AGE INDEPENDENT ANTHROPOMETRIC INDEX FOR IDENTIFYING UNDERNOURISHED CHILDREN IN THE AGE GROUP 5-10 YEARS

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ABSTRACT

An age-independent anthropometric index to identify undernourished children in the age group of 5-10 years is described. Employing a mathematical approach (linear regression analysis) on data from 238 children, the index was derived to be wt/(ht)^2. Employing this index, a classification rule for identifying the undernourished was evolved, using as the 'Gold standard' a WHO classification based on NCHS standards. The sensitivity of the classification rule was 95%, the specificity was 92% and the overall efficiency was 92%.

Key words: *Age-independent nutritional index, Undernourished children aged 5-10 years, Cut-off values.*

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Anthropometric measurements are usually employed to assess the nutritional status of individuals. Earlier studies in India have shown that weight for height (%) and weight/(height)^2 are indices that are well correlated with the current nutritional status of infants and pre-school children(1-3). Attempts have been made in adults aged over 18 years also to identify anthropometric indices closely associated with body build(4). However, similar reports in children aged 5-15 years are rare, although Subash Babu and Chuttani(5) did demonstrate empirically that wt/(ht)^2 is age independent. The present study attempts to confirm this finding. It also employs an independent mathematical approach (regression analysis) but restricts itself to children aged 5-10 years, as those between 11 and 15 years could have growth spurts associated with the onset of puberty.

Material and Methods

Anthropometric data collected on 238 children of 5-10 years age-group, as part of a study on hookworm infestation in a rural population in Tamil Nadu, South India, was utilized for this analysis. The socio-demographic characteristics were enumerated by a trained field investigator and the anthropometric measurements on height (ht), using height rod supplied by UNICEF with an accuracy of 0.1 cm, and weight (wt) using Seca weighing scale with an accuracy of 100 g, were taken by a trained doctor using the procedures recommended by the World Health Organization(6).

Following the approach of Subash Babu and Chuttani(5), three indices [wt/ht, wt/(ht)^2 and wt/(ht)^3] were computed for each child, and the mean index was determined for each of the age groups, namely, 5, 6, 7, 8, 9 and 10 years. The relative mean index was next determined, that is, with the mean

index at 5 years as the base, and variations in the relative mean were calculated for the 3 indices, to identify the index with the least variation. This approach, however, is empirical, and also it does not take into account variations between children of the same age. Therefore, the following mathematical technique (regression analysis) was employed to obtain a more objective index.

In this approach, it is assumed that $wt/(ht)^{\alpha}$ is the required index which is independent of age, *i.e.*, $wt/(ht)^{\alpha} = k$, a constant for all ages between 5 and 10 years. Taking logarithms, we have $\log wt = \log k + \alpha \log ht$. It follows that a linear regression analysis of log weight on log height would provide the optimal value of α; the higher the ratio of the regression sum of squares to the total sum of squares (*i.e.*, r^2, where r is the correlation coefficient) the smaller would be the sampling error of α and the narrower would be the 95% confidence interval of α.

The sensitivity and specificity of various decision rules, *i.e.*, various cut-off points of the chosen index, were determined *vis-a-vis* standards of the National Centre for Health Statistics, USA, namely (median –2 SD) of weight for height(7).

Results

For each age group, *Table I* gives the mean and the relative means with the mean at 5 years as the base, for the indices wt/ht ($\times 10^3$), $wt/(ht)^2$ ($\times 10^5$) and $wt/(ht)^3$ ($\times 10^7$). Considering the relative means, it may be seen that the index wt/ht ($\times 10^3$) increased steadily with the age by about 6 units (regression coefficient) per year, while the index $wt/(ht)^3$ ($\times 10^7$) decreased steadily with the age by about 3.5 units (regression coefficient) per year. In contrast, the index $wt/(ht)^2$ ($\times 10^5$) appeared to be fairly uniform for all the ages, suggesting that it is independent of age.

The mathematical approach $[wt/(ht)^{\alpha}]$, which takes into account variations within each age group, yielded an optimal value of 2.17 for α (approximately 2); the 95% confidence interval was narrow, namely 2.07-2.27, indicating that the estimate for α is precise; moreover, the linear regression provided an excellent fit ($r = 0.94$). These findings provide objective confirmation that $wt/(ht)^2$ is an index that is independent of age. The distribution of children according to this index $wt/(ht)^2 \times 10^5$ had a mean of 138 and a SD of 11.0 and

TABLE I—*Association Between Age and Three Anthropometric Indices*

Age	Number of children	Index								
		Wt/Ht ($\times 10^3$)			Wt/Ht^2 ($\times 10^5$)			Wt/Ht^3 ($\times 10^7$)		
		Mean	SD	Relative mean	Mean	SD	Relative mean	Mean	SD	Relative mean
5	52	140	13.0	100	136	9.9	100	134	13.3	100
6	27	145	19.5	104	135	13.8	99	127	12.4	95
7	39	156	17.0	111	136	9.6	100	120	9.3	90
8	47	161	15.5	115	137	10.4	100	116	10.1	87
9	34	170	13.5	121	138	9.3	101	113	10.8	84
10	39	183	22.6	131	142	13.0	104	111	9.2	83

the "Normal" distribution provided a good fit ($p>0.2$).

Table II sets out the sensitivity and specificity of various cut-off values of wt/(ht)^2 ($\times 10^5$), as well as the overall efficiency. It may be seen that both the sensitivity and the specificity exceed 90% for only one cut-off value, namely 130. The value of sensitivity is 95%, specificity is 92% and the overall efficiency is 92%. These are satisfactory findings, and so it may be concluded that if a child yields a value of less than 130 for wt/(ht)^2 ($\times 10^5$), he/she may be classified as undernourished.

Discussion

Using a mathematical approach, this study has evolved a nutritional index that is independent of age in children aged 5-10 years in Tamil Nadu. This index is wt/(ht)^2, and it is interesting to note that Subash Babu and Chuttani(5) also reported this index to be age-independent in Delhi children, although their approach was rather empirical. A cut-off point for classifying a child as undernourished is useful if the aim is to identify individual children as undernourished, and therefore eligible for specific intervention measures; it also has its value in charts commonly used for monitoring growth. Employing the NCHS standards of weight for height, which are well-recognized for international comparisons as the 'Gold standard'(8), the present study in Tamil Nadu suggests that a child may be classified as 'undernourished' if wt/(ht)^2 ($\times 10^5$) is less than 130.

It must be stressed, however, that if the aim is to measure the extent of undernutrition in a community, it is generally agreed that the appropriate method would be to compare the distribution of the index in the specific community with the distribution in normalized NCHS reference population(9).

TABLE II—*Sensitivity and Specificity of Various Cut-off Values of wt/(ht)^2 ($\times 10^5$)*

Cut-off value	Sensitivity (%)	Specificity (%)	Efficiency (%)
127	79	98	95
128	81	96	94
129	83	93	92
130	95	92	92
131	95	88	89
132	98	84	87
133	98	81	84

(Median –2 SD) of weight for height according to NCHS standards was employed as the 'Gold standard' for determining sensitivity and specificity of various decision rules.

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NOTES AND NEWS

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