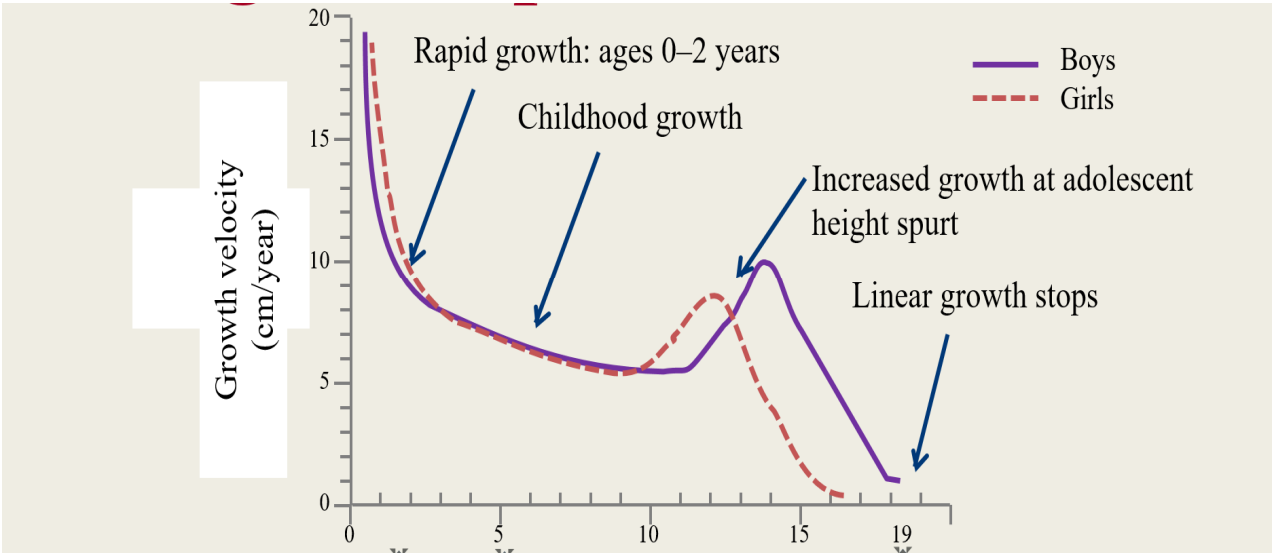

بسم الله النور

Postnatal Growth

- Infant (I)
- Childhood (C)
- Pubertal (P)



Linear growth

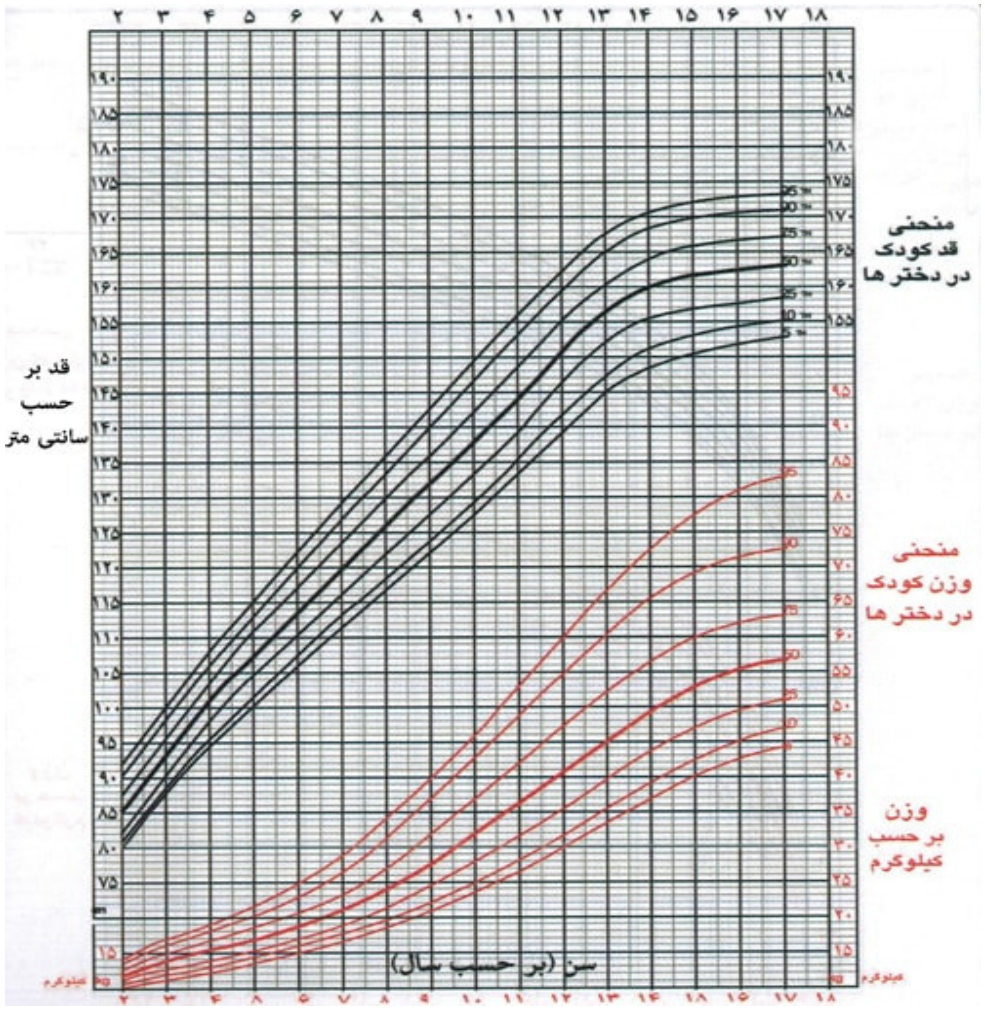
- 25 cm during the first year of life
- 10 cm between 12 and 24 months
- 7.5 – 10 cm between 24 and 48 months

Linear growth

- 5 cm/year between age four years and puberty.

In puberty

- Girls : 23 – 25 cm 9 cm /y
- Boys : 26 – 28 cm 10.3 cm/y
- After menarche : 1 - 7 cm


منحنی
قد کودک
در دختر ها
قد بر
حسب
سانتی متر
منحنی
وزن کودک
در دختر ها
وزن
بر حسب
کیلوگرم
سن (بر حسب سال)

سیر تغییرات قد

- .

- بین سن 18- 6 ماهگي منحني رشد کودکان تغییر مي کند .
- در سن دو سالگي کودکان به قد ژنتیکي خود میرسند .
- در سن ، 9- 2 سالگي منحني رشد کودکان ثابت است .

GROWTH'S REQUIREMENTS

Factors important for growth :

- Adequate nutrition
- Normal genetic constitution
- Absence of chronic illness
- Psychosocial wellbeing
- Sufficient hormone (growth hormone, thyroid hormone, cortisol , sex hormone


Evaluation of a child with short stature

Evaluation of the short stature

4

Medical History

Family and post medical history, birth history, past illness or chronic diseases, nutritional status, psychosocial and cognitive development

Physical Examination

Phenotypic, body proportion, pubertal staging, the timing of puberty in the parents and stature of first and second degree relatives, BMI

Genetic Test

Whether all short stature children should be tested?

Grimberg et al., 2016, Horm Res Paediatr, Guideline

Evaluation of a child with short stature

- Analysis of height velocity
- Interpretation of the child's growth in comparison of parental heights.
- Determination of bone age
- Estimation of adult height

Calculating height velocity

$$\text{HV(cm/year)} = \frac{\text{Present height} - \text{height 6-12 months previously}}{\text{Interval (months) between heights}} \times 12$$

Example

✓Boy

✓Age = 7 y

✓New height = 130

✓Height at 8 m ago = 125

✓HV = (130 -125) ÷ 8 × 12 = 7.5 Cm/ year

Height Velocity in cm/year

	MALES			FEMALES		
Age (years)	Minus 2SD	Minus 1SD	Mean	Minus 2SD	Minus 1SD	Mean
2.5	5.7	7.0	8.3	5.9	7.3	8.6
3	5.4	6.6	7.8	5.5	6.9	8.1
3.5	5.1	6.3	7.4	5.2	6.4	7.6
4	4.9	6.0	7.1	4.9	6.1	7.2
4.5	4.7	5.8	6.8	4.7	5.8	6.8
5	4.6	5.6	6.6	4.6	5.6	6.6
5.5	4.5	5.4	6.4	4.5	5.5	6.4
6	4.3	5.3	6.2	4.4	5.3	6.2
6.5	4.2	5.1	6.0	4.3	5.2	6.1
7	4.2	5.0	5.9	4.3	5.2	6.0
7.5	4.1	4.9	5.8	4.3	5.1	5.9
8	3.9	4.8	5.6	4.2	5.0	5.8
8.5	3.8	4.6	5.4	4.2	4.9	5.7
9	3.8	4.5	5.3	4.2	5.0	5.8
9.5	3.7	4.5	5.2	4.3	5.0	5.8
10	3.7	4.4	5.1	4.4	5.3	6.2
10.5	3.7	4.4	5.1	4.7	5.7	6.8
11	3.7	4.4	5.2	5.7	6.6	7.7
11.5	3.8	4.6	5.3	6.1	7.2	8.3
12	4.0	4.9	5.7	5.2	6.3	7.3
12.5	4.8	5.8	6.7	3.6	4.8	5.9
13	6.2	7.4	8.6	2.4	3.3	4.3
13.5	7.1	8.3	9.5	1.3	2.2	2.9
14	6.1	7.2	8.4	0.4	1.1	1.8
14.5	4.1	5.3	6.5	0.0	0.5	1.0
15	2.4	3.6	4.7			
15.5	1.2	2.3	3.3			
16	0.4	1.3	2.2			
16.5	0.1	0.7	1.5			
17	0.1	0.4	0.9			
17.5	0.1	0.1	0.5			

Who needs to be evaluated for short stature

- Predicted adult height **>1.5-2 SD below** the target height

- Decrease in height SD of more **than 0.5 SD** over past year in children over 2 years of age

Calculation of height standard deviation score

Example calculation:

A 9-year-old boy is 116 cm

Boy's age (years)	Mean	Standard deviation
8.0–8.49	128.62	5.76
8.5–8.99	131.58	5.93
9.0–9.49	134.71	6.22
9.5–9.99	136.91	6.51
10.0–10.49	139.59	7.67

Z - score

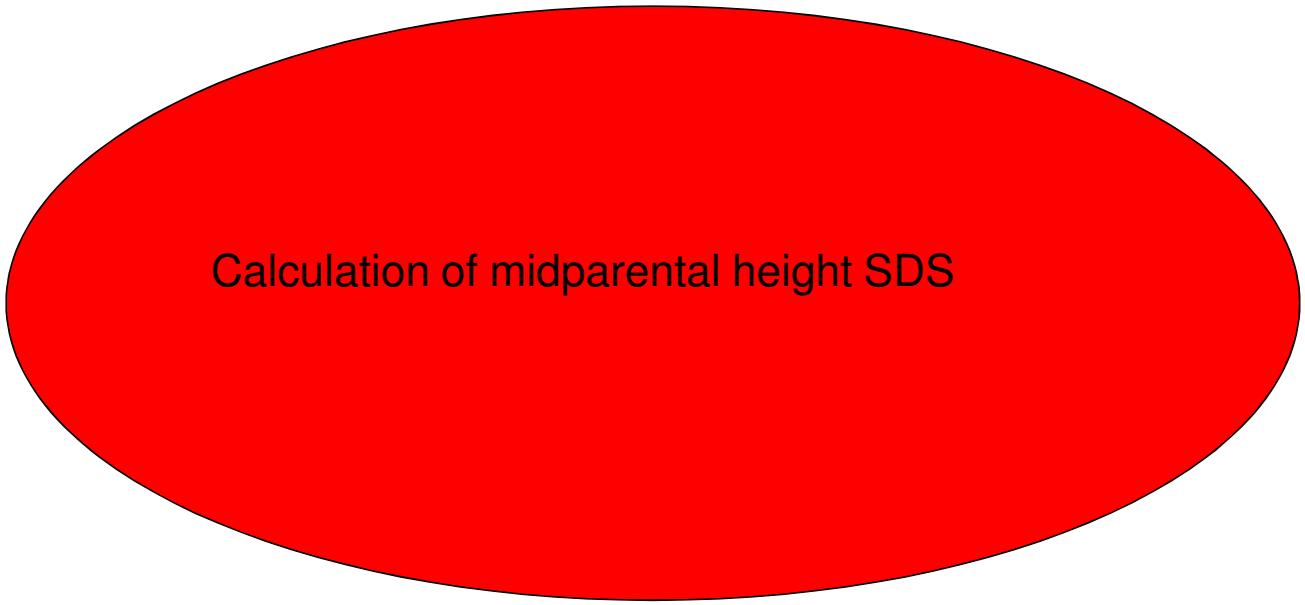
$$SDS = \frac{HT\ 50th - HT\ patient}{SD}$$

$$SD = \frac{HT\ 50th - HT5th}{2}$$

- Hpation 116
- Ht50th = 134.7
- HTth =122.2
- SD 134.7-122.2= **12.5**
- SD 12.5÷2=**6.22**
- SDS=134.7-116= 18
- SDS=18÷6= **-3**
- **As the boy's height SDS is –3 SDS**
- **He has short stature**

Age	Height	s.d.	Age	Height	s.d.	Age	Height	s.d.	Age	Height	s.d.
2.0	86.80	2.61	7.0	121.70	5.29	12.0	149.70	7.36	17.0	176.20	6.87
2.1	87.47	2.50	7.1	122.24	5.30	12.1	150.34	7.44	17.1	176.33	6.83
2.2	88.15	2.40	7.2	122.78	5.31	12.2	150.97	7.52	17.2	176.45	6.80
2.3	88.86	2.34	7.3	123.33	5.33	12.3	151.61	7.60	17.3	176.55	6.78
2.4	89.61	2.35	7.4	123.87	5.34	12.4	152.28	7.69	17.4	176.64	6.76
2.5	90.40	2.43	7.5	124.40	5.35	12.5	153.00	7.78	17.5	176.70	6.75
2.6	91.25	2.60	7.6	124.93	5.36	12.6	153.77	7.88	17.6	176.74	6.74
2.7	92.14	2.84	7.7	125.45	5.37	12.7	154.57	7.97	17.7	176.77	6.74
2.8	93.06	3.10	7.8	125.97	5.38	12.8	155.38	8.07	17.8	176.79	6.74
2.9	93.99	3.37	7.9	126.48	5.39	12.9	156.16	8.17	17.9	176.80	6.75
3.0	94.90	3.59	8.0	127.00	5.41	13.0	156.90	8.27	18.0	176.80	6.75
3.1	95.79	3.75	8.1	127.52	5.43	13.1	157.57	8.36			
3.2	96.65	3.86	8.2	128.04	5.45	13.2	158.18	8.45			
3.3	97.49	3.93	8.4	128.56	5.48	13.3	158.75	8.52			
3.4	98.30	3.97	8.4	129.08	5.50	13.4	159.32	8.58			
3.5	99.10	4.01	8.5	129.60	5.53	13.5	159.90	8.63			
3.6	99.88	4.06	8.6	130.12	5.56	13.6	160.51	8.66			
3.7	100.64	4.11	8.7	130.64	5.58	13.7	161.14	8.68			
3.8	101.40	4.17	8.8	131.16	5.60	13.8	161.79	8.69			
3.9	102.15	4.24	8.9	131.68	5.63	13.9	162.45	8.69			
4.0	102.90	4.32	9.0	132.20	5.65	14.0	163.10	8.69			
4.1	103.65	4.40	9.1	132.72	5.67	14.1	163.74	8.69			
4.2	104.41	4.48	9.2	133.23	5.70	14.2	164.38	8.68			
4.3	105.15	4.56	9.3	133.75	5.72	14.3	165.00	8.67			
4.4	105.89	4.63	9.4	134.27	5.75	14.4	165.60	8.65			
4.5	106.60	4.68	9.5	134.80	5.78	14.5	166.20	8.63			
4.6	107.29	4.72	9.6	135.33	5.81	14.6	166.78	8.60			
4.7	107.96	4.74	9.7	135.87	5.84	14.7	167.35	8.55			
4.8	108.61	4.76	9.8	136.41	5.88	14.8	167.91	8.51			
4.9	109.26	4.78	9.9	136.95	5.92	14.9	168.46	8.45			

- در صورتی که قد پدر 177 و قد مادر 150 سانتی متر باشد ایا باز هم نسبت به والدین کوتاه ست ؟


Calculation of midparental height SDS

Target height is calculated based on midparental height

- Target height is a term used for the expected height of a child given the heights of the parents[1]
- A commonly used formula for calculation of target height is:[2]

$$\text{Target (midparental) height (boys)} = \frac{(\text{father's height [cm]} + \text{mother's height [cm]})}{2} + 6.5\ \text{cm}$$

$$\text{Target (midparental) height (girls)} = \frac{(\text{father's height [cm]} + \text{mother's height [cm]})}{2} - 6.5\ \text{cm}$$

1. Barstow C *et al. American Family Physician* 2015:92:43–50. 2. Rogol & Hayden. *J Pediatr* 2014;164(5 Suppl):S1–14.

Target height is calculated based on midparental height

- Father's height 177cm
- Mothers height 150cm
- MPH = 177+150 ÷2 =163.5
- Mid parental target HT =163.5+6.5=170

Target height SDS

- MPHSDS=TH −mean Height for boys (20/y) ÷SD
- MPHSDS= 170 – 176 = -6
- MPHSDS = **-6** ÷ 6=-1

Calculation of midparental height SDS

✓Mean height reference for maximum age (adult height)

✓Standard deviation reference for maximum age (adult height)

	Mean height	SD
Male	176	6
Female	164	6.5

Does growth of a child correspond to the genetic potential?

Calculate the difference between the height SDS of the child and the midparental height SDS

Example of calculation:

Height SDS of the child: –3 SDS
Midparental height SDS: –1 SDS
Difference: –2 SDS

As the height SDS is more than 1.5 -2 SDS below the midparental height SDS, he is short for his genetic potential

- **corresponding to ~10 cmdifference in adult height**

- MPH SDS - HTSDS >1.5

Who needs to be evaluated for short stature

- Predicted adult height **>1.5 SD below** the target height
- Decrease in height SD of more **than 0.5 SD** over past year in children over 2 years of age
- Height-for-age curve has deviated downwards across **two major height** percentile curves

Clinical Rounds in Endocrinology 2016

Up to date 2017

Diagnostic approach

What are the investigations required for evaluation of a short child

- Complete blood count
- Creatinine
- urine analysis
- Bicarbonate
- Calcium, phosphorous, alkaline phosphatase

What are the investigations required for evaluation of a short child

- SGOT, SGPT, albumin
- TSH, T 4
- Celiac
- Karyotype
- Hand X ray (Bone age for PAH), rickets, dysplasia

Diagnostic approach

- Insulin-like growth factor I (IGF-I)
- Insulin-like growth factor binding protein 3 (IGFBP-3)
- Abnormal results of IGF-I and/or IGFBP-3 levels should be confirmed by provocative GH testing

Who needs to be evaluated for short stature?

- Age two to four years: HV less than **5.5 cm**/year
- Age four to six years: HV less than **5 cm/year**

Age six years to puberty

- HV less than 4 cm/year for boys
- HV less than 4.5 cm/year for girls

Poor Height Velocity

Up to date 2017

Case 1

- پسر 10 ساله ای با شکایت کوتاهی قد به کلینیک غدد مراجعه کرده است .
- در شرح حال اخذ شده مورد مثبتی ندارد .
- کلیه معاینات طبیعی است . بلوغ در مرحله 1 تانر می باشد .
- قد = 125 سانتی متر (کمتر از صدک 5)
- وزن = 22 کیلوگرم می باشد . (کمتر از صدک 5)
- قد پدر = 165 سانتی متر
- قد مادر = 152 سانتی متر
- . چه اقداماتی انجام می دهید ؟

Z - score

$$SDS = \frac{\text{HT 50th} - \text{Child's HT}}{SD}$$

$$SD = \frac{\text{HT 50th} - \text{HT5th}}{2}$$

Height SDS

$$\text{SDS} = \frac{(\text{observed height} - \text{mean height for age and sex})}{\text{SD for that age and sex.}}$$

Case 1

- برای پسران 10 سال H 125
- قد صدک 50 = 140 cm قد صدک 5 = 130 cm
- SD = (Height 50 th – Height 5 th) ÷ 2
- SDS = (Patient Height – Height 50 th) ÷ SD
- (140 – 130) ÷2 = 5 **SD** ⟶
- SDS = (125 – 140) ÷ 5 = **- 3 SDS**

- SDS = - 2 NL variation & Follow up
- SDS = -2 - -3 Screen (step 1)
- SDS > -3 Endocrine test , genetic , ….

Target height is calculated based on midparental height

- Father's height 165cm
- Mothers height 152cm
- MPH = 165+152 ÷2 =158.5
- Mid parental target HT =158.5+6.5=165

Target height SDS

- MPHSDS=TH −mean Height for boys (20/y) ÷SD
- MPHSDS= 165 – 176 = -11
- MPHSDS = **-11** ÷ 6=-1.8

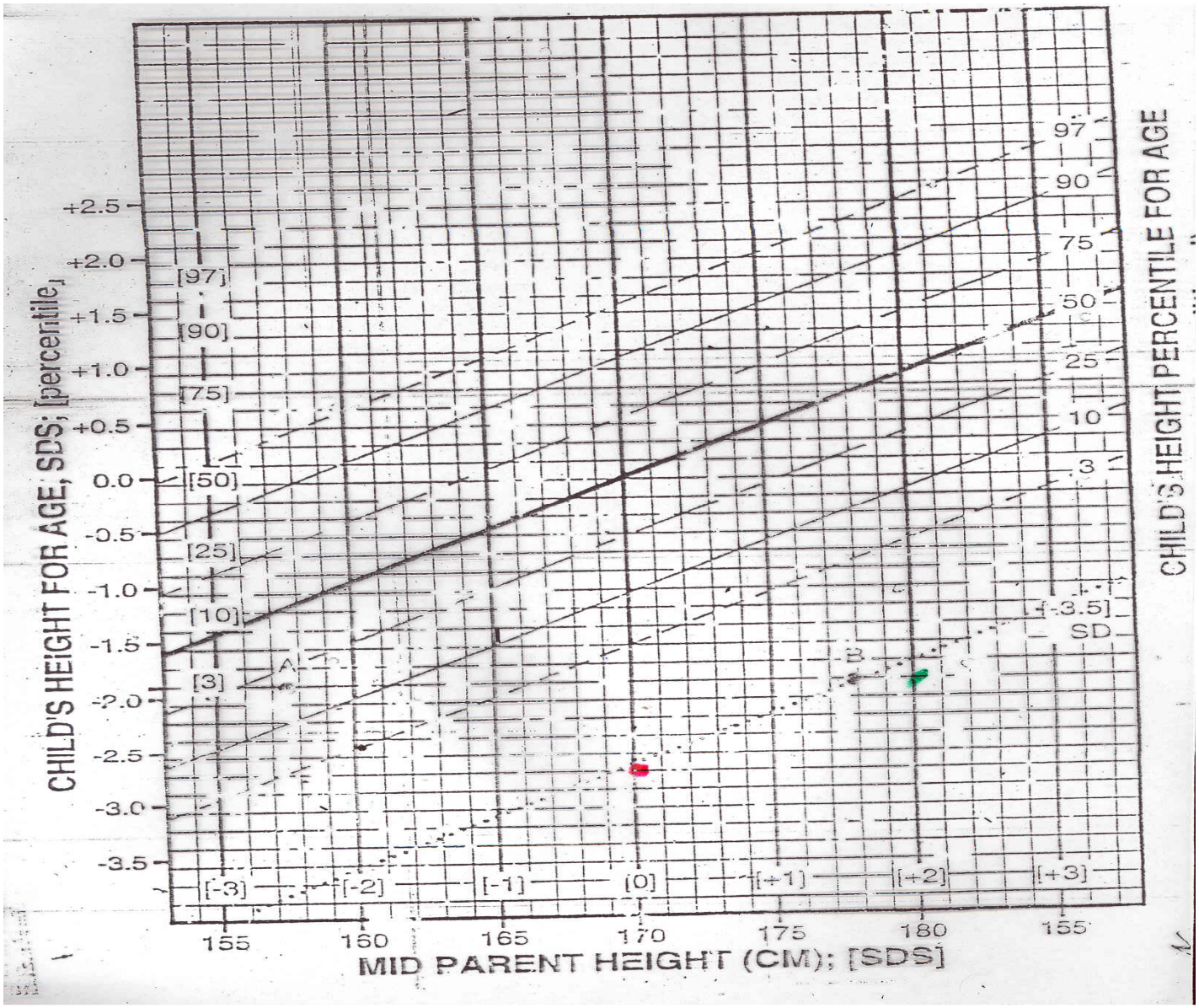
Calculation of midparental height SDS

✓Mean height reference for maximum age (adult height)

✓Standard deviation reference for maximum age (adult height)

	Mean height	SD
Male	176	6
Female	164	6.5

- MPH SDS - HTSDS >1.5
- -1.8 – (-3) =1.2


CHILD'S HEIGHT FOR AGE; SDS; [percentile]
+2.5
+2.0
+1.5
+1.0
+0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
[97]
[90]
[75]
[50]
[25]
[10]
[3]
[-3]
[-2]
[-1]
[0]
[+1]
[+2]
[+3]
[-3.5]
SD
A
B
155
160
165
170
175
180
155
MID PARENT HEIGHT (CM); [SDS]
CHILD'S HEIGHT PERCENTILE FOR AGE
97
90
75
50
25
10
3

Case 1

Our case : SDS = -3

Screen (step 1)

- CBC/diff
- ESR
- BUN , Cr
- U/A
- IGF-1
- IGFBP3
- TFT
- Anti TTG
- Kidney Sonography
- Bone Age

Case 1

- در بیمار ما کلیه آزمایشات طبیعی بود ..
- سن استخوانی = سن تقویمی
- چه تصمیمی می گیرید ؟

Case 2

- 1- دختر بچه 6 ساله ای به علت کوتاهی قد مراجعه کرده است . قد وی 103Cm است . با توجه به جدول زیرکه قد کودک 6 ساله در صدکهای مختلف را نشان میدهد ، به سوالات پاسخ دهید .

age	5th	10th	25th	50th	75th	90th	95th
6	106	108	111	115	118	121	123

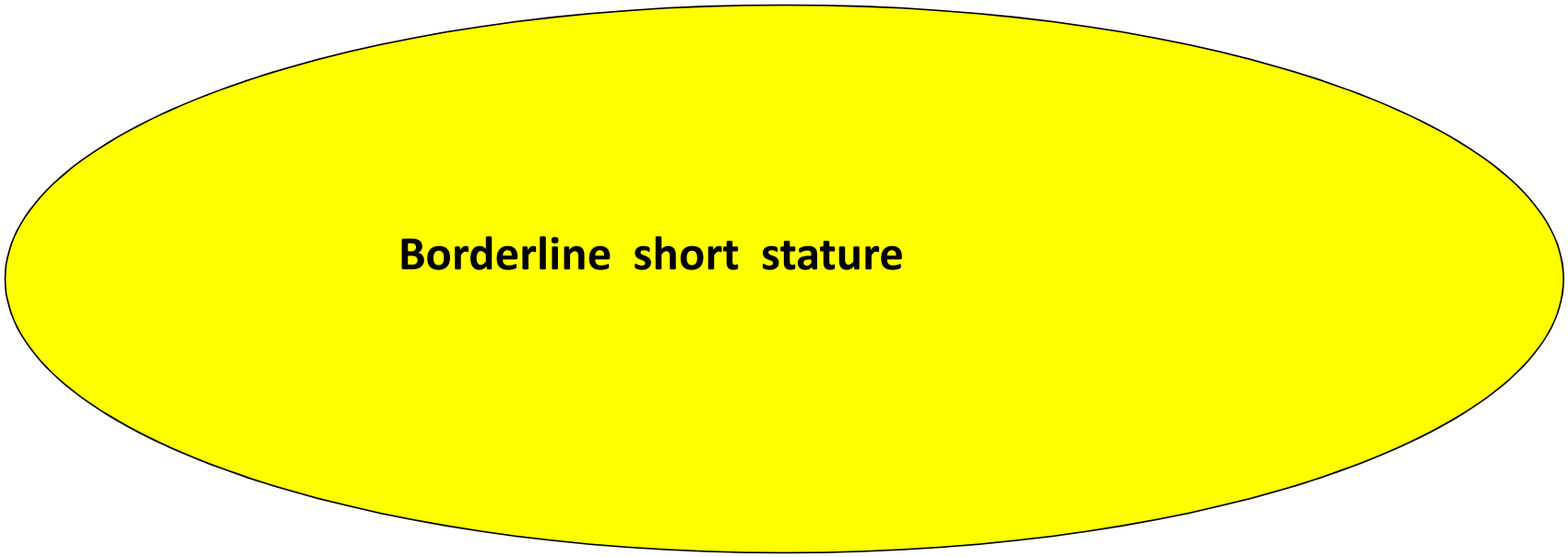
Case 2

- الف) SDS قد کودک چقدر است ؟
- برای کوتاه قدی وی چه می کنید ؟
- :

Case 2

- Ht50 th =115
- HT5th =106
- SD 115-106=9
- SD 9÷2= 4.5
- SDS=115-103=12
- SDS=12÷4.5= -2.6

Diagnosis?



- در صورتیکه قد پدر وی 180 سانتی متر و قد مادرش 165 سانتی متر باشد آیا کوتاهی قد برای وی مطرح است؟ آیا بررسی برای وی لازم است؟

Is the child's growth within the range for the family?

- Difference between the height SDS of the child and the midparental height SDS
- As the child's height SDS is *more than 1.5-2 SDS* below the midparental height SDS, he is short for his genetic potential

- 165+180 =345
- 345 ÷ 2 = 172.5
- Taget MPH : 172.5-6.5 = **166**

Calculation of midparental height SDS

✓Mean height reference for maximum age (adult height)

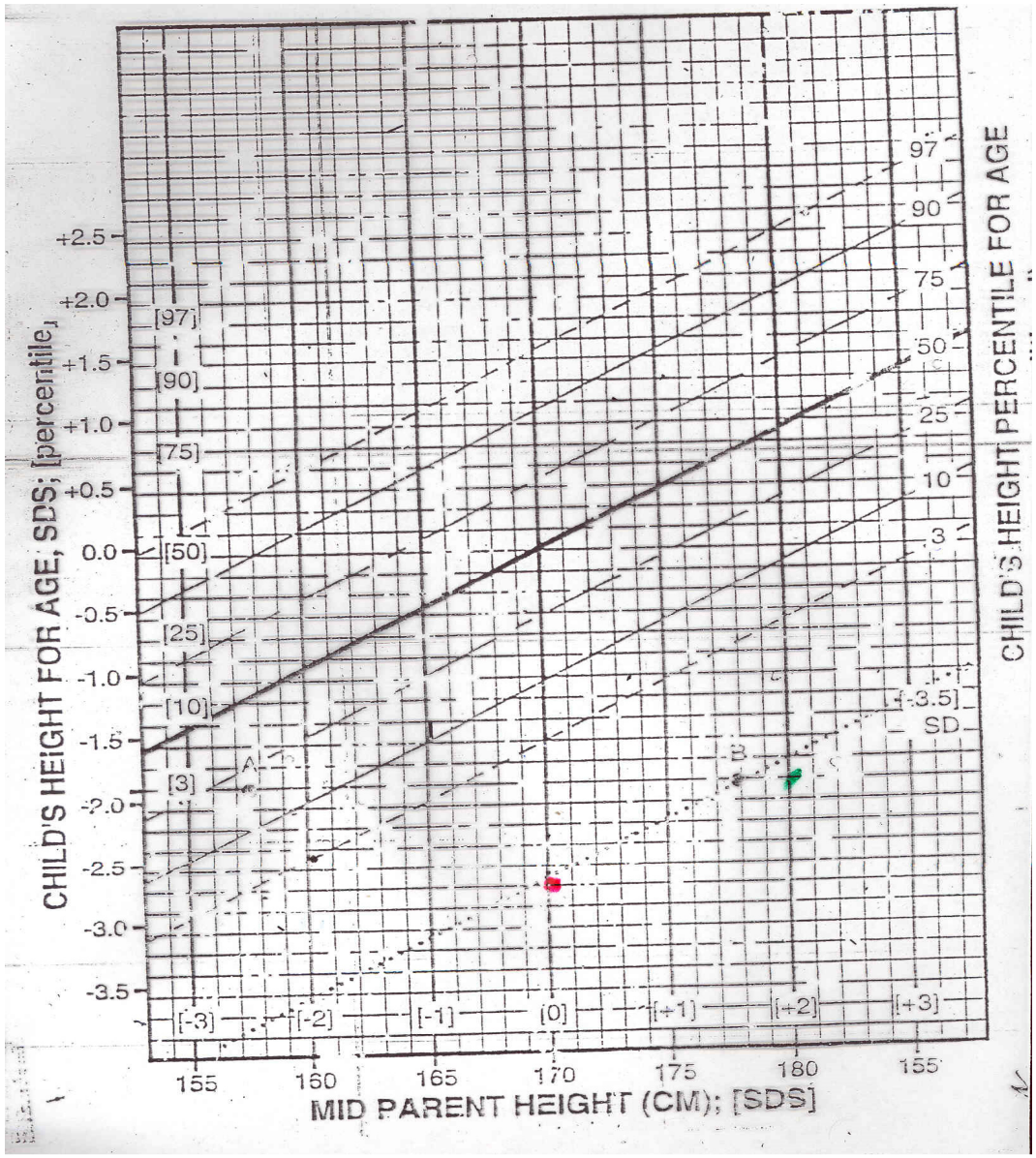
✓Standard deviation reference for maximum age (adult height)

	Mean height	SD
Male	176	6
Female	164	6.5

- **MPH Taget height** SDS (MPH SDS) = Mid parental target HT– **mean height** ÷ 6.5

- 166-164 = 2
- 2 ÷ 6.5 = **+ 0.3**

- MPH SDS - HTSDS
- +0.3 –(- 2.6) = **2.9**


CHILD'S HEIGHT FOR AGE; SDS; [percentile]
+2.5
+2.0
+1.5
+1.0
+0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
[97]
[90]
[75]
[50]
[25]
[10]
[3]
[-3]
[-2]
[-1]
[0]
[+1]
[+2]
[+3]
155
160
165
170
175
180
155
MID PARENT HEIGHT (CM); [SDS]
CHILD'S HEIGHT PERCENTILE FOR AGE
97
90
75
50
25
10
3
[-3.5]
SD
A
B

Case5

- بیمار در سن 11 سالگی مجددا به ما مراجعه می کند . بلوغ در مرحله 1 تانر می باشد .
- قد = 130 cm (کمتر از صدک 5)
- وزن = 24 kg (کمتر از صدک 5)
- Bone age = 10.5 y
- یک سال بعد قد 136cm دارد
- چه اقدامی لازم است ؟

Case5

- با توجه به سرعت رشد خوب نیاز به اقدام خاصی ندارد .
- تشخیص شما چیست ؟

Case5

- سرعت رشد طبیعی
- سن استخوانی متناسب با سن تقویمی
- والدین کوتاه قد

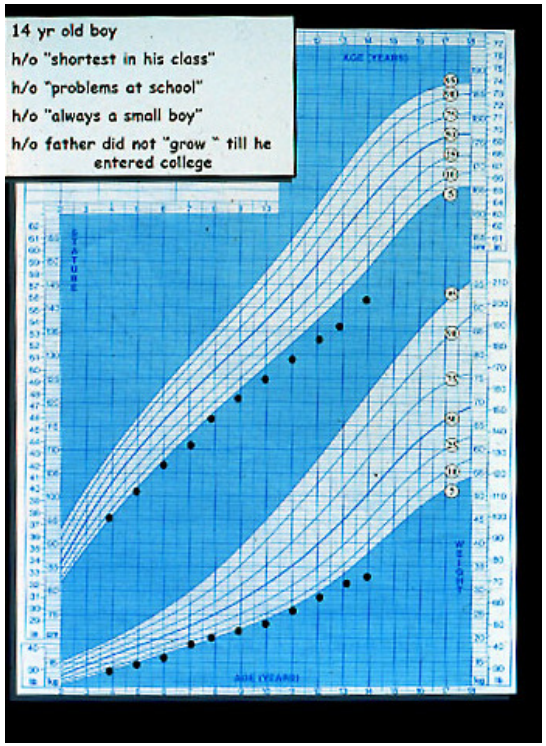
❖کوتاهی قد فامیلیال

Case6

- پسر 14 و نیم ساله به علت کوتاهی قد ارجاع شده است . او عنوان می کند کوچکترین دانش آموز کلاس است .
- در معاینه بلوغ در مرحله 1 تانر می باشد .
- سایر معاینات طبیعی است .
- پدر می گوید در سال های اول دبیرستان او هم کوتاه قد بوده است . در حال حاضر قد پدروی 172 سانتی متر می باشد .

Case 2

- نمودار رشد وی اینگونه می باشد :



Case 2

- سن استخوانی وی حدود 11 سال گزارش شده است .
- کلیه آزمایشات طبیعی است . آزمایشات بلوغ (prepubertal)
- تشخیص و اقدام مناسب چیست ؟

Case6

- تاخیر بلوغ
- سرعت رشد طبیعی
- سن استخوانی کمتر از سن تقویمی
- تاخیر بلوغ در پدر
- کوتاهی قد سرشتی
- پیگیری بیمار


Constitutional delay of growth and puberty

Prediction of Adult Stature: Fraction of Adult Height Attained at Each Bone Age

Bone Age (year-month)	Girls			Boys		
	Delayed	Average*	Advanced	Delayed	Average*	Advanced
6-0	0.733	0.720		0.680		
6-3	0.742	0.729		0.690		
6-6	0.751	0.738		0.700		
6-9	0.763	0.751		0.709		
7-0	0.770	0.757	0.712	0.718	0.695	0.670
7-3	0.779	0.765	0.722	0.728	0.702	0.676
7-6	0.788	0.772	0.732	0.738	0.709	0.683
7-9	0.797	0.782	0.742	0.747	0.716	0.689
8-0	0.804	0.790	0.750	0.756	0.723	0.696
8-3	0.813	0.801	0.760	0.765	0.731	0.703
8-6	0.823	0.810	0.771	0.773	0.739	0.709
8-9	0.836	0.821	0.784	0.779	0.746	0.715
9-0	0.841	0.827	0.790	0.786	0.752	0.720
9-3	0.851	0.836	0.800	0.794	0.761	0.728
9-6	0.858	0.844	0.809	0.800	0.769	0.734
9-9	0.866	0.853	0.819	0.807	0.777	0.741
10-0	0.874	0.862	0.828	0.812	0.784	0.747
10-3	0.884	0.874	0.841	0.816	0.791	0.753
10-6	0.896	0.884	0.856	0.819	0.795	0.758
10-9	0.907	0.896	0.870	0.821	0.800	0.763
11-0	0.918	0.906	0.883	0.823	0.804	0.767
11-3	0.922	0.910	0.887	0.827	0.812	0.776
11-6	0.926	0.914	0.891	0.832	0.818	0.786
11-9	0.929	0.918	0.897	0.839	0.827	0.800
12-0	0.932	0.922	0.901	0.845	0.834	0.809
12-3	0.942	0.932	0.913	0.852	0.843	0.818
12-6	0.949	0.941	0.924	0.860	0.853	0.828
12-9	0.957	0.950	0.935	0.869	0.863	0.839
13-0	0.964	0.958	0.945	0.880	0.876	0.850
13-3	0.971	0.967	0.955		0.890	0.863
13-6	0.977	0.974	0.963		0.902	0.875
13-9	0.981	0.978	0.968		0.914	0.890
14-0	0.983	0.980	0.972		0.927	0.905
14-3	0.986	0.983	0.977		0.938	0.918
14-6	0.989	0.986	0.980		0.948	0.930
14-9	0.992	0.988	0.983		0.958	0.943
15-0	0.994	0.990	0.986		0.968	0.958
15-3	0.995	0.991	0.988		0.973	0.967
15-6	0.996	0.993	0.990		0.976	0.971
15-9	0.997	0.994	0.992		0.980	0.976
16-0	0.998	0.996	0.993		0.982	0.980
16-3	0.999	0.996	0.994		0.985	0.983
16-6	0.999	0.997	0.995		0.987	0.985
16-9	0.9995	0.998	0.997		0.989	0.988
17-0	1.00	0.999	0.998		0.991	0.990
17-3					0.993	
17-6		0.9995	0.9995		0.994	
17-9					0.995	
18-0		1.00			0.996	
18-3					0.998	
18-6					1.00	

predicted adult height

- **Bayley-Pinneau**

- 133 ÷0.812 =163.8

Estimation of adult height

- Projected height(PH) :
- ✓Extrapolating the child's growth along the current channel to the 18- to 20-year mark .
- ✓If the child's BA is delayed or advanced, the PH should be plotted based on the BA rather than the CA.

Up to date 2016

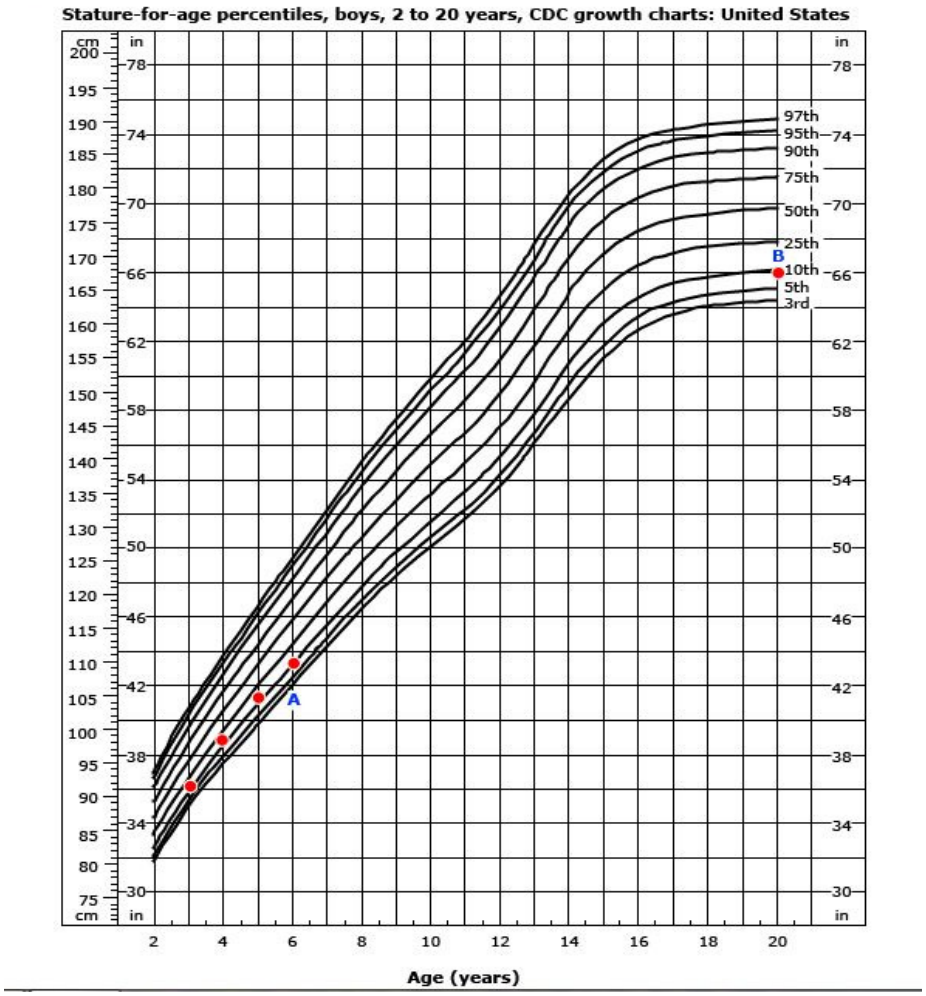
Example :

Male , 6 Y , BA = 6 Y

H = 110 Cm (10 th)

PAH = …. 168 Cm

Estimated projected height using current growth channel



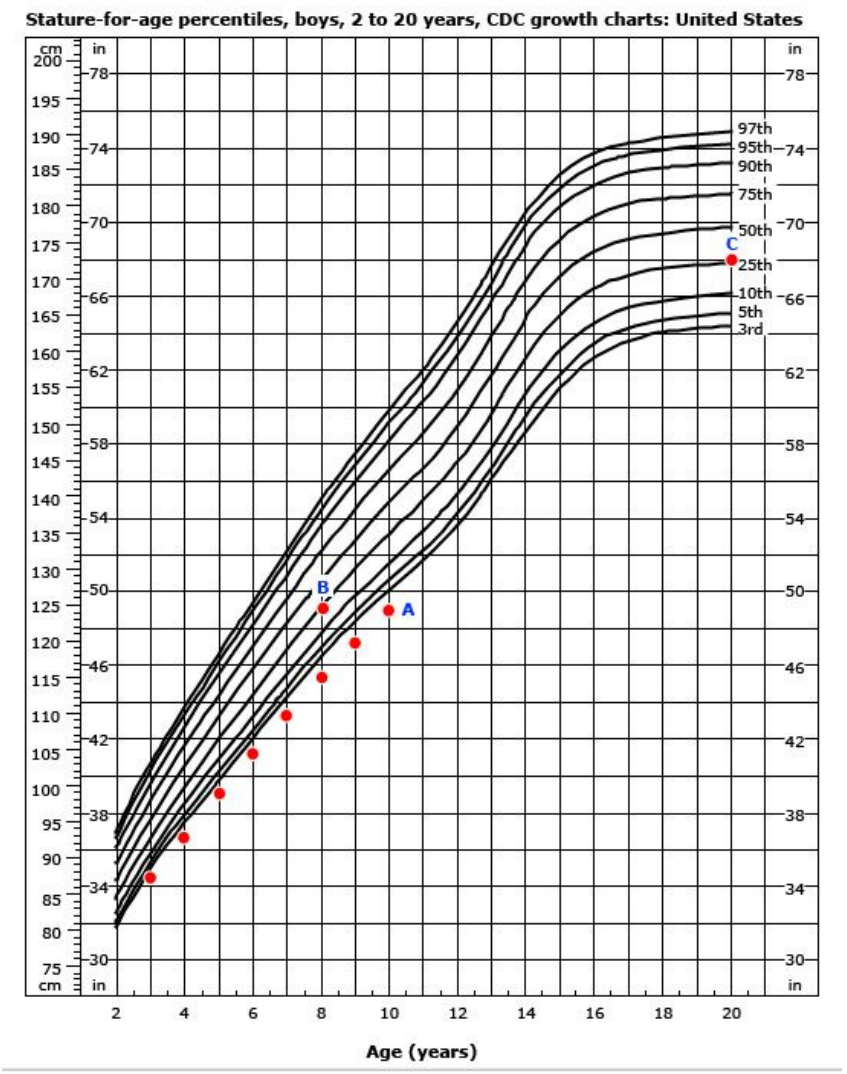
Example :

Male , 10 Y , BA = 8 Y

H = 123 (< 3 th point A)
BA …… (25 th point B)

PAH = ……. 172 Cm

Estimating projected height using skeletal age



Example :

Female

CA = 10 Y

BA = 7 Y

H = 120 Cm

PAH = ?

120 / 0.77 = 155.8

	Fraction of Adult Height Attained at Each Bone Age					
	Girls			Boys		
Bone Age (yr-mo)	Retarded	Average	Advanced	Retarded	Average	Advanced
6-0	0.733	0.720		0.680		
6-3	0.742	0.729		0.690		
6-6	0.751	0.738		0.700		
6-9	0.763	0.751		0.709		
7-0	0.770	0.757	0.712	0.718	0.695	0.670
7-3	0.779	0.765	0.722	0.728	0.702	0.676
7-6	0.788	0.772	0.732	0.738	0.709	0.683
7-9	0.797	0.782	0.742	0.747	0.716	0.689
8-0	0.804	0.790	0.750	0.756	0.723	0.696
8-3	0.813	0.801	0.760	0.765	0.731	0.703
8-6	0.823	0.810	0.771	0.773	0.739	0.709
8-9	0.836	0.821	0.784	0.779	0.746	0.715