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Anthropometry as a predictor for mortality among Ugandan children, allowing for socio-economic variables

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Length, height, weight and mid-upper arm circumference (MUAC) were measured in 4320 children aged between 0 and 59 months, and their socio-economic status was assessed, in 31 villages in Southwest Uganda during March–April 1988. A follow-up survey assessed the mortality of the children during the 12 months following anthropometry. Mortality rates were higher in those with low anthropometric indices at the first survey. MUAC was the most sensitive predictor of mortality followed by weight-for-age, height-for-age and weight-for-height. MUAC increased the predictive power of other parameters whereas the other parameters did not increase the predictive power of MUAC. MUAC below 12.5, 11.5 and 10.5 cm predicted 10.9%, 18.7% and 36.5% of the deaths respectively. Nutritional status was worse in the low socio-economic group but the predictive power of anthropometry for mortality was not influenced by socio-economic status. This suggests that nutrition *per se* has an influence on mortality which is independent of socio-economic status.

It has been claimed that malnutrition weakens a range of immunological defences (Reddy *et al.*, 1976; McMurray, Watson & Rayes, 1981), increases the prevalence and severity of infections, and increases mortality rates. However, there are considerable differences in the strength of relationship between malnutrition and risk of death among children (Tomkins, 1986).

In view of the poor living conditions in which malnourished children live it could be that the social, physical and economic environment may be more important than nutrition in determining the mortality risk associated with malnutrition.

Sommer & Lowenstein (1975) assessed mortality in relationship to the Quarter Arm Circumference stick method (Quac stick), based on the comparison of mid-upper arm circumference (MUAC) with height. Among a cohc of Bangladeshi children they showed, durii the 18 months following the anthropometr measurement, a relative risk of 3.4 for tho. below the 10th percentile of arm circumferenc for-height compared with those above the 50 percentile. Kielman & McCord (1978) four that mortality among Indian children, record during the 12 months following anthropometr decreased exponentially with each 10% ri: in % median weight-for-age (W/A). Che Chowdhury & Huffman (1980) followed 201 Bangladeshi children for 24 months aft anthropometry and found a relative risk (around 3 among severely malnourished childre (<60% W/A), with MUAC and W/A being tl best predictors for mortality, and weight-fo height (W/H) being the weakest. Briend, Wojt

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niak & Rowland (1987) followed up about 5000 Bangladeshi children monthly with anthropometric measurements. They showed a sensitivity for MUAC of 56% and a specificity of 94% in predicting death during the 4 weeks following the measurement. Specificity was improved if breast-feeding was absent and chronic diarrhoea, acute respiratory infections and oedema were present.

In a longitudinal study in Guinea Bissau, Smedman *et al.* (1987) found that height-for-age (H/A), but not W/H, was positively correlated with survival. The result of this study together with the results from a study in Kasongo (Zaire) (Kasongo Project Team, 1983), which also showed a weak discriminatory power of anthropometry, might at first sight suggest that in Africa (in contrast to Asia) anthropometry plays a relatively minor role in predicting child mortality. Bairagi (1985) suggested that the variation in the strength of relationship between anthropometry and mortality between communities could be due to the fact that nutritional status is much more linked with socio-economic status in some communities than others. Thus malnutrition is sometimes claimed to be a marker of a deprived environment. Food intake in Kasongo was reported to be independent from parental income.

Another possible explanation for differences in the predictive power of anthropometry is the variation in causes of death between studies. In Kasongo 56% of deaths were due to measles which has high fatality rates across a wide range of nutritional status. A problem with many of the published studies is that causes of death are not reported. If more deaths were attributable to diarrhoea and less to measles at Kasongo it seems likely that mortality would be more strongly related to nutrition.

Different anthropometric indices may represent different types of malnutrition; thus several researchers have suggested the use of more than one parameter at a time. After taking 10 037 measurements from 2625 Bangladeshi children, 12–59 months old, Alam, Wojtyniac & Rahaman (1989) found that for mortality in the first 3 months of follow-up the highest sensitivity was for MUAC and MUAC/age, and the lowest was for W/H. The predictive power of a model with W/A and H/A improved when MUAC was added, while the power of a model with MUAC alone did not improve after adding H/A or W/A.

A further consideration, often not addressed, is the variation in the strength of association between malnutrition and risk of mortality between groups of children of different ages.

The long-term value of these studies is the identification of anthropometric parameters and cut-off points which can identify children at higher risk of mortality. Early, appropriate interventions could then be initiated. We investigated the value of some predictors of mortality in Southwest Uganda. In addition we sought to examine the predictive powers of anthropometric indicators while allowing for differences in socio-economic status.

Methods

Between April and May 1988, 4320 children 0–59 months old from 31 villages in the District of Mbarara (Southwest Uganda) were selected. This was part of a baseline survey of a Primary Health Care (PHC) project. The children were measured for weight, height, length and MUAC. Weight was measured to the nearest 100 g with Salter spring scales (model 235 PBW) provided by UNIPAC (UNICEF warehouse for packing supplies and equipment in Copenhagen). The height of each child between 2 and 5 years was measured, while length was measured in children younger than 2 years; measurements were taken to the nearest mm using locally constructed length/height boards. MUAC was measured to the nearest mm on the left arm. Measurement techniques were standardized according to the United Nations manual 'How to weigh and measure children'. Twelve months after the measurements their families were revisited to know whether the children were still alive. Interviewers were trained in the assessment of the main cause of death according to the symptoms reported by the mother.

Information on 19 socio-economic variables was collected at the initial interview, namely: father's education, ethnicity and religion, mother's education, pregnancy status and marital status, ownership of a radio, acreage of land, type of cooking and lighting fuel, length of residence of the family in the village, number of people per room, use of protected water supplies, presence of a latrine, if the family hired people for labour in the previous 6 months, if anybody in the family worked on other people's land and the literacy of fathers and mothers.

Multiple Correspondence Analysis (MCA) (Benzecri, 1973; Greenacre & Hastie, 1987) was used to produce a descriptive analysis of the 19 variables, and the clustering of the households into social classes was carried out by the dynamic cluster method (Diday & Simon, 1976). MCA and the dynamic cluster method were carried out using the computer programme SPAD (Systeme Portable Pour l'Analyse des Donnes) (Lebart & Marineau, 1982).

Logistic regression, using the GLIM (Generalized Linear Interactive Modelling) (Baker & Nelder, 1978) package was applied to estimate the effect of social class on mortality. The NCHS (National Centre for Health Statistics, 1977) standards were used for calculating standardized anthropometric scores.

Results

Of the initial 4320 children measured in March–April 1988, 506 (11.7%) were lost to follow-up mainly because of migration. Those lost to follow-up did not differ significantly from those who remained for all the anthropometric parameters used.

Among the remaining children who were traced, there were 104 deaths which accounted for 2.7% of the whole sample traced. Of these 104 children who died, anthropometry was missing for eight of them and they were therefore excluded from the analysis. Among those traced (3814), 46 did not have valid anthropometric measurements and they were also excluded from the analysis. Mortality rates were around 9% below 3 months, 5.6% between 3 and 8 months, and remained around 2% among older children.

Table 1 shows the cause of death reported by the parents. Table 2 shows the distribution of deaths according to age of the children. Tables 3 and 4 show that compared to a baseline of above or equal to −1 SD, the relative risk (RR) for mortality started increasing significantly

Table 1. Causes of mortality among 104 Ugandan children

Cause	*Number*	*%*
Diarrhoea	23	22.1
Acute respiratory infections	20	19.2
Measles	14	13.5
Fever	13	12.5
Tetanus	4	3.8
Others	30	28.8

Table 2. Number and percentage of deaths at different ages

Age (months)	*Sample (n)*	*Number of deaths*	*% of children dying*	*% of deaths at each age*
<6	388	28	7.2	37.8
6–11	403	17	4.2	22.1
12–23	823	16	1.9	10.0
24–35	789	23	2.9	15.3
36–47	726	16	2.2	11.6
>47	685	4	0.6	3.1

Table 3. Percentage mortality according to different cut-offs in standard deviations (SD) for weight-for-age (W/A), height-for-age (H/A) and weight-for-height (W/H)

	SD cut-offs					
	<−3	*−3.00 to −2.51*	*−2.50 to −2.01*	*−2.00 to −1.51*	*−1.50 to −1.01*	*>−1*
W/A	12/132 9.1%	14/212 6.6%	11/343 3.2%	11/516 2.1%	9/609 1.5%	39/1956 2%
H/A	23/502 4.6%	8/321 2.5%	9/400 2.3%	14/501 2.8%	8/478 1.7%	34/1566 2.2%
W/H	4/34 11.8%	3/28 10.7%	5/80 6.3%	13/210 6.2%	10/365 2.7%	61/3051 2%

From a total of 3768 children with anthropometric measurements there were 96 (2.5%) deaths.

Table 4. Percentage mortality according to different cut-offs in cm of MUAC

	MUAC (cm) (cut-offs)					
	<10.5	*10.5 to 11.4*	*11.5 to 12.4*	*12.5 to 13.4*	*13.5 to 14.4*	*>14.5*
Mortality	15/41 36.6%	3/55 5.5%	7/133 5.3%	17/395 4.3%	18/863 2.1%	36/2261 1.6%

Table 5. Percentage mortality by anthropometric intervals by age groups in months; the numbers at risk are in parentheses

	0–5 months	*6–11 months*	*12–23 months*	*>24 months*	*Total*	*P*[a]
<–3 SD W/A	(3) 33.3%	(14) 21.4%	(31) 6.5%	(84) 7.1%	(132) 9.1%	0.14 (NS)
–3, –2.01 SD W/A	(12) 33.3%	(63) 5%	(145) 4%	(335) 3.6%	(555) 4.5%	<0.001
>–2.01 SD W/A	(336) 5.1%	(335) 3%	(642) 1.2%	(1768) 1.4%	(3081) 1.9%	<0.001
<–3 SD H/A	(10) 30%	(27) 7.4%	(120) 4.2%	(345) 3.8%	(502) 4.6%	0.001
–3, –2.01 SD H/A	(28) 14.3%	(74) 4.1%	(187) 2.1%	(432) 1.4%	(721) 2.4%	<0.000
>–2 SD H/A	(313) 4.8%	(311) 3.5%	(511) 1.4%	(1410) 1.6%	(2545) 2.2%	0.001
<–2 SD W/H	(8) 25%	(26) 7.7%	(49) 8.2%	(59) 6.8%	(142) 8.5%	0.38 (NS)
>–2.01 SD W/H	(343) 5.8%	(386) 3.6%	(769) 1.6%	(2128) 1.8%	(3626) 2.3%	<0.001
<12.5 cm MUAC	(113) 10.6%	(44) 9.1%	(42) 7.1%	(30) 20%	(229) 10.9%	0.34 (NS)
12.5, 13.5 cm MUAC	(100) 4%	(88) 5.7%	(124) 3.2%	(83) 4.8%	(395) 4.3%	0.84 (NS)
>13.5 cm MUAC	(135) 4.4%	(277) 2.5%	(646) 1.4%	(2066) 1.5%	(3124) 1.7%	0.06 (NS)

[a]The statistical significance relates to a χ^2-test of equality of death rate across the age groups (within each group defined by anthropometry).
NS = not significant.

below –2.50 SD for W/A ($P < 0.001$) and below –1.50 SD for W/H ($P < 0.001$) while it rose significantly below –3 SD for H/A ($P < 0.01$) and below 13.5 cm for MUAC ($P < 0.001$). These cut-off points were used during the subsequent analysis.

There were considerable differences in the RR in the groups 'below –3 SD' compared with 'above or equal to –1 SD'; RR was 4.5 times for W/A and almost 6 times for W/H while the increase was twice for H/A. Table 4 shows that the RR was 23 times if the group 'below 10.5 cm of MUAC' was compared with the group 'above 14.5 cm'.

Table 5 shows that when the mortality by anthropometric intervals was cross-tabulated by age groups, mortality was significantly higher below 6 months of age for all anthropometric parameters with the exception of MUAC.

Figure 1 shows the percentage of the mortality that is predicted according to different anthropometric indices. The data are presented showing the proportion of children who are below the individual cut-off levels.

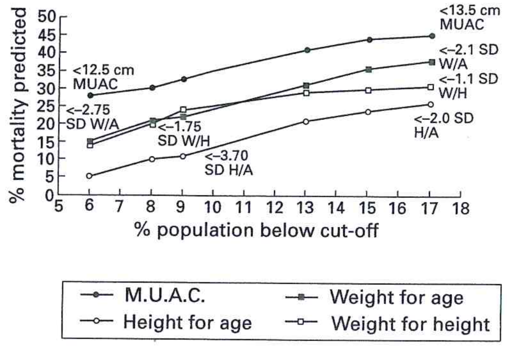

Fig. 1. The proportion of the population who are malnourished and their mortality risk according to different 'cut-off' indices.

Table 6 shows results from fitting different logistic models examining mortality dependent on anthropometry in which the influence of a single parameter with others included is examined. There is little influence of other parameters with MUAC included. In contrast, when MUAC was added into the logistic models containing W/A, H/A or W/H, the predictive value was significantly improved and the contribution of the other parameters was lost.

The MCA and the dynamic cluster method developed seven social classes. Due to similarities between some of the classes the population was classified by MCA into three socio-economic groups (SEGs) whose characteristics are outlined in Table 7. SEG 1 (806 households), which included classes 1–3, was the most advantaged and was made up of households in which parents had the highest level of education. The father was mainly a government officer, professional, cattle keeper or export crop grower. In comparison with other groups these families usually hired labour, had a radio and a latrine. This group tended to be Muslims and Protestants. In SEG II (1092 households), which included the original classes 4–6, agricultural occupations were prevalent with cattle keepers, export crop growers and subsistence farmers with small livestock (poultry, sheep and goats). These families had been resident for a long time, their educational level was low and very few owned radios but latrines were relatively frequent. Catholics and Banyankoles (a tribal group) were more prevalent than in other groups. This group formed a sort of wide middle class between the better-off and the

Table 6. Estimates and changes in deviance in logistic regression with MUAC and other anthropometric parameters as predictors for mortality

Model	*Parameter*	*Regression coefficient*	*SE*	*Change in deviance*[a]	*P*
1	MUAC	−0.4687	0.0544		
2	MUAC	−0.4461	0.0576		
	W/A	−0.1051	0.0840	−1.6	0.21 (NS)
3	MUAC	−0.4414	0.0581		
	W/A	−0.1589	0.1174		
	H/A	0.0579	0.0876	−0.4	0.53 (NS)
4	MUAC	−0.4428	0.0584		
	W/A	−0.0610	0.4387		
	H/A	0.0005	0.2631		
	W/H	−0.0781	0.3376	−0.1	0.75 (NS)
5	W/A	−0.3469	0.0851		
6	W/A	−0.4793	0.1136		
	H/A	0.1460	0.0833	−2.9	0.09 (NS)
7	W/A	−0.7487	0.4844		
	H/A	0.2985	0.2794		
	W/H	0.2153	0.3768	−0.3	0.58 (NS)
8	W/A	−0.0610	0.4387		
	H/A	0.0005	0.2631		
	W/H	−0.0781	0.3376		
	MUAC	−0.4428	0.0584	−49.1	<0.000

[a] Equal to χ^2 under a null hypothesis of no additional contribution by the added parameters.

Table 7. Distribution (%) of variables between socioeconomic groups (SEGs) (number of households in each SEG is in parentheses)

Variable	*SEG I (806)*	*SEG II (1092)*	*SEG III (451)*
Presence of latrine	85	77	68
Mother's education			
None	15	63	74
Primary	75	36	26
Post-primary	10	1	0
Father's education			
None	4	33	45
Primary	65	63	55
Post-primary	31	4	0
A radio is owned	40	16	5
Labour[a]			
Hiring	26	5	0
Hiring and working	1	1	0
Not hiring and not working	67	82	61
Working	6	12	39
>3 people per room	23	29	32
<2 acres of land	38	41	63
Father's occupation			
Professional	32	6	0
Government	21	0	0
Dependent	6	0	0
Cattle keeper	26	22	0
Subsistence with small animals	1	43	24
Cash crops	14	16	0
Subsistence with no animals	0	12	76

[a] Hiring + the household hired labour during the previous 6 months.
Working = somebody from the household worked on other people's land in the previous 6 months.

worst-off characterized by a mixture of conditions such as families with a good economic status and low educational level versus families with less good economic conditions but with relatively high level of education. SEG II (451 households) was formed by class 7. This was the most disadvantaged group mainly composed of subsistence farmers without small livestock, frequently working on other people's land, with minimal or no education and almost no ownership of radios.

To examine the role played by socio-economic factors in the association between malnutrition and mortality, the relationship between anthropometry and mortality was analysed controlling for SEG using logistic regression. Table 8 shows the mortality rates associated with different anthropometric cut-offs were similar in each SEG. There was no interaction between anthropometric indicators and SEGs in terms of predictive power for risk of mortality (Table 9). The mortality trend was the same in all the three socio-economic groups.

Table 10 shows how low anthropometric values were associated with a high risk of death from fever, diarrhoea, respiratory infections, measles and malnutrition.

Discussion

Previous studies (Sommer & Lowenstein, 1975; Kielmann & McCord, 1978; Briend, Wojtyniak & Rowland, 1978; Chen, Chowdhury & Huffman, 1980; Smedman *et al.*, 1987) have shown an increased risk of mortality associated with various 'cut-off' levels of different anthropometric indicators.

Our data show that MUAC is particularly valuable as a screening tool. Under 10.5 cm of MUAC there was a big increase in mortality (36.6%) while at the lowest cut-offs for the other parameters (<–3 SD) mortality reached 11.8% with W/H, 9.1% with W/A and 4.6% with H/A. The RR (taking > –1 SD as a baseline) was statistically significant for H/A below –3 SD, W/A below –2.5 SD and W/H below –1.5 SD. For MUAC (taking >14.5 cm as a baseline), the RR was strongly significant below 13.5 cm. The number of children who would have been identified as 'malnourished' and the number of children who died in each anthropometric group are shown in Fig. 1.

Table 5 shows that the group most at risk are the young and thin or short. Inclusion of age improved the predictive power of all the anthropometric parameters except MUAC.

There was a difference in the proportion of individuals whose death was predicted by anthropometry below and above 1 year of age but, in general, MUAC represented the most sensitive indicator, followed by W/A, H/A and W/H. Sometimes the addition of other variables increases the predictive power of MUAC. Briend, Wojtyniak & Rowland (1987) found that a MUAC of <110 mm plus the presence of oedema, bloody diarrhoea, ARI (acute respiratory infections) and absence of breast-feeding were associated with a higher RR than MUAC alone. But we did not have the concurrent data

Table 8. Mortality associated with different cut-offs in various SEGs (numbers in parentheses are numbers at risk)

		SEG I	*SEG II*	*SEG III*	P^a
<–3	SD W/A	(38) 10.5%	(47) 8.5%	(36) 8.3%	0.93
–3 to –2.01	SD W/A	(133) 4.5%	(270) 4.8%	(93) 5.4%	0.95
>–2.01	SD W/A	(1016) 1.7%	(1259) 1.9%	(466) 3.2%	0.13
<–3	SD H/A	(109) 4.6%	(230) 3%	(111) 9%	0.05
–3 to –2.01	SD H/A	(196) 2.6%	(321) 2.5%	(126) 1.6%	0.82
>–2	SD H/A	(882) 1.9%	(1025) 2.5%	(358) 3.1%	0.44
<–2	SD W/H	(46) 6.5%	(57) 14%	(24) 4.2%	0.26
>2.01	SD W/H	(1141) 2.1%	(1519) 2.2%	(571) 3.9%	0.06
<12.5 cm	MUAC	(56) 10.7%	(95) 9.5%	(55) 16.4%	0.43
12.5–13.4 cm	MUAC	(107) 5.6%	(182) 4.9%	(81) 2.5%	0.56
>13.5 cm	MUAC	(1019) 1.5%	(1294) 1.8%	(452) 2.7%	0.28

[a] The statistical significance relates to a χ^2-test of equality of death rate across SEGs (within each group defined by anthropometry).

to test this here. With MUAC alone at a specificity of 95%, we have been able to identify 28% of children less than 1 year and 17% of children more than 1 year who died. This is lower than that reported by Briend *et al.* (1987), but it is higher than that reported by previous studies in Africa (Kasongo Project Team, 1983; Smedman *et al.*, 1989). The differences in results are probably due in part to the short period of follow-up by Briend in Bangladesh, compared with the 12 month follow-up in our study.

The addition of other parameters did not change the predictive power of MUAC. Adding MUAC to other parameters reduced their predictive power, while improving the power of the model as a whole. In summary MUAC can be considered as the best predictor of death.

Few of the previously published studies of anthropometry and subsequent risk of mortality have examined the possibility that socio-economic factors co-existed with malnutrition, thereby producing a higher mortality among the malnourished. We therefore examined the possible confounding effect of socio-economic status in this study. When the variable SEG is included in a logistic model predicting mortality with anthropometry, the contribution of anthropometry remained and there was no evidence that it was different in the separate SEGs (no interaction). When analysing in simple cross-tabulation, mortality rates at various anthropometric cut-offs did not differ significantly between one SEG and another.

Taking MUAC as the most sensitive predictor and 12.5 cm as a cut-off point, there is a

Table 9. Test for evaluating interaction between anthropometry and SEGs in their predictive power of mortality

Parameters interacting	*Change of deviance*	*Degrees of freedom*	*P*
MUAC with SEGs	–9.8	10	>0.50 (NS)
W/A with SEGs	–7.5	10	>0.50 (NS)
H/A with SEGs	–10.5	10	>0.25 (NS)
W/H with SEGs	–14.8	10	>0.10 (NS)

NS = not significant.

Table 10. Relative risks of death from different causes according to different anthropometric parameters (95% confidence intervals in parentheses)

		Fever	*Diarrhoea*	*ARI*	*Measles*	*PEM*	*Others*
<–3	W/A SD	5.9* (1.3–26)	4.6* (1.4–15)	3.4 (0.8–14)	8.7** (2.4–31)	4.2 (0.5–34)	1.3 (0.2–9)
<–3	H/A SD	4.7** (1.5–14)	1.4 (0.5–4.3)	2.3 (0.8–6.5)	1.2 (0.3–5.4)	2.2 (0.4–11)	1.7 (0.6–4.6)
<–2	W/H SD	2.4 (0.3–19)	5.8** (2–17)	1.5 (0.2–11)	4.8* (6–103)	26*** (0.2–5)	0.4
<12.5 cm MUAC		8.2** (2.5–27)	7.5*** (3.1–18)	9.4*** (3.7–23)	4.9* (1.4–17)	27*** (6.5–113)	0.7 (0.1–5)

ARI = acute respiratory infections: PEM = protein energy malnutrition.
The tests performed were Mantel–Haenzsel and Fisher exact test: $*P < 0.05$, $**P < 0.01$, $***P < 0.001$.

prevalence of 6.1% (229/3748) of malnutrition at the baseline survey. Of this target group (229 children) 25 (10.9%) died, which accounts for 26% of the total mortality. Therefore, screening with MUAC at 12.5 cm concentrates on about 6% of the child population, and if successful interventions could be implemented it would be possible to reduce child mortality by more than one-quarter.

We showed a prevalence of severe stunting of 13.3% (below –3 SD H/A) at the baseline survey. Of this group of children (502 subjects) 23 died (4.6%), which is nearly 1/4 of the total mortality. Therefore, as in the case of MUAC, using this low cut-off we would identify 1/4 of the deaths but at the expense of a low specificity. Thus screening with MUAC identifies 6.1% of the child population, whereas screening with a low H/A identifies 13.3% of the population. Shortness or stunting, even of a severe degree, is much less linked to mortality than MUAC. This is of interest in view of recent studies showing a higher risk of infections among stunted children even when socio-economic variables are controlled (Tomkins, Dunn & Hayes, 1989). Although extreme shortness (<–3 SD H/A) leads to a higher risk of death, some could argue that at such a low cut-off point for H/A there is also a high chance that the child will also be low for W/H and therefore the effect on mortality should probably be accounted for by the association of severe stunting with wasting. If the Waterlow classification is used, the mortality, which was 1.9% among the better nourished (>–3 SD H/A and –1.5 SD W/H), rose to 3.8% when shortness without thinness was present, then to 6.8% when shortness was absent and thinness was present, and to 17.6% when children were both below –3 SD H/A and below –1.5 SD W/H.

These different mortality rates, which were all significantly higher than in the better-nourished children, suggest that shortness *per se* in the absence of wasting doubles the risk of mortality. Furthermore, when wasting is associated with stunting, the effect (17.6%) seems to be higher than the single effect of the two added together (3.8% + 6.8%). This higher risk for mortality is present for severe stunting (<–3 SD H/A) while no higher risk was found using <–2 SD H/A.

It can be concluded that sensitivity was highest for MUAC followed by W/A, H/A and W/H. While the predictive power of W/A, H/A and W/H changed with age, that of MUAC was age independent. Bearing in mind that the presence of MUAC in the logistic model overwhelmed that of the other parameters, MUAC can be utilized to identify children at higher risk of death. The other advantages of MUAC, besides the high level of sensitivity, are that it is age independent, easy to use and does not require complicated equipment. Another characteristic of MUAC is its threshold effect when mortality suddenly increases below 10.5 cm.

The use of MUAC for targeting purposes might improve the effectiveness of interventions, enabling the identification of children at higher risk of death and focusing intervention inputs on those families which need priority. MUAC is an inexpensive, simple and sensitive indicator for the purpose of targeting children at higher risk of death.

Stunting in this part of Uganda should only be considered from its predictive power when below –3 SD H/A because there is no higher risk of death if we take –2 SD as the cut-off point. Therefore measurements of height or length would appear to have limited predictive value within the framework of routine MCH clinics.

Finally, being malnourished carried a higher risk for dying from specific infectious diseases. This is probably due to the widespread effects of malnutrition on host immune response to infections and the physiological responses to a range of pathogens. It will be important to re-evaluate the sensitivity of anthropometry for screening for children at risk of dying, in communities where the load of infection is less. Hopefully there will, in time, be very few children with measles and few children with acute lower respiratory tract infection who do not receive antibiotics. At present, however, the data we have presented provides a rational basis for the use of anthropometry in selecting a manageable number of children for particular attention.

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