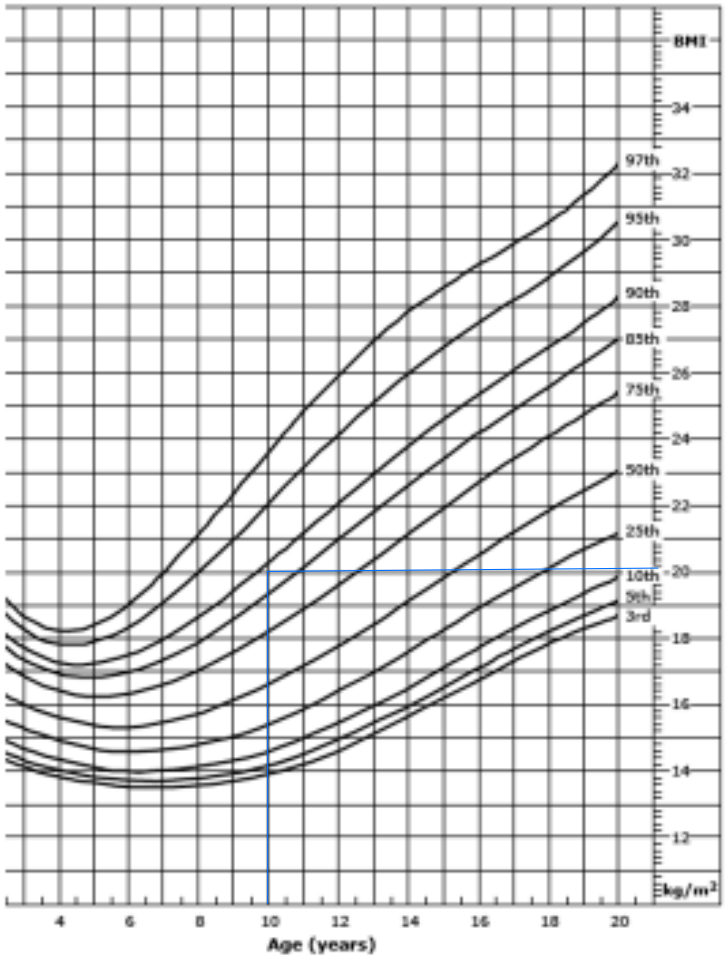

| Date | Age | Weight | Length | Head Circ. | Comment |
|---|---|---|---|---|---|
| | | | | | |

Published by the Centers for Disease Control and Prevention, November 1, 2009
SOURCE: WHO Child Growth Standards (http://www.who.int/childgrowth/en)

overweight: BMI>85$^{th}$<95$^{th}$ percentile

Obese: BMI>95$^{th}$ percentile

in children we don't base obesity/overweight classification on a specific number like adults (overweight ≥25, obese ≥30) but instead based on percentile



# Prader-Willi Syndrome

Obesity due to nutrition (mcc) tends to have children of normal height (or slightly tall). For very short + obese children suspect endocrine disorders (hypothyroidism, GH deficiency, Cushing's)

Prader-Willi:

1st 2 yrs of life → low weight
(hypotonia, poor suckling)

Afterwards → Obese
(appetite ↑)

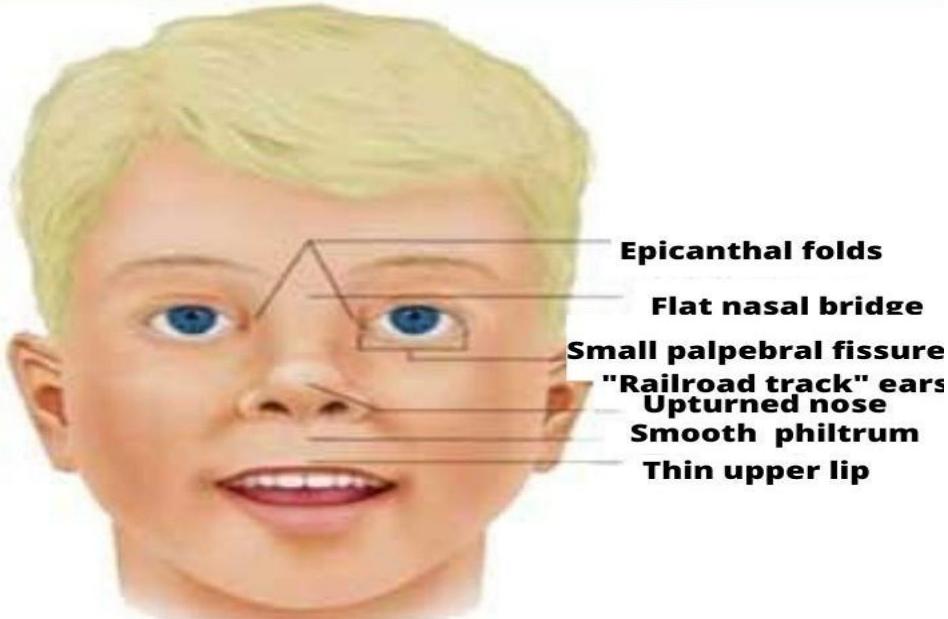
# PRADER WILLI SYNDROME

## A rare genetic disorder

**Temper outbursts, stubbornness, compulsive behaviour**

**Weak muscle tone, feeding difficulties, poor growth, delayed development, chronic over eating and obesity**

almond eyes



* **Height velocity** — A period of at least six months is necessary for reliable calculation of height velocity in children older than two years :

- 0 to 6 months — 2.5 cm per month
- 7 to 12 months — 1.25 cm per month
- 12 to 24 months — 12 cm per year
- 24 to 36 months — 8 cm per year
- 36 to 48 months — 7 cm per year
- 4 to 10 years — 4 to 6 cm per year

Growth velocity is imp. for determining if a pathology is present

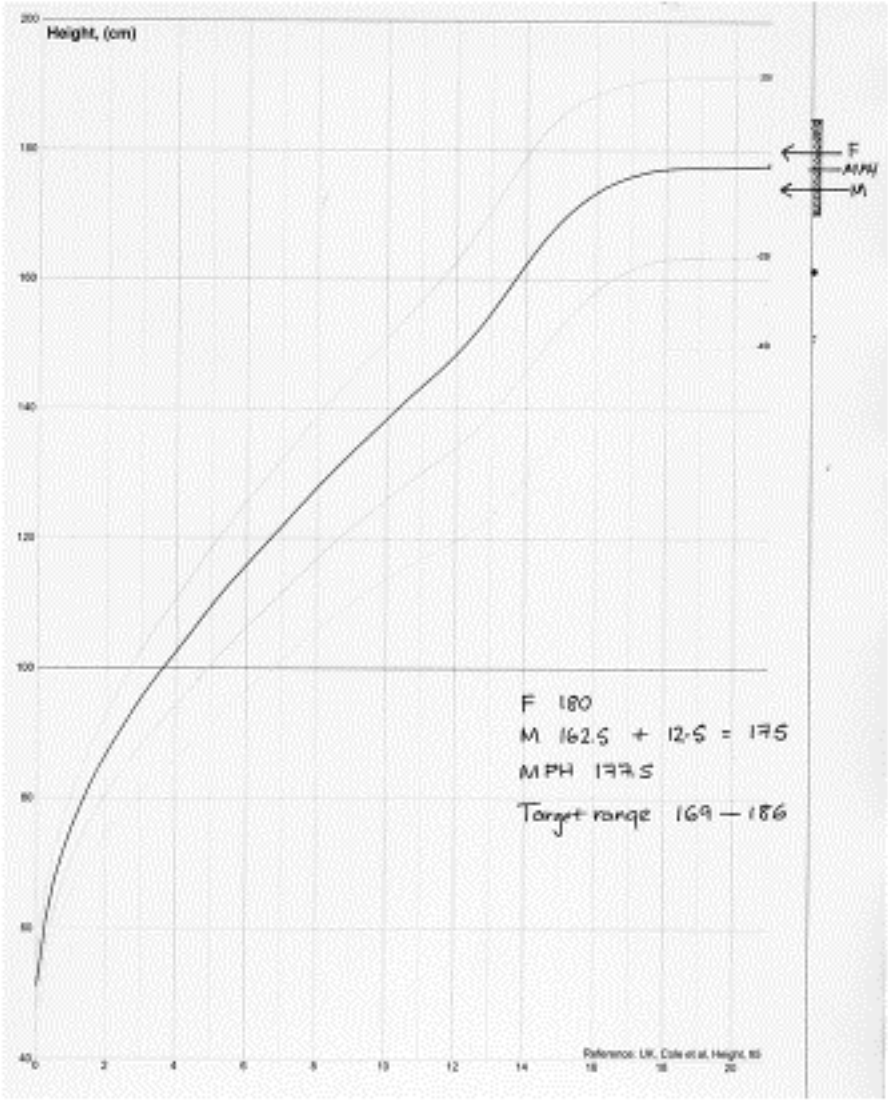
A 95% of normal individuals will attain final heights within 2 standard deviations of mid-parental height ($\pm$ 8.5 cm)

↓

This is a simplified version of:

Boy: $\frac{\text{height of dad} + (\text{height of mom} + 13)}{2}$ (this is to account for diff b/t genders)

Girl: $\frac{(\text{height of dad} - 13) + \text{height of mom}}{2}$


Height, (cm)
F
MPH
M
F 180
M 162.5 + 12.5 = 175
MPH 177.5
Target range 169 — 186

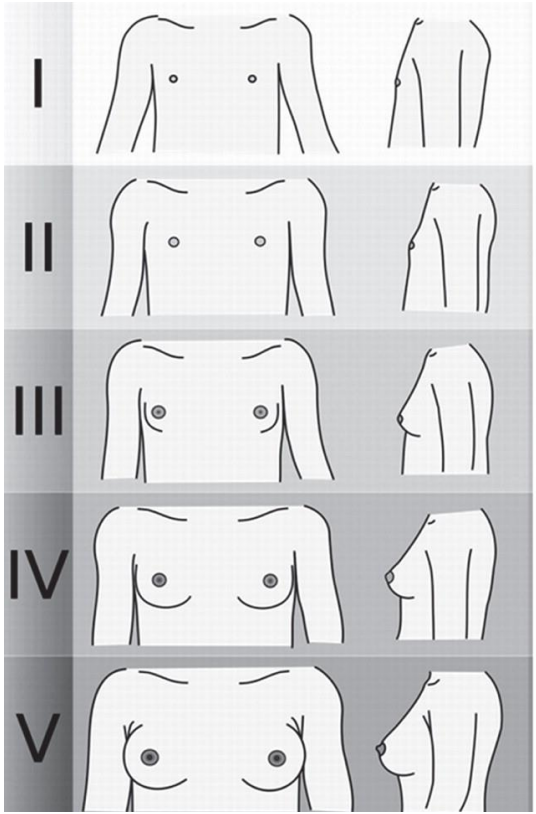
# Evaluation of Growth

- How short is the child?
- Is the child's height velocity (HV) impaired?
- What is the child's likely adult height?
- Is the child growing on a centile appropriate for the genetic target height?

# Pubertal staging

- Thelarche - appearance of breast buds
- Pubarche - appearance of pubic hair
- Adrenache - appearance of adrenal hormones (DHEAS)
- Menarche - first menstrual cycle

# Tanner Staging- females




**Stage I:** prepubertal

**Stage II:** breast bud with elevation of breast and papilla; enlargement of areola

Only elevation of areola

**Stage III:** further enlargement of breast and areola; no separation of contour

Elevation of any skin

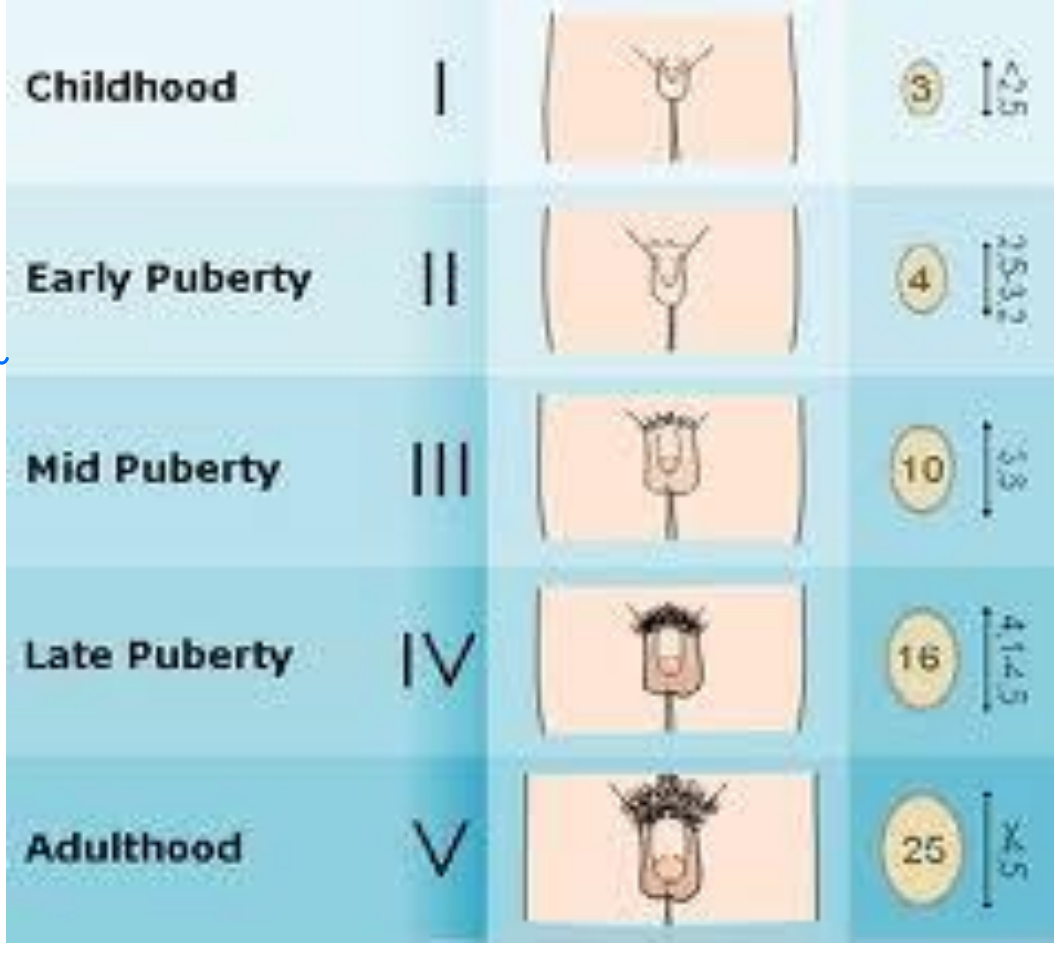
**Stage IV:** areola and papilla form secondary mound above level of breast

Protrusion of areola + skin

**Stage V:** mature stage; projection of papilla only, related to recession of areola

Areola no longer protrudes

# Tanner Staging- males




pubertal size of testes ≥4ml

Adult reaches 25 ml

Sexual hair, dark, coarse, curly

hair fills pubis

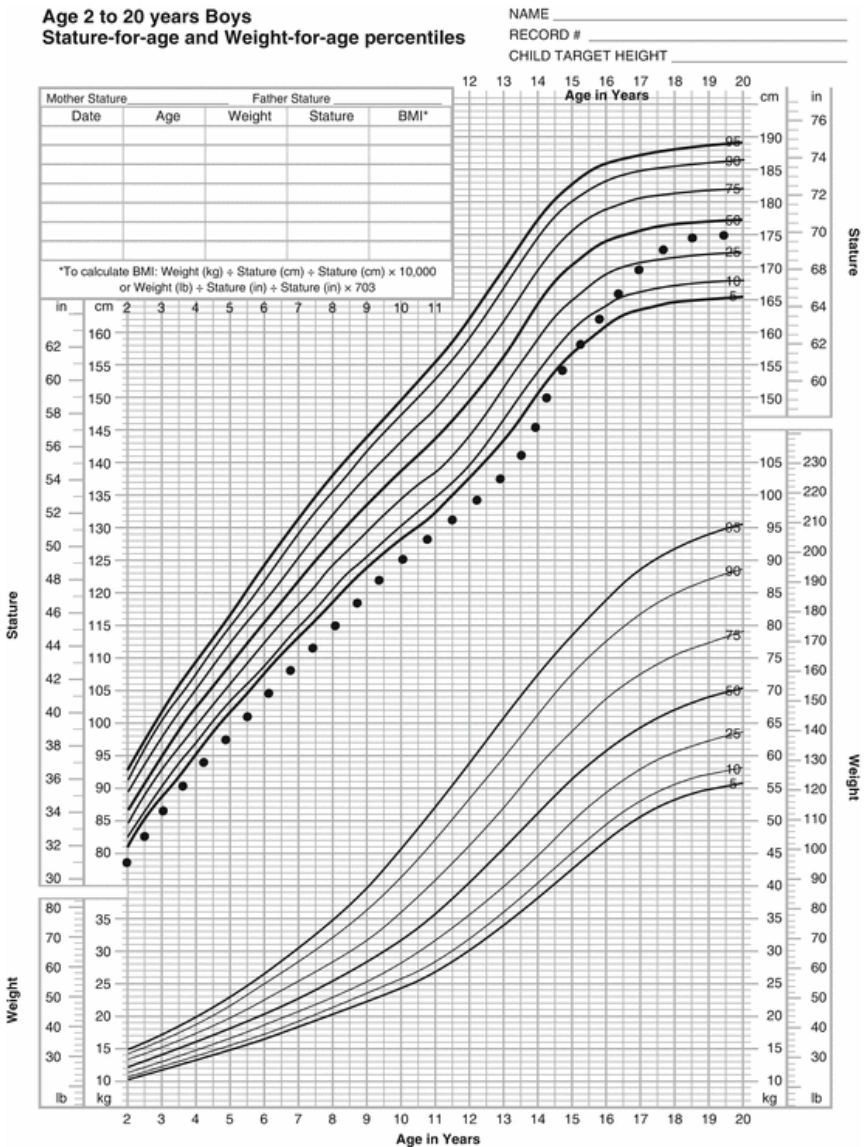
hair extends to thigh

# Causes of Short Stature

but not every familial growth stature is benign.
(check if growth velocity is normal)

- Normal (familial and constitutional delay)
- Small for gestational age
- Syndromes
- Skeletal dysplasias
- Systemic illnesses
- Endocrine disorders
- Psychosocial circumstances
- Idiopathic short stature

dotted line shows Constitutional delay (late bloomer)



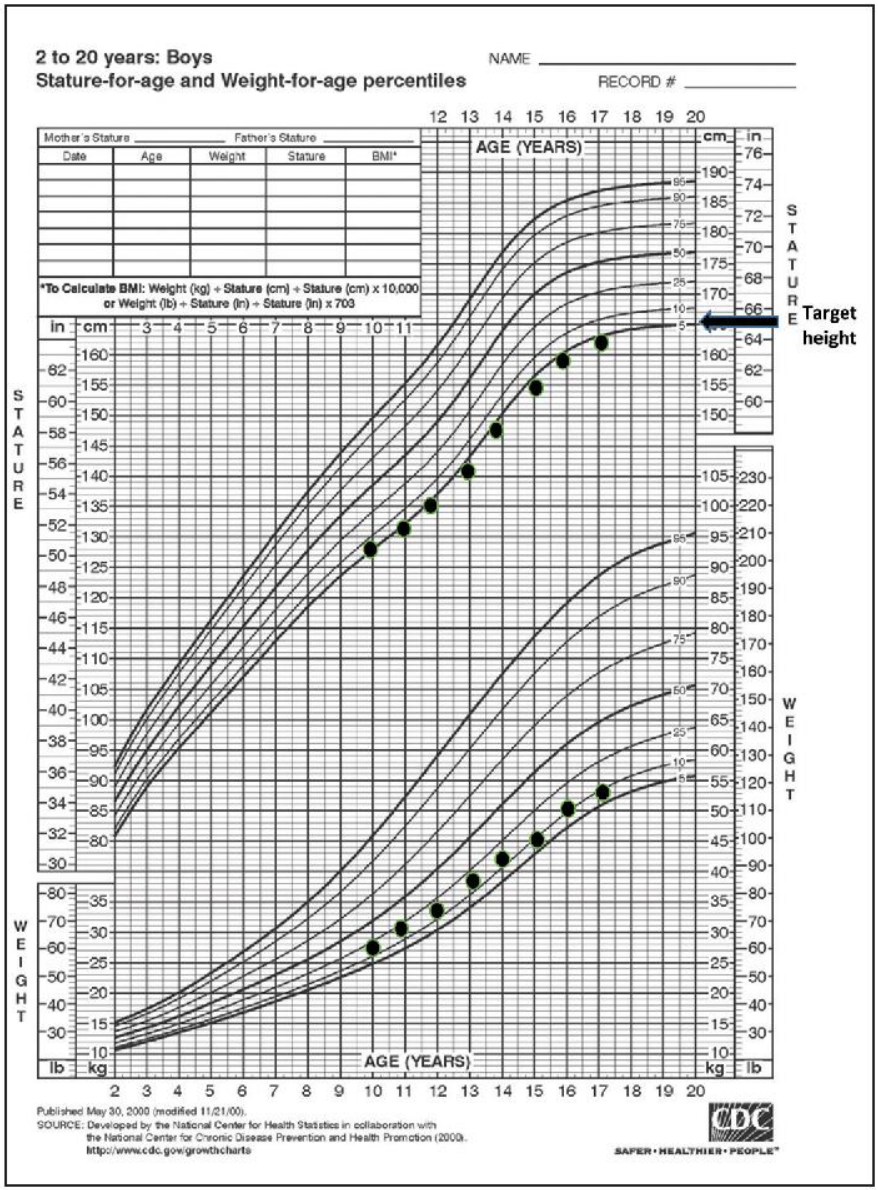
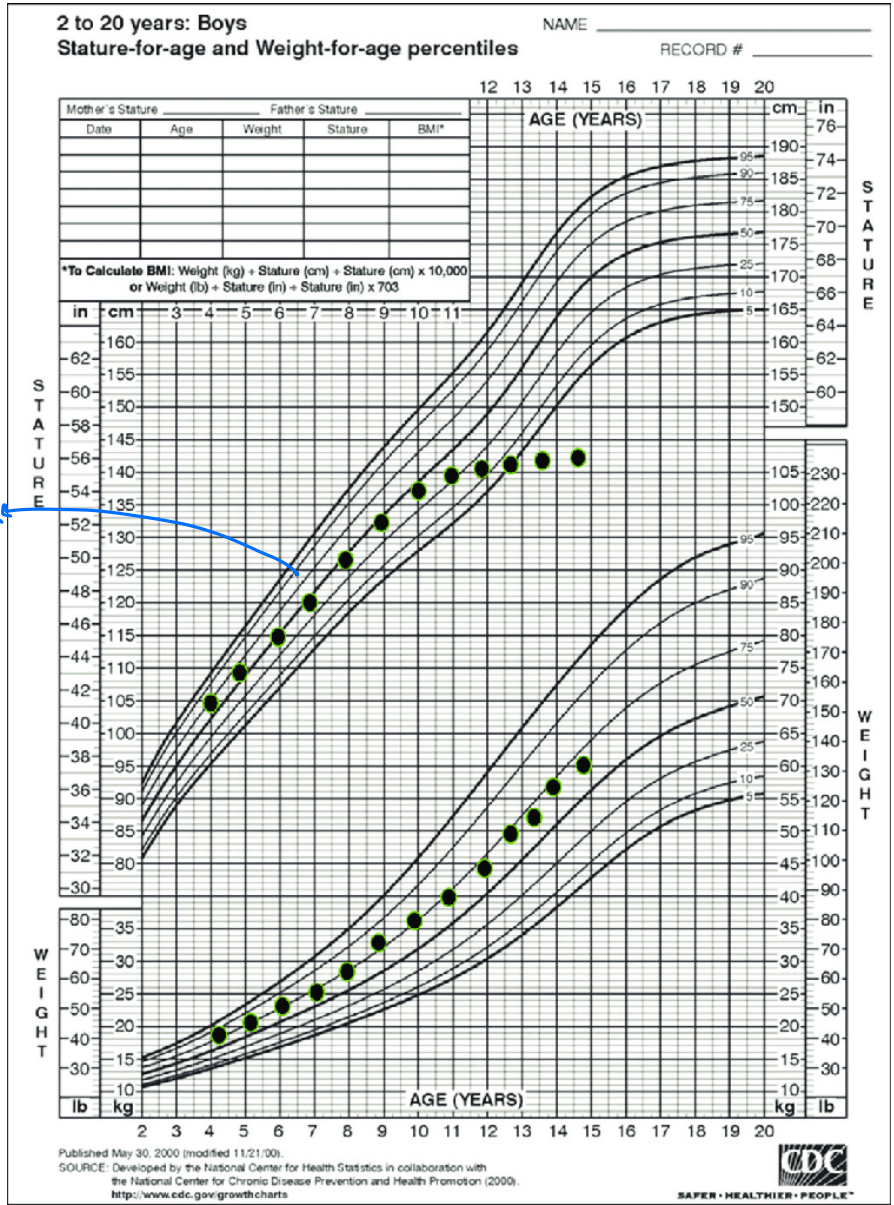



Figure courtesy of the US Centers for Disease Control and Prevention.

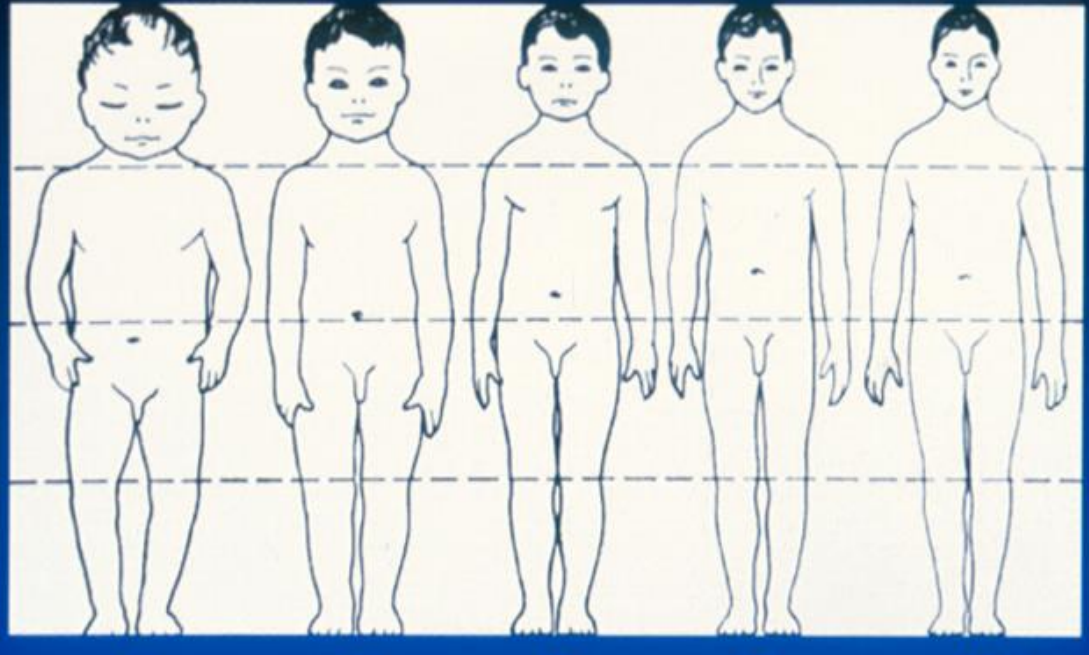
| Feature | Familial short stature | Constitutional Delay |
|---|---|---|
| Parents' stature | Small (one or both) | Average |
| Parents' puberty | Usual timing | Delayed |
| Birth length | Normal | Normal |
| Growth (0 to 2 years) | Normal | Normal to slow |
| Growth (puberty) | Normal | Slow |
| Bone age | Normal | Delayed |
| Timing of puberty | Normal | Delayed |

Constitutional delay: Bone age delayed up to 2 years
(more should make you suspect pathology like a systemic illness)




normal height then sudden deceleration: suspect systemic illness + acquired GH deficiency

# Stature divided into quarters



# Body proportions

- The proportions of the body change during fetal and postnatal growth. The most commonly used descriptors of body proportions are the ratio of the upper body segment to the lower body segment and the ratio of arm span to height.
- Approximate normal ratios of US/LS :

  Birth — 1.7

  3 years — 1.33

  5 years — 1.17

  10 years — 1.0

  >10 years — <1.0

Lower segment: Symphysis pubis to floor

- ↑ in children with rickets, achondroplasia, and Turner syndrome (because of decreased limb length) .
- ↓ in Marfan syndrome (because of increased limb length).

# Achondroplasia

Normal trunk
+
Short limbs

# Endocrine disorders

- Growth hormone deficiency and resistance
  cause (congenital or acquired)
- Thyroxine deficiency
- Cortisol excess
- Precocious puberty
- Idiopathic short stature

# Evaluation of the child with short stature - history

- History of growth pattern and previous measurements
- Parental heights,puberty
- Birthweight,postnatal hx
- General health
- Psychosocial situation

# Evaluation of the child with short stature - auxology

- Accurate measurement of child and parents
- Sibling measurement in selected cases
- Plot height and weight
- Plot mid parental height and target range
- Bone age by single observer

# X-ray of left hand and wrist for bone age assessment

# Evaluation of the child with short stature - examination

- General appearance and nutrition
- Body proportions
- Dysmorphic features
- Systemic examination including heart
- BP
- Pubertal status
- Fundi - if you suspect a central cause

# Investigation of short stature

- Low threshold for karyotype in girls with short stature.
- Short stature screening
- Further short stature investigation

# Short stature screening

- FBC and film, ESR, TTG a'bodies,LFT,Blood gas
- Karyotype
- TFT, IGF-1,IGFBP3, prolactin, cortisol
- Creatinine, Lytes, calcium and phosphate
- Urinalysis and culture

# Further investigation of short stature

- Endocrine stimulation testing
  - ITT/arginine/clonidine/glucagon
- Pituitary imaging
- Genetic evaluation – clinical, laboratory
- Skeletal survey

# Conditions where growth hormone therapy is recommended

- Growth hormone deficiency
- Turner syndrome/Noonan Syndrome/SHOX
- Prader-Willi syndrome.
- SGA with no catch up by 4 years
- Chronic renal insufficiency.
- ISS ??

(even tho some of these there is no GH deficiency)

# Treatment of GH deficiency

Recombinant human growth hormone (RHGH)

- Daily bedtime subcutaneous injections of aqueous solutions of biosynthetic (recombinant) GH
- Follow up q 3 months

# THANK YOU