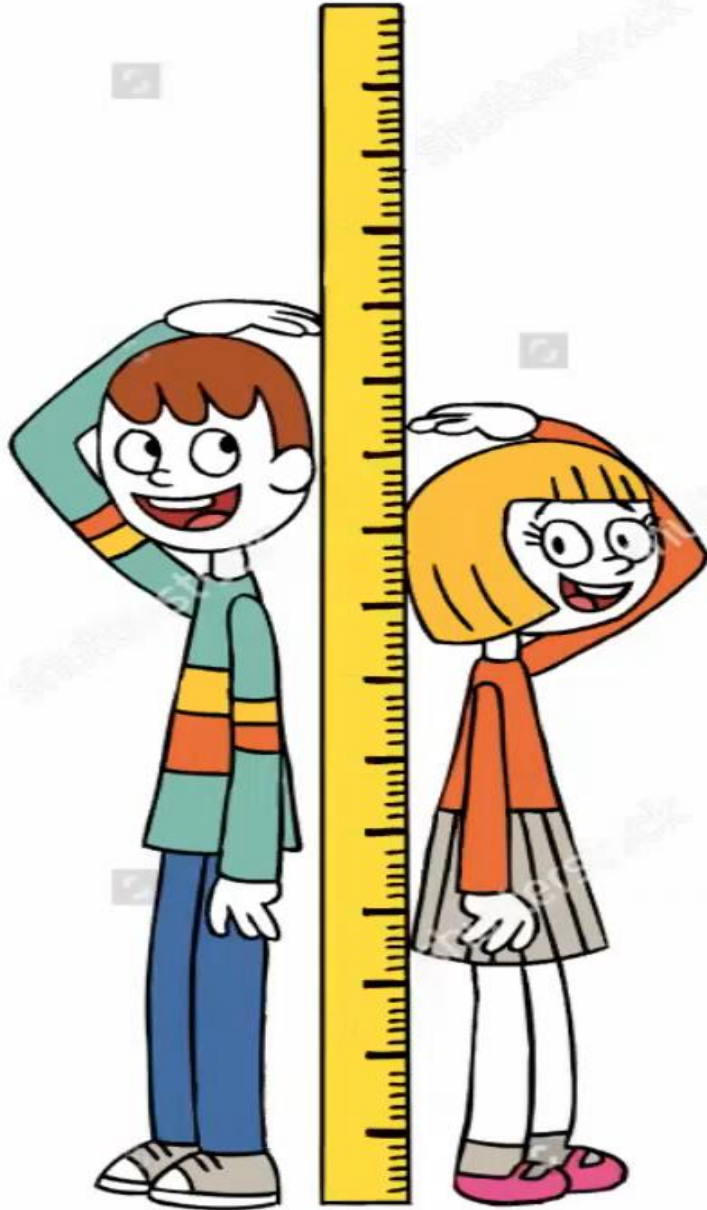


# Growth and puberty normal & abnormal patterns



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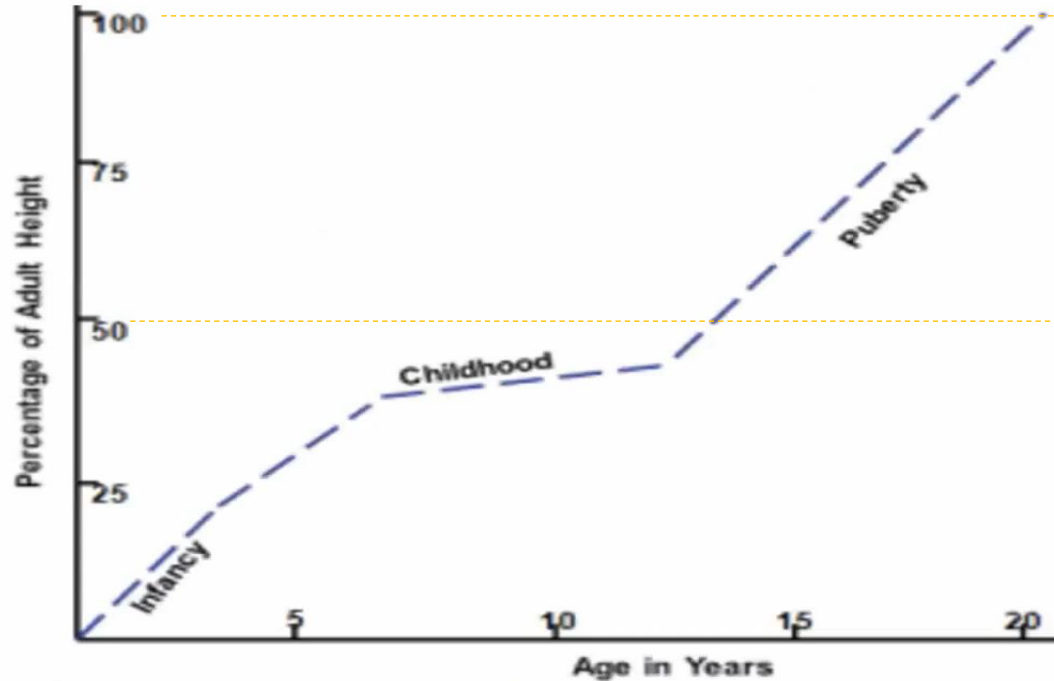
Notes are taken by : Minyal Bawazir

# Objectives

- Understand physiology of growth & puberty
- Know causes and management approach to :
  - Short stature
  - precocious puberty
  - delayed puberty

We are not going to discuss tall stature

# Normal growth



**Nutrition**

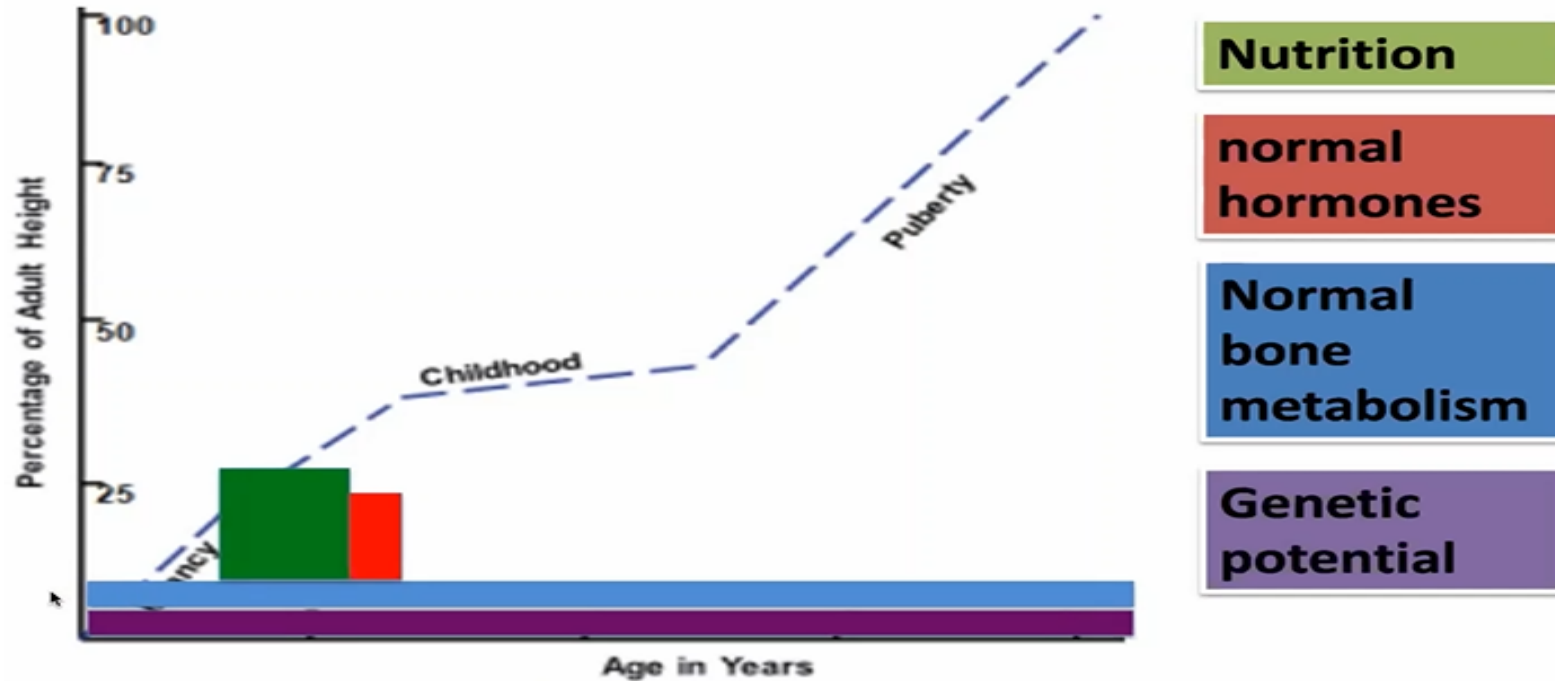
**normal  
hormones**

**Normal  
bone  
metabolism**

**Genetic  
potential**

- When person is born, He/she grows in terms of height gradually till they reach childhood when the growth somehow plateaus and then they go through growth spurt during puberty. So, the majority of the attained adult height is attained during puberty.
- If you drew a line, you would find almost 50% of adult height is attained during puberty.
- Almost 10% of adult height is attained during childhood.
- And the rest is attained during early infancy.

# Normal growth



❖ What are the factors that contribute to growth?

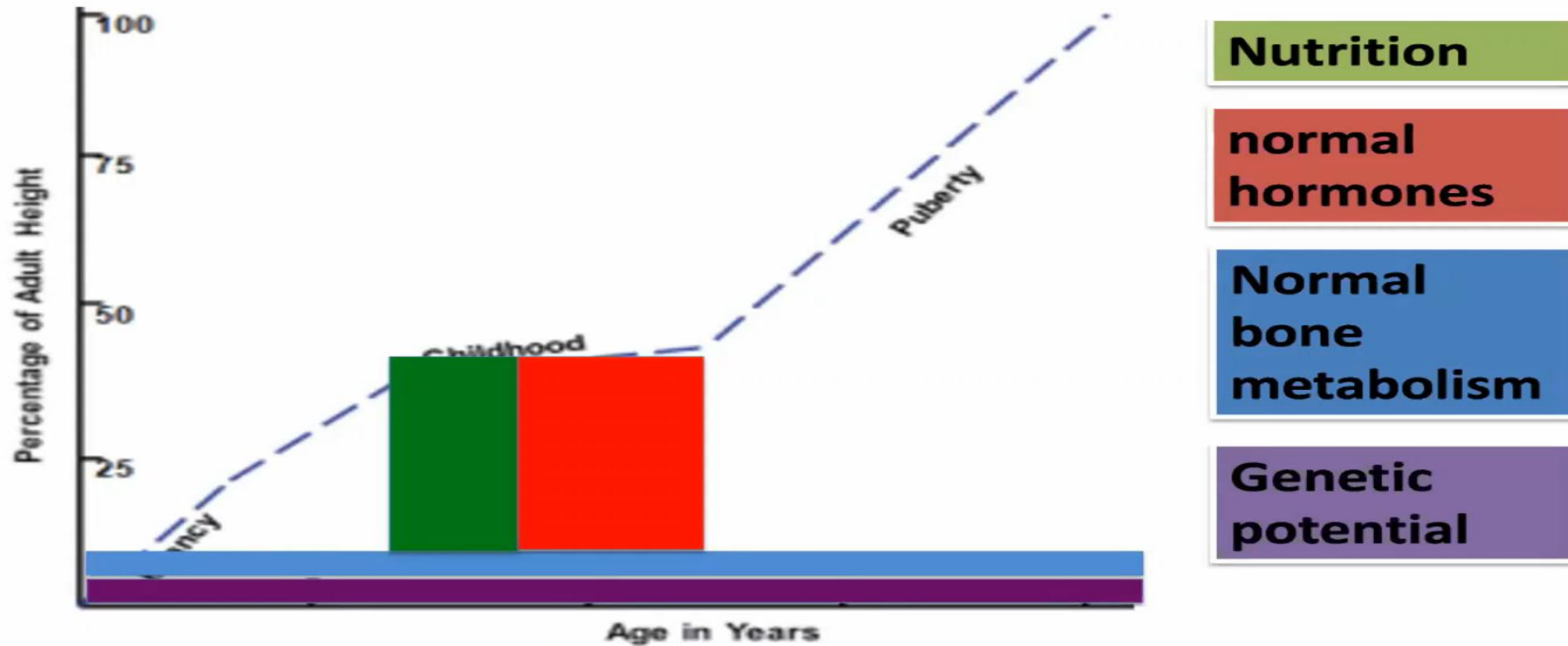
- Nutrition
- Normal hormones (including Growth hormone)
- Normal bone metabolism
- Family history (genetic potentials)

❖ Which factor out of these 4 is the greatest contributor to growth during early infancy?

**Nutrition** .Genetics is the second factor.

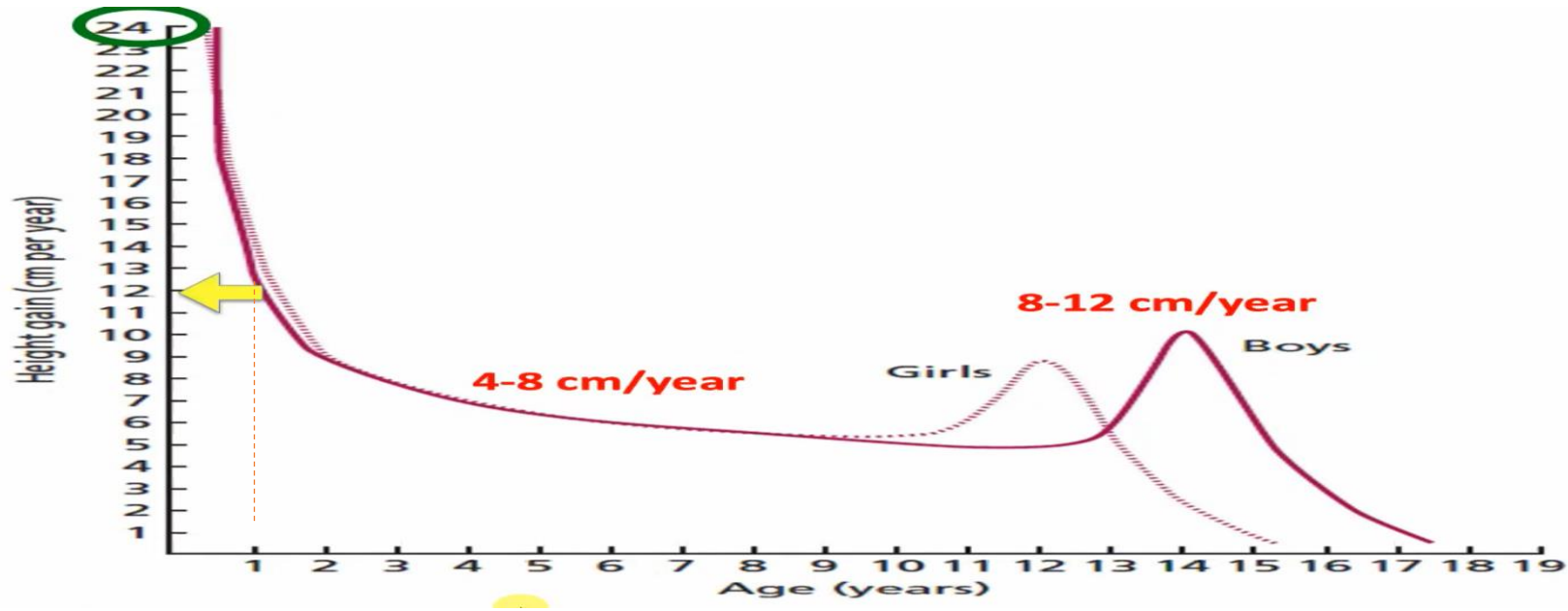
Genetics and normal bone metabolism play major role during the whole life, but nutrition take the main bulk in early infancy, and normal hormones plays a role but not major role like nutrition in the early 2 years of life.

# Normal growth



Then, both nutrition and normal hormones play almost an equal role during childhood and puberty. This is important to understand because we receive lots of questions about children who are born short, children who are born short are usually are not short because of growth hormone deficiency . growth hormone deficiency play a major role on height after the first 2 years of life . Rarely it leads to sever short stature in early infantile age.

*This plotting translates growth velocity meaning how many centimeters a child grows in a year as per age groups.*



if plot an imaginary line here crossing the first year of life you will notice that child grows almost 12 cm/year by the end of the first year.

But early on they grow 24 cm. So, the growth velocity starts as being so high 24cm/year and then starts quickly dropping to 12 cm/year and then it reaches a plateau of 4-8 cm/year during the childhood period.

Childhood period is the period when children attain 10% of their final adult height almost to 15%.

**The normal growth velocity is 4-8 cm/year.** (This is very important information to remember).

They also go through a peak that represents puberty. **During the puberty, a children go through what we called growth spurt which equals to 8-12 cm/year.**

Girls go through growth spurt around 12 years, while boys go through it around 14 years.

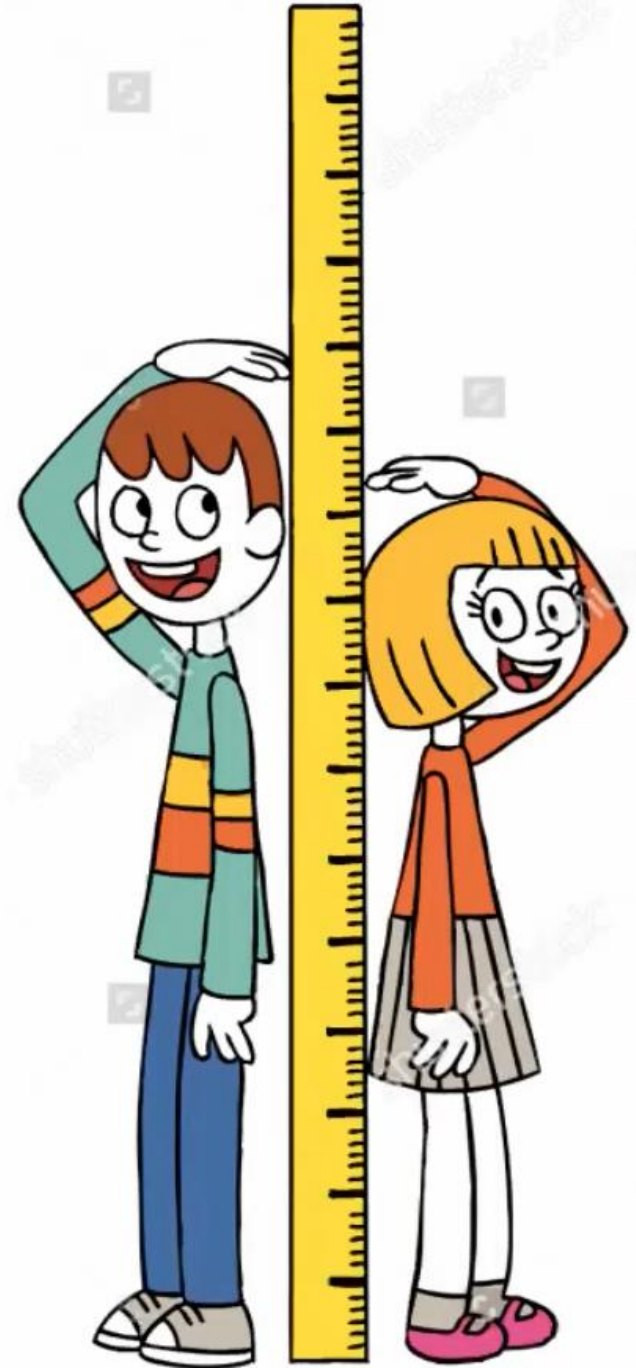
That is because girls go through puberty earlier than boys by almost 2 years. Therefore, girls enter growth spurt and finish growing before boys by 2 years.

# GROWTH ASSESSMENT

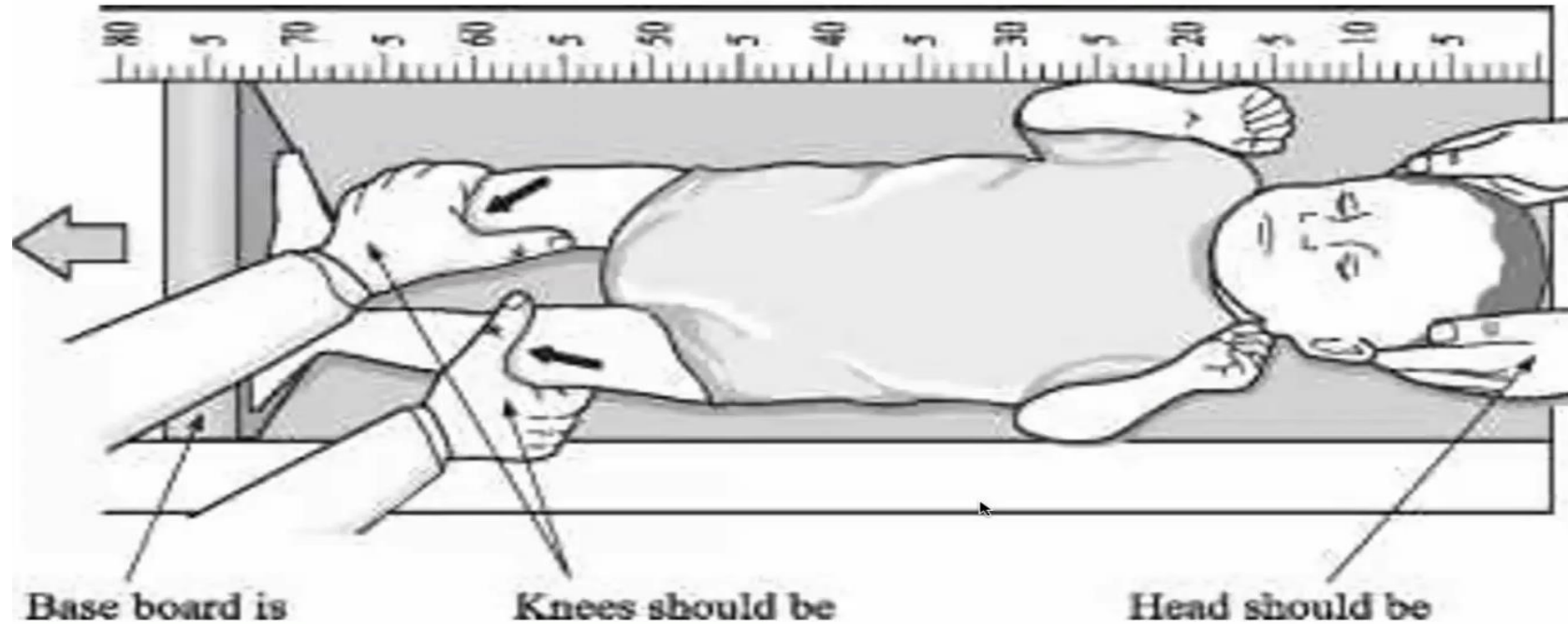
How can we measure height ?

Infantometer for children who are < 2 years of age.

stadiometer for children who are > 2 years.



# Infantometer



This measures the child's length; we call it length because children are measured while they are lying down. The word Height is used when children are measured while standing. It requires 2 people to help in assessing child length. The first person holds the head against the headboard which is at the zero level, and make sure that the child does not move their head. The second person holds the legs and straighten the knees. You cannot just stretch one leg alone when you do so the hip will be tilted, and the child would be measured falsely taller. After stretching both legs and straightening the knees, push the baseboard against the feet. And take the measurement in centimeters. Usually, children don't like this position and they will scream cry and kick. Repeat it 3 times and then take the average.



Another device is stadiometer that measures the height while child is standing. After age of 2 years.

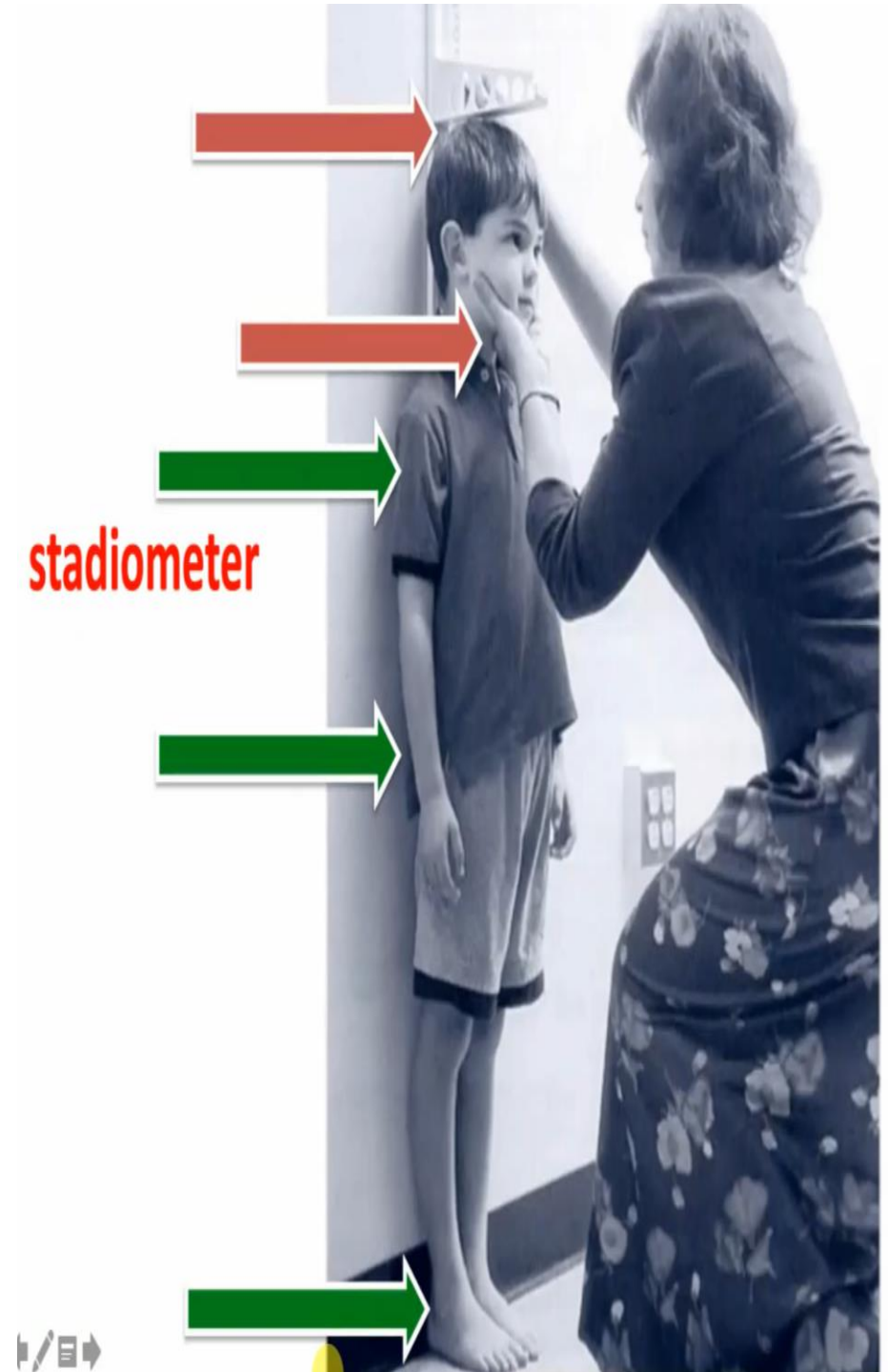
It can be done by one person but sometimes it is better done by two.

You have to make sure you align all three points against the wall the heel the hip the shoulder and the head all against The wall and the child must be barefoot.

The child should not bend their knees or be standing on tip toes .

The person taking the measurement should hold the head stabilizing the chin and child should be looking straight forward without looking up or down . Then, take the head bar slide till you reach child's head and then you read the measurement on the side of the wall.

You take three reading and then you take the average of these readings.



# Target height of the child mid parental height

**BOYS:**

$$\frac{[\text{Father's ht (cm)} + (\text{mother's Ht (cm)})] + 13}{2} \quad +/\text{- } 8\text{cm}$$

**GIRLS:**

$$\frac{[(\text{Father's ht (cm)}) + \text{mother's Ht(cm)}] - 13}{2} \quad +/\text{- } 8\text{cm}$$

Target height or mid parental height is estimating the final adult height for the child knowing the mother's height and father's height.

The difference between boy and girls' formula is that we add 13 in boys' formula while we subtract 13 in girls'.

The outcome is the average height. For every mean there is standard deviation, If we want to know the normal range for that height we add and subtract 8 from the result.

**Add/subtract 13 before you divide by 2.**

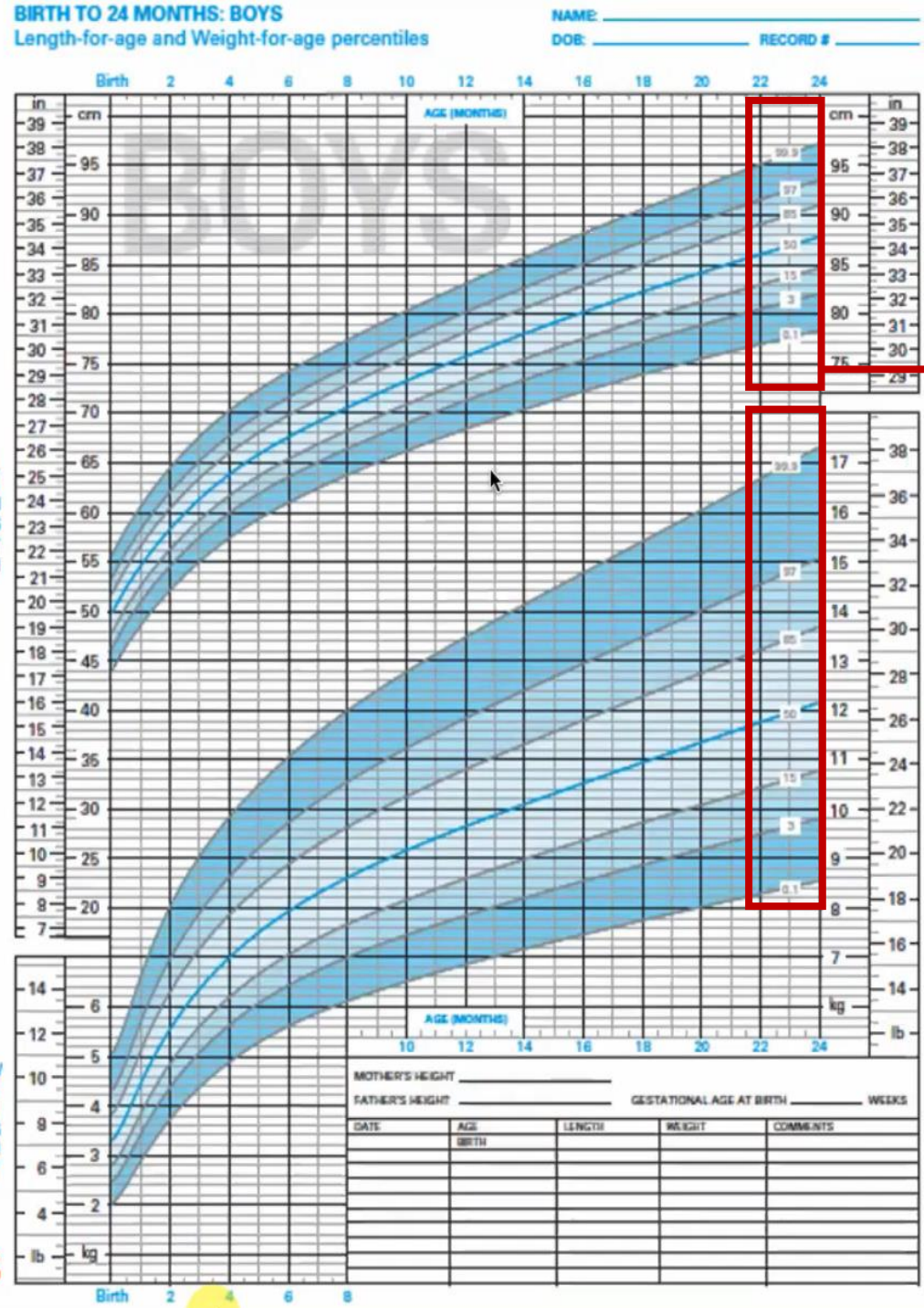
# Types of growth curves

- WHO
- CDC
- Saudi growth charts

# Birth- 2 years

This is WHO growth curve for boys from birth – 2 years.

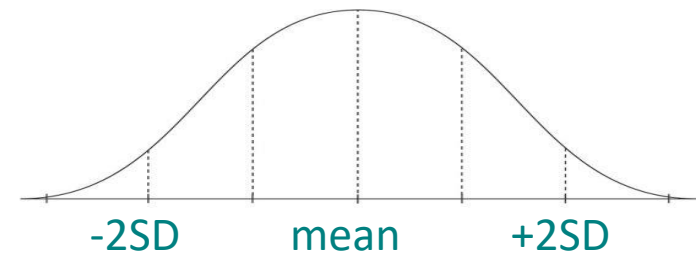
**Boy**  
**8 months**  
**Ht= 71 cm**  
**Wt= 8.9 kg**



**Height**  
**in cm/In**

These are the percentile, so we can compare the child to children in same age and gender.

**Weight**  
**in kg/IB**



If we take any measurement, it should follow the normal distribution of the “Bell curve”.

Where the 0 represents the mean , plus 2 standard deviation (+2SD) and minus 2 standard deviation (-2SD).

The growth curve idea was adopted from this. Where the mean represents 50<sup>th</sup> percentile + 2 SD represents 99<sup>th</sup> percentile -2 SD represents 3<sup>rd</sup> percentile.

**Age in months**

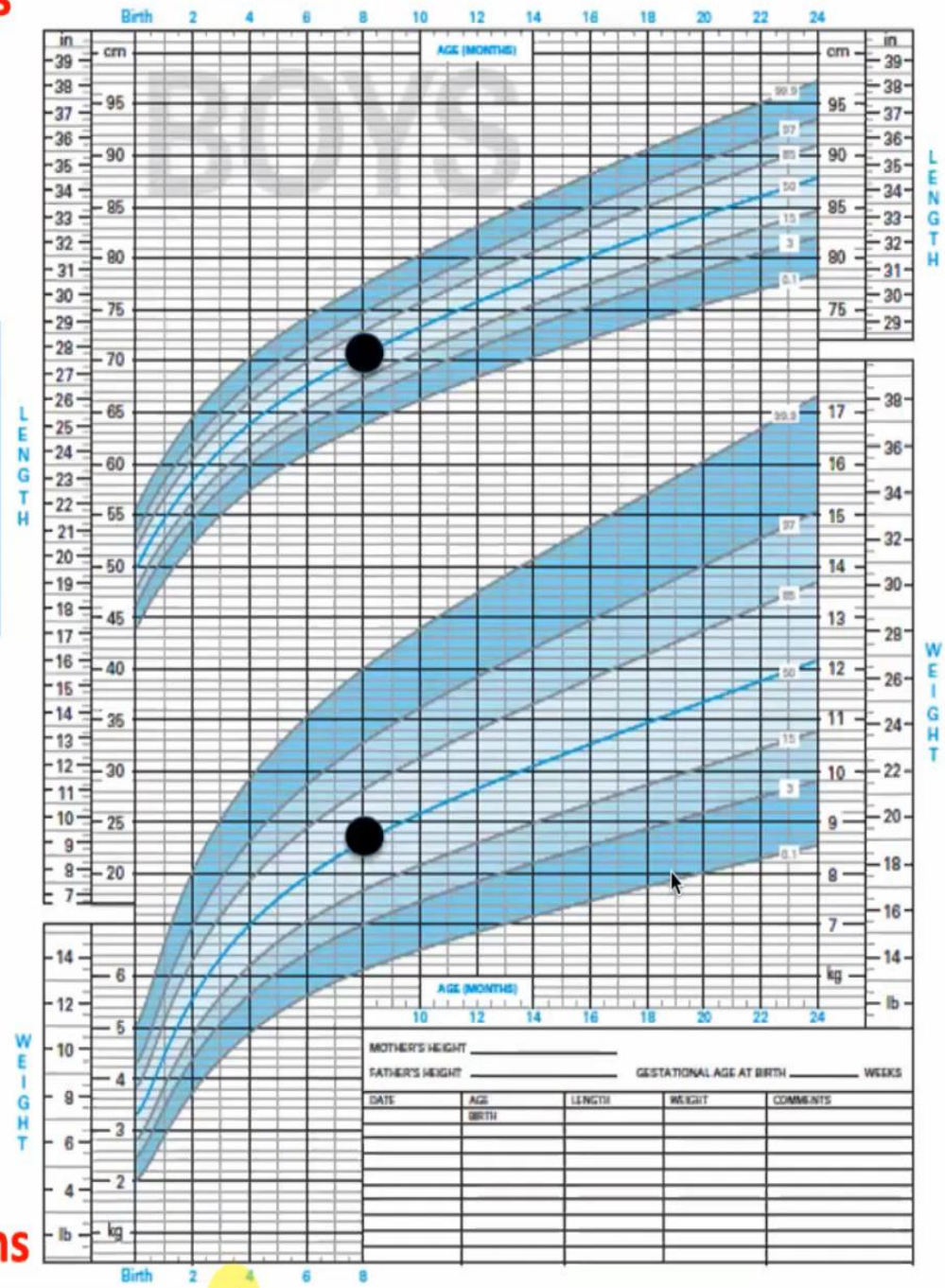
# Birth- 2 years

BIRTH TO 24 MONTHS: BOYS  
Length-for-age and Weight-for-age percentiles

NAME: \_\_\_\_\_ DOB: \_\_\_\_\_ RECORD # \_\_\_\_\_

How to plot height / weight data of a baby who is 8 months old his height is 71cm and wight is 8.9 ?  
draw imaginary line starting from the age going down till you reach the height of 71 cm the intersection between age and height is where you can plot this child  
The same for weight draw imaginary line from age going up until it meets the child's weight.

Boy  
8 months  
Ht= 71 cm  
Wt= 8.9 kg



Height in cm/In

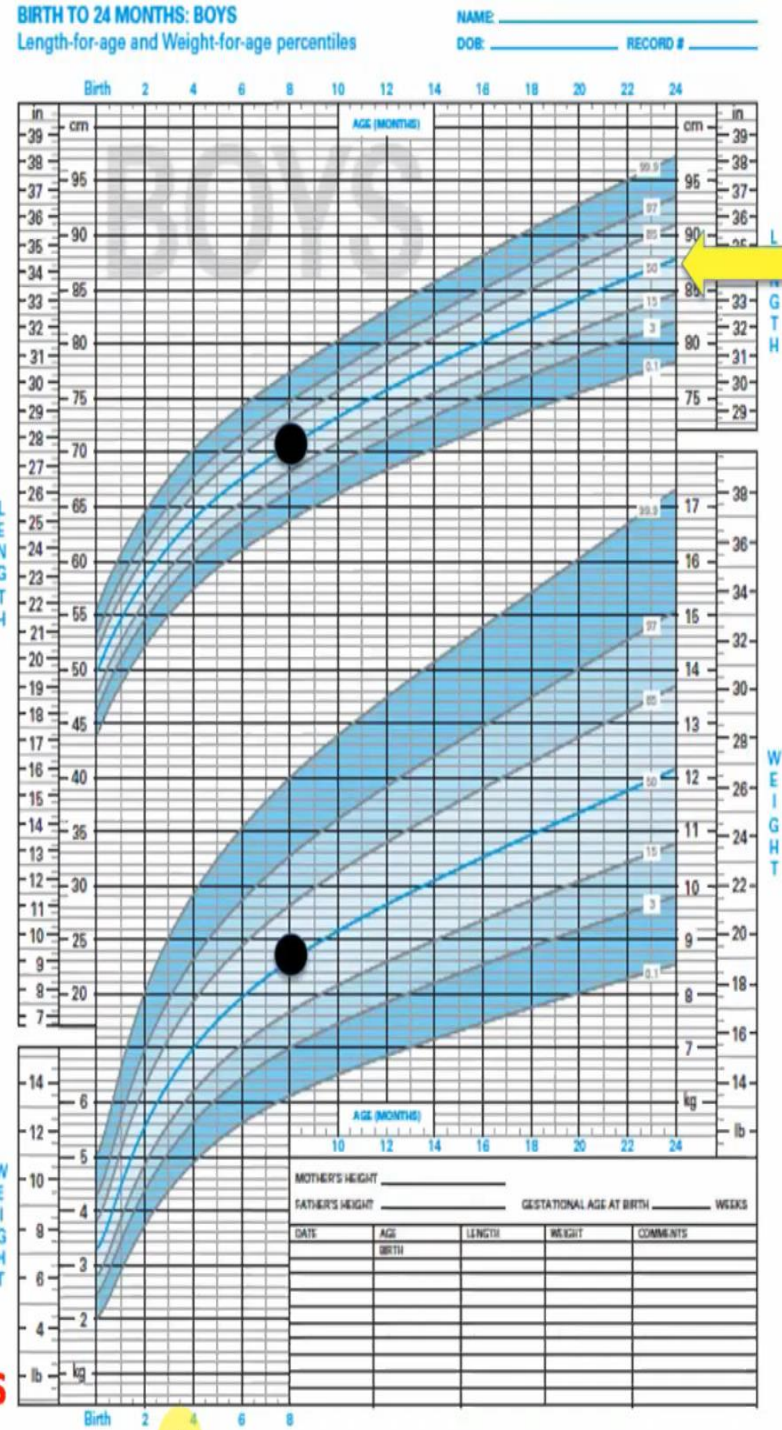
Weight in kg/lb

Age in months

# Birth- 2 years

What does the yellow arrow represent ?  
the answer in the next slide.

Boy  
8 months  
Ht= 71 cm  
Wt= 8.9 kg



Height  
in cm/In

Weight  
in kg/lb

Age in months

2-19 years

2 TO 19 YEARS: GIRLS  
Height-for-age and Weight-for-age percentiles  
NAME: \_\_\_\_\_  
DOB: \_\_\_\_\_ RECORD # \_\_\_\_\_

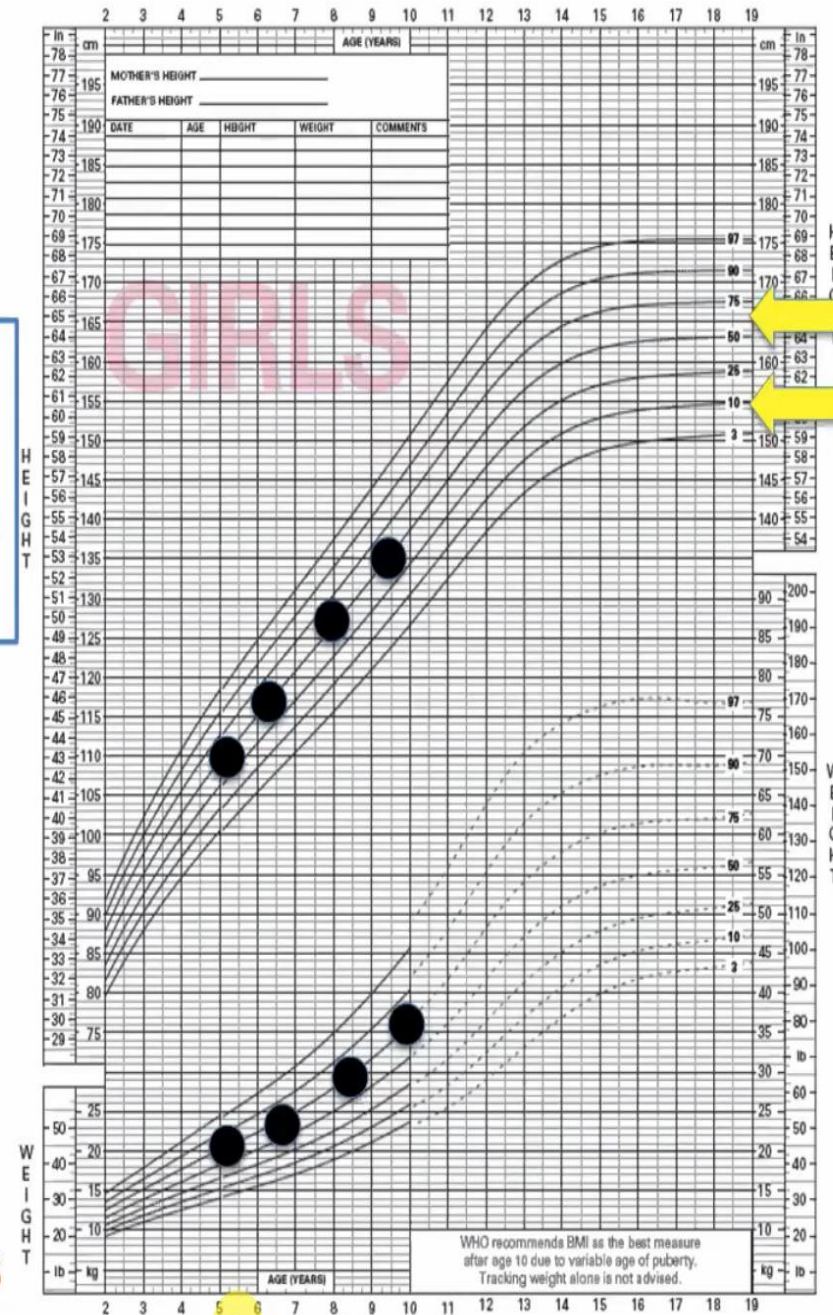
Plotting height data of 9.5-year-old girl  
the same principle applied

Other dots mans previous growth measurement  
Why is it important to look at pervious growth data ?  
Because it tells you about the pattern of growth

What does the yellow arrows represent ?  
The standard deviation of mid parental height calculated using the formula.  
That means the normal mid parental height of this child is between the 10<sup>th</sup> percentile and 55<sup>th</sup> percentile.  
We can also plot the average after calculating the mid parental height instead of putting 2 arrows of the normal range.  
(putting the result of the equation without adding/subtracting 8).

Girl  
9.5 years  
Ht= 135 cm  
Wt= 36 kg

Age in years



Height  
in cm/In

Weight  
in kg/lb

WHO recommends BMI as the best measure  
after age 10 due to variable age of puberty.  
Tracking weight alone is not advised.

All these values lie within the range of mid parental height.

That means the child is following their genetic potential.

**We learned three things :**

1. The value needs to be normal within normal population we have the comparison to other children in the same age and gender.
2. Child growth pattern follows the same tracking of the same line that he started since birth and growth velocity is normal.
3. These values are lying within mid parental height, so the child is following the same distant genetic potentials.

If these 3 information are normal so most likely the child growth is normal.

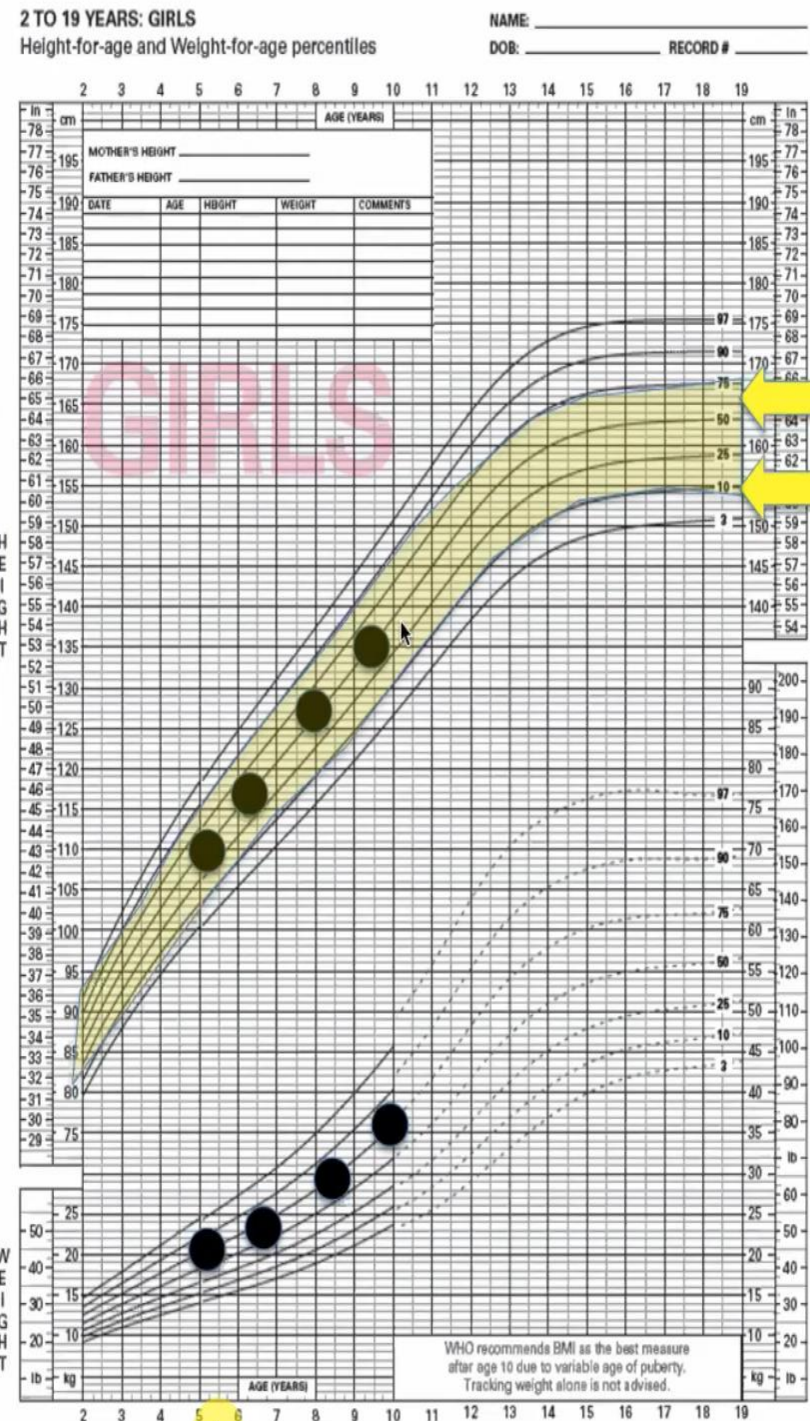
The average weight gain for children after 2 years of life is 1-2 Kg/ year.

Why does wight curve plotting disappear ?  
Because it is not important to follow the weight, we should follow the BMI instead, so we don't miss children with obesity.

2-19 years

Girl  
9.5 years  
Ht= 135 cm  
Wt= 36 kg

Age in years



Height in cm/In

Weight in kg/lb



These are growth patterns of three children :

The first one (in **BLUE**) started to grow in height in 3<sup>rd</sup> percentile and through years progressively gained height till he reach 90<sup>th</sup> percentile.

The second child (in **RED** ) started at 50<sup>th</sup> and continued at 50<sup>th</sup> .

The third child (in **GREEN**) started at the 97<sup>th</sup> percentile and then reached 25<sup>th</sup> percentile.

Which one is normal ?

the one in **RED** because the child started at 50<sup>th</sup> percentile and continued at 50<sup>th</sup> percentile.

Even if he started at 10<sup>th</sup> percentile and continued at 10<sup>th</sup> percentile, he is considered normal as long as he continued at the same pattern.

The blue line means the child was short and suddenly he became taller.(Abnormal)

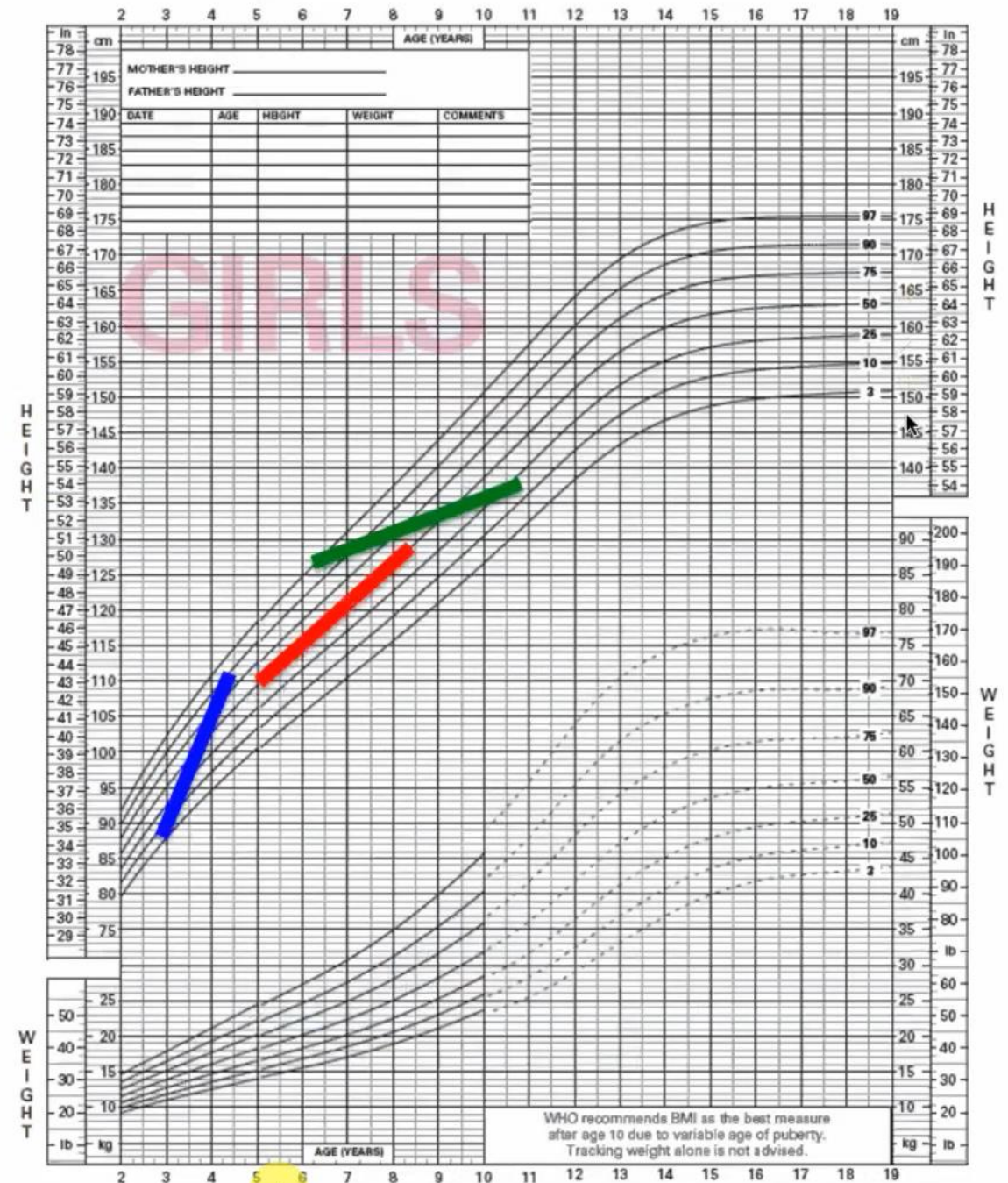
The green line means the child was tall and then he progressively became shorter. (Abnormal)

## 2 TO 19 YEARS: GIRLS

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

NAME: \_\_\_\_\_ RECORD # \_\_\_\_\_

DOB: \_\_\_\_\_



This is growth velocity curve where x-axis represents ages in years and Y-axis represents the cm gained per year.

This is marked by Z score as you can see -4, -3, -2, -1, 0, +1, +2.

Some of growth curves are marked similarly using -3,-2,-1,0,+1,+2 not translated in percentiles.

If you want to translate it to percentiles:

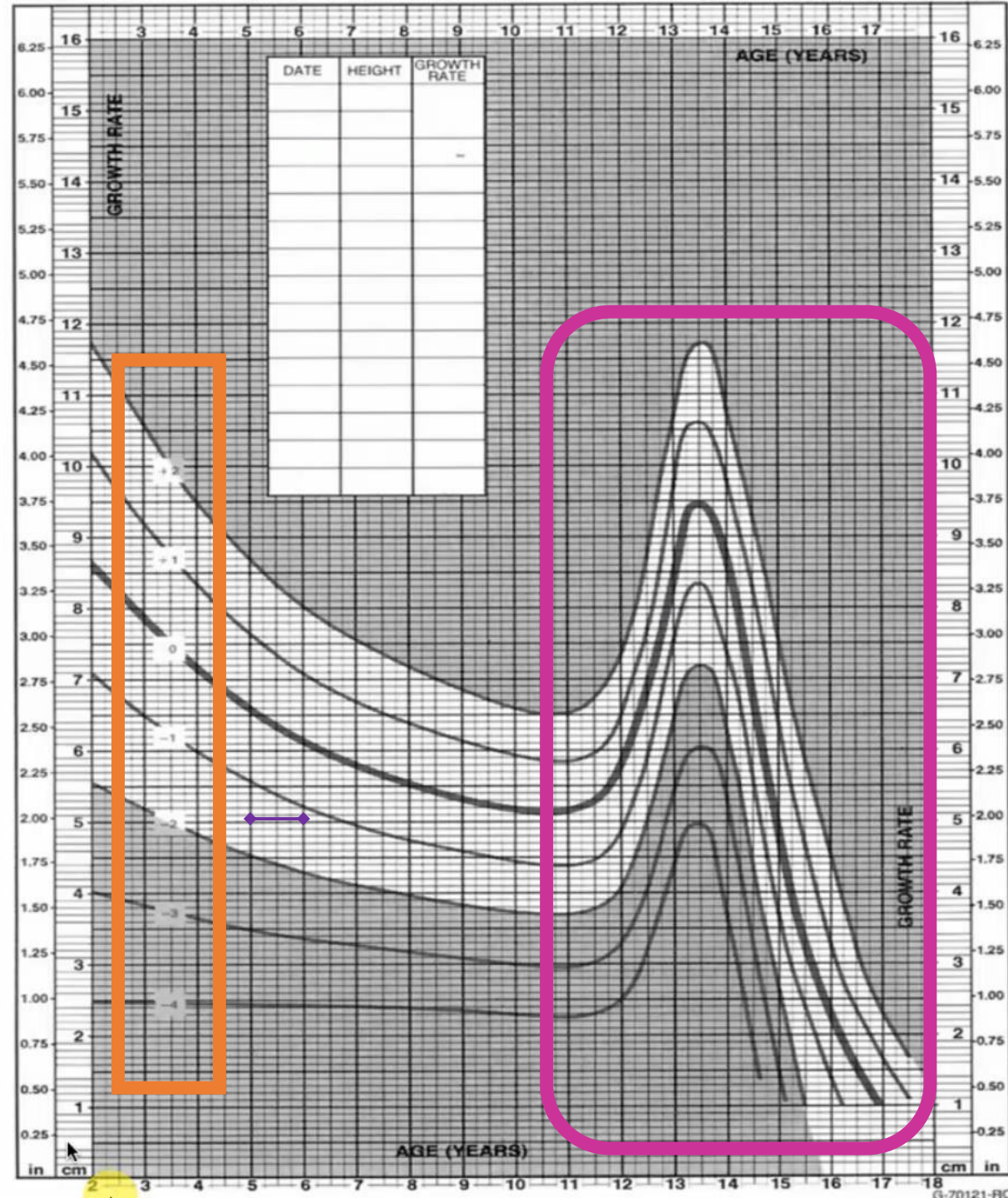
- 2 = 3<sup>rd</sup> percentile
- 1 = 25<sup>th</sup> percentile
- 0 = 50<sup>th</sup> percentile
- +1 = 75<sup>th</sup> percentile
- +2 = 95<sup>th</sup> percentile

**Cm /In  
gained  
per year**

To plot a child in growth velocity curve :

If we have child who grew 5 cm between 5 and 6 years of age, we drew a line from 5-6 years at the level of 5 cm.

There is peak and decline that represents the puberty ( growth spurt), and then you complete your growth while growth velocity declines. once you reach the final adult height you don't grow anymore therefore your growth velocity becomes zero.



**Age in years**

This the BMI growth curve age in the x-axis and BMI in y-axis.

Numbers are in Z score.

Zero is the zone for normal(-2 to +1).

BMI curve give a little information about nutritional status and those who are less than -2 standard deviation , are thin and those who are less than -3 are severely thin or malnourished

Those who are between +1 and +2 standard deviation are called overweight.

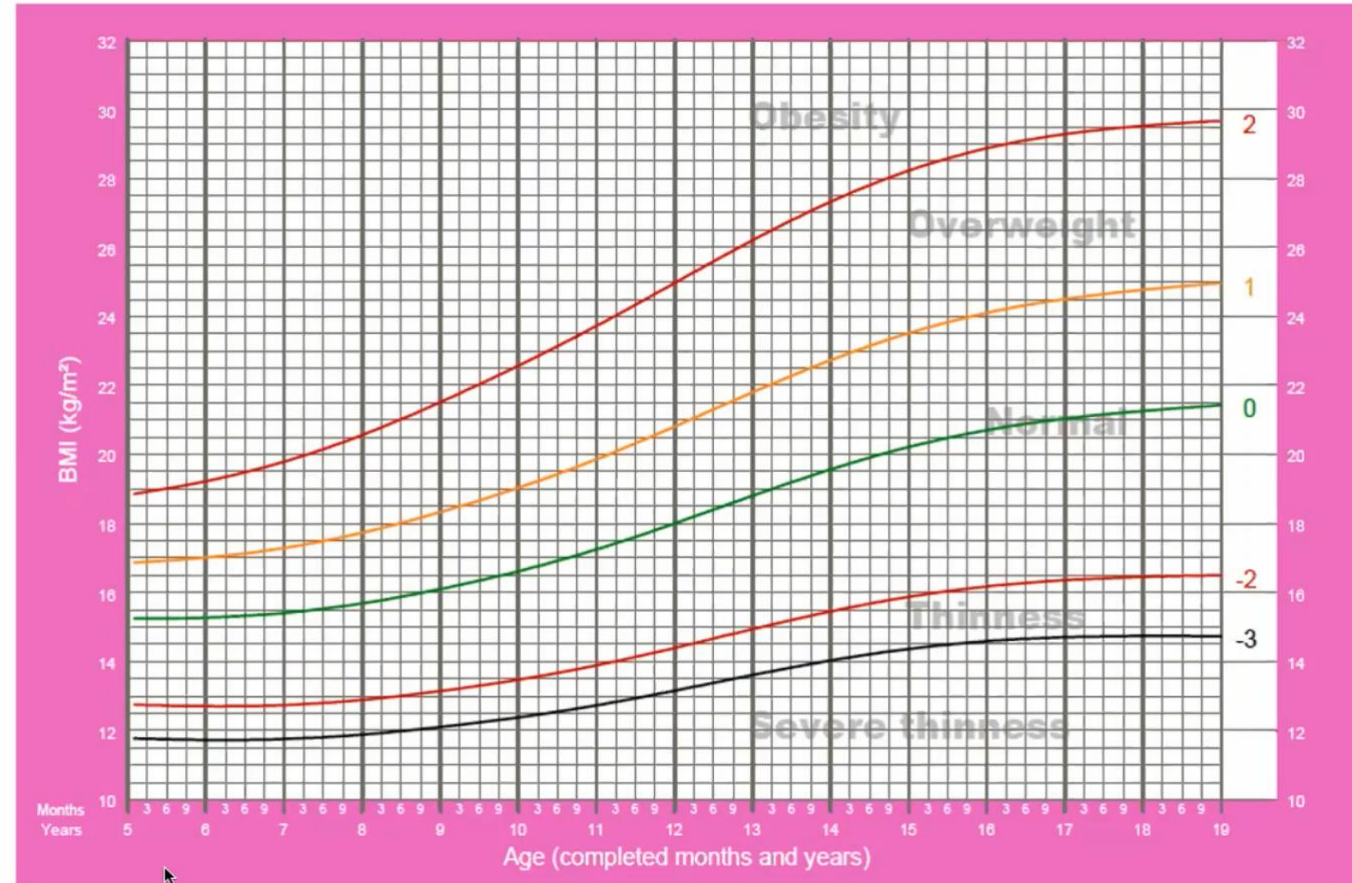
Those who are more than +2 are called obese.

Some BMI curves shows percentile where +1 standard deviation equals to 85<sup>th</sup> percentile.

It is important in counselling children with obesity.

We have to catch them before they reach the obesity zone.

And to work on children who are severely thin.

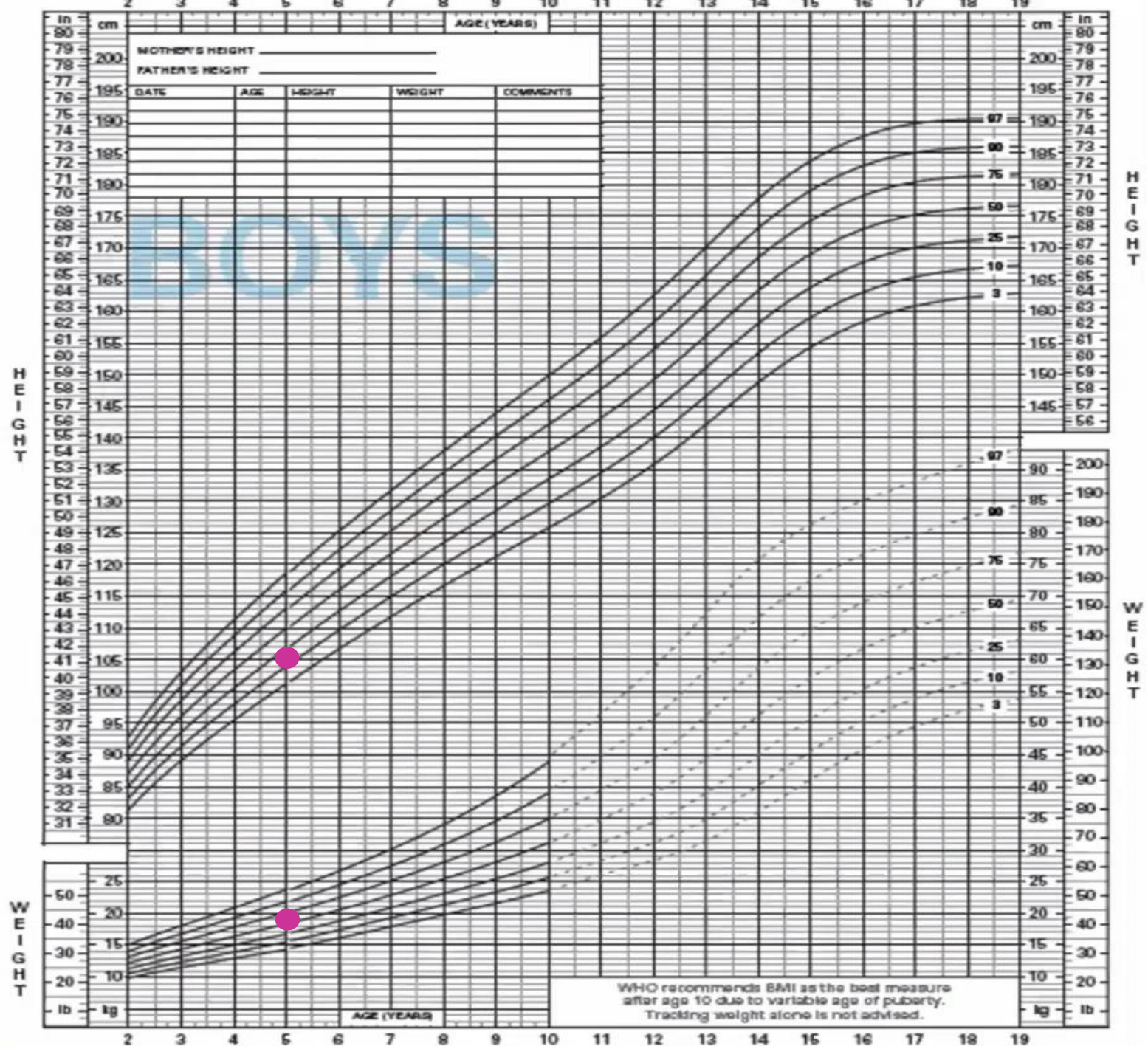


# Plot the following

- 5 years boy
- Height 105 cm
- Weight 18 kg
- BMI
- Father height 170 cm
- Mother height 160 cm

This is an exercise apply what you learned.

Mid parental height =  
 $((170+160) + 13 / 2) +/- 8 =$   
**171.5 +/- 8**



# Plot the following

- 5 years girl
- Father height 170 cm
- Mother height 160 cm

<b>age</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
Ht	105	106	107	108
Wt	18	18	19	20



# Is she short?



# short stature

- height < 2 standard deviations below the mean for the population
- height < 2nd or 3rd centile
- height velocity < 25<sup>th</sup> ile
- Crossing percentile

What do we mean by crossing percentile?  
In the growth curve the child who was taller, then he became short ( the green line ) and the child who was short and then he became taller (the blue line ) they crossed lines of percentile across time. Once a child crosses percentile line that means the child has abnormal growth.



These are growth patterns of three children :

The first one (in BLUE) started to grow in height in 3<sup>rd</sup> percentile and through years progressively gained height till he reach 90<sup>th</sup> percentile.

The second child (in RED ) started at 50<sup>th</sup> and continued at 50<sup>th</sup> .

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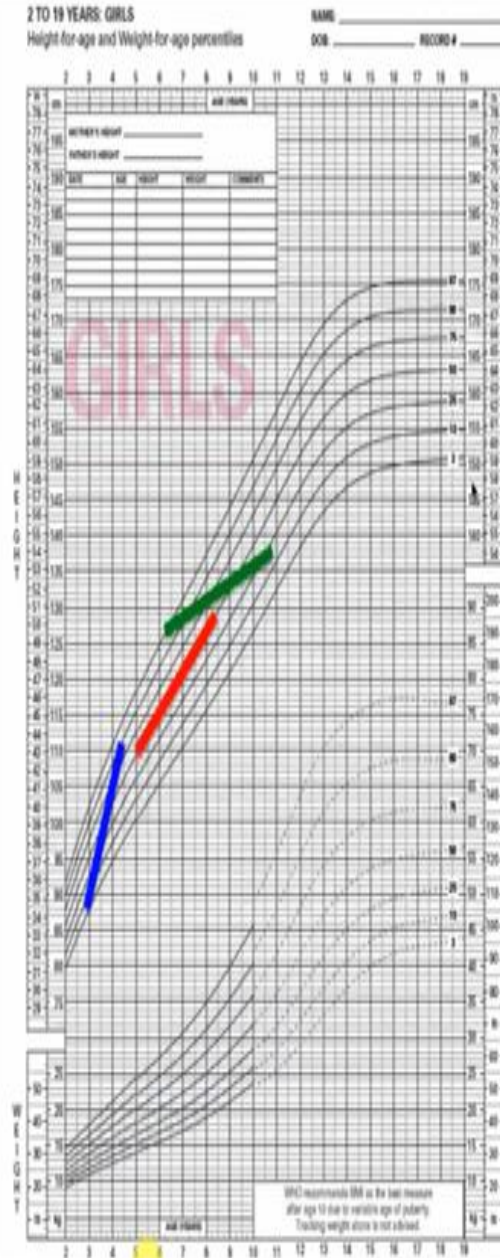
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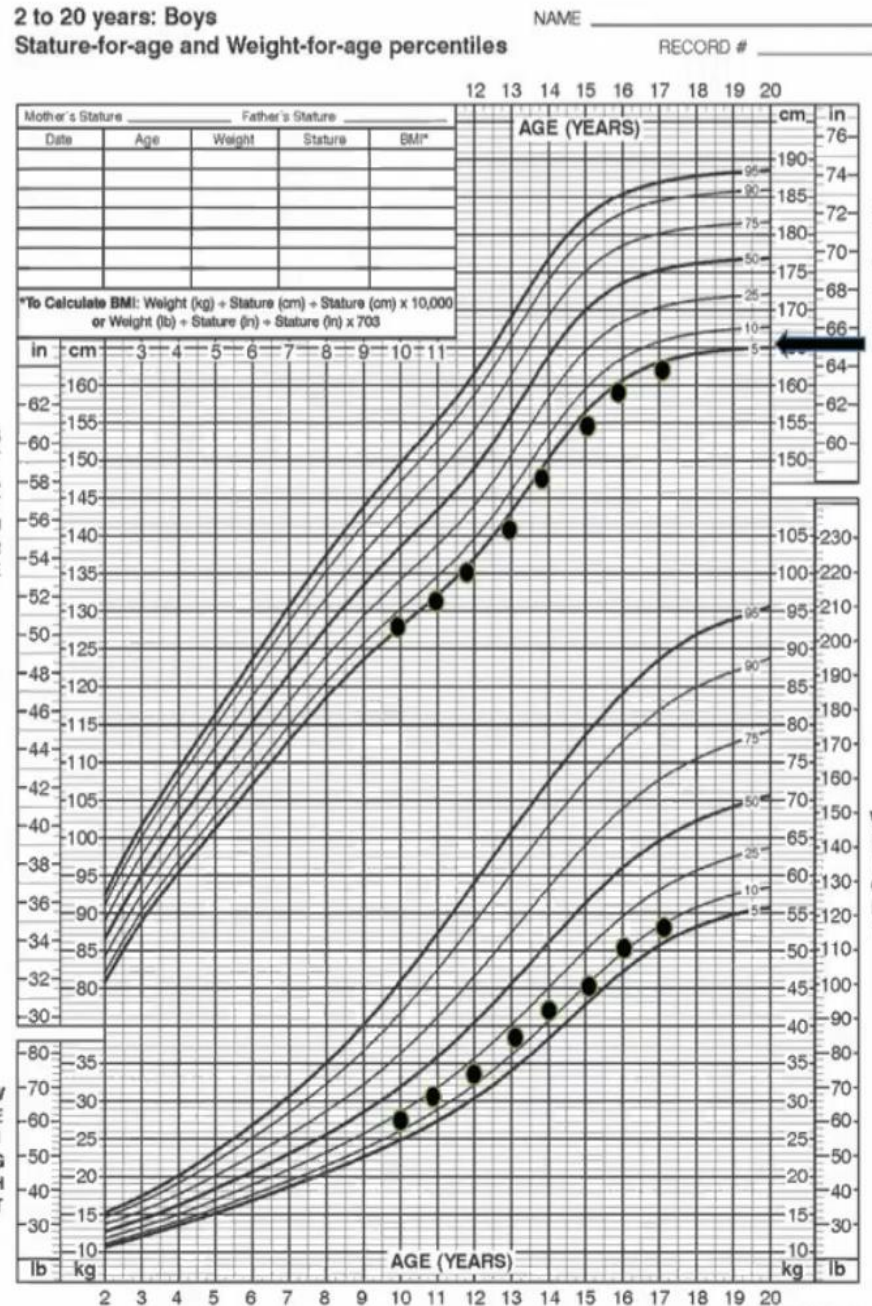




# Causes

- Normal variants
  - Constitutional
  - Familial ↗ (genetic)
- IUGR Intrauterine growth restriction
- Chronic illness
- Malnutrition
- Endocrine:
  - Growth hormone deficiency
  - Hypothyroidism
  - Cushing disease
- Syndromes

Here the child growth pattern follows the 5<sup>th</sup> percentile and falls in the normal range of mid parental height and did not cross percentile and this is normal familial short stature. Which is normal variant of height, if the parents are short then the child is distant to be short.



## Familial short stature

- Short family (MPH)
- No chronic illness
- Normal growth velocity
- Normal physical exam
- No dysmorphic features
- Normal puberty
- Normal bone age

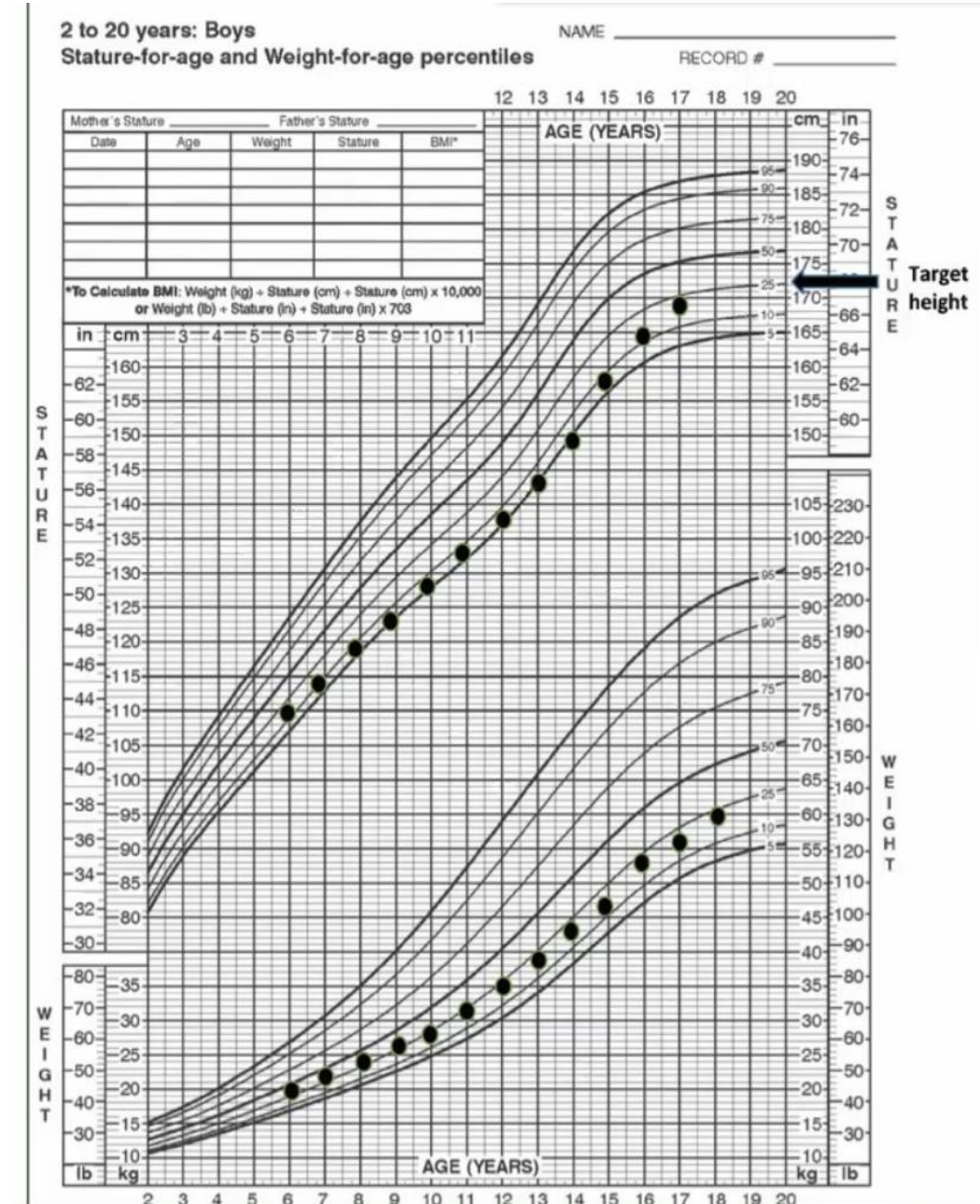
This is a bit difficult to get because most of the clues you get through the history and small clues in the growth chart.

they usually have a family member who had delayed puberty and was the short and once they go through puberty, they stretched out and they became the tallest in the family.

The height although it lies at the 5<sup>th</sup> percentile it is still within the normal mid parental height.

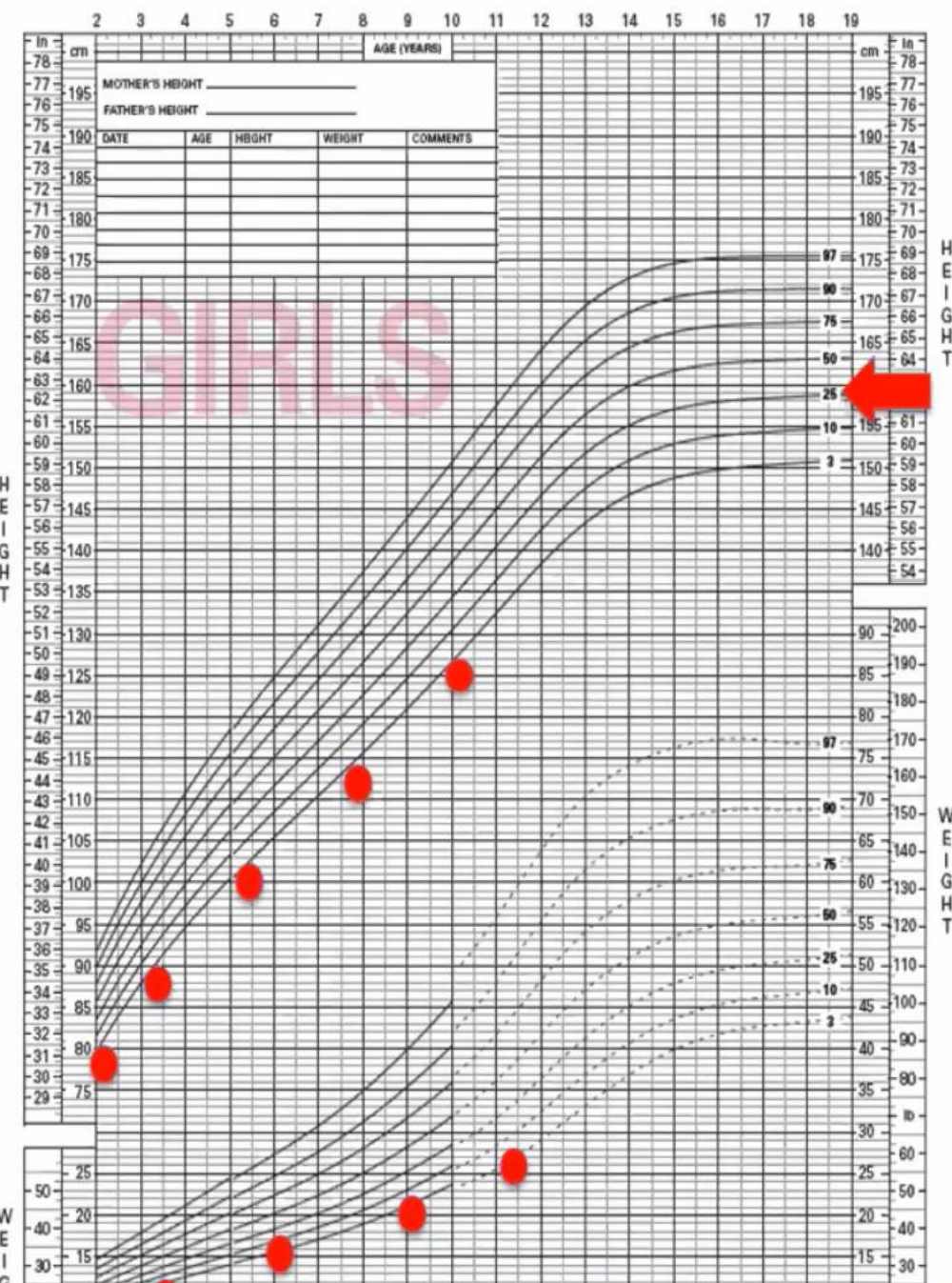
If you take an x-ray of the hand, it will show delayed bone age.

No treatment needed only reassurance and follow up, because they are going to have delayed puberty just like their family and they will grow and be the tallest in their family.



## constitutional short stature

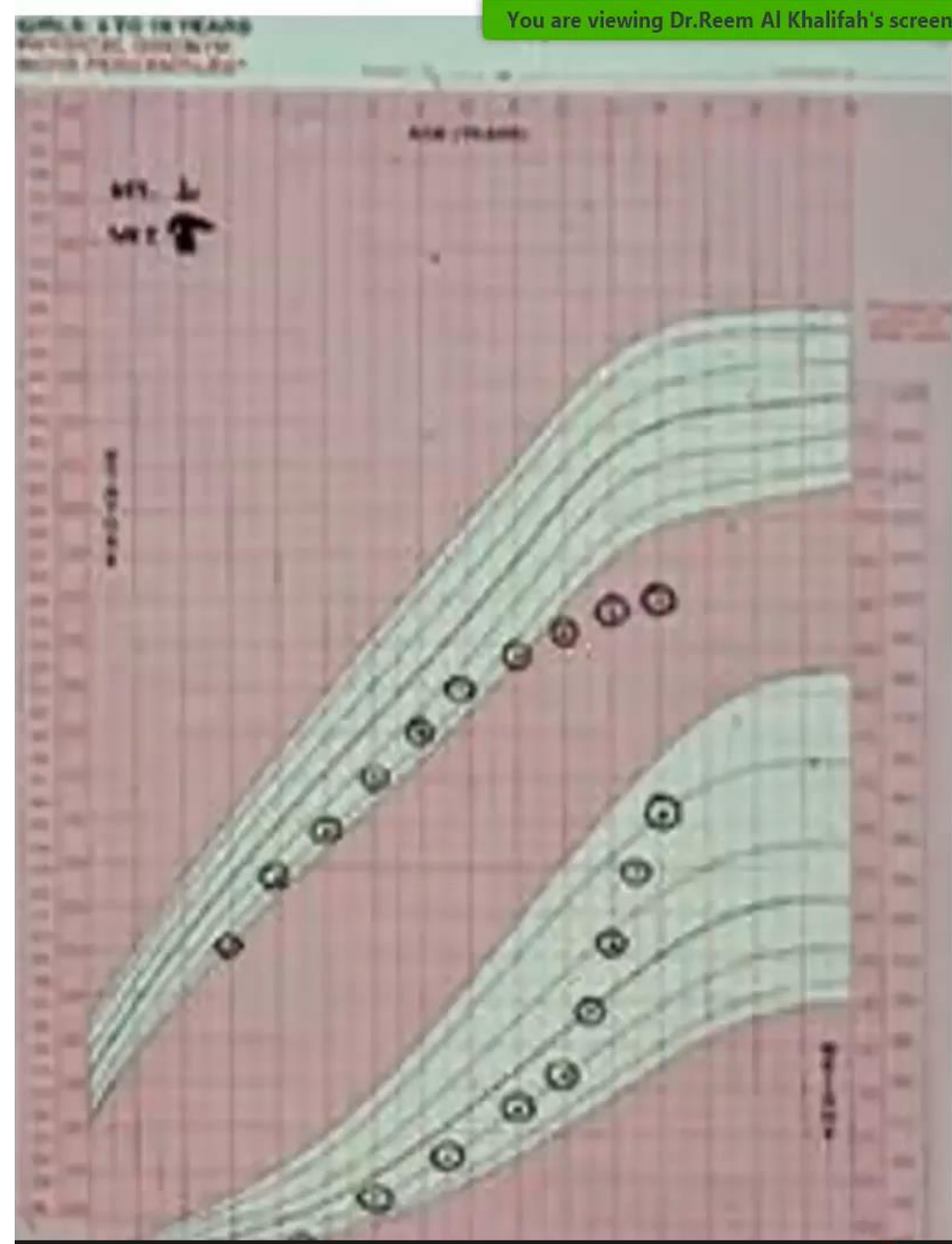
- Family history of delayed puberty
- Appropriate height for MPH
- Normal growth velocity
- Delayed puberty
- Delayed bone age



They are born with low birth weight and if they are well nourished, they will have catch up growth in the first 2 years. To catch up for whatever growth was missing when they were in Utero. If this does not happen, usually they will continue to be short for the rest of their life.

# IUGR

- Short since birth
- Low birth weight
- Never catch up !



The child becomes shorter with time although he is well nourished or obese.

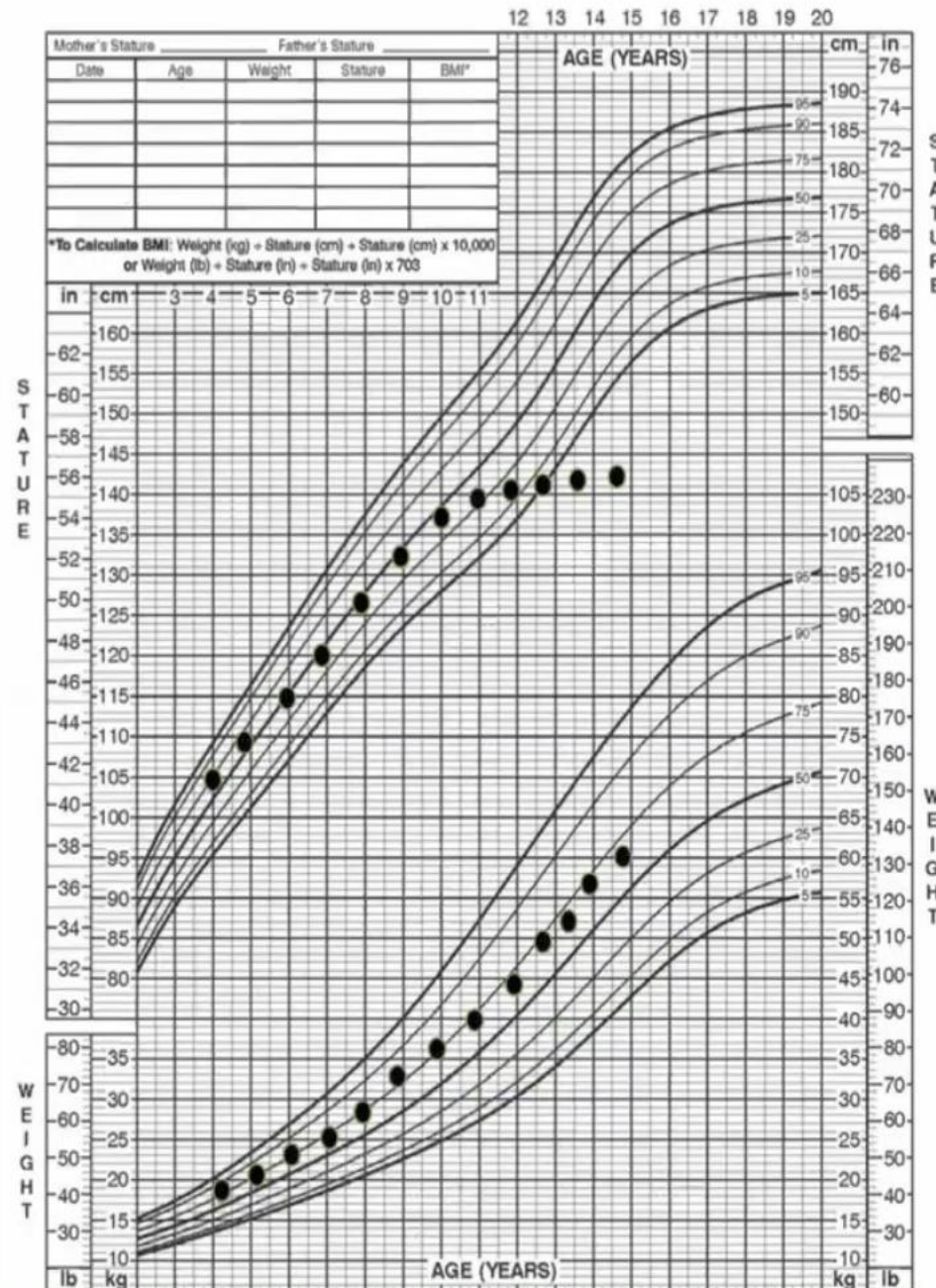
# Endocrinopathy

**Deceleration in a well-nourished or obese child:**

- GHD Growth hormone deficiency
- hypothyroidism
- glucocorticoid excess

Stature-for-age and Weight-for-age percentiles

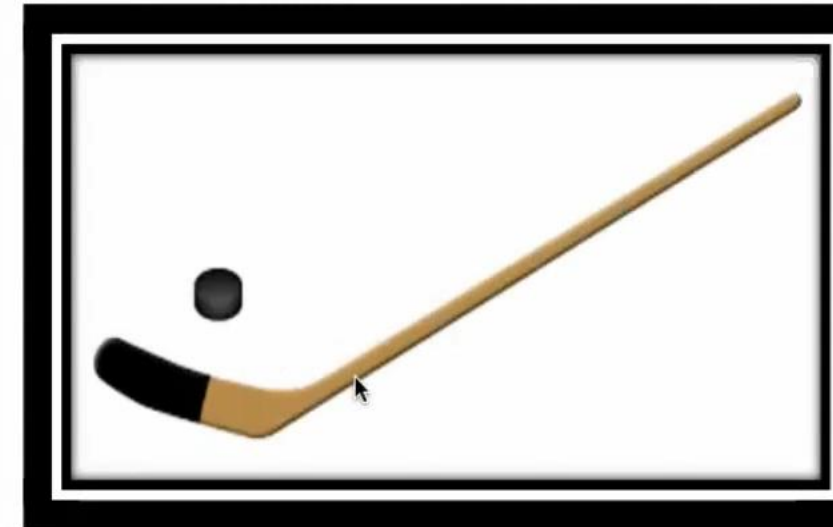
RECORD # \_\_\_\_\_



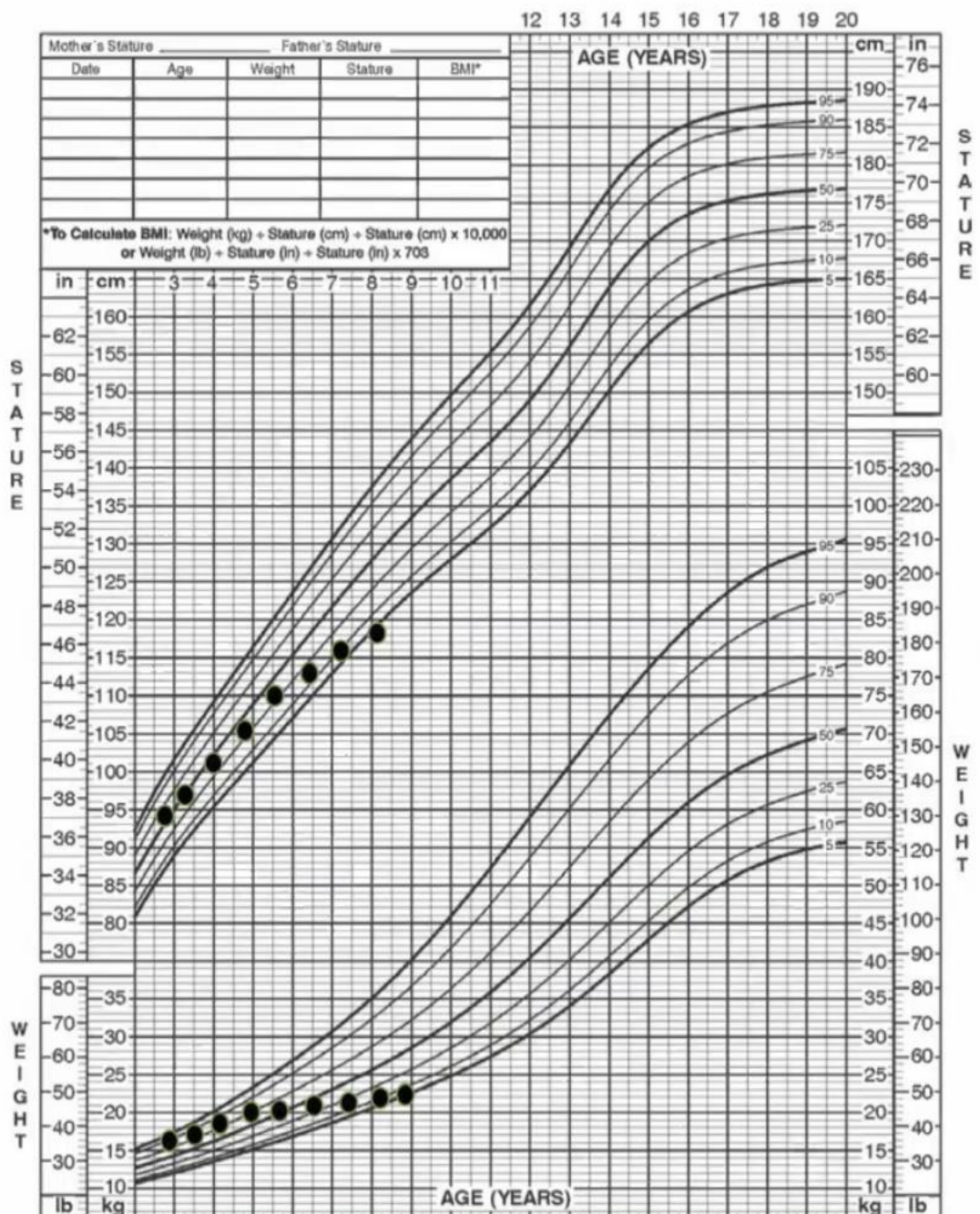
The child becomes shorter over time although he is well nourished. And that is endocrinopathy pattern, most likely hypothyroidism. The child stop growing. Hypothyroidism stop child growth more than GHD.

# Hypothyroidism

- Stopped growth
- Hooky stick pattern
- Increased weight



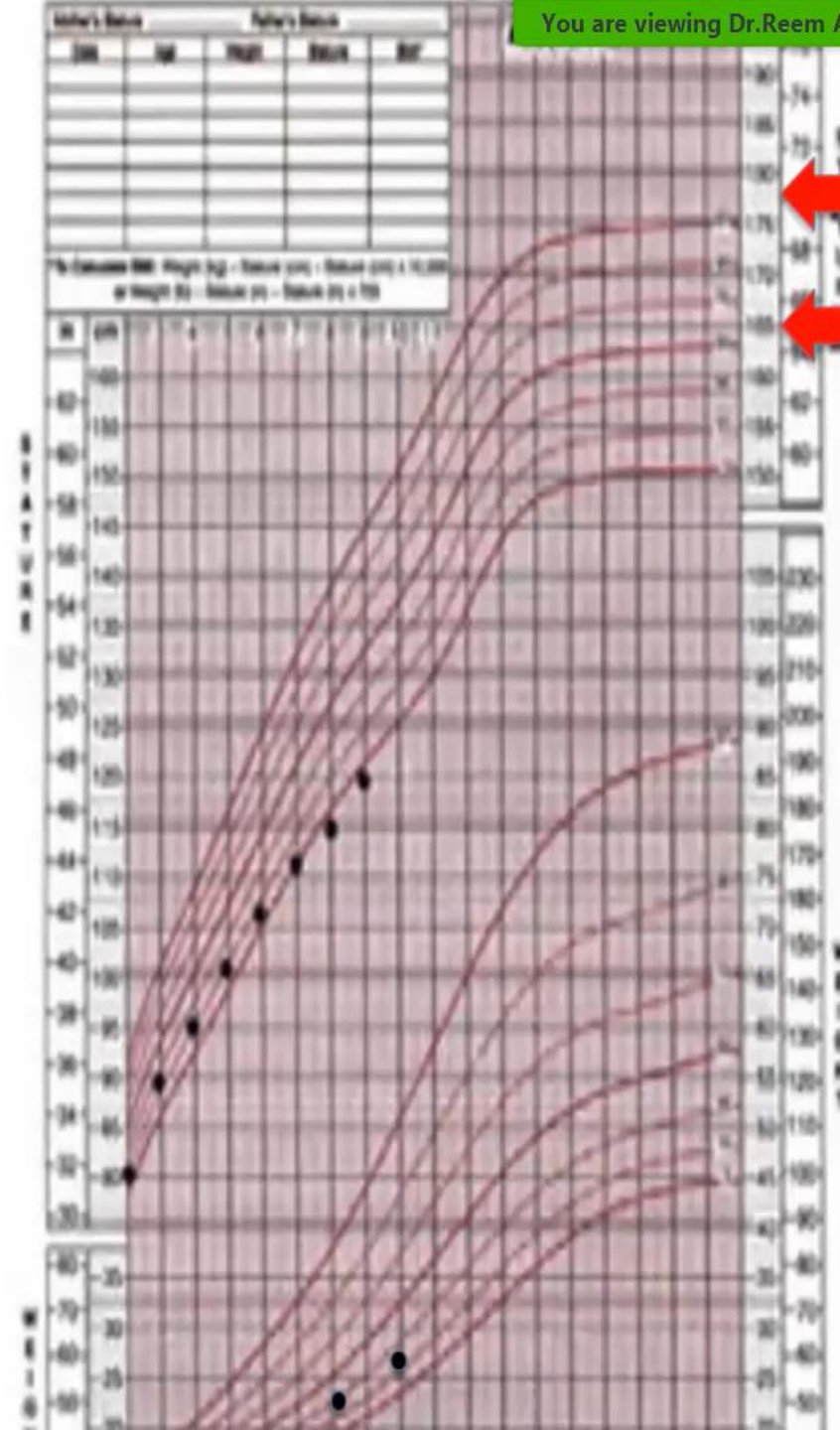
2 to 20 years: Boys  
Stature-for-age and Weight-for-age percentiles



Child crosses the percentiles in both height and weight, but the weight was first. He was malnourished and that's what affects their height. So, in this pattern the weight is more affected than height. The weight is first to be affected and the height after that. The differential diagnosis could include all GI diseases.

# Chronic illness under nutrition

- Weight affected more than height
- Celiac disease
- Malabsorption
- Cystic fibrosis
- Renal failure
- Crohn's disease



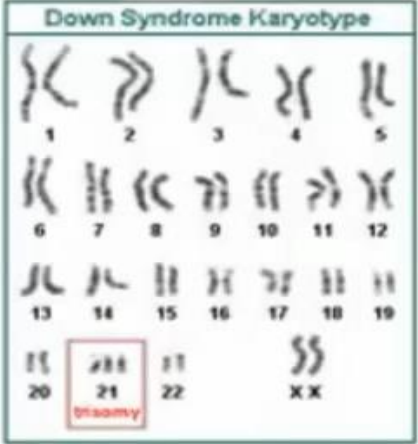
← Syndromic causes

Child crosses the percentiles in height. He is at the 3<sup>rd</sup> percentile which is very far from MPH.

This pattern is syndromic. Other clue is dysmorphic features in physical examination.

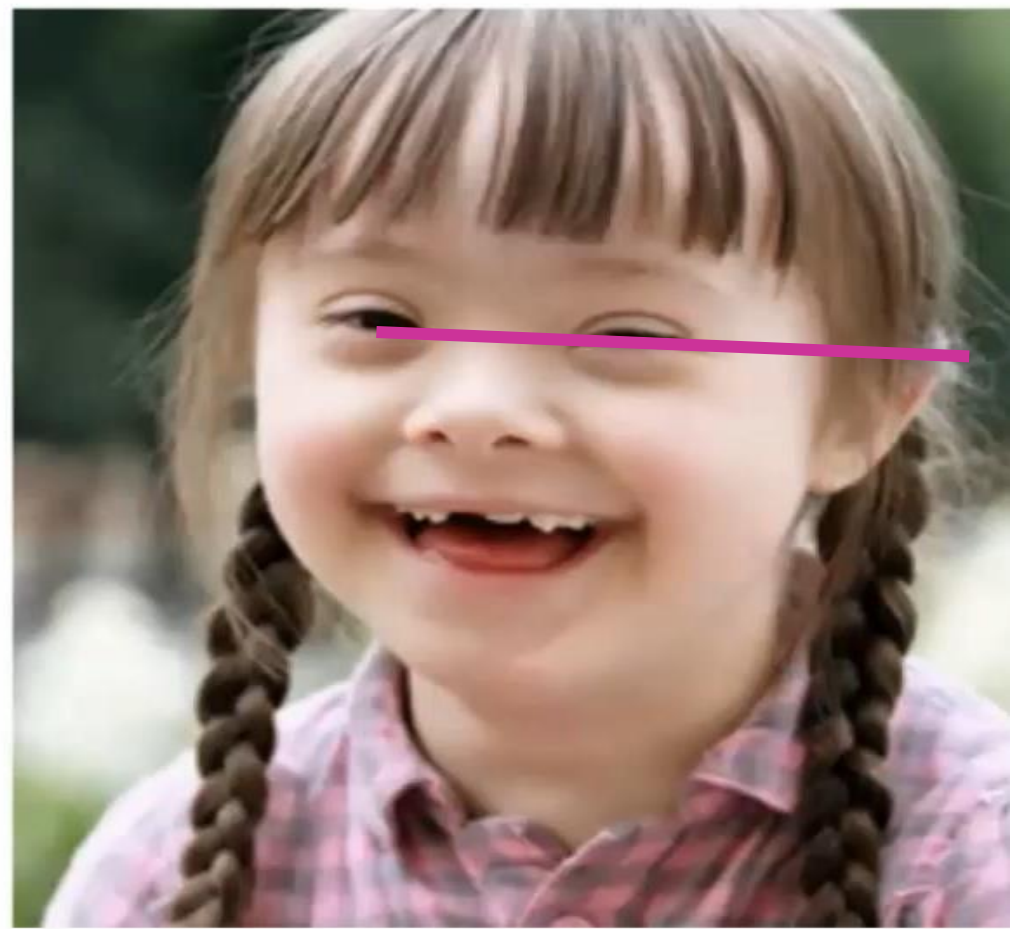
- Not appropriate for MPH
- Dysmorphic features





flattened nose and face, upward slanting eyes,

Down syndrome (Trisomy 21)  
 One of the feature is low-set ear.  
 If we draw a line crossing the eyes, we will find that most parts of the ears are below that line.  
 Doctor did **not** skip the features.



single palmer crease, short fifth finger that curves inward



widely separated first and second toes and increased skin creases

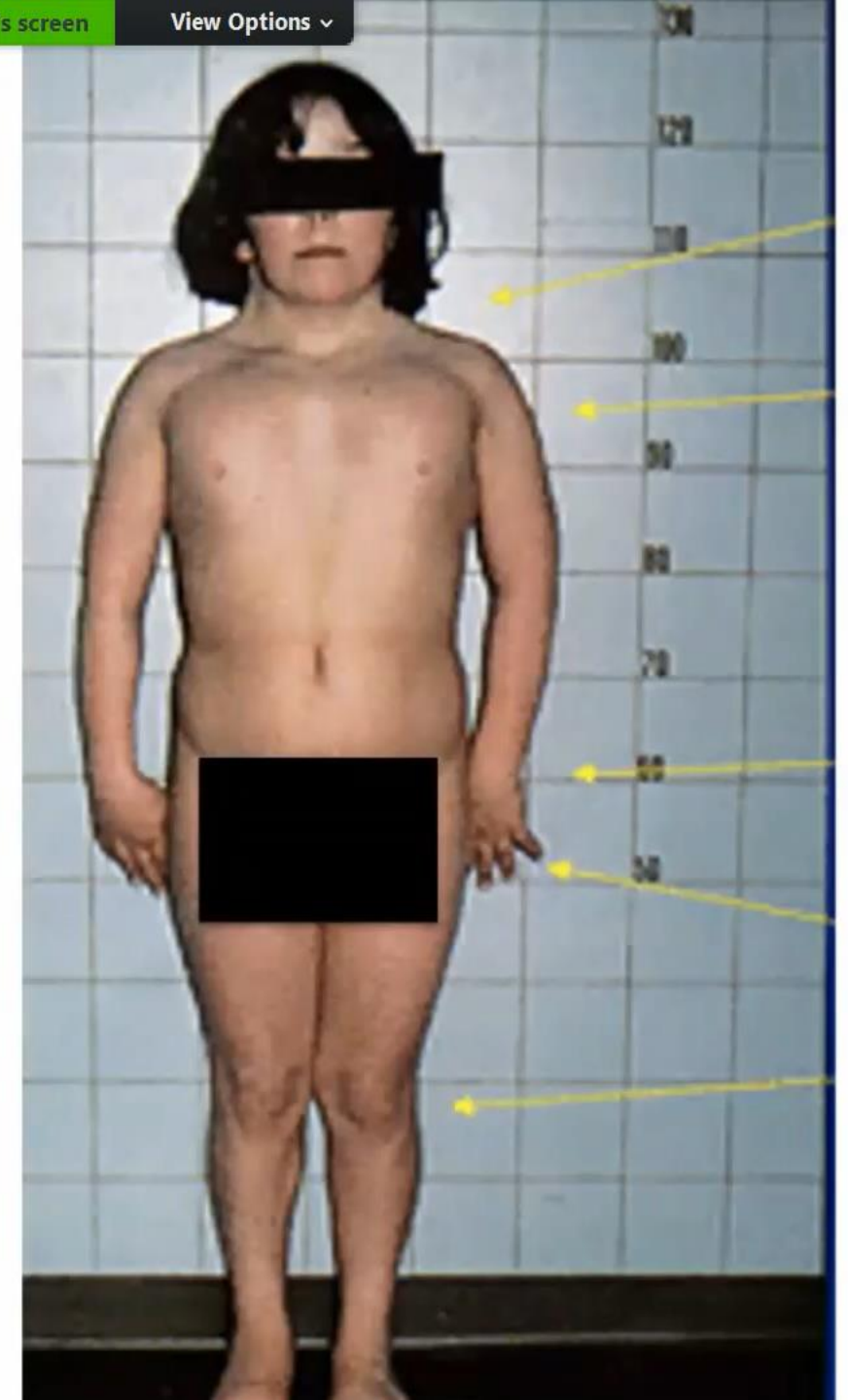


# Turner syndrome

Female X 0 45

Dysmorphic features are:

- Broad chest
- Short stature
- Webbed neck
- Edematous hand and feet that disappears with time
- Increased nuchal fold
- they could look normal just like the girl in the picture.



# Russell-Silver syndrome

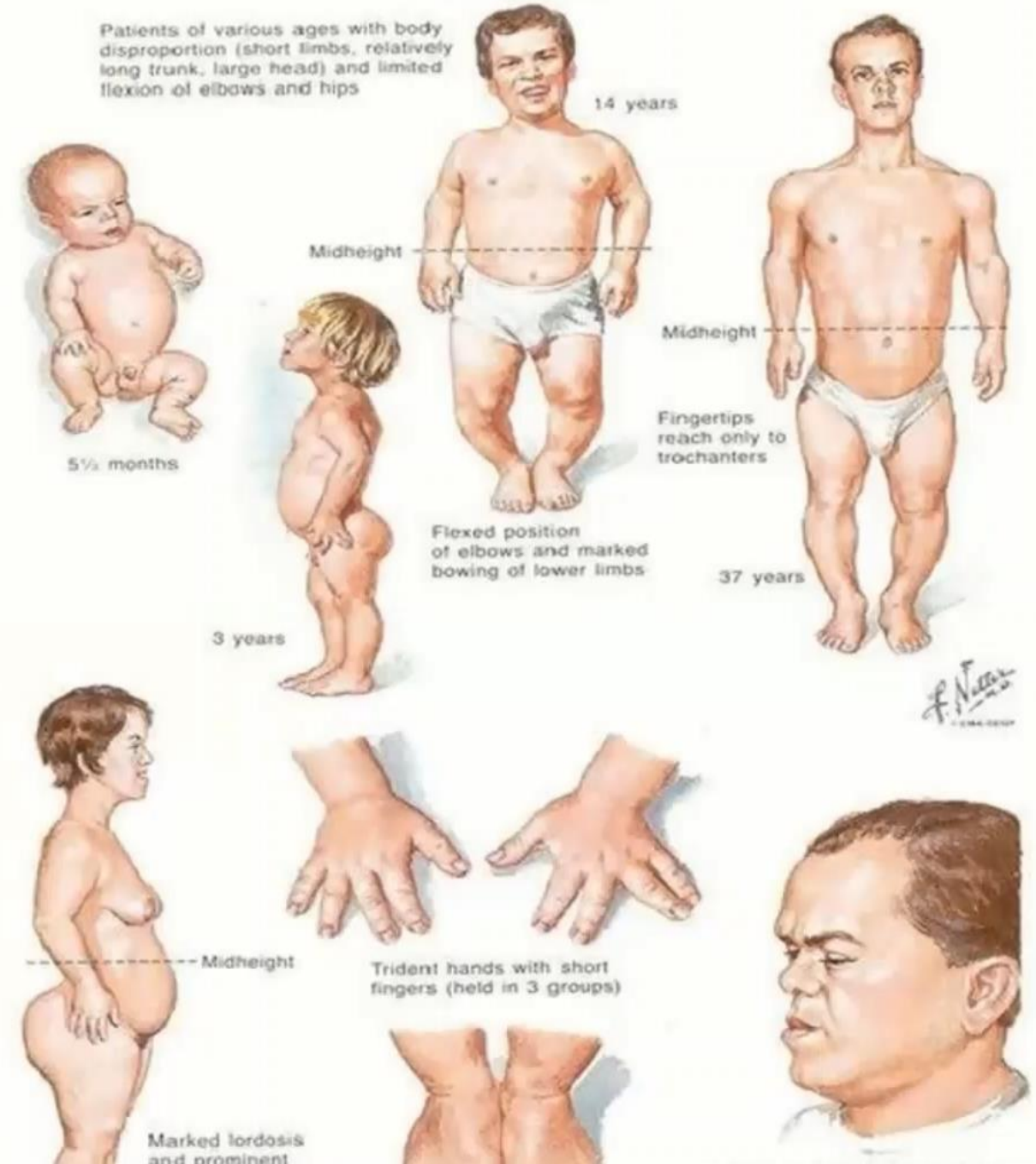
## Characterized by:

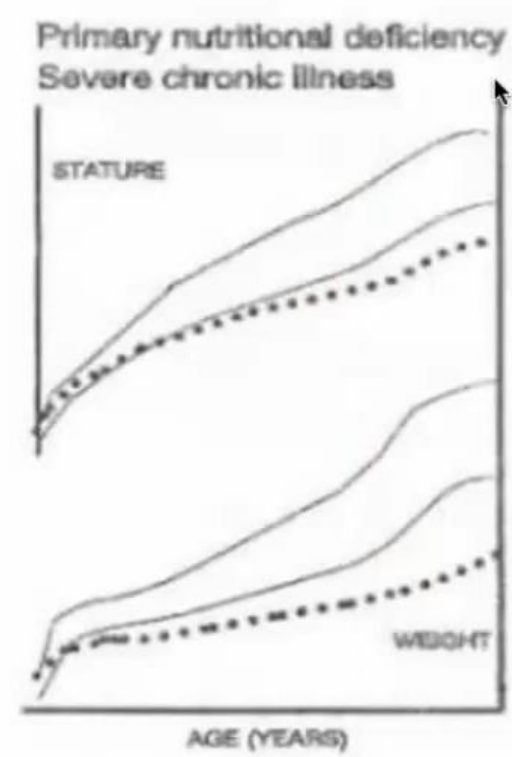
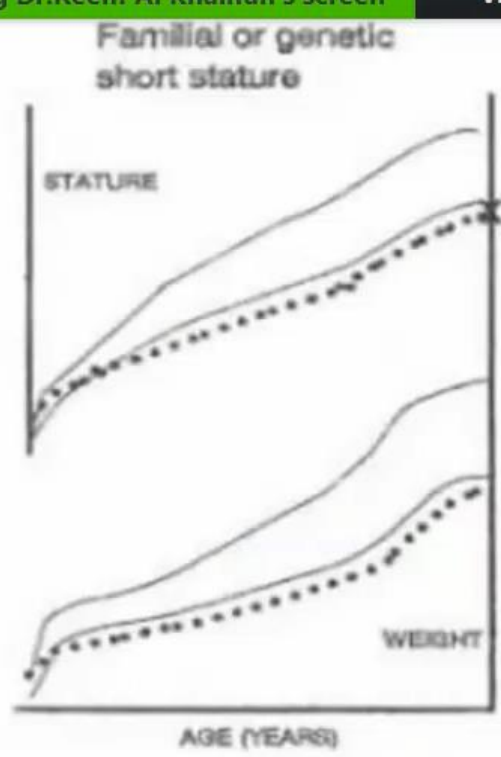
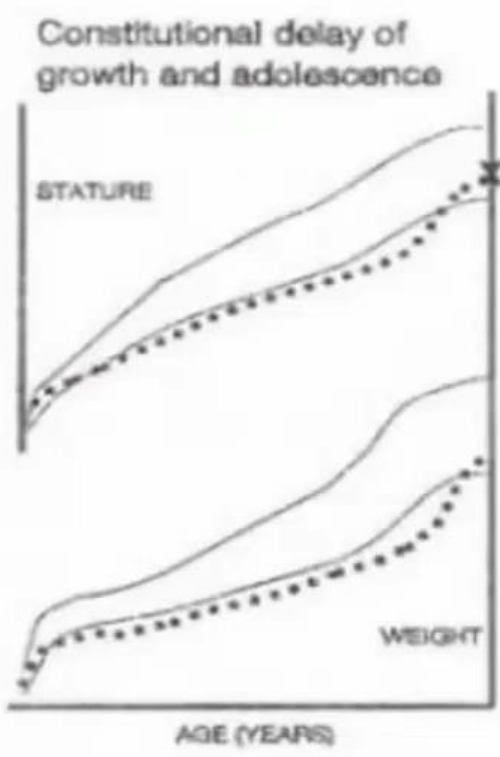
- Short stature petite
- History of hypoglycemia at birth
- café au lait spots
- Low-set ears
- Triangular face
- Sclerodactyly



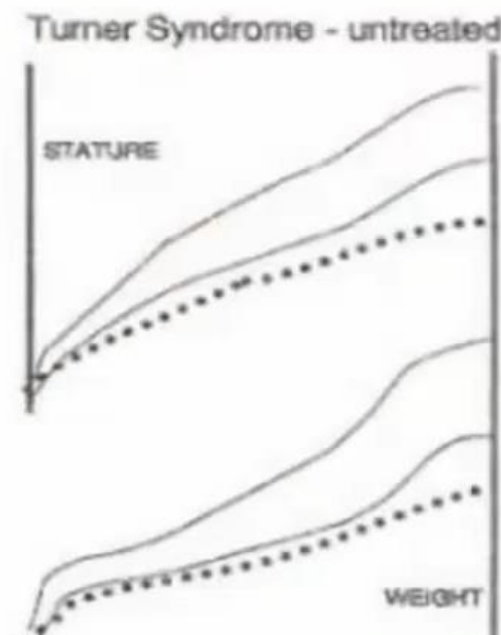
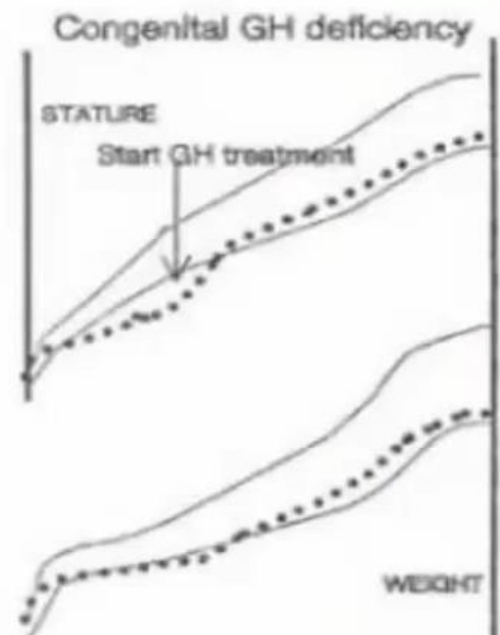
# Achondroplasia

- Large head
- Short arms and short legs (their arms barely touch the pelvis)
- Trident hands
- Lordosis in the back
- Scoliosis
- Small chest





Summary of all growth curves  
You have to remember for life.



# Investigations

FEMENINO

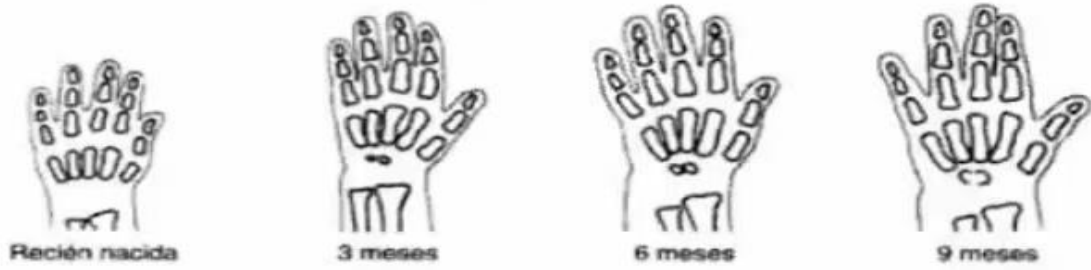
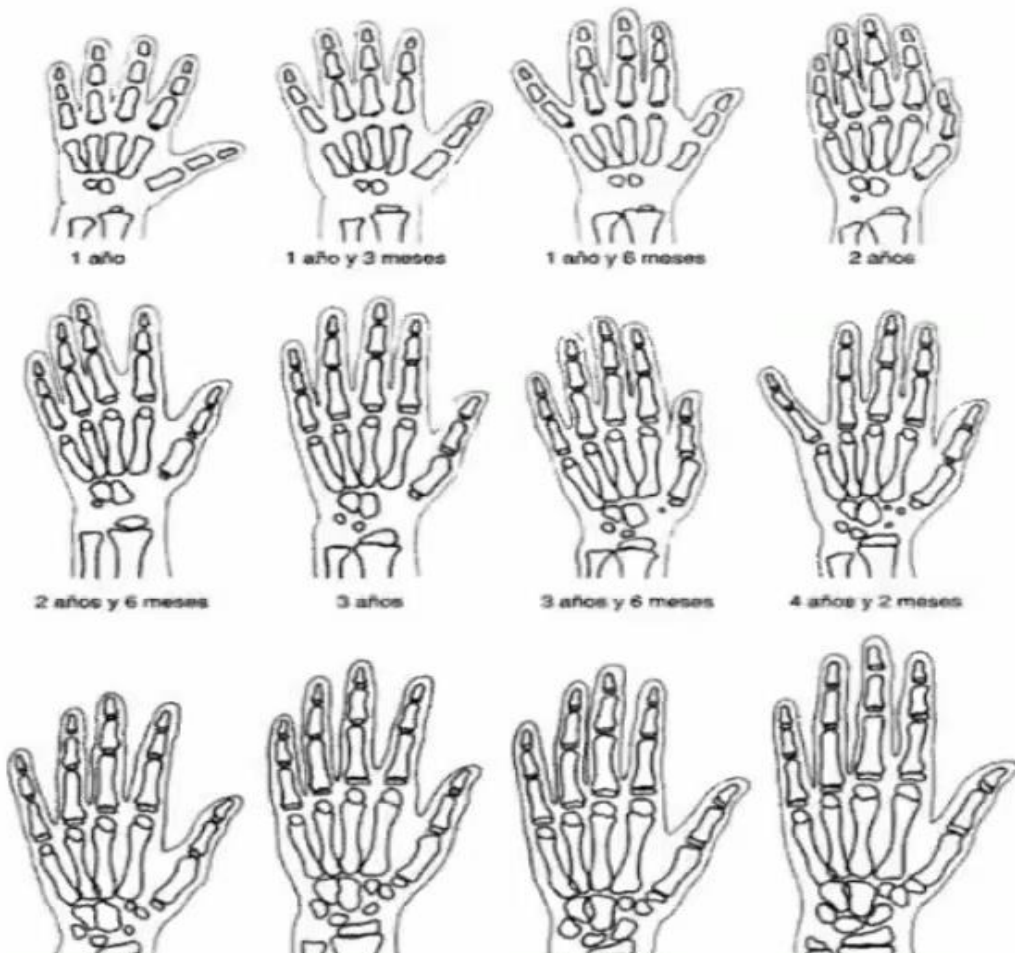


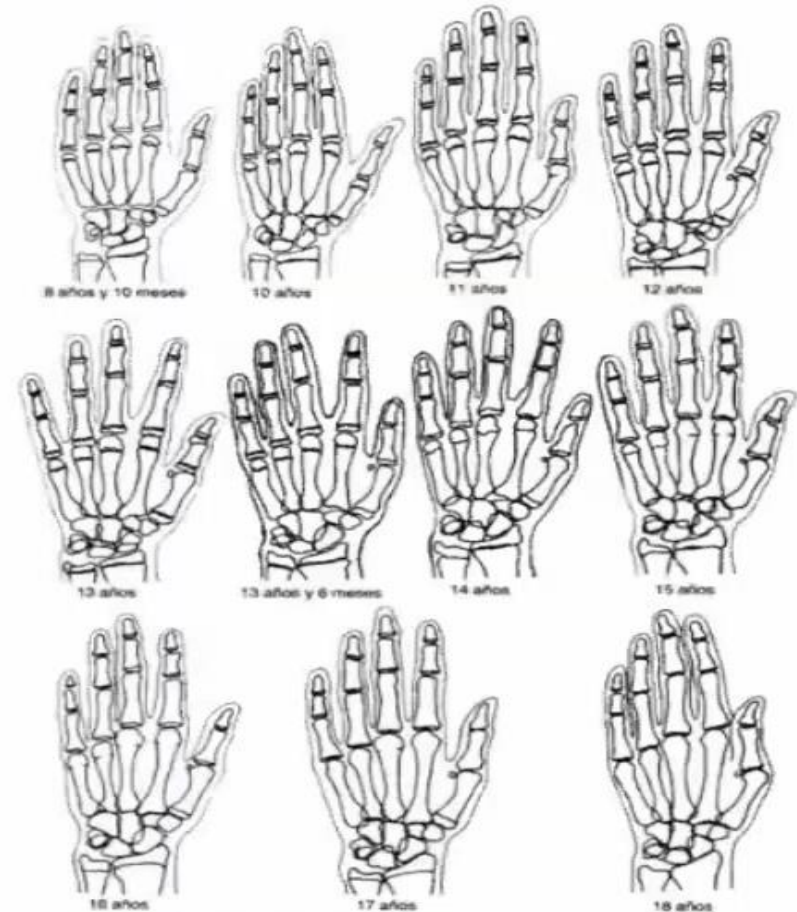
Figura 1 • Cont.

# Greulich & Pyle Atlas

The first investigation we should order is Bone age.



FEMENINO (cont.)



## Bone age

We have an atlas for bone age that looks at bone maturity across all age groups, which is taken through an x-ray of the left hand and wrist.

You look at maturation of all growth plates this is hand of female who is 1 year old and female who is 11 years old.

You can observe the difference female 11 y: all carpal bones achieved major part of their maturation compared to 1 year old.

And even all growth plates here are more mature while in 1yr old there is no growth plates that start maturation.





# Investigations

- **1<sup>st</sup> line testing:** Ordered by primary physician or general pediatrician
  - CBC
  - BUN, creatinine
  - electrolytes
  - TTG To rule out coeliac
  - Karyotype To rule out turner and trisomy 21
  - TSH, FT4
  - Bone age
- **2<sup>nd</sup> line testing:** If basic investigations are done, then refer to endocrine who will order the 2<sup>nd</sup> line tests
  - GH testing
  - MRI pituitary

Renal profile

**TREATMENT**

# Indications for GH therapy

- GH deficiency
- Turner
- Prader-willi syndrome
- SGA/IUGR who didn't catch up
- Renal insufficiency
- HIV



We don't treat familial short stature and constitutional short stature they are normal variants.

# What is your diagnosis?

- 5 years girl
- Father height 170 cm
- Mother height 160 cm

<b>age</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
Ht	105	106	107	108
Wt	18	18	19	20

- You are evaluating a 6 yo girl for short stature. Her birth length was at 60th percentile, and a current height at 5th percentile. Her growth velocity in the last 3 yrs has been cm/yr. Her weight is at the 90th percentile. On PE: her intelligence appears normal. There are no midline defects or dysmorphic features. Here Bone age is 4 yrs. What is the most likely dx?

1. Crohn disease
2. GH deficiency
3. IUGR
4. Turner

- You are evaluating a 6 yo girl for short stature. Her growth chart reveals a birth length at 60th percentile, and a current height at 5th percentile. Her growth velocity in the last 3 yrs has been 2 cm/yr. Her weight is at the 90th percentile. On PE: her intelligence appears normal. There are no midline defects or dysmorphic features. Her Bone age is 4 yrs. What is the most likely dx?

1. Crohn disease
2. GH deficiency
3. IUGR
4. Turner

# Puberty

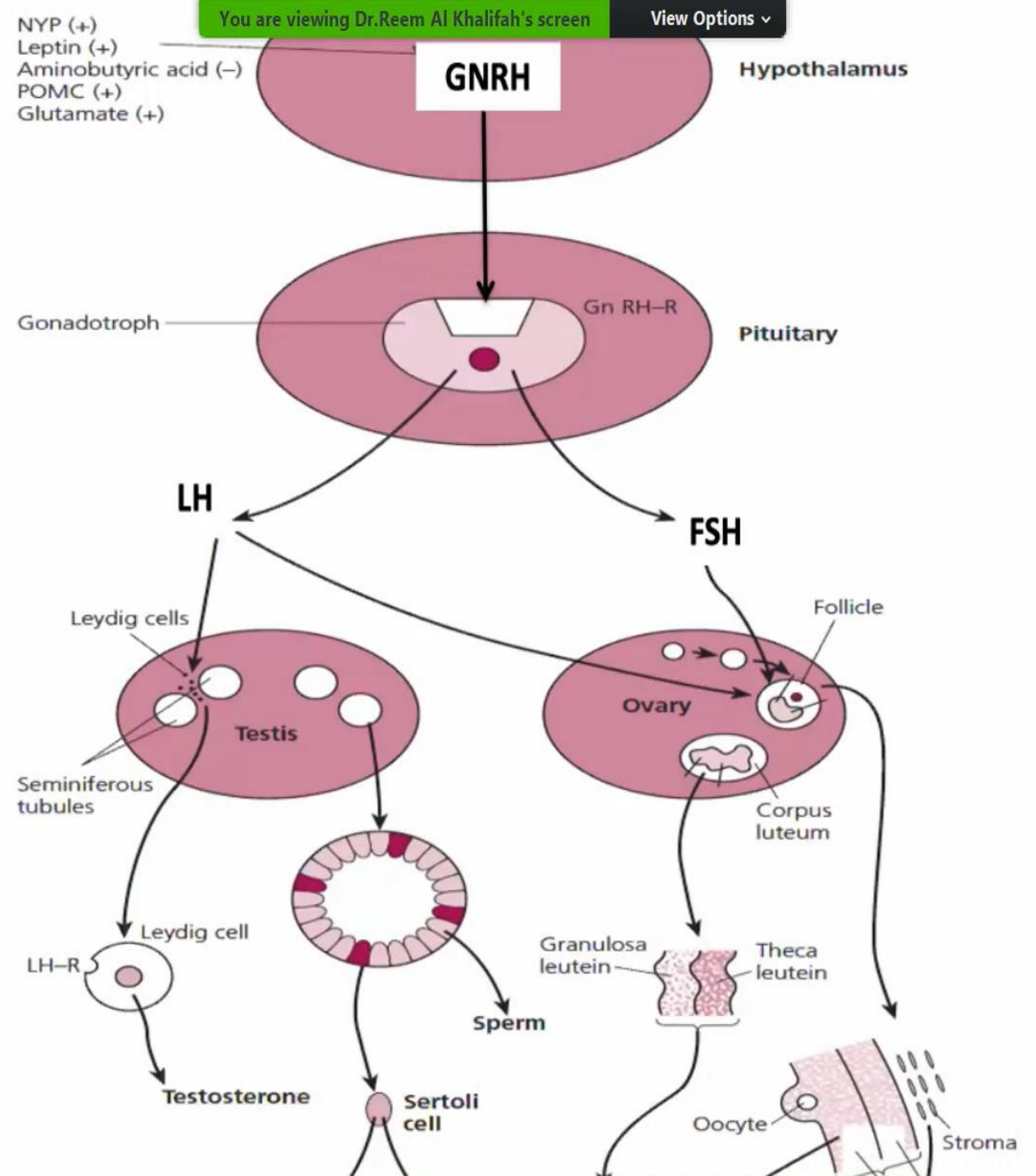


# How does puberty happen?

Hypothalamus secretes the GNRH hormones, they reach pituitary gland he stimulate pituitary gland especially gonadotrophs to secrete FSH and LH.

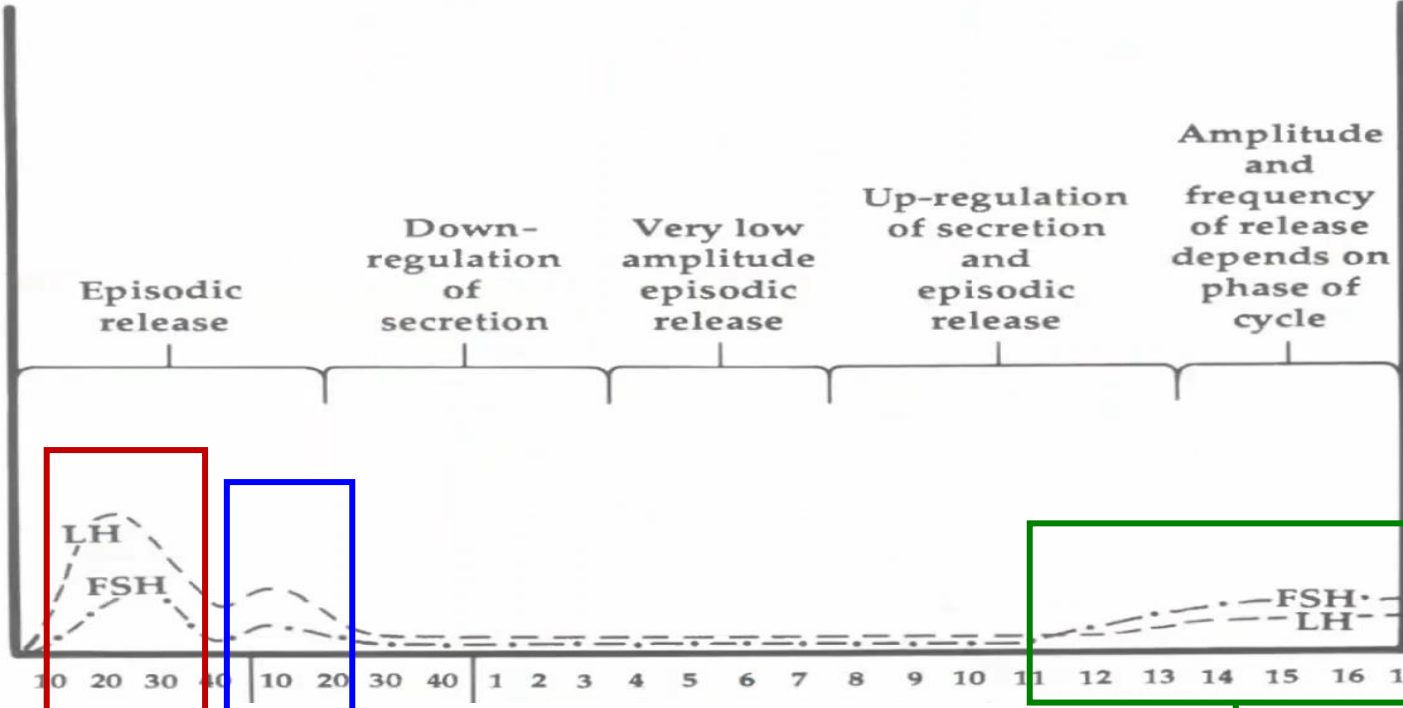
These hormones travel through the body reaches either ovaries in girls or testicles in boys. To secret estrogen and start working to mature oocyte in ovaries and in boys it mature the testicles to secrete testosterone and produce sperms.

If enough estrogen or testosterone is secreted it will have negative feedback inhibition on hypothalamus and pituitary.





# LEVELS OF LH & FSH DURING LIFE



FSH and LH levels are highest while the baby is still in utero even higher than puberty levels. Why is that? Because they are still forming the ovaries and testicles in utero. Upon birth these levels start to decline.

And then children pass through mini puberty in the first 2-3 months of life and then these levels start to decline and reach pre-pubertal values and the axis is turned off.

The levels remain very low till the pre-pubertal age, they start to go up to allow puberty to happen.

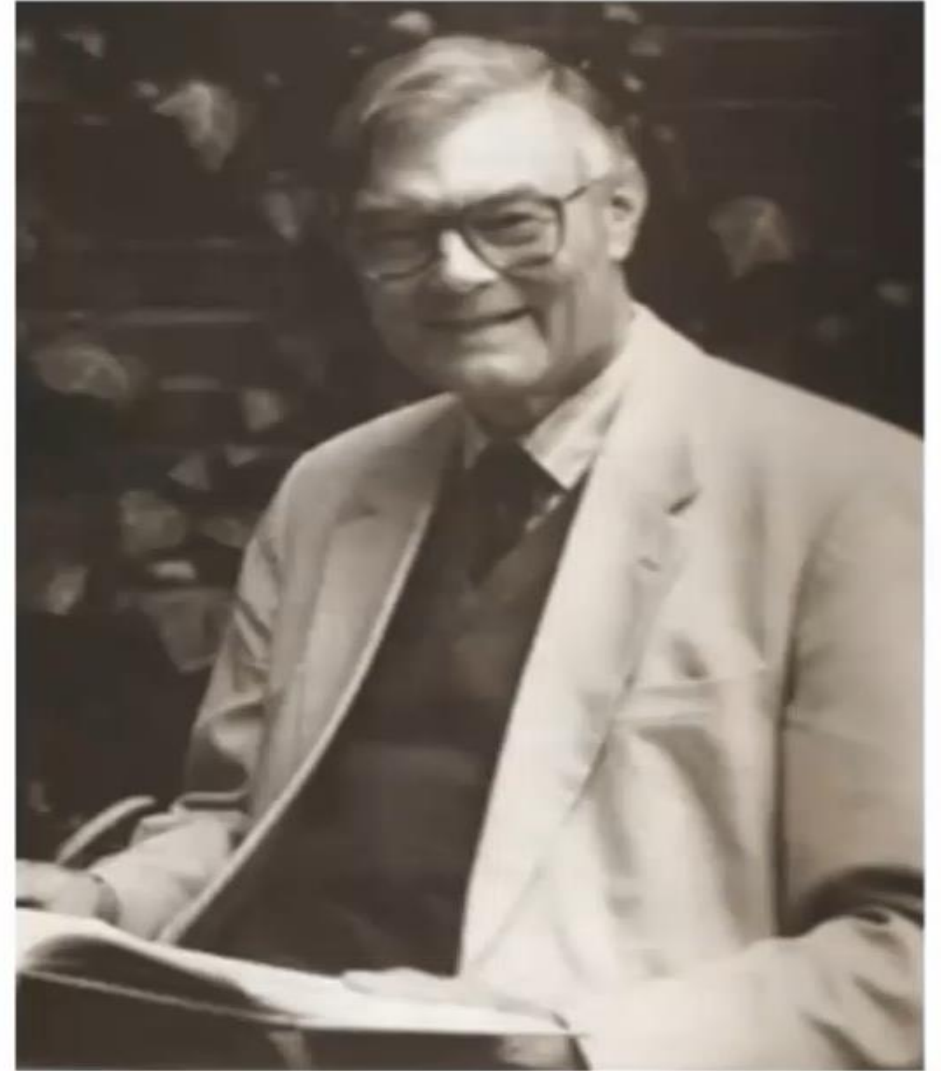
# Sexual Maturity Ratings (SMR)

Or called tanner stages

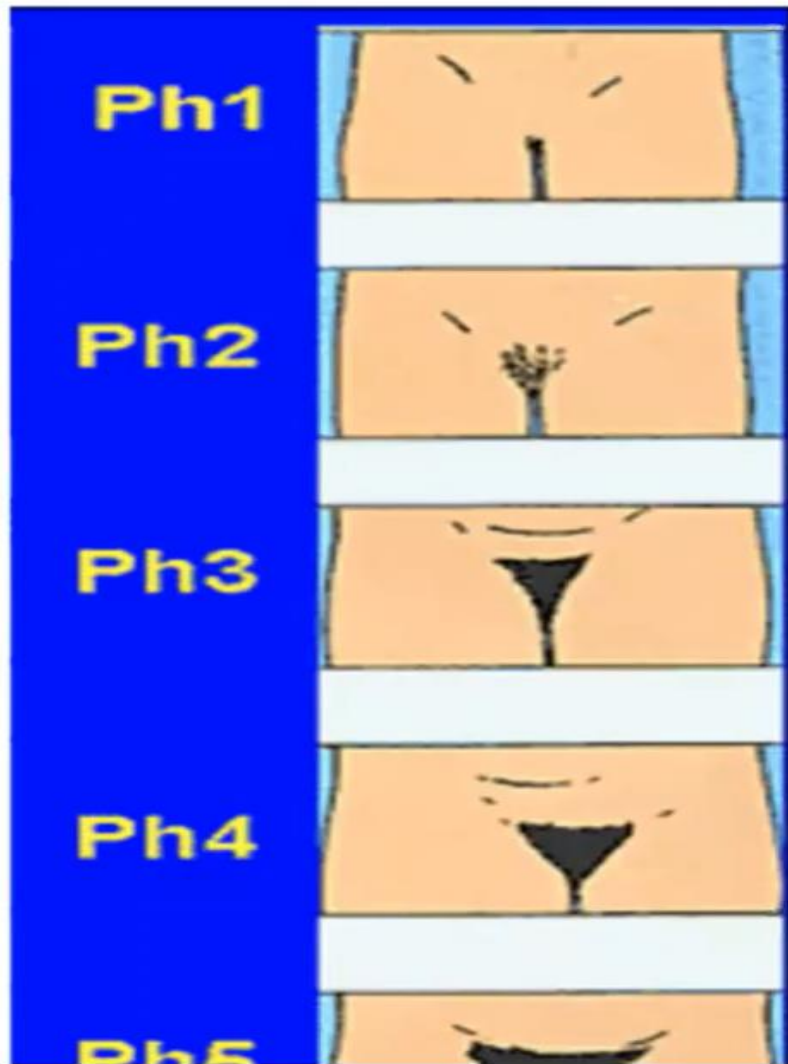
## **Dr. James Tanner**

developed a scale in 1962  
that divides the SMRs into  
5 classes based on:

- pubic hair
- breasts in females
- genitalia in males



# Tanner Stages Females



SMR 1: pre-pubertal, **no hair**

SMR 2: light, downy hair along the labia majora in females

SMR 3: moderate amount of curly, pigmented, and coarser hair, extending more laterally

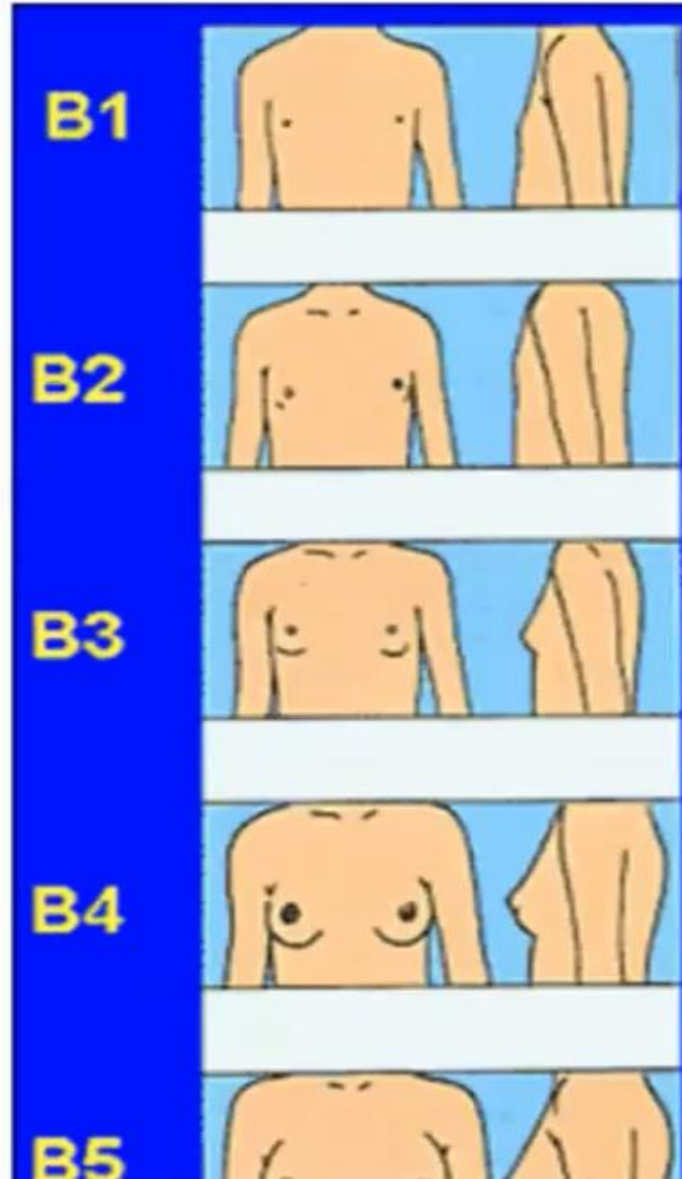
SMR 4: hair that resembles adult hair in coarseness and curliness but does not extend to medial surface of thighs

*covers all the pubic area.*

SMR 5: adult type and quantity, extending to medial surface of thighs

*extending to the medial surface of the thighs.*

# Tanner Stages Females



B1: Pre-pubertal, **no breast buds**

B2: Breast buds, small amount of glandular tissue, Areola widens

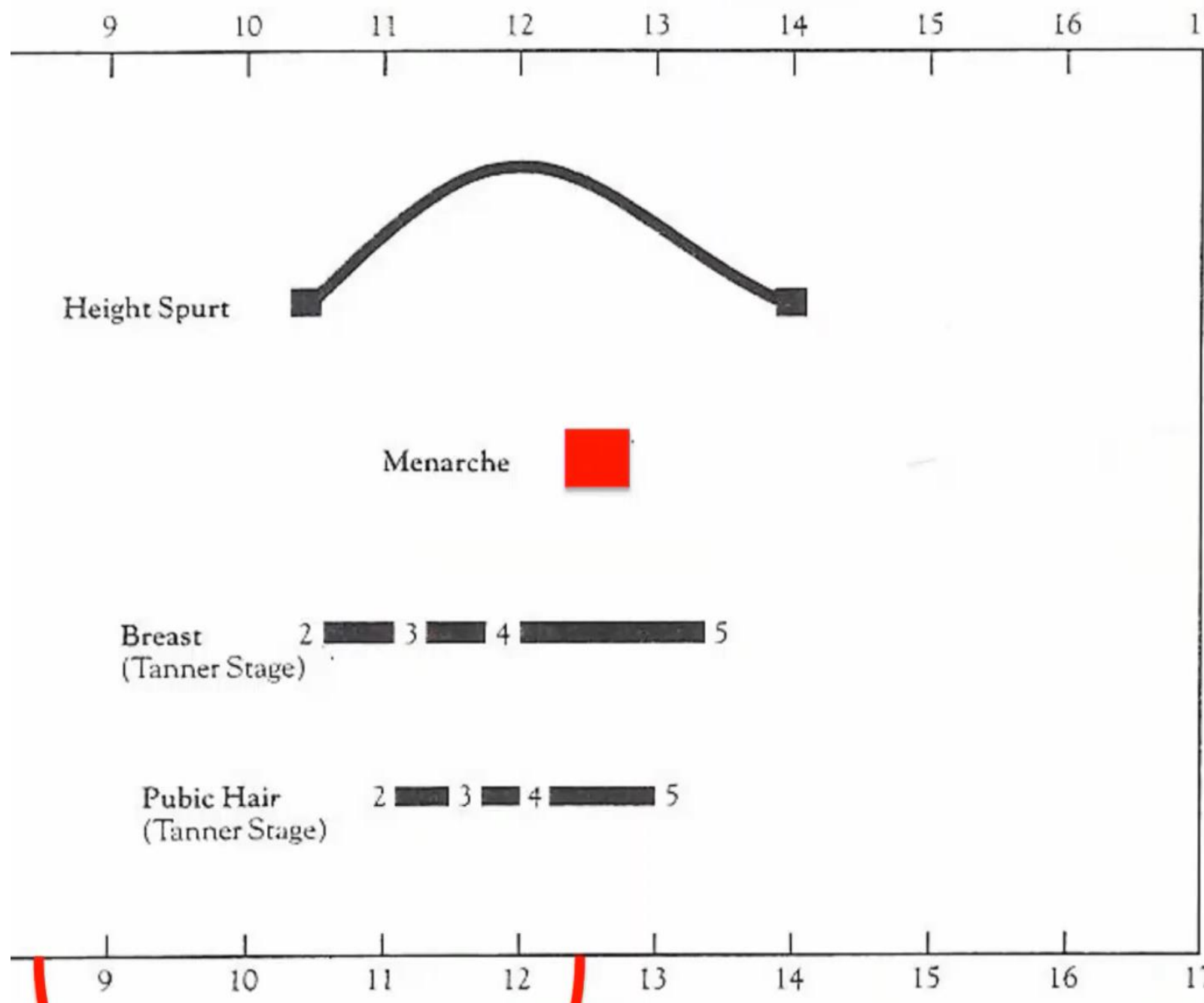
If it extends below the areola, it is still considered stage 2 however when it goes beyond that it becomes stage 3.

B3: Breasts enlarge, Areola and papilla: areola continues to enlarge but remains in contour w/ breast

B4: Areola and papilla form a mound projecting from the breast contour  
“ice cream cone”

The difference between stage 3 and 5 is that in stage 5 the areola is bigger and stretched and there is papillary projection

B5: Areola and breast in same plane, with papilla projecting above areola



### Stages in relation to ages

In girls:






puberty started at age 8 years and the latest starts at the age 12 and ¾.

Once puberty start, the first stage we have is stage 2 Breast and then the child progress to have pubic hair, and then growth velocity start to increase till it reaches the peak at stage 3-4 breast, and then declines till the end of stage 5.

Menarche happens at stage 4 of breast.

Once menarche happens, the peak of growth spurt had happened already.

# Tanner Stages Males

I		3 ↕ <2,5
II		4 ↕ 2,5-3,2
III		10 ↕ 3,6
IV		16 ↕ 4,1-4,5
V		25 ↕ >4,5

SMR 1: pre-pubertal, **no hair**

SMR 2: light, downy hair along the base of the scrotum and phallus in the male

SMR 3: moderate curly, pigmented, and coarser hair, extending more laterally  
*covers all the pubic area.*

SMR 4: hair that resembles adult hair in coarseness and curliness but does not extend to medial surface of thighs

SMR 5: adult type and quantity,  
*extending to the medial surface of the thighs.*

# Tanner Stages Males






Stage 1 = 3ml

Stage 2 = 4-8 ml

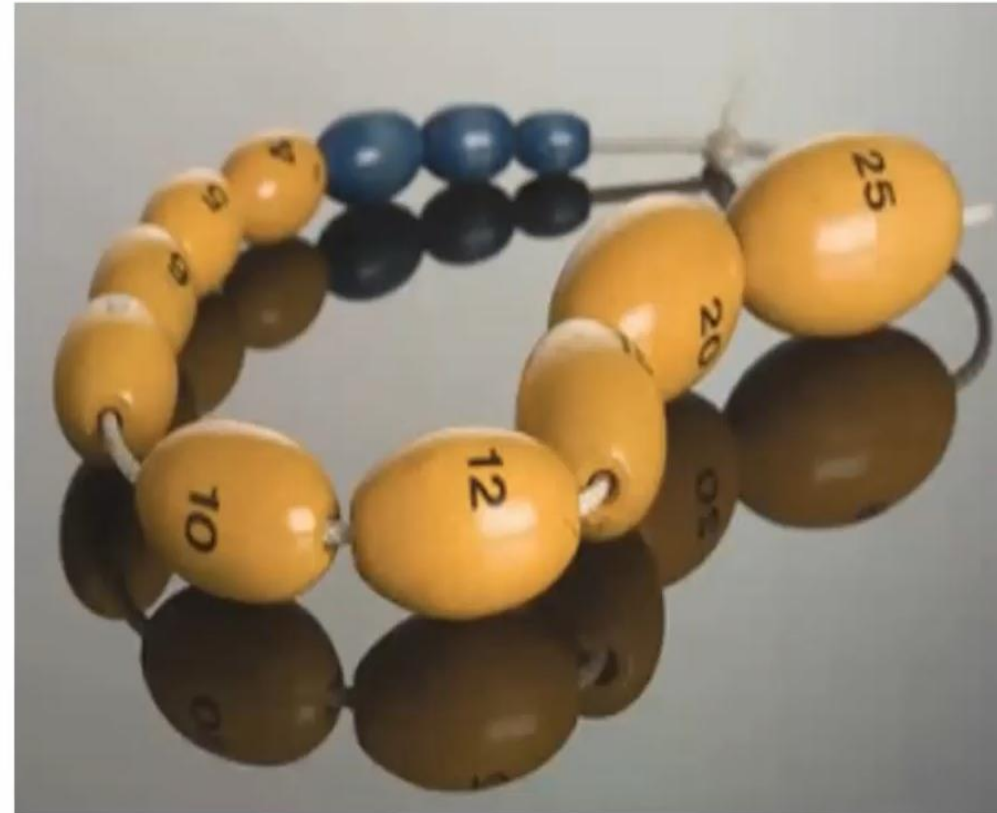
Stage 3 = 10-15 ml

Stage 4 = 16 -20 ml

Stage 5 = 25 ml

I		3	<2,5
II		4	2,5-3,2
III		10	3,6
IV		16	4,1-4,5
V		25	>4,5

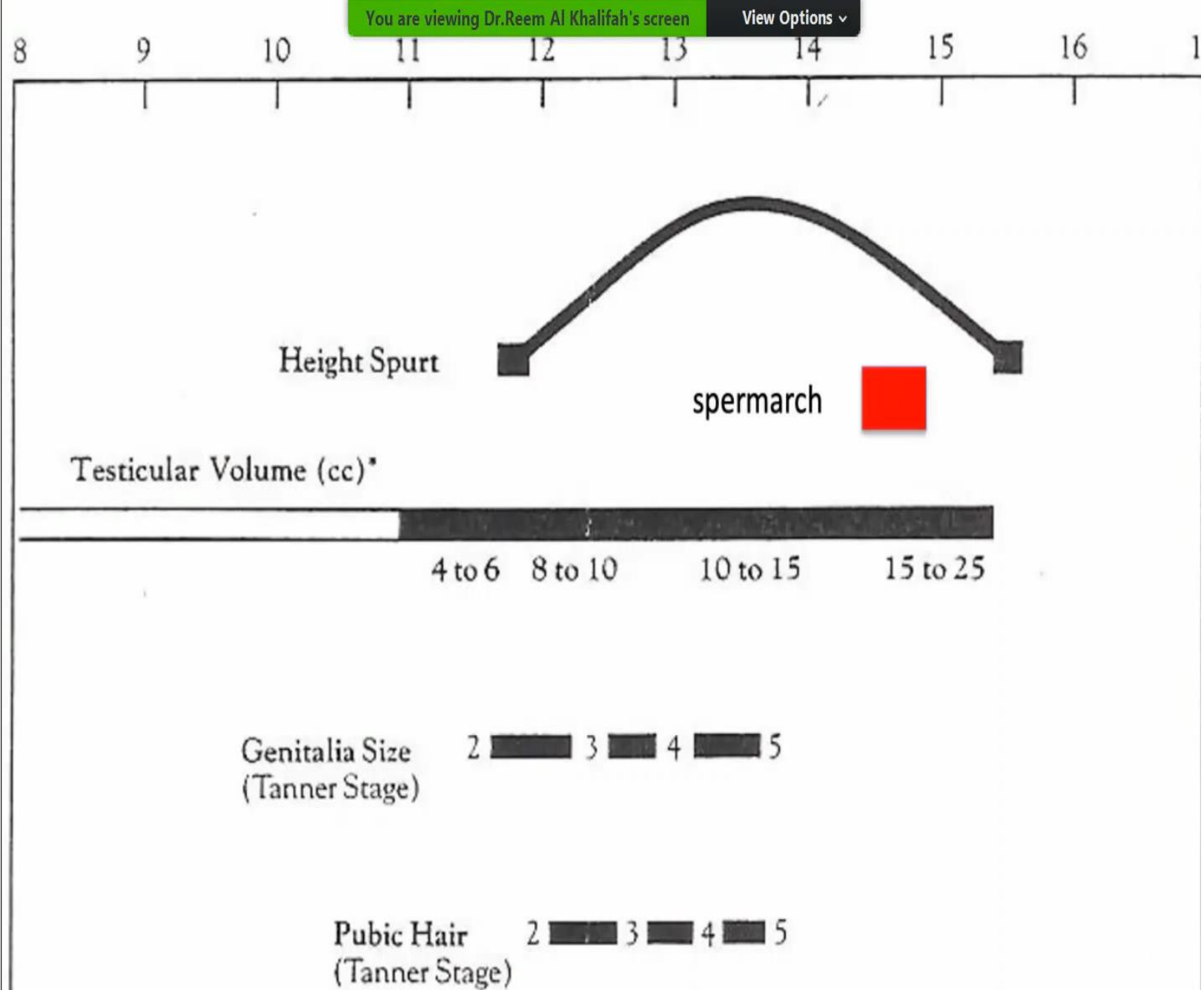
If there is no orchidometer we can measure the longitudinal axis in cm  
2.5 cm = 3ml



In boys we measure the testicular volume using this device (orchidometer).

It has beads we can compare the bead volume to the testicular volume. The first three beads, measuring 1ml, 2 ml, 3ml, and then 4,5,6,8,10,12, 15,20,25ml.

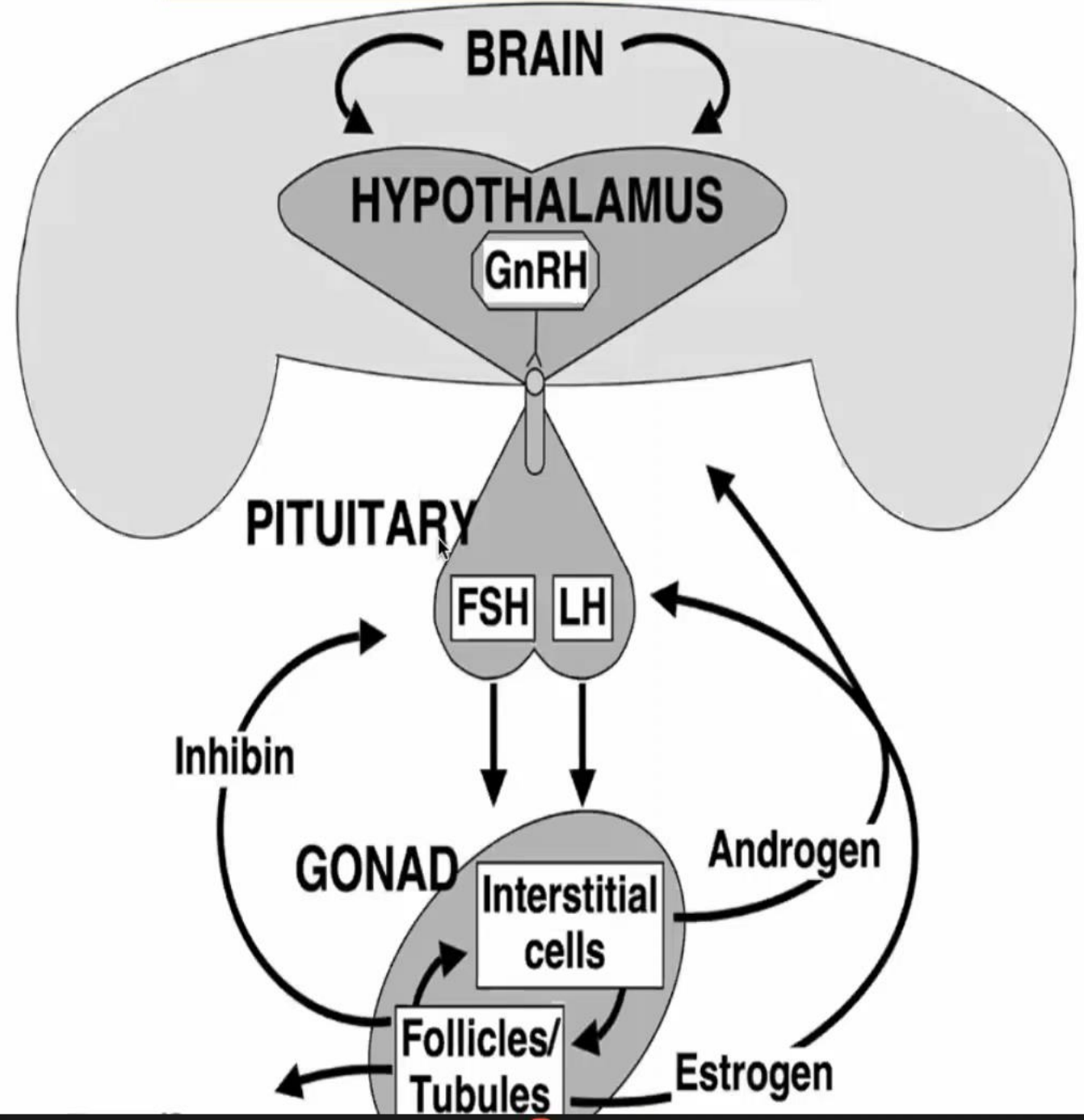
Boys enter the puberty around age of 10 years. And the latest finish for puberty in boys is around age of 13. Puberty in boys starts with testicular volume increase from 3 ml to 4 ml. Followed by increase in genitalia size and pubic hair appearance. And with that growth velocity starts to increase to reach the maximum growth velocity which is around stage 3 in boys. Spermarch at stage 4 .



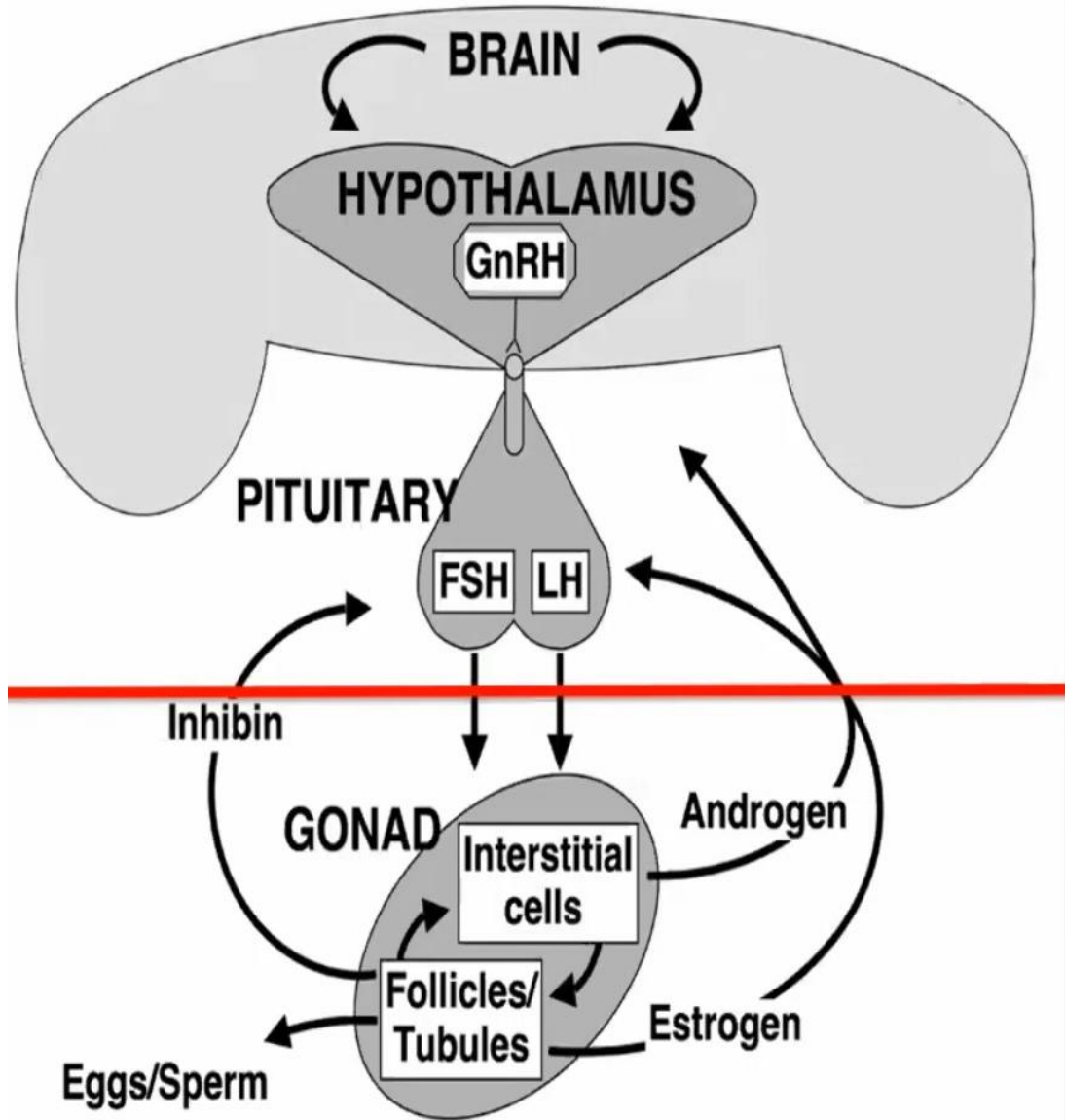


	Girls	Boys
<b>Normal</b>	8.5-12.5	10-13
<b>precocious puberty</b>	8 years	9 years
	Before age of 8 in girls and before the age of 9 in boys.	
<b>Delayed puberty</b>	13 years	14 years

# **PRECOCIOUS PUBERTY**



Precocious puberty can happen as a result of FSH LH secretion (the problem in Hypothalamus –pituitary – gonadal axis )  
Or gonads start to function independently of FSH LH hormones (the problem is in the gonads).

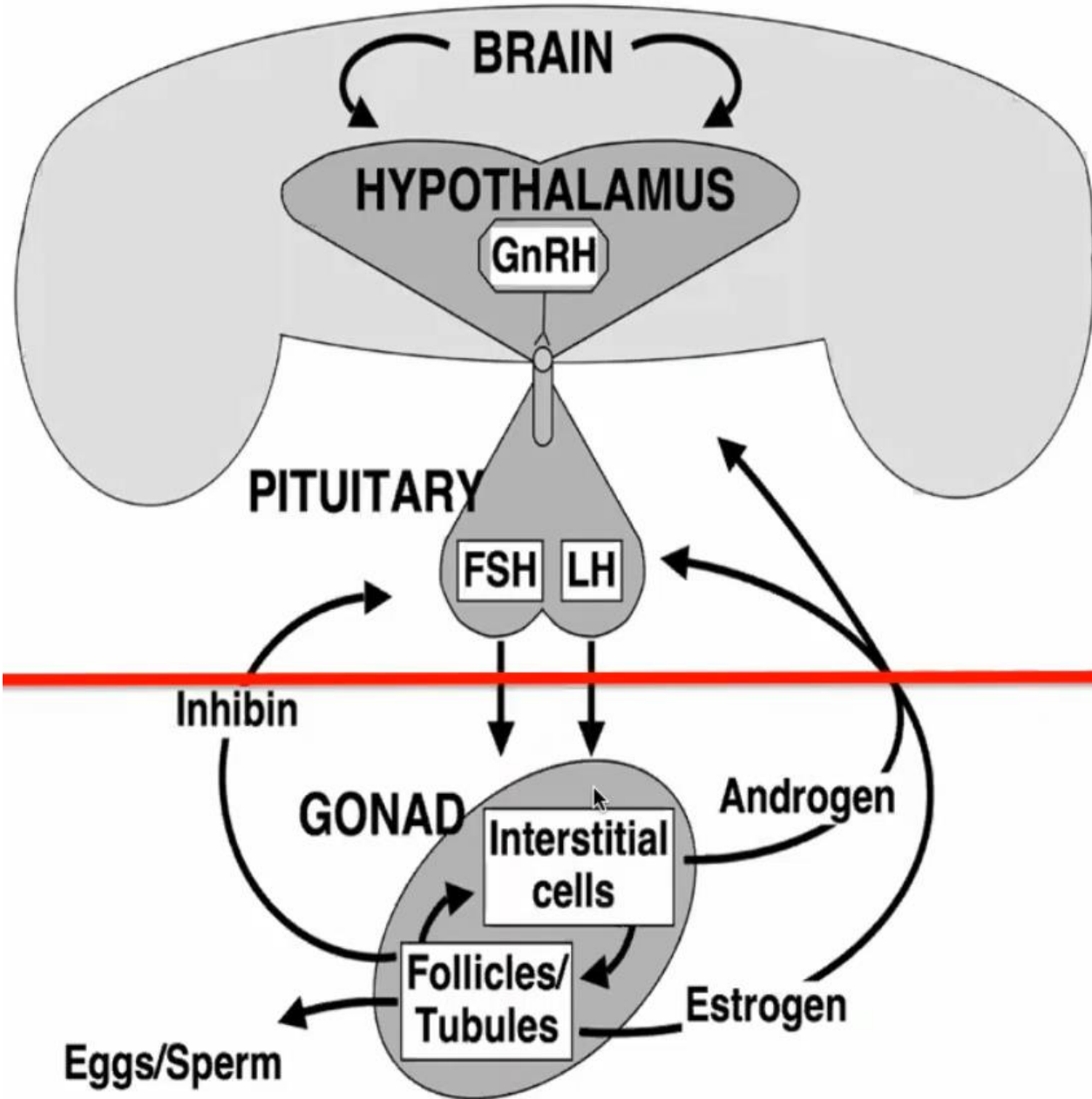


## Gonadotropic dependent

- Idiopathic central precocious puberty
- brain tumors , e.g. optic nerve gliomas, hamartomas
- hydrocephalus
- post-infection
- post-trauma
- post-cranial radiotherapy

There is increase in FSH LH

Idiopathic central puberty is the most common cause of precocious puberty in girls almost 90% of the cases but in boys it is most likely pathological we have to look for the cause



## Gonadotropic independent

- Ovarian cysts
- Gonadal tumors (ovary, testis)
- Adrenal tumors
- Exogenous sex steroids

Like estrogen and testosterone gels it can lead to precocious puberty

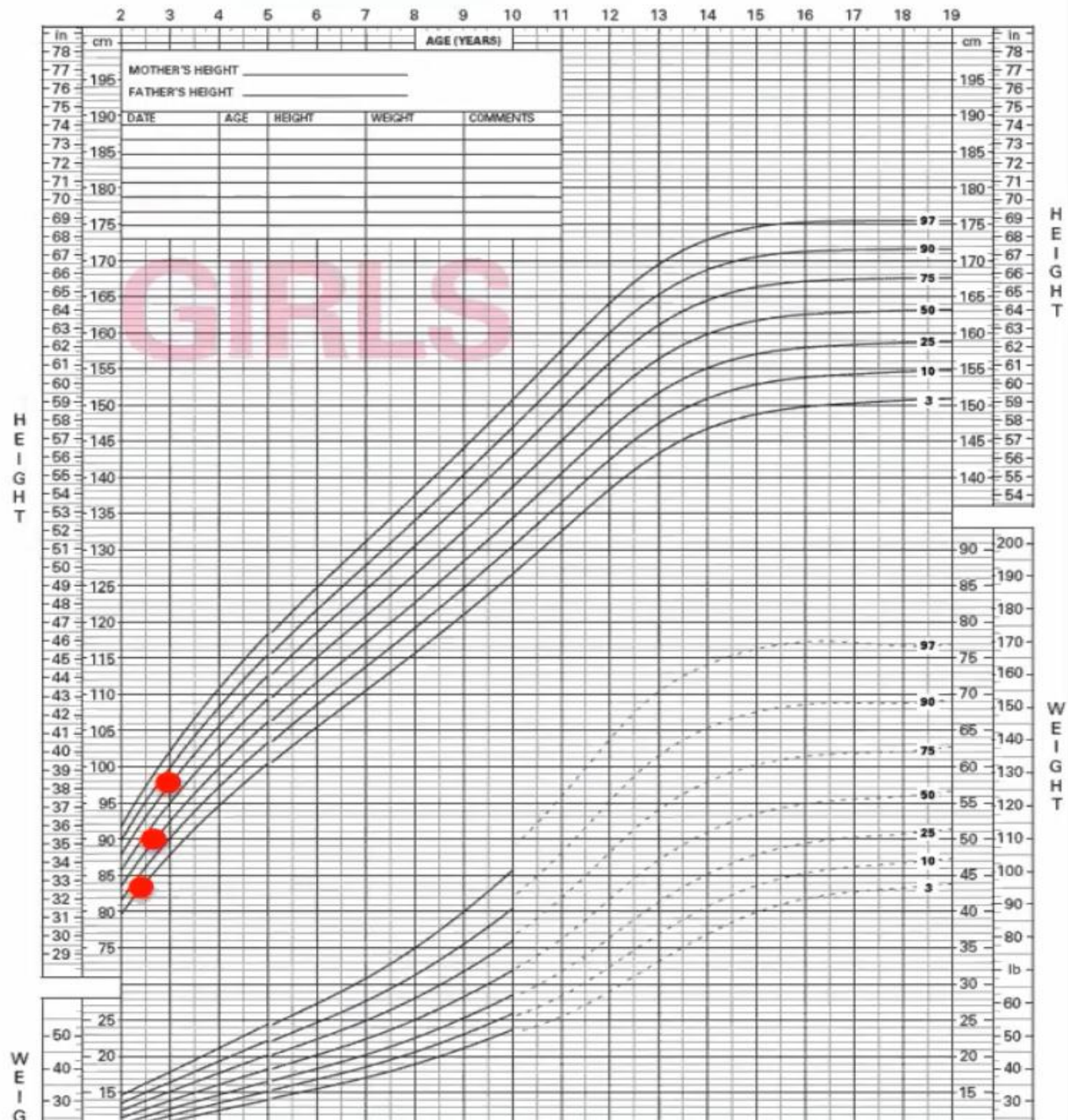
- 3 years old girl previously healthy came to the ER because of vaginal bleeding for 1 day, frequent falls in the last month. Exam Tanner 2 breast, estrogenized vaginal mucosa. No pubic hair.



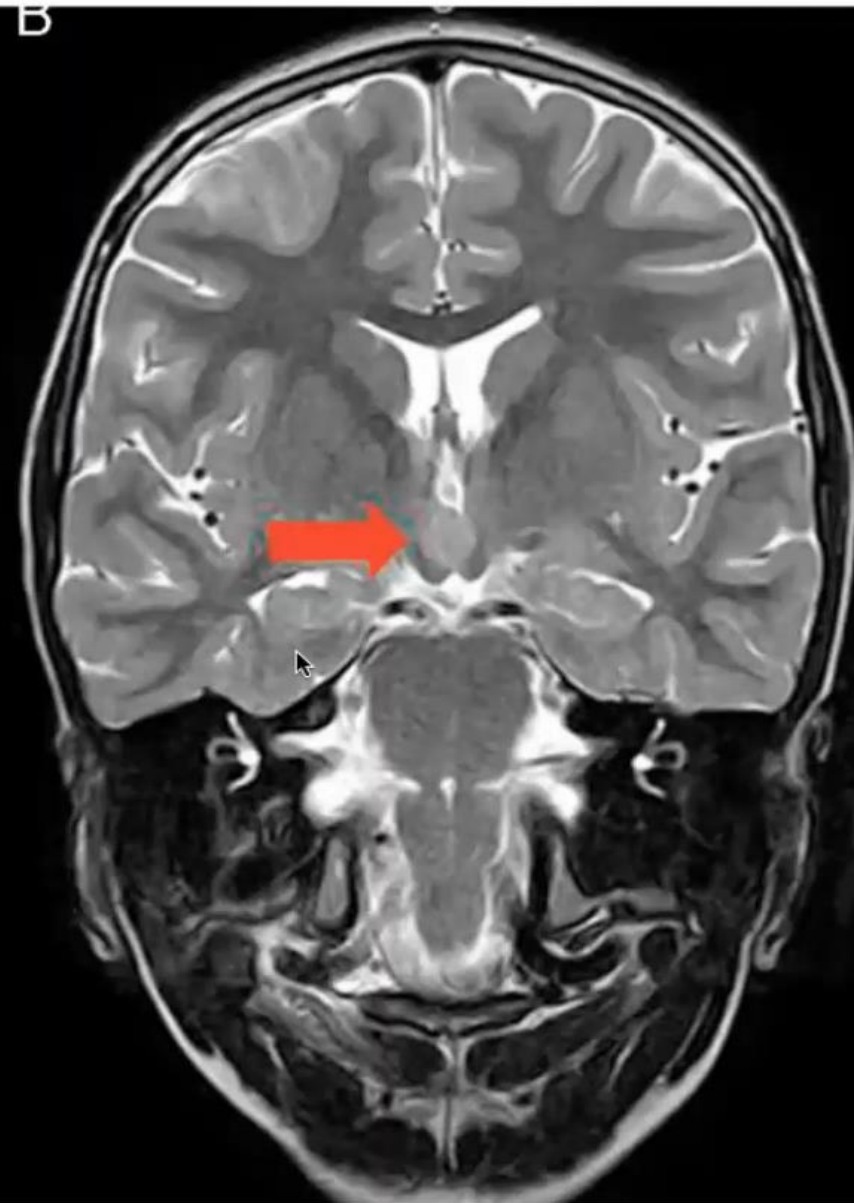
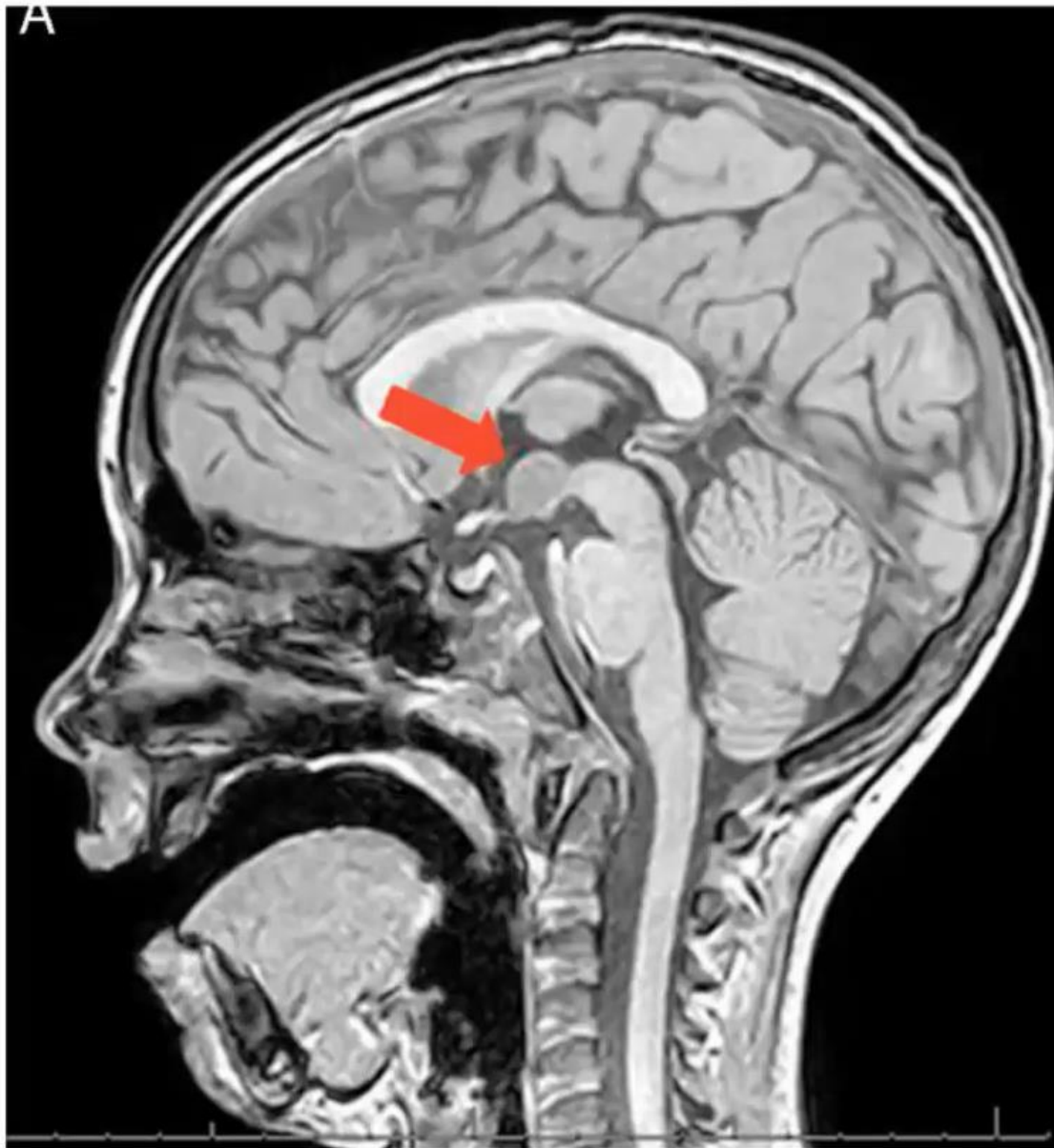
# What is your diagnosis?

- A. Idiopathic central precocious puberty
- B. brain tumors**
- C. Premature thelarche
- D. Adrenal tumors

Her growth pattern crosses the percentile lines like puberty she is having growth spurt.



She has Brain tumor in pituitary






# Red flags for pathological causes

- Abnormal sequence of puberty Like having vaginal bleeding before breast growth
- Rapid progression
- Advanced bone age
- Virilization of female or feminization of male
- Neurological symptoms

Headache, seizures, frequent falls.

Like male pattern hair growth in female and change in voice  
In males breast growth. That indicate there is a tumor secretes testosterone in female or estrogen in male.



# **VARIANTS OF PUBERTY**

# Premature thelarche

Normal variant

- 6 months- 2 years <6 months or > 2 years is abnormal
- **Isolated** breast development No vaginal bleeding
- No growth acceleration
- No pubic or axillary hair
- No neurological symptoms
- Self-limiting
- No need for treatment



# Premature adrenarche

- **Isolated** Pubic or axillary hair development Or change in body odor
- No growth acceleration
- No breast or testicular progression
- **No virilization**
- Self-limiting
- No need for treatment

# Investigations

- Bone age To determine the bone age.
- US abdomen/ pelvis
- MRI brain
- Hormonal profile:
  - LH/FSH, estradiol, testosterone, HCG, alpha-fetoprotein

We have to check tumor markers and hormonal profile

# TREATMENT

GNRH agonist if precocious puberty is suspected.  
If normal pubertal variant no need for treatment.  
If the cause is a tumor, we take it out.

# GNRH analogues

- Lupron for GNRH dependent

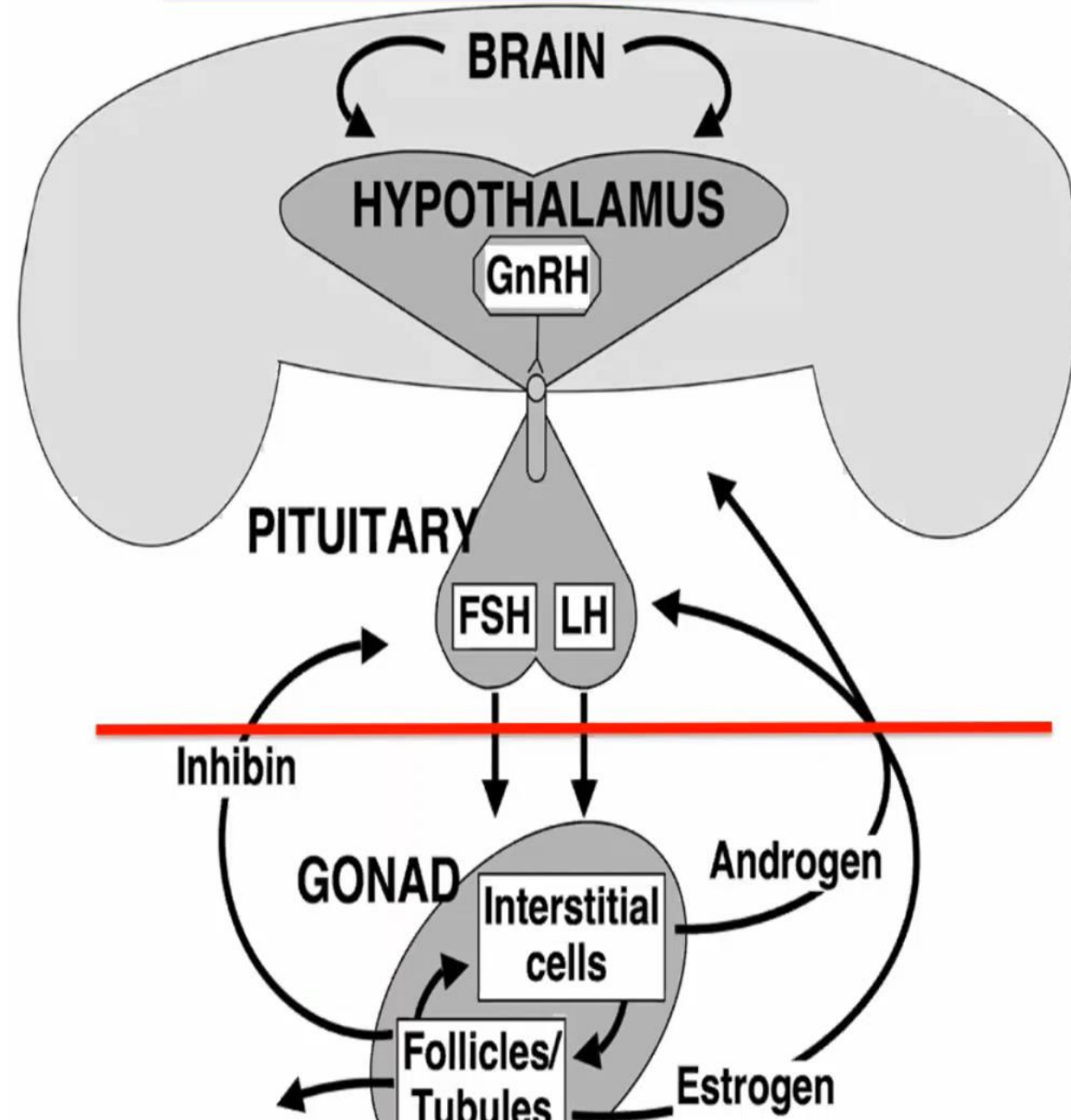
Pulsatile secretion stimulate puberty but if we give high dose of GNRH it will suppress the puberty

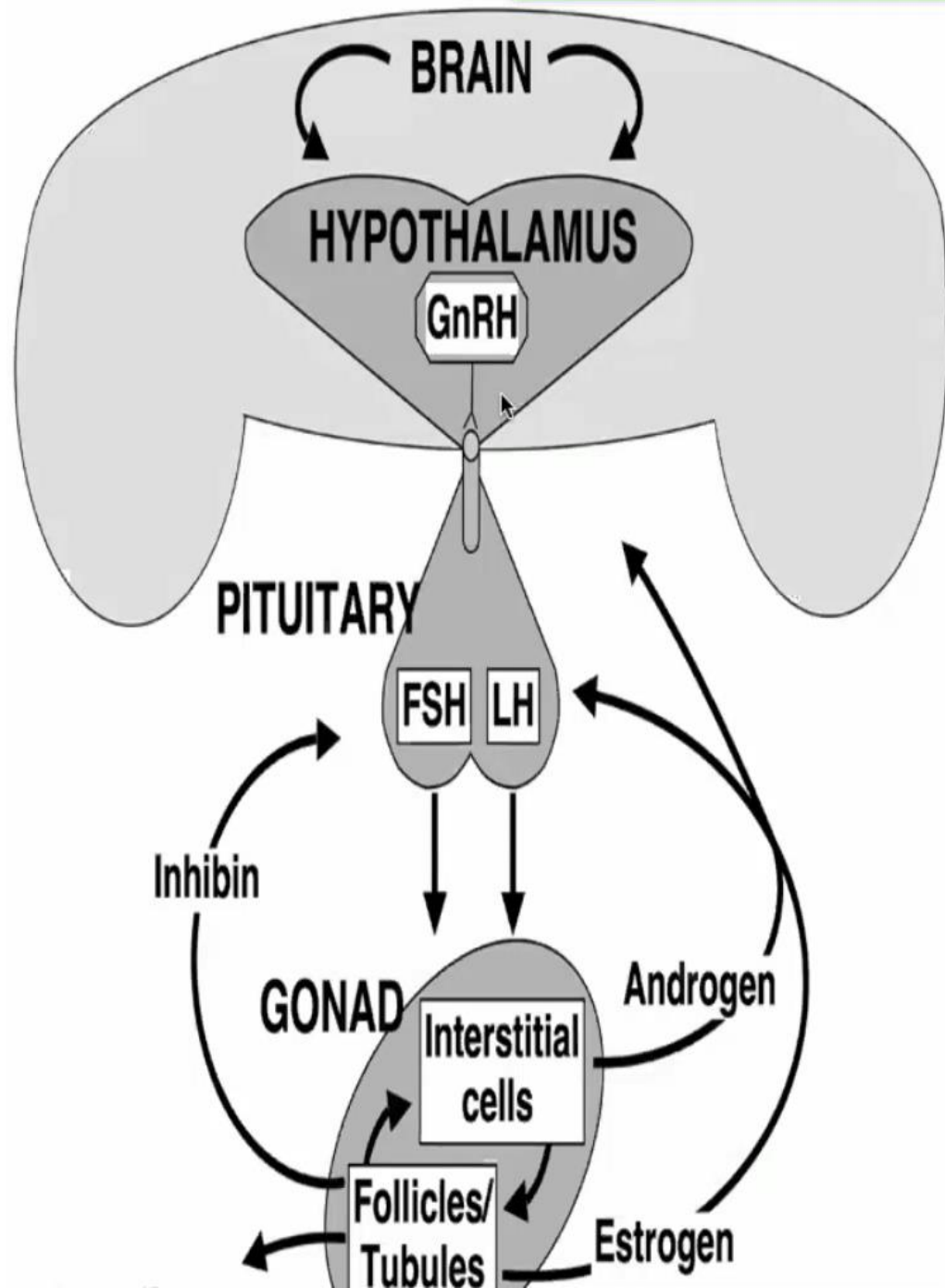


# **DELAYED PUBERTY**



It has the same classification  
Gonadotropin dependent and  
gonadotropin independent but  
the names are different here.

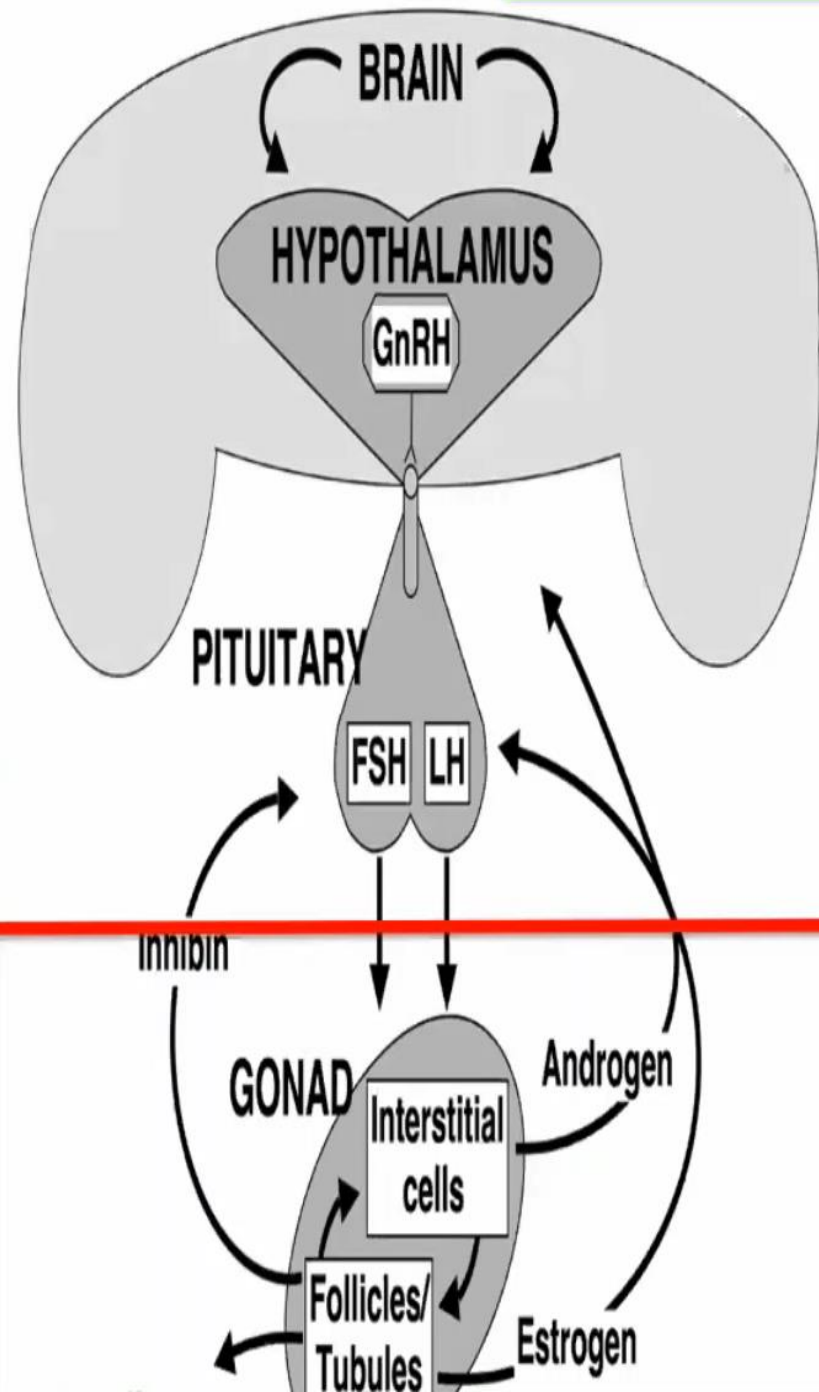




## Low GNRH:

Problem in hypothalamus or pituitary

- Multiple pituitary hormone deficiency
- Isolated gonadotropin deficiency
- Kallmann syndrome (Kallmann syndrome has characteristic feature They don't smell)
- Chronic illness (Chronic renal disease, GI, malnutrition, Sickle cell disease, cystic fibrosis)
- Anorexia nervosa
- Extreme exercise



## High GNRH:

### Chromosomal abnormalities:

- Turner syndrome
- Klinefelter syndrome

### Gonadal damage:

- Surgery, infection, radiation, chemotherapy, trauma, autoimmune

The problem is in gonads the gonads are not working and not responding to normal signals come from hypothalamus and pituitary, hypothalamus secretes GnRH and pituitary secretes FSH, LH but the gonads do not respond

Why don't gonads respond?

Because of chromosomal abnormality (gonads are not normal to start with ) like in turner or Klinefelter syndromes

Or

Gonads are damaged by surgery, infection, autoimmune, radiation, chemotherapy or trauma.

All High GnRH causes are called gonadal failure.

# Investigations

High ad low GNRH presents with delayed puberty but the treatment is different.  
Investigations are like those for short stature

- Nutritional status      CBC, renal profile, liver profile, coeliac,..etc. to make sure that the nutrition is ok and we are not dealing with chronic illness.
- Sex steroids      FSH , LH , estradiol in girls , and testosterone in boys
- Karyotype      To rule out chromosomal abnormalities.
- US abdomen/ pelvis

- **16 years old girl, was treated for ALL at age 5 years. Has no breast development yet**
- **US showed normal uterus & 2 ovaries**
- **LH 35, FSH 40, estradiol 18**

• **What is your diagnosis?**

A. Turner syndrome

B. Gonadal failure

C. Chronic illness

D. Multiple pituitary hormone deficiency

The key: She had leukemia and treated with chemotherapy

# Treatment

- Puberty induction:
  - Boys: testosterone
  - Girls: estradiol

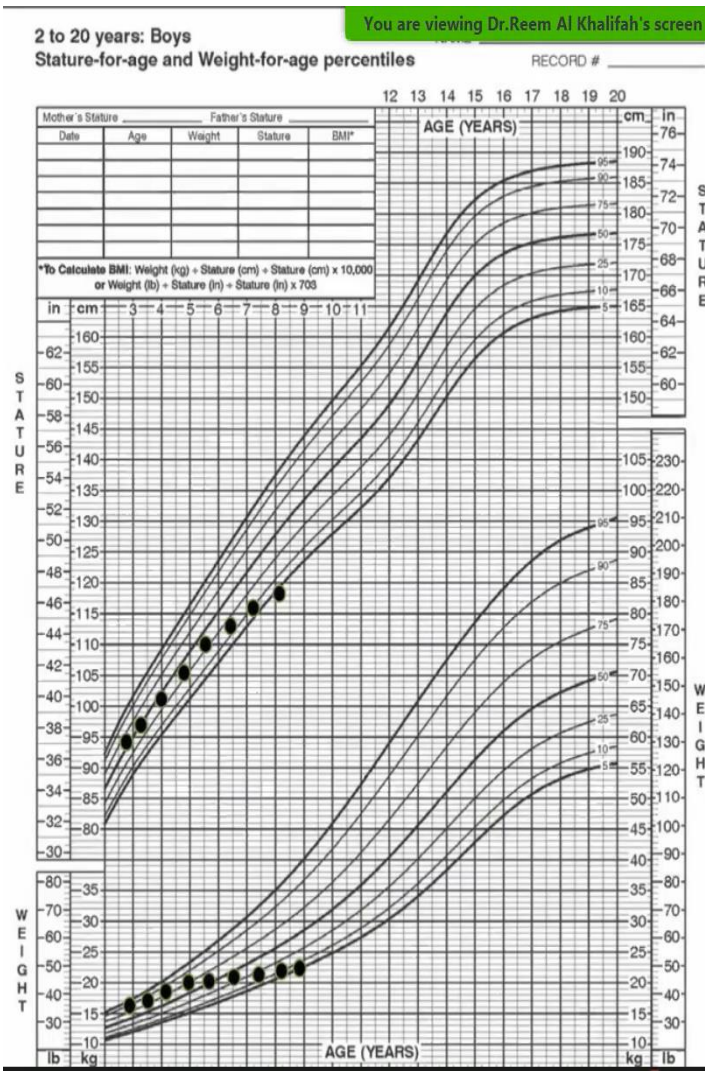
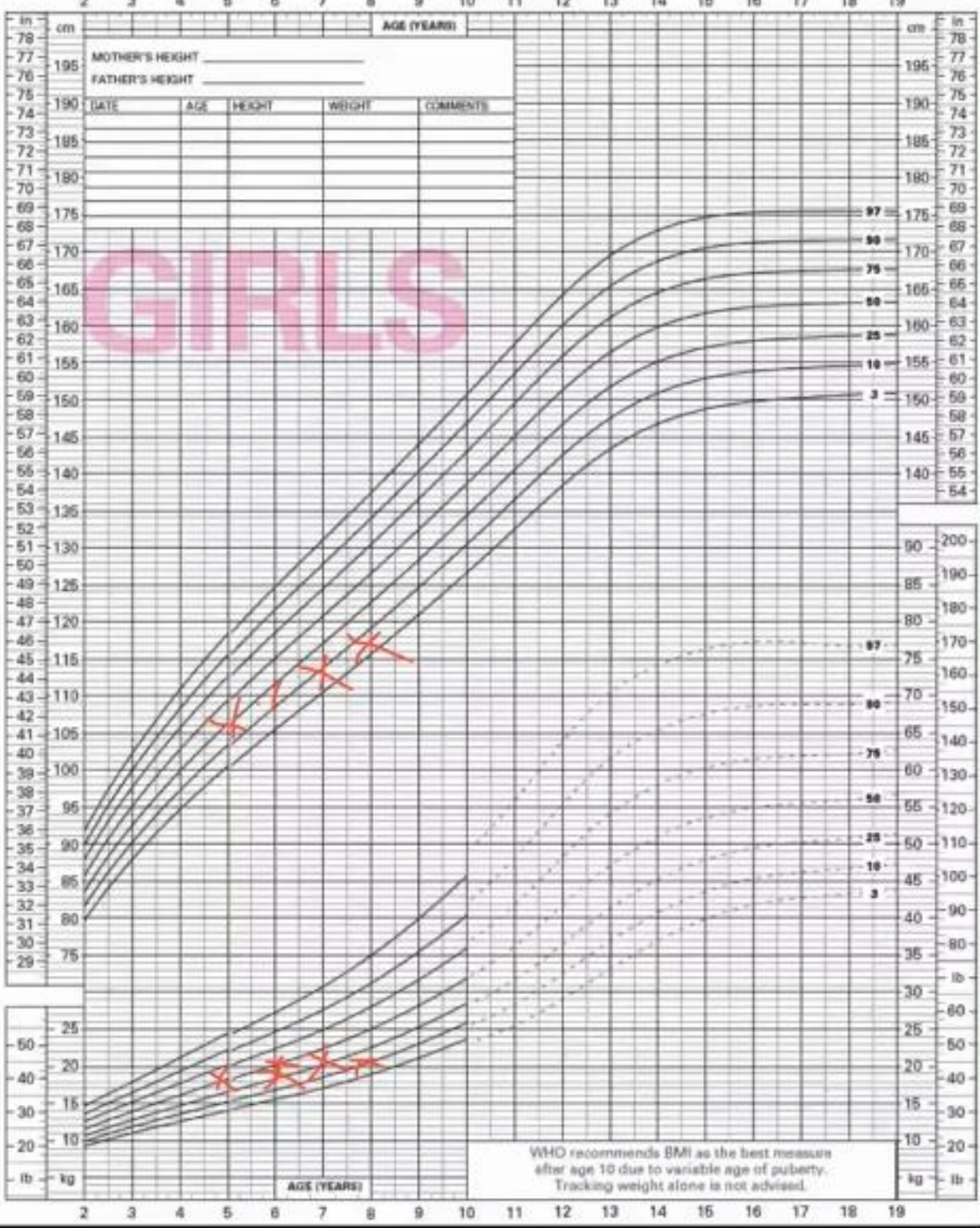
This is to treat delayed puberty only.

Regarding fertility when they become adult, they can receive fertility treatment.

## In summary

- Normal growth & puberty
- Short stature
- Precocious puberty
- Delayed puberty

# The correct answer



You are viewing Dr.Reem Al Khalifah's screen     View Options

Chronic illness under nutrition

- Weight affected more than height
- Celiac disease
- Malabsorption
- Cystic fibrosis
- Renal failure
- Crohn's disease



# Additional resources

- Pediatrics in review journal:
  - Approach to short stature
  - Delayed puberty
  - Precocious puberty
  - Assessment of obesity

# Questions

