سحيّات في طب الأطفال

النمو والبلوغ

Prof. Abdul Muttaleb Alsah (Ph.D, MBBCH, MA, AMRCPCH)

Senior Consultant Paediatrician/Neonatologist

Member of The Genetics Society of America

Member of The European Society for Human Genetics

Member of The International Society for Low Vision Research and Rehabilitation

كل الوسائط مسموحة:
تسجيل .. تصوير .. نسخ .. نقل الخ

ملامح النمو والبلوغ هي:

- النمو عنصر رئيس في صحة الطفل ويجب أخذه في الحسبان عند مشاهدة الأطفال.
- يجب مراقبة نمو جميع الأطفال بانتظام خصوصاً في الأشهر الأولى من الحياة ويجب تسجيله ضمن مخطط النمو في المعلومات الشخصية للوالدين والسجل الصحي للطفل.
- يجب معرفة النمو الطبيعي وتطور البلوغ لملاحظة أي انحراف عن المسار الطبيعي.
- نحتاج لتقييم (استقصاء) إضافي في حال انحراف النمو عن المخطط المتوقع أو انحراف التسلسل الطبيعي لتطور البلوغ.

النمو الطبيعي

هناك أربع مراحل للنمو الطبيعي للإنسان (الشكل ١٢-١).

المرحلة الجنينية

أربع مراحل

- الجنينية
- الرضع
- الطفولة
- قفزة النمو والبلوغ

- **Fetal**
- This is the fastest period of growth, accounting for about 30% of eventual height. Size at birth is determined by the size of the mother and by placental nutrient supply, which in turn modulates fetal growth factors [insulin-like growth factor 2 (IGF-2), human placental lactogen, and insulin]. Optimal placental nutrient supply is dependent on an adequate maternal diet.

- **Fetal**
- Size at birth is largely independent of the father's height and of growth hormone (GH). Severe intrauterine growth restriction and extreme prematurity when accompanied by poor postnatal growth can result in permanent short stature. Paradoxically, low birth weight increases the later metabolic risk of childhood obesity.

Infantile phase

- Growth during infancy to around 18 months of age is also largely dependent on adequate nutrition. Good health and normal thyroid function are also necessary. This phase is characterized by a rapid but decelerating growth rate, and accounts for about 15% of eventual height.

Infantile phase

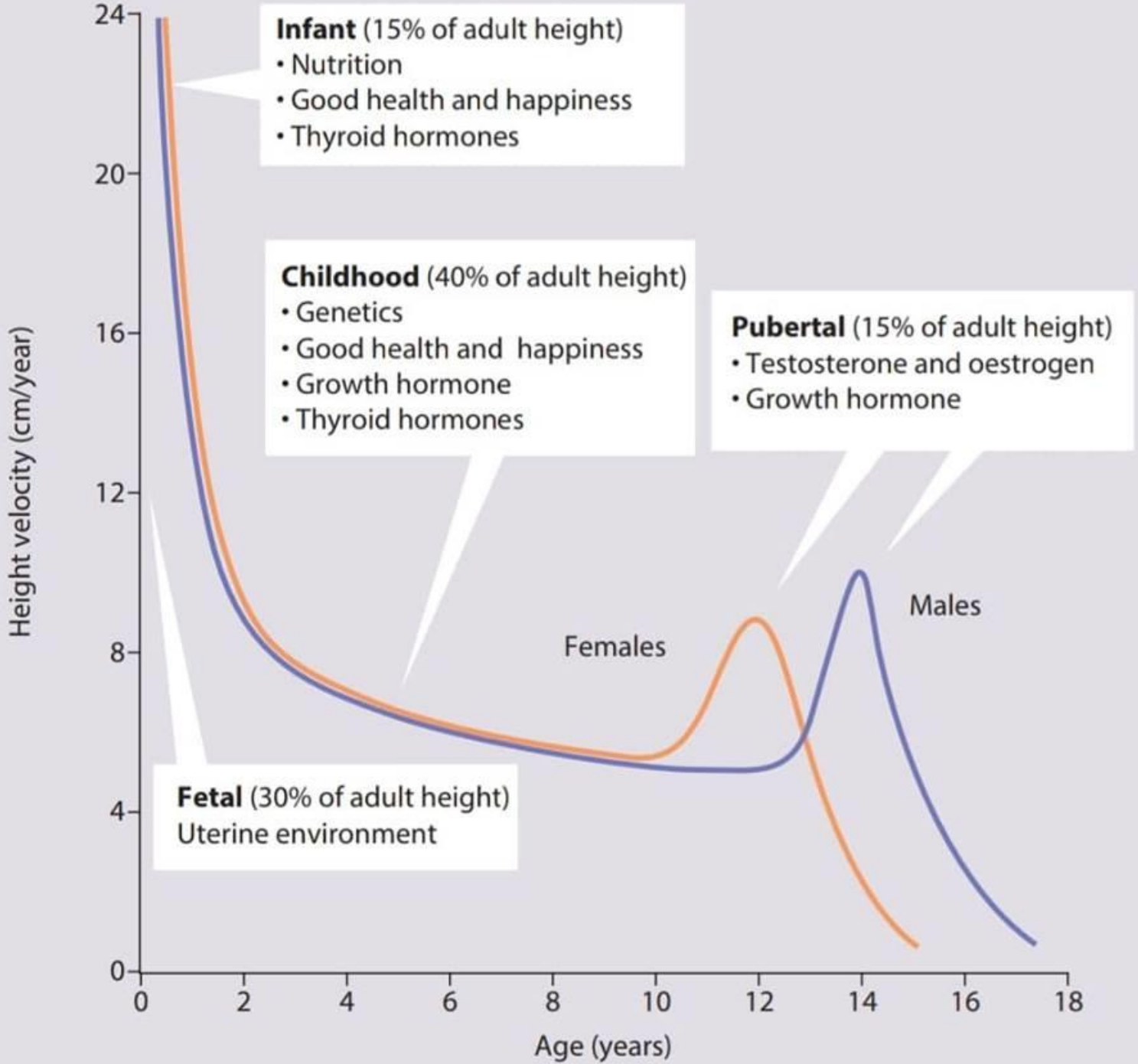
- By the end of this phase, children have changed from their fetal length, largely determined by the uterine environment, to their genetically determined height. An inadequate rate of weight gain during this period is called ‘faltering growth’ .

Childhood phase

- This is a slow, steady but prolonged period of growth that contributes 40% of final height. Pituitary GH secretion acting to produce IGF-1 at the epiphyses is the main determinant of a child's rate of growth, provided there is adequate nutrition and good health. Thyroid hormone, vitamin D, and steroids also affect cartilage cell division and bone formation. Profound chronic unhappiness can decrease GH secretion and accounts for psychosocial short stature.

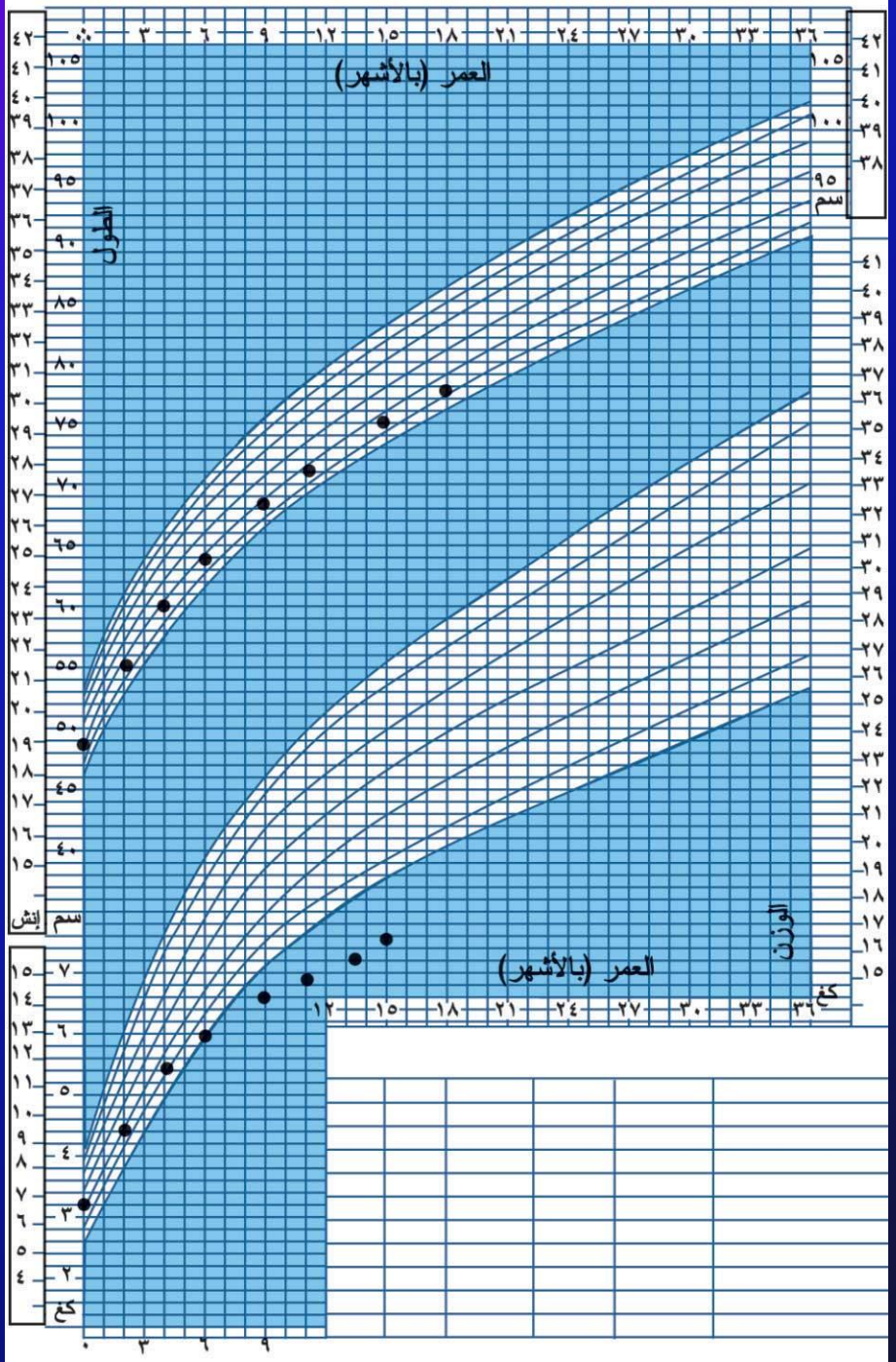
Pubertal growth spurt

- Sex hormones, mainly testosterone and oestradiol, cause the back to lengthen and boost GH secretion. This adds 15% to final height. The same sex steroids cause fusion of the epiphyseal growth plates and a cessation of growth. If puberty is early, which is not uncommon in girls, the final height is reduced because of early fusion of the epiphyses.


Infant (15% of adult height)
• Nutrition
• Good health and happiness
• Thyroid hormones
Childhood (40% of adult height)
• Genetics
• Good health and happiness
• Growth hormone
• Thyroid hormones
Pubertal (15% of adult height)
• Testosterone and oestrogen
• Growth hormone
Fetal (30% of adult height)
Uterine environment
Females
Males
Height velocity (cm/year)
Age (years)
0
4
8
12
16
20
24
0
2
4
6
8
10
12
14
16
18

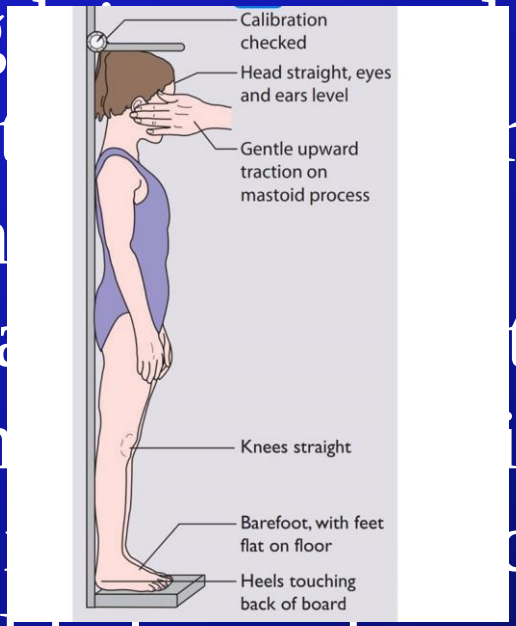
Measurement

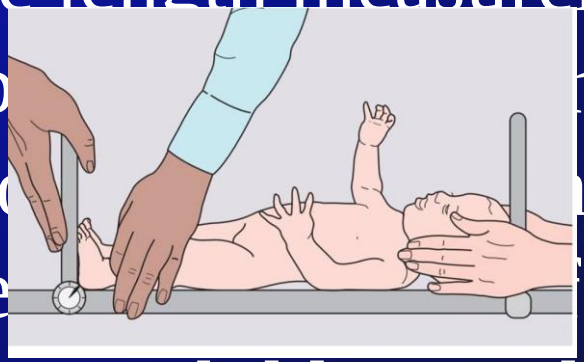
- Growth must be measured accurately, with attention to correct technique and accurate plotting of the data:
- • weight – readily and accurately determined with electronic scales but must be performed on a naked infant or a child dressed only in underclothing as an entire month's or year's weight gain can be represented by a wet nappy or heavy jeans, respectively


العمر (بالأشهر)
الطول
سم
إنش
العمر (بالأشهر)
الوزن
كغ

Measurement

- Height – the equipment must be regularly calibrated and maintained. In children over 2 years of age, the standing height is measured. In children under 2 years, leng lying horizontally , using the parent rate length measurement in infants can ob need to be held stra ts g held still. For th ine length in infancy d from child surveillance, but it should always be performed whenever there is doubt about an infant's growth

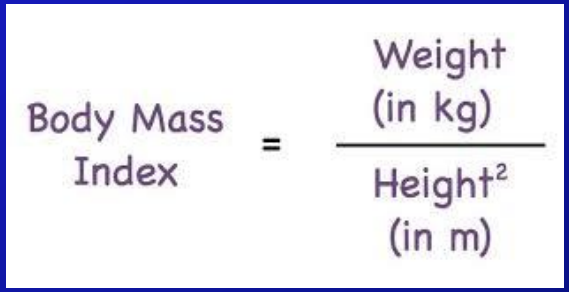




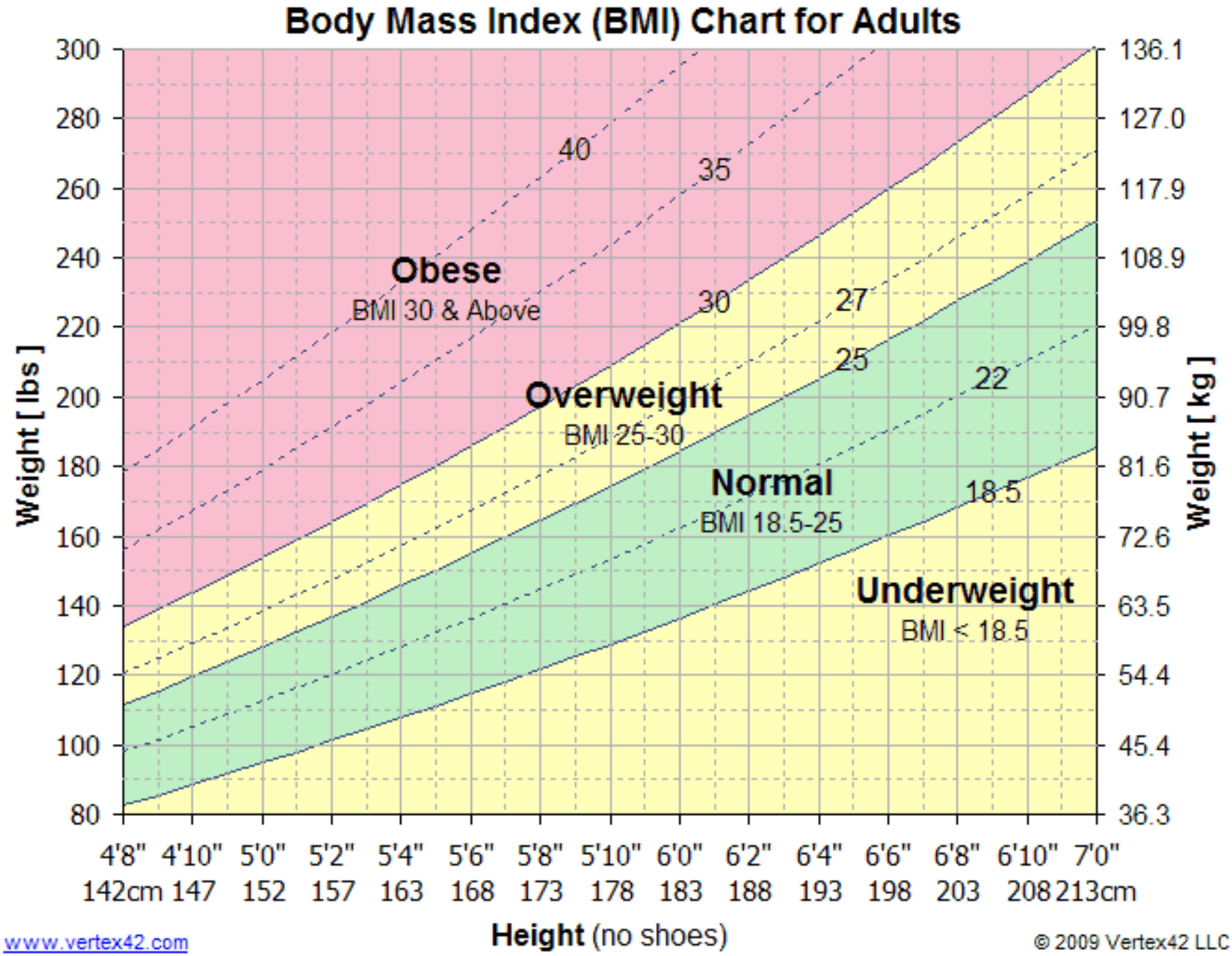
Measurement

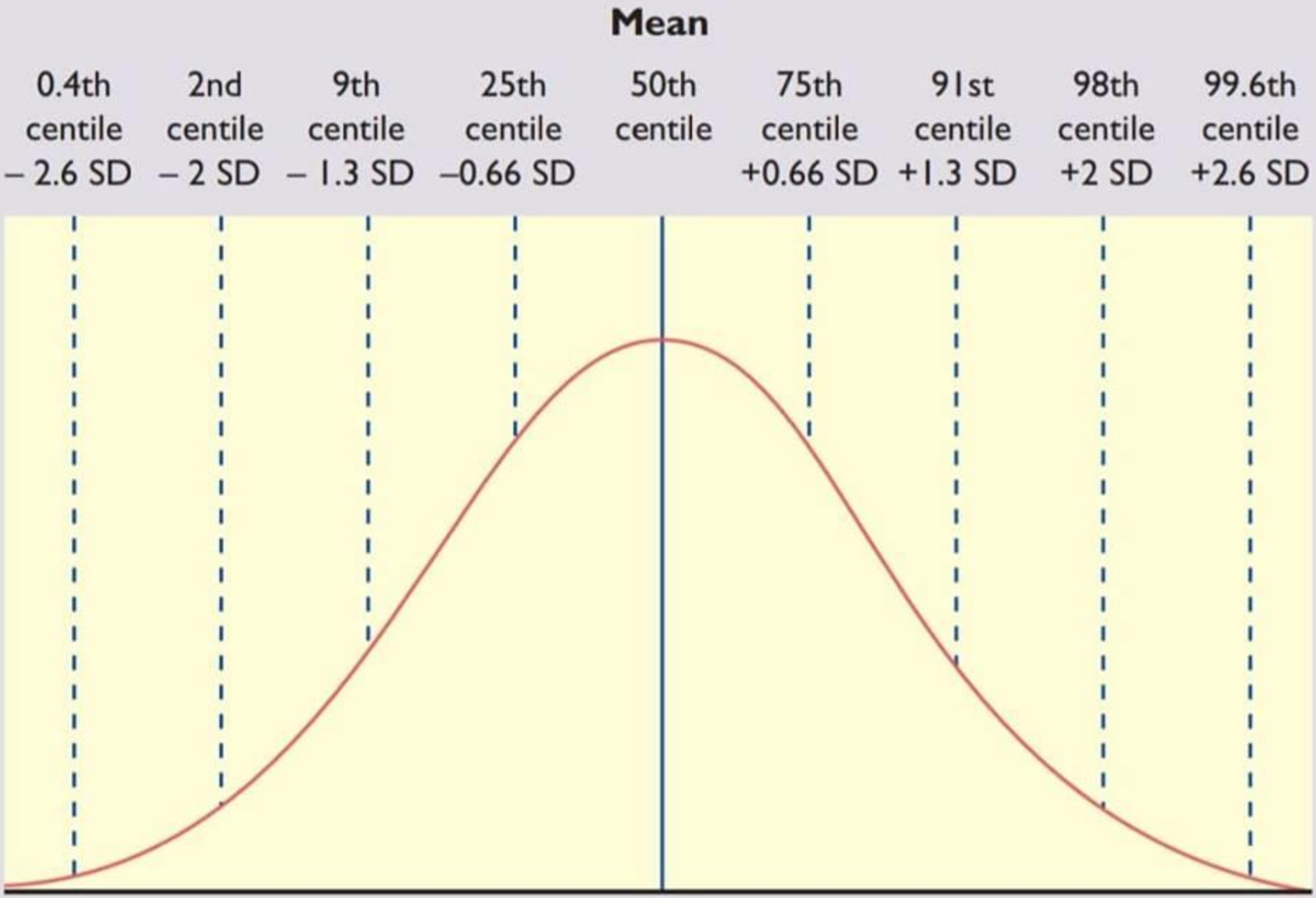
- • Head circumference – the occipitofrontal circumference is a measure of head and hence brain growth. Plot the maximum of three measurements. It is of particular importance in developmental delay or suspected hydrocephalus.

Measurement



- • Body mass index – calculate this using height in square metres/weight in kilogram and plot on a gender-specific body mass index centile chart to assess underweight or obese children. These measurements should be plotted as a simple dot on an appropriate growth centile chart. Standards for a population should be constructed and updated every generation to allow for the trend towards earlier puberty and taller adult stature from improved childhood nutrition.


Body Mass Index (BMI) Chart for Adults
Weight [lbs]
Weight [kg]
300
280
260
240
220
200
180
160
140
120
100
80
136.1
127.0
117.9
108.9
99.8
90.7
81.6
72.6
63.5
54.4
45.4
36.3
40
35
30
27
25
22
18.5
Obese
BMI 30 & Above
Overweight
BMI 25-30
Normal
BMI 18.5-25
Underweight
BMI < 18.5
4'8" 4'10" 5'0" 5'2" 5'4" 5'6" 5'8" 5'10" 6'0" 6'2" 6'4" 6'6" 6'8" 6'10" 7'0"
142cm 147 152 157 163 168 173 178 183 188 193 198 203 208 213cm
Height (no shoes)
www.vertex42.com
© 2009 Vertex42 LLC


Mean
0.4th centile – 2.6 SD
2nd centile – 2 SD
9th centile – 1.3 SD
25th centile –0.66 SD
50th centile
75th centile +0.66 SD
91st centile +1.3 SD
98th centile +2 SD
99.6th centile +2.6 SD

Measurement

- Height in a population is normally distributed and the deviation from the mean can be measured as a centile or standard deviation . The bands on the growth reference charts have been chosen to be two-thirds of an SD apart and correspond approximately to the 25th, 9th, 2nd, and 0.4th centiles below the mean, and the 75th, 91st, 98th, and 99.6th centiles above the mean. The further these centiles lie from the mean, the more likely it is that a child has a pathological cause for his/her short or tall stature.

Measurement

- For instance, values below the 0.4th or above the 99.6th centile will occur by chance in only 4 per 1000 children and can be used as a criterion for referral from primary to specialist care. A single growth parameter should not be assessed in isolation from the other growth parameters, e.g. a child's low weight may be in proportion to the height if short, but abnormal if tall. Serial measurements are used to show the pattern and determine the rate of growth.

Measurement

- This is helpful in diagnosing or monitoring many paediatric conditions. The child's growth should be assessed in the context of his/her family size. Heights from both biological parents should be used to calculate midparental height and the child's target range.

مقاييس اسرته. يجب أن يستعمل طول الوالدين لحساب
الطول الوالدي الوسطي والمجال المناسب للطفل.

الخلاصة

قياس الأطفال:

- يجب القياس بدقة من أجل مراقبة دقيقة للنمو.
- يجب وضع معايير النمو على المخططات.
- الشذوذات الأساسية للطول هي:

  قياسات تحت الخط المئوي ٠,٤ أو فوق ٩٩,٦ أو خارج معدل الطول الوسطي للوالدين.

  في حال التناقض الواضح مع الوزن.

  سلسة قياسات والتي تتقاطع مع خطوط النمو بعد عمر سنة.

- نمط النمو وهو معلومة مهمة في سياق تقييم صحة الطفل،مع الأخذ في الحسبان الوراثة، التغذية، الصحة العامة، والهرمونات كسبب محتمل لشذوذ النمو.

الوزن

- ولادة
- 4
- سنة
- ٦ سنوات

- 3.2
- 6
- 10
- 20

الطول

- ولادة
- 1
- 4
- ٦ سنوات

- 50
- 75
- 102
- 112

محيط الجمجمة

- 35
- 47

- ولادة
- 1

Puberty

- Puberty follows a well-defined sequence of changes that may be assigned stages, as shown in Figs 12.5 and 12.6. Over the last 20 years, the mean age at which puberty starts in girls has lowered. However, the age at which menarche occurs has remained stable. Therefore, females now remain in puberty for longer.

Puberty

- In females the features of puberty are:
- • breast development – a palpable breast disc is the first sign, usually starting between 8.5 and 12.5 years
- • pubic hair growth and rapid height growth – occur almost immediately after breast development

Puberty

- menarche – occurs on average 2.5 years after the start of puberty and signals that growth is coming to an end, with only around 5-cm height gain remaining.

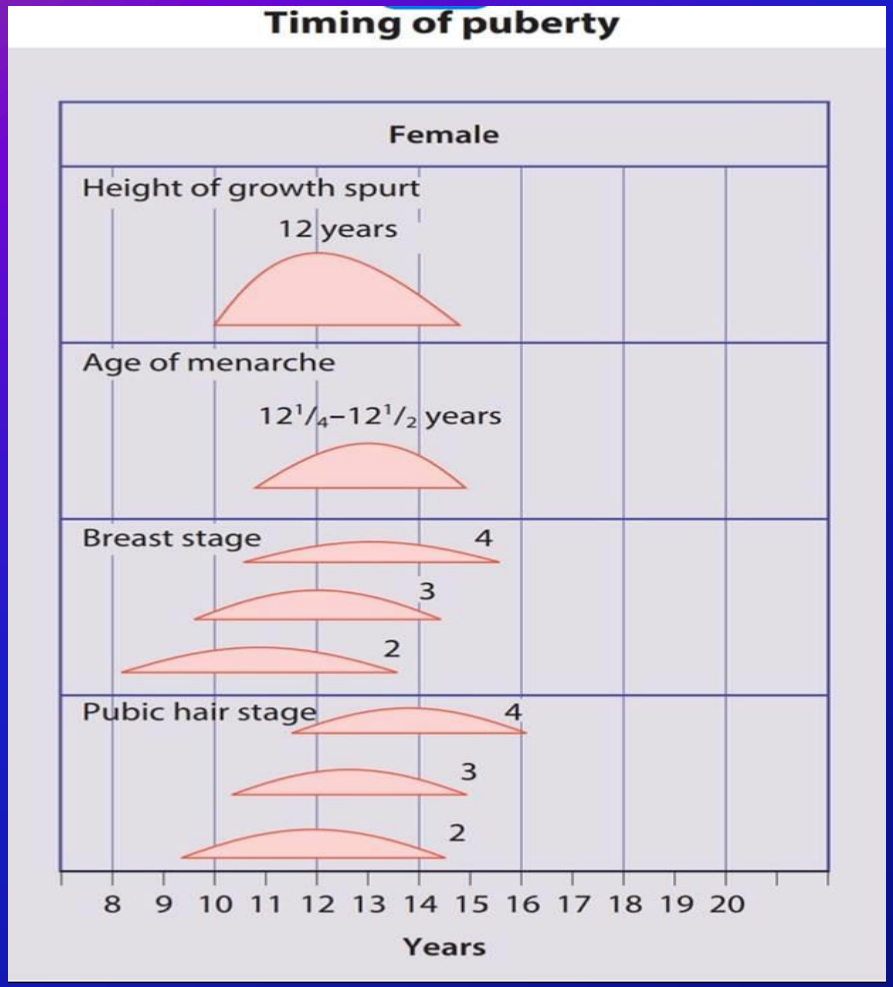
Puberty

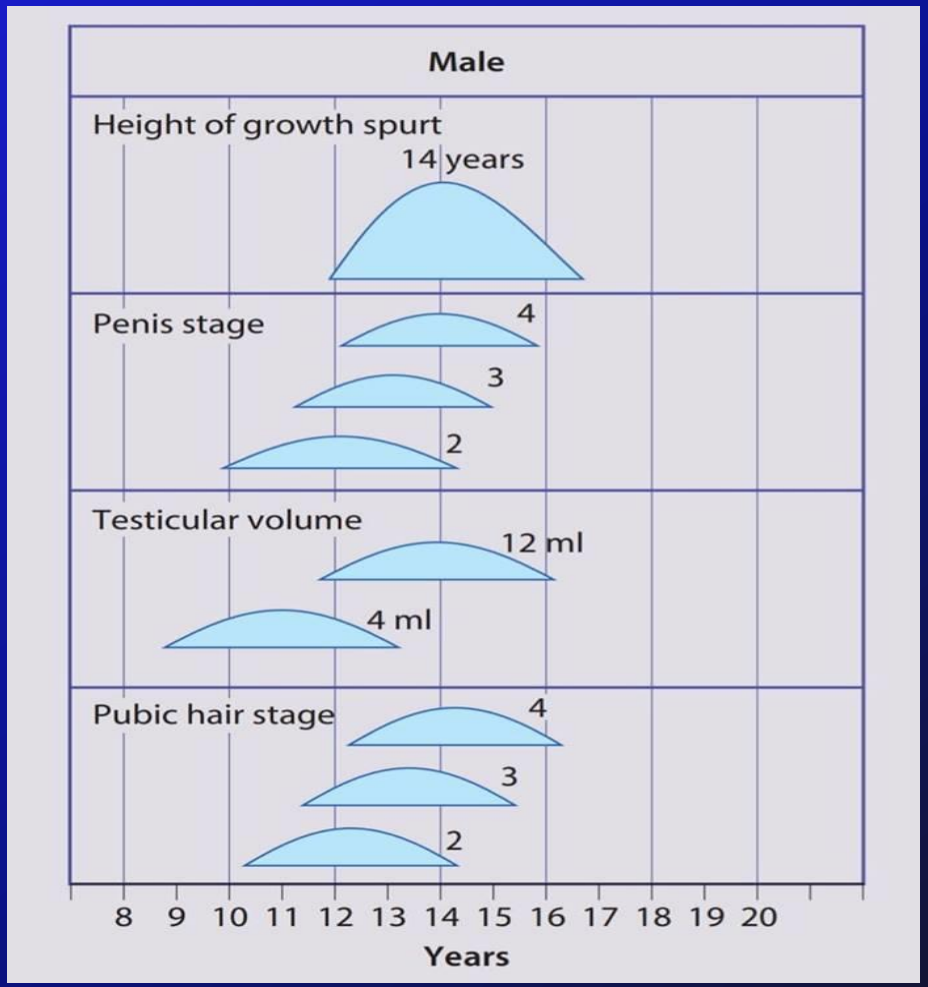
- In males:
- • testicular enlargement to over 4-mL volume measured using an orchidometer– the first clinical sign of puberty
- • pubic hair growth – follows testicular enlargement, usually between 10-years and 14-years of age
-

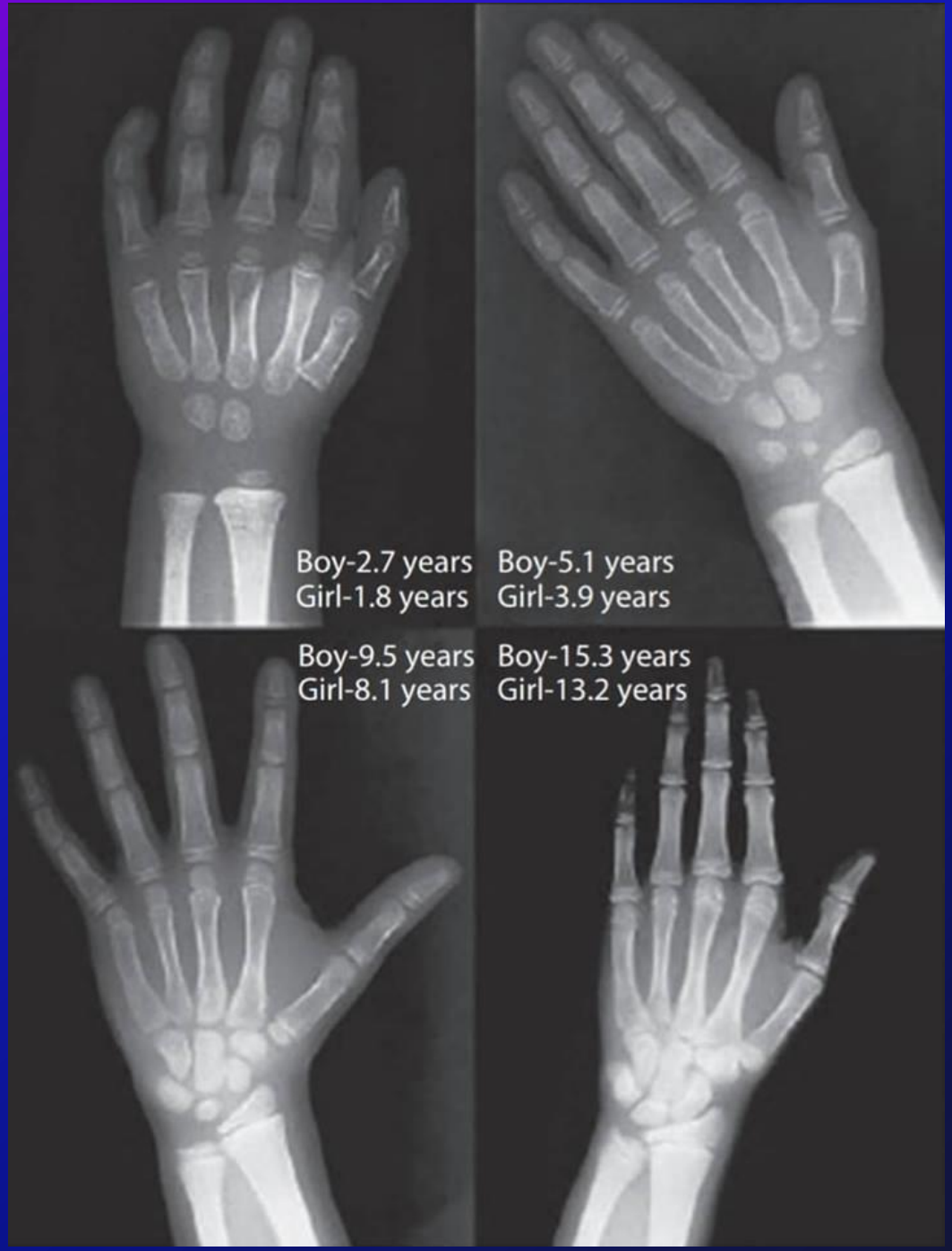
Puberty

- In males:
- • rapid height growth – when the testicular volume is 12 mL to 15 mL, after a delay of around 18 months
- • The growth spurt in males occurs later and is of greater magnitude than in females, accounting for the greater final average height of males than females.


12
15
20
25
1
2
3
4
5
6
8
10


Timing of puberty
Female
Height of growth spurt
12 years
Age of menarche
12¼–12½ years
Breast stage
4
3
2
Pubic hair stage
4
3
2
8 9 10 11 12 13 14 15 16 17 18 19 20
Years


Male
Height of growth spurt
14 years
Penis stage
4
3
2
Testicular volume
12 ml
4 ml
Pubic hair stage
4
3
2
8 9 10 11 12 13 14 15 16 17 18 19 20
Years


Boy-2.7 years
Girl-1.8 years
Boy-5.1 years
Girl-3.9 years
Boy-9.5 years
Girl-8.1 years
Boy-15.3 years
Girl-13.2 years

اضطرابات في

الخلاصة

البلوغ

- أول إشارة إلى بلوغ الأنثى هو برعم ثدي ملموس وعند الذكر تكون أول شارة هي حجم خصية أكبر من ٤ مل.
- تحدث عند الإناث ذروة الطول بعد فترة قصيرة من تطور الثدي وعند الذكور بعد ١٨شهراً من أول إشارات البلوغ.

قصر القامة

يعرف قصر القامة بأنه الطول تحت الخط المئوي الثاني (انحرافان معياريان تحت المتوسط. إن ١ من أصل ٥٠-سيكونون طبيعيين (أي معظم هؤلاء الأطفال) رغم أنهم قصيرو القامة ومن والدين قصيرين. على كل حال كلما كان الطفل أخفض عن هذه الخطوط المئوية كلما زاد

أسري

أغلب الأطفال
ضمن المجال المت

ومع ذلك يجب تق
وراثي لدى الطفل

التأخر البنيو

وهو تباين النمو
سنوات المراهقة

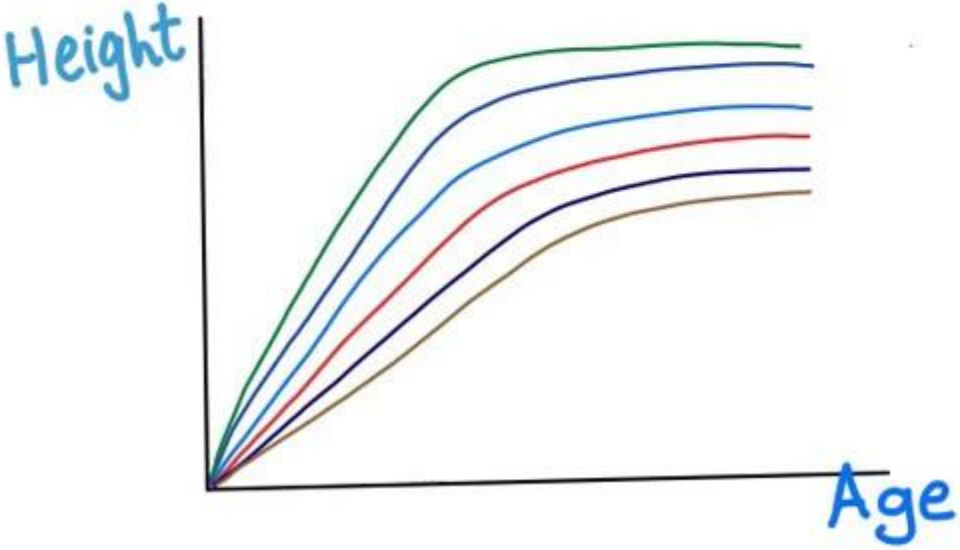
يكون النموضمن
ويتأخر العمر
الجنسية الثانوية

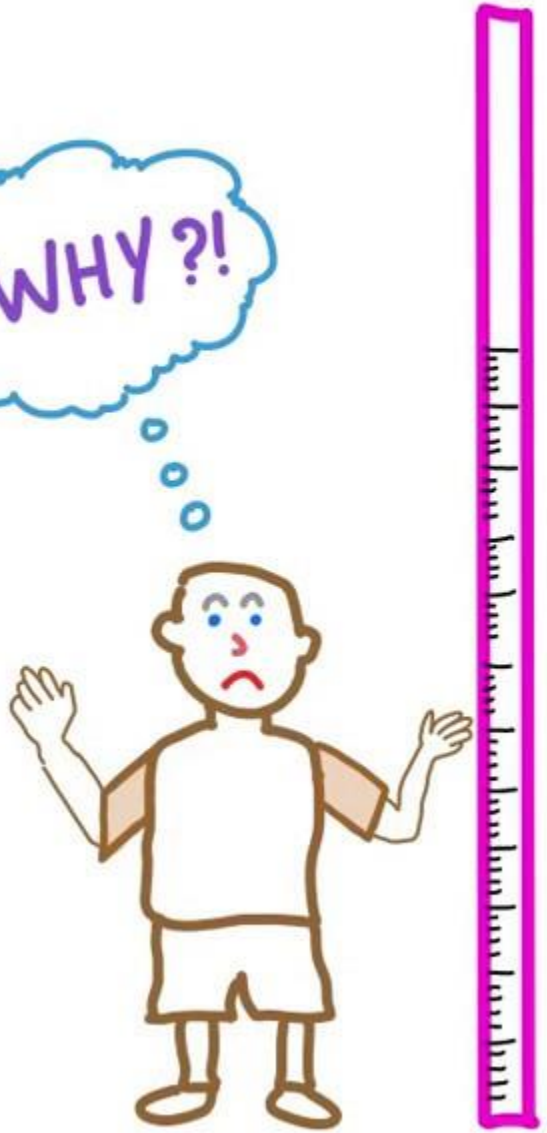
عادة ماتكون هنا
طول طبيعي عند

الخداج الشدي

نحو ١٠ ٪ من الا

SHORT STATURE





Short stature

Short stature is usually defined as a height below the second centile (i.e. 2 SDs below the mean). Most of these 1 in 50 children will be normal, though short, with short parents. However, the further the child is below these centiles, the more likely it is that there will be a pathological cause. Only 1 in 250 (4 in 1000) children are shorter than the 0.4th centile (–2.6 SD) and these should be assessed for a cause. However, the rate of growth may be abnormal a long time prior to the child's height being below these values. This growth failure can be identified from the child's height falling across centile lines plotted on a height velocity chart (Fig. 12.1). This allows growth failure to be identified whilst the child's height is still above the 2nd centile.

Measuring height velocity is a sensitive indicator of growth failure. Two *accurate* measurements at least 6 months but preferably a year apart allow calculation of height velocity in cm/year (Fig. 12.1). This is plotted at the midpoint in time on a height velocity chart. A disadvantage of using height velocity calculations is that they are highly dependent on the accuracy of the height measurements and so tend not to be used outside specialist growth clinics.

The height centile of a child must be compared with the weight centile and an estimate of his/her genetic expected height calculated from the height of his/her parents. This is calculated as the mean of the father's and mother's height with 7 cm added for the midparental target height of a boy, and 7 cm subtracted for a girl. The 9th to 91st centile range of this estimate is given by ±10 cm in a boy and ±8.5 cm in a girl (see Fig. 12.9a).

140
135
130
125
120
115
110
105

Most short children are psychologically well adjusted to their size. However, there may be problems from being teased or bullied at school, poor self-esteem, and they are likely to be at a considerable disadvantage in most competitive sport. They are also assumed by adults to be younger than their true age and may be treated inappropriately.

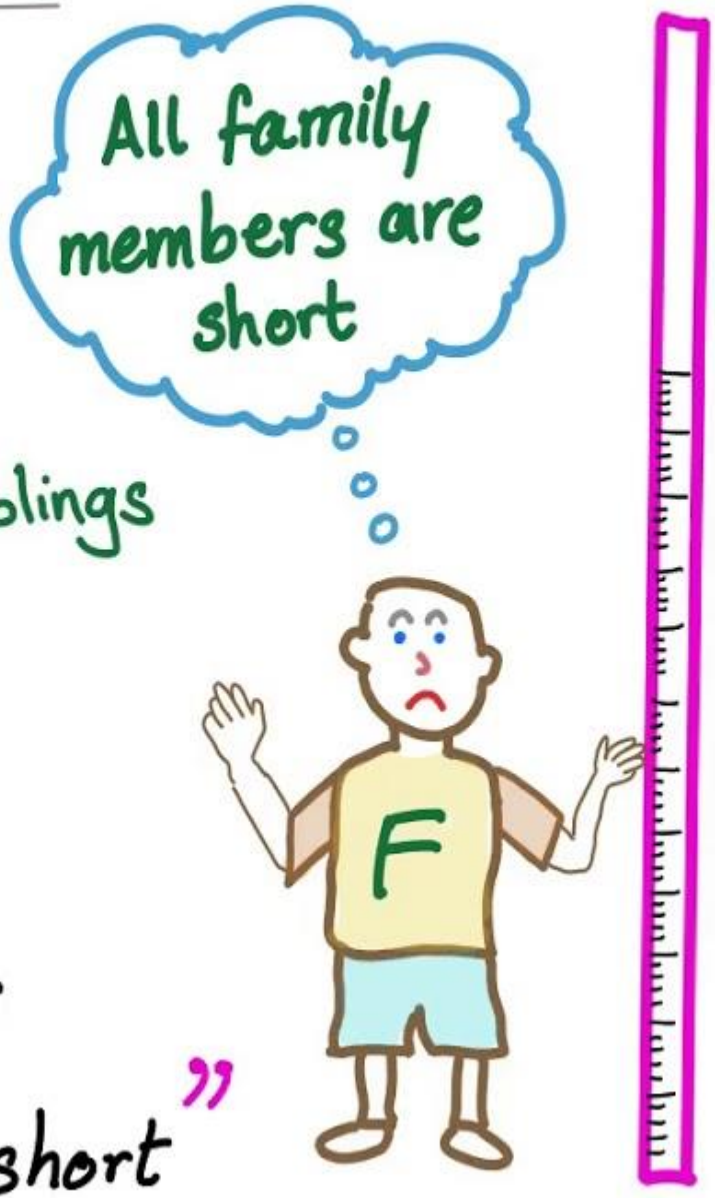
Familial

Most short children have short parents and fall within the centile target range allowing for midparental height. Care needs to be taken, though, that both the child and a parent do not have an inherited growth disorder, such as a skeletal dysplasia.

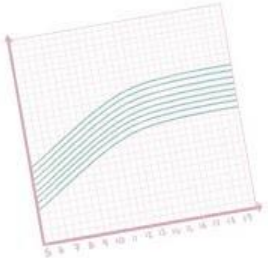
Familial short stature

- Child has always been short but parallel to the curves
  - BA = CA
- Short parents, grandparents & Siblings
- Normal physical exam
- Normal development

"Familial Fits & Family is short"



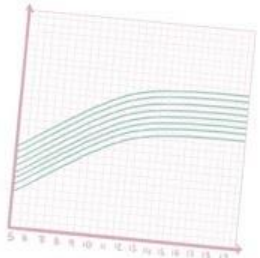






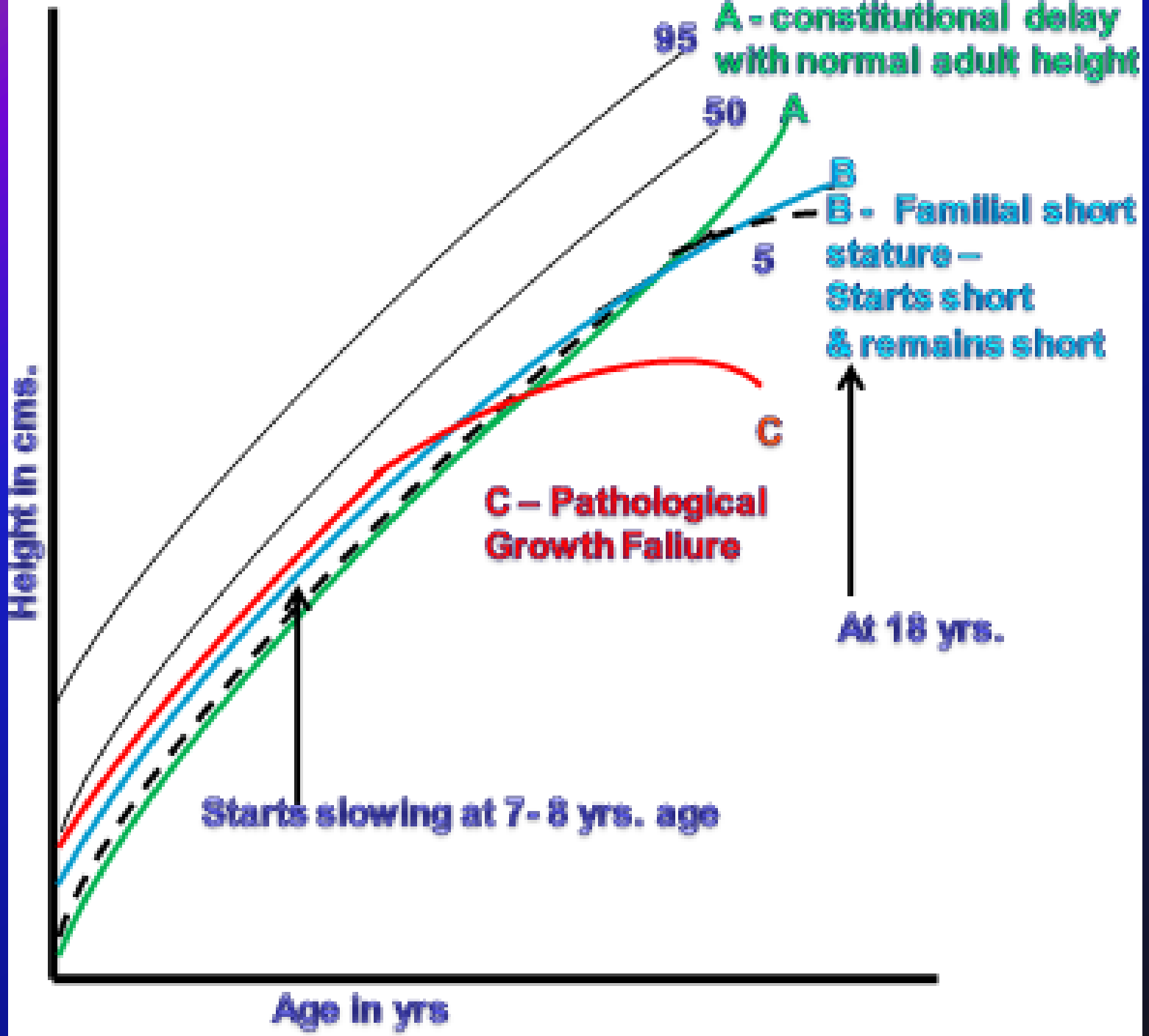
CONSTITUTIONAL GROWTH DELAY



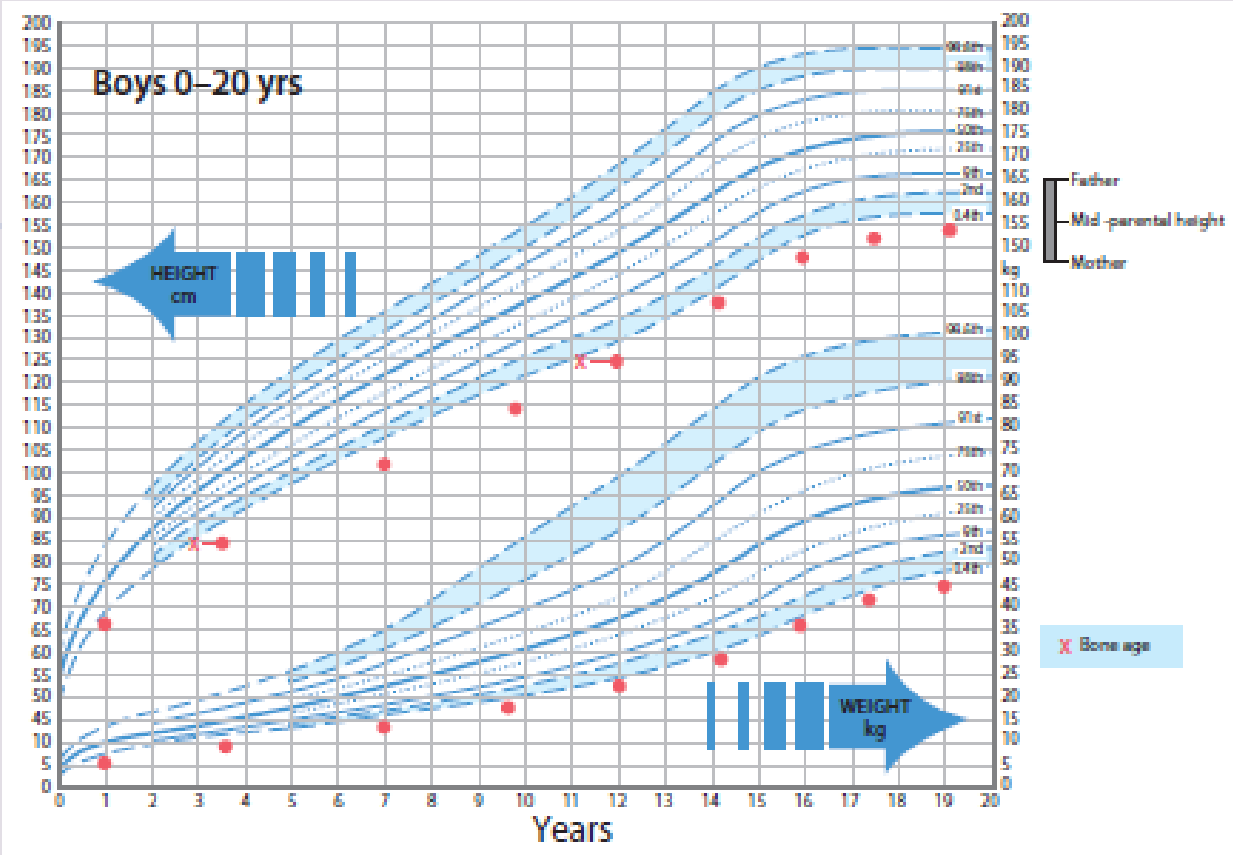
Constitutional delay in growth and puberty

Constitutional delay in growth and puberty is a variation of normal growth, which presents with short stature in teenage years because of a delay in the onset of puberty. Growth during childhood is usually within the lower limits of normal, bone age is somewhat delayed, and onset of secondary sexual development is delayed but final height is normal. There is usually a family history of delayed growth and puberty but normal height as adults (Case History 12.5).


95
50
5
A - constitutional delay with normal adult height
A
B
B - Familial short stature – Starts short & remains short
C
C – Pathological Growth Faliure
At 18 yrs.
Starts slowing at 7 - 8 yrs. age
Height in cms.
Age in yrs

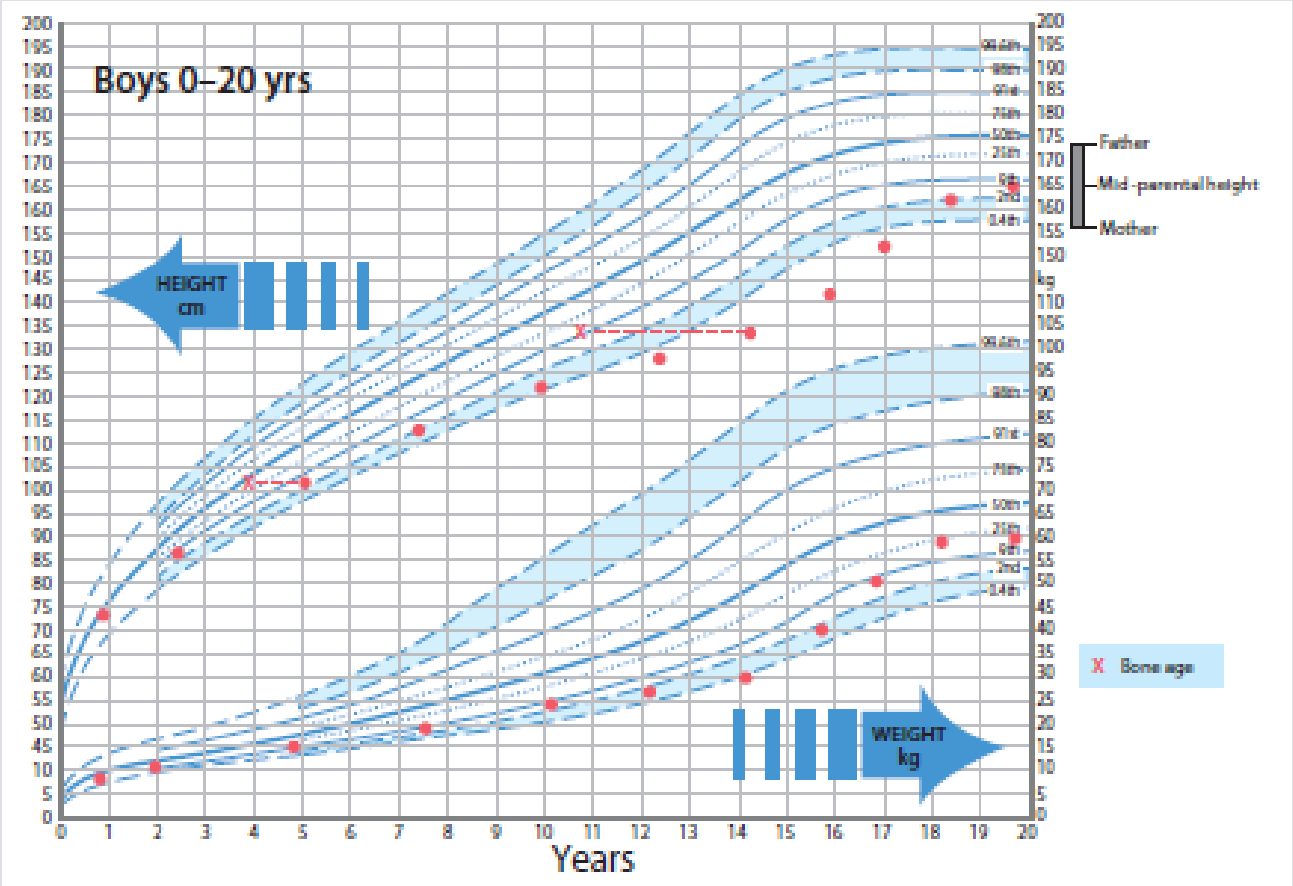
Causes & evaluation of short stature

Cause	Growth	Example
(a) Familial	Following growth centile within predicted range for parental height	
(b) Severe intrauterine growth restriction or prematurity	Short from birth (but normal mid-parental height)	



(c)
Constitutional delay of growth and puberty

Short stature accentuated by delayed puberty. Delayed bone age

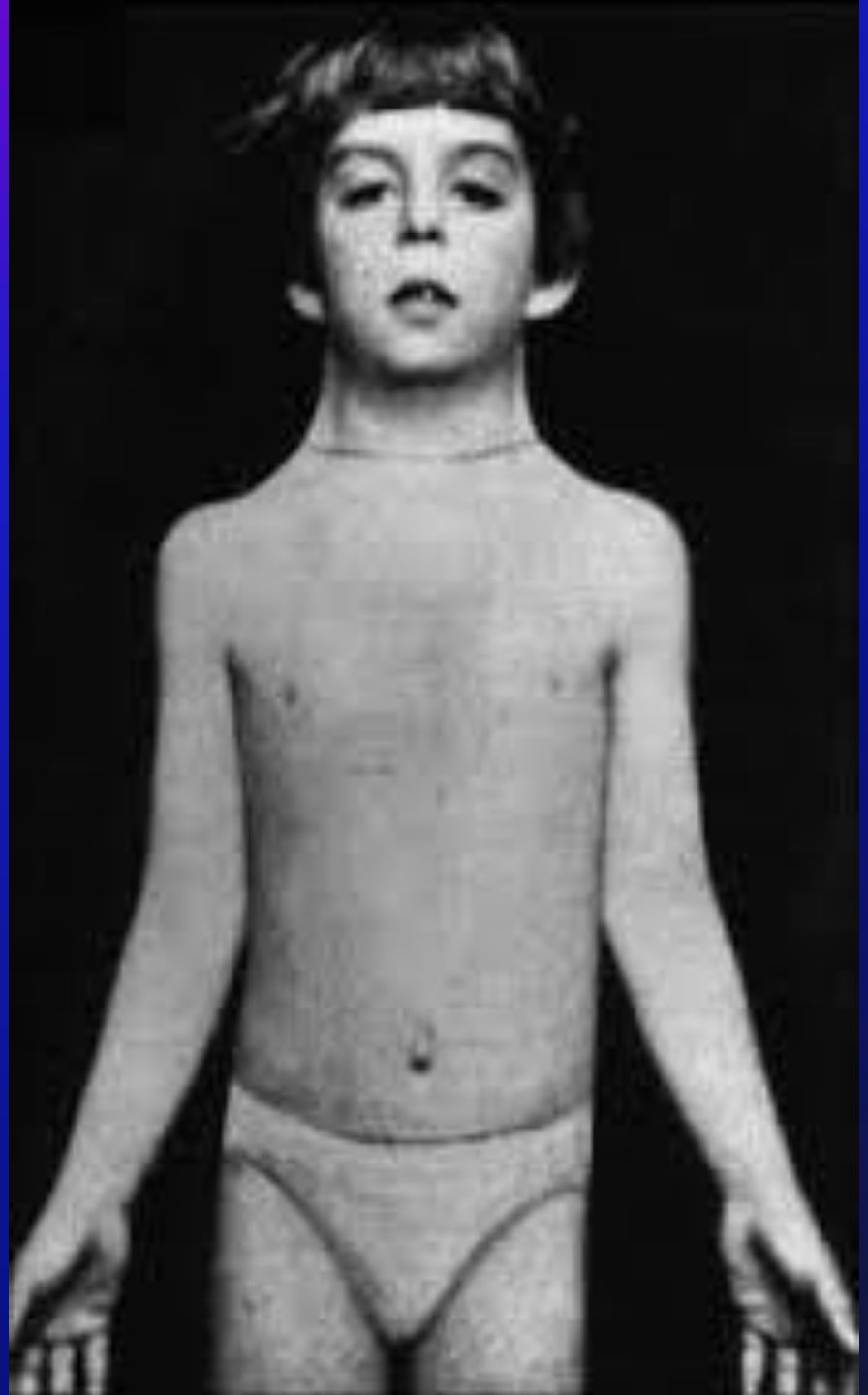


Small for gestational age and extreme prematurity

About 10% of children born small for gestational age or who were extremely premature remain short. GH treatment may be indicated if there is insufficient catch-up growth by 4 years of age.

Chromosomal disorder/syndromes

Many chromosomal disorders and syndromes are associated with short stature. Down syndrome is usually diagnosed at birth, but Turner (see Fig. 12.10 and Ch. 9), Noonan (Fig. 9.17), and Russell–Silver (Fig. 12.9) syndromes may present with short stature and minimal symptoms. Turner syndrome may be particularly difficult to diagnose clinically and should be considered in all short females.

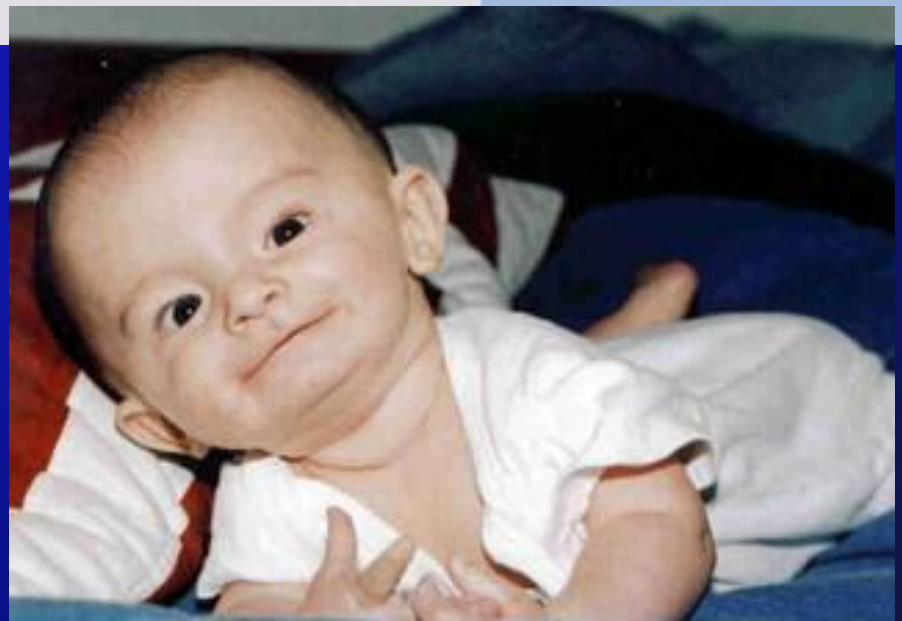


(g)
Syndromes
- Turner
- Noonan
- Down
- Russell–Silver

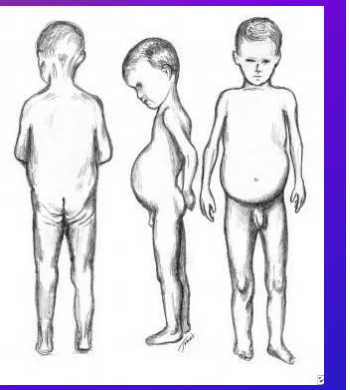
→ Dysmorphic features. →

Russell-Silver syndrome

(h)
Extreme short stature → Rare

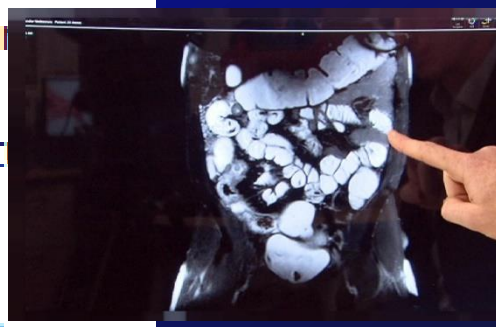


Nutritional/long-term illness

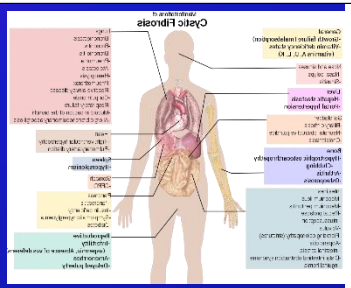


This is a relatively common cause of abnormal growth. These children are usually short and underweight, i.e. their weight is on the same or a lower centile than their height. Inadequate nutrition may be due to insufficient food, restricted diets or poor appetite associated with a long-term illness, or from the increased nutritional requirement from a raised metabolic rate. Chronic illnesses that may present with short stature include:

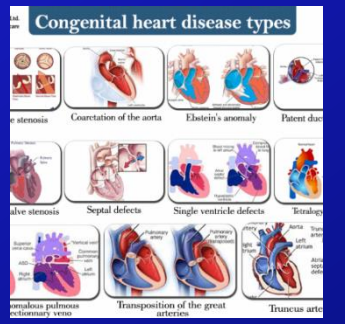
- coeliac disease, which usually presents in the fi years of life, but can present late with faltering growth. Coeliac disease may result in short stat without gastrointestinal symptoms



- Crohn's disease
- chronic kidney disease – may be present in the absence of a history of renal disease



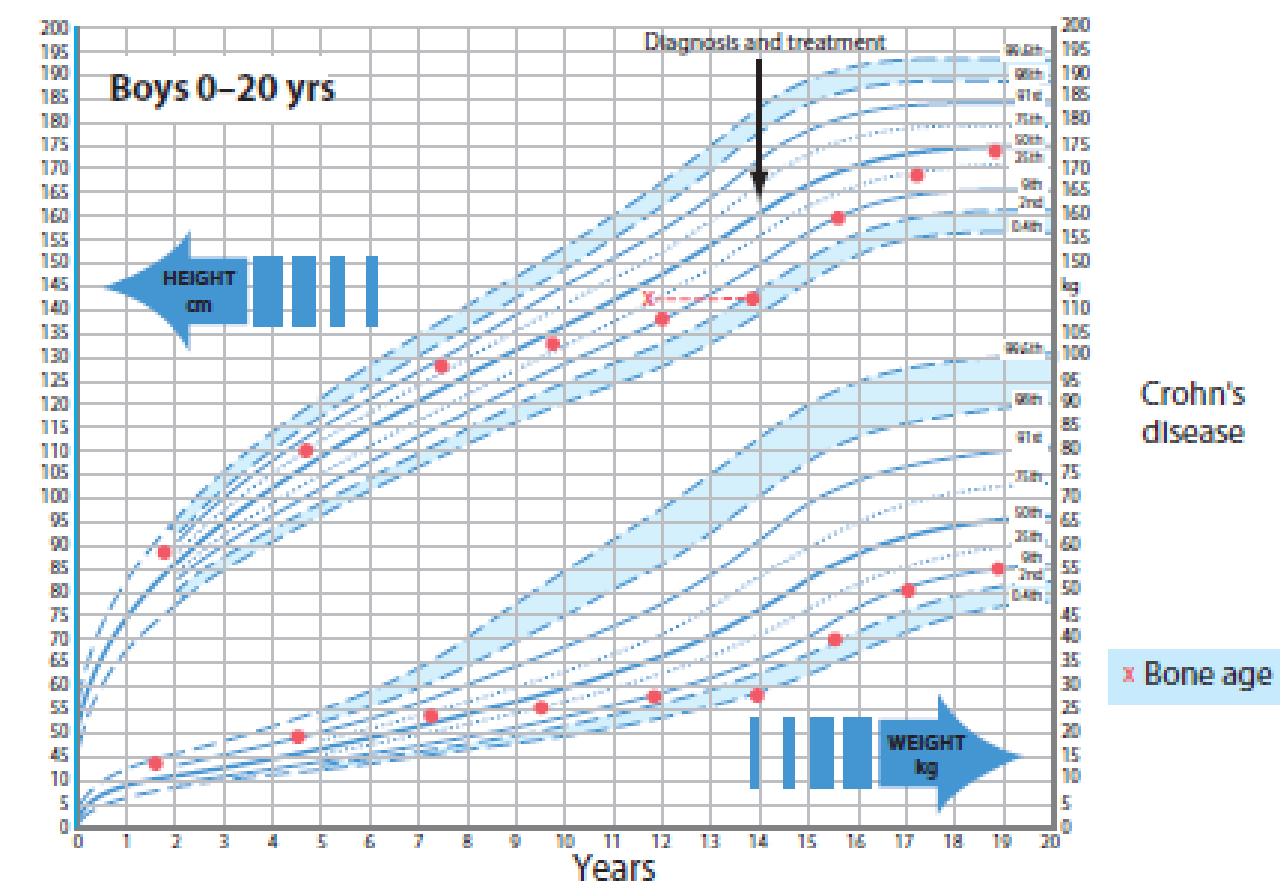
- cystic fibrosis – malabsorption, recurrent infections, increased work of breathing, and reduced appetite



- congenital heart disease – increased work of breathing.

Psychosocial deprivation

Children subjected to physical and emotional deprivation may be short and underweight and show delayed puberty. This condition may be extremely difficult to identify, but affected children show catch-up growth if placed in a nurturing environment.

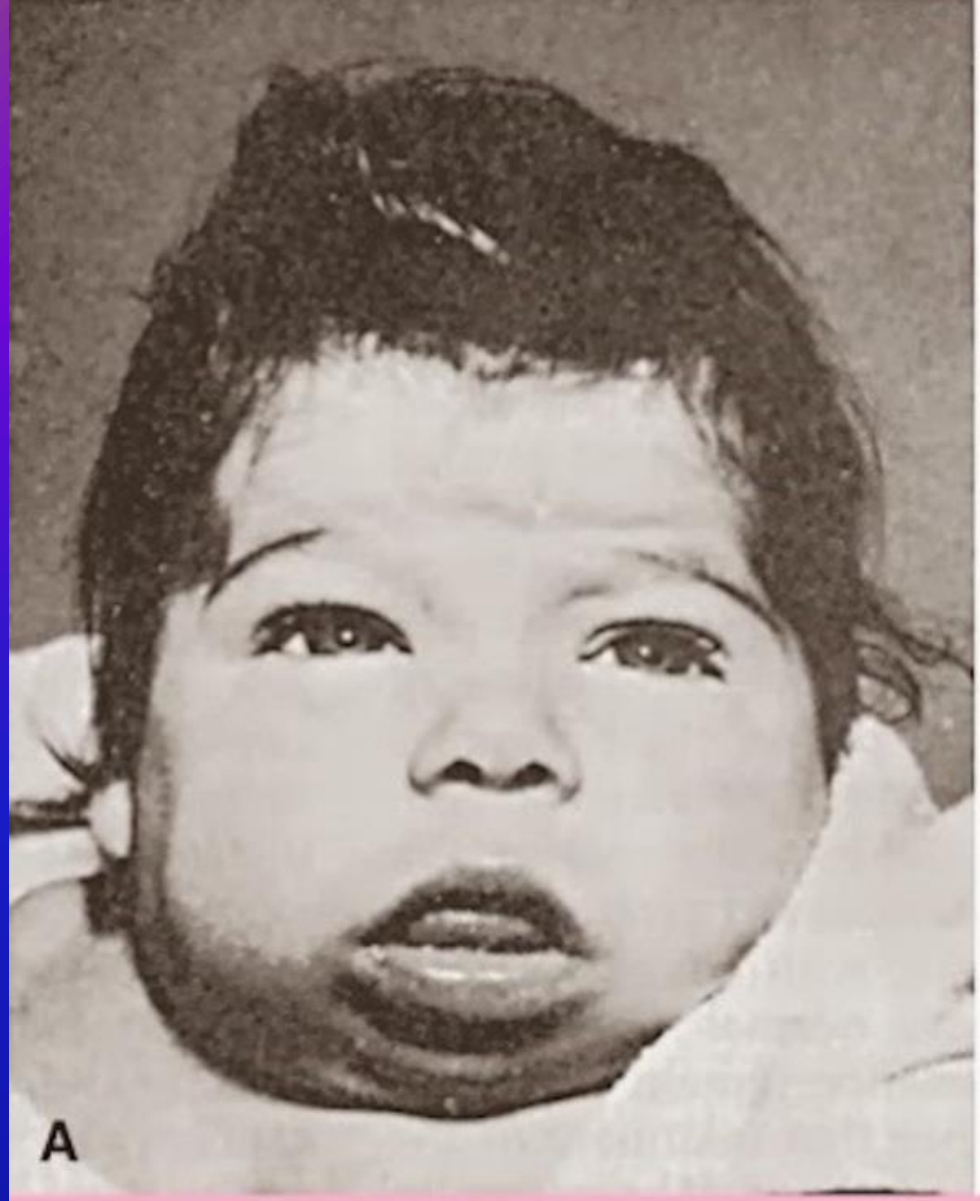
Cause	Growth	Example
(e) Nutrition/ long-term illness • gastrointestinal – coeliac, Crohn's disease • chronic kidney disease **(f) Psychosocial** • emotional deprivation/ neglect	Falling off height centiles. Weight centile < height centile. Delayed bone age	

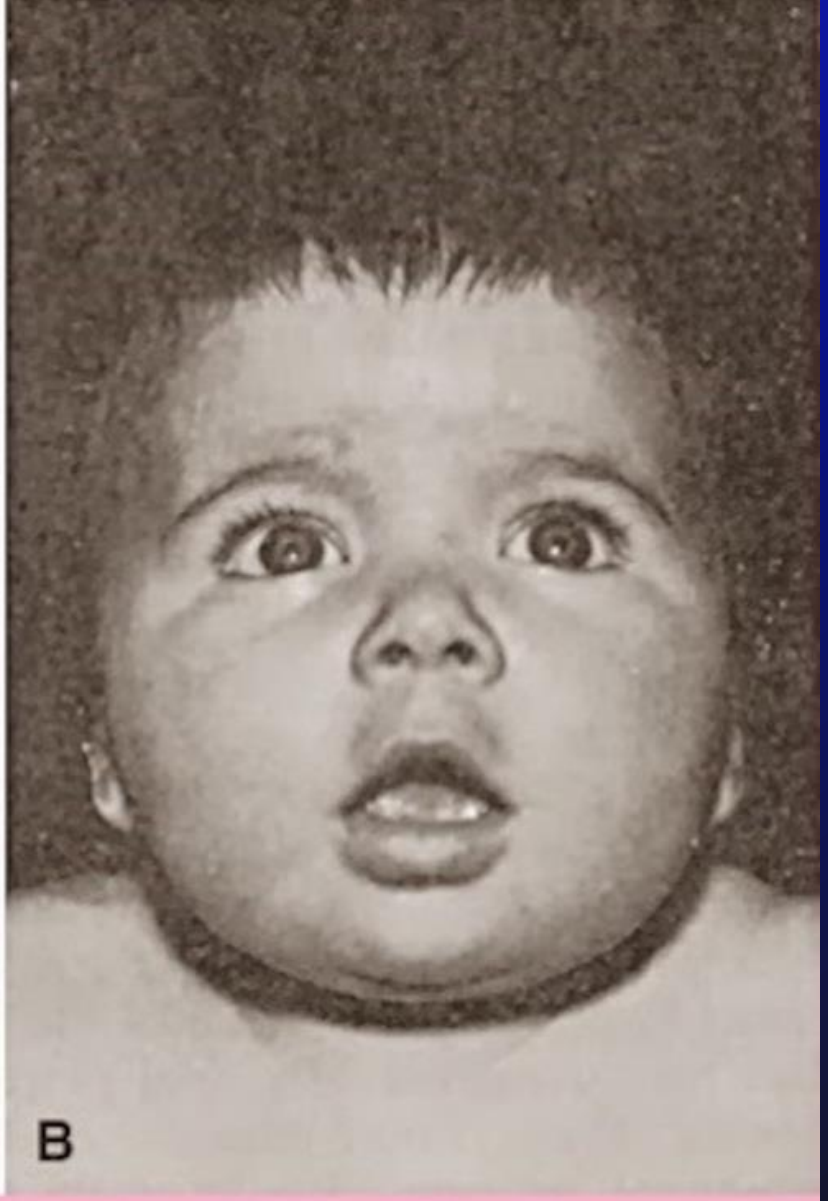
Endocrine

Hypothyroidism, GH deficiency, IGF-1 deficiency, and steroid excess are uncommon causes of short stature. They are associated with children being relatively overweight, i.e. their weight on a higher centile than their height. By contrast, children with nutritional obesity tend to be relatively tall compared with midparental height range.

Hypothyroidism

This is usually caused by autoimmune thyroiditis during childhood (see Ch. 26). This produces growth failure, usually with excess weight gain. It may go undiagnosed for many years and lead to short stature. When treated, catch-up growth rapidly occurs but often with a rapid entry into puberty that can limit final height. Congenital hypothyroidism is diagnosed soon after birth by neonatal biochemical screening and with treatment does not result in any abnormality of growth.



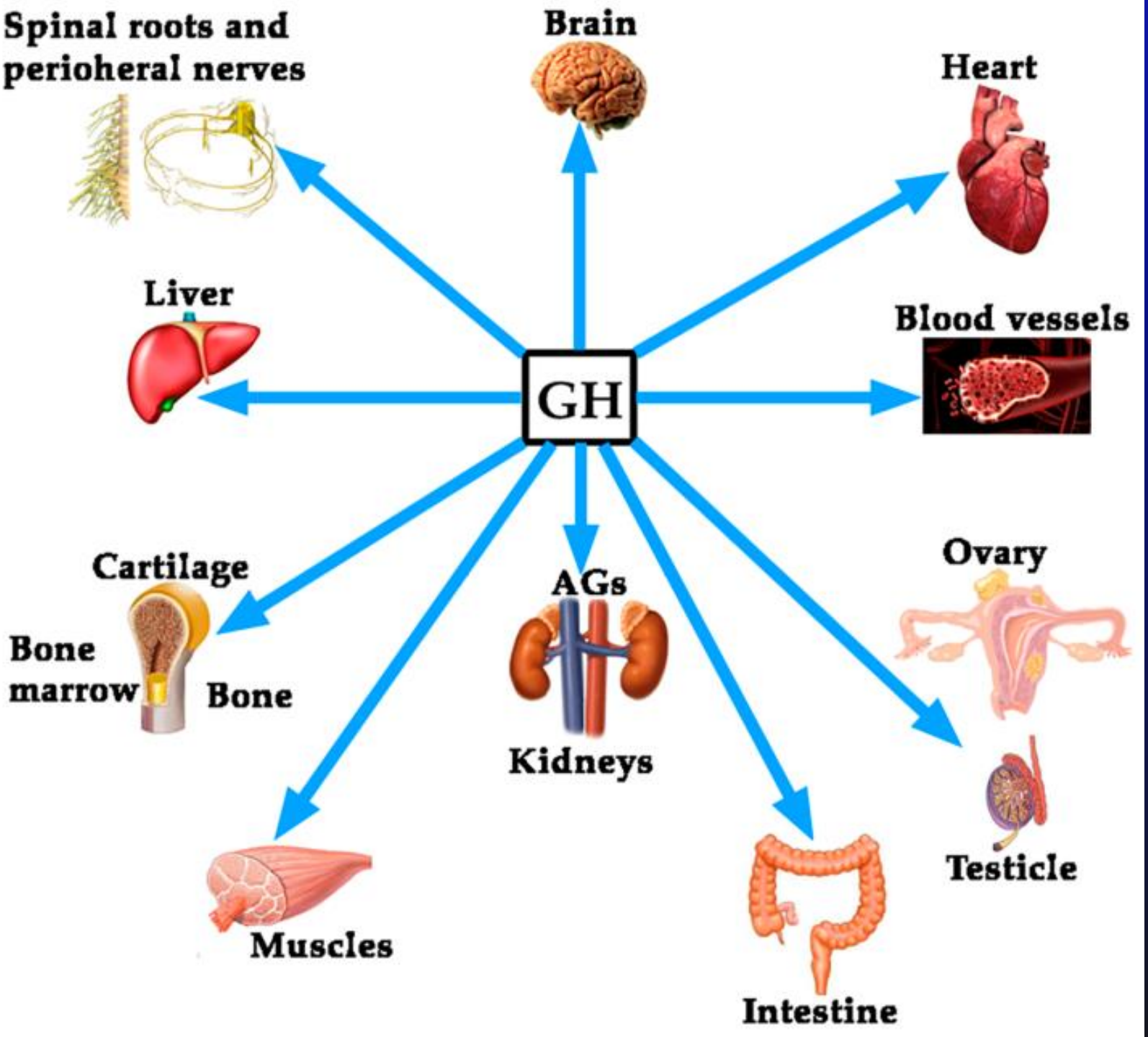


BEFORE TREATMENT
(puffed up, dull looking face, protuded tongue)

AFTER TREATMENT
(alert looking, swelling less, tongue inside)

Growth hormone deficiency

This may be isolated or secondary to wider pituitary dysfunction. Pituitary function may be abnormal in congenital midfacial or midline defects or as a result of a craniopharyngioma (a tumour affecting the pituitary region), a hypothalamic tumour, or trauma such as head injury, meningitis, and cranial irradiation. Craniopharyngioma (see Ch. 22) usually presents in late childhood and may result in abnormal visual fields (characteristically a bitemporal hemianopia as it impinges on the optic chiasm), optic atrophy, or papilloedema on fundoscopy. Laron syndrome is a condition due to defective GH receptors resulting in GH insensitivity. Patients with this condition have high GH levels but low levels of the downstream active product of GH known as IGF-1 produced at the growth plate and in the liver. Rare abnormalities in the gene producing IGF-1 have recently been discovered in children.


Spinal roots and perioheral nerves
Brain
Heart
Liver
Blood vessels
GH
Cartilage
Bone marrow
Bone
AGs
Kidneys
Ovary
Testicle
Muscles
Intestine

Corticosteroid excess, Cushing syndrome

This is usually iatrogenic, as corticosteroid therapy is a potent growth suppressor and a number of chronic conditions are treated with corticosteroids. This effect is reduced by alternate day therapy, but some growth suppression may be seen even with relatively low doses of inhaled or topical steroids in susceptible individuals. Noniatrogenic Cushing syndrome is very unusual in childhood and may be caused by pituitary or adrenal pathology. Growth failure may be very severe, and is accompanied by excess weight gain, although normalization of body shape and height occurs on withdrawal of corticosteroid therapy or treatment of the underlying steroid excess. Cushing syndrome during puberty can result in permanent loss of height (see Ch. 26).

Extreme short stature

There are a few rare conditions that cause extreme short stature in children. Idiopathic short stature refers to short stature that does not have a diagnostic explanation. In addition, abnormalities in a gene called short stature homeobox (*SHOX*) located on the X chromosome lead to severe short stature with skeletal abnormalities when present on both copies of the gene. Absence of one *SHOX* gene in Turner syndrome is thought to be the cause of short stature in this condition (and additional copies in Klinefelter syndrome produce taller than normal stature). Polymorphisms in this gene probably account for a proportion of idiopathic short stature.

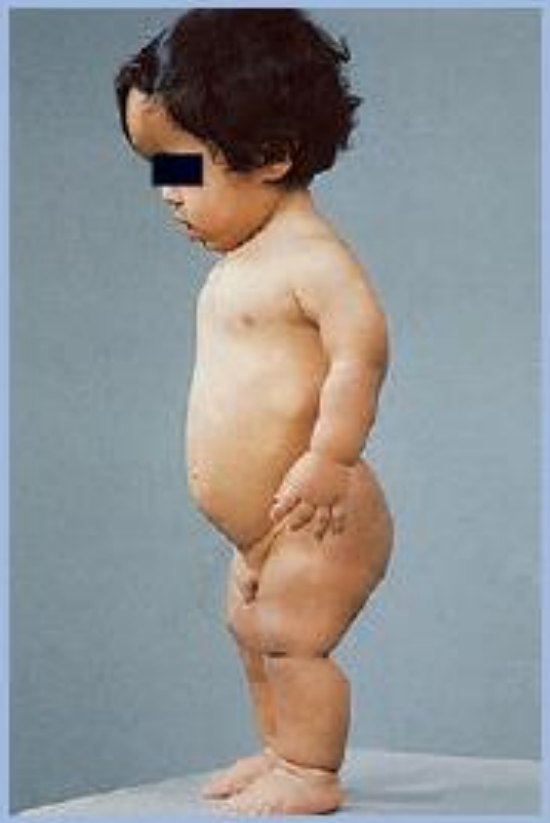
Disproportionate short stature

This is confirmed by measuring:

- sitting height – base of spine to top of head
- subischial leg length – subtraction of sitting height from total height
- limited radiographic skeletal survey to identify the skeletal abnormality.

Charts exist to assess the normality of body proportions. Conditions with abnormal body proportions are rare and may be caused by disorders of the formation of bone (skeletal dysplasias). They include achondroplasia and other short-limbed dysplasias. If the legs are extremely short, treatment by surgical leg lengthening may be appropriate. The back may be short from severe scoliosis or some storage disorders, such as the

(I)
Disproportion
- skeletal dysplasia – legs>back
- storage disorders – back>legs



Achondroplasia

Assessment of a child with short stature

History

- Birth length, weight, head circumference and gestational age
- Pregnancy history: infection, intrauterine growth restriction, drug use, alcohol/smoking
- Feeding history
- Developmental milestones
- Family history of constitutional delay of growth and puberty or other diseases?
- Consanguinity pertaining to inherited conditions
- Features of chronic illness, endocrine causes, e.g. hypothyroidism, pituitary tumour, Cushing syndrome or psychosocial deprivation?
- Medications, e.g. corticosteroids?

Assessment of a child with short stature

Examination of the growth chart:

- Following growth centile lines for length/height, weight and head circumference?
  Consider familial, low birthweight, constitutional delay of growth and puberty, syndromes and skeletal dysplasias
- Faltering growth with crossing of centile lines?
  Consider endocrine (including therapeutic corticosteroids), nutrition/chronic illness, psychosocial deprivation

Determine the mid-parental height

- For genetic target range

Assessment of a child with short stature

Examination

- Dysmorphic features – chromosome/syndrome present? (But in Turner syndrome other stigmata may be absent)
- Chronic illness, e.g. Crohn's, cystic fibrosis, coeliac disease?
- Evidence of endocrine causes?
- Disproportionate short stature from skeletal dysplasia?
- Pubertal stage?

Diagnosis

Cause can usually be determined from the above and no tests are required

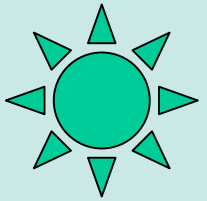
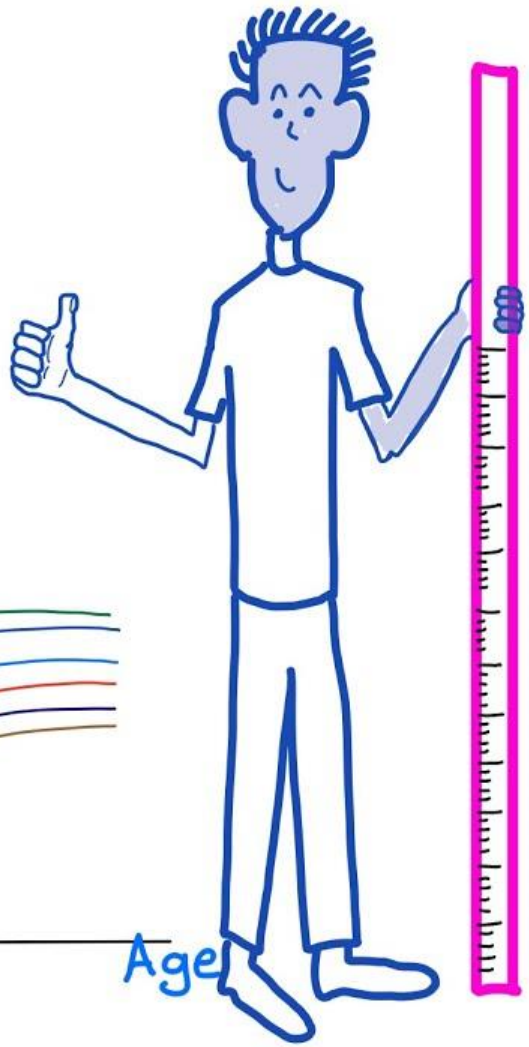


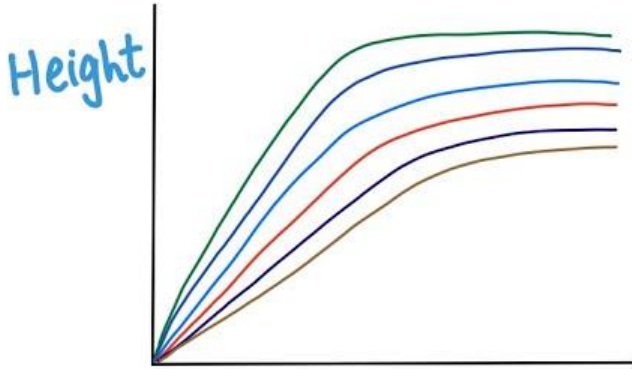
Table 12.1 Investigations considered for short stature

Investigation	Significance
X-ray of the left hand and wrist for bone age	Some delay in constitutional delay of growth and puberty. Marked delay for hypothyroidism or growth hormone deficiency
Full blood count	Anaemia in coeliac or Crohn's disease
Creatinine and electrolytes	Creatinine raised in chronic kidney disease
Calcium, phosphate, alkaline phosphatase	Renal and bone disorders
Thyroid-stimulating hormone	Raised in primary hypothyroidism
Karyotype	Turner syndrome shows 45,XO, other chromosomal disorders

IGF-1	Disorders of the growth hormone axis, including IGF-1 deficiency
0900 h cortisol and dexamethasone suppression test	Cushing syndrome
MRI scan if neurological symptoms/signs	Craniopharyngioma or intracranial tumour
Limited skeletal survey	Skeletal dysplasia, scoliosis

Tall Stature





When Do Men Stop Growing ?

Tall stature

This is a less common presenting complaint than short stature, as many parents are proud that their child is tall. However, some adolescents become concerned about excessive height during their pubertal growth spurt. The causes are presented in Table 12.2. Most tall stature is inherited from tall parents. Obesity in childhood 'fuels' early growth and may result in tall stature; however, because puberty is often somewhat earlier than average, it does not increase final height.

Secondary endocrine causes are rare. Both congenital adrenal hyperplasia and precocious puberty (PP) lead to early epiphyseal fusion so that eventual height is reduced after an early excessive growth rate.

Marfan (a disorder of loose connective tissue) and Klinefelter (XXY – an excess of *SHOX* dose) syndromes both cause long-legged tall stature, and in XXY there is also infertility and learning difficulties.

Tall children may be disadvantaged by being treated as older than their chronological age. Excessive height in prepubertal or early pubertal adolescent females and males can be treated with oestrogen therapy and testosterone therapy, respectively, to induce premature fusion of the epiphyses, but as it produces variable results and has potentially serious side-effects, it is seldom undertaken. Surgical destruction of the epiphyses in the legs may also be considered

Table 12.2 Causes of excessive growth or tall stature

Familial	Most common cause
Obesity	Puberty is advanced, so final height centile is less than in childhood
Secondary	Hyperthyroidism
	Excess sex steroids – precocious puberty from whatever cause
	Excess adrenal androgen steroids – congenital adrenal hyperplasia
	True gigantism (excess growth

	hormone secretion)
Syndromes	Long-legged tall stature: • Marfan syndrome • Homocystinuria • Klinefelter syndrome (47,XXY karyotype) Sotos syndrome – associated with large head, characteristic facial features, and learning difficulties
Excessive growth at birth	Proportionate tall stature at birth: • maternal diabetes • primary hyperinsulinism • Beckwith syndrome

Abnormal head growth

Most head growth occurs in the first 2 years of life and 80% of adult head size is achieved before the age of 5 years. This largely reflects brain growth, but small or large heads may be familial, so comparison with measurements of parents' heads should be made. At birth, the sutures and fontanelle are open. During the first few months of life, the head circumference may increase across centiles, especially if small for gestational age. The posterior fontanelle has closed by 8 weeks, and the anterior fontanelle by 12 months to 18 months. If there is a rapid increase in head circumference, raised intracranial pressure should be excluded.

Macrocephaly

Macrocephaly is a head circumference above the 98th centile. The causes of a large head are listed in Box 12.1. Most are normal children and often the parents have large heads. A rapidly increasing head circumference, even if the head circumference is still below the 98th centile, suggests raised intracranial pressure and may be due to hydrocephalus, subdural haematoma, or brain tumour. It must be investigated promptly by cranial ultrasound if the anterior fontanelle is still open, otherwise by computed tomography or magnetic resonance imaging (MRI) scan.

If an infant's head circumference is enlarging and crossing centile lines, check for raised intracranial pressure

Box 12.1 Causes of a large head

- Tall stature
- Familial macrocephaly
- Raised intracranial pressure (in an infant):
  - chronic subdural haematoma
  - brain tumour
  - neurofibromatosis
- Cerebral gigantism (Sotos syndrome)
- Central nervous system storage disorders, e.g. mucopolysaccharidosis (Hurler syndrome)

Microcephaly

Microcephaly, a head circumference below the 2nd centile (Fig. 12.11), may be:

- familial – when it is present from birth and development is usually normal
- an autosomal recessive condition – when it is associated with developmental delay
- caused by a congenital infection
- acquired after an insult to the developing brain, e.g. perinatal hypoxia, hypoglycaemia, or meningitis, when it is often accompanied by cerebral palsy and seizures (Case History 12.2).

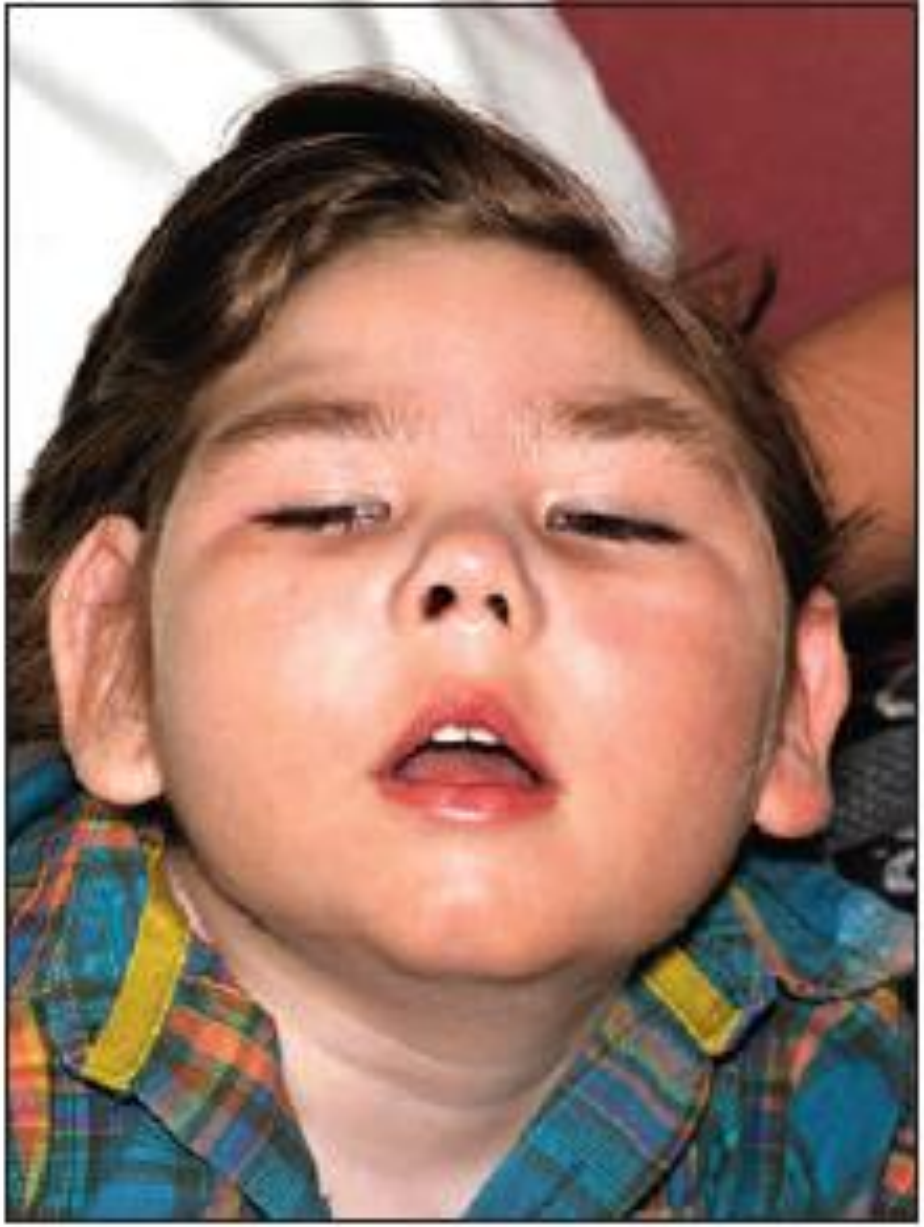
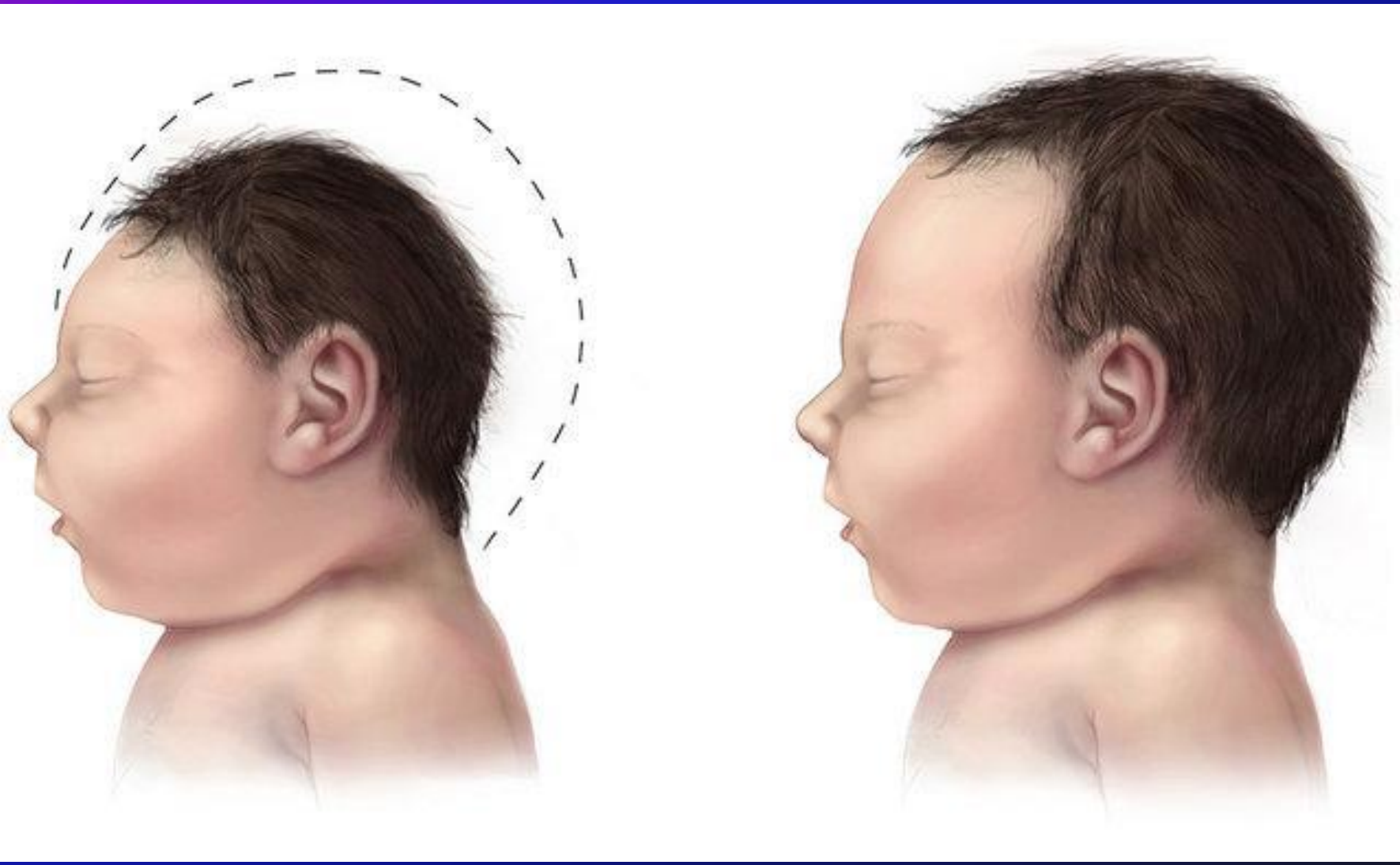


Figure 12.11 This boy has microcephaly. He has cerebral palsy. (Courtesy of Dr Gabby Chow.)



Asymmetric heads

Skull asymmetry may result from an imbalance of the growth rate at the coronal, sagittal, or lambdoid sutures, although the head circumference increases normally. Occipital plagiocephaly, a parallelogram-shaped head with flattening of the back of the skull, is seen with increased frequency since the advice to parents that babies should sleep lying on their back to reduce the risk of sudden infant death syndrome. It improves with time as the infant becomes more mobile. Plagiocephaly is also seen in infants with hypotonia. Preterm infants may develop long, flat heads from lying on their sides for long periods on the hard surface of incubators. This can be moderated by providing the infant with a soft surface to lie on and changing their head position frequently (Fig. 12.13). Under these circumstances, it is not associated with abnormal

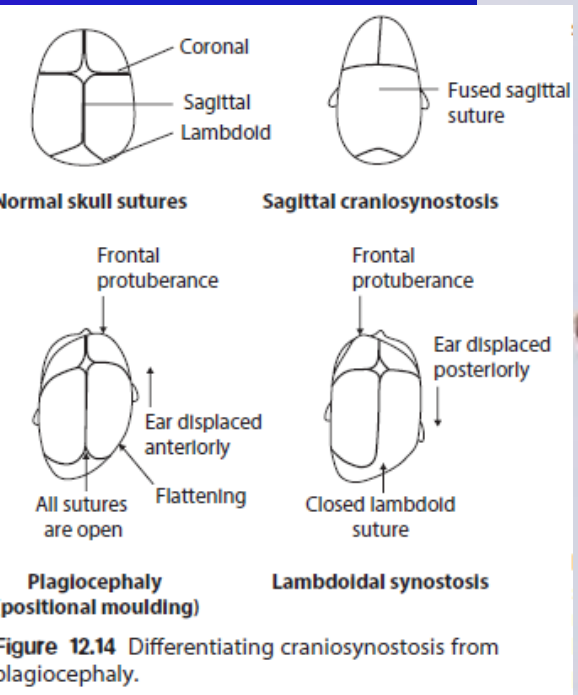
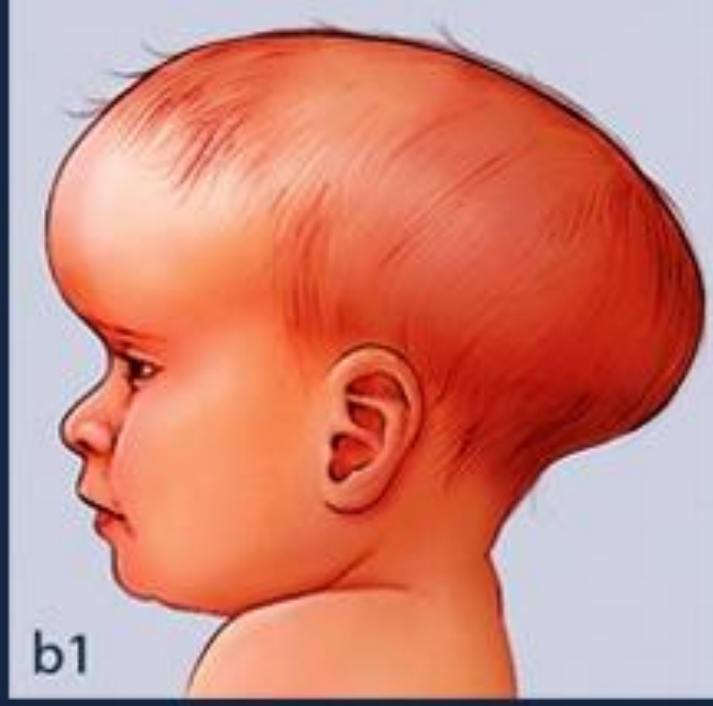
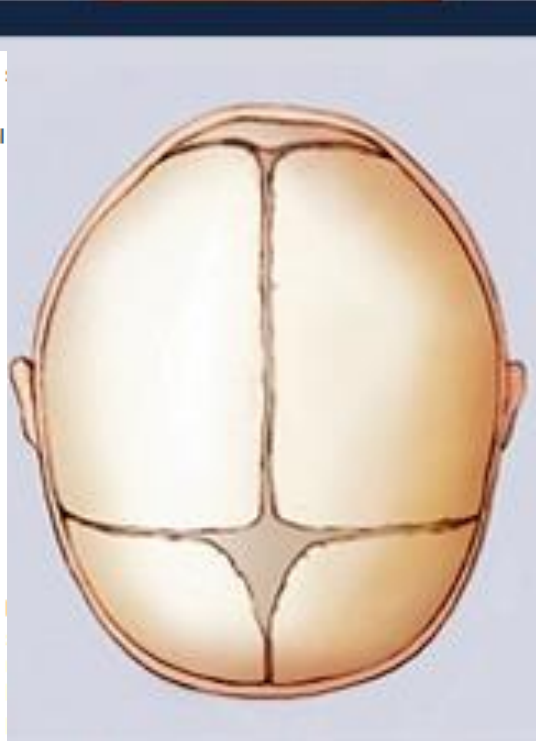
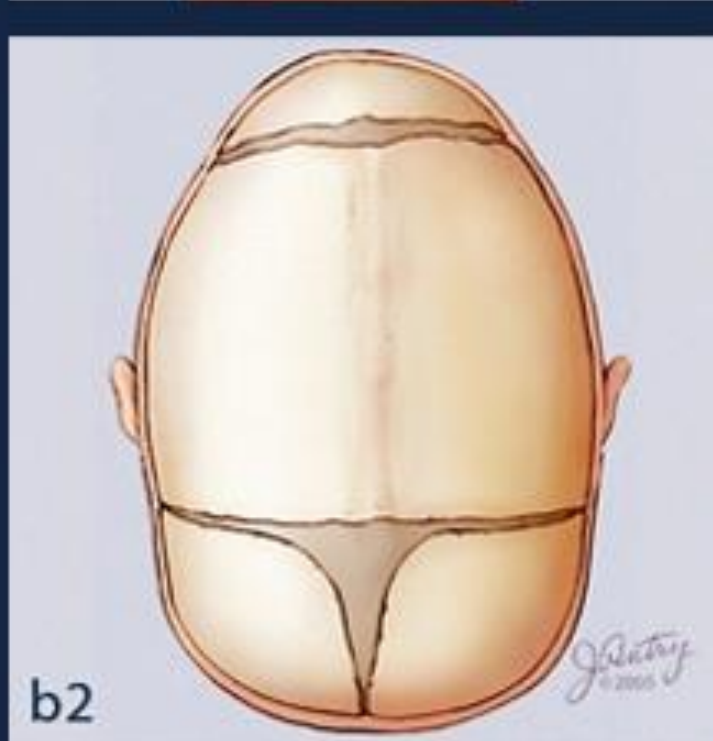


Figure 12.14 Differentiating craniosynostosis from plagiocephaly.







Craniosynostosis

The sutures of the skull bones start to fuse during infancy but do not finally fuse until late childhood.

Abnormal head shape

Box 12.2 Forms of craniosynostosis

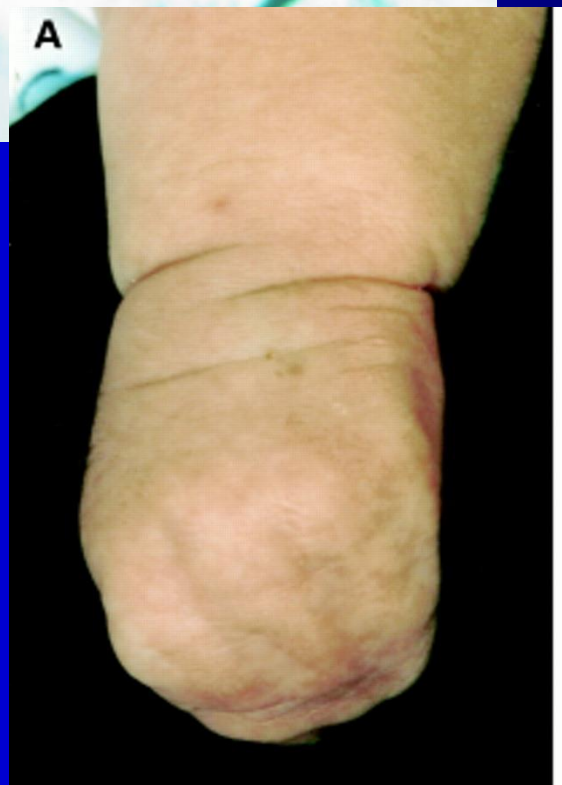
Localized

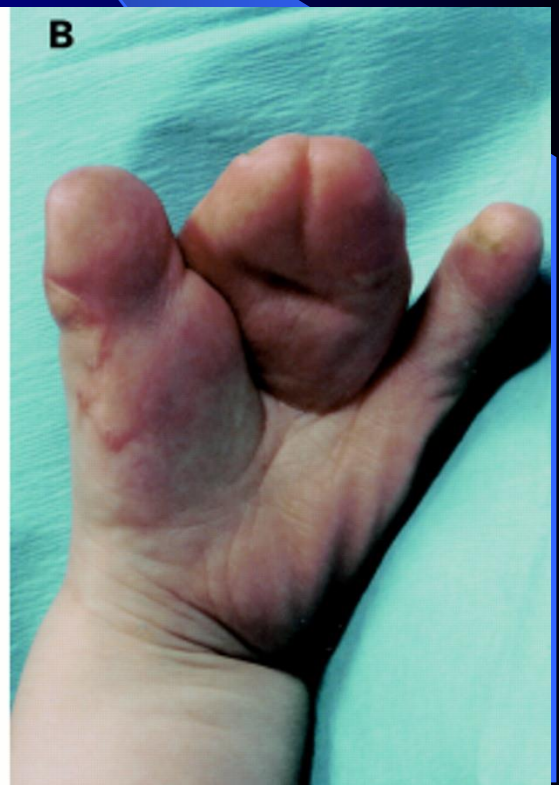
- Sagittal suture – long narrow skull
- Coronal suture – asymmetrical skull
- Lambdoid suture – flattening of skull

Generalized

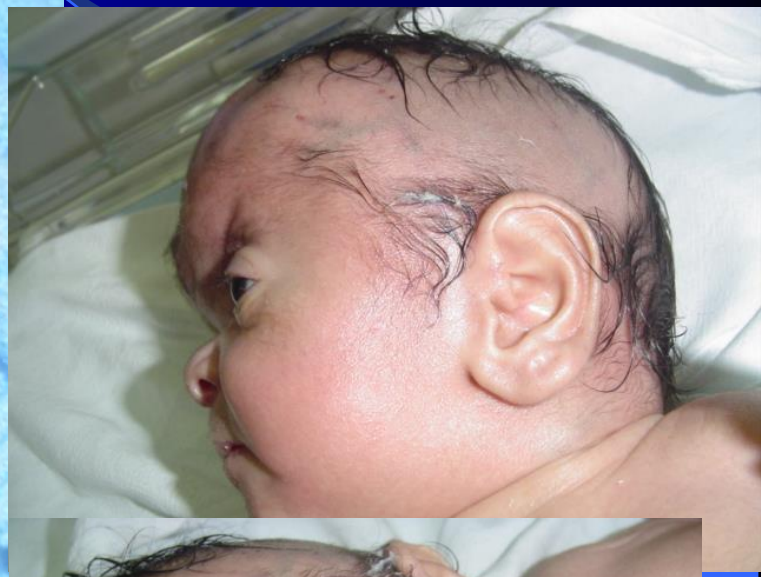
- Multiple sutures resulting in microcephaly and developmental delay
- Genetic syndromes, e.g. with syndactyly in Apert syndrome, with exophthalmos in Crouzon

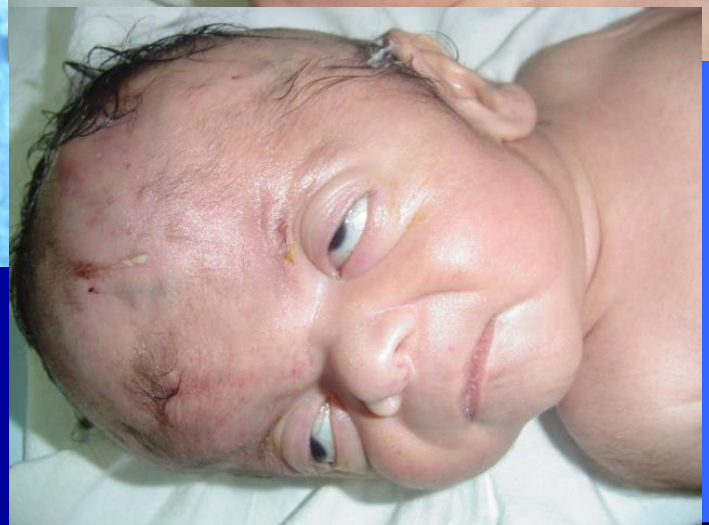
Figure 1. Pfeiffer syndrome type 2 – physical aspects.


A


B

- ٤ أشهر





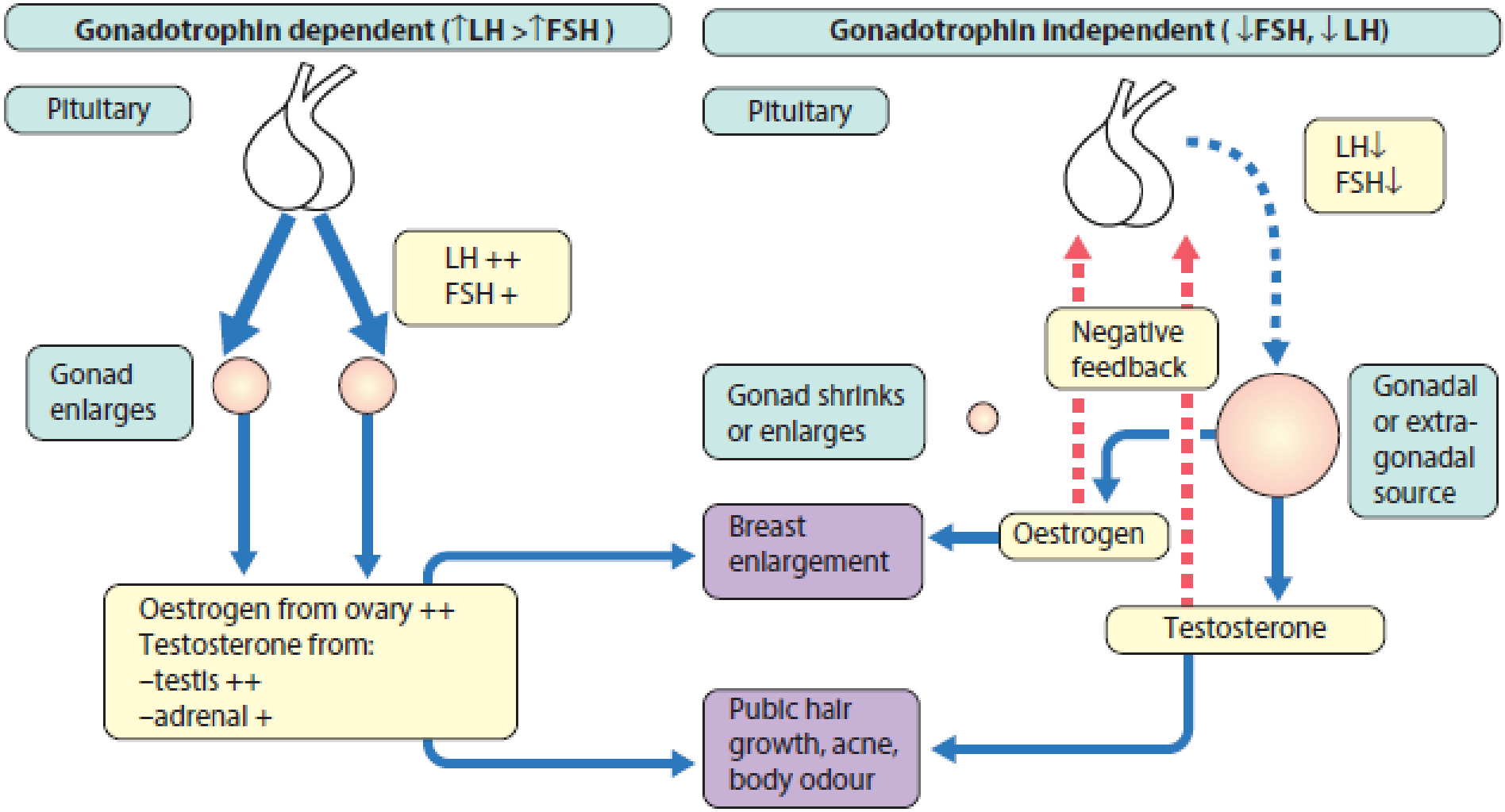
Premature sexual development

The development of secondary sexual characteristics before 8 years of age in females and 9 years of age in males is defined as outside the normal range in the UK. There are several recognized patterns of premature sexual development:

- precocious puberty
- premature breast development (thelarche)
- premature pubic hair development (pubarche or adrenarche)
- isolated premature menarche.

Precocious puberty in females is usually due to the premature onset of normal puberty

Causes of precocious puberty



Gonadotrophin dependent (↑LH >↑FSH)

Signs of puberty are consonant.

Idiopathic/familial

CNS abnormalities

- Congenital anomalies, e.g. hydrocephalus
- Acquired, e.g. post-irradiation, infection, surgery, brain injury
- Tumours, e.g. craniopharyngioma, neurofibromatosis

Hypothyroidism

Gonadotrophin Independent (↓FSH, ↓ LH). Rare and signs of puberty often not consonant

Adrenal disorders – tumours, congenital adrenal hyperplasia

Ovarian – tumour (granulosa cell)

Testicular – tumour (Leydig cell)

Exogenous sex steroids

Gonadotrophin-dependent precocious puberty in males often has a pathological cause

Premature breast development (thelarche)

This usually affects females between 6 months and 2 years of age. The breast enlargement may be asymmetrical and fluctuate in size, rarely progressing beyond stage 3 of puberty. It is differentiated from gonadotrophin-dependent precocious puberty by the absence of axillary and pubic hair and of a significant growth spurt. It is nonprogressive and self-limiting. Investigations are not usually required (Case History 12.4).

Premature pubarche (adrenarche)

This occurs when pubic hair develops before 8-years of age in females and before 9-years in males but with no other signs of sexual development. It is most commonly caused by an accentuation of the normal maturation of androgen production by the adrenal gland between the age of 6 years and 8 years. It is more common in Asian and Black children. There may be a slight increase in growth rate and bone age (by 12–15 months). It is usually self-limiting. A more aggressive course of virilization would suggest nonclassical congenital adrenal hyperplasia (see Ch. 26) or an adrenal tumour. Obtaining a urinary steroid profile, evaluating levels of androgens in the blood, and measuring bone age help differentiate premature pubarche from nonclassical congenital adrenal hyperplasia or an adrenal tumour. Girls who develop premature pubarche are at an increased risk of developing polycystic ovarian syndrome in later life.

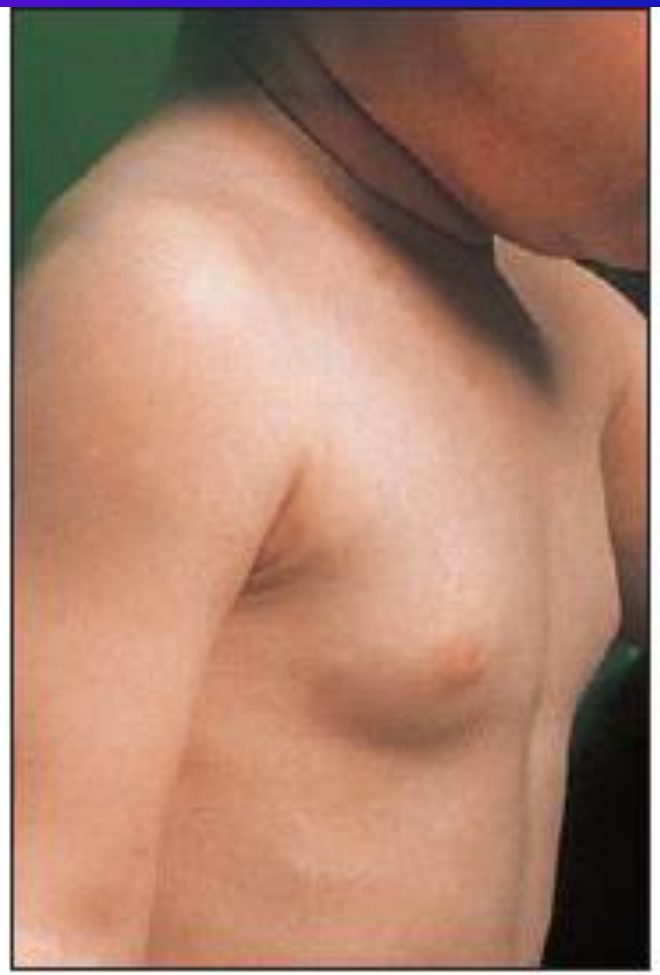


Figure 12.18 Premature breast development in an 18-month-old girl. The absence of a growth spurt and axillary and pubic hair differentiates it from precocious puberty. It is self-limiting and usually resolves. (From Wales JKH, Rogol AD, Wit JM: *Pediatric Endocrinology and Growth,* London, 2003, Saunders, with permission.)

Delayed puberty

Delayed puberty is often defined as the absence of pubertal development by 14 years of age in females and 15 years in males. The causes of delayed puberty are listed in Box 12.3.

In contrast to PP, delayed puberty is more common in males due to relative insensitivity of the testes to gonadotrophin secretion. Most commonly, this is constitutional delay in growth and puberty, often with a family history of delayed puberty (Case History 12.5). It is a variation of the normal timing of puberty rather than a pathological condition. It may also be induced by dieting or excessive physical training. An affected child will have delayed sexual changes compared with his/her peers, and bone age would show moderate delay. The legs will be long in comparison to the back. Eventually, the target height will be reached as growth in affected children will continue for longer than in their peers. The condition may cause psychological upset from teasing, poor self-esteem, and disadvantage in competitive sport.

Summary

Delayed puberty

- Delayed puberty is common in boys and usually due to constitutional delay in growth and puberty.
- Delayed puberty is uncommon in girls and a cause should be sought.