SHORT REPORT

A comparison of two commonly used methods of weight estimation

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In the practice of emergency medicine, it is often necessary to know a child's weight when planning therapeutic interventions. The majority of drug dosages are calculated on a per kilogram basis, as are resuscitative measures such as equipment sizing and fluid boluses. The most accurate method of determining a child's weight is to weigh the child on scales. This "gold standard" should be obtained in all cases when possible. Unfortunately when resuscitating a critically ill child this is not always practicable. It is often more straightforward to use an estimation of their weight in these circumstances. However, staff members may be relatively inexperienced in which method of estimation to use, because of a lack of knowledge and confidence.

A number of methods have been developed to estimate the child's weight in these circumstances. When "guesstimation" is used the accuracy is poor.[1] An alternative is to use a parental estimate. Several studies have found this to be variable and that significant errors can occur.[2–4]

One method of weight estimation commonly used in the United Kingdom, and taught on the Advanced Paediatric Life Support course, is the age plus four formula.[5] This is applicable to children aged 1–10 years. It is calculated as follows:

Weight estimation, kg = 2 × (age in years + 4)

Another alternative is to estimate from body height.[6] A tape measure is commercially available, the Broselow tape, which is calibrated to allow the use of height to give an estimated weight up to a maximum length of 1.45 m or 34 kg in weight. It also includes drug dosage recommendations and equipment sizes for a child of that weight.

The aim of this study was to investigate the accuracy of these two commonly applied methods of weight estimation for use in the paediatric emergency department.

Table 1 Difference of estimated weight from actual weight

Age (y)	Difference of age formula weight from actual weight	Difference of Broselow weight from actual weight
1	–0.84 to –2.98	–0.18 to –2.18
2	–0.71 to –1.93	0.41 to –1.25
3	–1.84 to –3.42	–0.97 to –2.30
4	–0.89 to –3.55	–0.44 to –3.03
5	–1.52 to –3.66	–1.00 to –2.64
6	–2.26 to –5.99	–1.69 to –4.68
7	–2.94 to –7.41	–2.49 to –5.86
8	–1.20 to –8.19	–1.16 to –8.43
9	–3.56 to –7.86	–3.08 to –7.14
10	–6.44 to –13.98	–5.89 to –12.53

PATIENTS AND METHODS

Over a 12 week period, a convenience sample of 300 children aged 1–10 years, who were attending the emergency department at Manchester Royal Infirmary, were recruited, voluntarily and with their parents' consent.

The age of the child was recorded in years and months. Children were weighed and measured without coats and shoes, by one of three senior nursing staff in the paediatric unit of the emergency department. Their weight in kilograms and height in centimetres were measured using the same set of calibrated electronic scales and headboard (SECA electronic). These were recorded to the nearest 0.1 kilogram and nearest millimetre. Their weight estimation was taken from the Broselow tape, and the age formula estimate calculated from their age in years, rounded down to the nearest year, using the above mentioned method.

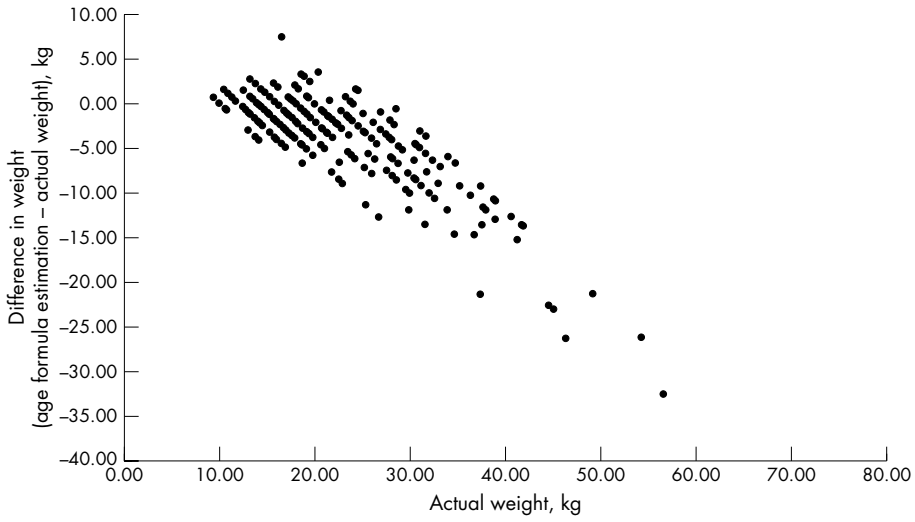

Figure 1 Differences in estimated weight from actual weight for age formula estimation.

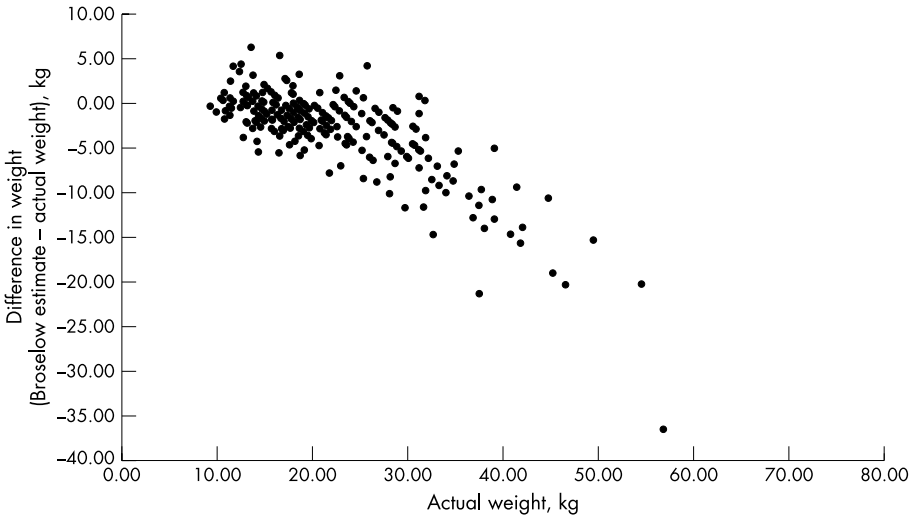

Figure 2 Differences in estimated weight from actual weight for Broselow tape estimation.

Linear regression was used to analyse the data comparing the actual weight with that estimated; from this we calculated the Pearson correlation coefficient, *r*.

The difference between estimated and actual weight was calculated and we were able to plot a chart showing the differences in results from those expected.

RESULTS

A total of 300 children were recruited and had complete data recorded; age ranged from 1 year 2 months to 10 years 10 months (median 5 years 5 months). Measured weight ranged from 9.4 to 56.7 kg (median 19.25 kg). Height ranged from 75 to 147 cm (median 112 cm).

There was good correlation between estimated weight and actual weight with an *r* value of 0.82 for the age formula, and 0.85 for the Broselow tape.

Table 1 shows the difference of estimated weight from actual weight with 95% CI of bias.

Figures 1 and 2 show the differences from actual weight for the two methods of estimation, versus actual weight. The mean bias was –3.52 kg for the age formula (95% CI –2.95 to –4.09 kg), and –2.74 kg for the Broselow tape (95% CI –2.21 to –3.27 kg). A negative bias is noted, with both methods underestimating the actual weight.

DISCUSSION

This study confirms that both methods of estimation correlate well with actual weight, but have significant outliers. It has also shown that both methods of weight estimation underestimate the actual weight and that the error increases with age.

A recent paper from Switzerland[7] also found that there was a negative bias for the Broselow tape, but this was less marked than this data with only a –0.52 kg mean bias overall. The authors agreed that the underestimation was more pronounced in children over 20 kg in weight. Another paper from Australia[8] shows again that there was a negative bias for the Broselow tape and age formula, but suggested that the Broselow tape was more accurate. They recommended the use of the Broselow tape or the derived weight estimation method which requires the assignment of body habitus.

The implications of this study are that both commonly used methods are relatively inaccurate and that with increasing age and weight they become more inaccurate.

Further work is required to revise the methods by which weight estimation is performed; either with modifications to the formulae used to calculate weight or derivation of a new measuring tape to reflect the increasing weight of children. Our own calculations using this dataset have shown that the formula **(age + 2) × 3** has a mean bias of –0.52 kg (95% CI –0.01 to –1.05 kg). This would have to be validated before being suggested as a new method.

In conclusion it would appear that the average weight of children is increasing and that the current methods of weight estimation are not keeping up with this trend.

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