Puberty starts at the age of 10 for girls, for boys they enter puberty a bit later, earliest is ten but the typical is the age of 12.

How can we assess growth?

Growth parameters: weight, height and head circumference. **How can you measure them?**

1- **Infantometer:**
   - You need two people; one controls the head and one controls the legs. Both legs are straight, knees are straight. Children don't like it, you sometimes need 3 people to stabilize the kid. (recumbent position on a hard flat board)
   - Head is touching the headboard, legs are straight, both heels are touching the measurement board
   - < 2 yrs old = We measure length, we measure it when lying down.
   - Height is when person is standing
   - Height lying down is longer than when standing, big difference.

2- **Stadiometer,** it's very tricky, because kids don't really stand still. You need to align everything. In the same line. You need someone to hold the jaw, knees are straight.

Another part of assessment: mid parental height (parents height) why do we need to know it? To make sure what is the familial target.

Boys: father + mother height +13 /2 (+/- 8 cm)

Girls: father + mother height - 13 /2 (+/- 8 cm)

Why do we add or subtract 8? Range, what is it? Standard deviation.

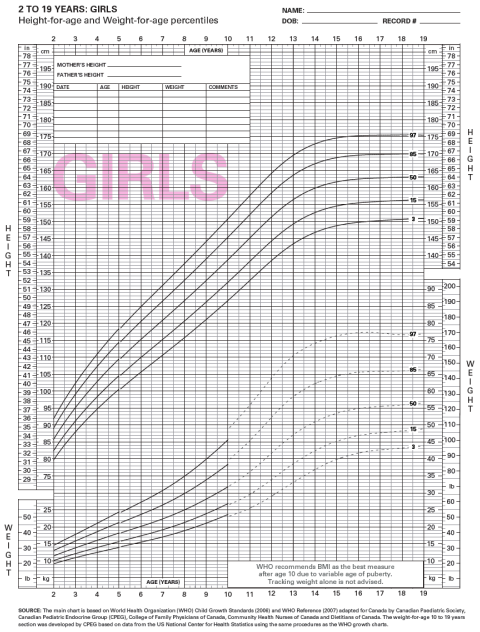
Fracture in the back could affect height. Otherwise no other fracture could. Only mechanical changes can give an effect of a change in height, but not really.

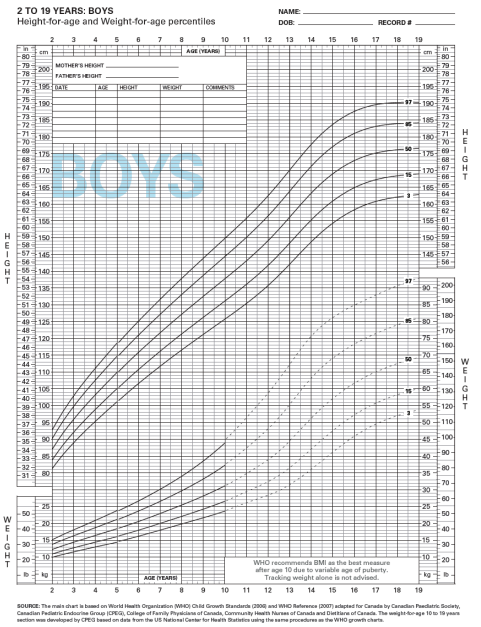
How do we decide whether a child's growth is normal or not? By comparing him to other kids.

Types of growth charts:

- Who most recognized (best study you could plan)
- CDC (present American standard)
- Saudi growth charts

Peak growth velocity before it becomes static is different in girls and boys. Girls stay longer in plateau than boys.





who is this chart for?

Age range

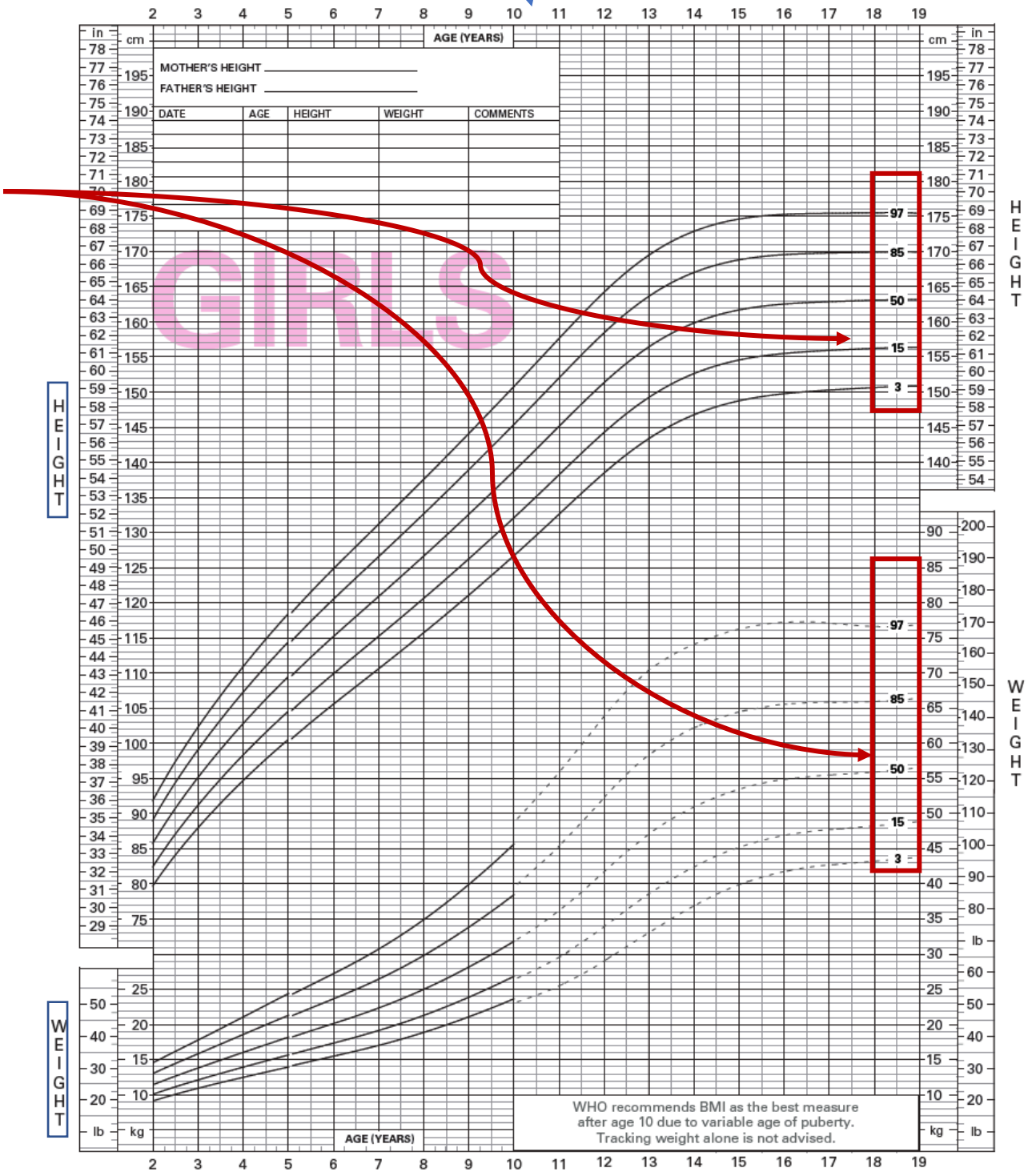
child ID

2 TO 19 YEARS: GIRLS

Height-for-age and Weight-for-age percentiles

NAME: _____

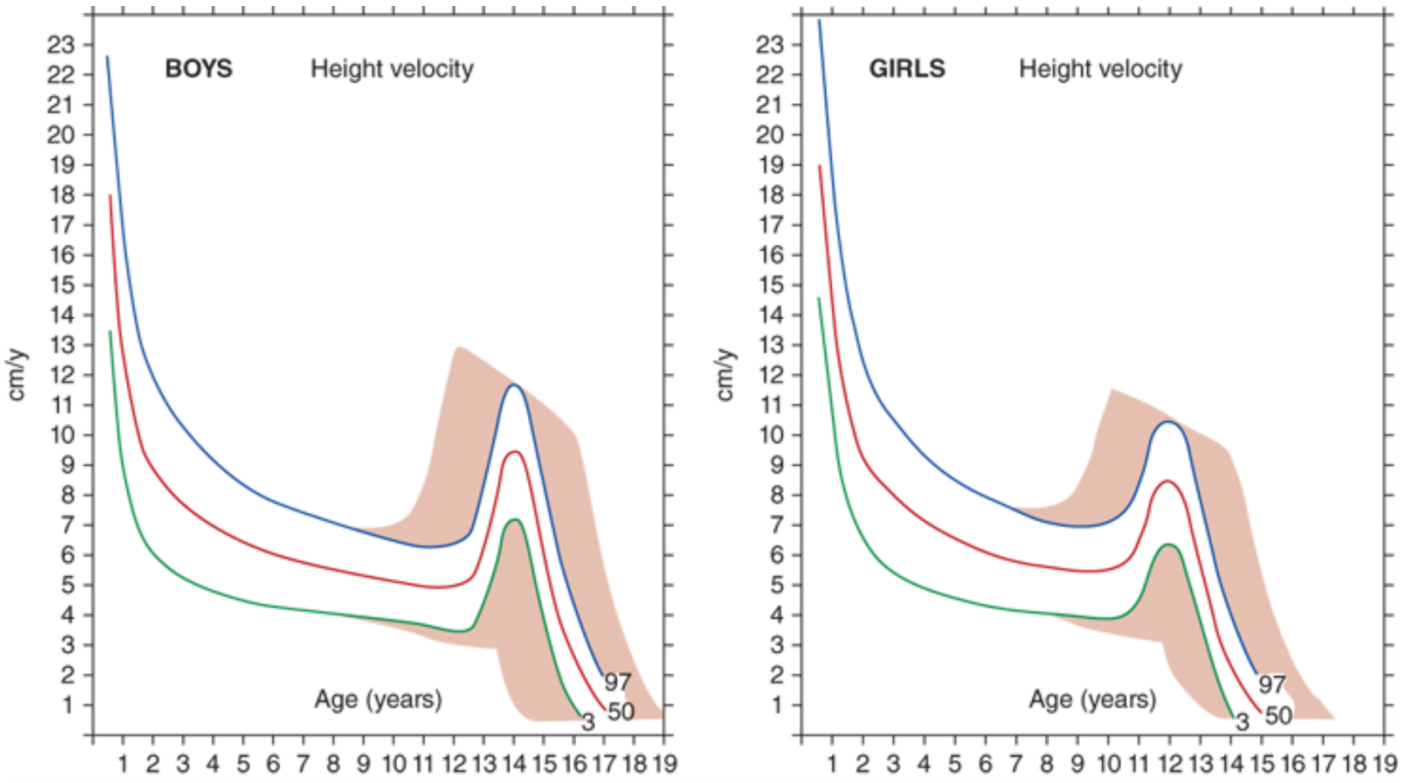
DOB: _____ RECORD # _____



Percentile lines

SOURCE: The main chart is based on World Health Organization (WHO) Child Growth Standards (2006) and WHO Reference (2007) adapted for Canada by Canadian Paediatric Society, Canadian Pediatric Endocrine Group (CPEG), College of Family Physicians of Canada, Community Health Nurses of Canada and Dietitians of Canada. The weight-for-age 10 to 19 years section was developed by CPEG based on data from the US National Center for Health Statistics using the same procedures as the WHO growth charts.

Growth velocity: The annual rate of growth in height (cm/year).



It starts high, then declines, then increases again during growth spurt, and then declines once again.

Rule of Thumb (Length and Height):

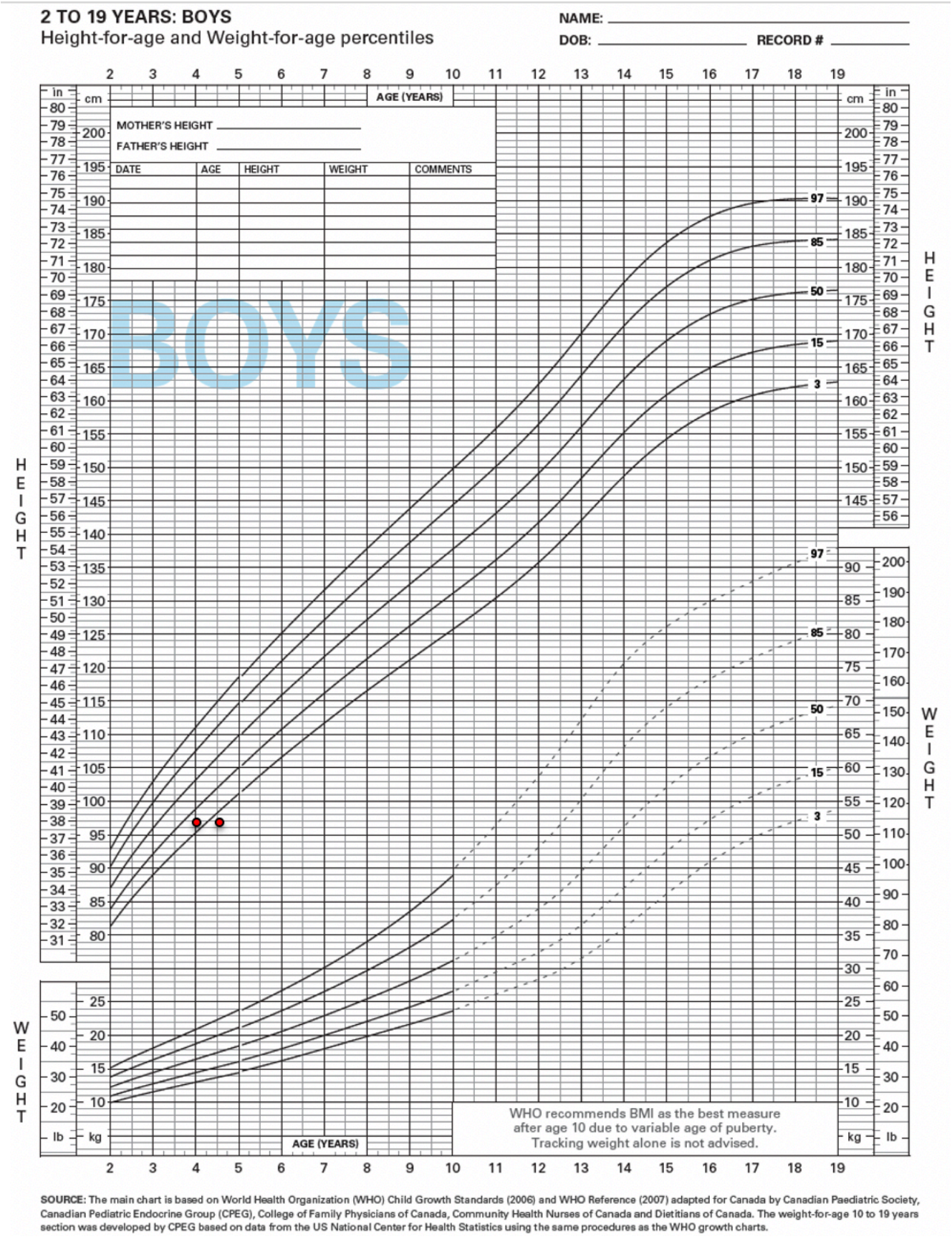
- Average length at birth is 50 cm
- Average Length at 1 year is 75 cm
- At 4 years, birth length doubles.
- Between 4 years and puberty, annual height increase by 5-8 cm/year

Rule of Thumb (weight):

- Newborns lose 5-10% of body weight in the first few days after birth.
- Newborns regain birth weight in 7-10 days.
- Birth weight doubles at 4 months
- Triples at 1 year
- Quadruples at 2 years.

Example:

- Mohammed came today to the general pediatrics clinic for his annual health check up.
- His date of birth is 7-3-2014. His mother states that he is 4 years old.
- His height is today is 97 cm and his weight is 15 Kg
- Mohammed's mother asks: " Is his growth normal?"



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- Mohammed's height is in the area below the < 3rd percentile at 4 ½ years of age.
- Mohammed is shorter than (>97%) of Boys at his age.

Short stature:

Define it by either the single point data or the serial measurement data
Single measurement data: Height > 2 SDS below mean of age and sex (≤2nd %ile).
Or height velocity less than 25% (- 2 SD for age)
Normal height velocity is: 4-5 cm per year, in puberty: 8-12 cm per year

Growth failure:

Height Velocity > 2 SDS below the mean for age and sex (<3rd %ile)

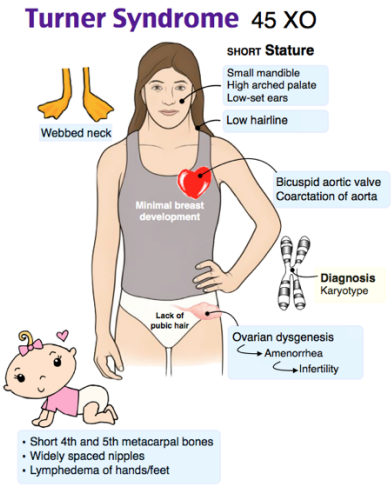
Causes:

Short Stature (Normal growth velocity)	Growth Failure
Constitutional Delay of Growth and Puberty (CDGP)/ Constitutional short stature	**Endocrinopathies:** 1- Growth hormone deficiency 2- Hypothyroidism 3- Cushing syndrome
Nutritional deficiency	
Chronic illnesses: 1- GI diseases, Malnutrition, malabsorption… 2- DM 3- Cystic fibrosis 4- Congenital heart disease Heart failure, renal failure, liver disease…	Genetic (Turner syndrome, Silver-Russell Syndrome, Noonan Syndrome, Prader-Willi syndrome, SHOX gene insufficiency, Pseudohypoparathyroidism Skeletal Dysplasias
	Familial Short stature

Assessment:

- Midparental Height
- Body proportions
  - Arm span (normal arm span = height)
  - lower body segment (Symphysis pubis to floor while standing), Upper segment = height – lower segment) (normal = 1:1 by 10 years of age)
- Bone age:
  - Left hand and wrist x-ray compared to a standard. (Used to assess skeletal maturity and to predict remaining growth and final adult height)

Dx	Clinical features
Constitutional Short stature	Usually in a healthy boy with normal height early in life, associated with delayed puberty and delayed bone age, FHx of delayed puberty.
Familial short stature	Height within genetic target as per midparental height. Bone age = chronological age, no pubertal delay
Endocrinopathy	Growth failure (usually), weight is not affected (well-nourished child), bone age is delayed. No growth spurt, stopped growing, gaining weight (mainly Cushing) or well-nourished child Endocrinopathies If a child is hypothyroid, they will just stop growing! (thyroid hormone controls growth more than the growth hormone itself) (hockey stick appearance)
Chronic illness	Growth failure, weight is also affected.
GI disease/ Malabsorption	Growth failure, weight is more affected than height
Genetic	Down syndrome, turner syndrome, Russel silver syndrome Can never achieve the mid parental height, clues come from physical examination



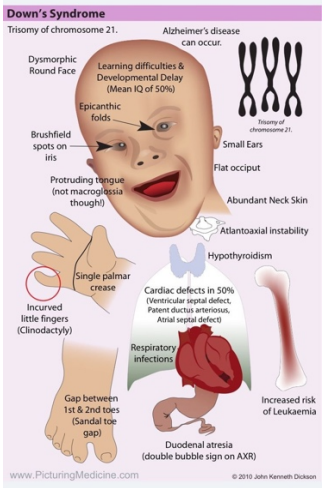


Table 4. Suggested Laboratory Tests for Children with Short or Tall Stature

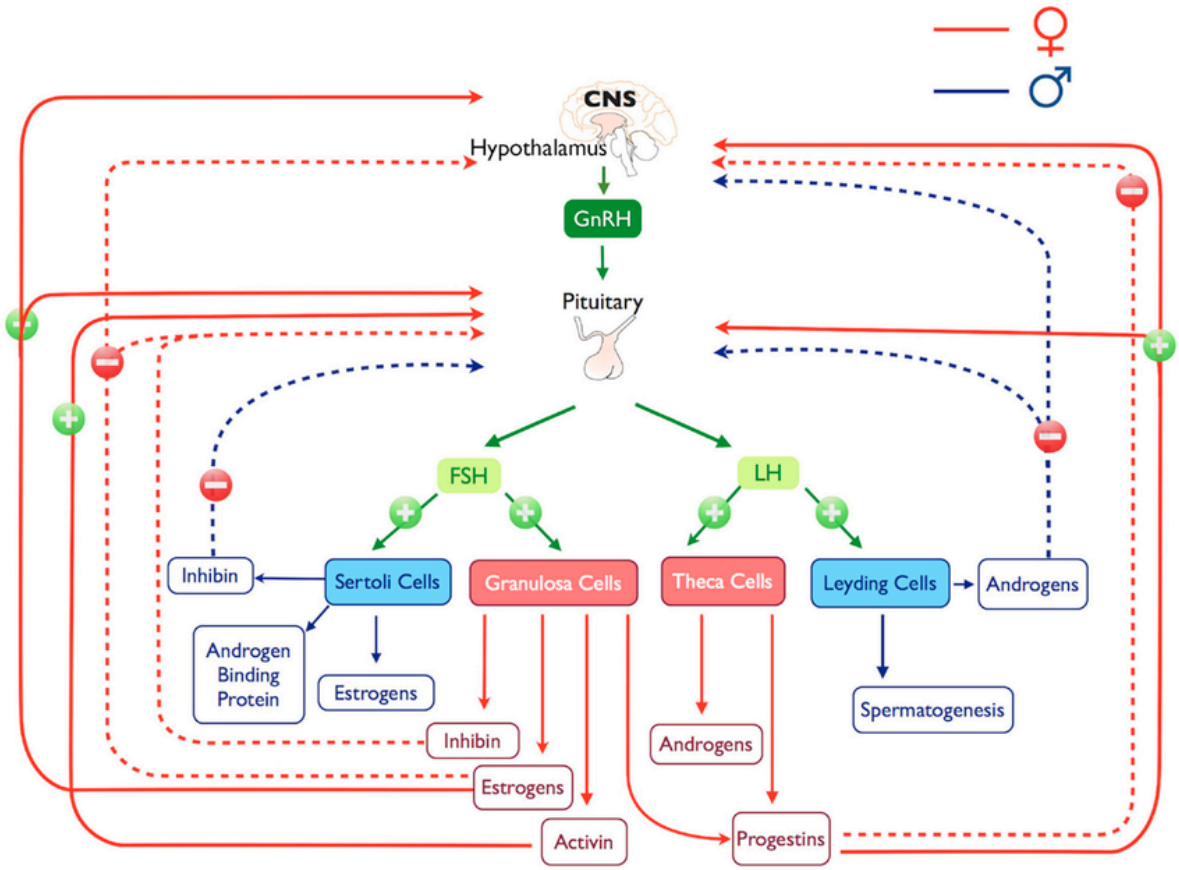
Test	*Indication*
Short stature	
Complete blood count	Anemia
Comprehensive metabolic panel	Hepatic and renal diseases
Erythrocyte sedimentation rate, C-reactive protein	Inflammatory bowel disease
Follicle-stimulating hormone, karyotyping	Turner syndrome
Insulinlike growth factor 1*	Growth hormone deficiency
Thyroid-stimulating hormone, free thyroxine (T4)	Hypothyroidism
Tissue transglutaminase and total immunoglobulin A	Celiac disease
Urinalysis	Renal disease

Investigations for the cause of short stature?

- Rule out chronic illnesses: CBC, renal profile, electrolytes, ABG, celiac
- Thyroid profile
- Chromosomal analysis
- Bone age

Treatment:
Familial: no treatment
Malnutrition, Chronic illness: correct
Growth hormone deficiency, turner syndrome, IUGR, renal failure, HIV: Growth hormone

How is Hypothalamic – Pituitary – Gonadal Axis regulated?



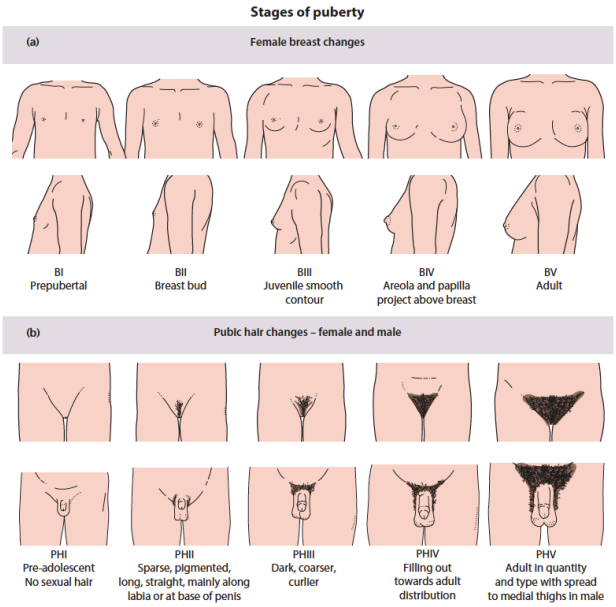
Term	Signs	Result of
Gonadarche	Testicular enlargement	Testicular activation by FSH/ LH
Adrenarche	Body odor, skin oiliness, Pubic hair, Axillary hair and acne	Adrenal gland activation by ??
Thelarche	Breast development	Ovary activation by FSH/LH
Pubarche	Pubic hair growth	Adrenal, ovarian or testicular androgens
Menarche	First menses	Ovarian activation by FSH/LH
Spermarche	Appearance of sperms in morning void	Testicular activation by FSH/ LH

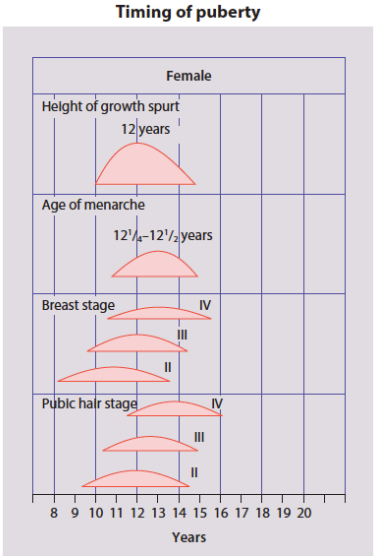
When baby is in uterus, levels of LH & FSH are higher than in puberty and they go down dramatically prior to birth, when the child is born, they go up again (mini puberty, almost resemble the levels in puberty stage), it is normal, because the axis is going to be turned off 3 months later until the time of puberty. God knows what turns it on and off.

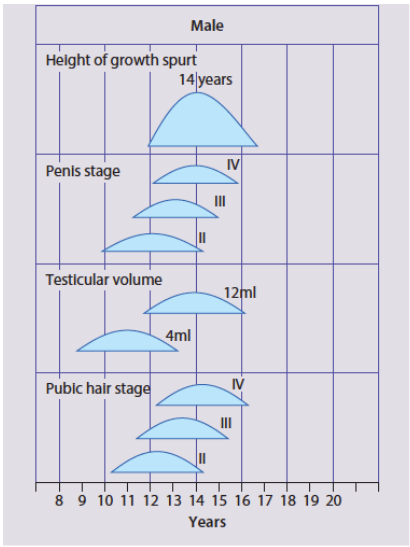
Pubertal Assessment:

1- Tanner staging

- Breast budding in girls (Tanner II) indicates onset of puberty







- In girls peak growth happens prior to menarche (stage 4), then decelerates.

2- Orchidometer

- Testicular volume in boys of 4 ml indicates the onset of puberty
- 2.5 cm, more than 2.5 cm means puberty had started
- Testicular volume increases (1st) then genetalia size and pubic hair, then growth accelerates, peak happens in stage 4 and spermarche happens in stage 5

Delayed Puberty:

In boys: Absence of pubertal signs by age 14.
In girls: Absence of pubertal signs by age 13.

Approach:

Constitutional delay of growth and puberty	Hypogonadotropic hypogonadism	Hypergonadotropic Hypogonadism
- In an otherwise healthy child. - Family Hx of delayed puberty in a parent - Short stature, delayed bone age. - Spontaneous recovery at Bone age 12-13 - FSH/LH and sex steroids in prepubertal range - A retrospective diagnosis.	- Difficult to differentiate from CDGP - If congenital, could be associated with, cryptorchidism and/ or micropenis in boys. - Due to Pituitary/ Hypothalamic pathologies - No spontaneous recovery - **FSH/LH and sex steroids in prepubertal range** **DDx**: - Pituitary hypoplasia (associated with other pituitary deficiencies, septo-optic dysplasia, CHARGE) - Isolated Gonadotropin Deficiency **[Kallman syndrome]** (associated with anosmia/hyposmia). - Secondary (Trauma, Tumor, Radiation, Autoimmune , under nutrition anorexia, excessive exercising, hypothyroidism, hyperprolactinemia, cushing's)	- Difficult to differentiate from Hypogonadtropic hypogonadism in prepubertal age range. - If congenital, could be associated with Ambigious genitalia, cryptorchidism and/or micropenis in boys. - Due to a gonadal pathology - **FSH/LH are extremely elevated in pubertal age range.** **DDx:** - Gonadal failure (congenital dysgenesis, Turner Syndrome, Klinefelter syndrome) - Secondary: - Trauma, Tumor, infection (mumps), radiation, Autoimmune, galactosemia.

Investigations:

- Bone age
- FSH, LH levels
- Testosterone (boys), estradiol (girls)
- TSH, FT4 and prolactin
- Karyotype
- LHRH stimulation test in consultation with endocrinology
- MRI Pituitary + Olfactory pulp, gonadal imaging (US to abdominal pelvis)

LH FSH level 35 and estradiol is 18, where is the problem? Very low estradiol, very high FSH LH = **Hypergonadotropic Hypogonadism (primary gonadal failure)**

Precocious Puberty:

- Appearance of pubertal signs before age 8 in girls.
- Appearance of pubertal signs before age 9 in boys.

Causes:

Central (hypothalamic-pituitary axis) and peripheral (gonadal)

Hypothalamic-pituitary axis		Gonadal
- Pituitary tumor - Infiltrative disease - Idiopathic - Genetic / inherited	- Infection - Post trauma - Post cranial radiation	- Ovarian cyst - Adrenal hyperplasia/ cancer - Gonadal tumor - Exogenous steroids

McCune- Albright Syndrome
Caused by auto activation of the gonadotropin receptor
Gonadotropin independent precocious puberty (Suppressed FSH/LH)
CALMs respect midline and have rough borders
Associated with fibrous dysplasia Café-au-lait macules (CALMs) & Cyst in the ovary
Caused by somatic GNAS mutations

Red flags for pathological causes:

- Abnormal sequence of puberty
- Rapid progression (Tanner 1 this month then tanner 4 the next month)
- Virilization in females (testosterone involved, most likely tumor there) feminization in boys (estrogen, most likely tumor)
- Neurological symptoms

Premature thelarche:

- Between 6months to two years
- Only breast growth (isolated)
- No neurological symptoms
- Self-limiting, no treatment

Investigations:

- Bone age
- FSH, LH levels
- Testosterone (boys), estradiol (girls)
- Adrenal androgens for boys and girls.
- TSH, FT4 and prolactin
- LHRH stimulation test in consultation with endocrinology
- MRI Pituitary (if gonadotropin dependent)
- Gonadal/ Abdominal imaging to r/o tumors (if gonadotropin independent)

Treatment: depends on cause
Tumor? Take it out
Idiopathic? Suppress puberty by GNRH agonist, because puberty happens when GNRH is pulsatile. So we give Lepron injections every 1-3 months