Assessment of potential indicators for protein–energy malnutrition in the algorithm for integrated management of childhood illness

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Potential indicators were assessed for the two classifications of protein–energy malnutrition in the guidelines for integrated management of childhood illness: severe malnutrition, *which requires immediate referral to hospital, and* very low weight, *which calls for feeding assessment, nutritional counselling and follow-up. Children aged <2 years require feeding assessment and counselling as a preventive intervention.*

For severe malnutrition, *we examined 1202 children admitted to a Kenyan hospital for any association of the indicators with mortality within one month. Bipedal oedema indicating kwashiorkor, and two marasmus indicators (visible severe wasting and weight-for-height (WFH) Z-score of <−3) were associated with a significantly increased mortality risk (odds ratios, 3.1–3.9). Very low weight-for-age (WFA) (Z-score of <−4.4) was not associated with an increased risk of mortality. Because first-level health facilities generally lack length-boards, bipedal oedema and visible severe wasting were chosen as indicators of* severe malnutrition.

To assess potential WFA thresholds for the very low weight *classification, our primary source of data came from 1785 Kenyan outpatient children, but we also examined data from surveys in Nepal, Bolivia, and Togo. We examined the performance of WFA at various thresholds to identify children with low WFH and, for children aged ≤2 years, low height-for-age (HFA). Use of a WFA threshold Z-score of <−2 identified a considerable proportion of children (from 13% in Bolivia to 68% in Nepal) which, in most settings, would pose an enormous burden on the health facility. Among ill children in Kenya, a threshold WFA Z-score of <−3 had a sensitivity of 89–100% to detect children with WFH Z-scores of <−3, and, with an identification rate of 9%, would avoid overburdening the clinics.*

Potential modifications include use of a more restrictive cut-off in countries with high rates of stunting, or the elimination of the WFA screen in order to concentrate efforts on intervention for all children below the 2-year age cut-off. Key issues in every country include the capacity to provide counselling for many children and linkage to nutritional improvement programmes in the community.

Introduction

An algorithm was developed for use in the WHO/UNICEF course on integrated management of childhood illness (IMCI) (or integrated management of the sick child), which addresses the most common causes of mortality and morbidity among children in developing countries (*1*). The algorithm uses simple diagnostic criteria and offers treatment guidelines; for example, suspected pneumonia is classified on the basis of medical history and a focused physical examination, and the classification leads to recommendations for treatment with appropriate antibiotics. Included in the sick child chart is a nutrition component because malnutrition is an important underlying condition associated with 40–60% of deaths among under-5-year-old children in developing countries (*2, 3*).

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Unlike the acute conditions that the sick child chart was designed to manage, malnutrition in children is often chronic in the developing countries, where mild but continued deficits in dietary intake, together with repeated episodes of infection, result in a process of suboptimal growth. The usual outcome of this process is *stunting*, defined as insufficient height relative to age (*4*). In many developing countries, 30–60% of children have some degree of stunting (*5*).

By contrast, acute severe food deprivation and infections such as dysentery or persistent diarrhoea result in *wasting*, defined as insufficient weight relative to height, a condition related to recent or ongoing severe weight loss (*4*). Low weight-for-height (WFH) is the anthropometric indicator that best corresponds to wasting (*6*). In contrast to stunting, the prevalence of wasting in most populations is usually low, rates of 8% being considered very high (*5*). This form of malnutrition, which resembles the acute conditions managed by the chart, may develop rapidly, and prompt intervention could reverse it. In addition, wasting may serve as a marker for the severity of some other disease process to which it is secondary. Severe wasting can be seen as a medical emergency because the immediate mortality is high (*7*).

The primary aim of the nutrition component of the IMCI algorithm, like that of the other components, is to facilitate the diagnosis and treatment of acute, severe or potentially life-threatening conditions, which are likely to benefit from clinical intervention. For this reason, the emphasis in the analyses given below, is on the detection of wasting rather than stunting.

Specific content of the nutrition component of the IMCI algorithm

After several draft versions, the IMCI algorithm was finalized by WHO/CHD in November 1995 (Fig. 1) (*1*). This article deals only with the classifications which pertain to protein–energy malnutrition, *severe malnutrition* and *very low weight*; an analysis of potential indicators for anaemia is reported elsewhere (*8*). The *severe malnutrition* classification requires immediate referral to hospital. The *very low weight* classification is designed to identify children with less severe malnutrition, which is likely to be reversible and which can be addressed in the outpatient department.

The charts for management of childhood illness have been developed in a generic form, which individual country programmes are expected to modify for use under their specific conditions. In the generic version of the chart on the assessment and classification of sick children, the choice of indicators was guided by the assumption that most first-level health facilities would have a weighing scale but no length-board. Although length-boards can be constructed locally and inexpensively for use in cross-sectional surveys, most health centres currently do not have them. They require substantial maintenance, especially with heavy use in tropical climates, and health workers must be trained to use them correctly.

Fig. 1. **The nutrition component of the Integrated Management of Childhood Illness algorithm. Earlier versions differed in criteria and times for follow-up from this December 1995 version.**

Criteria	Classification	Treatment and follow-up
Visible severe wasting or severe palmar pallor or oedema of both feet	**Severe malnutrition or severe anaemia**	• Give Vitamin A • Refer urgently to hospital
Some palmar pallor or very low weight-for-age	**Anaemia or very low weight**	• Assess child's feeding and counsel the mother on feeding according to the Food Box on Counsel the Mother chart If feeding problem, follow-up in 5 days • If pallor: — Give iron — Give oral antimalarial if high malaria risk — Give mebendazole if child is ⩾ 2 years and no dose in last 6 months • Advise mother when to return immediately • If pallor, follow-up in 14 days • If very low weight, follow-up in 30 days
Not very low weight-for-age and no other signs of malnutrition	**No anaemia and not very low weight**	• If child is <2 years old, assess the child's feeding and counsel the mother on feeding according to the Food Box on Counsel the Mother chart • If feeding problem, follow-up in 5 days • Advise mother when to return immediately

This paper presents analyses for the choice of diagnostic indicators for protein–energy malnutrition in the IMCI algorithm, together with recommendations concerning their modification for use in countries with widely varying nutritional situations. The analyses of potential indicators for *severe malnutrition* and for *very low weight* are presented separately.

Visible severe wasting as an indicator of *severe malnutrition*

Kwashiorkor and marasmus are the two clinical syndromes of severe malnutrition. A sensitive, early indicator for kwashiorkor in the chart is bipedal oedema, which is easy to recognize (*8*, *9*). The following analysis primarily concerns the choice of indicator for marasmus. Expert clinicians diagnose marasmus using a constellation of findings, including loss of subcutaneous fat, muscle wasting, and a very low WFH *Z*-score (<-3) (*9*). For the reasons noted above, WFH is not used as an indicator in the generic sick child chart. We therefore examined two potential indicators for marasmus: an extremely low threshold of weight-for-age (WFA) as a proxy anthropometric indicator, and "visible severe wasting" which is based on visual inspection.

Methods

From June through November 1993, a health worker examined 1202 under-5-year-olds admitted to Siaya District Hospital, western Kenya, for the presence of visible severe wasting and bipedal oedema, and measured the height and weight at the time of admission. The health worker had been trained in the use of the chart for assessment and classification of the children. To identify visible severe wasting, the health worker was trained to recognize muscle wasting, especially in the gluteal region, and prominence of the bony structures owing to loss of subcutaneous fat, particularly over the thorax. The child's condition at the time of discharge (alive, near death) or death during the hospital stay was noted. All recorded deaths in the data set occurred within one month of admission. We included in the category assessing mortality both children who died in the hospital and those who had been discharged near death. We compared the two potential indicators for marasmus (visible severe wasting and extremely low WFA) and examined the conventional anthropometric indicator for severe wasting, i.e. a very low WFH (defined as a *Z*-score of <-3). We defined an extremely low WFA as a *Z*-score of <-4.4, the level which identified the same number of children as visible severe wasting (28, or 2%). Since referral to hospital is to treat those children with the most severe and potentially life-threatening illnesses, we examined for each indicator the strength of association with mortality.

For the present analyses, we expressed the anthropometric indicators as standard deviation or *Z*-scores based on the NCHS/CDC growth reference (*10*). For example, a WFH *Z*-score of -2 corresponds to a value two standard deviations below the median of the reference, while a *Z*-score of zero falls on the median.

Results

Among children admitted to Siaya District Hospital, both bipedal oedema and very low WFH (*Z*-score of <-3) were associated with a significantly increased risk of short-term mortality (Table 1). Children with very low WFH were 3.9 times and those with oedema 3.1 times more likely to die than children without these findings. Similarly, children with severe wasting by visual inspection had an almost fourfold increased risk of death. By contrast, children with extremely low WFA (*Z*-score of <-4.4) did not have a significantly increased risk of death. Of the 49 children who died, 11 (22%) had either oedema or visible severe wasting, the two physical examination-based indicators for *severe malnutrition*. Including a WFA *Z*-score of <-4.4 would not have identified any additional children who died. Two additional children would be identified by screening for very low WFH.

Discussion

Our data suggest that physical examination for bipedal oedema and visible severe wasting can be used successfully to identify a group of children with very high short-term mortality risk, and the strong association of visible severe wasting with mortality is similar to that for very low WFH, the conventional anthropometric indicator for wasting. WFA, even at a very low threshold, did not identify children with a significantly increased risk of mortality in the subsequent month. This is consistent with the findings of Trowbridge, who found that low WFA corresponded poorly to clinically evident acute malnutrition (*11*). In settings with length-boards and staff trained in their use, where WFH can be considered as an indicator for the *severe malnutrition* classification, examination for visible severe wasting should be retained as well. Both the present analysis and experience comparing assessment of visible severe wasting with anthropometry in the Sudan (R. Yip, unpublished data, 1995) suggest that some children

Table 1: **Indicators for the *severe malnutrition* classification, associated with short-term risk of mortality for 1202 children hospitalized at Siaya District Hospital, Kenya**

Indicator[a]	No. identified	No. of deaths[b]	Relative risk of death	95% confidence intervals
Oedema	71 (6)[c]	8 (11)	3.1	1.5–6.4
WFH *Z*-score of <−3	42 (3)	6 (15)	3.9	1.8–8.6
Visible severe wasting	28 (2)	4 (14)	3.7	1.4–9.6
WFA *Z*-score of <−4.4	28 (2)	2 (7)	1.8	0.5–6.9
Oedema *or* visible severe wasting	91 (8)	11 (12)	3.5	1.9–6.7
Oedema *or* WFH *Z*-score of <−3 *or* visible severe wasting	110 (9)	13 (12)	3.5	1.9–6.4

[a] WFH = weight-for-height; WFA = weight-for-age.
[b] Values include children who died in hospital or were discharged near death; a total of 49 children (4%) met these criteria.
[c] Figures in parentheses are percentages.

with severe malnutrition have visible severe wasting but not very low WFH, due to oedema, ascites or organomegaly.

Because one trained observer made all the observations reported in our data, we cannot address how much the performance of visible severe wasting as an indicator will vary among health workers. None the less, preliminary work on the development of training materials in other countries such as the Sudan suggests that certain physical findings, notably atrophy of the gluteal muscles and the presence of gluteal skinfolds, are reliable signs of visible wasting and predictive of very low WFH (R. Yip, unpublished data, 1995). Training materials need to be refined, and the use of visible severe wasting should be evaluated in a variety of settings.

Setting weight-for-age thresholds for the *very low weight* classification

Stunting generally begins in infancy and develops in the first two years of life. After age 2 years, growth rates among children in most parts of the developing world become more like those of well-nourished children, although children who were stunted in early childhood usually remain lighter and shorter than the international reference (*12*). Because of this pattern of growth retardation, low WFA is often an indication of current undernutrition among very young children; but among children aged ⩾2 years, low WFA generally reflects stunting due to past undernutrition.

The algorithm recommends feeding assessment and nutrition counselling for all children <2 years, while those ⩾2 years receive feeding assessment and counselling only if they have *very low weight* (Fig. 1). For children <2 years, feeding assessment and counselling are both a preventive measure and a case management intervention for children with either wasting, or early, and therefore potentially reversible, stunting (*12*). For children ⩾2 years, stunting is not likely to be reversible, and nutrition counselling in this context may be seen primarily as a clinical intervention for children with wasting. Because the implications of a positive result differ by age, the performance of WFA as a screening indicator has been examined separately by age group.

It is important to note that the goal of WFA screening in the IMCI algorithm differs from that of nutrition surveys. For population-based assessments, the conventional threshold WFA *Z*-score of <−2 is a useful indicator for comparison among different areas and over time (*5*). For the purposes of the chart, and in particular for children ⩾2 years, WFA screening is intended to identify the subgroup of children whose weight is at the low end of the distribution, especially from a recent process such as an illness, who are therefore likely to be at the greatest risk for a poor outcome. In addition, the chart must take into account the burden that identification of children in need of intervention will place on the health care facility. Consequently, the conventional threshold WFA *Z*-score of <−2 may not be the most suitable screening threshold for the *very low weight* classification.

Methods

To guide decisions on the use of WFA screening in the chart, we examined the effect of using different WFA thresholds in various populations through the analysis of several data sets. The primary analysis used outpatient data from the Siaya District Hospital in western Kenya, the same facility which provided inpatient data for the *severe malnutrition* analysis. In the hospital outpatient department, anthropometric data were collected from 1785 children as part of the evaluation of the chart reported elsewhere in this supplement (*8*). These children were seen for acute illness, and thus give the most appropriate indication of how WFA screening would function in an outpatient clinic. However, because the background rates of malnutrition vary widely throughout the world (*5*), we also examined data from national nutritional surveys in Bolivia, Nepal, and Togo (*13–15*). We used these data to simulate the effect that this variation would have on the performance of WFA as an indicator. We followed the criteria of de Onis et al. (*5*) to categorize the anthropometric status of populations.

To compare thresholds, we calculated three standard measures of the performance of a clinical test: sensitivity (the ability to detect true cases), specificity (the ability to identify true negatives), and positive predictive value (the likelihood that a positive test result represents a true case). We used low WFH (Z-score of <-2) and very low WFH (Z-score of <-3) as the outcomes to be detected in most of the analyses that follow. However, during infancy and very early childhood, low height-for-age (HFA) is the most sensitive indicator for moderate malnutrition (*16*), and stunting at this age may be reversible. For these reasons, we also examined how well various thresholds of WFA detected low HFA among children aged <2 years. The outcomes we used for these analyses are not true "gold standards", in the sense of direct measurements of nutritional status. However, they are generally agreed to be the most appropriate anthropometric indicators for wasting and stunting, while WFA can be seen as a proxy indicator for use when other indicators cannot be ascertained.

Results

Descriptive characteristics. The four data sets used in this analysis varied widely in the prevalence of low anthropometry (Table 2). The data set from ill children seen in the outpatient department of Siaya District Hospital had a low prevalence of low HFA but a very high prevalence of low WFH, reflecting the effects of acute illness. Each of the other data sets represents a population with a different pattern of malnutrition: in Nepal, there was a very high prevalence of both stunting and wasting; in Togo, the prevalence of stunting was high, while that of wasting was low to moderate; in Bolivia, the prevalence of stunting was very high and that of wasting was low.

Of the 1785 children seen in the Siaya District Hospital outpatient department, more than 70% were aged <24 months (Table 3). The highest prevalence of low WFH occurred among children aged 12–23 months (21%), followed by those aged 6–11 and 24–35 months (13% and 10%, respectively). The prevalence of low HFA increased over the first 2 years of life, from 4% to 28%, and then remained nearly constant, at 24–28%. The rate of low WFA reflects the combination of these factors, with the highest prevalence among 12–23-month-old children (38%).

Performance of WFA at different thresholds. We examined the performance of WFA as an indicator to detect children with low WFH across a wide range

Table 2: **Nutritional status of children in four data sets used in analysis of potential indicators for the *very low weight* classification in the IMCI chart**

Location	Data source	Number	Low WFA[a] (%)	Low HFA[a] (%)	Low WFH[a] (%)
Kenya	Outpatient children[b]	1785	25	18	11
Togo	National survey	6103	26	34	4
Bolivia	National survey	5883	13	40	1
Nepal	National survey	6549	68	69	12

[a] Low WFA defined as weight-for-age Z-score of <-2; low HFA, height-for-age Z-score of <-2; low WFH, weight-for-height Z-score of <-2.
[b] Children examined in the Siaya District Hospital outpatient department during evaluation of the IMCI chart.

Table 3: **Age distribution and nutritional status of 1785 children seen in Siaya District Hospital outpatient department**

Age (months)	No. of children	No. with low WFA[a]	No. with low HFA[a]	No. with low WFH[a]
0–5	397 (22)[b]	20 (5)[b]	15 (4)	9 (2)
6–11	422 (24)	107 (25)	49 (12)	56 (13)
12–23	455 (25)	175 (38)	126 (28)	96 (21)
24–35	250 (14)	83 (33)	69 (28)	26 (10)
36–47	160 (9)	34 (21)	45 (28)	9 (6)
48–59	101 (6)	20 (20)	24 (24)	2 (2)
Total	1785 (100)	439 (24)	328 (18)	198 (11)

[a] Low WFA defined as weight-for-age *Z*-score of <−2; low HFA, height-for-age *Z*-score of <−2; low WFH, weight-for-height *Z*-score of <−2.
[b] Figures in parentheses are percentages.

of threshold values (Table 4). At a threshold *Z*-score of <−2, 24% of children aged <24 months and 27% of those ⩾24 months would be identified as needing follow-up. The sensitivity was slightly lower for younger than for older children, but the positive predictive value was substantially higher for children aged <24 months, because older children were more likely to have low WFA due to stunting. For both age groups, the sensitivity to detect children with very low WFH was high (74–100%) until very low thresholds of WFA (*Z*-score of <−4.0) were reached.

In most countries, the decision of where to place the threshold will depend on the capacity to handle children identified as having very low weight. For subsequent analyses, a threshold *Z*-score of <−3 was employed, based on the high sensitivity to identify children with WFH *Z*-score of <−3 (89–100% in the Siaya data), and the fact that the proportion of children identified as requiring follow-up (8–9%) may be assumed to be reasonably handled in the clinic.

According to the generic IMCI chart, feeding assessment and nutritional counselling are offered to all children aged <24 months regardless of their nutritional status, but, for children ⩾24 months, only if they meet the criteria for *very low weight*. A 1-month follow-up visit is scheduled for all children with very low weight. The need for intervention and follow-up can be simulated in the data from the Siaya outpatient department, following these criteria and using a threshold WFA *Z*-score of <−3. Of the 1785 children seen over the 6-month period, a total of 1317 would receive feeding assessment and counselling: 1274 (97%) because they were aged <24 months, and 43 (3%) children ⩾24 months who were classified as having *very low weight*. A total of 151 children would be scheduled for a follow-up visit in 1 month because of very low weight, 108 (72%) children aged <24 months, and 43 (28%) ⩾24 months.

Identification of stunting among children aged <2 years. The performance of WFA as a proxy indicator for stunting among infants and very young children varied with both the threshold chosen and the age group examined (Table 5). For infants aged <6

Table 4: **Effect of changing threshold on performance of weight-for-age (WFA) as a screening indicator to identify children with low and very low weight-for-height (WFH), among 1785 children seen in the Siaya District Hospital outpatient department, Kenya**

Age group and WFA *Z*-score threshold	No. of children identified	To detect low WFH:[a] Sensitivity (%)	Specificity (%)	Positive predictive value (%)	To detect very low WFH:[a] Sensitivity (%)	Specificity (%)	Positive predictive value (%)
0–23 months:							
−2.0	302 (24)[b]	84	85	45	100	78	12
−2.5	184 (14)	70	94	62	91	88	17
−3.0	108 (9)	48	97	72	89	94	29
−3.5	59 (5)	30	99	83	74	97	45
−4.0	26 (2)	14	99	92	46	99	64
−4.5	13 (1)	7	100	100	26	99	75
24–59 months:							
−2.0	137 (27)	84	78	23	100	74	4
−2.5	76 (15)	70	90	35	100	86	8
−3.0	43 (8)	51	95	45	100	93	14
−3.5	22 (4)	38	99	67	100	97	29
−4.0	16 (3)	27	99	67	100	98	40
−4.5	7 (1)	11	99	67	33	99	33

[a] Low WFH defined as weight-for-height *Z*-score of <−2; very low WFH defined as weight-for-height *Z*-score of <−3.
[b] Figures in parentheses are percentages.

Table 5: **Effect of various thresholds of weight-for-age (WFA) *Z*-score at detecting children aged <2 years with low and very low height-for-age (HFA), Siaya District Hospital outpatient department, Kenya**

Age group and WFA *Z*-score threshold	Percentage of children identified	To detect low HFA[a]			To detect very low HFA[a]		
		Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Sensitivity (%)	Specificity (%)	Positive predictive value (%)
0–5 months:							
−2.0	5	60	97	45	67	95	10
−2.5	2	33	99	56	0	98	0
−3.0	1	13	99	67	0	99	0
6–11 months:							
−2.0	26	92	83	42	100	76	9
−2.5	13	71	94	63	100	89	18
−3.0	8	47	97	70	90	94	27
12–23 months:							
−2.0	38	87	80	63	96	68	27
−2.5	26	72	92	77	96	82	39
−3.0	16	52	98	92	85	93	58

[a] Low HFA defined as height-for-age *Z*-score of <−2; very low HFA defined as height-for-age *Z*-score of <−3.

months, among whom stunting was uncommon, a generous WFA threshold (*Z*-score of <−2) identified the majority of children with low HFA (60%), without identifying an overwhelming proportion as needing intervention (5%). For children aged 6–11 and 12–23 months, using a WFA threshold *Z*-score of <−2.0 identified 26–38% of children as needing intervention. At the same time, because of the higher prevalence of stunting among children aged >6 months, more restrictive WFA thresholds of −2.5 to −3.0 performed better among these age groups than among very young infants.

Adaptation in other parts of the world. In the three survey data sets, the performance of WFA varied with the background status of the populations (Table 6). Among children from Togo, the sensitivity to detect a WFH *Z*-score of <−3 was high (67–88%), but the positive predictive value was low for children aged ⩾24 months: only 26% and 2% of children identified had WFH *Z*-scores of <−2 and <−3, respectively. In this population of children, the majority of those classified as *very low weight* had low HFA, but not low WFH. In the data from Bolivia, both sensitivity (⩽50%) and positive predictive value (⩽19%) were low. In the survey data from Nepal, the sensitivity was high (90–92% to detect very low WFH), but one-quarter of all children were identified as needing follow-up. Under different background conditions, different thresholds for screening may therefore be indicated.

Table 6: **Performance of WFA *Z*-score of <−3 to identify children with low and very low WFH, in three locations with different background nutritional status**

Country and age group (months)	Percentage of children identified	To detect low WFH:[a]			To detect very low WFH:[a]		
		Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Sensitivity (%)	Specificity (%)	Positive predictive value (%)
Togo							
6–23	7	39	96	48	88	94	10
24–59	4	48	97	26	67	96	2
Bolivia							
6–23	4	32	97	19	21	97	4
24–59	1	19	99	6	50	99	2
Nepal							
6–23	30	68	80	48	90	72	7
24–59	23	74	82	29	92	77	2

[a] Low WFH defined as weight-for-height *Z*-score of <−2; very low WFH defined as weight-for-height *Z*-score of <−3.

Discussion

The use of WFA as an indicator to identify children for nutritional intervention in the health facility setting is a complex issue. A balance must be struck between acceptable sensitivity in detecting children with wasting (and perhaps very young children with early stunting) and the burden that classifying large numbers of children as *very low weight* would place on the health facility, especially if the majority of children identified have stunting which is unlikely to respond to intervention. Feeding assessment and counselling are time-consuming for the health worker. At the same time, according to the criteria in the generic IMCI chart, a far greater proportion of children are to receive feeding assessment and advice because of their age than their nutritional status.

Nevertheless, the findings from the analysis of data from outpatients in Kenya suggest that WFA can detect children with WFH *Z*-score of <-3, those at highest risk, with good sensitivity, and that most of the children identified have a WFH Z-score of <-2, and therefore have some degree of wasting. In the clinic setting, because of the effects of acute illness, the prevalence of wasting is likely to be higher than in the community. Very low WFA therefore functions better as a proxy indicator in the clinic than in a non-ill population. In settings such as the Kenyan outpatient department, it appears that a WFA threshold *Z*-score of <-3 represents a reasonable compromise, and this is therefore the threshold recommended in the generic chart. With this threshold in the Kenyan outpatient department, the vast majority of children classified as needing feeding assessment and counselling were identified on the basis of age <24 months rather than because of *very low weight.*

When a country has a very high prevalence of malnutrition, as in the Nepal survey data where two-thirds of children had low WFA (*Z*-score of <-2) and one-quarter had very low WFA (*Z*-score of <-3), it may be necessary to determine the threshold based on the resources available. In such areas, a more restrictive WFA threshold (*Z*-scores of <-3.5 or even -4.0) might be used to keep the demand on the health centre manageable and to attempt to identify the children at higher risk. However, in a country such as Nepal, the majority of children have suboptimal growth and the population as a whole has an elevated risk of mortality compared with a better-nourished population (*17*). For this sort of "malnourished population", a potential alternative in the adaptation of the chart would be to concentrate efforts on all children below an age threshold, rather than using anthropometric screening at all.

In parts of Latin America where stunting is very common but wasting very uncommon, the argument can be made that the chart already targets its nutritional intervention to all children during the age when stunting is developing, and that this is another circumstance in which a better alternative may be to eliminate the WFA screen. Because stunting is the primary manifestation of moderate malnutrition in Latin America, targeting the intervention towards children during the period of development of stunting is likely to have the greatest impact in the population. If it is found necessary to screen for wasted children in health facilities, WFH is probably the only useful anthropometric screen.

If a more complex diagnostic system is considered, a new growth chart could be designed that would take into account the variation in prevalence of low WFA with the child's age (*18*). More analyses from other parts of the world are needed to examine how this would perform, but in theory, a growth chart could be designed using a generous threshold for infants aged <6 months and progressively more restrictive thresholds for each older age group.

The community context in which the IMCI charts are to be used should also be considered in decisions regarding the choice of WFA threshold. In the generic charts, feeding assessment and nutrition counselling are assumed to occur in the course of the sick child encounter. However, nutrition intervention in a clinical setting is only one component of the effort to improve the growth of children in a community, and an important aspect of the nutrition component of the IMCI charts may be to serve as a mechanism to link children and families treated in the clinic to community resources. If the IMCI can be linked to nutrition-oriented programmes, both the scope of the intervention and the capacity for including children may be altered. The choice of screening thresholds may then need to be modified depending on the resources available and the capacity for intervention.

Conclusions

Two indicators based on physical examination, bipedal oedema and visible severe wasting, appear to function effectively for the *severe malnutrition* classification, which leads to immediate hospital referral. Children identified by these indicators are at increased risk of short-term mortality. If length-boards are available, a WFH *Z*-score of <-3 can be added to the two physical examination-based indicators for *severe malnutrition.*

The major intervention for moderate malnutrition is preventive, with a recommendation of feeding assessment and nutrition counselling for all children aged <2 years. This intervention is intended to reach children during the period of life with the highest risk of wasting, and during which stunting is still reversible. The *very low weight* classification is intended to identify those children aged ≥2 years who may benefit from the same intervention, and children of all age groups who need more nutritional attention, including follow-up. For the *very low weight* classification, the basic recommendation in the generic sick child chart is to use WFA with a threshold *Z*-score of <-3 as the indicator for most localities. However, the performance of this indicator varies with the background rate of malnutrition and also with the age of the child examined. In areas with a high prevalence of malnutrition, a more restrictive threshold may be considered to decrease the potential burden on health facilities, taking into account the resources available. In regions with a high prevalence of stunting but a very low prevalence of wasting, a single threshold of WFA may not function well as a screen for the more acute forms of malnutrition and other solutions may need to be devised.

Linkage with other nutritional interventions may allow the screening conducted in the facility to serve as an entry point into community programmes. Decisions about indicators for identification of malnourished children should take into account the programmes available in the community and their capacity.

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Résumé

Evaluation d'indicateurs potentiels de la malnutrition protéino-énergétique dans l'algorithme pour la prise en charge intégrée des maladies de l'enfant

Des indicateurs potentiels ont été évalués pour les deux catégories de malnutrition protéino-énergétique figurant dans les recommandations pour la prise en charge intégrée des maladies de l'enfant: la *malnutrition sévère*, qui exige un transfert immédiat en milieu hospitalier, et le *très petit poids*, qui nécessite une évaluation alimentaire, un conseil diététique et un suivi. A titre d'intervention préventive, l'enfant de moins de 2 ans doit bénéficier d'une évaluation alimentaire et d'un conseil.

Dans le cas de la *malnutrition sévère*, nous avons examiné 1202 enfants admis dans un hôpital kényen, à la recherche d'une association de ces indicateurs avec la mortalité dans le mois. L'œdème prétibial bilatéral, indicateur de kwashiorkor, et deux indicateur d'athrepsie (émaciation visible sévère et Z du poids/taille < -3) étaient associés à une augmentation significative du risque de mortalité (odds ratios: 3,1–3,9). Un très faible poids/âge ($Z < -4{,}4$) n'était pas associé à une augmentation du risque de mortalité. En général, on ne trouve pas de planche-toise dans les centres de santé de premier niveau, et c'est la raison pour laquelle l'œdème prétibial bilatéral et l'émaciation visible sévère ont été choisis comme indicateurs de la *malnutrition sévère*.

Pour évaluer les seuils potentiels du poids/âge utilisés pour définir le *très petit poids*, nous avons utilisé, comme principale source de données, les observations recueillies sur 1785 enfants kényens vus en consultation externe, auxquelles se sont ajoutées les données d'enquêtes réalisées au Népal, en Bolivie et au Togo. Nous avons examiné les résultats obtenus avec divers seuils de poids/âge pour identifier les enfants de petit poids/taille, et, chez l'enfant de 2 ans ou moins, ceux de petite taille/âge. Si l'on utilise comme seuil du poids/âge un $Z < -2$, on peut identifier un pourcentage considérable d'enfants (de 13% en Bolivie à 68% au Népal) qui, dans la plupart des situations, seraient un énorme fardeau pour le centre de santé. Chez les enfants malades du Kenya, un $Z < -3$ comme seuil du poids/âge avait une sensibilité de 89% à 100% pour le dépistage des enfants ayant un Z du poids/taille < -3; de plus le taux d'identification de 9% éviterait la surcharge des services.

Les modifications envisageables sont notamment l'utilisation d'un seuil plus restrictif dans les pays où la fréquence du retard de croissance est élevée, et l'élimination du crible représenté par le poids/âge afin de concentrer les efforts sur une intervention en faveur de tous les enfants en dessous du seuil de 2 ans. Dans tous les pays, les problèmes majeurs sont la capacité de conseil à un grand nombre d'enfants, et le lien avec les programmes communautaires d'amélioration nutritionnelle.

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