



University  
of Glasgow

Wright, C.M., Williams, A.F., Elliman, D., Bedford, H., Birks, E., Butler, G., Sachs, M., Moy, R.J., and Cole, T.J. (2010) *Practice pointer: Using the new UK-WHO growth charts*. *British Medical Journal*, 340 (c1140). pp. 647-650. ISSN 0959-535X

<http://eprints.gla.ac.uk/36751>

Deposited on: 17 May 2012

## PRACTICE POINTER

### Using the new UK-WHO growth charts

Charlotte M Wright,<sup>1</sup> Anthony F Williams,<sup>2</sup> David Elliman,<sup>3</sup> Helen Bedford,<sup>4</sup> Eileen Birks,<sup>5</sup> Gary Butler,<sup>4,6</sup> Magda Sachs,<sup>7</sup> Robert J Moy,<sup>8</sup> Timothy J Cole<sup>4</sup>

<sup>1</sup>Faculty of Medicine, University of Glasgow, Glasgow

<sup>2</sup>St George's, University of London

<sup>3</sup>GOSH@Haringey, Great Ormond Street Hospital, London

<sup>4</sup>Institute of Child Health, University College London, London

<sup>5</sup>Division of Childhood and Family Studies, Northumbria University, Newcastle upon Tyne

<sup>6</sup>University College London Hospital, London

<sup>7</sup>Salford NHS Primary Care Trust, Salford

<sup>8</sup>Institute of Child Health, University of Birmingham

Correspondence to: C M Wright, Professor of Community Child Health, PEACH Unit, QMH Tower, Yorkhill Hospitals, Glasgow G3 8SJ  
[cmw7a@clinmed.gla.ac.uk](mailto:cmw7a@clinmed.gla.ac.uk)

Cite this as: *BMJ* 2010;340:c1140  
doi: 10.1136/bmj.c1140

In April 2006 the World Health Organization published a new growth standard for children aged under 5 years.<sup>1</sup> The United Kingdom was one of the first developed countries to adopt it, and the Department of Health commissioned the Royal College of Paediatrics and Child Health to design new growth charts and develop new evidence based instructions and supporting educational materials. These charts (known as the UK-WHO growth charts) are now in use for monitoring the growth of children aged under 4 years. This article explains how the new charts differ from the previous ones and how they should be used by anyone who plots or interprets growth measurements.

#### Why have new charts?

The WHO growth standard was compiled from data collected in six countries (the United States, Norway, Oman, Brazil, India, Ghana), recruiting only infants who were born at term to non-smoking, relatively affluent mothers after a healthy pregnancy. All were breast fed exclusively or predominantly for about the first six months of life.<sup>2</sup> The linear growth patterns of these highly selected, healthy infants were strikingly similar between countries, supporting the view that they represent a standard against which the growth of all children can be assessed, wherever they live and however they are fed.<sup>3</sup> The UK has

adopted the WHO standard as it establishes the breastfed child as the norm, is suitable for all ethnic groups, and defines optimal growth.<sup>4</sup>

The new charts amalgamate WHO data from age 2 weeks, with recalculated British 1990 (UK90) birth data. These data were used in preference to those of the WHO standard as the WHO dataset has no preterm birth data and the WHO term birth weights were appreciably lower.<sup>4</sup>

#### Who are the new charts for?

The new charts replace the current UK90 charts for all children born from May 2009 in England<sup>5</sup> (January 2010 in Scotland<sup>6</sup>); data for older children do not therefore need to be replotted. A5 versions of the charts are being incorporated into all new personal child health records, and hospitals and clinics should also have stocks of the A4 format chart. Remaining stocks of UK90 charts can be used for older children as they are still appropriate beyond the age of 4 years.

#### How do the new charts differ from the old?

The new charts can be downloaded as pdf files from the Royal College of Paediatrics and Child Health's website ([www.growthcharts.rcpch.ac.uk](http://www.growthcharts.rcpch.ac.uk)). The most obvious changes are around birth (fig 1). The charts are now presented with a separate preterm section, then an infancy 0-1 year chart. Birth weights for term babies born from 37 completed weeks' gestation are plotted at "age 0" on the infancy chart. There are no centile lines between ages 0 and 2 weeks, partly because of the disjunction between the two datasets but mainly because it is difficult to characterise a normal pattern of postnatal weight loss and regain as a centile distribution.

Like the previous UK90 charts,<sup>7</sup> the new charts display nine centile curves (fig 1), with the centiles spaced two thirds of a standard deviation apart.<sup>8</sup> The lowest centile, the 0.4th, represents the threshold below which only 1 in 260 optimally growing children will fall and helps to identify extremely low measurements. In the new design the 50th centile has been deliberately de-emphasised to avoid implying to parents that all children should grow along this line. However, there are centile labels at both ends of each curve and the parameter label (such as weight, length) always sits on the 50th centile to support plotting accuracy (fig 1).

#### SUMMARY POINTS

The new UK growth charts for children aged 0-4 years (designed using data from the new WHO standards) describe the optimal pattern of growth for all children, rather than the prevailing pattern in the UK (as with previous charts)

The new charts are suitable for all ethnic groups and set breast feeding as the norm  
UK children match the new charts well for length and height, but after age 6 months fewer children will be below the 2nd centile for weight or show weight faltering, and more will be above the 98th centile

The new charts look different: they have a separate preterm section, no lines between 0 and 2 weeks, and the 50th percentile is no longer emphasised

The charts give clear instructions on gestational correction, and there is a new chart for infants born before 32 weeks' gestation

The instructions advise on when and how to measure and when a measurement or growth pattern is outside the normal range

The charts include a "look-up" tool for determining the body mass index centile from height and weight centiles without calculation and aid for predicting adult height

The charts and supporting educational materials can be downloaded from [www.growthcharts.rcpch.ac.uk](http://www.growthcharts.rcpch.ac.uk)

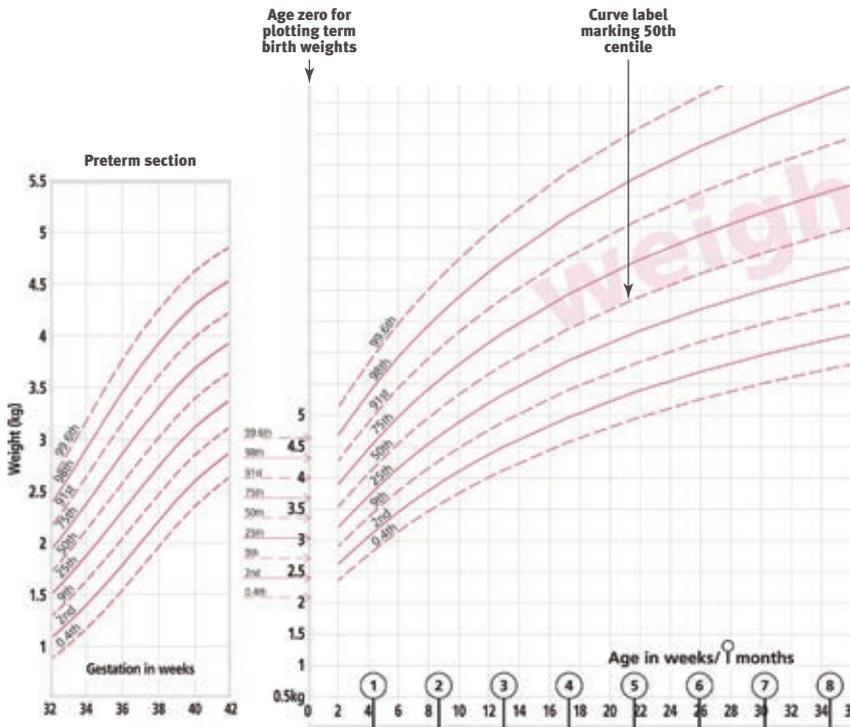


Fig 1 | Detail from A4 girls' chart

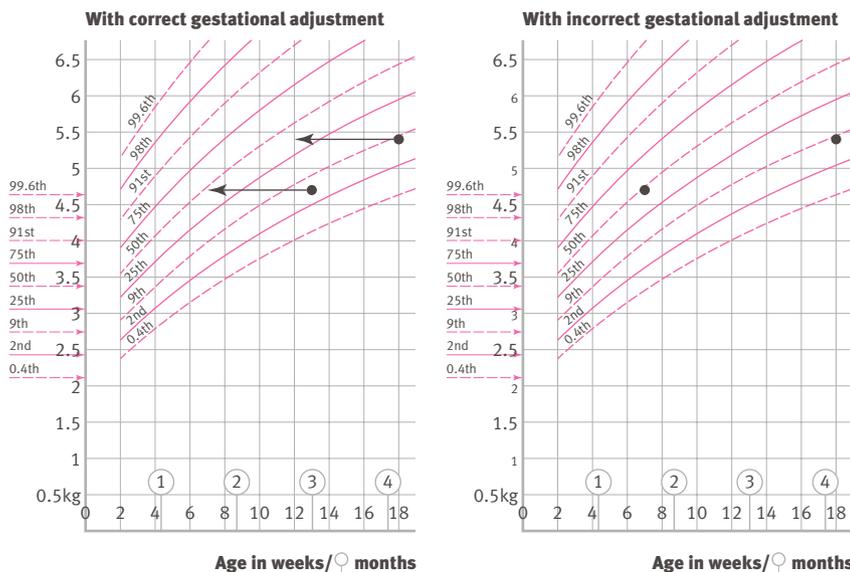


Fig 2 | Left panel: Gestational adjustment using “arrow drawn back” method. Plot the actual age and then draw a line back the number of weeks that the baby was early and mark with an arrow. The point of the arrow shows the baby’s centile with adjustment for preterm birth. Right panel: Failure to use the “arrow drawn back” method can lead to confusion and clinical risk: in the same baby the first point has been plotted at gestationally adjusted age (7 weeks) and the second at chronological age (18 weeks), leading to apparent weight faltering

**How will UK children’s growth look on the new charts?**

Analysis of two UK cohorts suggested that children can be expected to show a close match to the new charts for length and height at all ages.<sup>9</sup> Unlike all previous charts, the new charts accurately reflect the pattern of weight gain during the early weeks of life (as WHO collected measurements at that age). This means that

the apparent “dip” in weight associated with use of the UK90 reference in children aged 2-4 weeks<sup>10</sup> will no longer be present, and UK infants should on average be on roughly the same centile at 2 weeks as at birth. From age 2 weeks to 6 months UK infants match the new charts closely for weight<sup>9</sup> but after 6 months seem relatively heavy, with twice as many children expected to be above the 98th centile by the age of 1 year. The corollary of this is that probably only 0.5% of children will be below the 2nd weight centile, with far fewer children dropping to lower weight centiles over the first year.<sup>9</sup> As children approach school age the differences in weight between the new charts and the UK90 charts become much smaller. Most children will show little change in centile position when they switch back to the UK90 charts at age 4. However, very light children, who are more likely to have been monitored up to that age, may show a drop of up to one centile space.<sup>4</sup>

**How should the new charts be used?**

**The neonatal period**

Research has shown that, contrary to concerns by many health professionals, early weighing supports rather than discourages breast feeding.<sup>11</sup> It is therefore now recommended that babies be weighed as a minimum at birth and at age 5 days and 10 days as part of the assessment of feeding.<sup>12</sup> At this stage the important issue is not centile position, but how current weight relates to birth weight. Almost all babies lose some weight after birth, but longitudinal studies in healthy infants suggest that most will have recovered their birth weight by age 2 weeks and only 3-7% of children ever lose as much as 10% of their birth weight.<sup>10,13</sup> One of these studies found no major medical problems in 26 infants with more than 10% loss in the first 12 days,<sup>10</sup> making feeding problems the likeliest explanation. Thus in such circumstances, as well as exclusion of rare underlying medical problems, effective support of feeding is equally, if not more, important.

**Preterm infants**

Children born between 32 and 36 completed weeks’ gestation will now be plotted on the new preterm (birth for gestation) section of the chart until 2 weeks post-term (fig 1). After that, their data can be plotted on the infancy chart at their gestationally adjusted age, using the “arrow drawn back” method (fig 2, left panel). This method does not require additional calculations and shows clearly that adjustment has been made, which should reduce the risk of plotting errors (fig 2, right panel). There is also a new “low birthweight chart” (23 weeks’ gestation to 2 years) designed for infants born before 32 weeks, as well as any other sick neonates. The “arrow drawn back” method is not practical in this group so the chart has a system of date boxes to aid gestational adjustment. There are still no standards that fully reflect the postnatal growth of very preterm infants, so such infants plotted on this chart will commonly fall through two or more centile spaces in the early weeks. The chart has a larger scale and goes down to low values, with lines down to five standard deviations below the mean for the assessment of very small infants,

so it should also be useful for plotting measurements of infants requiring frequent review in the first two years of life, such as children showing weight faltering (failure to thrive).

For infants born at 32-36 weeks' gestation, adjustment makes little difference to centile position after 12 months, but for those born before 32 weeks it makes a considerable difference and needs to be continued to age 2 years.

### Measuring

Anyone who measures children should be properly trained. Digital video clips showing recommended measuring equipment and techniques can be downloaded from [www.growthcharts.rcpch.ac.uk](http://www.growthcharts.rcpch.ac.uk).

After the neonatal period the latest UK recommendations specify only that all babies should be weighed at a check at six to eight weeks, then only when there is parental or professional concern.<sup>14</sup> An earlier, more detailed review recommended that children should be weighed near the time of each routine immunisation.<sup>15</sup> The latter approach ensures reasonably close monitoring of weight in the first six months, when weight faltering usually begins.<sup>16</sup> If weights are recorded at intervals that are too close together, natural variability and measurement error will be greater than the potential weight gain in that period, so they can be misleading. The expert group therefore suggests that even where there is concern babies should be weighed no more than (a) monthly before 6 months, (b) every two months aged 6-12 months, and (c) every three months after that. This reflects the progressive slowing of weight gain in the first year.

Very little formal evidence exists on monitoring of head circumference or length. Current recommendations are that head circumference should be measured in the first few days, once any moulding has resolved, and at the eight week review, with subsequent measurements only if there are worries about head size or development.<sup>14</sup> During the evaluation and consultation on the design of the new UK charts, wide variation in the practice of length measurement was identified. Many districts almost never measured in primary care, while others did so frequently, though often with poor equipment or technique. The instructions thus emphasise the importance of measuring length using appropriate equipment and two staff to measure whenever slow or excessive weight gain or growth are a concern, rather than at set ages. The WHO standard provides data for length up to the age of 2 years and standing height thereafter. This causes a small step down in the centile lines at age 2, as height is consistently slightly less than length.

### Plotting

Plotting exercises used for evaluating the new charts showed very high rates of plotting errors on all formats, so the instructions recommend that plotting should be done in pencil, whereas the actual measurements should be recorded in ink in the clinical notes or personal child health record. The instructions now offer recommended descriptive terminology to avoid ambiguity (fig 3).

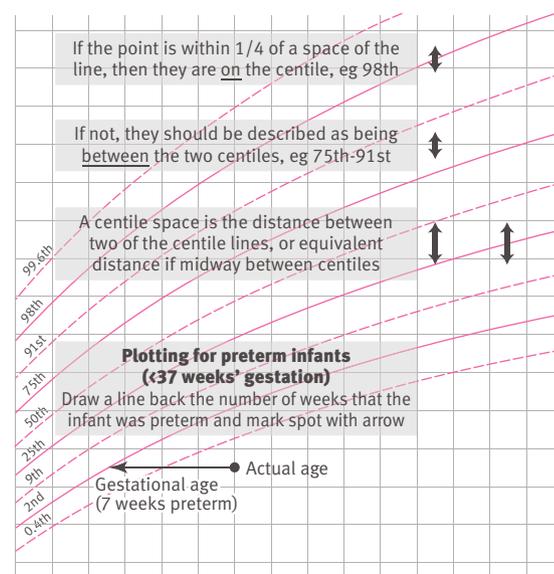
### New chart tools

#### Body mass index

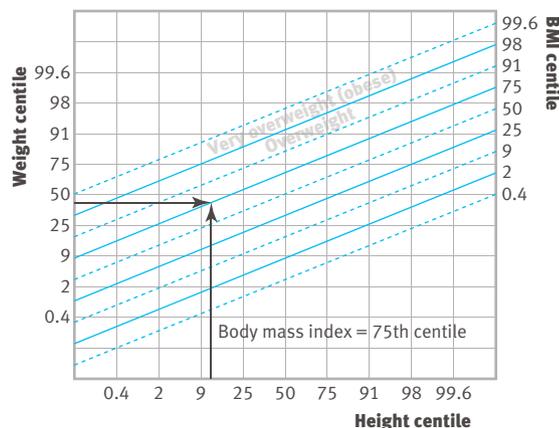
Body mass index is a useful indicator of fatness and thinness from the age of 2, when height can be measured with acceptable accuracy and precision. In the past, body mass index had to be calculated and then plotted on a centile chart as it changes through childhood. The new A4 chart now includes a "look-up" tool (fig 4), which enables the centile for the body mass index to be read without calculation, once height and weight centile are known.<sup>17</sup> This should encourage wider use of body mass index in childhood.

#### Adult height prediction

A child's final (adult) height is more closely related to his or her own height throughout childhood than to parental heights.<sup>18</sup> The UK-WHO chart includes an adult height predictor, for use from the age of 2 years, which applies this principle and adjusts for regression to the



**Fig 3 | Plotting terminology.** A child's measurement should be described as being on a centile or between two centiles. Movement up or down the chart can be expressed in terms of centile spaces



**Fig 4 | "Look-up" tool for ascertaining the body mass index centile**

- Plot the most recent height
- Find corresponding centile on the adult scale
- Four out of five children will be within 6 cm of this value as adults

For example, if a child is on the 75th centile for height, the adult height predictor suggests that he or she may reach an adult height of 181 (range 175-187) cm

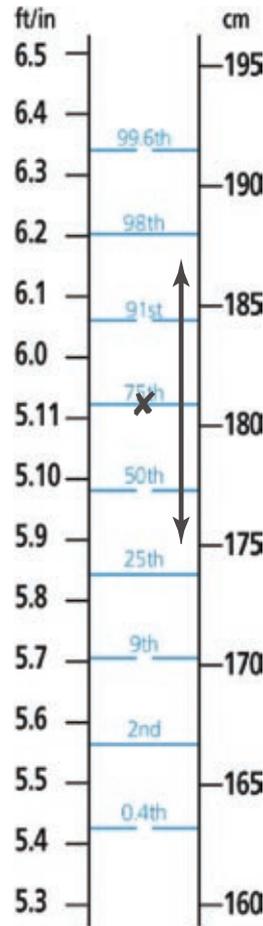


Fig 5 | Adult height predictor

**WHERE TO GET THE CHARTS AND FURTHER INFORMATION**

The charts can be purchased from Harlow Printing, Maxwell Street, South Shields NE33 4PU or from sales@harlowprinting.co.uk

The charts can be downloaded from [www.growthcharts.rcpch.ac.uk](http://www.growthcharts.rcpch.ac.uk). Anyone wishing to print the charts commercially should first obtain permission from the Department of Health (MBCrownCopyright@dh.gsi.gov.uk) and must adhere to the Department of Health printing specification

The electronic data on which the charts are based can be obtained from the Royal College of Paediatrics and Child Health ([growthchart@RCPCH.ac.uk](mailto:growthchart@RCPCH.ac.uk)) for use in any chart plotting software or growth database

The instructions on the A4 chart are aimed at health professionals. They draw on research evidence and UK policy on screening and referral and aim to be relevant to most users

All information in the personal child health record is now aimed at parents, and the charts are also referenced in the new *Birth to Five* book ([www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH\\_107303](http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_107303))

An A5 leaflet is also available in England from the Department of Health (visit [www.orderline.dh.gov.uk](http://www.orderline.dh.gov.uk) and quote 294502 "Using the new UK-World Health Organization 0-4 years growth charts")

A wide range of supporting educational materials is available from [www.growthcharts.rcpch.ac.uk](http://www.growthcharts.rcpch.ac.uk)

mean (fig 5). Eighty per cent of children will attain a height within a 6 cm range above or below the indicated estimate; more precise estimates involving estimation of bone age would not be useable at this age. A paper describing the predictor is in preparation.

**Conclusions**

Although the new charts look different from the old, they should be easier to use, once users are trained appropriately. Materials suitable for teaching both experienced staff and students are freely downloadable from [www.growthcharts.rcpch.ac.uk](http://www.growthcharts.rcpch.ac.uk). The availability of these materials should not only support the transition to the UK-WHO charts, but also strengthen general understanding of the use and interpretation of growth charts.

We thank John Short, Diane Hall, Christine Charlton, and Stephen van Vloten for their work on the illustrations used in this article.

**Contributors:** All authors collaborated in writing this article. CMW drafted it, and all the other authors commented on each draft.

**Funding:** No special funding.

**Competing interests:** All authors were members of the Growth Chart Expert Group. TJC and CMW have acted as advisers on certain elements of the WHO Multicentre Growth Reference Study. TJC receives royalties from his LMSchartmaker software used to construct the UK birth for gestation charts. GB has received research funding and lecture and professional consultancy fees from all the principal manufacturers of human growth hormone.

**Provenance and peer review:** Not commissioned; externally peer reviewed.

- 1 World Health Organization. The WHO child growth standards. 2009. [www.who.int/childgrowth/en/](http://www.who.int/childgrowth/en/)
- 2 De Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martines J. The WHO Multicentre Growth Reference Study: planning, study design, and methodology. *Food Nutr Bull* 2004;25:S15-26.
- 3 WHO Multicentre Growth Reference Study Group. Assessment of differences in linear growth among populations in the WHO Multicentre Growth Reference Study. *Acta Paediatr Suppl* 2006;450:56-65.
- 4 Scientific Advisory Committee on Nutrition (SACN). Application of WHO growth standards in the UK 2007. London: Stationery Office, 2008.
- 5 Chief Medical Officer of the Department of Health. CMO Update 49. 2009. [www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/CMOupdate/DH\\_106527](http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/CMOupdate/DH_106527).
- 6 Froggat J, Scottish Government. CEL 35 (2009). Introduction of the new WHO growth charts. 2009. [www.sehd.scot.nhs.uk/mels/CEL2009\\_35.pdf](http://www.sehd.scot.nhs.uk/mels/CEL2009_35.pdf)
- 7 Freeman JV, Cole TJ, Chinn S, Jones PRM, White EM, Preece MA. Cross sectional stature and weight reference curves for the UK, 1990. *Arch Dis Child* 1995;73:17-24.
- 8 Cole T. Do growth chart centiles need a face lift? *BMJ* 1994;308:641-2.
- 9 Wright C, Lakshman R, Emmett P, Ong KK. Implications of adopting the WHO 2006 Child Growth Standard in the UK: two prospective cohort studies. *Arch Dis Child* 2008;93:566-9.
- 10 Wright CM, Parkinson KN. Postnatal weight loss in term infants: what is normal and do growth charts allow for it? *Arch Dis Child Fetal Neonatal Ed* 2004;89:F254-7.
- 11 McKie A, Young D, Macdonald PD. Does monitoring newborn weight discourage breast feeding? *Arch Dis Child* 2006;91:44-6.
- 12 National Institute for Health and Clinical Excellence. Improving the nutrition of pregnant and breastfeeding mothers and children in low-income households. 2008. (Public health guidance 11.) <http://guidance.nice.org.uk/PH11/Guidance/pdf/English>.
- 13 Macdonald PD, Ross SR, Grant L, Young D. Neonatal weight loss in breast and formula fed infants. *Arch Dis Child Fetal Neonatal Ed* 2003;88:F472-6.
- 14 Department of Health, England. Healthy Child Programme. 2009. [www.dh.gov.uk/en/Healthcare/Children/Maternity/DH\\_081642](http://www.dh.gov.uk/en/Healthcare/Children/Maternity/DH_081642).
- 15 Hall DMB, Elliman D. Health for all children. OUP, 2003.
- 16 Wright C, Birks E. Risk factors for failure to thrive: a population based survey. *Child: Care, Health and Development* 2000;26:5-16.
- 17 Cole TJ. A chart to link child centiles of body mass index, weight and height. *Eur J Clin Nutr* 2002;56:1194-9.
- 18 Molinari L, Gasser T, Largo R, Prader A. Child-adult correlations for anthropometric measurements. In: Hauspie R, Lindgren G, Falkner F, eds. *Essays on auxology*. Castlemead Publications, 1995:164-77.

Accepted: 17 February 2010