Original Article

Weighing the child: Are we getting it right?

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Abstract

Background: The weighing scale is vital to pediatric practice especially in calculation of drug dosages and anthropometric assessment. Occasionally, it may be difficult measuring the actual weight of a child; weight estimation comes handy. Several estimation methods have been developed, some peculiar to some settings. It is common practice in weight estimation to subtract maternal weight from the combined maternal and child's weight, in-order to derive an estimated child's weight. However, this method has not been validated to the best of our knowledge. Therefore, this study seeks to establish if this method is accurate. **Materials and Methods:** This study was prospective cross-sectional with a systematic random sampling design. This included children aged 0-5 years; their weights were measured using bassinet weighing scales and the beam balance stand for children less than and more than 3 years respectively. **Results:** There were 409 subjects recruited, 239 (58.4%) males and 170 (41.6%) female with male to female ratio of 1.4:1. The mean weights were higher in the estimation group, but these were not statistically significant. Proportion of agreement within 10% of the actual weight showed remarkable agreement in all age groups. The highest percentage difference observed was 26% and the mean percentage difference for the different ages being <5%, while the square of the difference between both methods was 0.18 ± 0.83. However, the actual weight was underestimated in 23.7% of cases. **Conclusion:** This "crude method" is an efficient alternative method of weight estimation in Nigerian children.

Key words: Crude method, Measurement, Nigerian children, Weight estimation

INTRODUCTION

The act of weight taking dates back to 24,000-1800 BC in the region of the Indus River Valley which is now in modern-day Pakistan, whereby uniformly polished cube stone of known weight were used to estimate the weight of goods during trading,[1] over the years, various weighing scales have been developed for this purpose.[2,3] The weighing scale has also been adopted into medical practice especially in pediatrics.[4,5] It is used as a tool for anthropometric assessment in growth and development of children; it is equally useful in pediatric drug prescriptions, therefore correct weight determination is important in order to avoid erroneous drug prescription; because some errors are not permissible especially when dealing with potentially toxic drugs.

While different weighing scales are readily available for different clinical states[6-8] in developed countries, such is not the case in developing countries; it is a common practice in our setting for parents or caregivers carrying sick recumbent child while taking the combined weight of both caregiver and sick child and subsequently subtracting the weight of the caregiver from the combined weight in order to establish an estimated weight of the sick child in a situation where a recumbent weighing scale or Broselow's tape is not available.

Weight is dependent on mass and the gravitational force field acting on it, which may be dependent on the distance of the object from the earth's center of gravity, just as the earth's gravitational pull has an impact on the blood pressure in different positions; a child lifted off the surface during weight measurement may have a different weight measurement while standing child. Therefore, there may be variation in results of weight estimation when different weighing techniques are adopted such as subtracting caregivers weight from combined

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child/caregivers weight. Therefore, are we really doing the correct thing using this method? This study sets out to determine if there is any difference in the estimated weight of children using the method of subtracting the weight of the caregiver from the combined weight of the child and caregiver, compared to actual weight measurement using appropriate weighing scale.

MATERIALS AND METHODS

This study was prospective cross-sectional done between May 2014 and July 2014, and a systematic random sampling design was adopted. Children attending the Pediatric Outpatient Clinic and the Pediatric Emergency Unit were enrolled after obtaining permission from the Ethics Committee of Aminu Kano Teaching Hospital, Kano and also getting consent from their parents. This included children aged 0-5 years. The subjects were lightly dressed and their weights were measured (in kg) using bassinet weighing scales (model 180 salter for children <3 years), whereas the beam balance stand was used for children ≥3 years. The weight of the subjects combined with the caregiver was taken together, afterward the weight of the caregiver alone was taken; this was subtracted from the combined weight to get the estimated weight of the child; finally the actual weight of the child was taken for comparison. All results were entered into a proforma designed for each subject. Uncooperative children making it difficult to take their weight were excluded.

Data analysis

Data generated were analyzed using Statistical Package for Social Sciences (SPSS) version 16; tables were constructed and summarized using means, percentages and relevant variables were compared using Student's *t*-test of significance, while $P < 0.05$ was set as being statistically significant.

RESULTS

There were 409 subjects enrolled, 239 (58.4%) males and 170 (41.6%) female male to female ratio of 1.4:1. Majority of those studied were within 1 year of age.

There were 173 (42.3%) subjects in the 1-year group, 105 (25.7%) in the 2-year group, 64 (15.6%) in the 3-year group, 34 (8.3%) in the 4-year group, and 33 (8.1%) in the 5-year group.

The mean weight was higher in the estimated group, but they were not statistically significant [Table 1].

Proportion of agreement within 10% of the actual weight for the various age groups showed remarkable agreement in all age groups, especially in the 2-5 years age bracket [Table 2].

The highest percentage difference observed was 26.0% however the mean percentage difference for the different ages were <5.0%. The square of the difference between both methods was 0.18 ± 0.83. However, the actual weight was underestimated in 23.7% of cases [Table 3].

Bland Altman plot

The plot of the difference between both methods and the average of their means showed significant agreement between both methods: Estimate of the mean difference was 0.06 (95% CI of 0.021-0.094); estimate of 95% lower level of agreement of –0.68 (95% CI of – 0.738 to – 0.614); estimate of 95% upper level of agreement of 0.79 (95% CI of 0.728-0.852) [Figure 1].

This showed lower bias, especially among those between 3-5 years [Table 4].

Table 1: Mean weight of the study groups

Age	Weight measurement	Number	Mean	SD	*t*	*P*
1	Weight of patient	173	5.3803	1.92688	0.3690	0.7124
	Weight of child estimation	173	5.4572	1.94981		
2	Weight of patient	105	8.5219	1.81224	0.1215	0.9034
	Weight of child estimation	105	8.5524	1.82641		
3	Weight of patient	64	11.1937	2.02303	0.1329	0.8945
	Weight of child estimation	64	11.2422	2.10440		
4	Weight of patient	34	13.0941	1.98203	0.0790	0.9373
	Weight of child estimation	34	13.1324	2.01626		
5	Weight of patient	33	14.5758	1.85877	0.1665	0.8683
	Weight of child estimation	33	14.6515	1.83493		

*Weight of patient is the actual weight of the child measured using weighing scale, Weight of child estimation is the weight of the child estimated from subtracting weight of caregiver from the combined weight of the child and cargiver. SD - Standard deviation

Table 2: Proportion of agreement within 10% of the actual weight of the study population

Age of patient	Agreement	Frequency	Percentage
1	Agree	131	75.7
	Disagree	42	24.3
	Total	173	100.0
2	Agree	96	91.4
	Disagree	9	8.6
	Total	105	100.0
3	Agree	62	96.9
	Disagree	2	3.1
	Total	64	100.0
4	Agree	34	100.0
	Disagree	0	0.0
	Total	34	100.0
5	Agree	33	100.0
	Disagree	0	0.0
	Total	33	100.0

Table 3: Percentage difference of weight estimation

Age of patient		*n*	Minimum	Maximum	Mean	SD
1	Percentage difference	173	–7	26	2.72	6.512
2	Percentage difference	105	–8	15	1.04	4.794
3	Percentage difference	64	–9	15	0.62	3.466
4	Percentage difference	34	–5	4	0.26	2.035
5	Percentage difference	33	–3	4	0.58	1.582

SD - Standard deviation

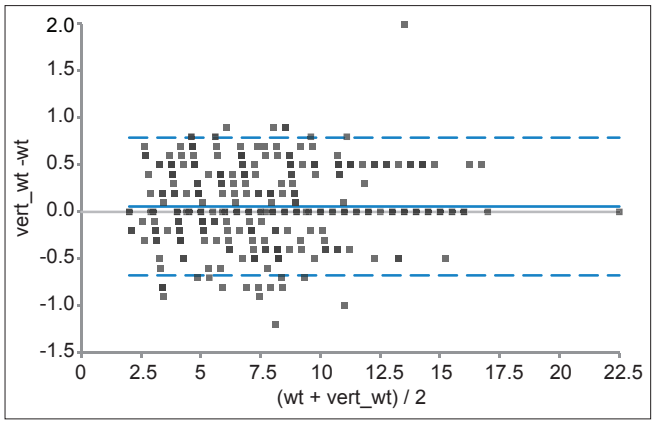

Figure 1: Bland Altman plot of the difference and average of both methods

Table 4: Estimates of bias and their limits of agreement

Age range	*n*	Weight estimation	
		Bias	Limit of agreement
1	173	0.2948	1.02-(−0.43)
2	105	0.2924	0.92-(−0.34)
3	64	0.1828	0.83-(−0.47)
4	34	0.1265	0.56-(−0.31)
5	33	0.1061	0.52-(−0.31)
Total	409	1.0022	3.86-(−185)

DISCUSSION

The performances of various weight estimation methods in different settings have produced variable results. Some of these weight estimation methods[9-12] are still alien in most resource-limited settings; furthermore in countries with high indices of malnutrition use of weight estimation formula derived from developed countries may be inappropriate. The advanced pediatric life support (APLS) formula ($2x$ + 8) has been used extensively in Nigeria but has not been validated among Nigerian to the best of the authors knowledge. The APLS formula has witnessed several changes over the years due to its underestimation of actual weights in some population.[13,14]

Geduld *et al.*,[15] in cape Town South Africa and House *et al.*,[16] in Western Kenya reported better performance of Broselow and APLS while that was not the case with that of Abdel-Rahman *et al.*[17]

Though our method of weight estimation has been in practice for a long time but it has not been validated to the best of our knowledge; it is being used especially in the rural setting where appropriate weighing scale such as a bassinet for younger children is not readily available. This method which I will suggest should be called the "crude method" - for lack of a common name - performed incredibly well; though the mean values of the estimated weight were higher than the actual weight, they were not statistically significant. The proportion of agreement within 10% of the actual weight was impressive ranging from 75% to 100%, which was better than the performance of APLS formula reported by Luscombe *et al.*,[9] and the Brosselow reported by Rosenberg *et al.*,[10] and House *et al.*;[16] similarly the percentage difference ranged from 0.26% to 1.04% and it underestimated the actual weight in only 32.7% of case especially in the within 1-year group. Hence, the "crude method" had much accuracy and precision; therefore it will serve as an appropriate substitute in situations where actual weight measurement may be difficult, though not a replacement for actual weight measurement. These are common clinical situations we see on daily practices; such as handling toddlers who would not want to be separated from their parents/caregivers during weight taking (separation anxiety)[18] or in emergency care where it may be difficult measuring the actual weight of an unconscious child.

CONCLUSION

The "crude method" is an easy and efficient alternative method of weight estimation especially in resource-poor settings where other options like the Broselow tape are not readily available. It could also be generally used in clinical situations where measuring the actual weight of the child is not possible such as an unconscious child.

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