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Errors arising through using the Harvard tables and percentage levels of median weight-for-age in assessing nutritional status

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SUMMARY A self-selected sample of 417 urban and 379 rural preschool children attending the under-5s clinics was weighed in Sierra Leone. The individual weights were related to the weight-for-age Harvard 3rd centiles and 80% levels of the Harvard medians. In this analysis there were considerable discrepancies between the sexes. Further investigation showed that the distribution of the weight-for-age Harvard centiles for girls is much wider than the distribution of the Harvard centiles for boys. These distributions appear to be unusual when compared with those from London and Hong Kong studies. Accordingly, use of the weight-for-age Harvard centiles may lead to inaccuracy in the assessment of the nutritional status of preschool children.

The 'percentage method' as suggested by Jelliffe (1966) and Gomez *et al.* (1956) does not take account of the normal range of distribution of the standards. This study has shown that the 80% levels of sex-specific median weight-for-age occupy positions as much as 600 g below the sex-specific 3rd centiles for Hong Kong Chinese children, while the 80% levels closely follow the 3rd centiles for London children in the preschool age group. Thus the Hong Kong 80% levels are not comparable with the London 80% levels. Therefore, the 'percentage method' appears to be misleading in the assessment of nutritional status using weight measurements.

The weight-for-age Harvard tables (Stuart and Stevenson, 1950) are extensively used as general standards of reference in assessing the nutrition of children. The norms from birth to 5 years are based on measurement between 1930 and 1939 of a low to middle socioeconomic group of Boston children, mostly of Irish descent (Stuart, 1939). Degrees of malnutrition can be expressed by relating a single weight measurement to four levels below 90%, 80%, 70%, and 60% of a standard median weight-for-age, i.e. the 50th centile or P_{50} (Jelliffe, 1966). This method (here called the percentage method) has been widely used in Africa and Asia. A similar system using 90%, 75%, and 60% levels has been much used in South America (Gomez *et al.* 1956).

The opportunity for this study of methodology in the assessment of nutritional status arose in July 1972, when the author visited Sierra Leone for 10 weeks during the Elective Period of the Newcastle upon Tyne Medical School Course. As well as providing an opportunity to see the practice of medicine in a tropical country, the visit was set up to compare weights of preschool children from urban Freetown with those from rural Bumpe Chiefdom.

The purpose of this paper is to show where considerable error may arise in the weight-for-age Harvard tables for preschool children and to show some difficulties encountered in the use of the 'percentage method'. In this paper the proportion of children whose weights lie below the Harvard 3rd centile weight-for-age (P_3) is compared with that proportion whose weights lie below the curve representing 80% of the Harvard median weight-for-age (P_{50}), i.e. the 80% level of Harvard P_{50}. The discrepancies between the sexes when this comparison was made led to a comparison of the Harvard tables with those from other centres.

Background

Sierra Leone is a small, hot and humid country on the West Coast of Africa with a population of around 3 million. There are two major tribes, Mende and Temne. Its main exports are diamonds and other mining products. The major urban community

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and port is Freetown which has a population of mixed tribal origin, and here trading is the main occupation. The rural community chosen for comparison was Bumpe Chiefdom of the Mende tribe, 120 miles from Freetown. In this community each extended family cultivates about 7 acres of land, close to one of the villages scattered in a tropical rain forest, growing rice (the basic foodstuff), ground-nuts, and cassava. The infant mortality rate has been estimated to be 332 per 1000 for a rural area in the Eastern Province based on births over the period 1956–1962 (Wilkinson, 1965) and 125 per 1000 for urban Freetown in 1958 (Colonial Office, 1960).

Method

During the rainy season a cross-sectional study was undertaken of weight for sex and age of a self-selected sample of 796 children composed of all those attending the under-5 clinics in Freetown and Serabu, and the mobile unit of Serabu Hospital which visited three villages, Bumpe, Bongor, Taninahun. All the measurements were made by the author, using the same robust Welux Supreme machine which was set at zero every 10th child measured. It was checked before and after the survey against a Salter 250 machine. Weights were taken to the nearest 0·5 ounce (14g), and converted to metric units. The children's growth charts (Morley, 1973) were marked to prevent reweighing. All the dates of birth of the children in Freetown were known at least to the month, and in the rural area about two-thirds were similarly known. The remaining third were derived from a local calendar of agricultural activity and events with the assistance of a local Mende nurse as an interviewer and interpreter, as suggested by Jelliffe (1966). The dates were converted into decimal years and decimal ages were calculated.

Means, standard deviations, and medians were calculated for age group and sex and the analysis of weight growth in urban and rural areas is in preparation. The individual weights were plotted in relation to the Harvard centiles (Stuart and Stevenson, 1950); the 90%, 80%, 70%, and 60% levels of sex-specific Harvard P_{50} (calculated from Stuart and Stevenson, 1950); the 90%, 80%, 70%, and 60% levels of sex-combined Harvard P_{50} (Jelliffe, 1966).

The 'percentage method' as recommended by Jelliffe (1966) has the sex-combined Harvard P_{50} as the general standard of reference. In this study the sex-specific Harvard P_{50}s were also used as general standards for comparison. The 80% level of standard P_{50} (Seoane and Latham, 1971) and the standard P_3 (Bengoa, 1970) were selected for closer study because of the significance attached to them in the past in the assessment of malnutrition.

Results

There were 417 children, aged 0–4 years, weighed in Freetown and 379 in Bumpe Chiefdom. The sexes were approximately equally distributed and the age group samples were 372 at 0–1 years, 225 at 1–2 years, 116 at 2–3 years, and 83 at 3–4 years. The Table shows the number of boys and girls in the urban and rural communities falling below the sex-specific Harvard P_3 (Stuart and Stevenson, 1950), the 80% level of sex-combined Harvard P_{50} (Jelliffe, 1966), the 80% level of sex-specific Harvard P_{50} (calculated from Stuart and Stevenson, 1950).

In girls a clear difference was found in the nutrition level of the urban and rural residents according to any of the three methods of analysis; boys, however, are apparently similar in urban and rural areas. However, the figures in the Table show certain discrepancies. In Freetown the number of boys falling below the sex-specific P_3 is similar to the number of girls, but the number of boys falling below the sex-combined 80% level is considerably smaller than the number of girls. In contrast to this, in the Bumpe Chiefdom, more boys fall below the sex-specific P_3 than girls, but the number of

Table *Number and percentage of boys and girls falling below Harvard weight-for-age curves in Freetown and Bumpe chiefdom*

	No.	*3rd centile (P_3) sex specific*		*80% of P_{50} sex-combined*		*80% of P_{50} sex-specific*	
		No. below	*% below*	*No. below*	*% below*	*No. below*	*% below*
Freetown							
Boys	200	67	33·5	43	21·5	49	24·5
Girls	217	72	33·2	79	36·4	76	35·0
Bumpe							
Boys	190	60	31·6	46	24·2	46	24·2
Girls	189	46	24·3	50	26·5	49	25·9

boys falling below the sex-combined 80% level is smaller than the number of girls. Even when the relationship of the number of boys to girls below the sex-specific 80% level is compared with the relationship below the sex-specific P_3 for each of the two communities, the marked discrepancy between the methods is still shown. This will be discussed below.

Discussion

In Fig. 1 the 80% level of the sex-combined Harvard P_{50} is related to the Harvard P_3 for boys and girls in the age group 1–4 years. This shows that the P_3 for boys lies 450–650 g above the sex-combined 80% level, while the P_3 for girls lies close to this 80% level. Thus, in the author's study considerably more boys fall below the sex-specific P_3 than fall below the sex-combined 80% level but fewer girls fall below the sex-specific P_3 than fall below the sex-combined 80% level, in both Freetown and Bumpe Chiefdom. For example (Table), in Freetown 21·5% of boys fall below the sex-combined 80% level while many more, 33·5%, fall below the sex-specific P_3. In contrast, 36·4% of girls fall below the sex-combined 80% level while slightly fewer, 33·2%, fall below the sex-specific P_3. The discrepancy between the sexes using these two methods of analysis is only slightly reduced when the 80% level of the sex-specific P_{50} is used.

Accordingly in the Harvard tables, the relationship of the 80% level of the sex-specific P_{50} to the sex-specific P_3 for boys is different from the relationship for girls. Therefore weight-for-age distribution of the Harvard sample is different in boys and girls. This finding is further examined. In Fig. 2 the Harvard P_3, P_{50}, and P_{97} for boys and for girls aged 1–4 years are plotted and compared with similar graphs for a random sample of 160 London children followed longitudinally from birth (Tanner *et al.*, 1966); a sample of 3600 healthy Southern Chinese preschool children of a low socioeconomic urban Hong Kong background, measured during 1963–4 (Chang *et al.*, 1965). This figure shows that in the Harvard tables there is a wider spread between P_3 and P_{50} for girls than there is for boys by 300–500 g. However, in both the London and Hong Kong studies the tendency is for girls to have a narrower spread than the boys between the P_3 and P_{50}. In addition, from 3 to 5 years of age the Harvard P_{97} for girls is at least 1 kg above that for boys (18·96 kg versus 17·78 kg at 3 years of age). This unexpected anomaly is possibly due to the method of analysis or sampling in the Harvard study. Clearly the distributions of weight-for-age in the Harvard tables for preschool children appear to be unusual, and the use of the Harvard centiles may lead to error in the assessment of nutritional status.

Furthermore, in the 'percentage method' of assessment of malnutrition there seems to be inherent error because this method does not take account of the normal range of distribution of the standards. In Fig. 3 the relationship of the 80% level of the local sex-specific P_{50} to the local sex-specific P_3 is illustrated for 'Harvard', London, and Hong Kong children aged 1–4 years. It can be seen that in the Hong Kong study the local sex-specific 80% levels occupy positions as much as 600 g below the local sex-specific P_3, whereas in the London study the local sex-specific 80% levels closely follow the local sex-specific P_3. This study

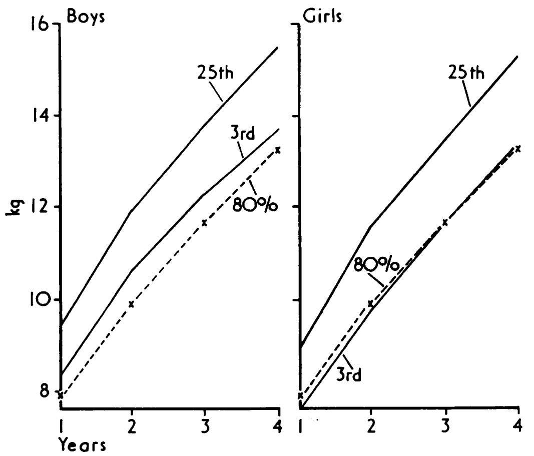

Fig. 1 *Comparison of the 80% level of sex-combined Harvard median weight-for-age with the Harvard 3rd and 25th centiles for boys and for girls.*

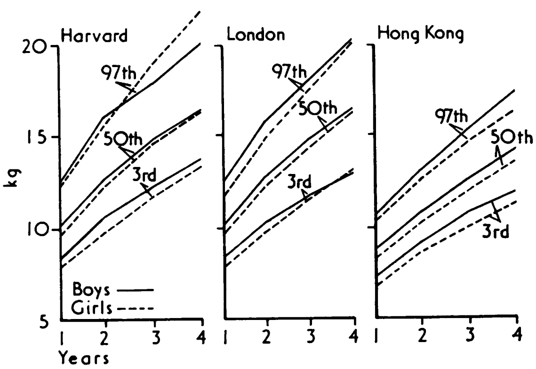

Fig. 2 *Comparison of the distributions of the 3rd, 50th, and 97th centiles weight-for-age for Harvard, London, and Hong Kong Chinese boys and girls.*

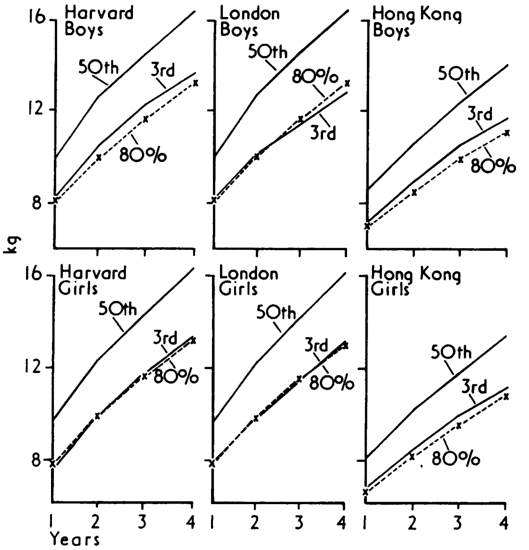

Fig. 3 *Comparison of the 80% level of local sex-specific median weight-for-age with the 3rd and 50th centiles for Harvard, London, and Hong Kong Chinese boys and girls.*

has shown that such a difference may lead to substantial error in the assessment of prevalence of malnutrition.

Accordingly, the Hong Kong sex-specific 80% levels when used as local standards of reference are not comparable with the London sex-specific 80% levels. This is largely because the figures for Hong Kong Chinese children have narrower spreads between P_3 and P_{50} than the figures for the London children. Stuart and Meredith (1946) have already stressed, '*Some meaning may be derived by relating it* (a recorded measurement) *to a standard figure representing the average, but much more is obtained when it is related to figures depicting the distribution for the measurement*'. The experience of this study supports this view. Clearly the 'percentage method' as suggested by Jelliffe (1966) and Gomez *et al*, (1956) presents many difficulties when used for the assessment of nutritional status.

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