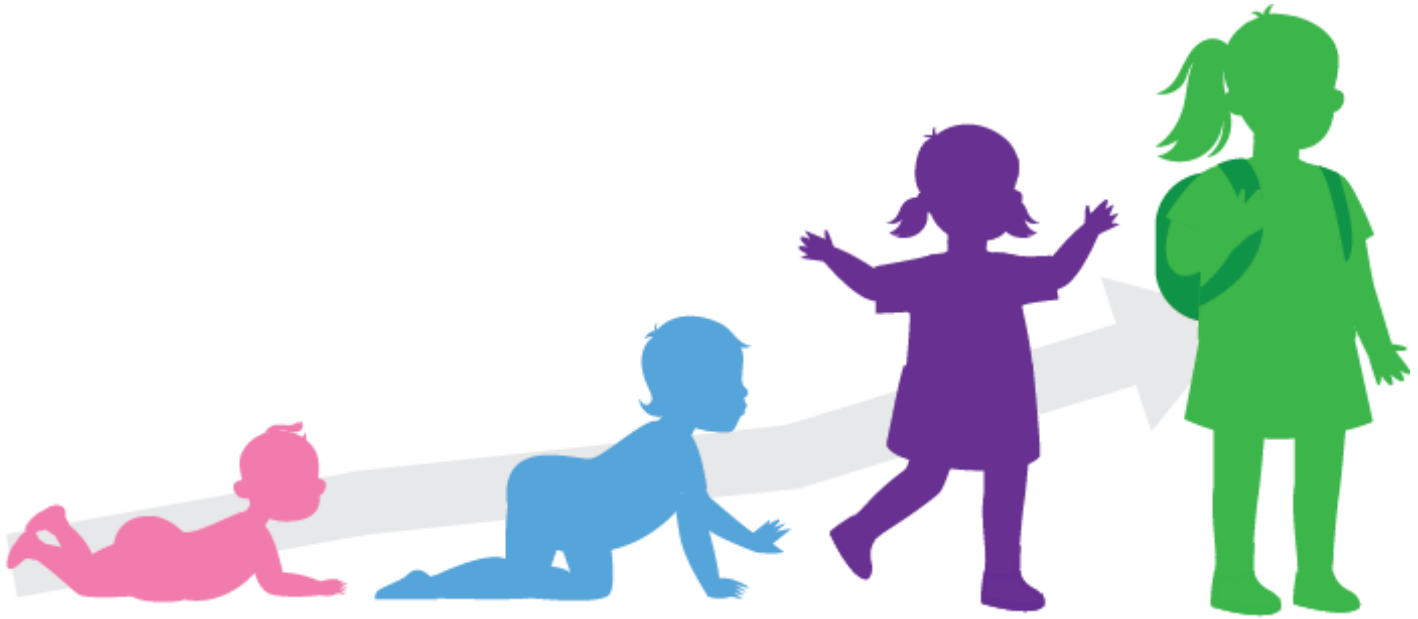

Normal Growth in Children

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Outlines

- Definition and importance of Normal growth
- Determinants of Normal Growth
- Fetal growth
- Growth in infants and toddlers (the 1st & the 2nd yrs of life)
- Growth in childhood (preschool ages: 3-5 yrs & School ages: 6-11 yrs)
- Growth in adolescence (12-18 years)

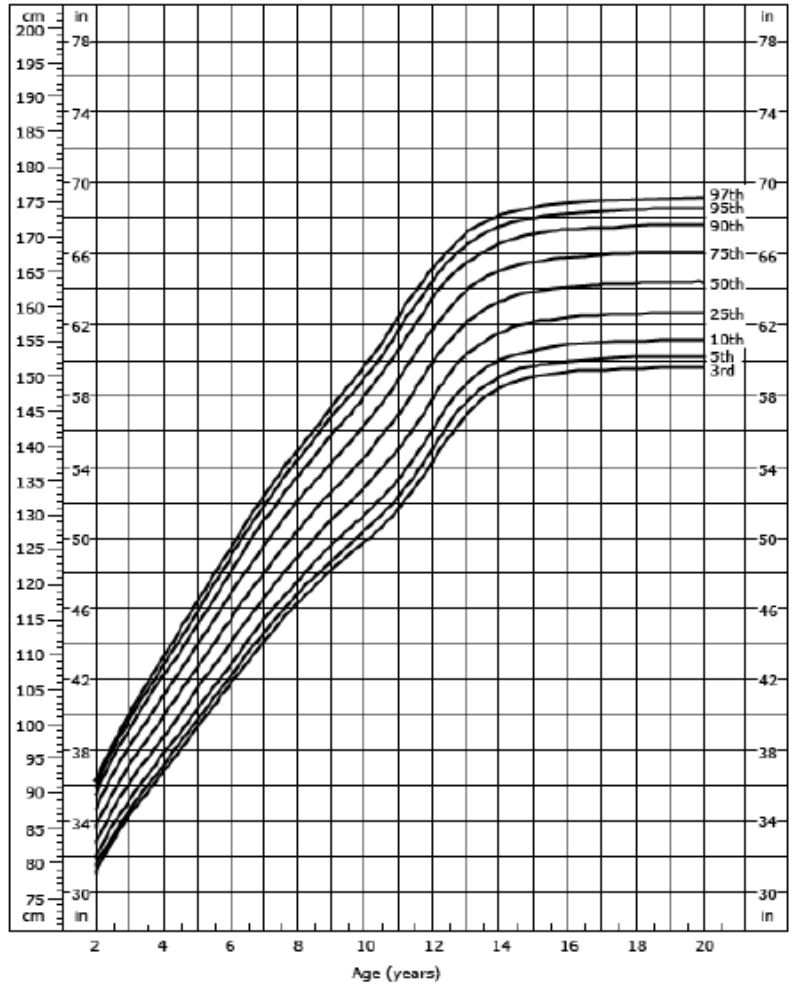
Definition of Normal Growth

- Changes in Ht, Wt, and HC

- Compatible with:
- Standards for a given population
- Genetic potential

- A predictable fashion
- Four major phases

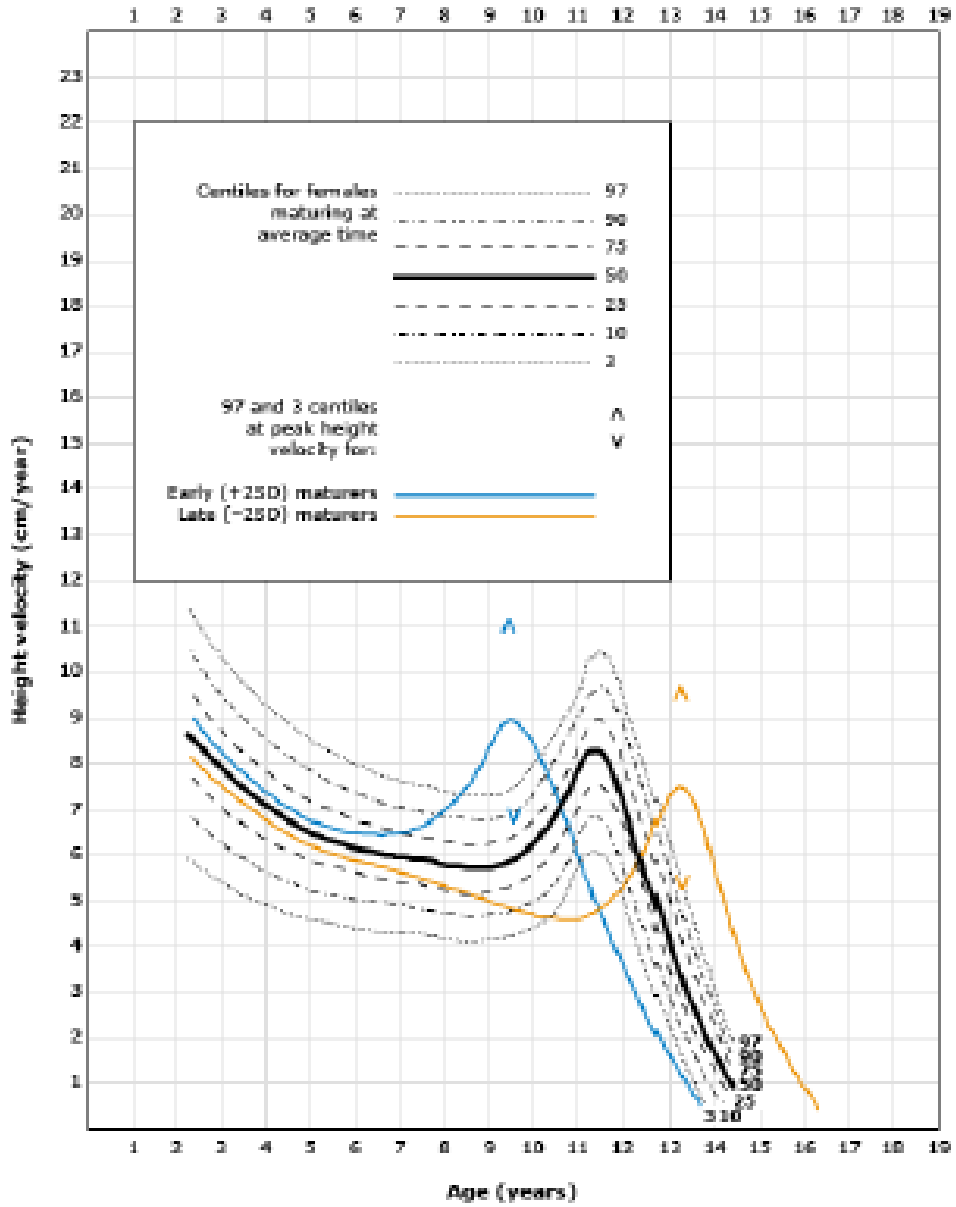
Stature-for-age percentiles, females 2 to 20 years, CDC growth charts: United States



Normal Patterns

- Growth rate varies by age and by time
- Pulsatile
- Seasonal
- Growth spurts

- Serial measurements
- Plotted on growth charts



The Importance of Normal growth

- Reflects health
- Reflects nutritional status

- Pathologic deviations
- NL variations

Determinants of Normal Growth

Maternal nutrition

Intrauterine environment

Genetic factors

Environmental factors

Nutrition

Acute and chronic diseases

Exercise

Psychology

Growth Spurts

- **Neonatal and infantile growth spurts:**

7-10 days, 2-3 wks, 6 wks, 3 mo, 6 mo, 9 mo
(vary in time, last 2-3 days, overnight growth)

- **In toddlers and childhood:** less common

(lasting eight weeks, separated by 18 days intervals)

- **Pubertal growth spurts:**

girls: 8 - 13 years
Boys: 10 - 15 years
(last to weeks)

Growth Spurts

- Sleep patterns (disturbed sleep, sleepiness)
- Appetite
- Attitude & emotional outbursts

- Return to the previous sleeping and eating habits once subsides

- Teeth eruption or shedding
- Sexual development

Temporary Loss of Appetite

- If healthy, happy, growing baby: NL
- End of a growth spurt often triggers a drop in appetite
- In 3-4 months old

Developmental stages	*Environmental causes*	*Diseases*
• Decreased growth rate • Teething	• Overheating • Introducing solid foods • Excess fluid intake • Type of food • Too much strain	• Chronic illness • Sore throat • Worm infestations • Food intolerance • Vaccination • Constipation • Anemia

Fetal Growth

The fastest growth phase

- *Maternal*:

nutrition, diseases, psychologic distress

- *Intrauterine environment and placental*:

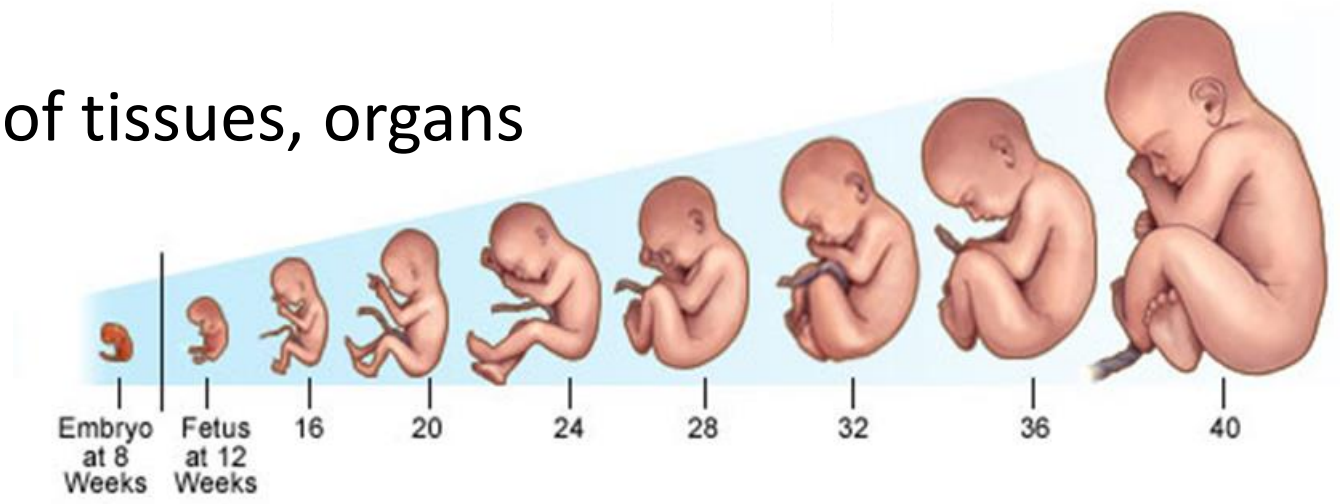
drugs & toxins, uterine and placental abnormalities

- *Fetal*:

Genetic factors, diseases, infections

Fetal Growth

- Rapid body growth & differentiation of tissues, organs



- **Fetal growth assessment:**
- 1st trimester by crown-rump length (CRL)
- >= 2nd trimester combination of BPD, HC, AC, FDL
- In the 3rd trimester, weight triples and length doubles (pro, fat, iron, ca)

Abnormal Fetal Growth

- Usually preterm
- **Low birthweight (LBW):** any live birth <2,500 g
- **Very-low-birthweight (VLBW):** any live birth <1,500 g

- At any GA
- **Intrauterine growth restriction (IUGR):** deficiency of fetal growth
- **Small-for-gestational-age (SGA):** constitutionally normal neonates

Growth in prematurity

- Over diagnosis of growth failure
- Correct growth parameters for gestational age
- The rate and duration of "catch-up growth" vary

- **WT: 24 months**
- **Stature: 40 months**
- **HC: 18 months of age**
- **VLBW: catch-up growth to early school age**

- Focus on growth rate (corrected age)
- weight-for-length (reference standard)

SGA

- Different patterns of growth
- Depending on etiology and severity

- Catch up growth:

Most infants till 2 years reach the 3%

10% no catch up growth till childhood

Birth Weight and Metabolic Outcome

Fetal programming:

- Adaptations to adverse situation
- Change response to environmental and nutritional signals
- Epigenetic imprinting

- SGA
- LGA
- Premature

Lifelong implications

- Mismatch between fetal and neonatal environmental condition
- Insulin resistance
- Metabolic syndrome
- CVD
- Diabetes
- Obesity

Neonatal Period

- From birth and includes the 1st mo of life
- Regardless of gestational age
- In term neonate:
- BW: 3500gr
- Birth Length: 50 cm
- Birth HC: 35 cm ± 2
- BW and Lnt does not necessarily correlate with adult height

Growth in the 1st Year of Life

0-2 MONTHS

- Wt decrease 10% below birthweight in the 1st wk
- >= BW by 2 wk
- 30 g /day in 1st mo
- Length: 2.5 cm/month
- HC: 2cm/ mo
- The fastest postnatal growth

2-6 MONTHS

- Decrease in growth rate between 3-4 mo of age
- 20 g/day
- Length: 2.5 cm/month
- By 4 mo: BW doubled

6-12 MONTHS

- Growth slows more
- 10 g/day
- Length 1.25 cm/month
- By 1 y/o
- BW: tripled
- Length: increased by 50% (25 cm)
- HC: increased by 10 -12cm

Growth in the 2nd Year of Life

12-18 MONTHS

- Growth rate declines

- **Ht: 10-12.5 cm increase**
- **Wt: 2-2.5 kg increase**
- By 24 mo: 50% of final height

- Brain growth continuous
- **HC: 2 cm increase**
- By 24 mo: HC 85% of adult

- Concern about poor food intake as growth slows
- Growth chart for reassurance

18-24 MONTHS

Crossing Linear Percentiles of Infancy

- Crossing of percentiles in the 1st 2 yrs of life
- Normal variant of growth
- 2/3 of normal infants
- Increase or decrease
- Approach to the genetic potential

The 1st 1000 Days of Life

The prenatal period and the 1st two years of life are critical periods for metabolic programming and a platform for growth, puberty and development

Association between rates of weight gain during infancy or early childhood and subsequent obesity or metabolic syndrome

Growth in Early Childhood (2-5 yrs)

- The Somatic and brain growth slows
- **Wt: 2 kg/yr**
- **Ht: 6 cm/yr**
- 4 yr old: Ht twice birth (100 cm)
- HC: only 5-6 cm between ages 3 and 18 yr

- Decrease in appetite
- “Picky” eating habits

- Concern about nutrition
- Growth charts for reassurance

- Early increase in BMI (**adiposity rebound**) increased risk for adult obesity

Growth in Middle Childhood (6-11 yr)

- **Wt: 3-3.5 kg/year**
- **Ht: 6 cm/ year**

- Slow brain growth
- Myelination continues
- HC: 2 cm in throughout the entire period
- Loss of deciduous teeth: around 6 yr

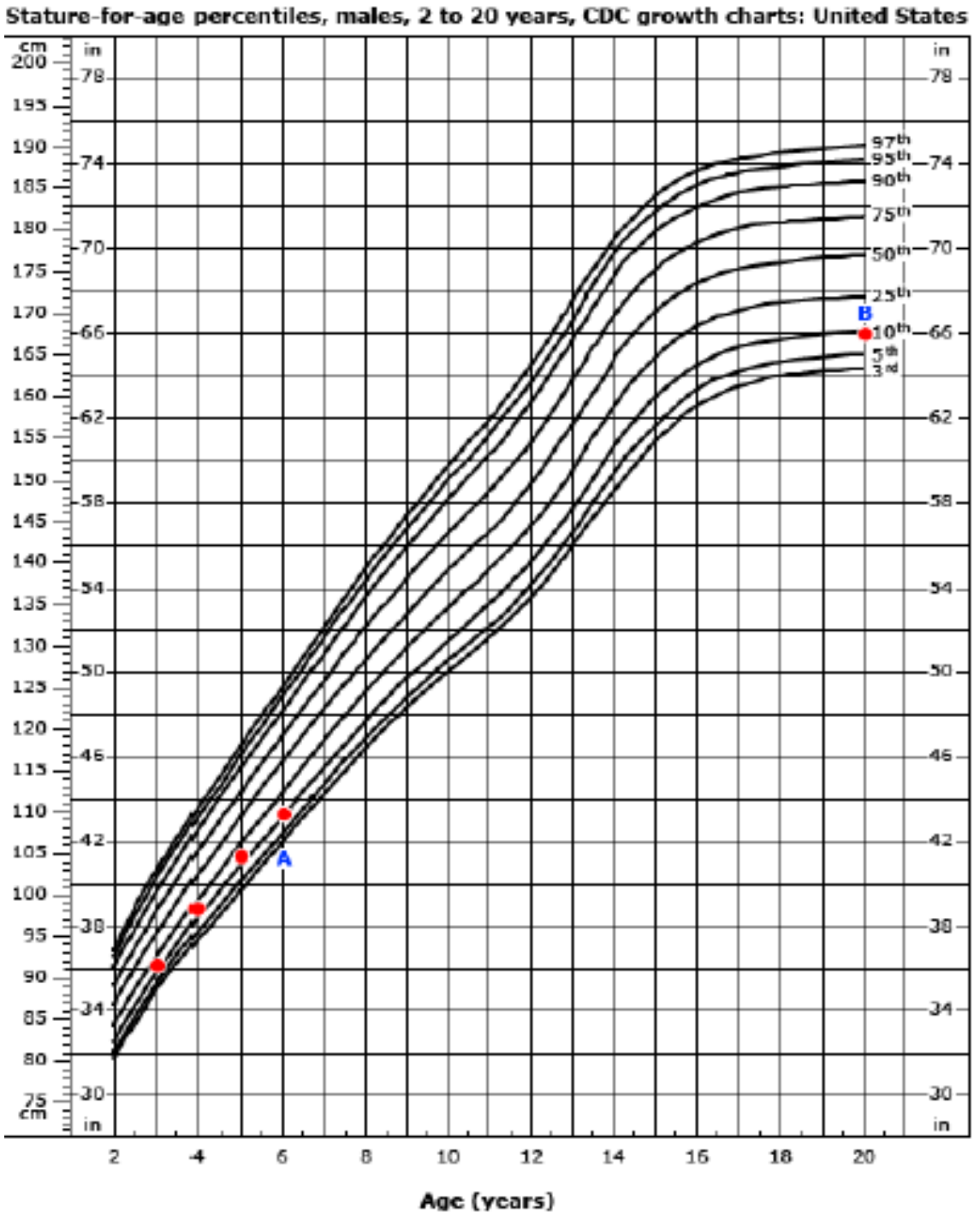
- Sedentary habits
- lifelong risk of obesity, CVD, and lower self esteem

Childhood Growth

2yrs-puberty

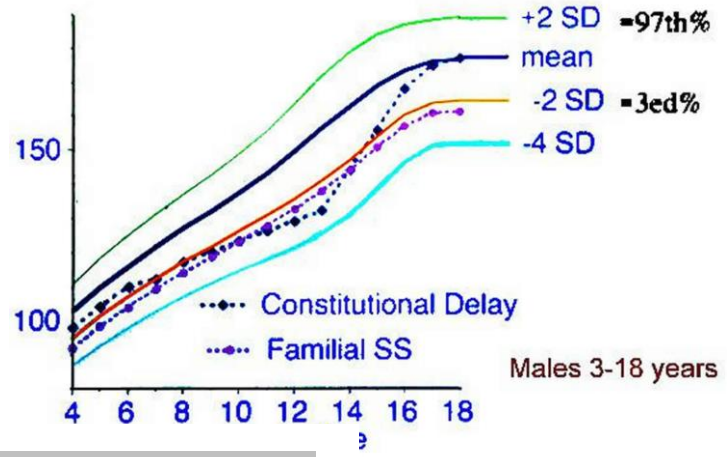
- Growth most steady and predictable
- Grow along the same channel
- Used to predict adult height

A prepubertal child
HV <5 cm/year
Weight velocity <1 kg/year
Monitor closely for nutritional deficits



Variants of Normal Growth

Two most common causes of short stature >2years



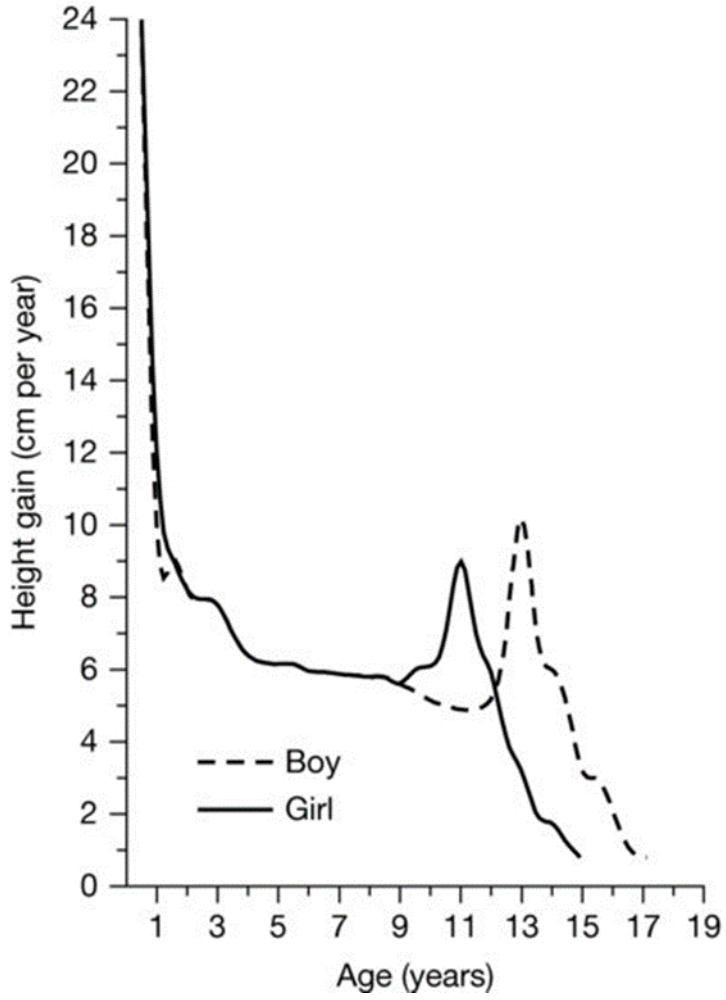
Feature	Familial short stature	Constitutional delay
Parents' stature	Small (1 or both)	Average
Parents' puberty	Usual timing	Often delayed
Birth length	Normal or low-normal	Normal
Growth (0 to 2 years)	Normal	Slow from mid-infancy to mid-childhood
Growth (2 years to puberty)	Normal	Slow
Bone age	Normal	Delayed
Timing of puberty	Normal	Delayed
Pubertal growth	Rate low-normal	Growth spurt delayed, rate slightly diminished
Adult height	Short	Normal

Growth in Adolescence (12-18 years)

- Pre pubertal dip

- In puberty
- **Ht: 8 cm/yr** (a sharp increase)
- Induced by sex hormones and GH
- **weight spurt: 1-4 kg/six months**

- Caution in using growth charts in adolescence
- Normal variations in timing of growth spurt
- Misdiagnosis of growth abnormalities



Growth in Adolescence (12-18 years)

Females

- Start of puberty: breast buds 8-13 years
- Peak growth: 6-12 months before menarche, SMR 2-3 (11.5 yr)
- 5-10 cm/year for 2.5 years
- 20-25 cm increase height in puberty (12% of final height)
- Menarche average 12.5 years
- Growth after menarche 1-7 cm

Growth in Adolescence (12-18 years)

Males

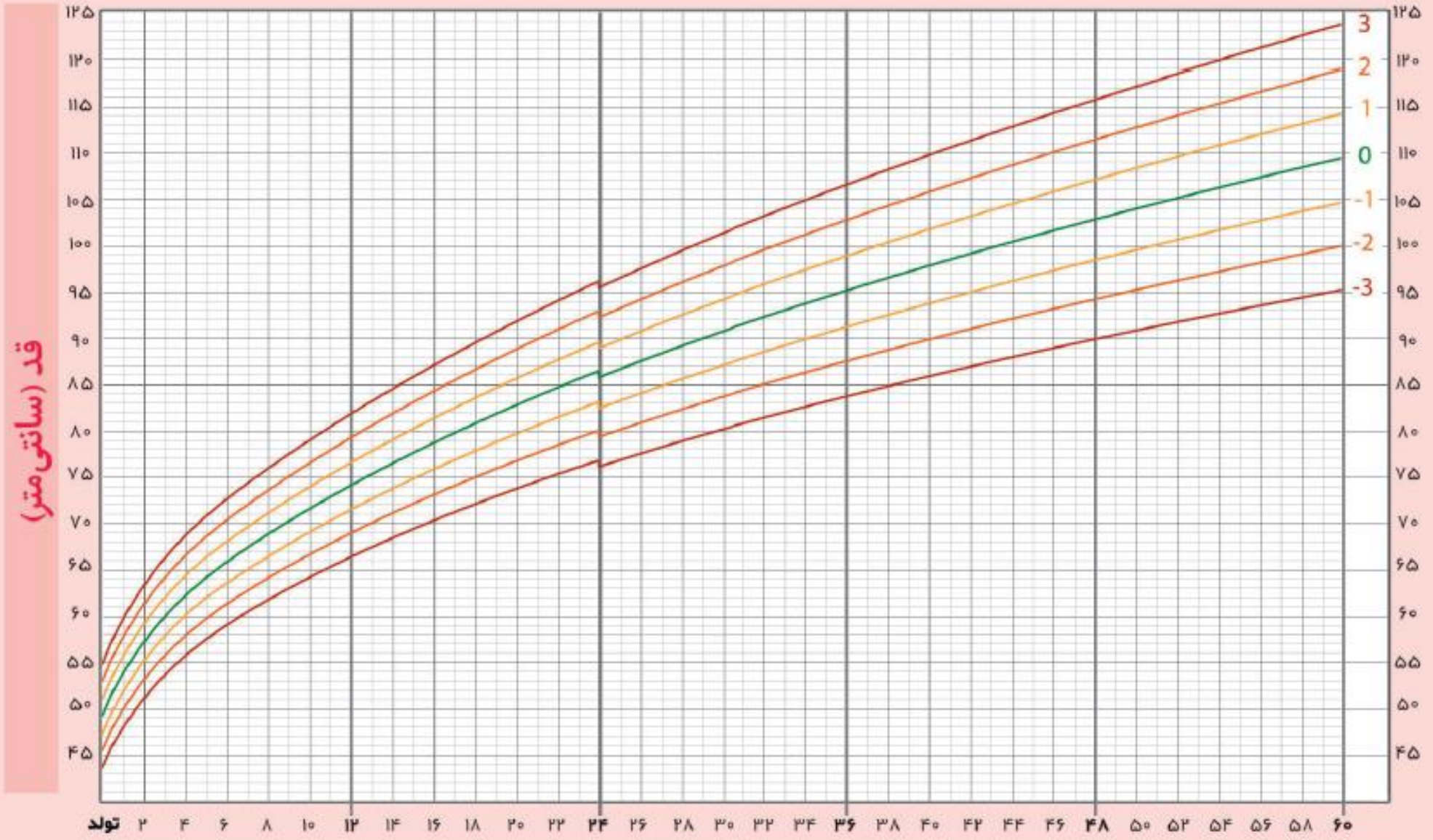
- Start of puberty: testicular enlargement (9-14 years)
- Growth spurt: two years after girls, SMR 3-4 (13.5 years)
- 6-12 cm/year for 4 years
- 25-30 cm increase height in puberty (17% of final height)
- Peak growth more than girls and last longer
- Taller average Ht of adult men compared with adult women

Evaluation of Growth

- Accurate measurement
- Determination of growth percentiles
- Assessment of the growth trajectory
- History and P/E
- The laboratory and radiologic evaluation

- **Abnormal growth:**
- Below 3 percentile
- Above 97 percentile
- Cross two major percentile curves

نمودار قد برای سن از تولد تا ۵ سالگی (Z-Score) دختر



Interpretation of Growth Parameters

Z-score between -2 and +2	• The parameter is within 2 SD of the mean • Normal range • 2.3 and 97.7 percentiles
Z-score <-2	• The parameter is more than 2 SD below mean • <2.3 percentile
Z-score <-3	• The parameter is more than 3 SD below mean • < 1 percentile

Interpretation of Z-Score for Growth Parameters

Z-score	Growth indicators			
	Height* for age	Weight for age	Weight for height*	BMI for age
Above 3	Very tall¶	Δ	Obese	Obese
Above 2		Δ	Overweight	Overweight
Above 1		Δ	Possible risk for overweight◇	Possible risk for overweight◇
0 (median)				
Below −1				
Below −2	Stunted§	Underweight	Wasted	Wasted
Below −3	Severely stunted§	Severely underweight¥	Severely wasted	Severely wasted

Thanks for Your Attention