# Do growth chart centiles need a face lift?

T J Cole

**European height and weight growth charts commonly extend from the 3rd to the 97th centile, whereas in North America the extremes are usually the 5th and 95th centiles. There is no good reason for the difference, and neither chart is particularly useful for screening owing to the high false positive rate associated with a cut off based on the lowest centile. The World Health Organisation's international growth reference uses cut offs based on standard deviation scores rather than centiles, which are more suitable for the extremes of growth status seen in the developing world. This chart, however, is incompatible with charts based on centiles. Here a unified growth chart is proposed: it has nine rather than seven centiles, and they are spaced two thirds of a standard deviation score apart rather than the more usual unit spacing. This gives a set of curves very like the conventional 3rd to 97th centiles, but with additional curves at 2·67 standard deviation below and above the mean (roughly the 0·4th and 99·6th centiles). The 0·4th centile is a more practical cut off for screening purposes than the 3rd or 5th centile.**

Growth charts are currently in the news. In Britain, the long awaited successor to the Tanner-Whitehouse charts is starting to appear, and elsewhere an expert committee of the World Health Organisation has recently met to report on physical status: the use and interpretation of anthropometry. The remit of this committee is to review the evidence for using anthropometric charts at different stages of life and, where the evidence supports it, to suggest suitable charts.

It is an appropriate moment to question the way growth charts are designed. The chart's general form is a series of smooth curves representing selected centiles of the distribution of the measurement of interest (weight or height, usually) in the reference population, plotted against age. The actual centiles to be used on the chart have not been standardised.

There are essentially three schools of thought on the choice of centiles, most conveniently called the European, North American, and World Health Organisation schools. All agree that the centiles should be symmetrical above and below the median (50th centile) curve, but there the consensus ends. In Europe the 3rd, 10th, and 25th centiles are used below the median and the 75th, 90th and 97th above.[1,2] Figure 1 shows the new British girls' height chart for 5 to 18 years.

In North America, the National Center for Health Statistics chart uses the 5th and 95th centiles instead of the 3rd and 97th,[3] whereas the World Health Organisation's international reference doesn't use centiles at all.[4] Instead it uses standard deviation scores (SDS; also known as z scores), which can be converted to centiles if the measurement is normally distributed (see fig 2). The World Health Organisation curves are set at −3, −2 and −1 SD score below the median and 1, 2 and 3 SD score above, corresponding to the 0·14th, 2·3rd, 16th, 84th, 97·7th and 99·86th centiles respectively.

The 3rd through to the 97th centiles were originally chosen to be approximately equally spaced in terms of the standard deviation score, about 0·65 SD score apart.[5] This is a useful property, common to both the European and World Health Organisation formats. It has the unfortunate side effect, though, that the two charts can be confused if the centile curves are unlabelled. A child on the 3rd centile is very different from one on the 0·14th.

The three different approaches to choice of centile are due at least in part to differing requirements. In Europe and North America, the vast majority (notionally 94%) of children lie between the 3rd and 97th centiles, whereas in the developing world, where the World Health Organisation reference is used, many children lie below the 1st centile, which makes a classification based on centiles useless.

The American National Center for Health Statistics chart uses the 5th rather than the 3rd centile because the original compilers felt that the 3rd centile was too extreme to estimate accurately. However, this is no longer a valid argument. With large samples and improved statistical methods[6,7] it is straightforward to estimate centiles down to the 3rd or lower. This applies both to height, which is normally distributed, and to non-normal measurements such as weight. The estimation process does not, however, extend to −3 SD score, as by definition only 0·14% of the reference

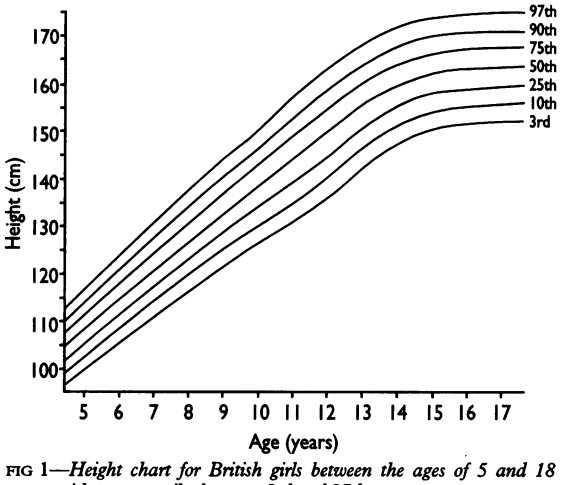


FIG 1—*Height chart for British girls between the ages of 5 and 18 years, with seven centiles between 3rd and 97th*

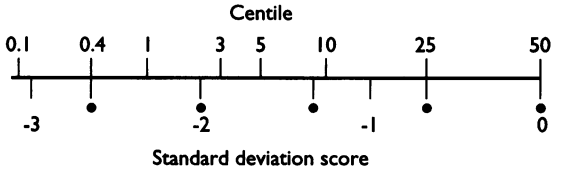


FIG 2—*Conversion chart between centile and standard deviation score. The bulleted points are two thirds of an SDS apart*

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population is found below this cut off. So the standard deviation score at −3 on the World Health Organisation chart is a simple extrapolation, not based on real data.

In Europe and North America, children below the lowest centile are considered for referral, but relatively few get referred as the false positive rate is unacceptably high: 5% of normal children in the United States and 3% in Britain fall below the cut off. There are currently suggestions in Britain that it might be better to use the −2 SD score than the 3rd centile; this would reduce the false positive rate to 2·3%. A −2 SD score line would need to be added to the chart for this to be possible. Ideally what is needed is a much lower centile to act as a realistic cut off for referral.

In practice there is no need for three different formats of growth chart—far better to use a common format worldwide. The crucial requirement is the −2 SD score curve, which is close to the 3rd centile. Curves similar to the 10th and 25th centiles can be achieved by using −1·33 SD score and −0·67 SD score, corresponding to the 9th and 25th centiles. The centile curves are then equally spaced, two thirds of a standard deviation score apart, as shown marked with bullets in figure 2.

The −1 SD score and −3 SD score curves of the World Health Organisation reference do not fit this scheme, but the −1 SD score curve is little used for classification and could be omitted. The −3 SD score curve could be retained as it is or it could be moved up to −2·67 SD score, equal to the 0·4th centile, which would maintain the two thirds SD score spacing. This would still be useful for classification in the developing world, and it would provide a chart with nine equally spaced centiles (assuming +2·67 SD score is included for symmetry). Figure 3 shows how the girls' height chart (fig 1) would look.

The obvious clinical advantage of this type of chart is that the lowest two curves provide a decision region for referral. Patients below the −2 SD score line can be considered for referral (but in practice may well not be), whereas those below −2·67 SD score should definitely be referred. Only one normal child in 260 lies below the lower cut off, as against one in 44 for −2 SD score, so the false positive rate is realistically low.

For too long there has been a lack of standardisation in growth chart design. Here is an opportunity not only to unify the next generation of growth charts but also to improve the chart's clinical utility.

Sets of the new British growth charts in A5 size suitable for parent-held child health records can be obtained through the Child Growth Foundation, 2 Mayfield Avenue, London W4 1PW. A3 and A4 versions of the charts are in preparation.

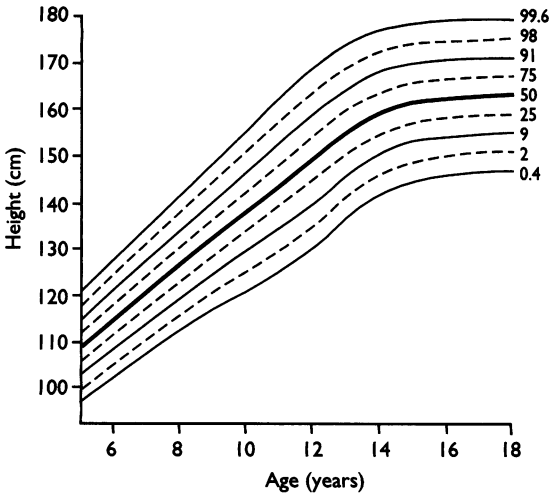


FIG 3—*The height chart of fig 1 with nine equally spaced centiles between 0·4 and 99·6, the spacing being 0·67 SDS*


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## A PATIENT WHO CHANGED MY PRACTICE

### Sham treatment is not justified

We were final year medical students observing at the gynaecology outpatient clinic. The consultant was explaining to the anxious patient that all the investigations had given normal results. He assured her that he had found nothing wrong. Then he wrote out a prescription, instructing her to take one tablet twice daily for a month. They were multivitamins he explained to us. "But doctor," she asked, "if there is nothing wrong with me, why do I need to take tablets?" The consultant agreed and crossed out his prescription. The patient was now obviously reassured and she left.

I resolved not to forget the lessons of this episode. Firstly, I learnt the importance of listening to patients and deducing the real purpose of the consultation. I began to realise how often people merely wanted a careful examination, followed by a reliable and trustworthy explanation. They did not expect to be cured—not even to be treated.

Secondly, I was impressed by the consultant's quick reversal of his prescribing decision in response to the patient's misgivings. We had a precise and shrewd perception of our teachers. Some consultants were pompous and would never have reversed their decision. I learnt to mistrust such arrogance. Candid admission of the limits of my knowledge and of treatment possibilities, when necessary, was always readily accepted by patients.

But the most important lesson was that ordering a treatment which is known not to affect the condition is wrong. It wastes the patient's time and money and it wastes medical resources. But worse than that it gives the patient false expectations, leading to disappointment, followed by loss of confidence and trust.

I have encountered many patients whose conditions could not be reversed or affected to any marked extent. A careful assessment, followed by an honest unhurried explanation with reassurance, will always take longer than prescribing placebo treatment. If we have verified that there is nothing wrong sham treatment is not justified.

Generations of medical students have been educated to regard placebo treatment as legitimate. But I kept remembering that gynaecological patient and her opinion of the multivitamin tablets. She influenced my career. I have never knowingly prescribed anything that I believed would be of no proved effect. No tonics or linctus, no heat treatment or multivitamins—no placebos.—WALTER Y LOEBL *is a retired rheumatologist in Barnet*