This chart will most commonly be used for the assessment of individual children, rather than for population growth monitoring purposes and includes a number of new features which can be used, when relevant, to help in the interpretation of growth and development:

- Birth centiles plotting scales
- Scales to predict adult height and mid parental centile
- BMI lookup and plotting grid
- A new guide to assessing puberty

This chart combines data from the UK 1990 growth reference for children at birth and from 4-18 years, with the WHO growth standard for children aged 2-weeks to 4 years. The growth of children less than 2 years of age should be plotted on the more detailed UK-WHO 0-4 year growth charts.

**Measuring techniques**

**Height**

A correctly installed stadiometer or appropriate portable measuring device is the only equipment that can be reliably used to measure height. The measurement should be recorded to the nearest completed millimetre (first decimal place). Accurate measurement is essential and shoes must be removed for all measurements. The child should stand with their heels, bottom and back of head touching the vertical measuring column, looking straight ahead, making sure the chin is not tipped up or down (see illustration of the Frankfurt plane). The height measurement is taken by lowering the measuring arm onto the child’s head after asking the child to breathe in and then out and the measurement should be then read on expiration.

If a child cannot stand, measure length lying down with a Dunmow measure and plot as for height (obtainable from www.healthforallchildren.com).

**Weight**

Remove heavy clothing and shoes and weigh using class III clinical electronic scales in the metric setting.

**Plotting**

Plot each measurement by placing a small dot where a vertical line through the child’s age crosses a horizontal line through the measured value. The lettering on the charts (‘weight’, ‘height’ etc.) sits on the 50th centile, providing orientation for ease of plotting.
Birth centiles plotting scale
The chart only starts at age 2 years, so there is a plotting scale on the left of the chart where birth weight (and length, if measured) for children born at term (after 37 completed weeks) can be plotted, to allow comparison of the birth centile with later growth.

What do the centiles mean?
These charts indicate a child’s size compared with children of the same age and sex. The centile lines show the range of heights and weights for age and the number of children in the population expected to fall below a particular line (e.g. 50% below the 50th, 91% below the 91st). Children come in all shapes and sizes, but 99 out of 100 children who are growing optimally will be between the two outer lines (0.4th and 99.6th centiles); half will lie between the 25th and 75th centile lines.

When is a measurement abnormal?
There is no single threshold below which a child’s weight or height is definitely abnormal, but only 1 in 250 children are expected to have weight or height below the 0.4th centile, so these children should be assessed further, if not already fully investigated when younger. If weight is above 75th centile or if weight and height centiles differ, the BMI centile should be calculated (see below).

When a plot falls within the shaded area on the height chart between 8 and 13 years, pubertal assessment may be required (see below).

Growth patterns before puberty
Successive height measurements before puberty are highly correlated and generally between 4 and 8 years of age heights track fairly close to the same centile with only 5-10% changing by more than one centile space. If height measurements vary more than this it is important to check for errors either in the measuring, recording or plotting. It is known that measurements may be imprecise and the need for careful accurate measuring cannot be too strongly stressed.

When do individual children need further assessment of growth?
If any of the following:
1. Where weight or height or BMI is below the 0.4th centile, unless already fully investigated at an earlier age.
2. If the height centile is more than 3 centile spaces below the mid-parental centile.
3. A drop in height centile position of more than 2 centile spaces, as long as measurement error has been excluded.
4. Smaller centile falls or discrepancies between child’s centile and parents’, if seen in combination, or if associated with possible underlying disease.
5. If there are any other concerns about the child’s growth.
Adult Height Predictor

This allows you to estimate the child’s adult height based on their current height, but with a regression adjustment to allow for the tendency of very tall and short children to be less extreme in height as adults. Four children out of five will have a final adult height within ±6 cm of the predicted adult height.

- Use an X to mark the child’s most recent height centile in the centre line
- Read off the child’s estimated adult height from the right hand scale
- 80% of children will be within ±6 cm of this value
- Scale also shown in feet and inches on left

Parent Height Comparator

The Parent Height Comparator is on the flap to the right of the height centile chart. It is desirable and more accurate to use measured parents' heights rather than reported heights. The ‘mid-parental centile’ is the average adult height centile to be expected for all children of these parents. It incorporates a regression adjustment to allow for the tendency of very tall and short parents to have children with less extreme heights. This means that children of very short or tall parents will have mid-parental centiles nearer to average than one might expect.

- Mark mother’s height on the left hand scale and father’s height on the right scale using arrows
- Draw a line between arrowheads and read off mid-parental centile where this crosses the central line

Comparing this to the child’s current height centile can help assess whether the child’s growth is proceeding as expected. The larger the discrepancy between the two, the more likely it is that the child has some sort of growth disorder.

Most children’s height centiles (nine out of ten) are within ±two centile spaces of the mid-parental centile and only one percent will be more than three centile spaces below. Most of these will have no underlying medical condition, but if there are other concerns about the child’s growth rate, a height centile well below the mid-parental centile should be investigated further.

Remember also that a child growing abnormally may still be within mid parental height range, so that any child with obviously abnormal slow growth (e.g., a fall of more than 2 centile spaces) should be investigated whatever their parental heights.
**Body Mass Index (BMI) centile look-up and plotting grid**

In a child over 2 years of age the BMI centile is the best indicator of thinness and fatness. The chart below allows you to read off the BMI centile, accurate to a quarter of a centile space. There is a BMI centile grid at the top of the growth chart where this centile can be plotted.

- Note the weight and height centiles from the growth chart.
- Plot the weight centile against the height centile on the chart. If between centiles, read across in this position.
- Read off the corresponding BMI centile from the red slanting lines.
- Plot the centile in the BMI grid at the top of the growth chart at the appropriate age.

**What does a high or low BMI mean?**

Most children will have a BMI between the 25th and 75th centiles, whatever their height centile. A BMI above the 91st centile suggests overweight. A child above the 98th centile is very overweight (clinically obese). BMI below the 2nd centile is unusual and may reflect undernutrition, but may simply reflect a small frame or low muscle mass. BMI can vary a lot over time due to measurement error. If there has been a change it is therefore important to check whether this reflects a real change in weight or inaccurate measurements.
Assessment of puberty using Puberty Phases

Pubertal assessment requires care and sensitivity and should not be undertaken unless a parent or carer is present. A detailed evaluation of the development of puberty may be made using the five Tanner stages, where pre-puberty is Stage 1 and maturity is Stage 5. This staging process requires considerable user experience and intimate examination.

A simpler system involves placing the child in one of just three phases of puberty: **Pre-puberty**, **In Puberty** and **Completing Puberty**. This Puberty Phase can often be ascertained through simple questions about the appearance of secondary sexual characteristics and milestones such as starting periods.

If an intimate examination is required a parent of chaperone should always be present and these should only be undertaken by staff who have been trained in this area.

### Puberty Phases

**By history from parents, carers, or young person**

<table>
<thead>
<tr>
<th></th>
<th>Pre-puberty (Tanner stage 1)</th>
<th>In Puberty (Tanner stage 2-3)</th>
<th>Completing Puberty (Tanner stage 4-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Girls</strong></td>
<td>If all of the following:</td>
<td>If any of the following:</td>
<td>If all of the following:</td>
</tr>
<tr>
<td>No signs of pubertal development</td>
<td>Any breast enlargement pubic or axillary hair,</td>
<td>Started periods with signs of pubertal development</td>
<td></td>
</tr>
<tr>
<td><strong>Boys</strong></td>
<td>If all of the following:</td>
<td>If any of the following:</td>
<td>If any of the following:</td>
</tr>
<tr>
<td>High voice and</td>
<td>Slight deepening of the voice</td>
<td>Early pubic or axillary hair growth</td>
<td>Voice fully broken</td>
</tr>
<tr>
<td>No signs of pubertal development</td>
<td>Enlargement of testes or penis</td>
<td></td>
<td>Facial hair</td>
</tr>
</tbody>
</table>

**By clinical examination**

<table>
<thead>
<tr>
<th></th>
<th>Pre-puberty (Tanner stage 1)</th>
<th>In Puberty (Tanner stage 2-3)</th>
<th>Completing Puberty (Tanner stage 4-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Girls</strong></td>
<td>If all of the following:</td>
<td>If any of the following:</td>
<td>If all of the following:</td>
</tr>
<tr>
<td>No signs of pubertal development</td>
<td>Any breast enlargement so long as nipples also enlarged</td>
<td>Started periods (menarche) with breast, pubic and axillary hair development</td>
<td></td>
</tr>
<tr>
<td><strong>Boys</strong></td>
<td>If all of the following:</td>
<td>If any of the following:</td>
<td>If any of the following:</td>
</tr>
<tr>
<td>High voice and</td>
<td>Reddening of the scrotum</td>
<td>Early testicular or penile enlargement</td>
<td>Voice fully changed (broken)</td>
</tr>
<tr>
<td>No signs of pubertal development</td>
<td>Early pubic or axillary hair</td>
<td></td>
<td>Adult size of penis with pubic and axillary hair</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Facial hair</td>
</tr>
</tbody>
</table>

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**RCPCH**

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Leading the way in Children’s Health
**Is the timing of puberty normal?**

Children with measurements plotted on the left hand page of the chart will usually be in the ‘Pre-puberty’ phase. Signs of puberty before 8 years in girls and 9 years in boys are precocious and further assessment is necessary. The three vertical black lines (puberty lines) indicate the normal age limits for the phases of puberty described above.

After age 8 years children will be in either ‘Pre-puberty’ or ‘In puberty’.

If there are no signs of puberty by 13 years in girls and 14 in boys, then puberty is delayed and further assessment is indicated.

After 13 years in girls and 14 in boys most young people will be either ‘In puberty’ or ‘Completing puberty’.

After 16 years in girls and 17 years in boys most will usually be ‘Completing puberty’. If this is not the case, maturation is delayed and further assessment may be needed.

**Growth patterns during puberty**

Assessing growth during puberty is complex because of the variation in age when puberty starts and its varying rates of progression. As a result an individual’s centile during puberty will commonly differ from the centile tracked before puberty by up to one centile space, while children with relatively late or early puberty may differ by as much as 1½ centile spaces.

**What does a height in the shaded area below the 0.4th centile mean?**

This chart provides some extra guidance about the lower limit (0.4th) for height in girls 8-13 years and boys 9-14 years. For young people plotting in the shaded area their mid-parental centile should be assessed.

If they are In puberty or Completing puberty, they are below the 0.4th centile and should be referred.

In most instances a Pre-pubertal young person plotted in this area is growing normally, but comparison with the mid-parental centile and growth trajectory will assist the assessment of whether further investigation is needed.
References


2. www.who.int/childgrowth


