

# GROWTH AND ITS MEASUREMENT

[www.infantandtoddlerforum.org](http://www.infantandtoddlerforum.org)



## LEARNING POINTS

- 1 Measuring the growth of infants, toddlers and children is an important part of child health surveillance. It can help to detect overweight and underweight, short stature and faltering growth. It can also provide reassurance about normality.
- 2 Healthcare professionals should consider measuring the weight and length/height of toddlers if they or the parents have concerns about the toddler's health, feeding pattern, size or growth.
- 3 Healthcare professionals should be competent at taking accurate anthropometric measurements (weight, length/height and head circumference) and plotting them on growth charts.
- 4 Healthcare professionals whose role involves growth monitoring should be appropriately trained.
- 5 Measuring equipment requires regular calibration and maintenance for accuracy.
- 6 The UK has adopted WHO growth charts for the age range two weeks to four years based on measurements of normal healthy infants and toddlers who were breastfed during infancy.
- 7 Growth charts currently recommended for use in the UK are the UK-WHO and the UK90 growth charts. They come in a variety of formats and can be ordered from [www.healthforallchildren.co.uk](http://www.healthforallchildren.co.uk).
- 8 Normal healthy toddlers usually grow steadily along centile lines or parallel to them. Weight and length/height will not necessarily be on or close to the same centile lines.
- 9 Weight measurements are likely to vary more than length/height measurements in relation to centile lines. Small ups and downs in weight may be seen with short-term illnesses that affect food intake.
- 10 Most cases of 'growth faltering' are caused by inadequate food intake, which can have a number of causes, but can usually be dealt with in primary care settings.
- 11 To assess if a toddler is overweight or obese, his or her Body Mass Index (BMI) should be calculated and plotted on a BMI centile chart.
- 12 When referring toddlers with growth concerns to a paediatrician it is good practice to include both biological parents' height measurements and a mid-parental height calculation.

# GROWTH AND ITS ASSESSMENT

Growth, development and health are inextricably linked. Measuring the growth of infants, toddlers and children is an important part of child health surveillance. It can help to detect overweight and underweight, short stature and faltering growth. It can also provide reassurance about normality.

The linear (*length/height*) growth of toddlers (*defined as children aged one to three years of age*) is largely under the control of growth hormone (*secreted by the pituitary gland*) and thyroxine (*from the thyroid gland*). Food also plays a critical role, particularly in weight growth. Genes, inherited from each parent, mainly determine length/height.

Adequate nutrition will ensure that normal healthy toddlers maintain their genetically determined growth rate.

Inadequate or inappropriate food intakes can cause 'growth faltering' and in severe cases malnutrition. Excessive intakes of food and/or sugary drinks will lead to overweight or obesity.



## EXPECTED RATES OF GROWTH

Growth comprises two dimensions – weight and length/height. The body grows most rapidly during the first six months of life – healthy newborn infants double their birth weight by four to five months and triple it by a year. By the age of two years a healthy toddler is approximately half his or her adult height. Gains in both weight and length/height slow down throughout the toddler years as shown in the table alongside.

Average growth rates of infants and toddlers		
Age	Weight Gain (kg/yr)	Height Gain (cm/yr)
0-12 months	6.6	25
1-2 years	2.4	12
2-3 years	2	8



## ASSESSING THE GROWTH OF TODDLERS

When assessing the growth of a toddler both weight and length/height should be measured. Measurements of weight and length/height at intervals of about three and six months respectively are needed to provide meaningful information about growth rate. Measurements should be plotted on a growth chart.



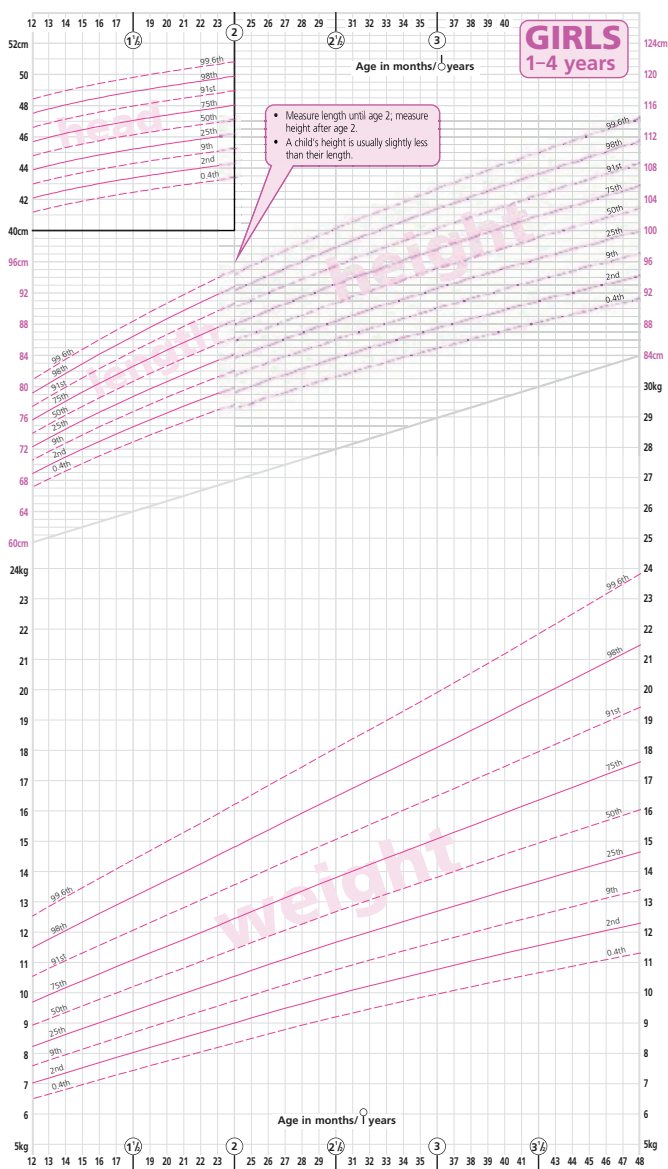
# WHAT IS A GROWTH CHART?

A growth chart is a visual representation of the normal distribution of the weights and length/heights of healthy normal children.

Two sets of growth charts, published by the Royal College of Paediatrics and Child Health, are recommended for use in the UK:

- For children 0-4 years: plot their measurements on the UK-WHO Growth Chart 0-4 years.
- For children over 4 years: plot their measurements on the UK Growth Chart 2-18 years.

1. data from a WHO study of children aged 2 weeks to 4 years which form growth standards rather than growth references and represent optimal growth. This is regarded as the most appropriate standard against which to measure the growth of all children, irrespective of their ethnicity or how they are fed. The length/height sections of charts have a disjunction at two years, corresponding to a change in measurements from supine length to standing height. There is a separate pre-term section for babies born from 32 - 37 weeks gestation.



UK-WHO growth chart for girls 1-4 years

The UK-WHO charts 0-4 years are based on two sets of data:

1. measurements at birth of Caucasian children in the UK between 1978 and 1990 and

The UK Growth Chart 2-18 years uses the same data for children 2-4 years. But for children over 4 years the data is based on Caucasian children in the UK measured between 1978 and 1990.

Close Monitoring growth charts are available for plotting children requiring closer monitoring. Specialist charts are available for certain conditions in which patterns of growth differ from normal e.g. *Down Syndrome and Turner Syndrome*.

## OBTAINING GROWTH CHARTS

Growth charts are included in the Personal Child Health Record but can be obtained in a number of other formats from:

[www.healthforallchildren.co.uk](http://www.healthforallchildren.co.uk)

Three growth charts are used most commonly: one for weight, one for length/height and one for head circumference. There are separate growth charts for boys and girls. BMI charts are also available from the same website.

## WHAT IS A CENTILE LINE?

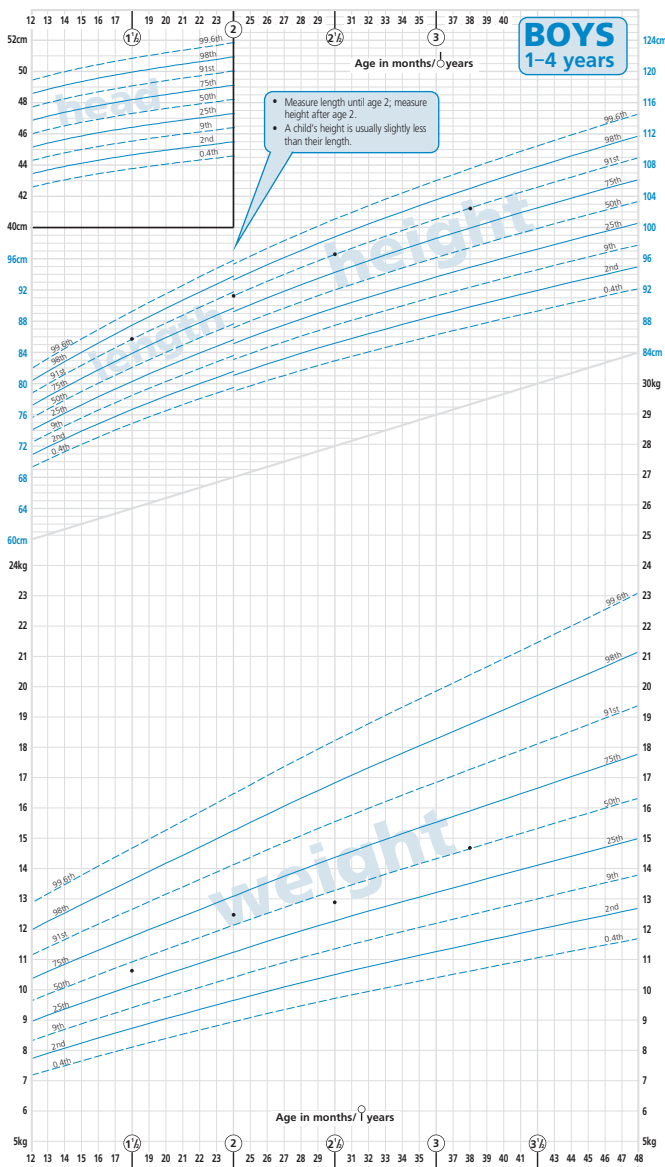
Take 1,000 toddlers of the same age – say two years and three months – arranged in a queue in order of their height. If this queue is divided into 100 equal small queues of 10 toddlers each, then each division between these small queues is called a 'centile'. The 2nd centile separates the 20 shortest toddlers from the other 980 toddlers. The 75th centile separates the 750 shortest toddlers from the other 250 toddlers. The 50th centile represents the 'median' height for the group and divides the 500 shorter toddlers from the 500 taller ones.

Centile lines describe the distribution of growth measurements for all ages. The charts have nine centile lines – the 0.4th, 2nd, 9th, 25th, 50th, 75th, 91st, 98th and 99.6th centiles. Centile lines are also applied to weight growth charts. Indeed the growth of any part of the body, such as head circumference or mid upper arm circumference, can also be described using centile charts, which are constructed in the same way.

# HOW ARE TODDLERS EXPECTED TO GROW?

The weights and length/heights of most toddlers who are growing and developing normally will be on or between the 2nd and 98th centiles. As toddlers get older and subsequent measurements of length/height and weight are plotted, measurements are expected to remain fairly close to the same centile. This is called 'growing along a centile'. In general, weight will vary more around a centile line than does length/height. Food intake can affect weight, but not length/height except in prolonged malnutrition. Emotional deprivation and some rare diseases can affect both weight and length/height growth.

**Toddlers will not necessarily be on the same centile line for both length/height and weight.**



Growth charts illustrating a tall, slim, boy toddler

The weights and length/heights of some toddlers will lie on roughly the same corresponding centiles, while others will have their height close to one centile line and their weight near another centile line. For example the length/height of a tall slim toddler might be on the 91st centile and his weight on the 50th centile. A toddler whose length/height is on the 25th centile and weight on the 75th centile will be shorter and chubbier than average. These differing builds of normal healthy toddlers are partly determined by their genetic makeup, as well as their diet.

Plotting measurements of weight and height on a growth centile chart enables comparison of a toddler's growth with expected growth, or with a 'reference population' of normal healthy children.

# WHEN TO MEASURE

## WEIGHT

Weight measurements during infancy should be taken at birth, then during the first week as part of the feeding assessment. Once feeding is established infants only need to be weighed at clinic attendances for immunisations at two, three and four months<sup>3</sup>. Weight may be measured more frequently if there are concerns about health and development, but not more often than once a month up to 6 months and once every two months from 6 to 12 months<sup>3</sup>.

Toddlers should be weighed next when they attend for their immunisations at about 13 months and then again at their two year review between two and two-and-a-half years old<sup>4</sup>, but thereafter not usually until school entry, unless there are concerns.

## LENGTH/HEIGHT

There has been no research to support the routine measurement of length in the first two years of life. However routine length measurements are recommended for all toddlers who are very small for gestational age at birth or have dysmorphic features<sup>5</sup>. This is usually carried out during clinical and developmental assessments. Height should be measured at their two year review between two and two-and-a-half years old<sup>4</sup>.

## HEAD CIRCUMFERENCE

Head circumference should be measured at birth and at six to eight weeks. If there is a crossing of centiles upward or downward or signs suggestive of hydrocephalus or microcephaly then two further measurements over a four-week period should be carried out. Obviously if there are concerns about a toddler's development then measuring head circumference should be part of a full neurological examination.

	Weight	Length/Height	Head circumference
<b>Infants and toddlers born at term</b>	At birth, during the first week and at 2, 3, 4 & 13 months and then again between two and two-and-a-half years old <sup>4</sup> .  Additional weights may be taken if there are health concerns or parents request reassurance however weight should not be measured more frequently than once per month during infancy	When there are health concerns or parents request reassurance.  Height should be measured between two and two-and-a-half years old <sup>4</sup>	At birth and 6-8 week examination
<b>Infants and toddlers</b> • <i>born preterm, or</i> • <i>noted to be very small for gestational age at birth</i> • <i>with dysmorphic features</i> • <i>with health problems</i>	At birth, during the first week and at attendance for immunisations and clinical assessments	At birth, at 6-8 weeks and when there are specific indications or parental concerns	At birth and 6-8 week check and as part of examinations for hydrocephalus or microcephaly
<b>Toddlers with developmental concerns</b>	At clinical assessments	At clinical assessments	As part of neurological examination

Summary chart of different measures and when it is recommended they be done<sup>3,5</sup>

During the preschool years parents may seek reassurance that their toddler is growing well and growth measurements can be taken for this purpose. Healthcare professionals should consider measuring the weight and length/height of toddlers if they or the parents have any concerns about a toddler's health, feeding pattern, size or growth<sup>5</sup>.



# HOW TO MEASURE BODY WEIGHT

Up until their second birthday, toddlers should be weighed nude, without a nappy. Over this age they should be weighed in light underwear without shoes and socks. They should be weighed to the nearest 10g (*1/100th of kg*).

Toddlers who are unsettled or distracted can be held by a parent and both weighed together. The parent's weight is then taken separately and subtracted from the total weight. Alternatively the parent sits on the scales, which are zeroed. The parent, while still on the scales, holds the child and both are weighed together, so the scales show the weight of the child only.



Infant scales

European regulations state that scales should be digital, electronic, metric — weigh in kilograms (kg) and grams (g) — and self-zeroing<sup>6</sup>.

## Equipment and calibration

Digital electronic scales that conform to European regulations should be used. Measurements should be made in kilograms (kg) and grams (g). Infant scales can be used for toddlers of up to 10kg. Toddlers over 10kg should be weighed on sitting or standing scales.



Sitting scales

Scales should be checked daily to ensure they are accurate by weighing a known weight, such as a bag of pasta. It is the responsibility of the person using the scales to make sure they are maintained and calibrated. If many people use them then one person should be responsible for calibration. Scales should be carefully calibrated at least once a year<sup>3,6</sup>. The companies that sell scales offer service agreements to do this. Care should be taken when children are weighed in different settings such as, at home, at the GP surgery or at a clinic, as calibration may vary.

# HOW TO MEASURE LENGTH/HEIGHT

## TODDLERS UNDER TWO YEARS

Up until a toddler's second birthday, length is measured lying down and after that standing height should be measured. The length of the toddler should be measured without any clothing, including the nappy, which can distort the hips and shorten the length measurement. Two people are needed to obtain an accurate length measurement. The toddler should lie on his or her back with one person (*ideally a parent*) holding the head against the headboard with both hands. The corner of the toddler's eye should be in a vertical line with the middle of the ear (*known as the Frankfort Plane*). The second person should gently flatten the knees and flex the ankles of the toddler to 90 degrees and bring the footboard up to the flat soles of the flexed feet. The length measurement is then read off the scale, to the nearest 1/2cm. Readings in a specialised unit by experienced staff may be taken to the nearest millimetre<sup>5</sup>.

## Equipment and calibration

A rollameter or a lying stadiometer is usually used. Most equipment is either self-calibrating or comes with a one-metre standard measure with which to calibrate before use.



Stadiometer for measuring length

## TODDLERS OVER TWO YEARS

The toddler should be wearing light underwear, without socks and shoes. He or she should stand upright with heels, buttocks and shoulders touching the stadiometer and look straight ahead with the corner of the eyes horizontal with the middle of the ear. To maximise the height, the head should be lifted slightly by placing fingers below the toddler's jaw just below the ears at the mastoid process.

### Equipment and calibration

A Leicester Height Measure or a stadiometer with the scale fixed to the footplate, is the ideal equipment because when installed correctly, it is self-calibrating. A stadiometer fixed to the wall must be installed appropriately to be accurate and should always be calibrated with a rule before use<sup>5</sup>.



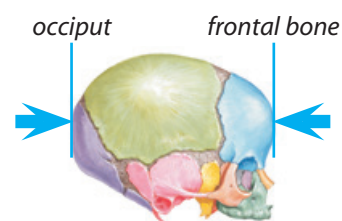
Standing stadiometer

## HOW TO MEASURE HEAD CIRCUMFERENCE



Head circumference measurement using Lasso-o™ tape

Head circumference should be measured three times, to the nearest millimetre, and the average circumference taken. The tape is placed around the middle of the forehead to make sure that it encircles the widest diameter around the frontal and occipital bones.



### Equipment

A non-stretch tape measure should be used, such as a Lasso-o™ Child Growth Foundation tape, which needs to be threaded.

## PLOTTING MEASUREMENTS ON GROWTH CHARTS

1. First calculate the age of the toddler and mark it on the horizontal axis of the growth chart. Correct the age of toddlers born prematurely.
2. Find the length/height or weight on the vertical axis of the growth chart.
3. Put a dot on the chart to mark where a vertical line from the age axis and a horizontal line from the weight/length/height axis intersect. Do not use a cross or a dot with a circle around it because these symbols are difficult to read when plotted closely together.

### Correcting the age of toddlers born prematurely

It is important to correct for prematurity:

- For infants born 32-37 weeks age should be corrected during the first year of life
- For infants born before 32 weeks gestation age should be corrected for two years.

A toddler under two years of age, born at 31 weeks gestation, for instance, was born nine weeks early ( $40 - 31 = 9$  weeks). This child's corrected age will always be nine weeks less than his or her actual age since birth. When calculating the corrected age, subtract nine weeks from the actual age since birth date. For example, when the child is one year and 26 weeks old the corrected age will be one year and 17 weeks ( $26 - 9 = 17$  weeks). This weight is then plotted at their actual age with a horizontal arrow drawn back through 9 weeks to a plot of corrected age. The arrow shows quite clearly that age has been corrected.

# INTERPRETING PLOTS ON GROWTH CHARTS

## SINGLE PLOTS OF WEIGHT, HEIGHT OR LENGTH

Single plots of weight will indicate where a child is in relation to the general population, i.e. heavier or lighter than average. Similarly for height, a single plot will indicate if a toddler is of average height or taller or shorter than average.

Measurements of both weights and heights should both be considered when interpreting either. Plots between the 2nd and 98th centiles are generally regarded as 'normal.' Plots outside this range should be considered carefully.

A toddler with a length or height below the 0.4th centile should be referred to a paediatrician for investigation of 'short stature'<sup>5</sup>.

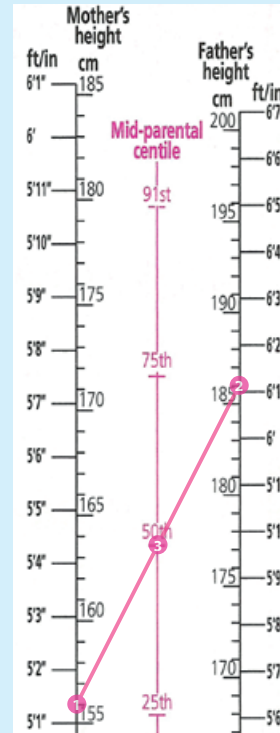
The parent height comparator can be used to determine the mid parental centile if the toddler's height growth appears out of step with the adult heights of his or her biological parents. It is included in the UK Growth chart 2-18 years and the 2-20yr Childhood and puberty close monitoring chart.

To do this obtain the heights (in cm) of both parents and plot them on their respective scales. Join the two points with a line and the mid parental centile is the point where this line crosses the centile line in the middle.

The comparison of the child's current height or length centile with their mid parental centile should be discussed with a GP or paediatrician to consider whether the child should be investigated<sup>5</sup>.

### Parent Height Comparator - Girls

1. Mother's Height (MH) 156cm
2. Father's Height (FH) 186cm
3. Mid parental centile is 50th centile



Example of a mid-parental height calculation for a girl

## INTERPRETING GROWTH WITH TWO OR MORE PLOTS OF LENGTH/HEIGHT AND WEIGHT

It is more important to know whether a child is following a centile line than to simply know what his or her weight or length/height is at a single point in time. Two plots taken at different ages give a measure of a child's rate and pattern of growth. While changes in weight centiles can be attributed to short-term health problems, such as a bout of gastroenteritis, changes in height growth can indicate longer-term concerns.

### Factors to consider when interpreting the pattern of growth

- **Measurement error:** when a toddler crosses centiles, first check that both weight and length/height measurements are correct – many instances of growth concern arise from a gross error of measurement – for instance the scales are not accurate or are incorrectly calibrated.
- **Toddler's genetic potential:** A toddler with short parents is also likely to be short, but a child who is short and has very tall parents may not be achieving his or her appropriate genetically expected height.
- **Weight and height are both on low centiles:** A toddler who follows the lower centiles of the chart for both weight and length/height, and who has always followed these centile lines, is likely to be growing appropriately – both weight and length/height are proportional. Because the centile lines describe the growth of the normal population, there will always be some toddlers whose weights and length/heights lie around the lower centiles and, similarly, some toddlers whose weights and length/heights lie around the upper centiles. Parents may need reassurance that their short toddler is growing as expected. As discussed above, there will be a few toddlers who have short stature – height/length <0.4th centile. In some cases this will be normal for that toddler, but in other toddlers it may be due to an underlying medical condition (*growth hormone deficiency for instance*).



- **Weight measurement is on a much lower centile than length/height measurement:** Some children are thin compared to others of their age, but if they have always been thin, and their height continues to follow the 'usual' centile line for that child, then it is unlikely that there is a problem. However a toddler whose weight crosses centiles downwards over time has 'growth faltering' and may be failing to thrive. There are a number of possible causes of this growth pattern, which include insufficient food intake, certain diseases, and other social, domestic and environmental problems. **see Factsheet 3.2**
- **Weight centile is more than two centile lines above that of the length/height centile OR the weight has crossed centile lines upwards:** A toddler with either of these growth patterns may be overweight or obese or becoming so. This should be assessed by calculating the BMI and plotting it on a BMI centile chart. There is one for boys and one for girls. A BMI over the 91st centile indicates overweight, and above the 98th centile is defined as obesity. **see Factsheet 3.3**

Growth charts simply describe the rates and patterns of growth of normal healthy children. The plots on them can raise concerns about growth, health and development, and they can suggest causes of impaired growth, but they are not diagnostic.

**Factsheet 3.2** discusses the diagnosis and treatment of undernutrition, failure to thrive and growth faltering.

**Factsheet 3.3** discusses the identification and management of overweight and obesity.

### Open Book On Growth

An interactive, web-based, learning programme designed to teach the principles and practice of growth assessment, including how to measure accurately, use equipment, plot measurements on growth charts, interpret them and take appropriate action. See [www.infantandtoddlerforum.org](http://www.infantandtoddlerforum.org).

### References and Further Reading

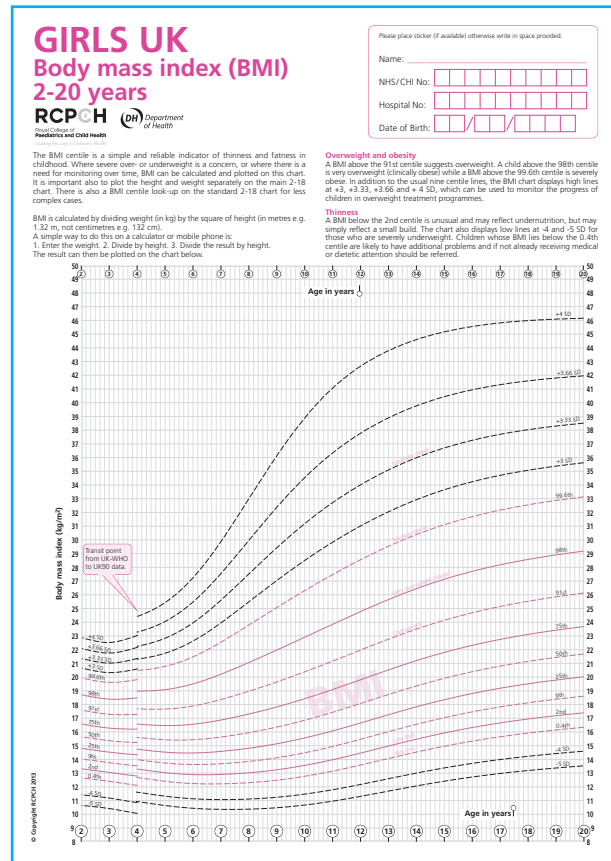
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2. WHO Child Growth Standards: length /height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age. Methods and development. Geneva, Switzerland: World Health Organization, 2006.
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6. Council Directive 90/384/EEC on the harmonization of the laws of the Member States relating to non-automatic weighing instruments. 20 June 1990.
7. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ*. 2007; 335:194.

### Resources

<http://www.rcpch.ac.uk/growthcharts>  
<http://www.rcpch.ac.uk/who-uk-growth-charts-resources-videos>

## BMI CENTILE CHARTS

Body Mass Index (BMI) is the WHO agreed measure of thinness and fatness although it is not a measure of body fat.



Example of a girls BMI centile chart

BMI is defined as weight in kilograms divided by height in meters squared ( $BMI = Wt / (Ht)^2$ ). A toddler with a BMI below the 2nd centile is classified as very thin<sup>7</sup>. The cause should be considered.

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# GROWTH AND ITS MEASUREMENT GUIDANCE & TIPS FOR PARENTS



- Growth measurements can help to monitor your child's health and development and reassure you that your child is growing normally. They can also identify:
  - toddlers who are likely to become overweight or underweight
  - toddlers who are growing too slowly
  - toddlers who are very short or very tall and who may have a health problem
- Toddlers grow more slowly than they did in their first year.
  - On average toddlers gain about 2.5kg (5 pounds) and grow about 12cm (4 inches) in length between their first and second birthdays.
  - On average toddlers gain about 2kg (4 pounds) and grow about 8cm (3 inches) in height between their second and third birthdays.
- If you have no concerns about your toddler's health or development then there is no need for them to be weighed and measured except at clinical or developmental assessments. However if you do have worries then ask your health visitor to carry out measurements. These will be plotted on a growth chart to determine if your child's growth is as expected for his or her age.
- Children of tall parents tend to be taller than children of the same age whose parents are short.
- Toddlers under two years old should be weighed and measured with no clothes, nappy or shoes and socks on. They will have their length measured while lying down. You may be asked to hold your toddler's head while his or her length is being measured.
- Toddlers over two years old will be measured in light underwear with no shoes or socks on. They will have their height measured when standing up.
- At least two consecutive measurements of weight and length/height over time are needed to give a picture of a toddler's growth rate.
- If your child is growing normally then his or her weight or height will steadily rise along, or be parallel to, the centile lines marked on the growth chart.
- Your toddler's weight and length/height will not necessarily be on the same centile.
- Toddlers whose length or height is below the 0.4th centile or drops from a higher to a lower centile may have a health problem. This may require referral to a paediatrician for assessment.
- Toddlers on a much higher centile for weight than height may be overweight or obese. This can be checked on a BMI centile chart.
- The head circumference of toddlers is usually only measured when there are concerns about their development.

