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Detection of moderate protein-energy malnutrition in pre-school

Table I—Biochemical data of children classified according to several anthropometric tests [a]

		No. of children	Total protein g/100 ml	Albumin g/100 ml	Albumin / Globulins	Prealbumin mg/100 ml	Transferrin mg/100 ml	Complement C3 mg/100 ml	Hydroxy-proline index
Percentage	>91	400	6·92 ± 0·04[e]	3·71 ± 0·02[e]	1·21 ± 0·01[e]	12·9 ± 0·2[e]	300·6 ± 3·1[e]	86·6 ± 0·8[e]	3·5 ± 0·1[e]
expected	90-81	264	6·96 0·05[e]	3·67 0·03[e]	1·13 0·01[d]	12·3 0·3[e]	293·0 3·8[e]	84·3 1·0[e]	3·0 0·1[d]
weight	80-71	113	7·04 0·07[e]	3·64 0·03[e]	1·09 0·02[d]	12·3 0·3[e]	290·0 5·8 [e]	84·6 1·9[e]	2·8 0·1[d]
for age	70-61	24	6·87 0·13[b]	3·52 0·08[b]	1·07 0·03[b]	10·7 0·6[b]	268·8 11·3[b]	77·5 3·3[b]	2·1 0·2[b]
	⩽60	9	6·24 0·27[b]	3·12 0·19[b]	1·02 0·07[b]	9·9 1·5[b]	212·4 35·4[b]	63·5 3·3[b]	2·1 0·3[b]
Percentage	>91	641	6·89 ± 0·03[e]	3·67 ± 0·02[e]	1·17 ± 0·01[e]	12·7 ± 0·1[e]	297·3 ± 2·5[e]	85·6 ± 0·7[e]	3·3 ± 0·1[e]
expected	90-81	149	7·10 0·04[d]	3·70 0·04[e]	1·12 0·02[d]	12·2 0·3[e]	284·2 5·0[d]	83·5 1·4[e]	2·7 0·1[d]
weight	80-71	16	6·46 0·12[b]	3·46 0·10[b]	1·18 0·15[b]	10·8 0·9[b]	268·8 15·1[b]	78·2 5·3[b]	2·2 0·3[b]
for height	⩽70	4	6·35 0·54[b]	3·22 0·39[b]	1·04 0·13[b]	9·5 2·9[b]	227·5 57·1[b]	68·8 12·9[b]	2·4 0·3[b]
Percentage	>86	610	6·94 ± 0·03[e]	3·71 ± 0·02[e]	1·18 ± 0·01[e]	12·9 ± 0·1[e]	299·6 ± 2·5[e]	86·5 ± 0·7[e]	3·4 ± 0·1[e]
expected	85-81	133	6·89 0·07[e]	3·59 0·04[d]	1·10 0·02[de]	11·9 0·3[d]	284·0 5·4[d]	82·4 1·4[d]	2·7 0·1[d]
arm circ.	80-71	62	6·97 0·10[e]	3·53 0·05[d]	1·10 0·05[ce]	10·8 0·4[e]	274·3 7·6[d]	77·4 2·6[d]	2·6 0·2[d]
for age	⩽70	5	6·83 0·19[b]	2·91 0·22[b]	1·01 0·10[b]	8·2 0·9[b]	184·4 49·3[b]	50·4 11·4[b]	2·2 0·5[b]
ratio	>0·311	357	6·99 ± 0·04[e]	3·76 ± 0·02[e]	1·20 ± 0·01[e]	13·1 ± 0·2[e]	301·5 ± 3·2[e]	88·6 ± 0·9[e]	3·5 ± 0·1[e]
arm circ./	0·310-0·291	246	6·93 0·05[ce]	3·67 0·03[e]	1·15 0·01[d]	12·4 0·2[d]	300·0 3·9[c]	85·8 0·8[d]	3·1 0·1[d]
head circ.	0·290-0·271	153	6·77 0·06[de]	3·51 0·04[d]	1·12 0·03[de]	12·0 0·3[d]	274·9 4·7[d]	79·5 1·3[e]	2·6 0·1[e]
	⩽0·270	54	6·73 0·12[de]	3·48 0·06[d]	1·08 0·03[e]	10·7 0·4[e]	259·0 10·0[d]	77·5 2·9[e]	2·8 0·2[e]

[a] values given mean ± s.e.m.
[b] number of children too small for valuable statistical comparisons.
[c, d, e] for each anthropometric and biochemical test, values with no common superscript are significantly different from one another ($P < 0·05$).

l data of children simultaneously classified by four anthropometric tests (a)

	Groups				
	0	1	2	3	4
	482	110	98	67	53
	99.0 ± 0.6^{b}	94.4 ± 0.9^{c}	87.2 ± 0.9^{d}	80.9 ± 1.1^{e}	71.5 ± 1.1^{f}
	103.6 ± 0.5^{b}	95.5 ± 0.7^{c}	92.8 ± 0.8^{d}	88.1 ± 0.7^{e}	84.5 ± 0.7^{f}
	96.6 ± 0.3^{b}	89.2 ± 0.3^{c}	85.2 ± 0.4^{d}	81.7 ± 0.4^{e}	78.1 ± 0.3^{f}
	0.321 ± 0.001^{b}	0.300 ± 0.002^{c}	0.286 ± 0.002^{d}	0.281 ± 0.002^{d}	0.268 ± 0.002^{e}
	6.90 ± 0.03^{b}	6.98 ± 0.07^{b}	6.92 ± 0.07^{b}	7.02 ± 0.11^{b}	6.77 ± 0.11^{b}
	3.72 ± 0.01^{b}	3.65 ± 0.07^{bc}	3.59 ± 0.04^{c}	3.65 ± 0.07^{bc}	3.42 ± 0.06^{d}
	1.19 ± 0.01^{b}	1.15 ± 0.02^{bc}	1.11 ± 0.03^{cd}	1.09 ± 0.02^{d}	1.05 ± 0.03^{d}
	13.2 ± 0.3^{b}	12.5 ± 0.3^{bc}	11.8 ± 0.4^{cd}	11.5 ± 0.5^{cd}	11.3 ± 0.5^{d}
	302.4 ± 2.8^{b}	286.5 ± 5.7^{c}	285.8 ± 8.8^{c}	284.5 ± 8.8^{c}	256.4 ± 8.9^{d}
	86.9 ± 0.8^{b}	85.6 ± 1.7^{bc}	81.7 ± 1.7^{cd}	78.8 ± 2.2^{d}	79.4 ± 2.8^{d}
	3.4 ± 0.1^{b}	3.2 ± 0.1^{c}	2.7 ± 0.1^{d}	2.4 ± 0.1^{e}	2.5 ± 0.2^{de}

ith no common superscripts are significantly different from one another ($P < 0{\cdot}05$).

protein on strips of acetate cellulose stained with Ponceau red; prealbumin, transferrin and the third component of complement by radial immunodiffusion on plates and with "Behringwerke" control serum; urine hydroxyproline index as described by WHITEHEAD (1967). Comparisons of means were performed with Student's 't' test. Significance is given for $P < 0{\cdot}05$.

Results

Table I includes all the biochemical results from children classified according to the various anthropometric tests.

Classification according to weight for age: only the albumin/globulins ratio and the hydroxyproline index show a significant decrease for the group having a weight less than 90% expected. The decreases observed in the group less than 70% could not be statistically interpreted because of the small number of individuals.

Classification according to weight for height: a significant decrease is observed for albumin/globulins ratio, transferrin and hydroxyproline index, beginning with the 90% threshold. The number of individuals below 80% is too small to enable us to reach any conclusion about the significance of the decreases.

Classification according to arm circumference for age: all the parameters assayed except total protein have mean values which are significantly reduced in the group of children whose arm circumference is lower than 85% expected.

Classification according to the ratio of arm/head circumferences: the albumin/globulins ratio, prealbumin, complement C3, and hydroxyproline index all have mean values which are signficantly lower in the group below 0·310. The other variables decrease below 0·290.

Table II indicates the means values of the anthropometric and biochemical parameters of the children classified according to the number of anthropometric criteria lower than the thresholds chosen. Group 0 may thus be considered a group of control children. The only significant differences observed between Groups 0 and 1 involve trans-

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which compensates the decrease of the other protein fractions. The weight thresholds seem to be less satisfactorily verified since only some parameters (transferrin, albumin/globulins and hydroxyproline index) exhibit decreased values beneath these thresholds. In our population, the weight criteria, which incidentally are often taken as a reference, thus seem less sensitive than the arm tests for defining states of moderate malnutrition. This does not, however, mean that they should be abandoned, since in certain cases they are capable of detecting undernourished children who would otherwise be classified as "well to do healthy" by arm tests only.

The second finding of our study is to show the importance of employing several tests for estimating a prevalence of malnutrition in a population, as well as for detecting individual cases. Concerning the estimation of a prevalence, the numbers of children for each class (Table I) show that, for the thresholds chosen and in spite of the maximum level of agreement, the percentages of children classified as undernourished are somewhat different as a function

included whenever possible. The importance of inter-individual variations of the biochemical values in a group of children leads us to recommend a diagnosis based on several parameters. The hydroxyproline index, which is very sensitive and which requires only a urine sample, appears to us to be a highly valuable diagnostic tool. However, recent work by WENLOCK (1977) has shown that malaria could depress this index. This fact must be taken into account when considering the significance of the index in malarial areas. Prealbumin and transferrin, assayed with 5 ml of serum (blood taken by a simple finger puncture), have a great interest. For the population studied, transferrin seems to be a more sensitive indicator than prealbumin. They indicate together an alteration of the liver function which leads to depressed synthesis. It should be also recalled that transferrin concentrations are modified in cases of severe anaemia (INGENBLEEK *et al.*, 1975).

Finally we would insist on the fact that our study has been carried out in Southern Cameroon where the staple is plantain, cassava and other tubers. On